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Addendum to the Calcined Waste Storage at the Idaho Nuclear Technology and Engineering Center

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ABSTRACT

This report is an addendum to the report *Calcined Waste Storage at the Idaho Nuclear Technology and Engineering Center*, INEEL/EXT-98-00455 Rev. 1, June 2003. The original report provided a summary description of the Calcined Solids Storage Facilities (CSSFs). It also contained dozens of pages of detailed data tables documenting the volume and composition (chemical content and radionuclide activity) of the calcine stored in the CSSFs and the liquid waste from which the calcine was derived. This addendum report compiles the calcine composition data from the original report. It presents the compiled data in a graphical format with units (weight percent, curies per cubic meter, and nanocuries per gram) that are commonly used in regulatory and waste acceptance criteria documents. The compiled data are easier to use and understand when comparing the composition of the calcine with potential regulatory or waste acceptance criteria.

This addendum report also provides detailed explanations for the large variability in the calcine composition among the CSSFs. The calcine composition varies as a result of reprocessing different types of fuel that had different cladding materials. Different chemicals were used to dissolve the various types of fuel, extract the uranium, and calcine the resulting waste. This resulted in calcine with variable compositions.

This addendum report also identifies a few trace chemicals and radionuclides for which the accuracy of the amounts estimated to be in the calcine could be improved by making adjustments to the assumptions and methods used in making the estimates.

A compact disk of this report is included to facilitate data manipulation and analysis.

SUMMARY

This report provides data on the chemical content and radionuclide activity of the calcine currently stored at the Idaho Nuclear Technology and Engineering Center (INTEC). Calcine composition data will be required for the future retrieval, treatment, and disposal of the calcine. There are few historical calcine samples that provide analytical calcine composition data. Obtaining additional calcine samples will be difficult because the calcine storage facilities were not specifically designed for calcine sampling. A previous report, *Calcined Waste Storage at the Idaho Nuclear Technology and Engineering Center* INEEL/EXT-98-00455 Rev 1, estimated the calcine composition based upon extensive historical process data. These data include sample analyses of the liquid waste from which the calcine was formed, Calciner operating history, Calcine Solids Storage Facility (CSSF) operating history, and knowledge of the INTEC fuel reprocessing and calcination processes.

This report compiles and analyzes the calcine composition data given in INEEL/EXT-98-00455 Rev 1. This report provides the chemical content of the calcine on a weight percentage basis and the radionuclides on an activity-per-unit-mass (nCi/g) or activity-per-unit-volume (Ci/m^3) basis. These composition bases are commonly used in national standards and regulations related to waste treatment and disposal. The calcine composition data is presented in both graphical and tabular formats.

The chemical and radionuclide content of the calcine varies dramatically between CSSFs and within individual bins. The calcine composition varies because the calcine was formed from liquid wastes of varying compositions. This report discusses the sources of the liquid wastes that were calcined, the chemical and radiochemical content of those wastes, and the composition of the resulting calcine.

This report also describes some anomalies in the estimated calcine composition and the assumptions inherent in the estimation model that cause the anomalies. Some of these assumptions could be modified to improve the accuracy of the calcine composition estimates.

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1. INTRODUCTION

The Idaho Nuclear Technology and Engineering Center (INTEC) reprocessed spent nuclear fuel (SNF) for a period of forty years from 1953 through 1992. Reprocessing SNF generated liquid radioactive wastes that were temporarily stored in underground stainless steel tanks. The calcination process converted the liquid wastes into a solid granular material called calcine. Calcine is stored in six Calcined Solids Storage Facilities (CSSF 1 through 6). A recent report (Staiger 2003) contains a summary description of the CSSFs. It also contains a historical processing model (HPM) with detailed estimates of both the amount and composition (chemical and radionuclide) of the calcine stored in the CSSFs.

Knowing the composition of the calcine is important in performing safety analyses, assuring regulatory compliance, developing future waste treatments processes, etc. However, there are only a few chemical and radiochemical analyses of calcine samples upon which to base the calcine composition. Obtaining additional calcine samples from the CSSFs would be difficult because the CSSFs do not have installed sampling equipment. Even if calcine samples were obtained, performing detailed analyses would be difficult due to the high radiation fields associated with calcine. Some chemicals and radionuclides of interest cannot be detected in the calcine. The HPM is an alternative to extensive calcine sampling and analysis to estimate the composition of the calcine. The HPM provides detailed estimates of the calcine composition based upon INTEC (SNF reprocessing and calcination) process knowledge and sample analyses of the liquid wastes that were calcined.

Unlike liquid wastes that can be mixed to provide a uniform composition within a tank, the calcine in the CSSF bins is not mixed and its composition can vary significantly within a CSSF and even within an individual bin. The calcine composition varies because chemically different liquid wastes were calcined, which created layers of chemically different calcine in the CSSF bins. The HPM captures the variability in calcine composition by dividing each bin into several segments and estimating the composition of the calcine in each segment. There are six CSSFs, three to twelve bins in each CSSF, and six to twelve segments in each bin. This results in dozens of characterized calcine segments. The HPM uses the location of thermocouple probes in the CSSFs as a convenient method to divide the bins into small segments. Although not shown in the Staiger report, the HPM can also predict the composition of calcine in "sub segments" or individual layers based on individual Calciner feed batches.

The Staiger report contains tables of data that report the mass of selected chemical constituents and the activity of selected radionuclides in each bin segment. This report compiles the HPM data and provides the chemical content of the calcine on a percentage basis and the radionuclide activity in an activity-per-unit-mass (nCi/g) or activity-per-unit-volume (Ci/m^3) basis, units that are commonly used in sample analyses and national standards and regulations related to waste treatment and disposal. This report is an addendum to the Staiger report and provides graphical presentations of the calcine composition data in each storage bin for the chemicals and radionuclides listed in the Staiger report. The graphical format and use of standard composition units make the HPM data easy to use and understand when comparing the calcine composition against potential waste acceptance criteria.

This report also contains an explanation of the calcine composition data including the source of both major and minor elements in the calcine. It explains why the composition of the calcine varies so dramatically among the CSSFs and even within individual bins. This report also evaluates the estimated calcine composition and identifies some areas of the HPM that could be modified to improve the accuracy of the estimated calcine composition.

2. INTEC WASTE GENERATION HISTORY

The Idaho National Engineering and Environmental Laboratory (INEEL) has stored and reprocessed SNF since 1953 using facilities located at INTEC, formerly known as the Idaho Chemical Processing Plant (ICPP). Historically, SNF was brought to INTEC from a variety of reactors throughout the world and stored in either underwater or dry storage facilities for an interim period. Some of the SNF was chemically reprocessed to recover highly enriched uranium (U) and other products for the Department of Energy (DOE) and its predecessor organizations. SNF reprocessing produced liquid radioactive waste, which was stored in underground tanks in the INTEC Tank Farm.

Fuel reprocessing produced two general categories of liquid waste. One category of waste, called first-cycle raffinate, was produced by the dissolution of SNF and the extraction of uranium. Typically, SNF reprocessing began by dissolving SNF (cladding, fission products, and uranium) in acid. Highly enriched uranium was recovered from the acidic dissolver product using a liquid-liquid solvent extraction system. The extraction process produced an aqueous, acidic waste called first-cycle raffinate. First-cycle raffinate contained the dissolved fuel cladding and the bulk of the fission products originally in the SNF. First-cycle raffinate had a variety of names. The early names included “first-cycle waste”, “high-level waste” (HLW), and “IAR” (an acronym for first-cycle, A column, raffinate). Such names referred to the source (first-cycle) or radioactivity level (high) of the waste. Over time, INTEC reprocessed various types of fuel having different cladding material, which generated wastes with different chemical compositions. The names of the waste evolved to reflect the fuel cladding and resulting chemical composition of the waste. The chemical-based waste names were most often used in recent history and are used in this report. These names include aluminum (Al), zirconium (Zr), stainless steel (either sulfuric acid or electrolytic), and ROVER wastes. These names generally referred to the fuel cladding material, and consequently one of the principle chemical constituents of the corresponding waste. The name “ROVER” was an acronym for a type of graphite matrix fuel and did not relate to the cladding material or chemical composition of the waste.

The second major category of liquid waste was sodium-bearing waste (SBW). The name “sodium bearing” came from the waste’s relatively high concentration of sodium ion (1 to 2 molar). The high sodium content was the result of activities that made extensive use of sodium-based chemicals such as sodium hydroxide and sodium carbonate. SBW contained much less radioactivity (over an order of magnitude) than first-cycle raffinate. The primary source of SBW was the Process Equipment Waste (PEW) Evaporator concentrate (bottoms). The PEW Evaporator collected dilute wastes from a variety of plant activities (equipment decontamination, analytical laboratories, off-gas condensate, ion exchange regeneration, etc.) and concentrated it prior to storage in the Tank Farm. SBW also included some of the second and third cycle SNF reprocessing raffinates. The SNF second and third cycle processes purified the uranium recovered in the first-cycle process. The second and third cycle raffinates contained much less radioactivity than the first-cycle raffinate and were originally combined with the low activity SBW (PEW Evaporator concentrate). First-cycle raffinate and SBW were generally stored separately in the Tank Farm due to differences in chemical composition, heat generation/cooling requirements, and subsequent processing (calcination) requirements.

A variety of SNF types were reprocessed at INTEC. The chemical composition of the first-cycle raffinate depended on the type of fuel processed. The major chemical components of the waste came from the fuel cladding and chemicals used to dissolve the fuel and extract uranium. For example, Al-clad fuel was dissolved in nitric acid and generated waste that contained primarily Al, nitrate, and hydrogen (acid) ions. Zr-clad fuel was dissolved in hydrofluoric acid and generated waste composed primarily of Zr, fluoride (F), Al (from fluoride complexing), nitrate, and hydrogen (acid) ions. In addition to the major chemical constituents, each waste contained a variety of minor waste components such as mercury (Hg), or chromium (Cr). The minor components came from a variety of sources including trace components in the fuel cladding and from the catalysts, oxidants, neutron poisons, corrosion control additives, etc. used to reprocess the SNF and treat the resulting waste.

From 1953 to 1992, SNF was routinely reprocessed and liquid wastes were stored in the Tank Farm. Most of the liquid waste was removed from the Tank Farm and solidified using a process called calcination. Calcination was a high-temperature (400^{o}C to 600^{o}C) waste evaporation process. Liquid waste was sprayed into a fluidized bed where the water and volatile components of the waste evaporated. Most of the dissolved solids, including the Al and Zr from the fuel cladding and radioactive constituents such as cesium (Cs-137) and strontium (Sr-90), formed oxides, nitrates, and fluorides in the form of dry granular solid called calcine. The calcine is stored in six CSSFs consisting of stainless steel bins contained in concrete vaults. From 1963 to 1981, liquid waste was calcined in the Waste Calcining Facility (WCF). From 1982 to 2000, liquid waste was calcined in the New Waste Calcining Facility (NWCF).

In April 1992, DOE announced that spent fuel would no longer be reprocessed and called for a shutdown of the reprocessing facilities at INTEC. Since that time, no more first-cycle raffinate or high-level waste (HLW) has been generated from SNF reprocessing. However, calcination of the Tank Farm inventory continued through May 2000. The Calciner processed the last of the first-cycle raffinate that was stored in the Tank Farm in February 1998. Calcination of SBW continued through May 2000. Today, approximately 1 million gallons of SBW remain in the Tank Farm. Options for treating the last million gallons of Tank Farm waste are being evaluated.

3. CALCINE COMPOSITION ESTIMATION METHOD

The chemical content and radionuclide activity of calcine depends on the composition of the liquid waste from which it was formed. Two methods to determine the calcine composition include analyzing calcine samples, and estimating the calcine composition based on liquid waste samples and process knowledge. Determining the composition of the calcine based on calcine sample analyses is difficult because there are not enough historical calcine sample data to fully characterize the contents of the CSSFs. Thousands of calcine samples were taken from the Calciner on a daily basis during the 40 years of Calciner operation. However, the calcine sample analyses generally determined only the bulk density and particle size of the calcine, the parameters that affected the daily operation of the Calciner. Only a few historical calcine samples were analyzed for chemical and radionuclide content. Only three of those historical samples still exist and are available for further analysis. Those three calcine samples include one taken from the NWCF Calciner vessel during Calciner operation in 1993, and two taken from CSSF 2 in 1978. The NWCF calcine sample was made from a blend of Fluorinel waste (a type of Zr waste) and SBW. The CSSF 2 samples include one each from Al and Zr calcine. Both of the CSSF 2 samples came from calcine made in the WCF. The CSSF 2 and NWCF calcine samples were analyzed for both chemical and radionuclide content when they were initially obtained (Staples, Pomiak, and Wade 1979, Staples 1994, and Staples 1995), and then retained for potential future analyses.

Although the three historical calcine samples (still available for analysis) represent of a large portion of the different types of calcine stored in the CSSFs, they do not include every type of calcine. Obtaining additional calcine samples from the bins would be difficult because the CSSFs were not built with any remote sampling capability. The calcine in the bins is not homogenous. Many of the bins contain multiple layers of calcine with diverse chemical content. Even if sampling were possible, a large number of samples would be required to obtain a statistically representative sample set from a given bin to accurately characterize it. This is due to the calcine stratification and an unknown degree of mixing that may have occurred between the boundaries of the stratified layers. A statistical sampling design for a highly stratified media has been developed for application to the bins in CSSFs based on the assumption that all the calcine within any given stratum of a bin has the composition predicted by the HPM (Thomas 2003).

The HPM was developed to estimate the composition of the calcine in the CSSFs based on process knowledge and Tank Farm liquid sample data. The HPM used the composition of the liquid waste, the volume of waste that was calcined, and the calcine storage bin filling history to estimate the amount and composition of calcine formed from a given volume of liquid waste. The HPM calculated the mass of a given calcine constituent as the product of the concentration of the constituent in the liquid waste and the volume of waste calcined. Historical CSSF operating data were used to determine the volume of calcine produced over time, and how much calcine went into each calcine storage bin. The HPM used large databases of historical Tank Farm waste compositions, Calciner operation, CSSF operation, etc.

The HPM databases, data manipulation, CSSF bin filling assumptions, calcine composition assumptions, and database manipulation techniques were reviewed for accuracy and completeness (Childs et al. 2003). To test the validity of the calcine composition estimates in the HPM, a comparison of the calcine composition estimated by the HPM with some of the available historical calcine sample analyses was done (Swenson 2003b). In general there was excellent agreement between the HPM estimated compositions and those of the calcine samples. This comparison was limited to the major chemical and radionuclide components. Some discrepancies between the HPM estimates and the actual calcine composition will exist for some trace components due to assumptions in the HPM. These are discussed in subsequent sections of this report.

3.1 Liquid Waste Composition

Predicting the composition of calcine based on the liquid waste composition requires detailed information on the composition and the amount of the liquid waste that was calcined. Unlike the calcine, all liquid wastes were sampled and characterized as part of the calcination process. During the history of calcination, hundreds of samples of the Tank Farm liquid waste were taken and analyzed for chemical content and radionuclide activity. The data from the Tank Farm waste analyses were collected and organized into an historical liquid waste composition database. The database was reviewed to assure the data and assumptions used in generating the database were accurate (Swenson 2003a). The HPM used the liquid waste composition database to predict the composition of the calcine.

The effort to compile detailed data on the composition of Tank Farm waste was limited by the scope of the historical sample analyses. Typically, historical liquid waste analyses focused on the major chemical species (such as Al, Zr, and F) and those species needed for corrosion control (such as chloride), heat generation and shielding calculations (fission products), and other parameters needed to manage the waste. Trace components that had no immediate effect on waste management were typically not included in the sample analyses. However, current rules and regulations may require data for components that were typically not included in historical sample analyses. Therefore, the liquid waste database also includes estimates of several trace components (both chemicals and radionuclides) for which sample data do not exist, but were deemed important to the long-term management of the waste. The estimates are based on process knowledge, metallurgy, bulk chemical vendor data, nuclear reactor physics, etc.

3.1.1 Chemical Composition of Liquid Waste

The chemical composition of the calcine varies significantly among the CSSFs and within individual storage bins because chemically different liquid wastes were calcined. The composition of the liquid wastes varied because reprocessing different types of SNF generated chemically different wastes. The original SNF reprocessing design was based on reprocessing Al-clad fuel. With time, the mission of INTEC expanded and the plant was modified to reprocess a variety of fuel types. These included Zr-clad, stainless steel-clad, and graphite matrix (ROVER) fuels. In some cases, different chemical processes were used to reprocess a given type of fuel, which changed the chemical composition of the waste. Thus the original stainless steel waste (sulfuric acid based) is not the same as the more recent stainless steel waste (electrolytic/nitric acid based). Each type of fuel and dissolution process generated a chemically unique type of liquid waste and subsequently a chemically unique calcine.

Historically, the bulk of the liquid waste in the INTEC Tank Farm was first-cycle raffinate from the dissolution of SNF and extraction of uranium. First-cycle waste contained the bulk of the fuel cladding material and radioactive fission products originally in the SNF. The chemical composition of first-cycle waste depended on the type of fuel (cladding material) and the method of fuel dissolution. SBW was the second largest type of waste in the INTEC Tank Farm (Loos 2004). Table 1 gives the typical chemical composition for five different first-cycle raffinates, Al, Zr, Fluorinel, electrolytic stainless steel, and ROVER, as well as SBW.

The chemical compositions of the five first-cycle wastes in Table 1 reflect the type of fuel (fuel cladding) and the chemicals used during fuel reprocessing. Dissolving Al-clad fuel in nitric acid generated Al waste. Al waste contained high concentrations of Al, nitrate, and hydrogen (acid) ions. Dissolving Zr-clad fuel in hydrofluoric acid generated Zr waste. Zr waste contained large amounts of Zr, F, Al (from F complexing), nitrate, and hydrogen (acid) ions. Fluorinel was the name of the process used to dissolve Zr-clad fuels in the late 1980s. Fluorinel waste differed from earlier Zr waste in that it contained cadmium (Cd). Cadmium was used as a soluble neutron poison for criticality prevention in the Fluorinel process. Aluminum and zirconium-clad fuels were the most frequently reprocessed fuels and consequently produced the greatest volumes of liquid waste and calcine.

Smaller quantities of other fuels were reprocessed and generated smaller quantities of wastes. The original stainless steel fuel dissolution process used a sulfuric/nitric acid system and produced a relatively small amount of waste (not shown on Table 1). Sulfuric acid stainless steel waste was dilute (low dissolved solids content) and contained primarily iron (Fe), chromium (Cr), nickel (Ni), sulfate, nitrate, and hydrogen (acid) ions. Later, an electrolytic/nitric acid process replaced the sulfuric acid system for the dissolution of stainless steel fuel. The electrolytic stainless steel waste was dilute and contained Fe, Cr, Ni, nitrate, Al (from the first-cycle extraction system), and hydrogen (acid) ions. Graphite matrix (ROVER) fuels were processed by burning the graphite and dissolving the uranium-bearing ash in hydrofluoric acid. The ROVER waste was dilute and contained F (from ash dissolution), Al (from F complexing), nitrate, and hydrogen (acid) ions.

Table 1. Typical chemical composition of six liquid wastes calcined at INTEC.

Species	Units	First Cycle Raffinates					Sodium-Bearing Waste
		Aluminum	Zirconium	Fluorinel	Electrolytic Stainless Steel	ROVER	
Acid (H^+)	molar	0.81	1.40	1.50	2.2	1.0	1.28
Aluminum	molar	1.51	0.68	0.43	0.2	0.50	0.57
Boron	molar		0.19	0.15		0.15	0.017
Cadmium	molar			0.05			0.001
Chloride	mg/L			50			1,000
Chromium	molar		0.015	0.002	0.025		0.001
Fluoride	molar		3.2	2.10		0.68	0.04
Iron	molar	0.01	0.007	0.005	0.086	0.006	0.002
Mercury	molar	0.02					.0013
Nickel	molar				0.012		
Nitrate	molar	5.4	2.3	1.90	3.2	1.9	4.5
Potassium	molar		0.003	0.005		0.001	0.17
Sodium	molar	0.06	0.017	0.02		0.007	1.5
Tin	molar		0.005	0.003			
Zirconium	molar		0.41	0.31			0.03

In addition to the major chemical constituents, first-cycle waste contained a variety of minor components from the use of catalysts, oxidants, neutron poisons, etc. First-cycle Al raffinate typically contained a small amount of mercury (Hg), which was used as a catalyst to dissolve the Al cladding. First-cycle Zr waste contained boron (B), which was used as a neutron poison. Zr waste also contained Cr, Ni and tin (Sn), which were present in small quantities in the zirconium alloy used in the fuel cladding. Most Zr waste (except Fluorinel) contained additional Cr that was used as an oxidant used in the fuel dissolution process. Fluorinel waste contained Cd, which was used as a neutron poison.

Although it was not a significant component of any liquid waste (therefore not listed in Table 1), calcium (Ca) was added to fluoride-bearing wastes (Zr, Fluorinel, and ROVER) in the calcination process. The Ca formed calcium fluoride during calcination and prevented the volatilization of F and subsequent corrosion of the Calciner off-gas system. Therefore, Ca became a primary constituent of F-bearing calcine, even though it was not in the original liquid waste.

Table 1 shows that SBW contained significant quantities of both sodium (Na) and potassium (K). The Na and K came from processes that used alkali salts and caustics such as sodium hydroxide (NaOH) and sodium carbonate (Na_2CO_3). Such processes included scrubbers, ion exchangers, solvent cleanup, and equipment decontamination. Such waste was usually concentrated in the PEW Evaporator, resulting in the high Na and K concentrations characteristic of SBW. Because SBW included decontamination wastes, it had small amounts of chemicals from all of the first-cycle wastes (Al, Zr, F, Hg, Cd, etc.) that were removed from process equipment during decontamination.

One important first-cycle waste not shown in Table 1 was called "coprocessing" waste. Coprocessing waste was a mixture of first-cycle Al and Zr wastes. Zr-clad fuels were dissolved in hydrofluoric acid. The resulting solution had a high F content (up to 3 M) and was extremely corrosive. Aluminum nitrate was added to the Zr dissolver solution to complex the F (reducing its corrosiveness) and enhance the extraction of U. Beginning in 1970, Al-clad and Zr-clad fuels were sometimes dissolved simultaneously (in separate dissolver vessels). The Al dissolver solution (essentially acidified aluminum nitrate) was used in place of aluminum nitrate to complex the F in the Zr dissolver solution. This reduced the amount of waste generated by eliminating the use of nonradioactive aluminum nitrate as a complexing reagent for the Zr fuel dissolver solution. Simultaneously reprocessing Al and Zr fuels and blending the two dissolver solutions was called coprocessing. The coprocessing waste was similar in chemical composition to the Zr waste in Table 1.

When available, the HPM used liquid sample data to predict the chemical composition of calcine. However, some chemicals of interest (such as some RCRA metals) were present in the waste in such small quantities they had no immediate effect on waste management and were typically not included in historical sample analyses. Due to current interest in such chemicals, estimates were made for some constituents for which historical sample data do not exist. A variety of methods were used to estimate chemical constituents. In some instances, detailed compositions of bulk chemicals used in the INTEC processes were obtained from chemical vendors. Trace chemicals in the waste were then estimated based on the amounts of bulk chemicals used. Some chemicals were estimated based on process knowledge. For example, tin (Sn) and nickel (Ni) were present in much of the Tank Farm waste because they were present in the zirconium alloy (Zircaloy) used for fuel cladding. Estimates of Sn and Ni were made for some Zr wastes by multiplying the Zr concentration (from sample analyses) in the liquid waste by the Sn:Zr and the Ni:Zr ratios in the Zircaloy fuel cladding. Chromium (Cr) was added to most Zr dissolver solutions to oxidize Sn and U to soluble oxidation states. The amount of Cr was estimated based on the amount of Sn (which required oxidation) in the fuel cladding. Additional details on the chemical composition of the liquid wastes, estimation methods, and sample data validation are in a separate report (Swenson 2003a).

3.1.2 Radionuclides in Liquid Wastes

Historical liquid waste analyses included radiochemical data. The historical sample data include fission products such as Cs-137, Ce-144, and Sr-90 that were important to heat generation or shielding calculations. Data also exist for some of the principle TRU components such as Pu-238 and Pu-239.

However, as with the chemicals, there are few or no sample data for some radionuclides, typically those with low activity but long half lives. Such radionuclides were often present in such small quantities that they had no impact on immediate waste management. Many of them could not be detected by historical analytical methods.

Several computer models (Wenzel 2002) were developed to estimate radionuclides for which no analytical data exist. The models used ORIGEN2 (Croff 1980), a nationally recognized computer code, to generate data on fission and activation products present in SNF. Because INTEC processed different types of nuclear fuels, different ORIGEN2-based models were developed for four major first-cycle raffinates, Zr, Al, stainless steel, and coprocessing. The bulk of the fission products in the SNF went with the first-cycle waste. The ORIGEN2-predicted fission product activity was normalized to the waste activity from sample results to generate the models. Some of the actinides in the SNF were separated from the first-cycle waste with the uranium, and later separated from the uranium in the second and third cycle SNF reprocessing steps. The radionuclide models account for this by normalizing the ORIGEN2-predicted actinide values to those found in first-cycle raffinate sample analyses.

An ORIGEN2-based computer model was also developed for SBW by treating SBW as a “pseudo” fuel type. SBW was assumed to have the same relative ratios of fission products as HLW, but in significantly lower quantities. The SBW model blended the radionuclide activity predicted by the Al, Zr, and stainless steel models until the fission product content matched SBW sample data. The amounts of actinides in the SBW model were increased above the ORIGEN2 predicted values to reflect SBW sample analyses. The elevated actinide activity came from the portion of SBW derived from second and third cycle SNF reprocessing waste, which was relatively high in actinides and low in fission products.

Radionuclides for which analytical data were not available from historical liquid wastes analyses were estimated using one of the five waste models (Al, Zr, stainless steel, coprocessing, or SBW). The radionuclides estimates were made by multiplying the Cs-137 content in the waste of interest by the nuclide:Cs-137 ratio from the selected waste model. Cs-137 was used as the estimate basis because it is easily and accurately measured in Tank Farm wastes and there are no operations that partition cesium from the waste. Historical Cs-137 data exist on the bulk of the hundreds of historical Tank Farm waste samples, making it possible to use Cs-137 as the basis to calculate radionuclide quantities for any Tank Farm waste.

3.2 Historical Processing Model Calcine Composition Estimate

The HPM uses the composition and volume of the liquid wastes that were calcined and CSSF bin filling history data to estimate the amount and composition of calcine in the CSSFs. In general, the HPM assumes most of the metals in the liquid waste (such as Al and Zr) form metallic oxides (such as Al_2O_3 and ZrO_2) in the calcine. A small amount of the metal ions form metallic chlorides, phosphates, sulfates, etc. with the small quantities of those anions in the waste. Historically, Ca (in the form of calcium nitrate) was added to F-bearing wastes to suppress the volatility of F in the Calciner. The F in the liquid waste was assumed to form calcium fluoride. Typically, a small amount of extra Ca was added to the waste, above that required for stoichiometric reaction with the F, to assure F complexing and account for small variations in the F content of the waste. The excess Ca was treated as other metals and assumed to form oxides, chlorides, phosphates, etc. A separate report (O’Brien 1995) details the compounds assumed to form in the calcine and the method used to predict the amount of calcine generated from a given volume of waste.

For most of the calcination history (all of WCF operation and the 500^{o}C NWCF operation), the HPM assumed a fixed mole fraction (0.66) of the alkali metals sodium and potassium form nitrates, and the remaining fraction (0.34) formed oxides (O'Brien 1995). In 1999 and 2000, a new "high-temperature" calcination flowsheet was successfully tested. The high temperature flowsheet increased the normal Calciner operating temperature from 500°C to 600°C. At 500°C, most (66%) of the alkali metals in the liquid waste formed nitrates in the calcine. The alkali nitrates melted at the Calciner operating temperature, which led to calcine agglomeration problems. At 600°C, most (77%) of the alkali metals formed aluminates (such as $NaAlO_2$), and only 23% of the alkali metals formed nitrates (Wood 2000). The aluminates did not melt at the Calciner operating temperature and did not cause calcine agglomeration problems. As a result, the high-temperature flowsheet reduced the SBW-caused calcine agglomeration problems. With less agglomeration problems, the amount of SBW in the Calciner feed was increased and the amount of chemical additives was decreased, increasing the net calcination rate of SBW. The HPM used 0.23 as the fraction of the alkali metal nitrates in the calcine when the Calciner operated at 600°C.

During calcination, waste from a large Tank Farm tank with a given waste composition was typically calcined for an extended period of time (often until the tank was empty). This generated a layer of calcine in the CSSF bins with a given composition. Then waste from another tank, with a potentially different composition, was calcined, generating a chemically different layer of calcine on top of the first. The HPM treats each of the tanks of liquid waste as a unique waste "stream" and calculates the amount and composition of the calcine produced from each stream. Switching the Calciner feed from one stream to another changed the chemical composition of the calcine and generated the different layers of calcine in the CSSFs. The HPM tracks the Calciner operating time, the volume and composition of nearly 90 waste streams that were calcined, and the filling history of the CSSFs. The HPM calculates the composition of each calcine stream and the amount of each stream that went into each storage bin.

The HPM divides each CSSF calcine storage bin into segments and calculates the composition (mass of chemicals and activity of radionuclides) of the calcine in each segment. Each calcine storage bin contains a vertical array of thermocouples to monitor the temperature of the calcine. The thermocouples were used as level indicators when the bins were being filled. Calcine is self-heating due to radionuclide decay. When covered with warm calcine, the temperature of a given thermocouple increased above ambient temperature, indicating the calcine was at the level of that thermocouple. The HPM divides the bins into segments corresponding to the thermocouple elevations in each bin. Due to variations in the design of the storage bins and the thermocouple arrays in the various CSSFs, the bin segments vary in size. Even within a given bin, some bin segments vary in size because the thermocouple spacing is not always uniform.

4. CALCINE COMPOSITION DISCUSSION

The data in the Staiger report were compiled, converted into different units, and plotted on graphs to help data users better understand the composition and variability of the calcine. The compiled data and resulting data plots were verified to assure the data were accurately transcribed from the original Staiger report (Millet 2004). This section contains summary calcine composition data and explains the reasons for the large variations in the calcine composition. Detailed graphs of the calcine composition in individual bins are included in Appendices A (chemicals) and B (radionuclides). Tabular data on both the chemical and radionuclide content of the calcine is included in Appendix C.

The calcine composition varies among the CSSFs and within individual bins because the Calciners processed different types of waste that created calcine layers of varying composition in the storage bins. Table 2 contains typical chemical content of four of the most common types of calcine.

Table 2. Typical chemical composition of four types of calcine.

Chemical Species	Units	Type of Calcine			
		Aluminum*	Zirconium*	Fluorinel/SBW Blend*	Aluminum Nitrate/SBW Blend*
Aluminum	wt%	47	11	5.0	37
Boron	wt%	0.3	1.0	1.0	0.1
Cadmium	wt%			5.5	0.2
Calcium	wt%		25	28	3.2
Chloride	wt%			0.1	0.4
Chromium	wt%		0.3	0.1	0.1
Fluoride	wt%		27	18	1.8
Iron	wt%	0.1	0.3	0.3	0.6
Mercury	wt%	2.1			
Nitrate	wt%	4.3	0.1	6.7	6.1**
Oxygen	wt%	42	17	15	37
Potassium	wt%	0.3	0.1	0.8	1.9
Sodium	wt%	2.2		3.3	8.6
Sulfate	wt%	1.0		3.5	0.3
Tin	wt%		0.3	0.2	
Zirconium	wt%		18	12	1.4

*Column totals are not exactly 100% due to rounding values.

** The aluminum nitrate/ SBW blend nitrate value is the high-temperature (600°C) calcination value, which is lower than the normal (500°C) value.

Table 2 shows the calcine composition follows the composition of the corresponding liquid waste in Table 1. Calcine produced from Al waste is primarily of alumina (Al_2O_3), indicated by values of about 45 weight percent (wt%) each for Al and O. The Al calcine also contains small amounts of Hg, Na, and nitrate. Calcine produced from Zr waste contains large amounts of zirconia (ZrO_2) and calcium fluoride (CaF_2), with a moderate amount of alumina. Fluorinel calcine is similar to Zr calcine except it contains Cd and sulfate from the cadmium sulfate and cadmium nitrate used as neutron poisons in the Fluorinel fuel dissolution process. SBW was calcined as a blend with Zr, Fluorinel, and Al wastes, and with aluminum nitrate. Consequently, SBW blend calcine contains the chemicals found in Zr, Fluorinel, and Al calcine, as well as nitrates and oxides of sodium and potassium.

Some of the liquid wastes shown on Table 1 are not included as calcine in Table 2. Wastes from graphite matrix and stainless steel fuels were typically too dilute to calcine by themselves. Instead, they were calcined as a blend with Al or Zr wastes. Such wastes do not exist in the CSSFs as a unique type of calcine. Instead, they exist as a blend, causing minor variations to the Al or Zr calcine compositions shown on Table 2.

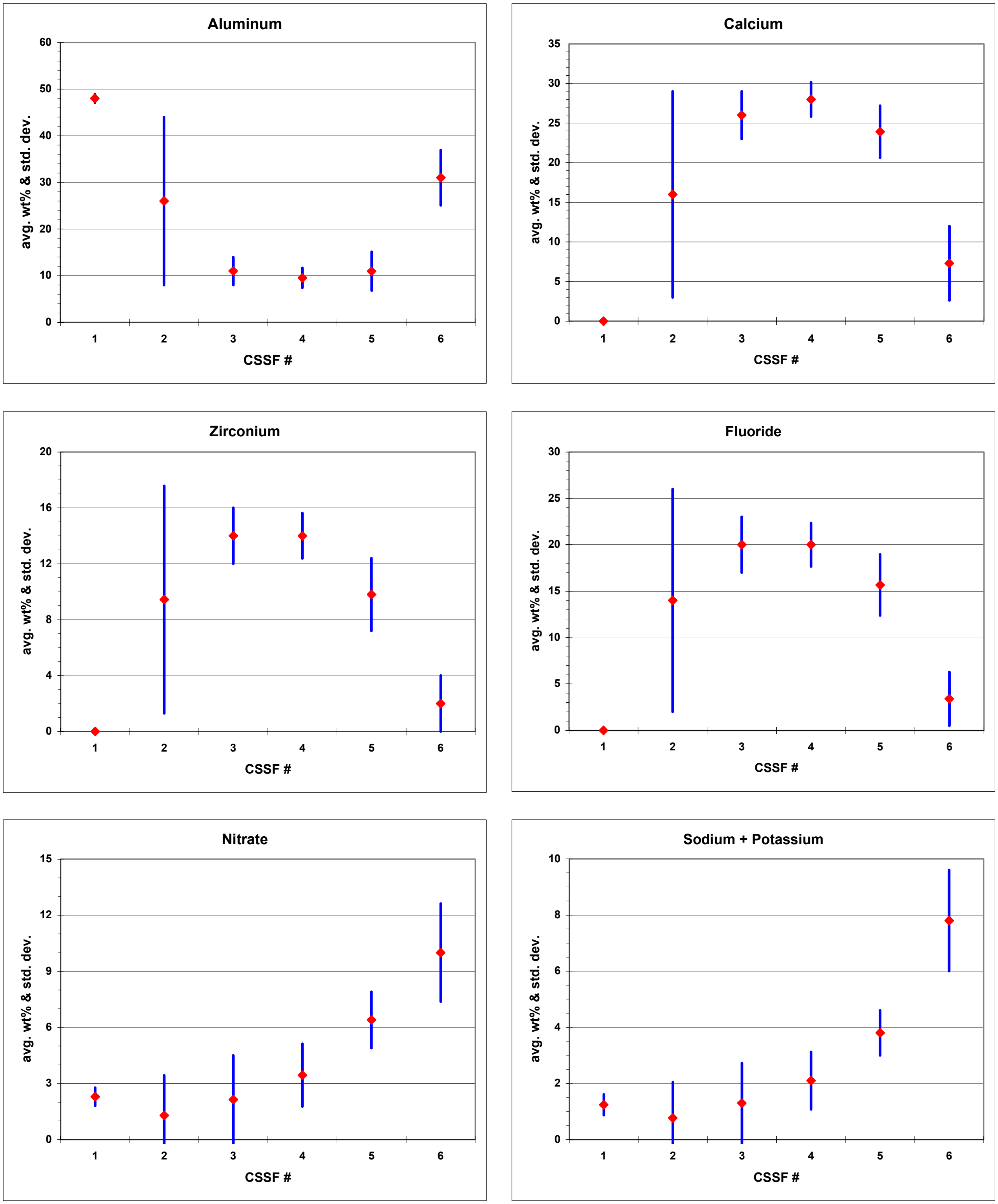
4.1 Major Chemical Constituents of Calcine

Figure 1 shows the average wt% and standard deviation of six major chemical constituents (Al, Ca, Zr, F, NO_3, and the combined alkali metals Na and K) of the calcine in CSSF 1 through 6, based on the HPM estimates. Figure 1 shows the average as a point, and the standard deviation as a bar above and below the average value. The average wt% on Figure 1 is the sum of the estimated wt% of a given constituent in the major bin segments within a given CSSF, divided by the total number of segments. The HPM divided each bin into 6 to 12 segments based on the location of the calcine-level-indicating thermocouples in the bins. In some bins, the thermocouples are nearly equally spaced and the average segment composition is nearly the same as the average calcine composition in the entire bin. However, in some bins, the thermocouples are irregularly spaced. In such bins the average segment composition is close, but not the same as the average bin composition because the composition of the small segments is weighted equally with that of the large segments.

Many of the bins have a thermocouple near the bottom of the bin. The bin segment defined by the lowest thermocouple is often only a few cubic feet in volume, less than 1% of the total volume of the bin. The volume of calcine such segments has a high uncertainty due to bin configuration, model assumptions, etc. The uncertainty in the volume of calcine in the small segments greatly affects calculations involving concentrations per unit volume. The very small calcine segments in the bottoms of the bins were not included in average composition calculations in this report to avoid skewing the calculations.

Figure 1 shows the variability in the chemical composition of the calcine in CSSFs 1-6. The Al content of the calcine varies from nearly 50 wt% in CSSF 1 to only 10 wt% in CSSF 4. The F content varies from 0 wt% in CSSF 1 to 20 wt% in CSSF 4. The standard deviation of the calcine composition also varies significantly among the CSSFs. A small standard deviation indicates the calcine in a CSSF is relatively uniform in composition, a large standard deviation indicates a CSSF contains varying types of calcine. For example, CSSF 1 contains only Al calcine. It has a high Al content with a very small standard deviation reflecting its uniform composition. On the other hand, CSSF 2 contains two different types of calcine, Al and Zr. Two of the CSSF 2 bins contain Al calcine, four bins contain Zr calcine, and one bin contains large amounts of both Al and Zr calcine. The Zr calcine has a high Zr content (18 wt%) and the Al calcine has no Zr. The Zr content in CSSF 2 (9 wt%) shown in Figure 1 is an average value between the high Zr value and low Al value. There is no calcine in CSSF 2 with the average (9 wt%) Zr content. The large standard deviation of the average Zr content reflects the extremes in the Zr content of the two types of calcine.

Figure 1. Average wt% and one standard deviation of major chemical constituents in CSSFs



In addition to showing the variability in the wt% of the chemical constituents of the calcine, Figure 1 also shows some general trends among the CSSFs. The absolute amounts of Zr, F, and Ca (with some exceptions) in the calcine vary among the CSSFs, but their relative quantities are generally the same in each CSSF. These three constituents generally track each other. Zirconium and F were primary constituents of Zr waste. They track each other because a given amount of hydrofluoric acid was used to dissolve a given amount of Zr clad fuel, resulting in a nearly constant Zr:F ratio. Calcium was added to F-bearing waste in the calcination process in a fixed ratio to prevent F volatility in the Calciner. CSSFs 2 through 6 contain Zr-based calcine with these three components present in nearly constant ratios.

The ratio of Ca to Zr and F occasionally varies slightly for two reasons; one was a small difference in the amount of Ca added to Zr waste and Zr/SBW blends, and the other was Ca from Calciner startup beds. Calcium nitrate was added to F-bearing waste to form calcium fluoride (CaF_2) in the calcine and prevent the volatilization of F and subsequent corrosion of off-gas components. Generally, one of two Ca:F ratios were used as the basis for the addition of Ca. When calcining Zr waste, Ca was usually added in a quantity equal to 110% of the stoichiometric requirement (a molar ratio of 0.55 Ca:F) to form calcium fluoride. However, when calcining Zr/SBW blends, a molar ratio of 0.7 Ca:F was generally used. Thus Zr/SBW blend calcine has relatively more Ca than Zr calcine. Table 2 shows both Zr and Fluorinel/SBW blend calcine compositions. The wt% of both Zr and F in the SBW blend calcine is about two-thirds the value of that in the Zr calcine. However, the wt% of Ca in the SBW blend calcine is slightly higher than that of the Zr calcine. The increase of Ca in the SBW calcine is the result of the extra calcium nitrate in the SBW blend.

Some calcine has extra Ca in it (but no Zr or F) due to the use of Ca-bearing Calciner start-up bed. The calcination process sprayed liquid waste into a heated, fluidized bed. When calcining operations began, the Calciner contained a start-up bed of a granular material similar to calcine. Various materials were used as Calciner start-up beds. These included nonradioactive calcine from the calciner pilot plants and from calcining facility test operations, dolomite ($CaMg(CO_3)_2$), and fluorapatite ($Ca_{10}(PO_4)_6F_2$). Dolomite was the most often used start-up bed material. Some calcine has an elevated Ca content (relative to Zr and F) from the dolomite and fluorapatite start-up beds. The calcine in CSSF 1 has no Ca, even from start-up beds, because the WCF used nonradioactive calcine from WCF testing as start-up bed during WCF Campaign 1. The CSSF 1 start-up bed and the WCF Campaign 1 radioactive calcine have virtually the same chemical composition (alumina). The use of dolomite and other material as start-up bed began after CSSF 1 was filled.

The combined amount of Na and K (Na + K) correlates with the amount of nitrate (NO_3) in each CSSF, except for CSSF 6. The amounts of Na, K, and nitrate are low in CSSF 2. They gradually increase in CSSFs 3, 4, 5, and 6, as efforts increased over time to calcine SBW. The amount of NO_3 in the calcine was calculated as a set percentage of the total alkali metals (Na + K) that form nitrates in the calcine. Therefore the NO_3 tracks the alkali metals. Na, K, and the NO_3 are included in Figure 1 as “major” constituents, even though they comprise less than 10 wt% of the calcine. They were significant in the calcining process chemistry. For most of the calcination history, the Calciners operated at 400 to 500^{o}C, which was above the melting temperature of Na and K nitrates. Large amounts of Na and K nitrates in the calcine could cause agglomeration of the calcine in the Calciner or the CSSFs. To avoid calcine agglomeration, waste with a high Na and K content (SBW) was calcined as a blend with other wastes (Zr, Fluorinel, and Al), and in some cases with nonradioactive aluminum nitrate. Blending the SBW with other wastes reduced the Na and K content and the calcine agglomeration potential to a manageable level.

Figure 1 shows the increase in Na + K in CSSF 6 is larger than the corresponding increase in the nitrate content. This is due to the testing of the high temperature calcination flowsheet. The high temperature calcine had a higher amount of Na + K but less nitrates than previous SBW blends. This accounts for the change in the Na + K to nitrate ratio in CSSF 6.

The amount of Al in the calcine varies among the CSSFs and does not track any of the other major constituents. This is because there are multiple sources of Al in the calcine. CSSF 1 contains only Al calcine. The large amount of Al in CSSF 1 comes from dissolved Al fuel cladding. CSSFs 3 through 5 contain primarily Zr calcine. Zr calcine also contains some Al from the aluminum nitrate used to complex F in the Zr fuel dissolver solution. CSSF 2 contains both Al and Zr calcine. The moderate amount of Al in CSSF 2 is the average of the high quantity in the Al calcine and the low quantity in Zr calcine. CSSF 6 contains Zr calcine and aluminum nitrate/SBW blend calcine. The moderate amount of Al is the average of the low amount of Al in the Zr calcine and the high amount of Al in the aluminum nitrate/SBW blend calcine.

4.1.1 Alumina Calcine and CSSFs 1 and 2

The first type of SNF to be reprocessed at INTEC had Al cladding. Al-clad fuel was dissolved in nitric acid, generating waste containing aluminum, hydrogen (acid), and nitrate ions. During calcination, the aluminum in the waste formed alumina, and the acid and nitrate were released in the off gas as water vapor, nitric acid, and NO_x. Al waste was the only waste calcined during the first WCF operating campaign (December 1963 to October 1964). The first WCF campaign ended when CSSF 1 filled. Figure 1 shows CSSF 1 calcine has a high Al content (48 wt%) and only small quantities of other constituents. CSSF 1 has the most uniform composition of any calcine in the CSSFs because it was filled entirely with Al calcine. This is evidenced by the very low standard deviation (0.9 weight percent) of the Al content in Figure 1. Other CSSFs contain a wider variety of calcine types, with a corresponding wider variety of chemical constituents.

The second WCF campaign (March 1966 to March 1968) began by processing Al waste, similar to that of the first WCF campaign. Calcine from the second WCF campaign was sent to CSSF 2. The calcine distribution system in CSSF 2 was designed to fill five of the seven individual bins (VES-136-3 through -7) in a sequential manner. Two of these bins (VES-136-3 and -4) and part of a third (VES-136-5) were filled with Al calcine during the first part (March 1966 through mid November 1967) of WCF Campaign 2. The WCF began calcining Zr waste in the latter part of Campaign 2 (November 1967), which changed the chemical composition of the calcine in CSSF 2.

4.1.2 Zirconia Calcine and CSSFs 2 through 5

By the mid 1960s, the focus of SNF reprocessing changed at INTEC. In the 1950s and early 1960s, most of the SNF reprocessed at INTEC was Al-clad fuel. INTEC began reprocessing Zr-clad fuel on a large scale in the mid 1960s. Zr-clad fuel was dissolved in hydrofluoric acid (HF), resulting in a solution containing high concentrations of Zr and F. Aluminum nitrate ($Al(NO_3)_3$) was added to the Zr dissolver product to complex the corrosive fluoride and protect plant equipment from corrosion, and to enhance uranium extraction. This added Al to the Zr waste. The calcination process added Ca in the form of fertilizer grade calcium nitrate ($Ca(NO_3)_2$) to F-bearing wastes. The Ca formed calcium fluoride in the Calciner and prevented fluoride volatilization and corrosion of the Calciner off-gas equipment. Consequently, Zr calcine contains primarily Zr, F, Al, and Ca.

The initial calcination of Zr waste occurred near the end of WCF Campaign 2 (mid-November 1967 though March 1968). The WCF was designed for Al waste, but it demonstrated it could calcine Zr waste as well. Two of the bins in CSSF 2 (VES-136-1 and -2) were not part of the sequential bin filling design. They were filled using an air-operated, calcine-diverter system that could be turned off and on, producing the effect of opening and closing a valve on the fill lines for those two bins. The diverter system was designed to selectively fill either of those two bins instead of sequentially filling bins VES-136-3 through -7. This allowed for the segregation of different types of calcine. When Zr waste calcination began, operators attempted to use the calcine diverter and segregate the Zr calcine from the Al calcine by putting it into bins VES-136-1 and -2. However, the calcine diverter system plugged and failed to operate as intended. As a result, most of the Zr calcine produced in WCF Campaign 2 went into bin VES-136-5, which was already partly filled with Al calcine. This created the first bin of calcine that varied significantly in chemical composition. Subsequent calcination of Zr waste in WCF Campaigns 3 and 4 added more Zr calcine to CSSF 2. As a result, CSSF 2 has two bins containing only Al calcine, four bins containing primarily Zr calcine, and one bin containing significant amounts of both Zr and Al calcine.

After the mid 1960's, INTEC reprocessed both Zr and Al-clad fuels in significant amounts. However, relatively small quantities of Al calcine exist outside of CSSF 1 and 2. In an effort to maximize SNF reprocessing efficiency and minimize waste generation, a fuel reprocessing flowsheet called "coprocessing" was implemented in 1970. Coprocessing included the simultaneous dissolution (in separate dissolvers) of both Al and Zr-clad fuel. The Al dissolver product was used in place of aluminum nitrate as the complexing/salting reagent for the Zr dissolver product. This reduced the amount of nonradioacitve aluminum nitrate used in Zr fuel reprocessing and reduced the volume of waste produced per kilogram of uranium reprocessed. It also eliminated the storage and calcination of most Al-fuel reprocessing raffinate as a pure waste stream. From a calcination standpoint, coprocessing waste was very similar to complexed Zr waste and many INTEC documents do not differentiate between the two. Zr waste and coprocessing waste constituted the bulk of the wastes calcined after WCF campaign 2.

The calcine compositions in CSSFs 1 through 5 on Figure 1 reflect the change in SNF reprocessing from primarily Al-clad fuel, to Zr-clad fuel and coprocessing. CSSF 1 contains Al calcine. CSSF 2 contains both Al and Zr calcine. CSSF 3, 4, and 5 contain Zr (and coprocessing) calcine. Figure 1 shows the Al content of the calcine progressively decreased from CSSF 1 to 3, while the Zr, Ca, and F content increased, reflecting the shift in the primary type of fuels reprocessed and the waste generated.

4.1.3 SBW Calcine and CSSF 4 through 6

In the 1960s and 1970s, first-cycle waste (Al, Zr, coprocessing) was the dominant type of waste produced and calcined. First-cycle waste contained very little Na or K. First-cycle waste could be calcined much faster and more efficiently than SBW, which contained large amounts of Na and K. Calcining first-cycle raffinate emptied Tank Farm tanks quickly and generated storage space for more SNF reprocessing raffinate. SBW could not be calcined by itself because it generated solids (nitrates) that melted at calcination temperatures, leading to calcine agglomeration. As a result, the Calcine in CSSF 1, 2, and most of 3 contains relatively little Na or K.

Calcination of SBW became a priority in the late 1970s during WCF Campaigns 8 and 9, when CSSF 3 was nearly full. By that time, all of the tanks in the INTEC Tank Farm designed for SBW storage (those without cooling coils) were full or nearly full. Tanks designed for HLW (those with cooling coils) were then used to store SBW. Storing SBW in the HLW tanks affected SNF reprocessing by limiting first-cycle raffinate storage space and waste segregation options. Calcining SBW became a high priority to manage Tank Farm storage space and to avoid limiting SNF reprocessing. The increase in the Na, K, and NO_3 content of the calcine in CSSFs 4, 5, and especially 6 is the result of increasing emphasis on calcining SBW.

CSSF 4, 5, and 6 contain primarily SBW blend calcine. During the 1980s and 1990s, the amount of SBW calcined gradually increased as more aggressive calcination flowsheets increased the Na + K content of the calcine. During most of the operating history of NWCF, there was an administrative limit on the Na + K content of the calcine. Calcine in the center of a storage bin can become very hot in storage due to the decay of radionuclides. Sodium and potassium nitrates melt at low temperatures and can cause the calcine to agglomerate in high temperature storage. This could hinder future calcine retrieval. To prevent calcine agglomeration in the bins, limits were placed on the amount of Na + K in the calcine while CSSF 4 and 5 were filled, and during the early filling of CSSF 6 (January through November 1993). The calcine produced during NWCF Campaign 2, which filled the upper half of CSSF 5, was near the administrative limit for Na + K.

CSSF 6 shows a dramatic increase in the amount of Na, K, and NO_3 in the calcine. CSSF 6 also shows a significant drop in the amount of Zr, Ca, and F in the calcine. Both of these phenomena resulted from the April 1992 DOE decision to stop SNF reprocessing. No first-cycle raffinate was generated from SNF reprocessing after that time. However, calcination of the Tank Farm waste inventory continued, with CSSF 6 being placed in operation in January 1993. The Calciner processed the last of the first-cycle waste remaining in the Tank Farm in early 1988, and continued calcining SBW until May 2000.

Since June 1997 (NWCF Campaign 4), all Tank Farm waste (including WM-188, the last tank of first-cycle raffinate) contained sufficient amounts of alkali metals that it was calcined as SBW. Aluminum nitrate was used as the SBW blend solution when first-cycle raffinate was no longer available. Because the radionuclide content of SBW is so low, the NWCF Campaign 4 SBW calcine had low radionuclide activity and heat generation. The SBW heat generation was so low that there was no potential for high-temperature agglomeration of the calcine in CSSF 6. Therefore the former limitations on the Na + K content of the calcine were eliminated and very aggressive calcination flowsheets were used to maximize the quantity of SBW calcined. This increased the Na + K content of the calcine in CSSF 6 over previous calcination campaigns.

In 1999 and 2000, the NWCF tested a new “high-temperature” calcination process that significantly increased the calcination rate of SBW by decreasing the amount of chemical additives used when calcining SBW. The historical Calciner operating temperature of both the WCF and NWCF Calciners had been 400 to 500^{o}C. In April and May 1999, the NWCF operated at 600^{o}C for two 2-week periods. At 600^{o}C the Na and K formed more aluminates (i.e. $NaAlO_2$) and less nitrates. The aluminates did not melt at Calciner operating temperatures and did not cause calcine agglomeration problems. Some off-gas line plugging problems occurred during the 1999 high-temperature test. The plugging problems were resolved, and the high temperature flowsheet was successfully retested from March through May 2000 for approximately 9 weeks. During that time, calcine having an average Na + K content of nearly 10 weight percent was produced. Even though the Na + K content of the calcine went up dramatically in the high-temperature operation, the nitrate content actually dropped due to the formation of aluminates instead of nitrates in the calcine. Figure 1 shows the results of the efforts to increase the calcination rate of SBW as the significant increase in the Na + K content of the calcine in CSSF 6.

4.2 Minor Chemical Constituents of Calcine

Each type of calcine has a distinctive set of minor chemical constituents. Figure 2 shows the average concentrations of four minor calcine constituents (Hg, Cd, Cr, and Ni) for CSSF 1 through 6. The amounts of these elements in the calcine depend on both the type of waste calcined and the Calciner operating conditions.

Figure 2. Average wt% and one standard deviation of minor chemical constituents in CSSFs

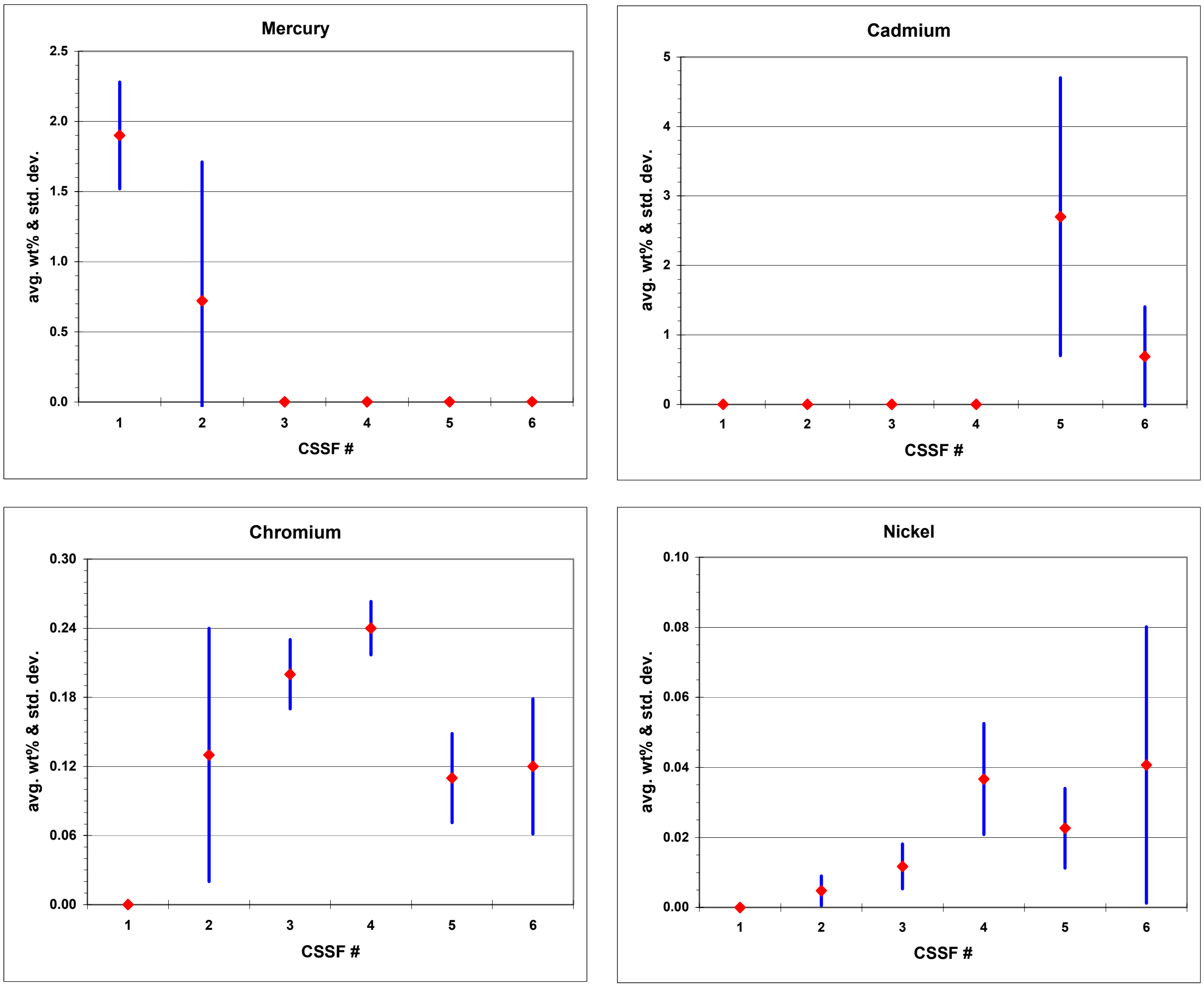


Figure 2 shows a relatively large amount of Hg (1.9 wt%) in CSSF 1, a moderate amount (0.7 wt%) with a large standard deviation in CSSF 2, and virtually none in CSSF 3 through 6. The dissolution of Al-clad fuels used mercuric nitrate as a catalyst. Consequently, first-cycle Al raffinate contained 2-4 g/L Hg, and the Al calcine in CSSF 1 also contains Hg. The Zr fuel dissolution process did not use Hg, so neither liquid Zr waste or Zr calcine contain Hg. SBW contained small amounts of chemicals from all the types of fuels reprocessed, so it also contained a small amount of Hg.

The amount of Hg in the calcine does not exactly follow the amount of Hg in the liquid wastes. Coprocessing waste contained moderate levels of Hg because it was composed of both Hg-free Zr waste and Hg-bearing Al waste, but the coprocessing calcine in CSSF 3-6 has little Hg. The Calciner operating conditions and Hg volatility controlled the Hg content of the calcine. In the first three WCF campaigns, the Calciner operated at 400°C. Heat for the first three WCF calcination campaigns was supplied by an in-bed heat exchanger. Under those operating conditions, most of the Hg in the liquid waste stayed in the calcine and was sent to CSSF 1 or 2. The in-bed heat exchanger used a mixture of liquid Na and K (NaK) as its heat transfer fluid. The NaK system had problems with leaks and fires, so it was replaced with an in-bed combustion (IBC) heating system between WCF campaigns 3 and 4 (1969-1970). The IBC system sprayed a mixture of kerosene and oxygen into the heated fluidized Calciner bed. The kerosene spontaneously burned in the hot Calciner vessel, providing the heat necessary to evaporate the liquid waste. The IBC system normally operated at 500^{o}C. With the introduction of the IBC system, most of the Hg in the liquid waste volatilized in the Calciner and was captured in the scrubbing system or vented with the off gas. Very little of the Hg was retained in the calcine. The calcine in CSSFs 3 through 6 has virtually no Hg because it was produced in an IBC-heated Calciner.

Cadmium (Cd) is minor calcine component whose quantity varies among the CSSFs. Figure 2 shows no Cd in CSSFs 1 through 4. There is a relatively large amount of Cd in CSSF 5 (2.7 wt%) and a smaller amount in CSSF 6 (0.7 wt%). Cd was a component of liquid Fluorinel waste and consequently is found in Fluorinel calcine. The Fluorinel process was a "new" Zr fuel dissolution process constructed in the mid 1980s to replace the original, aging Zr fuel dissolution facility. The Fluorinel process used Cd as a soluble neutron poison for criticality control. The original Zr-fuel reprocessing facility did not use Cd. Thus, Cd existed only in Fluorinel waste (and as a minor contaminant in recent SBW). Two Fluorinel processing campaigns were completed before the decision to stop fuel reprocessing. As a result, there is relatively little Fluorinel calcine. The Fluorinel waste was calcined in NWCF Campaigns 2 and 3. Most of the Fluorinel calcine is in the upper half of CSSF 5 where some bin segments contain nearly 6 wt% Cd. There is also a small amount of Fluorinel waste in the bottom of CSSF 6. The standard deviation of the Cd content is high in both CSSF 5 and 6 because the Cd content of the calcine varies from 0 in the non-Fluorinel calcine, to nearly 6 wt% in the Fluorinel calcine.

Figure 2 includes chromium (Cr) as a minor constituent of calcine. There is virtually no Cr in liquid Al waste. Chromium was present in small quantities in the Zr fuel cladding (Zircaloy) and therefore was in liquid Zr wastes. Chromium (as chromic acid) was used as an oxidant in the dissolution of most Zr fuel to oxidize tin (a fuel cladding component) and uranium to assure complete fuel dissolution. The oxidant Cr was the principle source of Cr in liquid wastes. Chromium was not used as an oxidant in the Fluorinel dissolution process, so Fluorinel waste has less Cr than other Zr wastes. Chromium was also a principal constituent of stainless steel wastes. Figure 2 shows the Cr content of the calcine in each CSSF correlates to the type of liquid waste calcined. There is no Cr in the Al calcine in CSSF 1. CSSF 3 and 4 contain relatively large amounts of (oxidant) Cr from Zr waste. Chromium is present in a moderate amount in CSSF 2, which contains a mixture of Cr-bearing Zr and Cr-free Al calcine. Chromium is also present in a moderate amount in CSSF 5, which contains a mixture of Zr waste and Fluorinel waste (which did not contain any oxidant Cr). There is a moderate amount of Chromium in CSSF 6 associated with stainless steel waste. Stainless steel waste also contributed Cr to the calcine in CSSF 4 and 5

Nickel is a minor component of calcine as shown on Figure 2. Like Cr, there is virtually no Ni in liquid Al waste. There is a small amount of Ni in Zircaloy fuel cladding and consequently in liquid Zr waste. The largest source of Ni was the stainless steel waste. Figure 2 shows the Ni content of the calcine in each CSSF correlates to the type of liquid waste calcined. There is no Ni in the Al calcine in CSSF 1. CSSFs 4, 5, and 6 have the most Ni because those CSSFs have the most calcine derived from liquid stainless steel waste. The calcine in CSSF 3 has a moderate amount of Ni because it has Zr calcine. CSSF 2 has a very small amount of Ni because it is a mixture of Ni-free Al calcine and Zr calcine

4.3 Data Plots of Calcine Chemical Constituents and Trends

Appendix A contains data plots showing the variability of the chemical constituents in the calcine from which the previous discussions and Figures 1 and 2 are based. There is a data plot for 24 chemical constituents listed in the Staiger report. The data plots are arranged in alphabetical order according to the name of the chemical species. Each data plot shows the wt% of a given constituent in the calcine in each bin segment of each bin in the CSSFs, with the exception of CSSF 1. For CSSF 1, data for only the four largest (outer) bins are plotted instead of all twelve bins. The calcine in CSSF 1 is uniform in chemical composition. The data for only the four largest bins of CSSF 1 are included to simplify the graphs and eliminate virtually redundant data plots. The data plots are arranged with the segment numbers (left-to-right) corresponding with bin elevation going from bottom to top. Thus, the data plots read left-to-right as the bins were filled over time.

The data plots in Appendix A include the average weight percentage and standard deviation for each component in the calcine in each CSSF. The average values do not include the very small segments that could skew the data as previously discussed. Each bin segment is weighted equally in computing the CSSF average, without compensation for segment volume. Therefore, the segment average may differ slightly from the overall CSSF average composition.

The data plots in Appendix A show the variability of the calcine composition within the CSSF bins. The variability is the result of varying liquid waste compositions, as previously discussed. The data plots in Appendix A contain details that do not appear in summary data plots (Figures 1 and 2). For example, magnesium (Mg) and carbonate (CO_3) are both minor components of the calcine. The average Mg concentration in the calcine is less than 1 wt%. With the exception of CSSF 1, there is no significant difference in the average amount of Mg or carbonate in any of the CSSFs. Because of this, Mg was not selected for detailed discussion in the previous section with other minor calcine constituents.

Although Mg and carbonate are generally minor constituents of the calcine, the Appendix A data plots show they vary significantly among individual bin segments, and are significant components in some bin segments. Appendix A shows the Mg and carbonate in the calcine track each other. Both components are normally present in very low concentrations in the calcine. However, the amounts of both components occasionally spikes upward, with the Mg reaching values of seven weight percent in some bins, an order of magnitude higher than its normal value. The principle source of the Mg and carbonate in the calcine is dolomite ($CaMg(CO_3)_2$) used as Calciner startup bed. As a result, the Mg and carbonate are not uniformly distributed throughout the calcine and do not track any other waste components. The Mg and carbonate are in small layers of dolomite scattered throughout the bins in layers that correspond to Calciner startups. For example, CSSF 4 has a large spike of Mg/carbonate in the bottom of each of its three bins (segment 1) and a smaller spike about 60% of the way to the top of the bins (near segment 8). The first Mg/carbonate spike (segment 1) corresponds to the initial dolomite startup bed of NWCF Campaign 1, in August 1982. The second spike corresponds to the startup bed used to restart the Calciner in March 1983, after a shutdown to repair the failed fines column valve within the NWCF. Both Calciner startups used about the same amount of dolomite. However, but the impact (size of the Mg/carbonate spike) is greater in the first segment because the first segment has a smaller volume and the startup dolomite occupies a larger percentage of the small segment volume.

The detailed data plots in Appendix A show low levels (less than 2 wt%) of phosphate except for the upper levels of CSSF 3, where the phosphate goes over 10 wt%. The large phosphate spike in CSSF 3 corresponds to the testing of phosphate-containing fluorapatite ($Ca_{10}(PO_4)_6F_2$) as a replacement for dolomite as Calciner startup bed during WCF Campaigns 8 and 9.

The data plots in Appendix A also show the previously discussed variation in the amount of Cd in the CSSFs. There is no Cd in the calcine in CSSFs 1 through 4. However, there is a large amount of Cd from Fluorinel waste, up to 6 weight percent, in the middle portion of the CSSF 5 calcine. There is also a large increase in the amount of sulfate in the calcine in CSSF 5, mirroring the data plot for Cd. About half of the Cd used in the Fluorinel process was in the form of cadmium sulfate, thus adding sulfate to the waste in addition to the Cd.

After CSSF 4 filled, CSSF 5 began filling without any interruption of the operation of the Calciner. As a result, the data plots show the calcine composition in the top of CSSF 4 is generally the same as that in the bottom of CSSF 5. The data plots for U and Ni are an exception. Appendix A shows the U in the bottom of CSSF 5 is about four times higher than that in the top of CSSF 4. The Ni in the bottom of CSSF 5 is about 50 % higher than that in the top of CSSF 4. The reason for the elevated U and Ni in the calcine in the bottom of CSSF 5 is the composition of liquid waste stream #73. Stream # 73 was ROVER (a graphite matrix fuel) waste that was calcined in July and August 1983 and placed in the bottom of CSSF 5. The ROVER waste sample analyses showed very high U concentrations in the waste (approximately 190 mg/L), compared to average first cycle raffinate values of 1-5 mg/L. Whether the high U values for the ROVER waste were correct is not certain. Several ROVER samples had high U and some with low U concentrations. Though it did not differ as much as the U, the Ni content of the ROVER waste was also higher than the average first-cycle raffinate. As a result, there are elevated amounts of Ni, in addition to U, in the calcine in the bottom of CSSF 5.

4.4 Radionuclide Content of the Calcine

The radionuclide content of the calcine varies among the CSSFs. The fission product activity in the calcine is a function of uranium burn up in the reprocessed SNF, the age of the waste, and the dissolved solids content of the liquid waste from which the calcine was formed. The fission product content is not dependent on the fuel cladding as the chemical content was. The activation and transuranic elements in the calcine vary according to fuel type (cladding), uranium enrichment, uranium burn up, and SNF reprocessing chemistry.

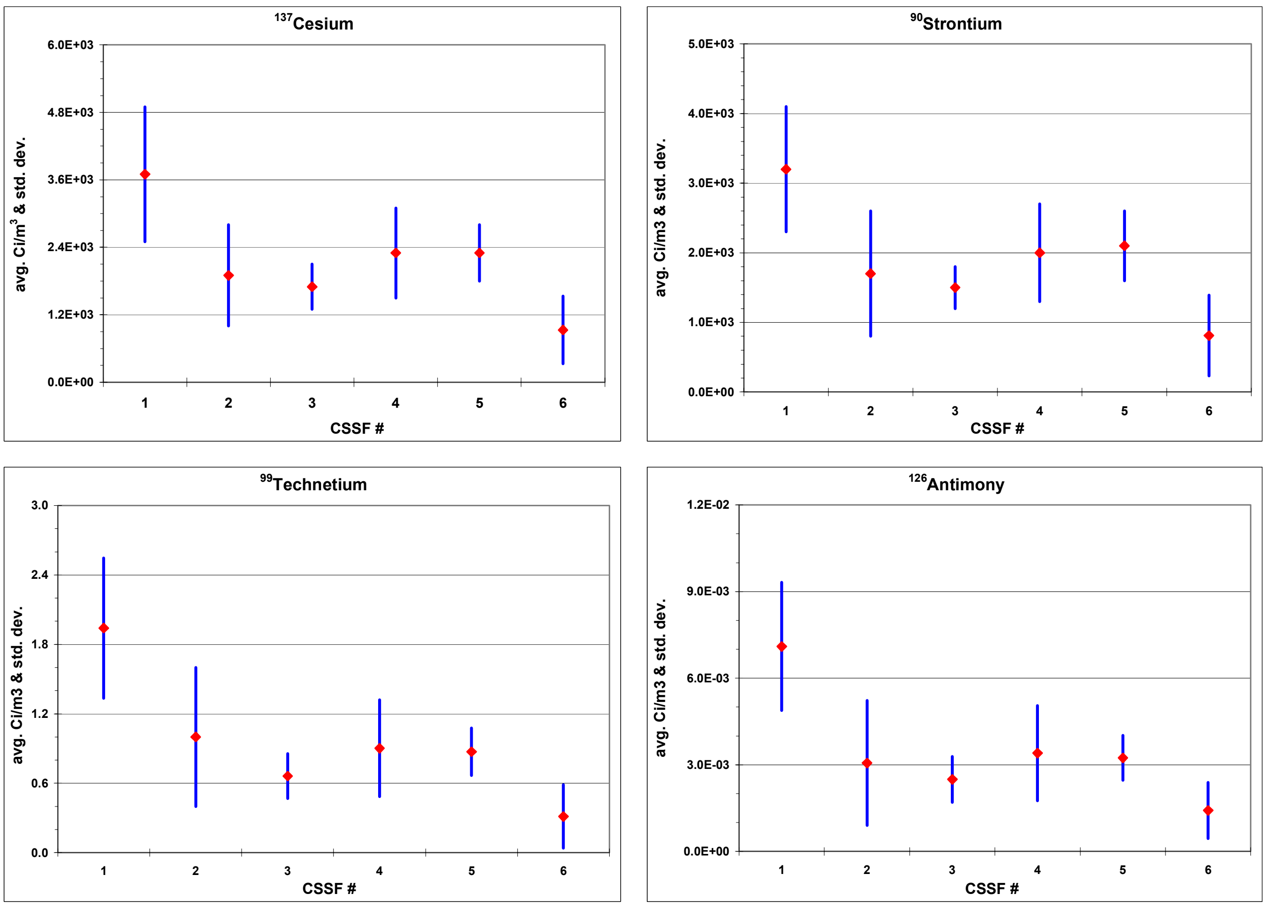
4.4.1 Fission Product Content of Calcine

The spectrum of fission products produced in a reactor is largely independent of the fuel cladding material, uranium enrichment, etc. The fission product activity of the SNF and first-cycle raffinate was primarily a function of uranium burn up and age of waste. Fuels with high uranium burn up had larger quantities of fission products than fuels with low burn up. Elements such as Zr-95 and Ce-144 (half lives of 64 and 285 days respectively) varied significantly in first-cycle raffinates due to the age of the waste because even a few years resulted in significant decay of such radionuclides. Because the newest calcine in the CSSFs came from fuel reprocessed over 15 years ago, there are no significant quantities of short-lived fission products such as Zr-95 and Ce-144 in the calcine. The primary fission products currently in the calcine are Cs-137 and Sr-90. The activity of Cs-137 and Sr-90 in the calcine depends on the activity originally in the liquid waste, the dissolved solids content of the liquid waste, and the age of the waste. The radioactivity of the calcine is directly proportional to the radioactivity of the original liquid waste, and inversely proportional to the dissolved solids content of the liquid waste. Liquid wastes with high activity generated calcine with high activity. Liquid wastes with few dissolved solids had a high liquid-to-solid concentration factor during calcination and generated calcine with high radioactivity.

In general, Al calcine has the highest fission product activity of any calcine. Liquid Al waste had the highest radionuclide activity and the fewest dissolved solids per unit volume of any waste. Both of these factors contributed to its high calcine activity. Liquid Zr waste had a relatively high dissolved solids content due to chemical additives. Aluminum nitrate was added to Zr fuel dissolver product to complex F prior to uranium extraction. Calcium nitrate was added to Zr waste to suppress F volatility in the calcination process. The addition of these chemicals increased the solids content and diluted the radionuclide content of the Zr waste. Liquid SBW had significantly lower (over an order of magnitude) fission product activity than first-cycle waste. Therefore, SBW calcine has lower radioactivity than calcine made from first-cycle raffinate.

Figure 3 shows the concentration of four fission products (Cs-137, Sr-90, Tc-99, and Sb-126 a short-lived daughter of the long-lived Sn-126) in each of the six CSSFs. As with the chemical content, the average radionuclide content of the CSSFs in Figure 3 is the average of the activity in the bin segments of all the bins within a given CSSF. The average is not weighted per size of segment; consequently the average of the segment values differs slightly from the weighted average of an entire CSSF. Figure 3 shows the activity of Cs-137, Sr-90, Sb-126 and Tc-99 is highest in CSSF 1. This is because CSSF 1 contains only Al calcine. CSSFs 2, 3, 4, and 5 have moderate concentrations of these radionuclides because they contain primarily similar (Zr) calcine. Figure 3 shows a significant drop in the fission product activity of CSSF 6 calcine. The calcine in CSSF 6 has the lowest fission product activity because it contains the most SBW and the least first-cycle raffinate.

Figure 3. Average Ci/m^3 and one standard deviation of fission products in CSSFs.



4.4.2 Activation Product and Transuranic Content of Calcine

Activation products, including transuranic (TRU) elements, in the SNF, liquid waste, and calcine, depended on parameters such as fuel cladding, uranium enrichment, and irradiation history of the SNF. The SNF reprocessing chemistry also affected the TRU content of the liquid wastes and subsequently the calcine. During SNF reprocessing, the bulk (well over 99%) of the fission products and light activation products were separated from the uranium in the first-cycle extraction system and went to the Tank Farm with the first-cycle raffinate. However, because the actinides have similar chemistry, some of the TRU components were separated with the uranium from the fission products in the first-cycle extraction system. The amount of TRU components separated from the first-cycle raffinate depended on the type of fuel, concentrations of complexing reagents (such as F), the oxidation potential of the solutions, etc. The TRU components separated from the first-cycle waste with the uranium product were separated from the uranium product in the second and third cycle uranium purification steps. This enriched the second/third cycle raffinate in TRU components relative to fission products. Sometimes the second/third cycle raffinates were stored with the first-cycle raffinate in the Tank Farm, and sometimes they were mixed with SBW. Mixing the second/third cycle raffinate with SBW enriched the SBW with TRU components, relative to fission products.

ORIGEN2 predicts the amounts of TRU components formed in a reactor, but cannot predict the path of the TRU components within the INTEC uranium extraction and waste handling systems. To account for the partioning effect of SNF reprocessing on the amounts of TRU components in the various wastes, the ORIGEN2-predicted values were replaced with waste sample analytical values in the radionuclide prediction models. This resulted in lower-than-ORIGEN2 predicted values in the first-cycle Al waste because much of the TRU activity was extracted from the first-cycle raffinate and mixed with SBW in the Tank Farm. On the other hand, the SBW model contains higher-than-ORIGEN2 predicted TRU activity. This is because SBW contains significant amounts of second and third cycle raffinates that were enriched with TRU components relative to the fission product activity.

Figure 4 shows the activity of four TRU components (Pu-238, Pu-239, Np-237, and Am-241) in CSSFs 1 through 6. In general, the Pu-238 and Am-241 are representative of the relative activities of most TRU elements. Figure 4 shows Pu-238 and Am-241 generally track each other. The TRU activity of the calcine generally correlates with the type of liquid waste from which the calcine was derived. The TRU activity is relatively low in Al wastes and high in Zr wastes. The early first-cycle Al raffinate was stored and calcined separately from its second and third cycle raffinate. This effectively reduced the TRU content of early (CSSF 1) Al calcine. CSSFs 3, 4, and 5 have the highest TRU activity because they contain primarily Zr calcine. CSSF 2 has a moderate amount of TRU activity because it has both Zr and Al calcine. The TRU content of CSSF 6 is moderate because it contains large amounts of SBW. Although the SBW is enriched in TRU content relative to its fission product content, its fission product content is low, over an order of magnitude below that of first-cycle raffinate. Therefore, in absolute terms, the TRU activity of SBW is moderate and the CSSF 6 TRU activity is also moderate.
The activity of Np-237 does not follow that of Pu-238 and AM-241 on Figure 4 for two reasons. One reason is the recovery of Np-237 from some uranium extraction raffinates. The second reason is a high Np-237 adjustment factor in the SBW model and the application of the SBW model to a specific waste in CSSF 6.

Between 1965 and 1973, INTEC recovered Np-237 as a product during SNF reprocessing. Thus, liquid wastes produced during that period were depleted in Np-237. Np-237 was recovered because it was a valuable source material for production of Pu-238, a radioisotopic heat source for space power units. The Al calcine in CSSF 1 (and part of 2) came from waste generated before Np-237 recovery began. The Al calcine in CSSFs 1 (and 2) has a relatively high Np-237 activity compared to wastes from which Np-237 was recovered. The calcine in CSSF 3, 4, and 5 is primarily Zr and coprocessing waste. The ORIGEN2-predicted activity of Np-237 in the Zr and coprocessing waste models was adjusted based on samples of waste generated in the mid 1960s and early 1970s, during the Np-237 recovery time. As a result, the radionuclide estimates for Zr and coprocessing wastes have a low, depleted Np-237 activity. Figure 4 shows the depleted Np-237 activity in the Zr and coprocessing calcine in CSSFs 3, 4, and 5 compared to the Al calcine in CSSF 1. However, most of the calcine in CSSF 4 and 5 came from Zr and coprocessing wastes generated after Np-237 recovery ceased. Therefore, the Np-237 activity in CSSF 4 and 5 is higher than that shown in Figure 4. The HPM does not include separate estimates for Np-237 depleted waste and non-depleted waste, in order to simplify the estimates and limit the number of waste models.

Figure 4 Average ηCi/g and one standard deviation of transuranics in CSSFs.

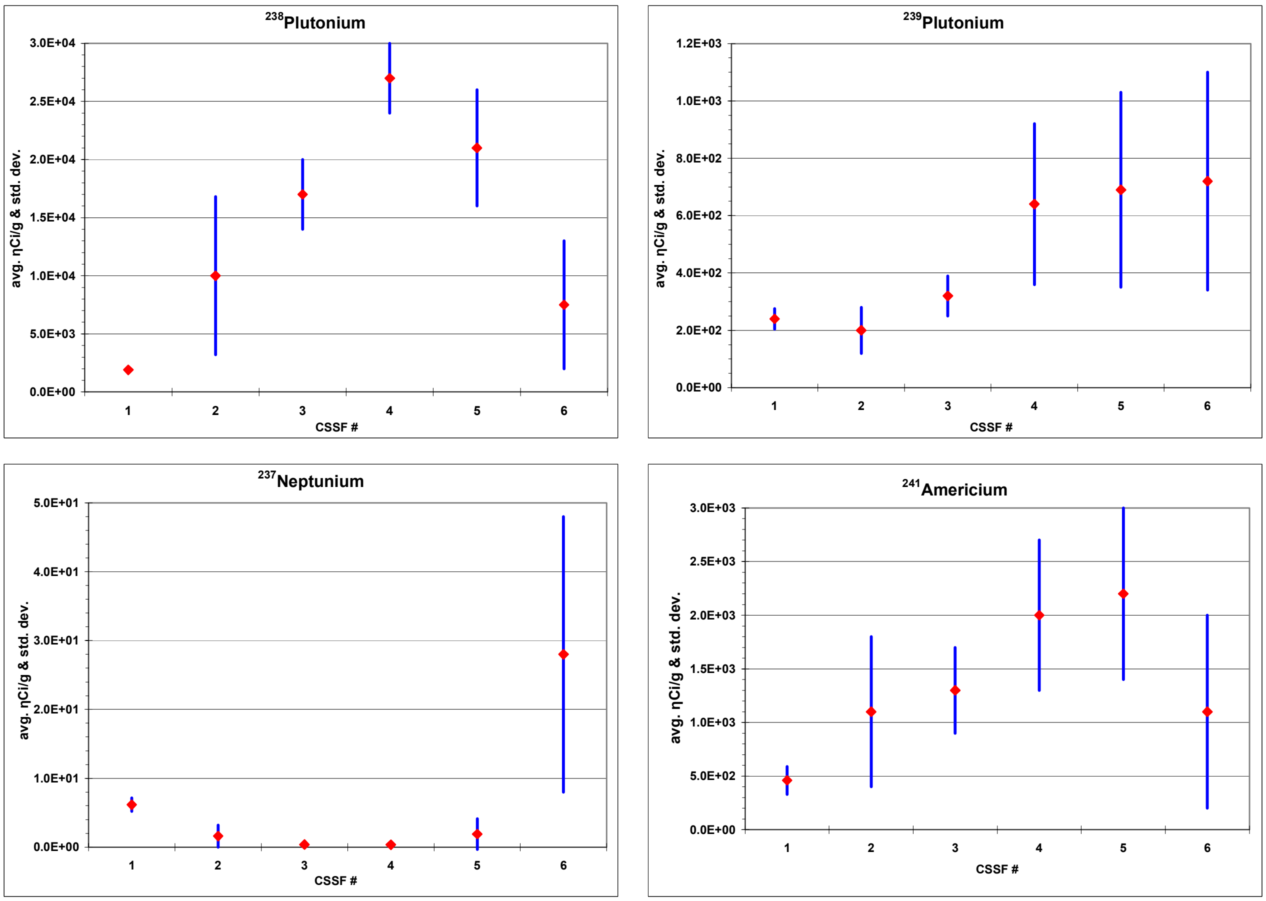


Figure 4 shows the Np-237 activity in CSSF 6 is much higher than other CSSFs. This is because a conservatively high Np-237 activity is in the SBW model used to estimate the activity in CSSF 6. The ORIGEN2-predicted activity for Np-237 in SBW was adjusted to reflect sample data from five tanks of SBW that existed in the 1990s. In some cases Np-237 was not detected in the waste, so the analytical detection limit was used as a conservatively high Np-237 value. For some wastes, several consistent historical Np-237 analyses were available, but the SBW model conservatively used an errant Np-237 analysis that was several times larger than historical values. The conservative use of high Np-237 values caused the SBW model to have a Np-237 activity about ten times higher than the ORIGEN2-predicted value. The activities of other actinides (Pu and Am) in SBW were generally three to four times higher than that predicted by ORIGEN2. The relative amount of Np-237 in SBW is likely similar to that of Pu and Am, a factor of three to four (instead of ten) times higher than that predicted by ORIGEN2. The SBW model likely overestimates the activity of Np-237 in SBW by a factor of about three (Swenson 2003c). This is most significant to the CSSF 6 activity estimate because CSSF 6 contains the most SBW.

In addition to the elevated Np-237 activity in the SBW model, the application of the SBW model to waste from tank WM-188 (identified as stream #86 in the HPM) further skews the Np-237 activity in CSSF 6. Waste from WM-188 calcined in 1997 and early 1998 contributed most of the Np-237 in CSSF 6. The

WM-188 waste was a unique mixture of wastes that did not correspond to any of the five waste models. It contained 31% first-cycle raffinate and 18% concentrated PEW Evaporator bottoms, 6% second/third cycle raffinate, and 44% from other sources such as decontamination solutions (Loos 2004). The HPM modeled the WM-188 waste as SBW, not first cycle raffinate, resulting in conservatively high estimates of Np-237 activity.

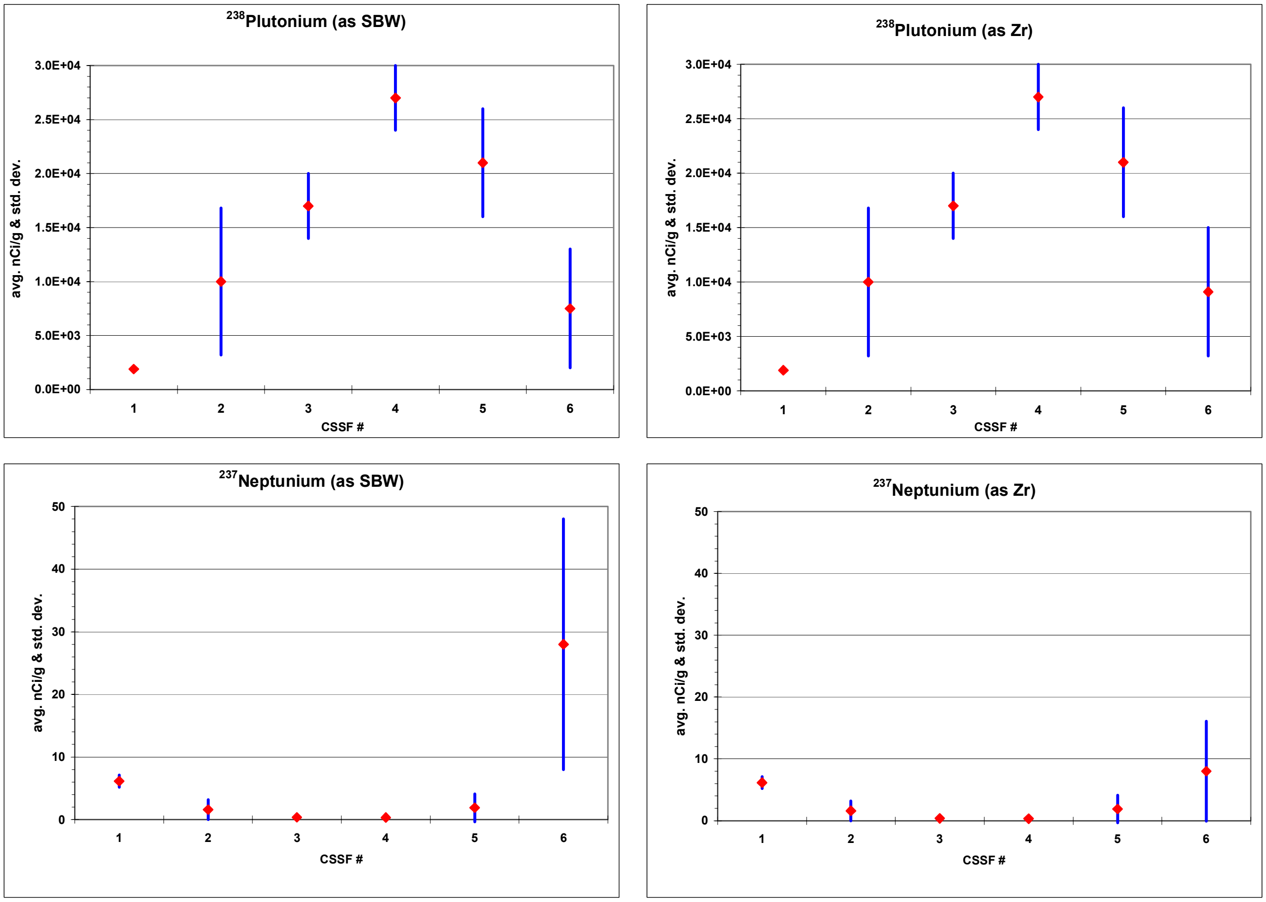
In the 1990s, first-cycle raffinate contained about 700 mCi/L Cs-137 and SBW contained about 70 mCi/L Cs-137. The waste in WM-188 had about 360 mCi/L Cs-137, five times that of SBW and one half that of first-cycle raffinate. The WM-188 waste was closer in activity to first-cycle raffinate than SBW and was tracked as first-cycle waste in many waste accounting and reporting systems. Emptying WM-188 in February 1998 was reported as meeting a milestone from the Settlement Agreement dated October 16, 1995 between the State of Idaho, Department of Energy, and the Department of the Navy to calcine all "non-sodium high level waste" remaining in the Tank Farm by June 1998. Although the activity of WM-188 was closer to first-cycle waste than SBW, the sodium content of the waste was high enough that it was calcined as SBW, by blending it with aluminum nitrate. Thus, some reports considered it SBW.

The WM-188 samples taken in 1997 when calcination of the waste began did not include any data for Np-237 or other TRU components. The HPM estimated the TRU activity by modeling the WM-188 as SBW, even though the fission product activity of WM-188 waste was closer to first-cycle raffinate than SBW. Modeling the WM-188 waste as SBW provided conservatively high estimates of TRU activity. At the time, the CSSF 6 Safety Analysis Report used the HPM data in some of its accident analyses, and Safety Analysis personnel preferred a conservatively high estimate for its radiological source term (Swenson 1999). The first-cycle waste portion of the WM-188 waste had low Np-237 and high Cs-137 activity. The SBW model has relatively high Np-237 and low Cs-137 activity. Applying the high Np-237:Cs-137 ratio from the SBW model to the first-cycle portion of the WM-188 waste resulted in a conservatively high estimate of the Np-237 activity in the WM-188 waste, and consequently the CSSF 6 calcine.

The HPM estimated the Np-237 activity in WM-188 to have been 0.02 mCi/L using the SBW model. Analyses of the WM-188 liquid obtained when the tank was nearly empty showed it contained only 0.0007 mCi/L, a factor of nearly 30 less than the SBW model estimate. The WM-188 waste contributed about three fourths of the total Np-237 in CSSF 6 and significantly skewed (increased) the Np-237 activity shown in Figure 4.

Figure 5 compares the effects of modeling the 1997 WM-188 waste as SBW versus Zr waste on the estimated activity of Np-237 and Pu-238. Figure 5 has two sets of data for Pu-238 and Np-237. The first set of data (left side) shows the Pu-238 and Np-237 activity when the WM-188 waste is modeled as SBW (same data as Figure 4). The second set of data (right side) shows the estimated Pu-238 and Np-237 activity when the WM-188 waste is modeled as first-cycle Zr waste. Figure 5 shows the activity of Pu-238 in CSSF 6 does not change significantly with the waste model used to estimate the activity. However, the Np-237 activity in CSSF 6 is strongly dependent on the waste model. Figure 5 shows the estimated Np-237 activity in CSSF 6 drops dramatically when the WM-188 waste is modeled as first-cycle Zr waste. The Zr waste model predicts a Np-237 activity of 0.0001 mCi/L compared to the sample value of 0.0007 mCi/L. As discussed, the SBW overestimates the activity of Np-237, and the Zr model underestimates the activity of Np-237. The actual activity of Np-237 in CSSF 6 is between the two extremes shown on Figure 5, but much closer to that obtained using the Zr waste model.

Figure 5. Comparison of transuranic activity in CSSFs with HPM stream #86 as sodium-bearing and as Zr waste.



4.5 Data Plots of Calcine Radionuclide Activity and Trends

Appendix B contains data plots of the radionuclide activity in the storage bins in the CSSFs. As with the chemicals, only the data from the four largest, outer bins from CSSF 1 are plotted. The calcine in CSSF 1 has relatively uniform radionuclide activity, so only the four largest bins are included to simplify the graphs and eliminate nearly redundant data plots. Most of the bottom and top segments in each bin are not included in the detailed data plots. The top and bottom bin segments are defined by thermocouples placed near the bottom and top of each bin. Those segments contain a very small volume of calcine, typically only a few cubic feet of the total bin volume of several thousand cubic feet. The volume of calcine in those segments is uncertain because it is an irregular shape defined by the curved bin heads and an uncertain angle of repose of the calcine. The small end segments was not included in the data plots and the statistical analyses because errors in those volumes could skew the concentrations for the entire bin. The data plots are arranged left-to-right corresponding with bottom-to-top in a bin. Thus, the data plots read left-to-right as the bins were filled.

Appendix B reports the activity of the calcine in the CSSFs for the 16 radionuclides listed in the Staiger report. The HPM includes many more radionuclides, but only 16 were included in the published report.

The data plots are arranged in order of the atomic weight of the radionuclides. Each page of Appendix B contains a data plot of the activity per unit mass (nCi/g) or volume (Ci/m^3) for a given radionuclide. The data plots show the radionuclide activity in the CSSFs varies among individual bins and between CSSFs. Each data plot in Appendix B includes the average activity and standard deviation for the radionuclide in each CSSF. As with the chemical constituents, the average radionuclide activity is the unweighted average of the bin segments, which differs slightly from the bin average. The average activities and standard deviations of selected radionuclides were used in Figures 3, 4 and 5 to illustrate general trends.

Based on comparisons of historical calcine sample analyses, the HPM accurately predicts the radionuclide content of most major radionuclides. However, the HPM has some limitations due to assumptions in the model.

4.5.1 Fission Products

The data plots in Appendix B show the fission products track each other and their data plots have the same shape, just as in Figure 3. This is because the fission product activity in the SNF, liquid waste, and calcine generally depended only on uranium burn up and age of waste. The data plots show the fission product activity is highest in the Al calcine in CSSF 1, slightly lower in the Zr calcine in CSSFs 3, 4, and 5, and lowest in CSSF 6. The fission product content of CSSF 6 starts off relatively high because first-cycle waste was calcined when CSSF 6 was initially placed in service. However, it decreases rapidly as the calcine transitions from first-cycle waste to SBW. The Cs-137 activity of calcine derived from first-cycle raffinate in CSSFs 1 through 5 is between 2,000 and 6,000 Ci/m^3. The Cs-137 activity of the newest calcine in CSSF 6 derived from SBW is between 200 and 300 Ci/m^3.

4.5.2 TRU Components

Some of the actinides and TRU components have skewed activities in CSSF 6 as previously discussed for Np-237. This is because the SBW model was used to estimate the TRU activity in the WM-188 waste (identified as stream 86 in the HPM). Radionuclides with skewed activity in CSSF 6 have a large increase in the middle portion of the CSSF 6 data plot. The significantly skewed actinides in CSSF 6 include thorium (Th-231) a short-lived daughter of U-235, protactinium (Pa-233) a short-lived daughter of Np-237, and Np-237. There is also some skewing of the Pu and Am activity, though it is much less than Th-231, Pa-233, and Np-237.

4.5.2.1 Thorium

The uranium isotopes (not included in Appendix B) in the WM-188 waste were estimated using the SBW model. The uranium in the SBW model was based on samples containing concentrated PEW Evaporator waste with relatively high uranium and low Cs-137 activity, resulting in a high U:Cs-137 ratio. The first-cycle component of WM-188 had low uranium and high Cs-137 activity. Applying the SBW model to the WM-188 waste resulted in skewed values (conservatively high) of uranium, similar to that of Np-237. The WM-188 liquid samples contained 2.5×10^{-8} Ci/L of U-235. The SBW estimated the U-235 activity to be 1.4×10^{-7} Ci/L, nearly six times the sample value. Th-231 (included in Appendix B) is a short-lived daughter of U-235 and is in equilibrium with U-235. Therefore, the estimated activity for Th-231 in the WM-188 waste, and the CSSF 6 calcine derived from that waste, is conservatively high and results in the large spike in the Th-231 activity in CSSF 6.

4.5.2.2 Protactinium

Protactinium (Pa-233) is a short-lived daughter of Np-237. As previously discussed, the SBW model conservatively estimated the Np-237 activity in WM-188 waste nearly 30 times higher than the sample results. Therefore, the estimated activity of the Np-237 daughter Pa-233 is also nearly 30 times higher than its actual value in the WM-188 waste and in the corresponding CSSF 6 calcine. This creates a large spike in the activity of Pa-233 in the CSSF 6 data plots.

4.5.2.3 Plutonium

The activities of Pu and Am in the CSSF 6 calcine derived from WM-188 waste were also estimated at levels above those of sample results. However, the differences between the estimated and actual activities were less than a factor of three. This resulted in only minor skewing of the data plots for CSSF 6 in Appendix B.

The data plot of the Pu-239 activity differs from those of Pu-238 and -240 in CSSF 4 and 5. The activities of Pu-238 and -240 are relatively constant throughout CSSF 4 and 5 with two exceptions; there is a dip in the Pu-238 and -240 activities near the bottom of CSSF 5, and a second dip at the top of CSSF 5. The drop in the Pu-238 and -240 activities near the bottom of CSSF 5 corresponds to the calcination of low activity ROVER waste. The Pu-239 activity in CSSF 4 and 5 is also nearly constant with two exceptions. However, the two exceptions differ from those of Pu-238 and -240. The Pu-239 activity has a large increase in the top of CSSF 4 that extends into the bottom of CSSF 5 and a second increase in activity in the top of CSSF 5.

One reason the Pu-239 activity in CSSF 4 and 5 differs from that of the other Pu isotopes is potentially errant liquid sample analyses used in the HPM. Waste from WM-189 (identified in the HPM as stream #63) was a major source of the calcine in the top of CSSF 4 and in the bottom of CSSF 5. The Pu-239 in stream #63 is the average of three analyses. The Pu-239 value in one of the three analyses (log number 83-040818) appears to be an errant (high) value because it is an order of magnitude higher than the other two. This results in the high Pu-239 activity in the upper portion of CSSF 4 and the lower portion of CSSF 5 seen in the Appendix B data plot. Likewise, there is a small amount of waste from WM-182 in the bottom of CSSF 5 (identified in the HPM as streams # 68 and 69). The Pu-239 activity in those two streams is based upon three analyses, one of which (log 83-09166) was an order of magnitude higher than the other two. The high Pu-239 activity in WM-182 also appears to be an error and contributes to the high Pu-239 activity in the bottom of CSSF 5.

Another waste from WM-182 (identified as stream #83 in the HPM) was a major source of the calcine in the top of CSSF 5. Stream #83 was first-cycle Al raffinate and had sample analyses that reported the total Pu activity, but not the isotopic distribution. An isotopic distribution of Pu was made using the Al waste model (90 % Pu-238 and 10 % Pu-239). Stream #83 had an order of magnitude more Pu than predicted by the Al waste model. The Al waste model was developed for first-cycle Al waste from which some of the actinides had been removed in the uranium extraction process, collected in the second/third cycle raffinate, and stored separately from the first-cycle raffinate in the Tank Farm. However, Stream #83 was first-cycle Al waste that had been combined with second and third cycle raffinate from several fuel dissolution campaigns. It contained approximately 30-volume percent second/third cycle raffinate (Loos 2003). Combining the actinide-enriched second/third cycle waste with the first-cycle waste resulted in Pu activities above those predicted by the Al waste model. The resulting Pu-238 was an order of magnitude above typical Al waste and about the same as first-cycle Zr waste. Consequently, the Pu-238 activity in the top of CSSF 5 (from stream #83) is about the same as the Pu-238 activity in the Zr calcine in the center of CSSF 5. The Pu-239 activity in stream #83 was also an order of magnitude above Al waste, but it was also a factor of three higher than Zr waste. Consequently, the Pu-239 activity in the top of CSSF 5 (from stream #83) is higher than the Zr calcine in the center of CSSF 5 as shown on the Appendix B data plots.

4.5.2.4 Other TRU components

There are a few other anomalies between the HPM estimates and the actual calcine composition for some of the minor TRU components (isotopes of Cf, Cm, etc.) that are not included in Appendix B. These anomalies are due to assumptions inherent in the radionuclide estimation models. The amounts of the TRU components predicted by ORIGEN2 were adjusted based on liquid or calcine sample results. In most models, the adjustment factors for Pu, as determined by sample analyses, were also applied to the TRU components for which sample data did not exist (minor components such as Cm, Cf, etc.). However, the Zr model is different from the other models. The Zr model adjusted the ORIGEN2-estimates for the major TRU components (for which sample data existed), but did not apply those adjustment factors to other TRU components. This underestimated the minor TRU components in the Zr calcine.

4.5.3 Nickel

The data plot for the activity of Ni-63 does not follow that of either the fission products or the actinides. This is because Ni-63 is formed from the activation of Ni in the SNF. Unlike fission products, light activation products such as Ni-63 and Co-60 varied significantly with fuel type and were a function of the composition of the fuel cladding. There was virtually no Ni in Al-clad fuel, consequently very little Ni-63 was formed in Al-clad fuel or is found in Al calcine. Zr-clad fuel contained a moderate amount of Ni in the cladding and a moderate amount of Ni-63 in its waste. Stainless steel-clad fuel had the highest amount of Ni in its cladding and the most Ni-63 of any waste type. Compared to Al and Zr waste, the amount of stainless steel waste generated at INTEC was not large. A small amount of stainless steel sulfate waste (contained in tank WM-106) was first calcined near the end of WCF Campaign 5 and stored in CSSF 3. Eventually, the stainless steel sulfate waste was mixed with other Tank Farm wastes and processed as a blend in the WCF and stored in CSSF 3. Electrolytic stainless steel waste was generated in the 1970s and early 1980s. It was blended with first-cycle Al and Zr wastes, calcined in the NWCF Calciner, and stored in CSSF 4, 5, and 6.

4.6 Tabulated Calcine Composition Data

Appendix C contains six data tables, Tables C-1 through 6, corresponding to CSSF 1 through 6. The data in Appendix C were the basis for the figures and the data plots in this report. The data tables in Appendix C contain the chemical content and radionuclide activity of the calcine in each bin segment for each CSSF. The data tables include the average and standard deviations of the bin segment compositions for each CSSF. The data with the shaded backgrounds were not used in the CSSF average composition and standard deviation calculations because those bin segments have very small volumes (some as little as one cubic foot) that could unreasonably skew the average calculations.

Appendix C contains the same data as that in Appendices A and B, but is presented in a different format. Appendices A and B present the data in a graphical format, and Appendix C provides the data in a tabular format. Appendices A and B provide data for a single chemical or radionuclide for all CSSFs on a single data plot. This format focuses on a given component in all CSSFs and shows how the component changed over time, which CSSFs contain large or small quantities of a given component, etc. The data tables in Appendix C group all of the components of a given CSSF together.

5. CONCLUSION

An earlier report, *Calcined Waste Storage at the Idaho Nuclear Technology and Engineering Center* INEEL/EXT-98-00455 Rev 1, estimated the chemical and radionuclide composition of the calcine stored in the INTEC CSSFs based on historical liquid waste samples, plant operating data, and SNF reprocessing and waste handling process knowledge. That estimate has been called an historical processing model (HPM). This addendum report compiles the HPM data in units commonly used in the waste treatment and disposal industry. It presents the calcine composition data in both a graphical and tabular format. This allows data users to view the HPM data in units that are commonly used in sample analysis, national standards and regulations related to waste treatment and disposal. This report also shows the chemical composition and radionuclide activity of the calcine varies significantly among the CSSFs.

The calcine composition varies because the composition of the liquid waste from which the calcine was formed varied. The variability in the calcine composition reflects the history of INTEC and the changes that occurred in fuel reprocessing, waste generation, and calcination. These changes included reprocessing different types of fuel with differing cladding material, and using various neutron poisons, catalysts, and chemical additives in the fuel and waste treatment processes.

Based on comparisons of limited historical calcine sample data, the HPM accurately predicts the composition of the calcine for the major chemical and radionuclide constituents, with a few exceptions. The exceptions are for minor components or for a few individual waste streams. The estimates of some actinides and TRU components in CSSF 6 are conservatively high due to the use of the SBW model for the WM-188 waste calcined in 1997-1998 (stream #86). The WM-188-related assumptions in the HPM were made several years ago when a conservatively high estimate of the radionuclide content of the calcine was required for a safety analysis. Treating the WM-188 as a blend of SBW and Zr waste would result in a more realistic estimate of the calcine composition. Alternatively, WM-188 sample data exist for some TRU components that were not used in the HPM. Those analyses could be used in place of the SBW model estimates to improve the accuracy of the HPM.

A few changes to the radionuclide estimate models would improve the accuracy of the HPM. For example, the sample adjustment factors for Cm and Np in the SBW model are conservatively high because they were based on data that included analytical detection limits. The SBW model could be revised to provide less conservative and more realistic estimates of Cm and Np. The radionuclide estimate models could also be improved by using a consistent method of adjusting actinides and TRU components for which sample data do not exist. The Al and coprocessing models apply an average TRU adjustment factor to all actinides and TRU components for which sample data do not exist, but the Zr model does not. Changing the Zr model to use an actinide and TRU adjustment factor like that of the Al and coprocessing models would improve the accuracy of the Zr model.

A few of the historical analytical samples used by the HPM have inconsistent data for some constituents, where one analyses differs significantly from other analyses of the same waste. Some inconsistent data were eliminated from the database when it was first compiled. However, a few more errant data could be eliminated to improve the accuracy of the HPM.

6. REFERENCES

Childs, K. F., Millet, C. B., O'Brien, B. H., Swenson, M. C., and Wood, R. A., 2003, *Validation of the Calcine Composition Model (Rev. 4) Used in INEEL/EXT-98-00455*, EDF-2765, July 17, 2003.

Croff, A. G., 1980, *ORIGEN2—A Revised and Updated Version of the Oak Ridge Isotope Generation and Depletion Code*, ORNL-5621, Oak Ridge National Laboratory, Oak Ridge, Tennessee.

O'Brien, B. H., 1995, *Estimation of Alkali Metal Mole Percent and Weight of Calcined Solids for ICPP Calcine*, INEL-95/0184, March 1995.

Loos, R. L., 2004, "INTEC Tank Farm Operating History Report and Completion of Sodium-Bearing Waste Treatment Process Project Milestone", CCN 47582, January 29, 2004.

Millet, C. B., 2004, "Calcine Waste Storage at Intec Addendum Files, Verification and Validation", Engineering Design File 4849, May 6, 2004.

Staiger, M. D., 2003, *Calcined Waste Storage at the Idaho Nuclear Technology and Engineering Center*, INEEL/EXT-98-00455 Rev. 1, June 2003.

Staples, B. A., Pomiak, G. S., and Wade, E. L., 1979, *Properties of Radioactive Calcine Retrieved from the Second Calcined Solids Storage Facility*, ICP-1189, March 1979.

Staples, B. A., 1994, "Composition of Calcines from H3 Campaign of the NWCF", Interoffice Memorandum, BAS-18-94, October 21, 1994.

Staples, B. A., 1995, "Radioassay of Calcines from H3 Campaign of the NWCF", Interoffice Memorandum, BAS-1-95, January 16, 1995.

Swenson, M. C., 1999, "Independent Verification of Estimate of Inventory of Selected CSSF VI", Interoffice Memorandum MCS-03-99, October 7, 1999.

Swenson, M. C., 2003a, "Comparison of Calcine Composition from Historical Samples and Flowsheet Modeling in INEEL/EXT-98-00455 Rev 1", Interoffice Memorandum MCS-05-03, March 31, 2003.

Swenson, M. C., 2003b, *Validation of Historical Tank farm Composition Database*, INEEL/EXT-2001-991 Rev. 2, October 24, 2003.

Swenson, M. C., 2003c, *Validation of the Radionuclide Inventory and Mass Balance used in the INTEC SBW and Tank Farm Residuals WIR Determination Reports*, INEEL/EXT-2001-534 Rev. 5, October 24, 2003.

Thomas, T. R., 2003, *Data Quality Objectives for In Situ Characterization and Sampling of the Calcine Solids Storage Facilities*, EDF-3848, June 20, 2003.

Wenzel, D.R., 2002, *Relative Inventories of Reactor-Produced Species in INTEC Waste Types*, EDF CRPD-001, November 4, 2002

Wood, R. A., 2000, "Updated Aluminum Nitrate; WM-189 Blend Calculations for 500^{o}C and 600^{o}C Operation During NWCF Run H4", Interoffice Memorandum RAW -01-00, February 14, 2000.

Appendix A

Concentrations of Chemicals in Calcine Data Plots

Appendix A

Concentrations of Chemicals in Calcine Data Plots

Contents

Figure A-1: Weight Percent Aluminum (TC Segments listed bottom to top)

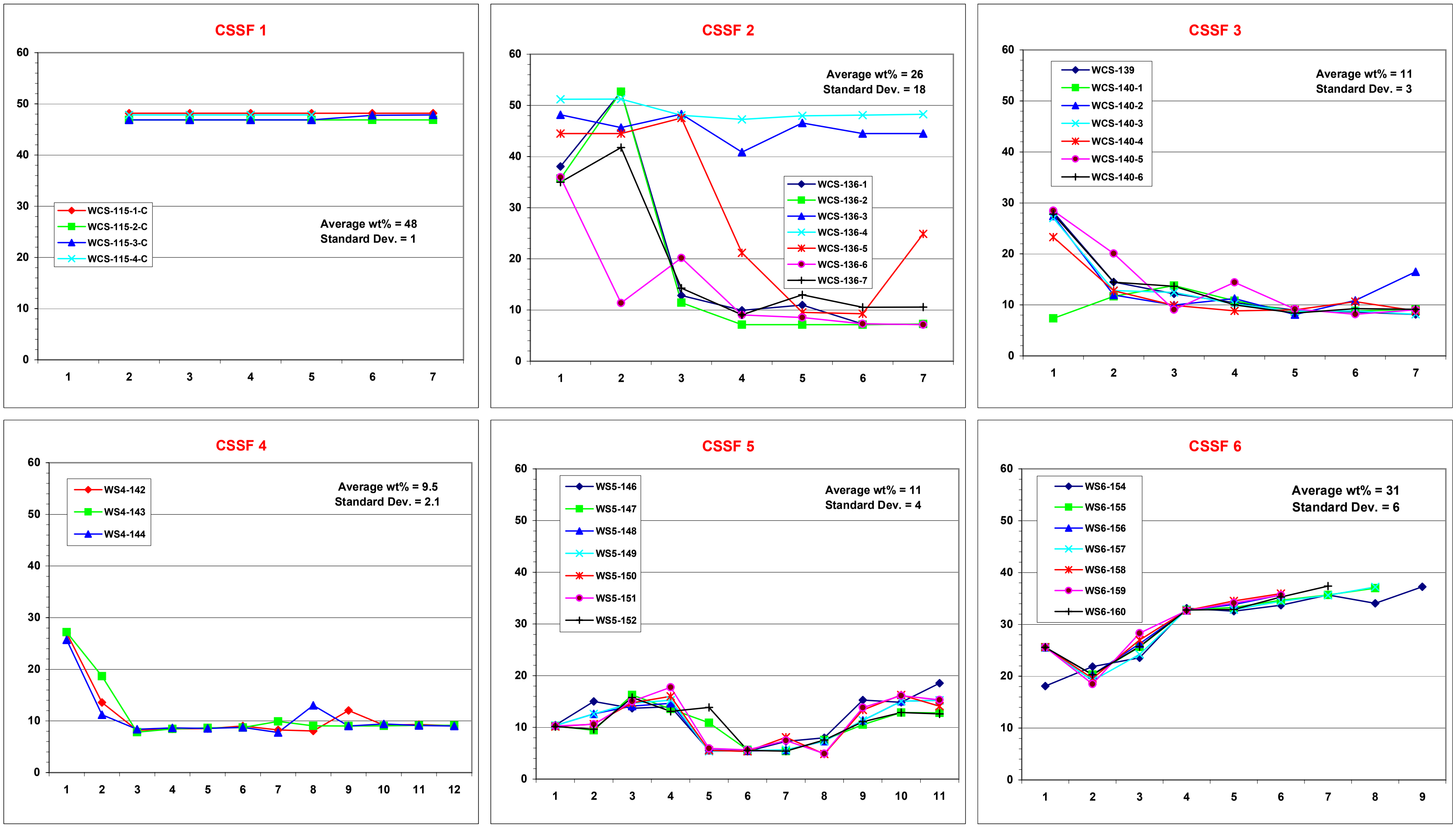


Figure A-2: Weight Percent Boron (TC Segments listed bottom to top)

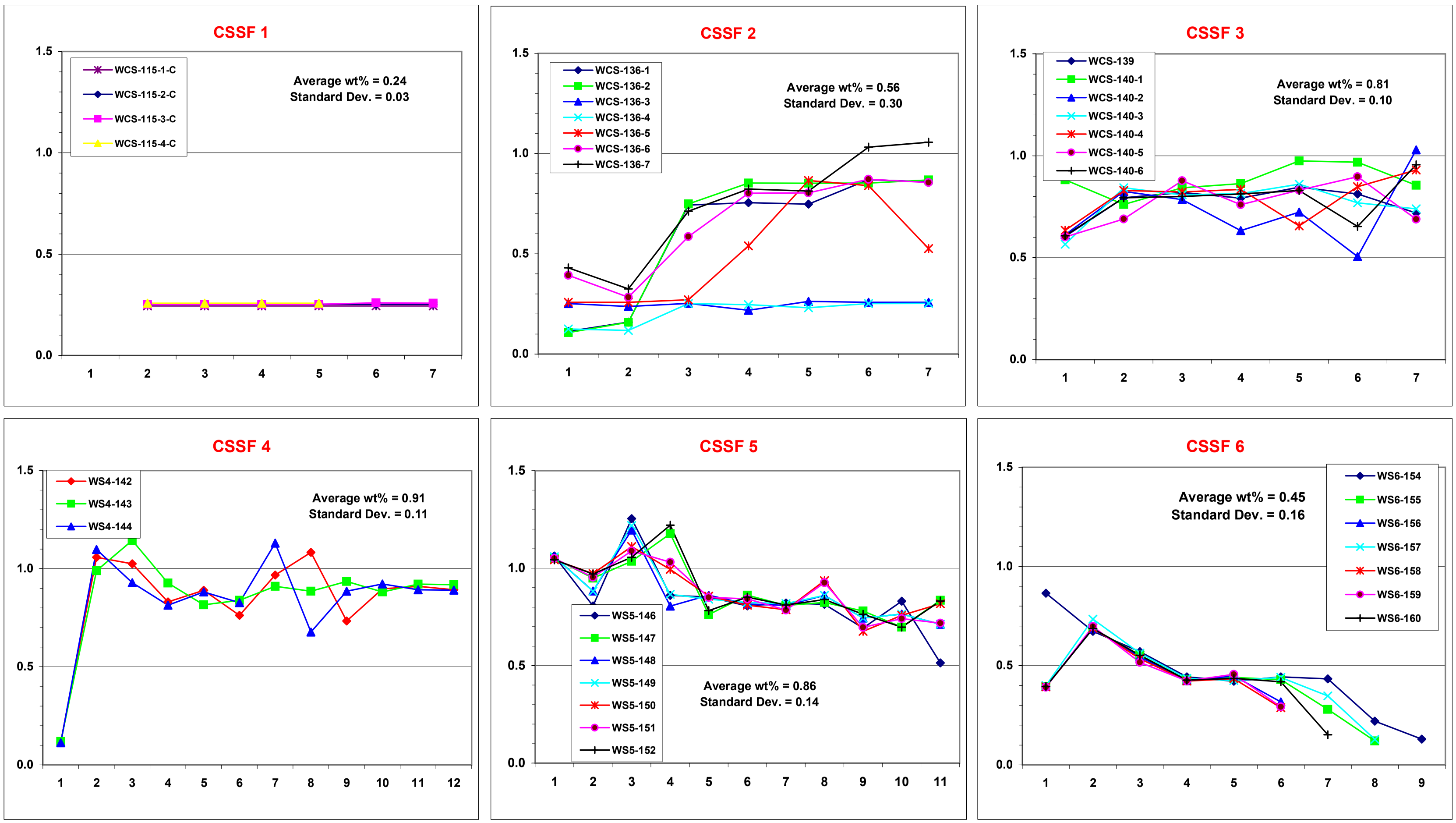


Figure A-3: Weight Percent Cadmium (TC Segments listed bottom to top)

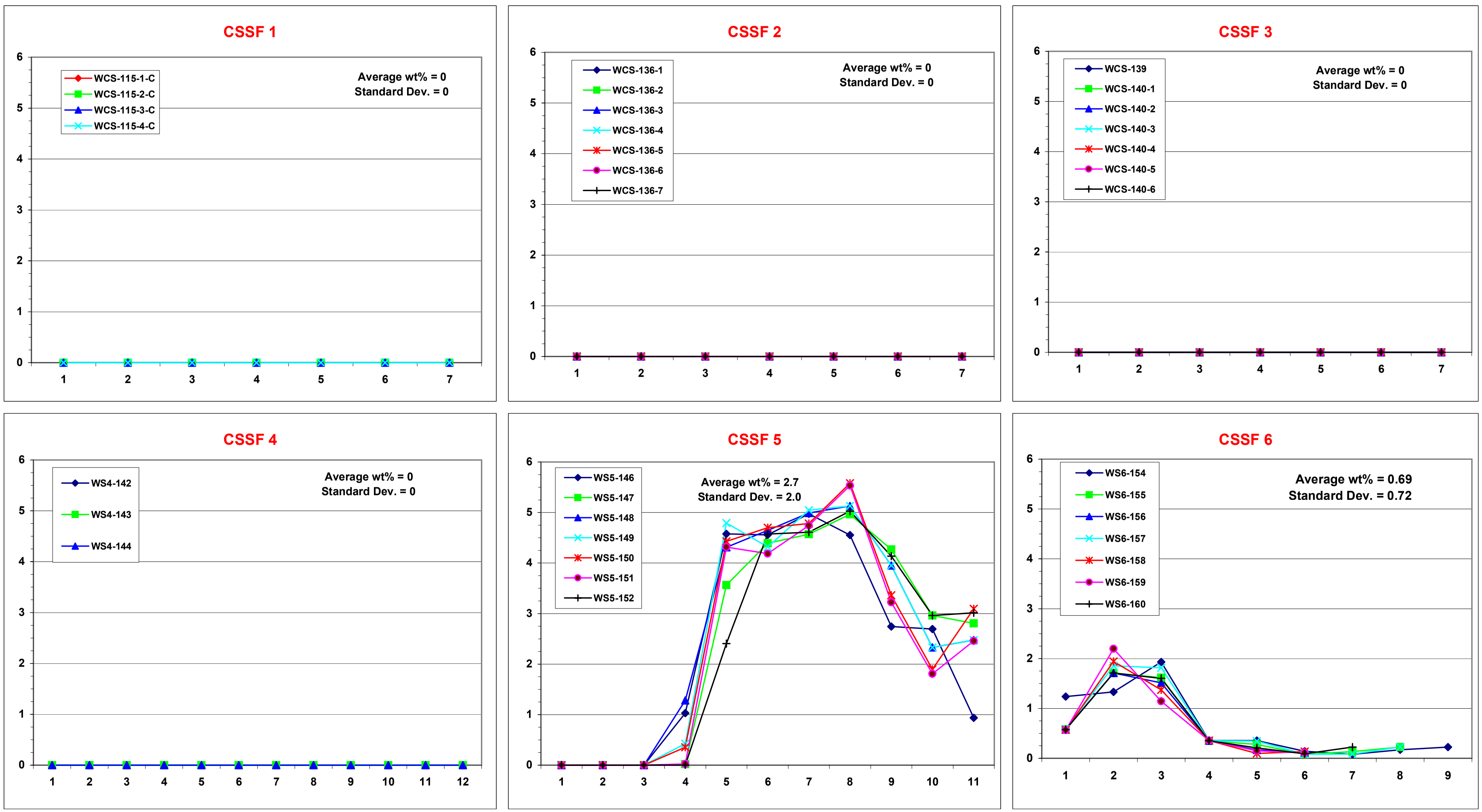


Figure A-4: Weight Percent Calcium (TC Segments listed bottom to top)

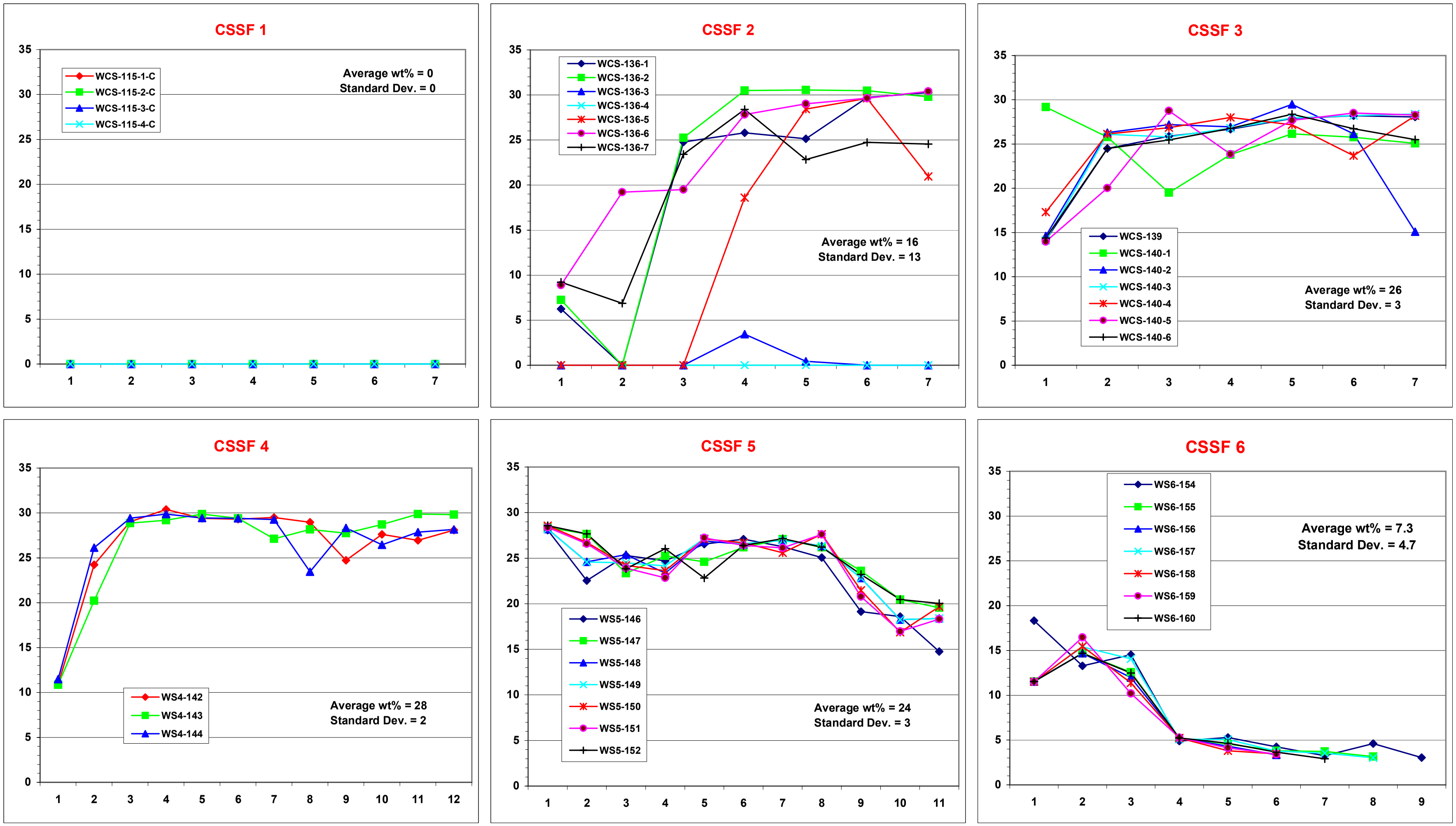


Figure A-5: Weight Percent Carbonate (TC Segments listed bottom to top)

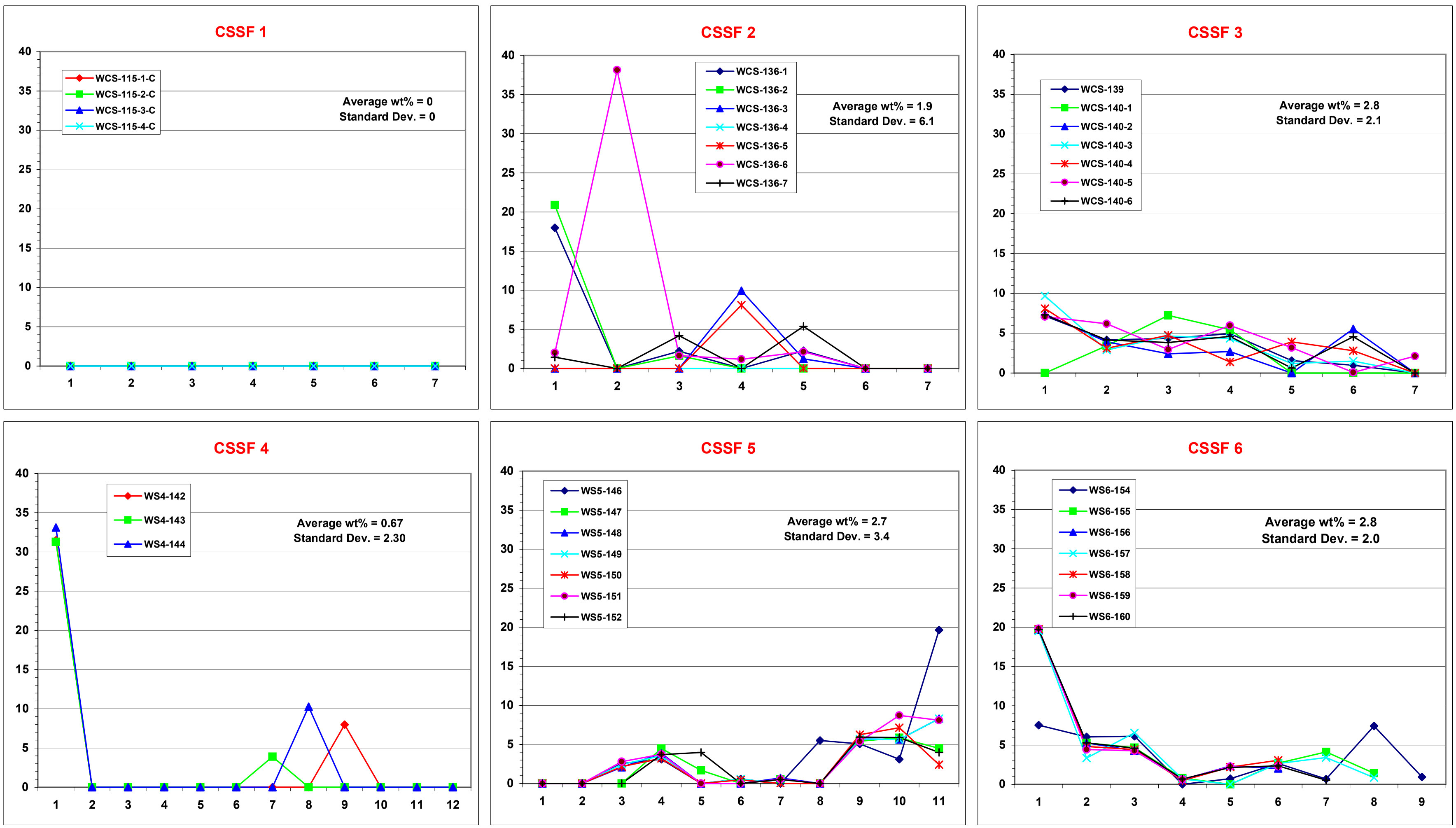


Figure A-6: Weight Percent Cesium (TC Segments listed bottom to top)

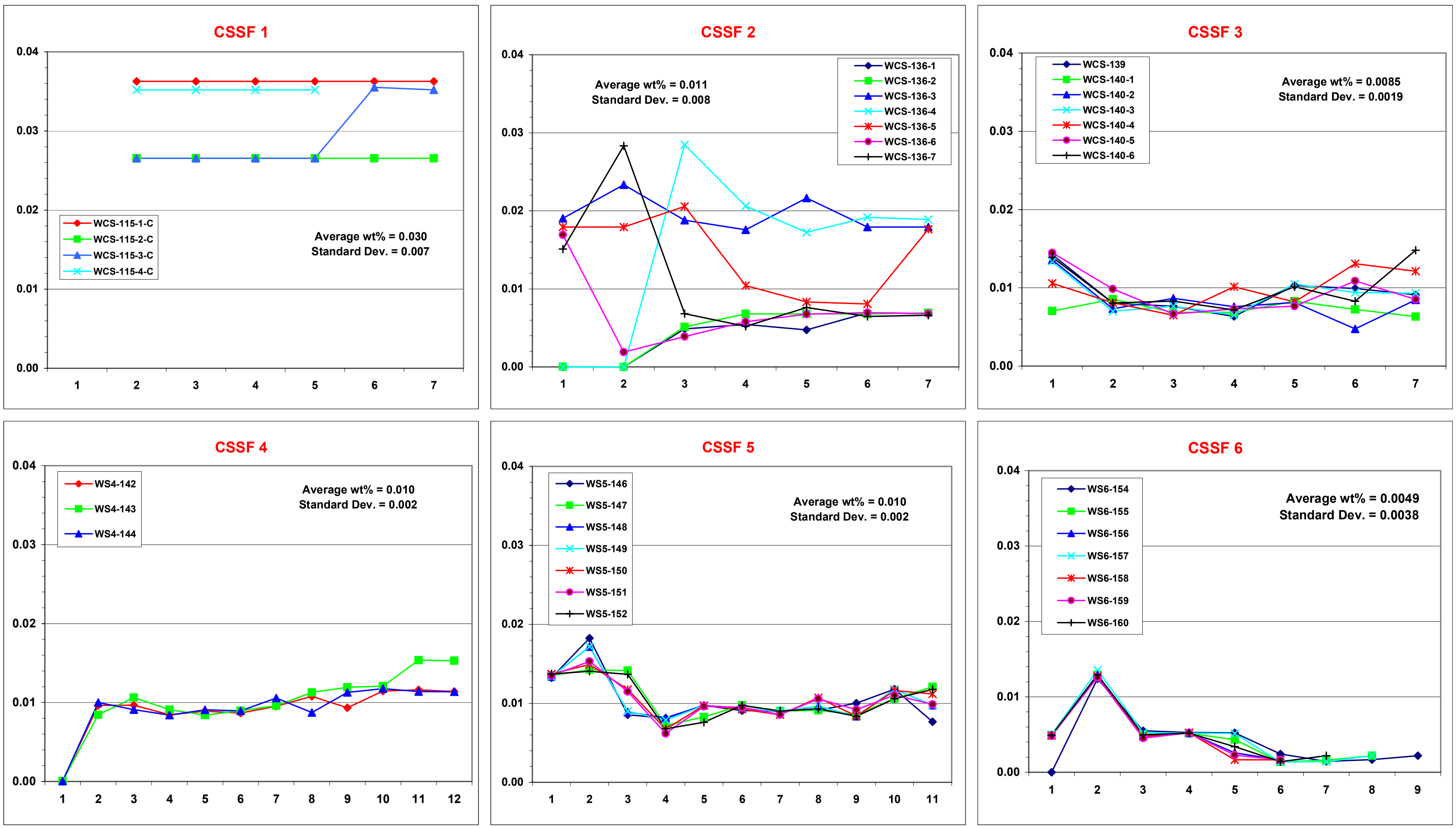


Figure A-7: Weight Percent Chloride (TC Segments listed bottom to top)

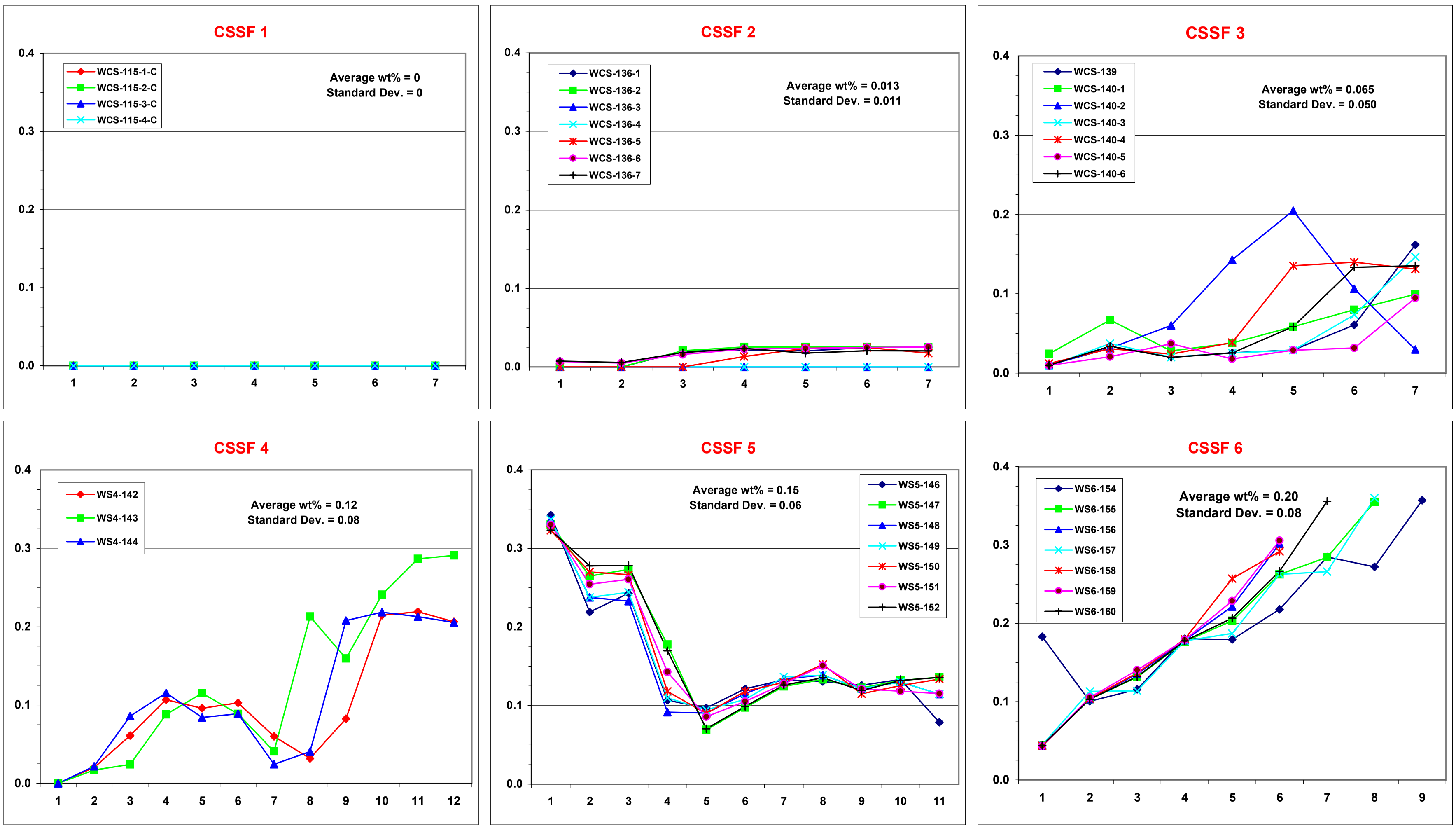


Figure A-8: Weight Percent Chromium (TC Segments listed bottom to top)

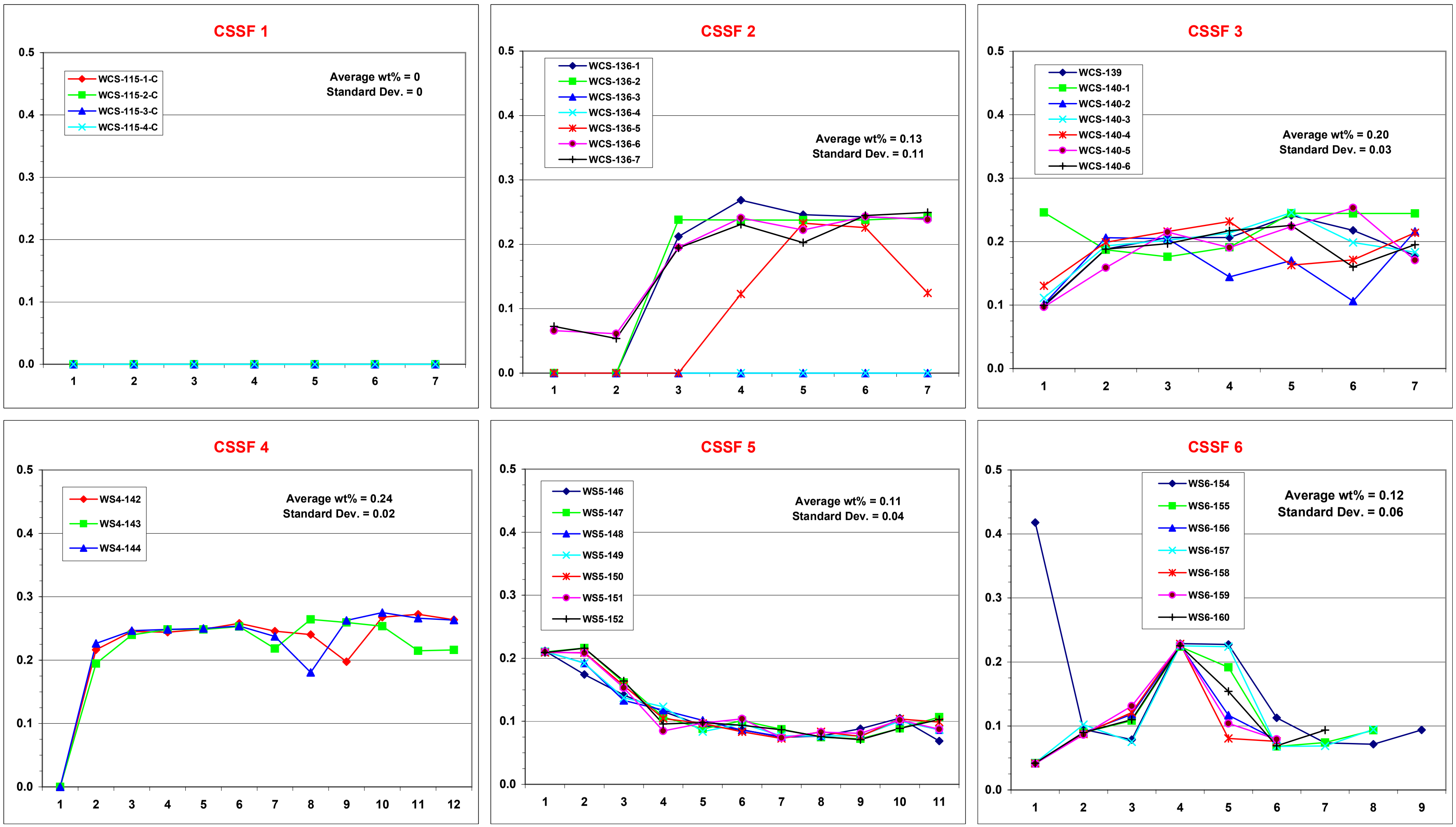


Figure A-9: Weight Percent Fluoride (TC Segments listed bottom to top)

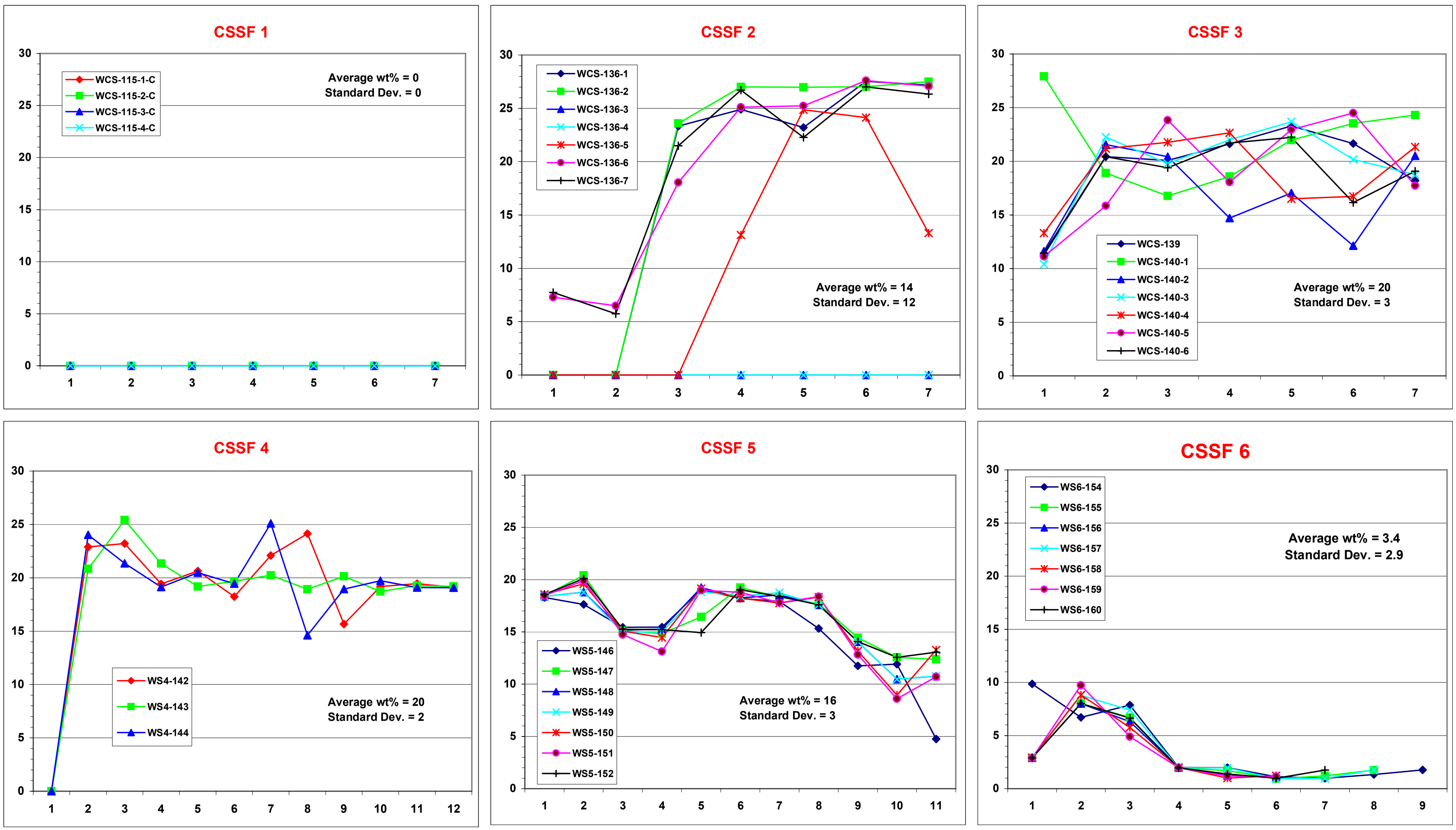


Figure A-10: Weight Percent Iron (TC Segments listed bottom to top)

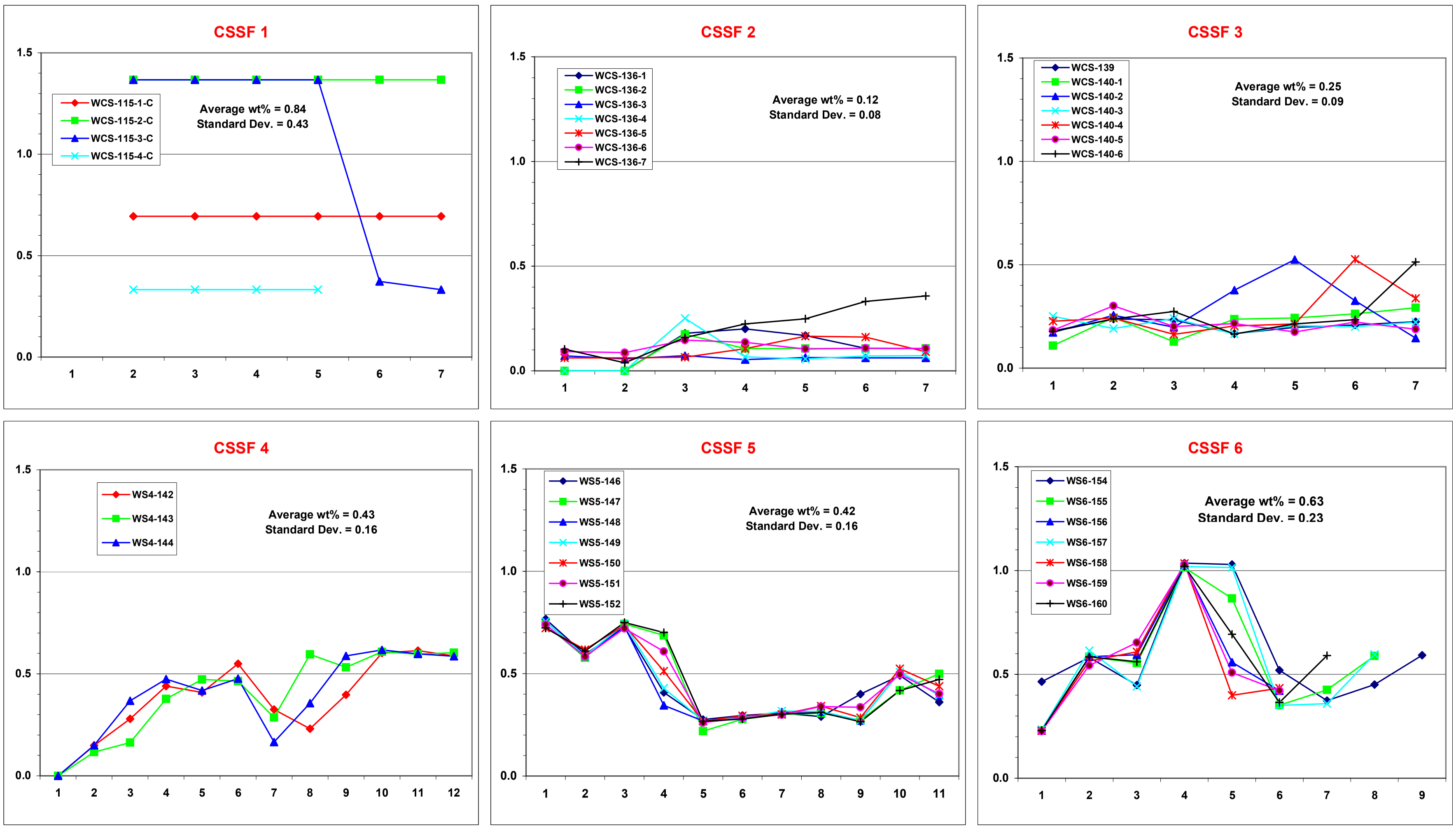


Figure A-11: Weight Percent Magnesium (TC Segments listed bottom to top)

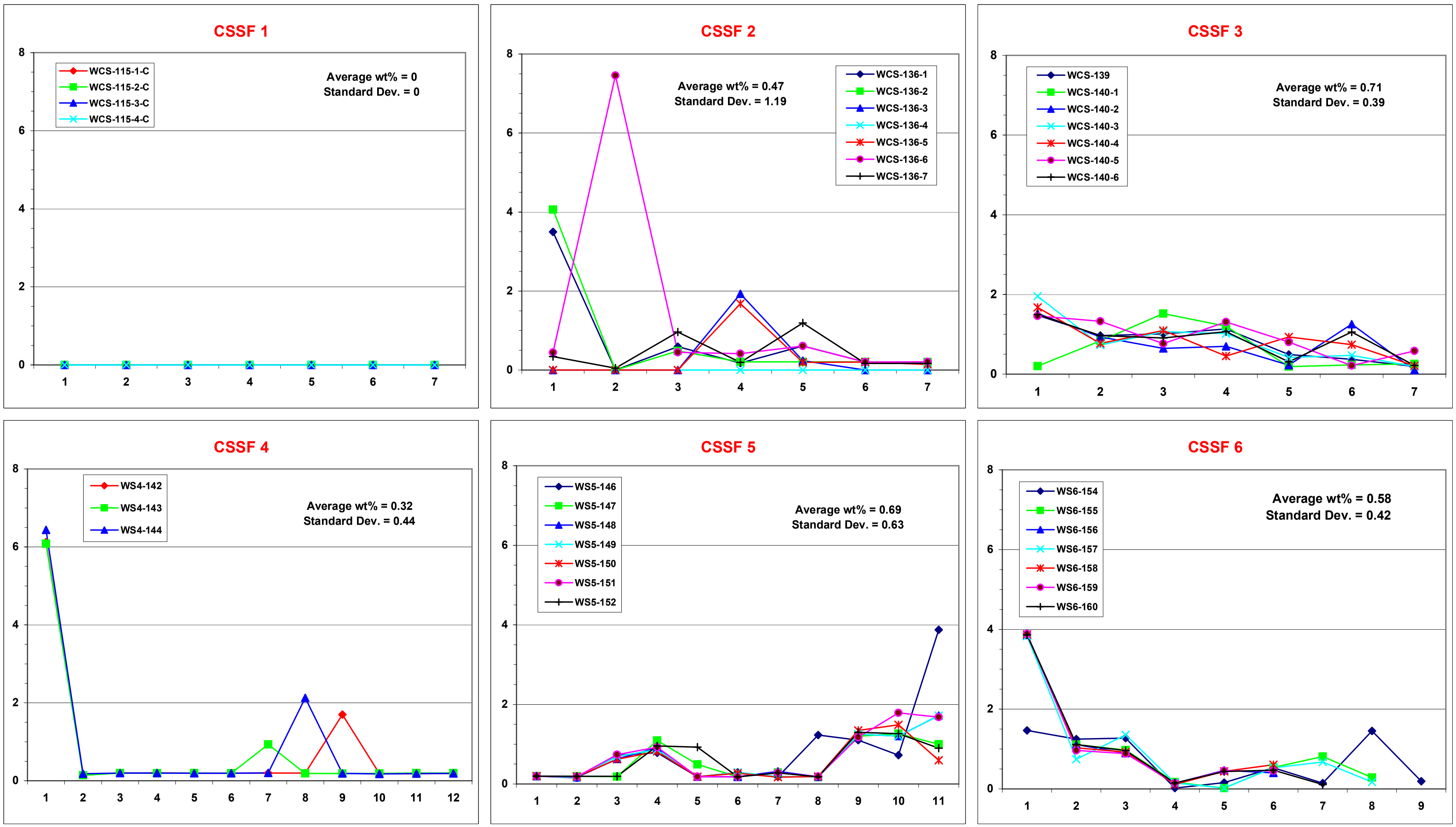


Figure A-12: Weight Percent Manganese (TC Segments listed bottom to top)

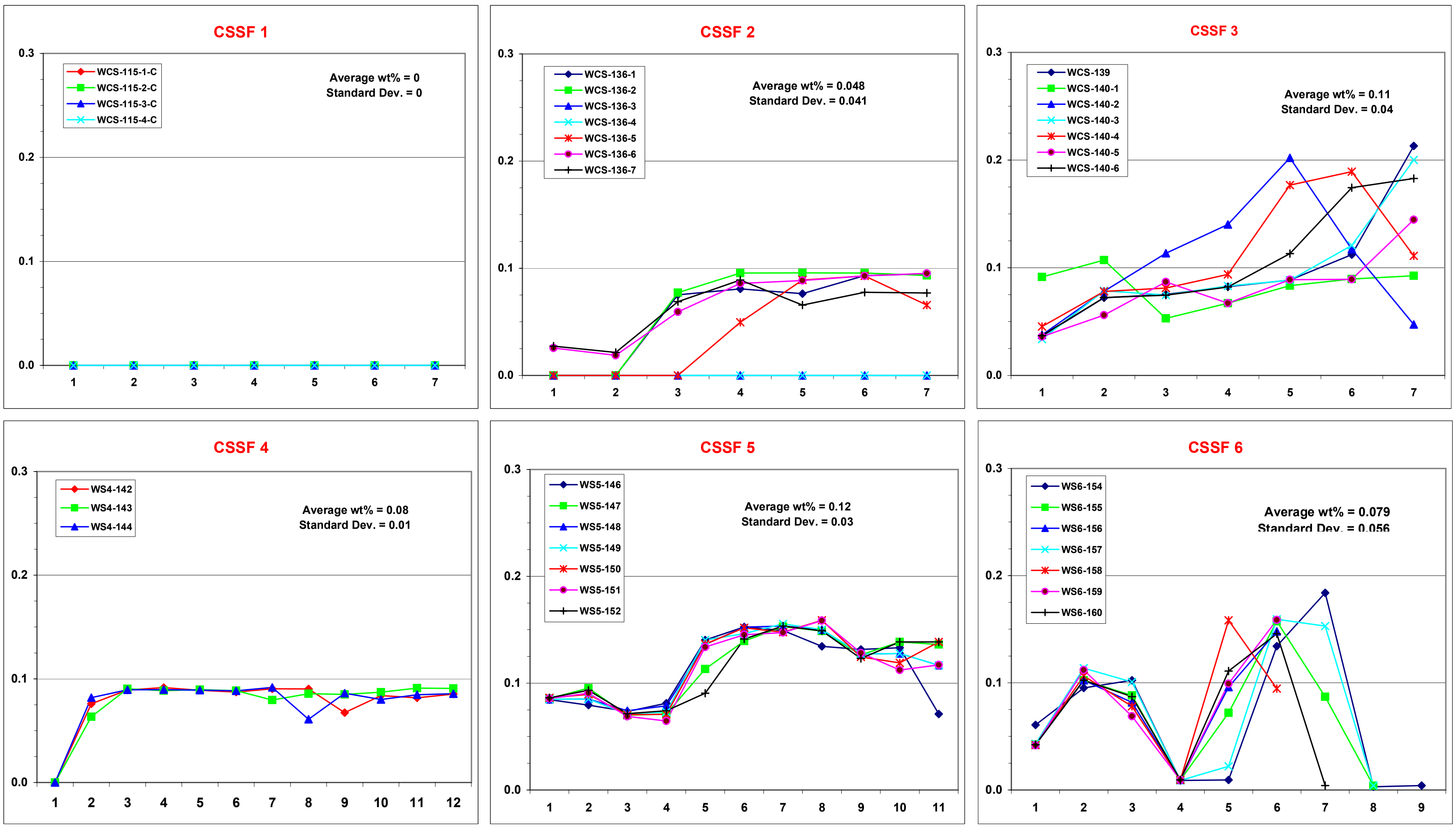


Figure A-13: Weight Percent Mercury (TC Segments listed bottom to top)

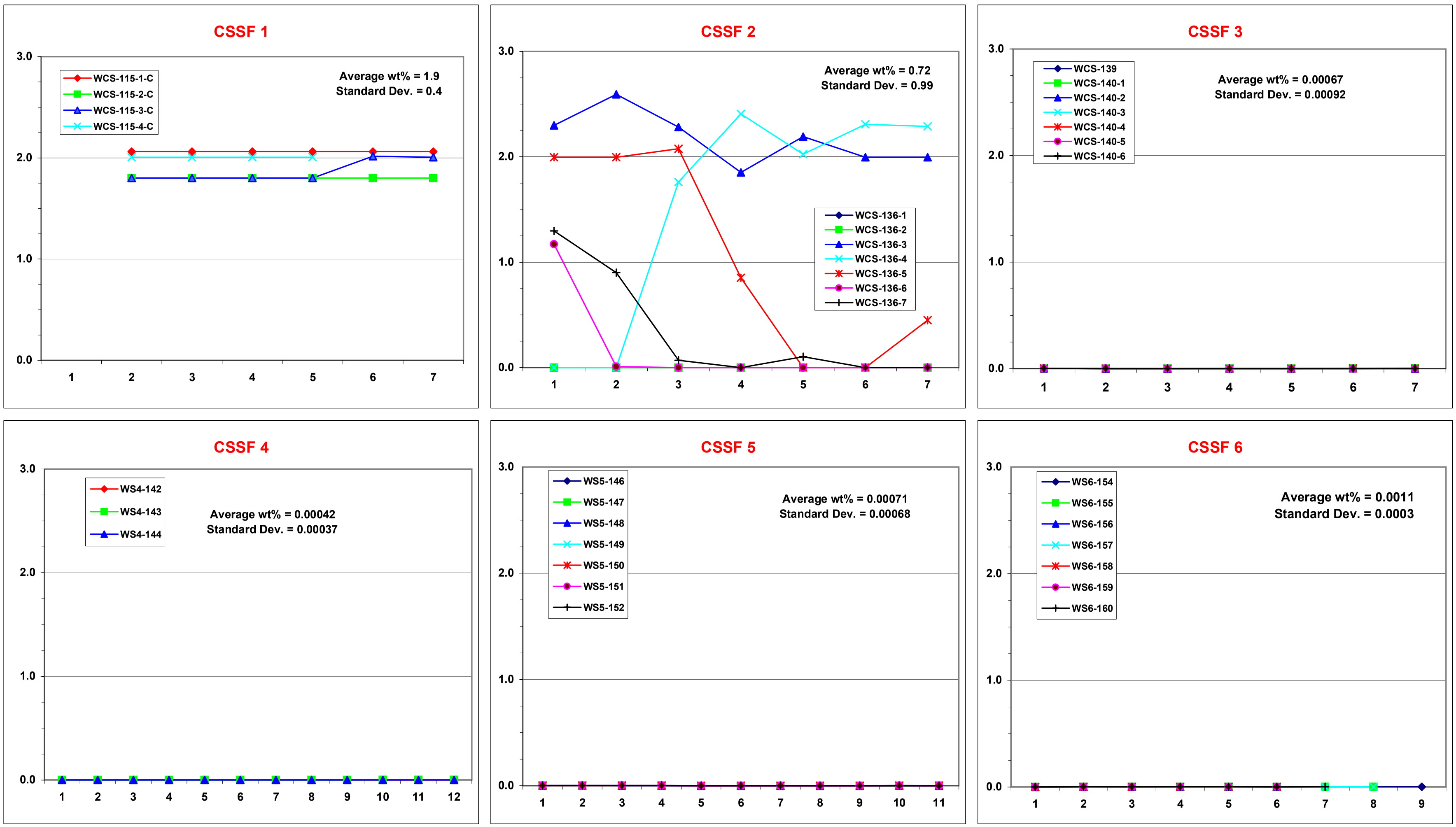


Figure A-14: Weight Percent Nickel (TC Segments listed bottom to top)

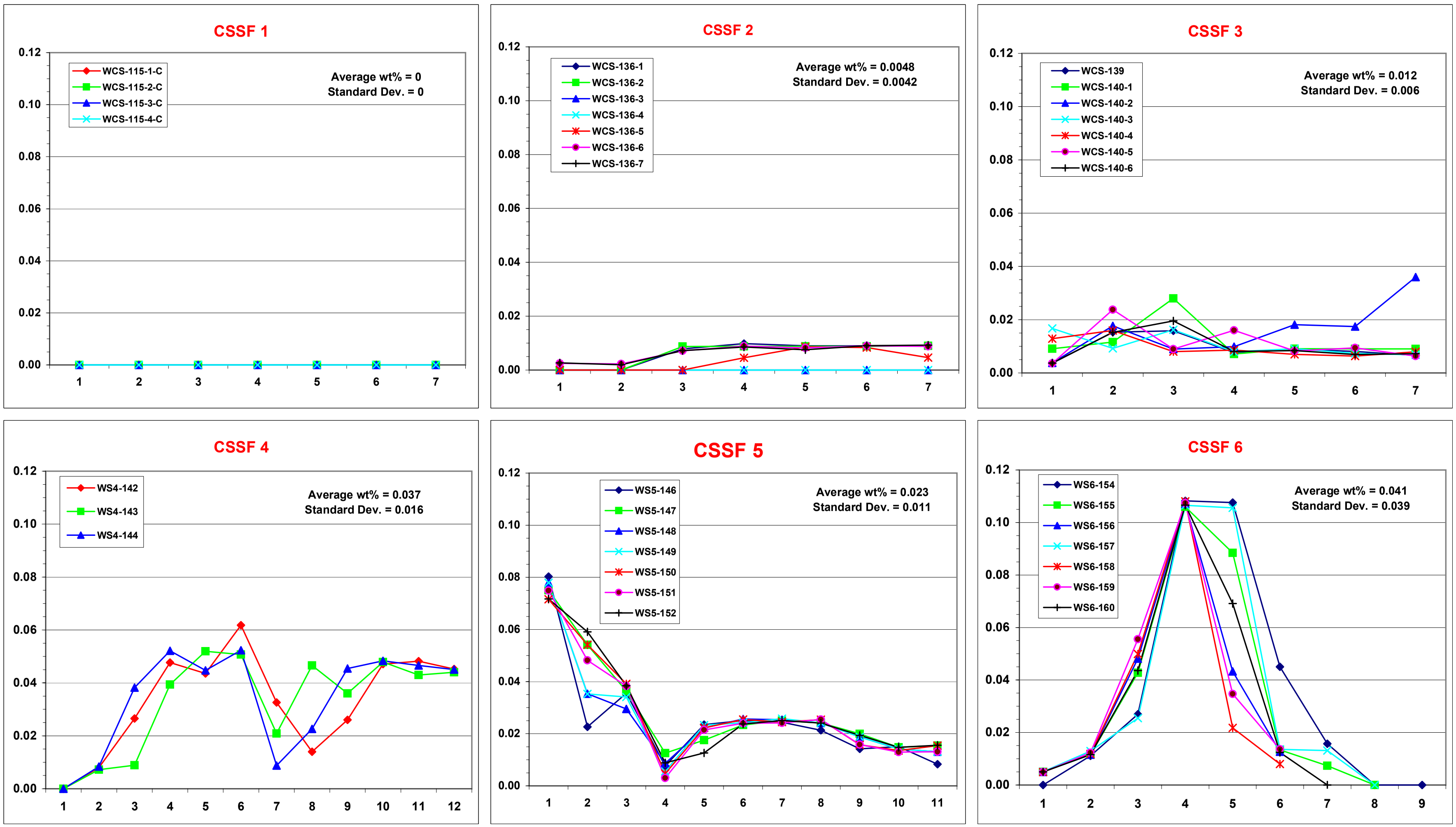


Figure A-15: Weight Percent Nitrate (TC Segments listed bottom to top)

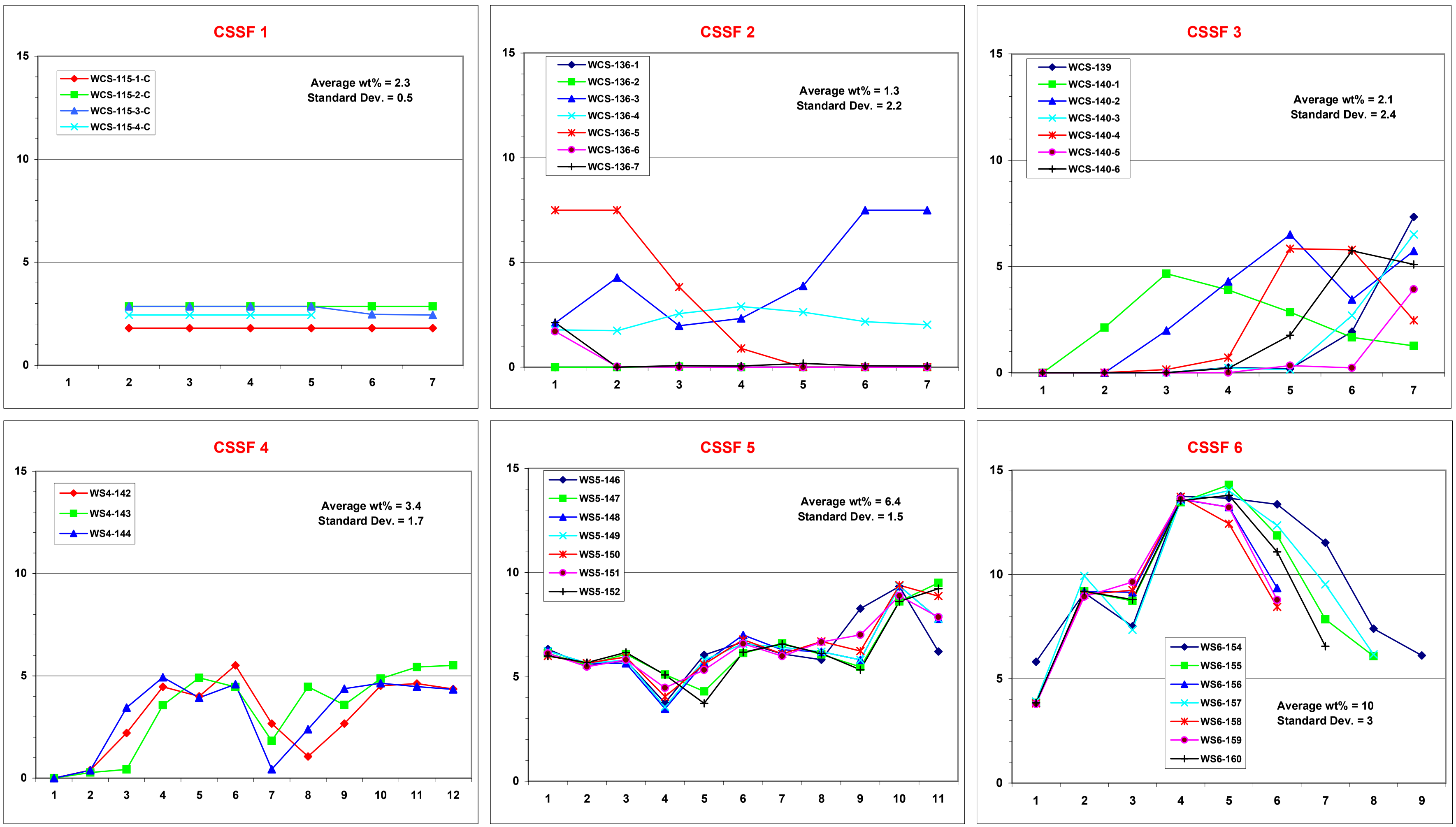


Figure A-16: Weight Percent Oxide (TC Segments listed bottom to top)

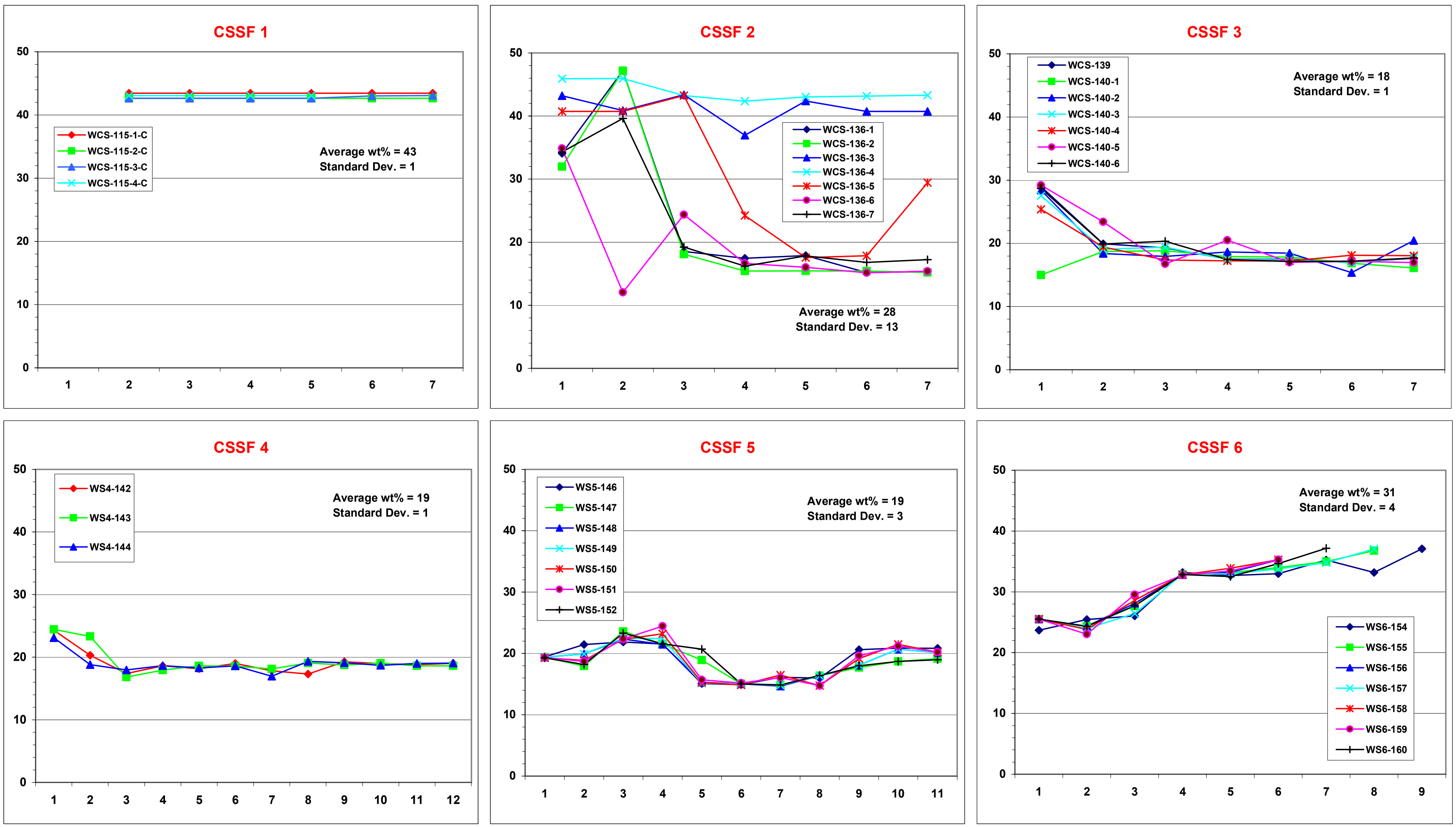


Figure A-17: Weight Percent Phosphate (TC Segments listed bottom to top)

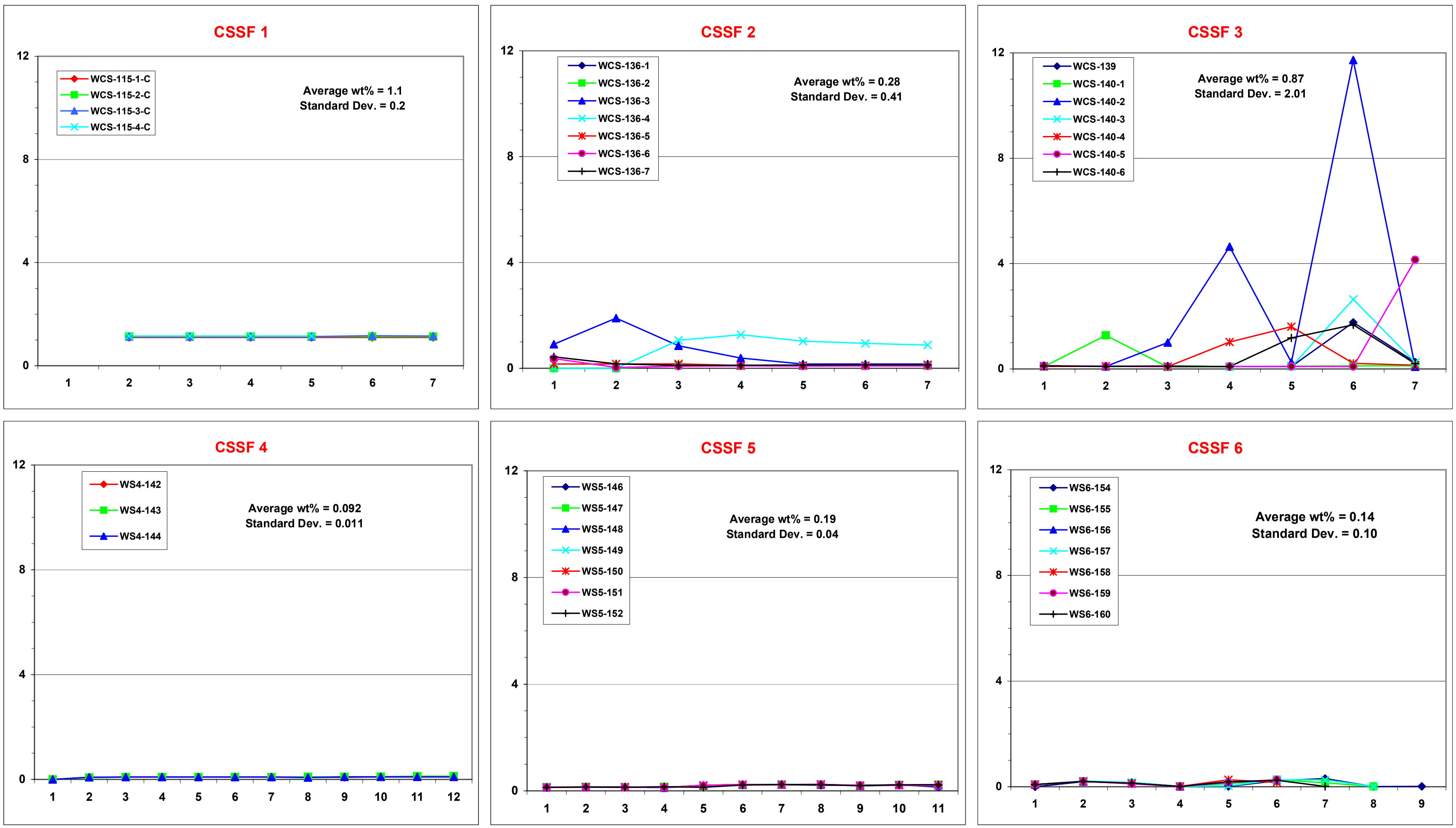


Figure A-18: Weight Percent Potassium (TC Segments listed bottom to top)

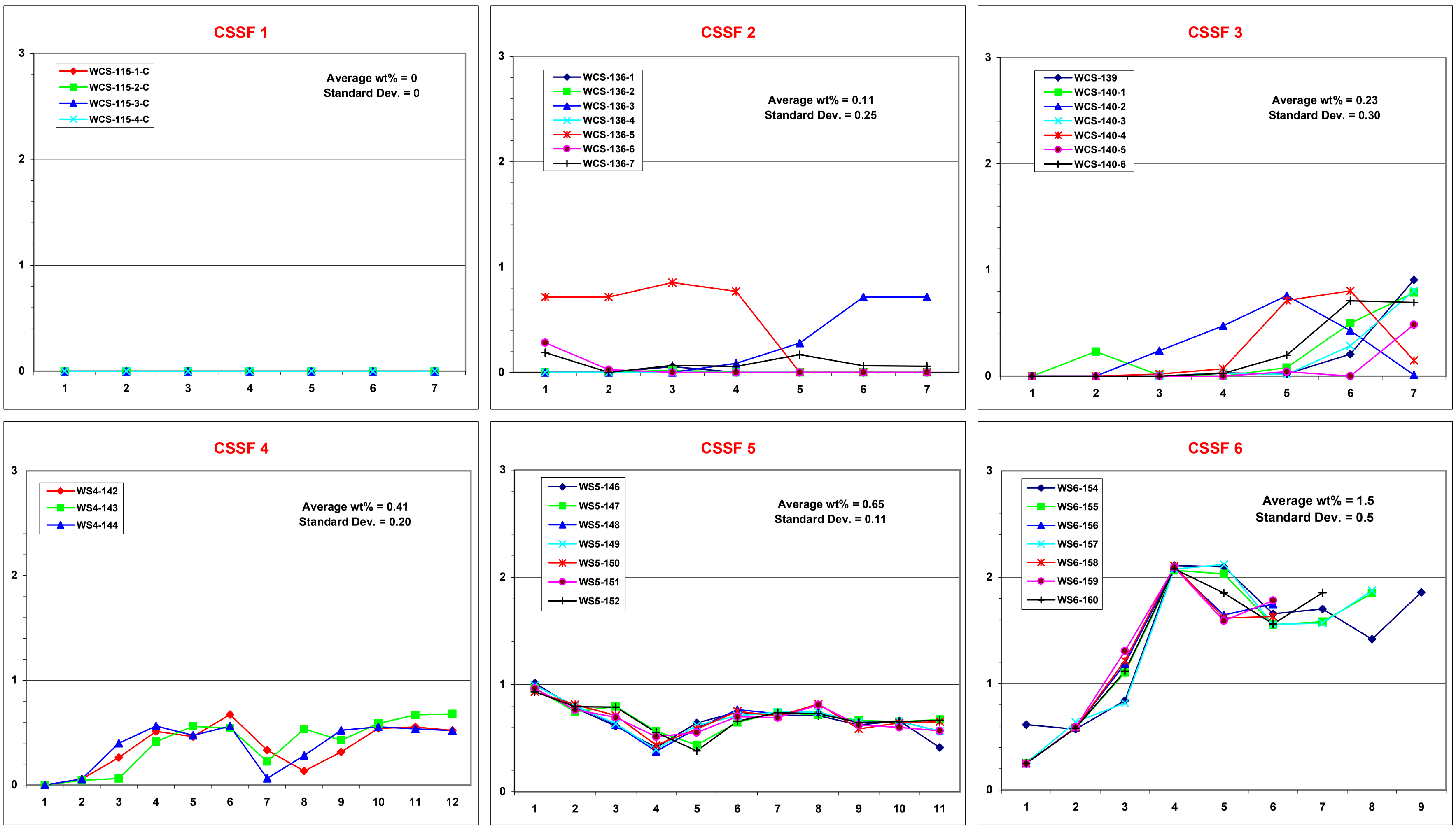


Figure A-19: Weight Percent Sodium (TC Segments listed bottom to top)

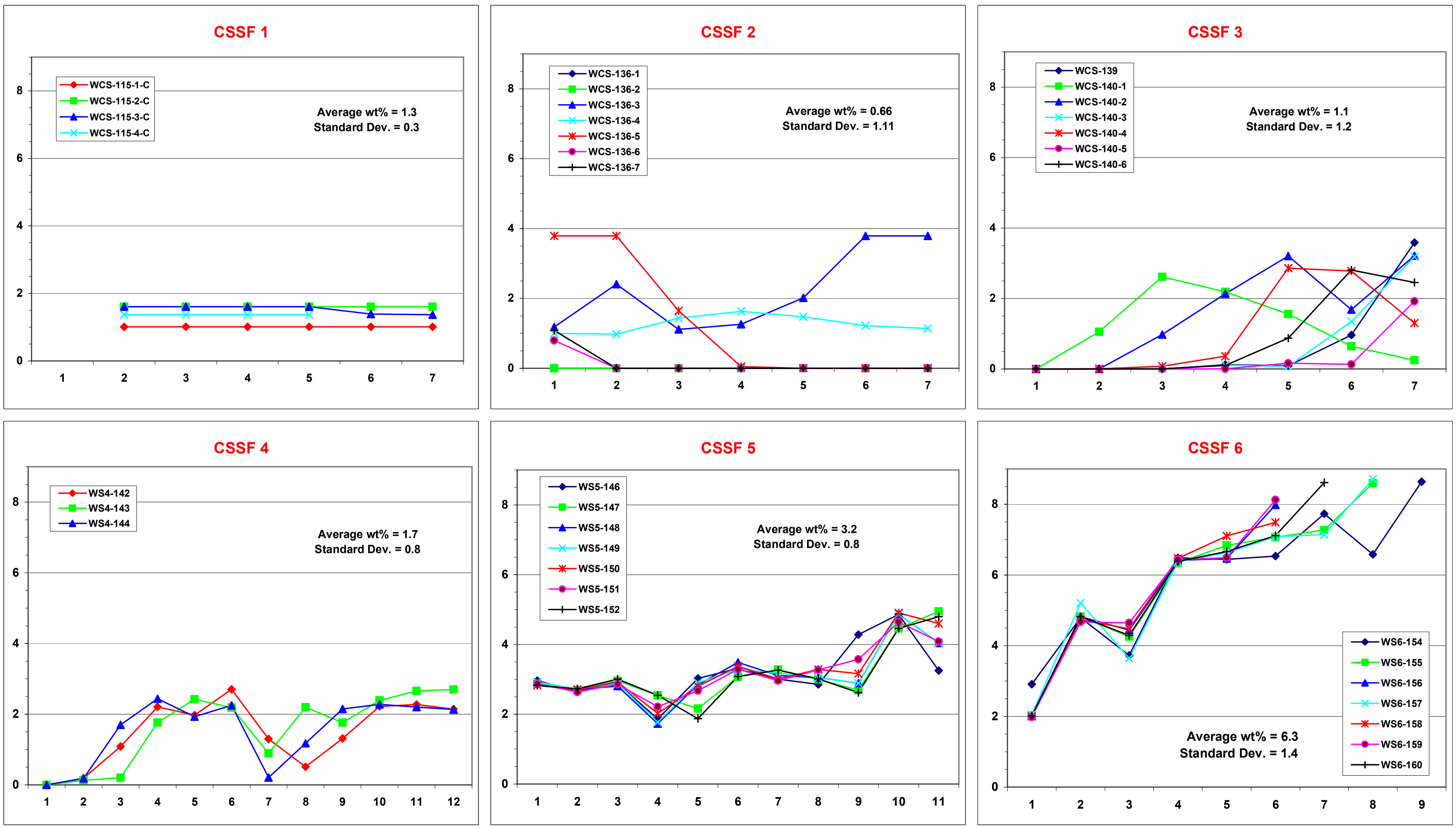


Figure A-20: Weight Percent Strontium (TC Segments listed bottom to top)

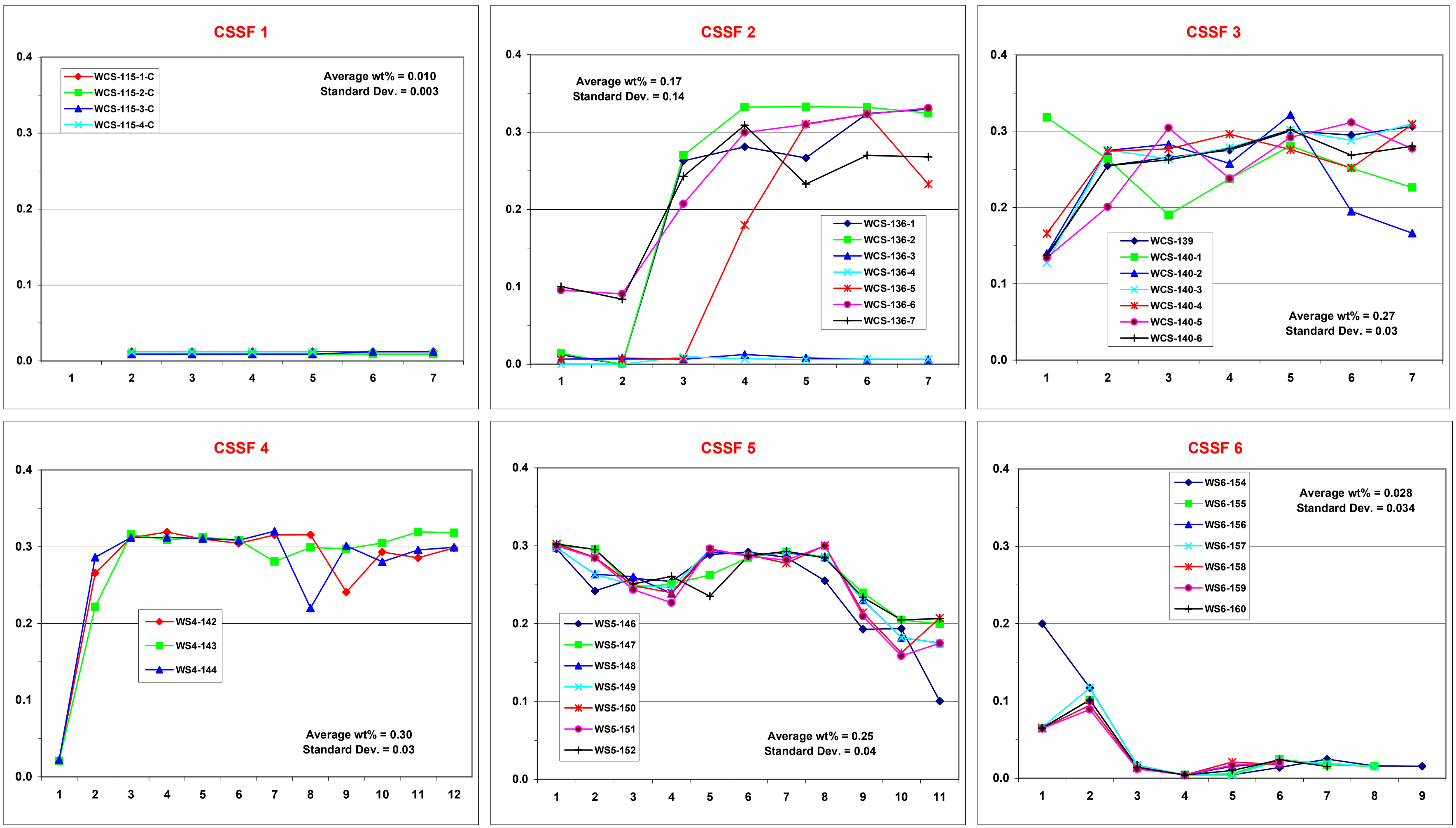


Figure A-21: Weight Percent Sulfate (TC Segments listed bottom to top)

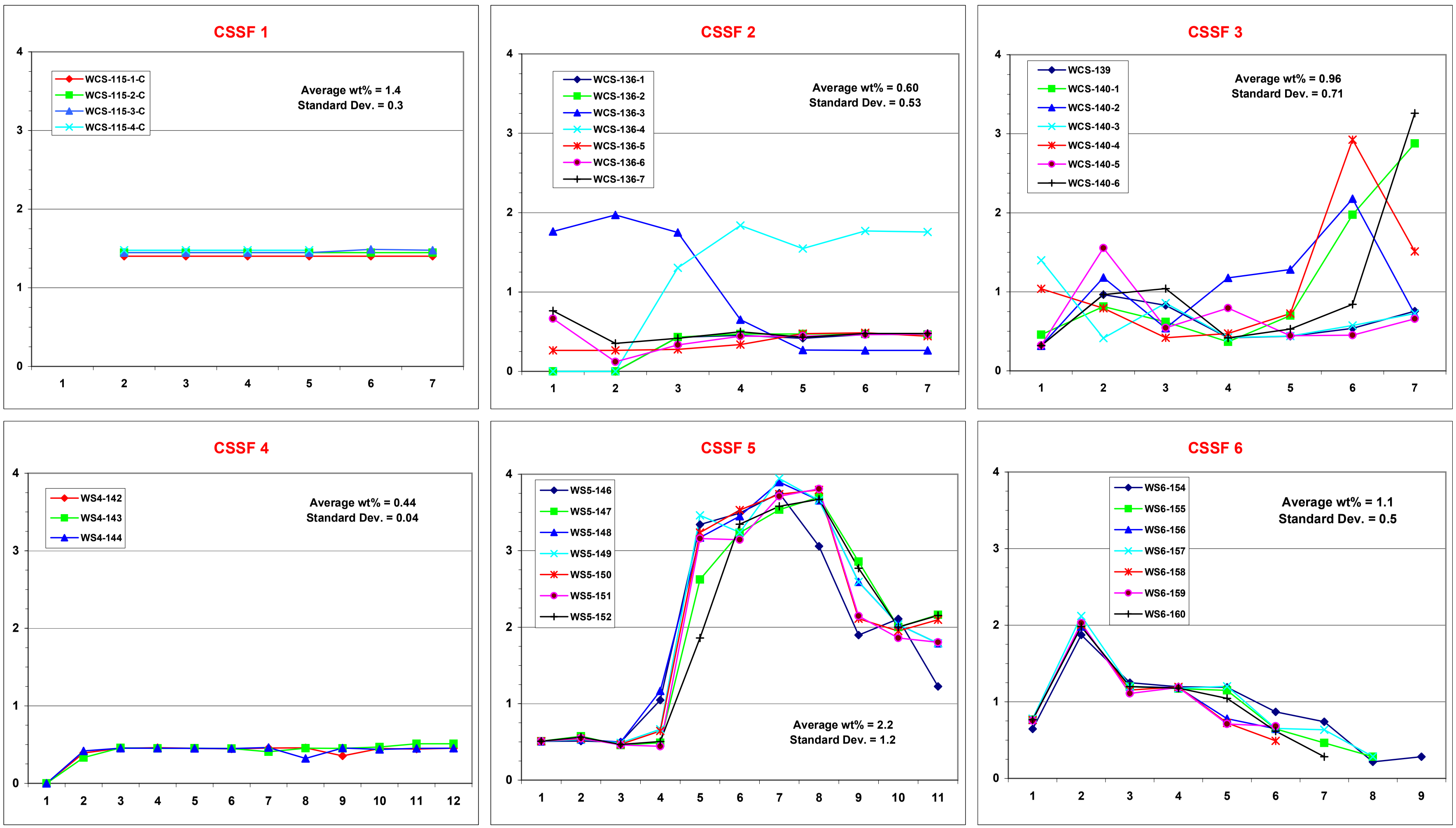


Figure A-22: Weight Percent Tin (TC Segments listed bottom to top)

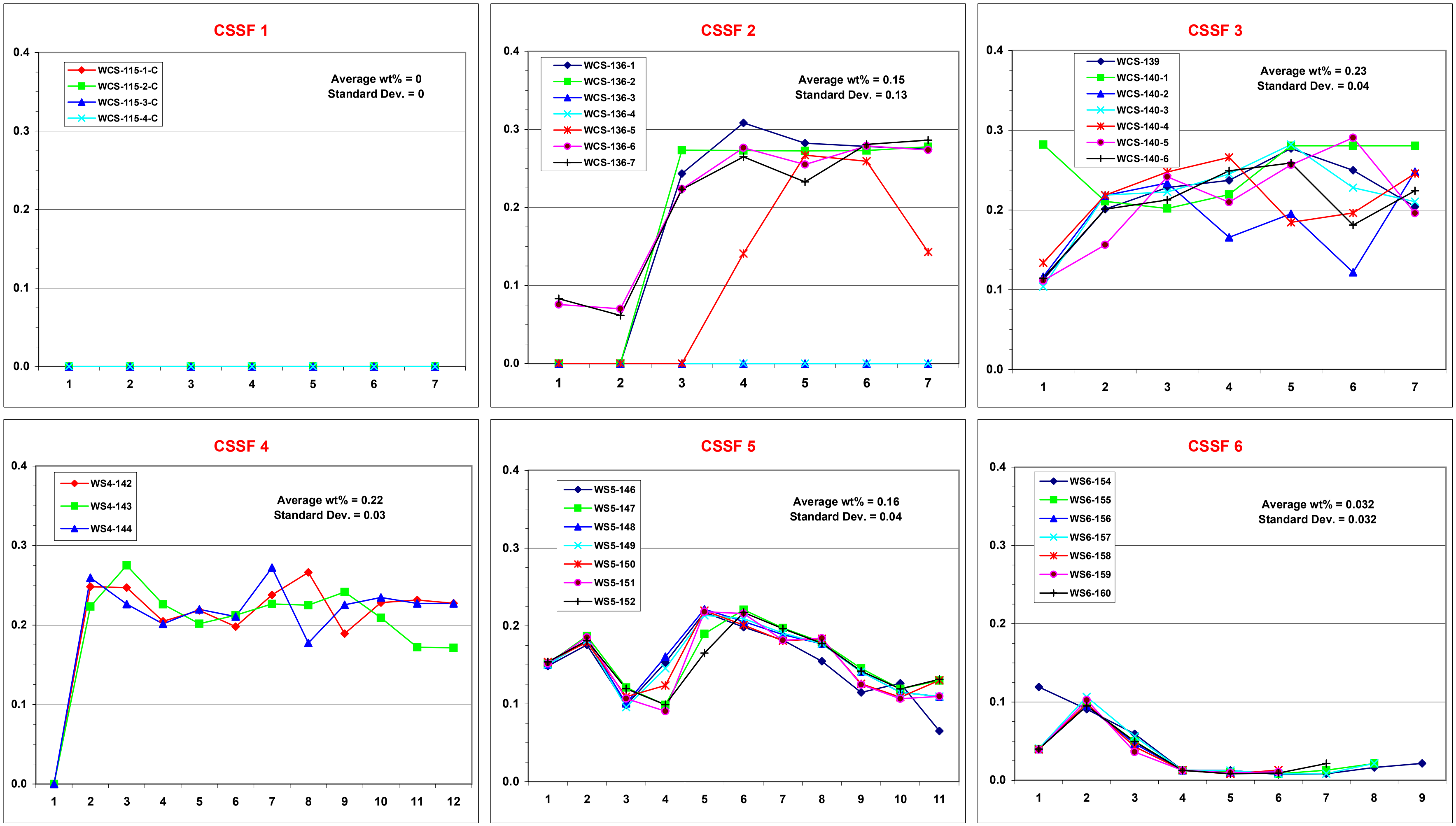


Figure A-23: Weight Percent Uranium (TC Segments listed bottom to top)

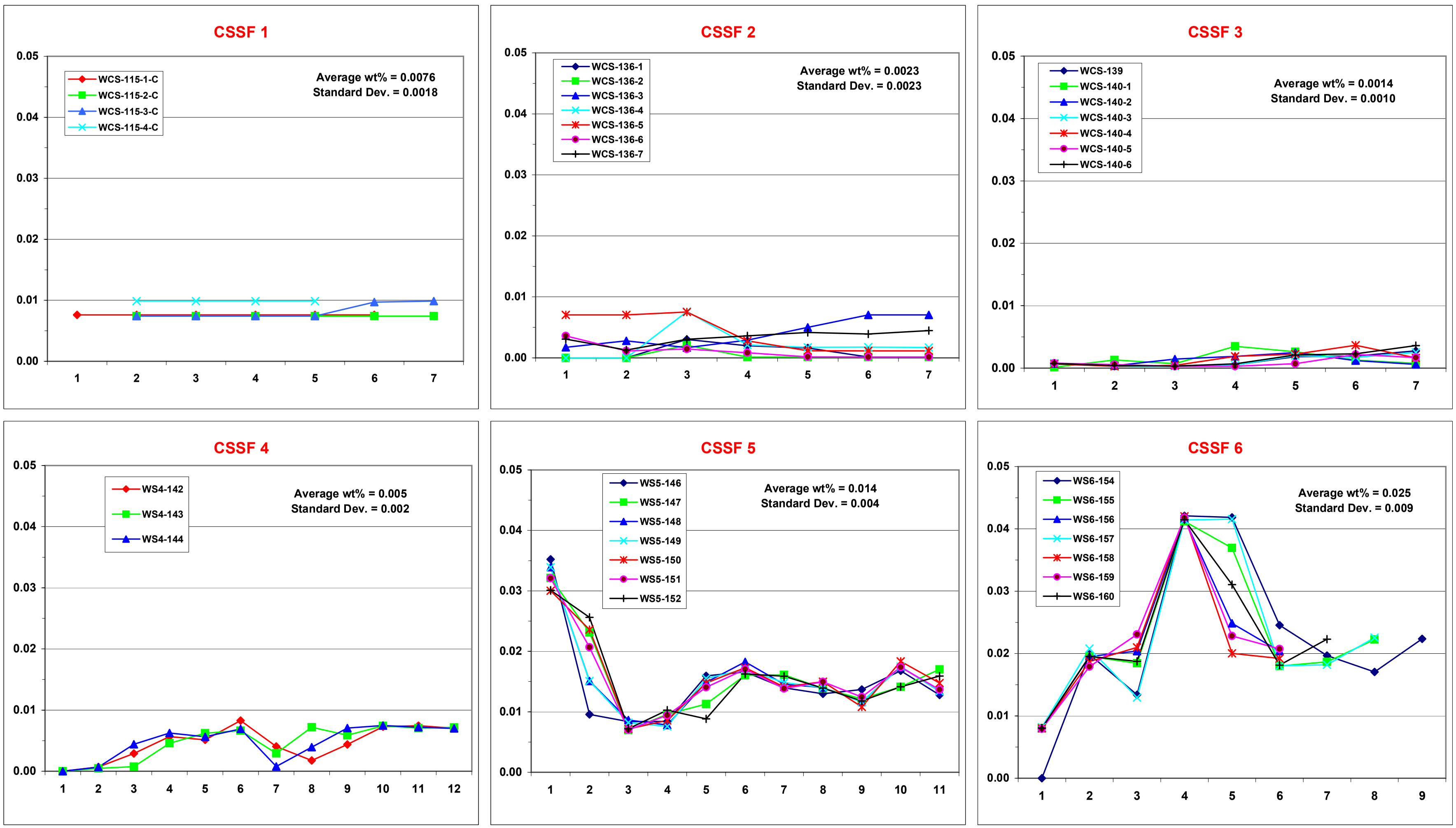
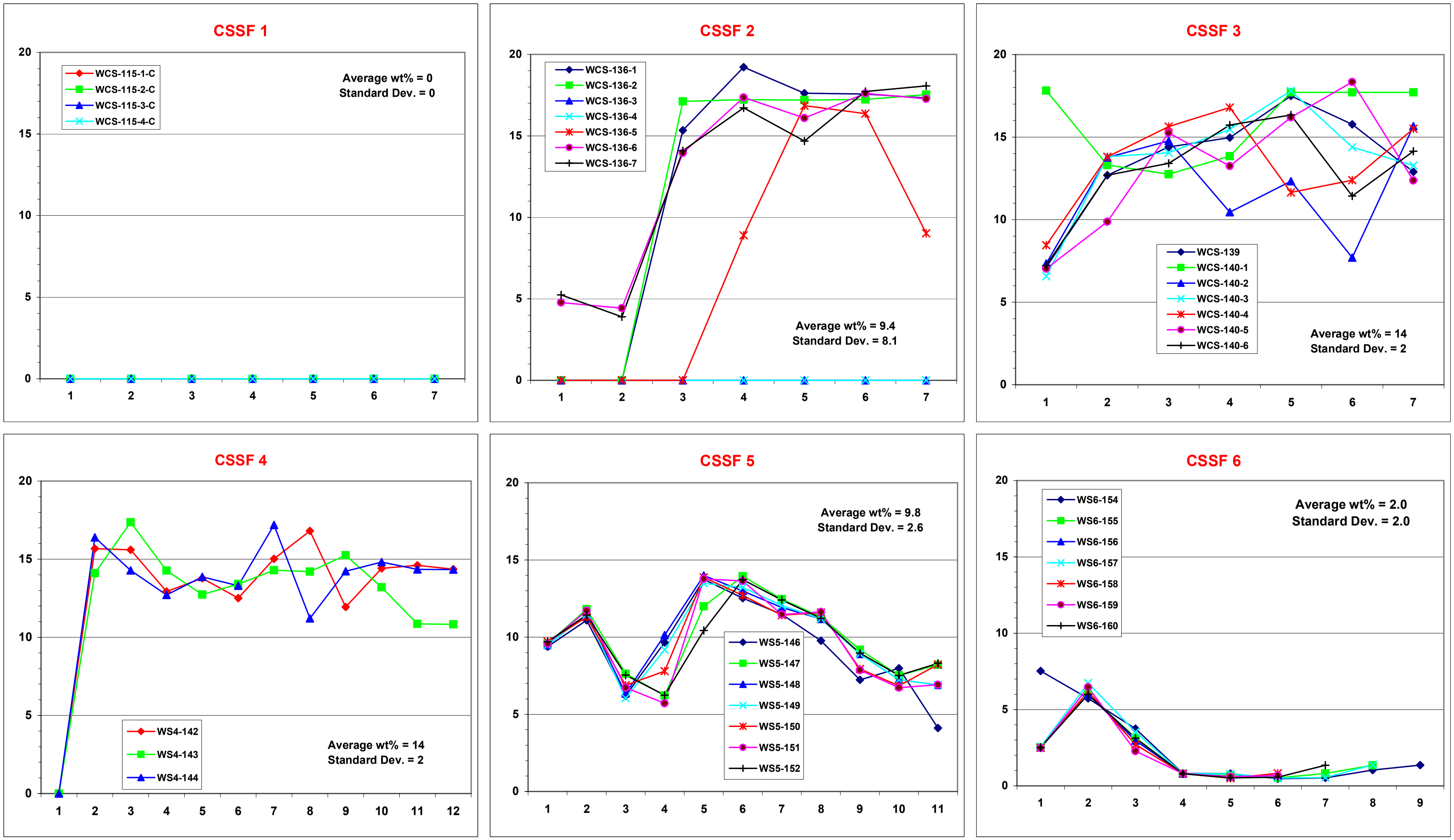


Figure A-24: Weight Percent Zirconium (TC Segments listed bottom to top)



Appendix B

Activity of Selected Radionuclides in CSSF Calcine Data Plots

Appendix B
Activity of Selected Radionuclides in CSSF Calcine Data Plots

Contents

Figure B-1: Curies of ^{63}Ni per Cubic Meter (TC Segments listed bottom to top)

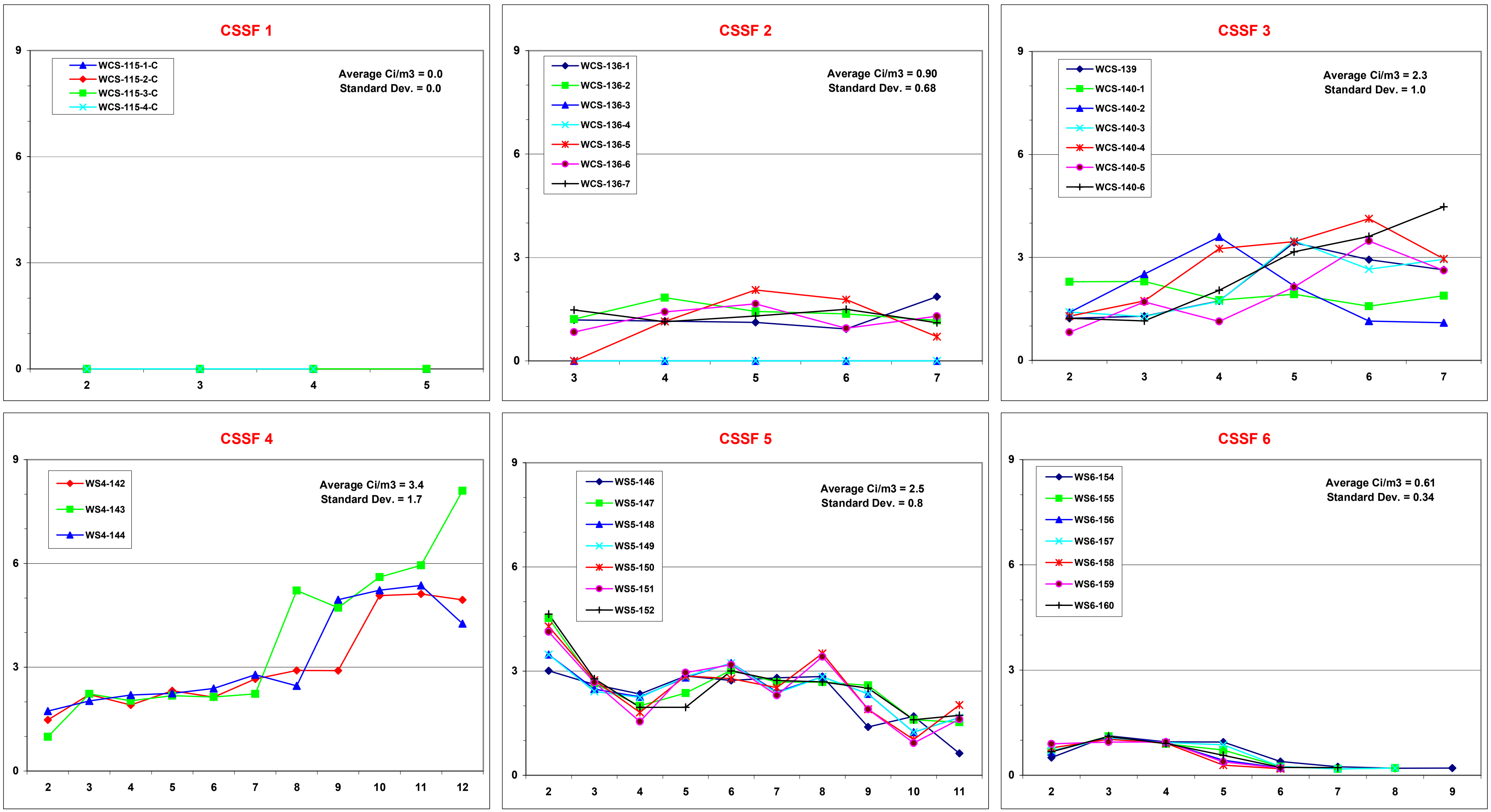


Figure B-2: Curies of ^{90}Sr per Cubic Meter (TC Segments listed bottom to top)

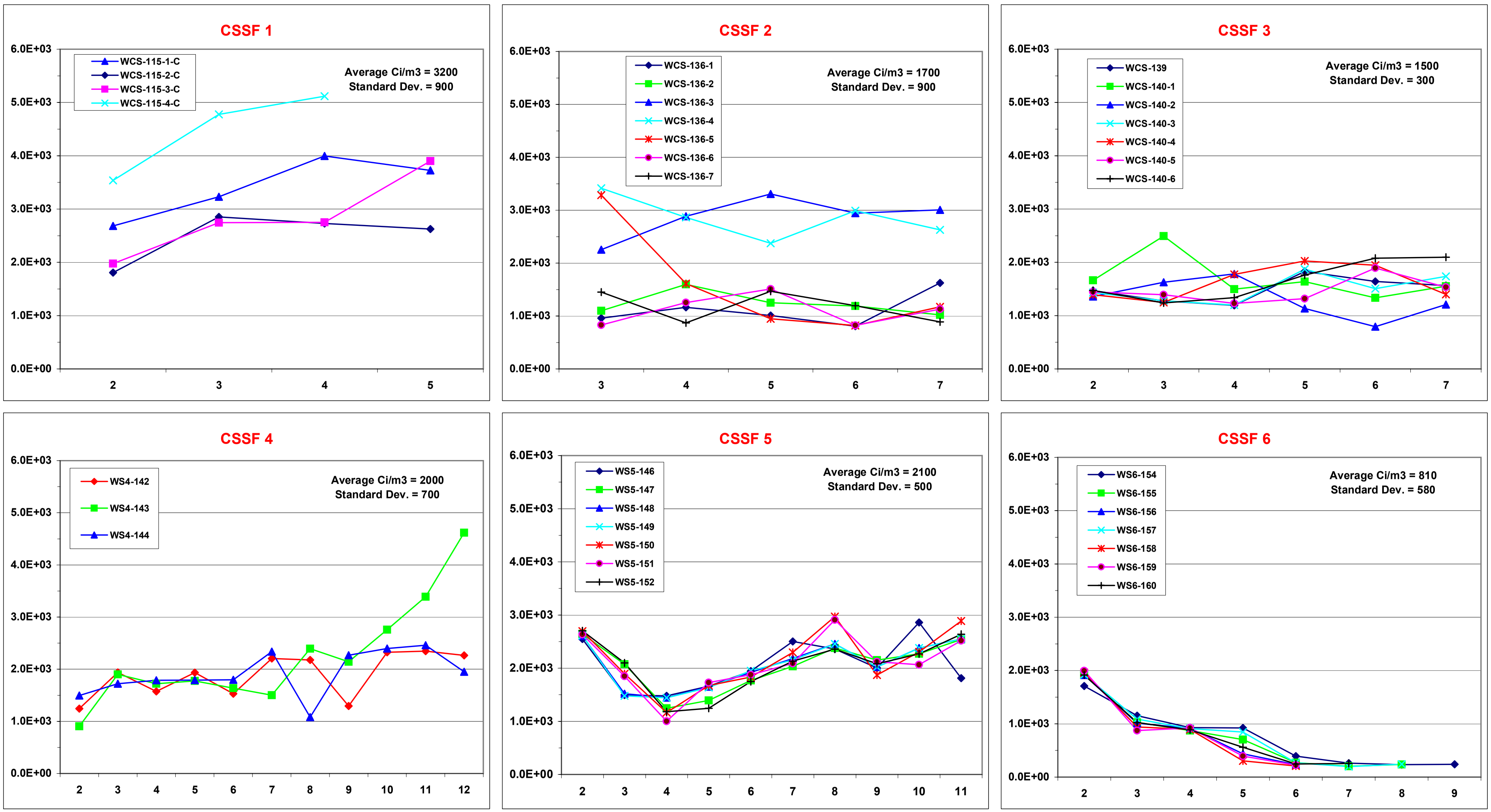


Figure B-3: Curies of ^{90}Y per Cubic Meter (TC Segments listed bottom to top)

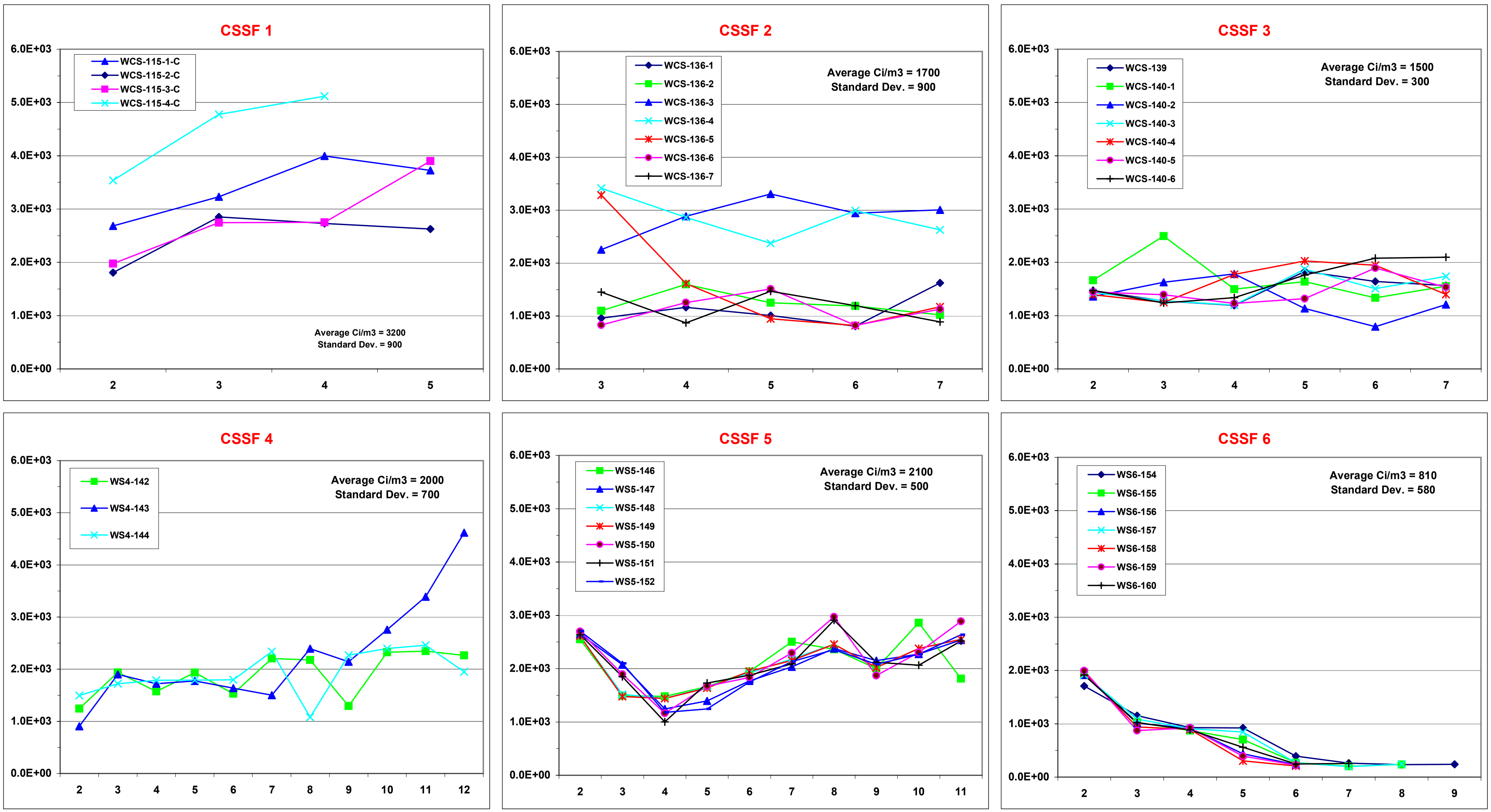


Figure B-4: Curies of ^{99}Tc per Cubic Meter (TC Segments listed bottom to top)

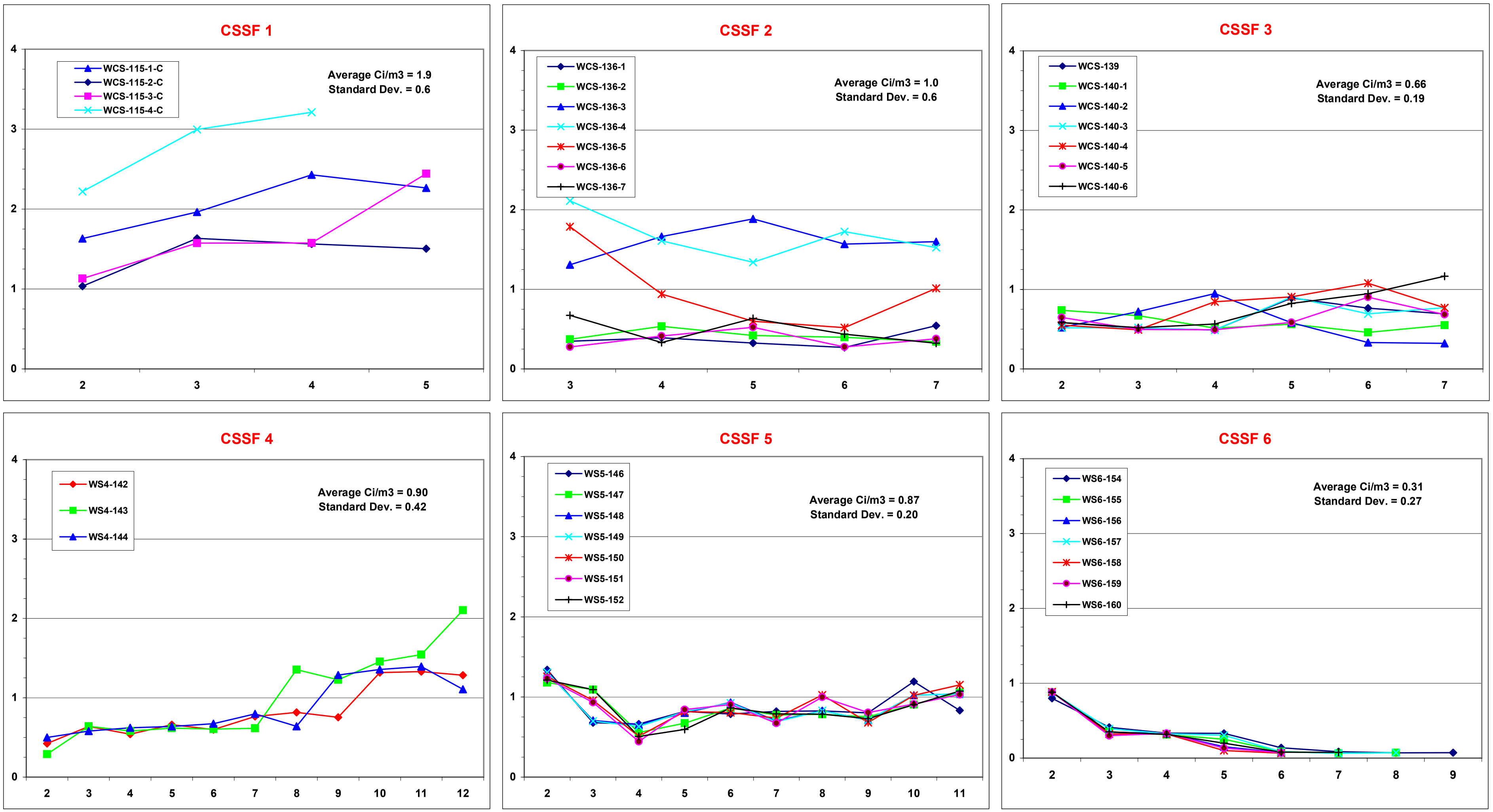


Figure B-5: Curies of ^{126}Sb per Cubic Meter (TC Segments listed bottom to top)

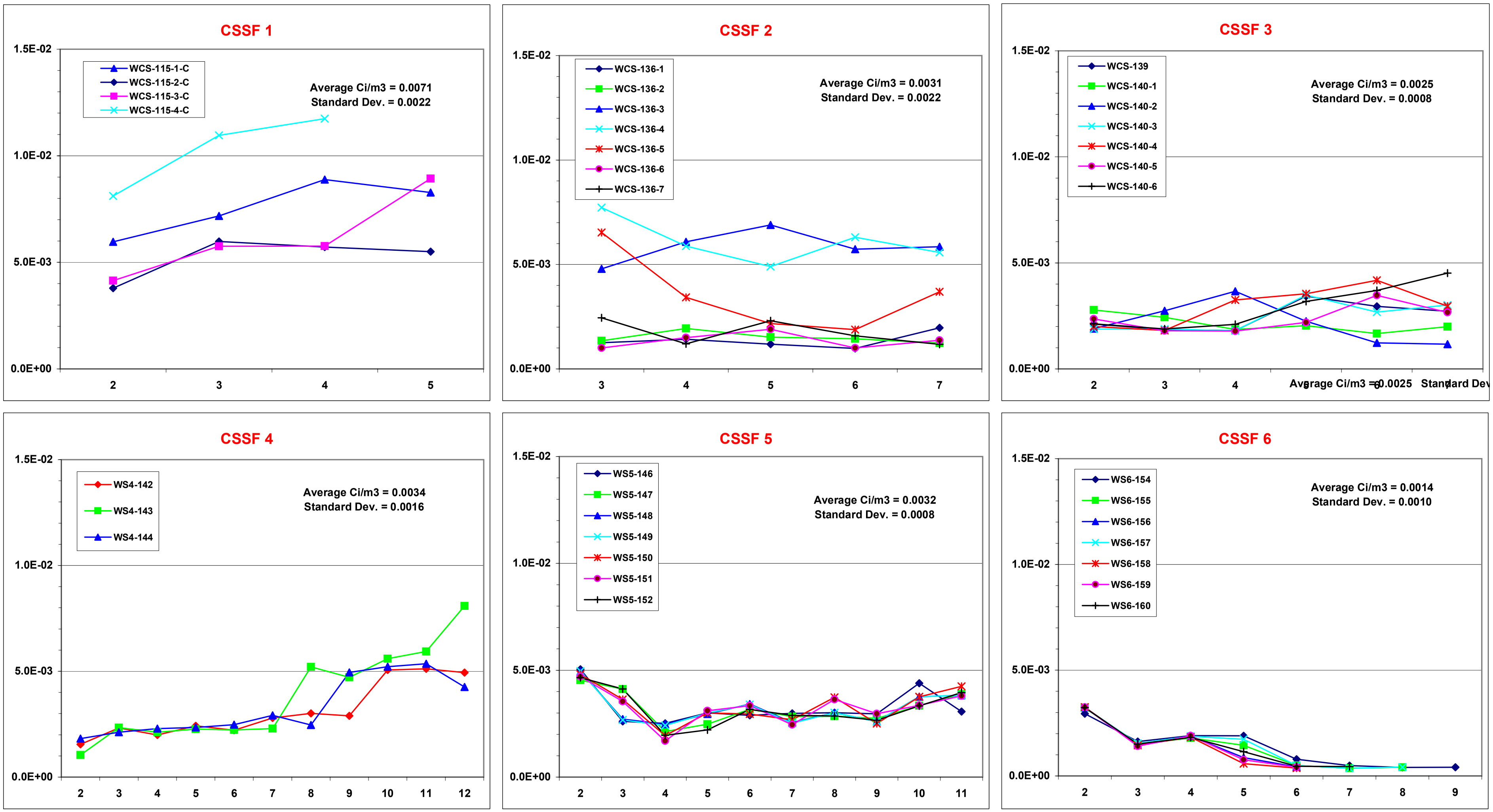


Figure B-6: Curies of ^{126m}Sb per Cubic Meter (TC Segments listed bottom to top)

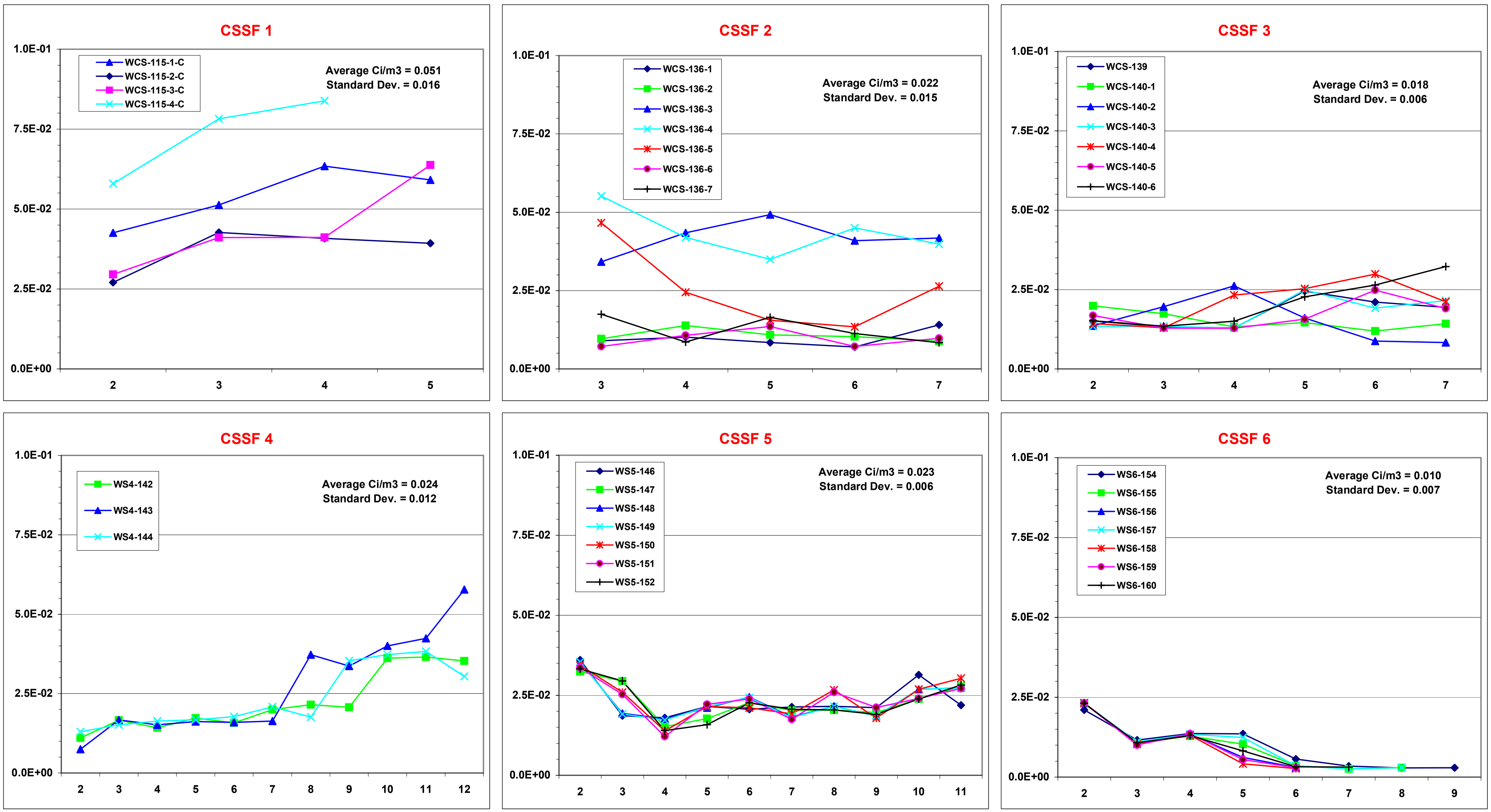


Figure B-7: Curies of ^{137m}Ba per Cubic Meter (TC Segments listed bottom to top)

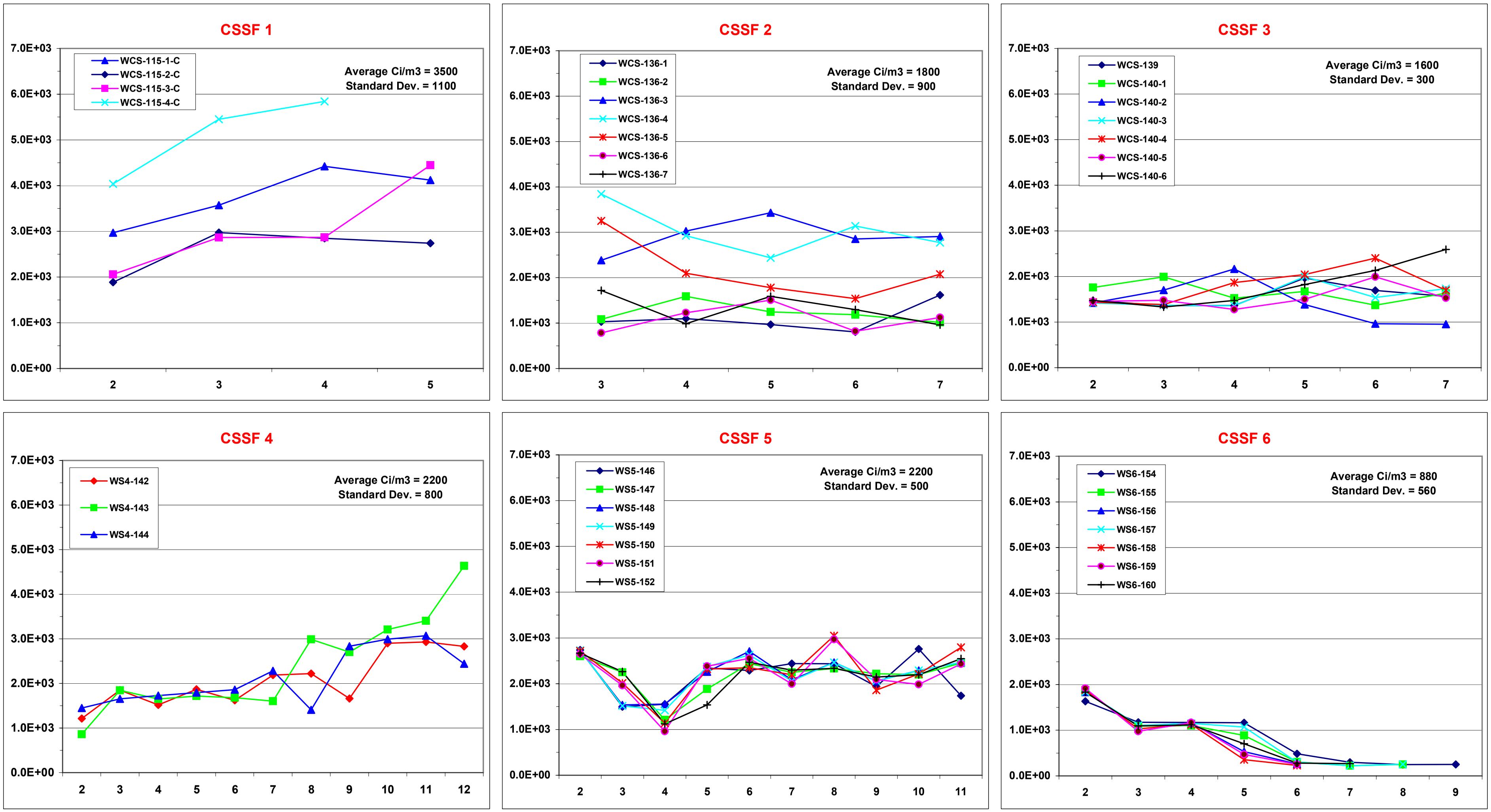


Figure B-8: Curies of ^{137}Cs per Cubic Meter (TC Segments listed bottom to top)

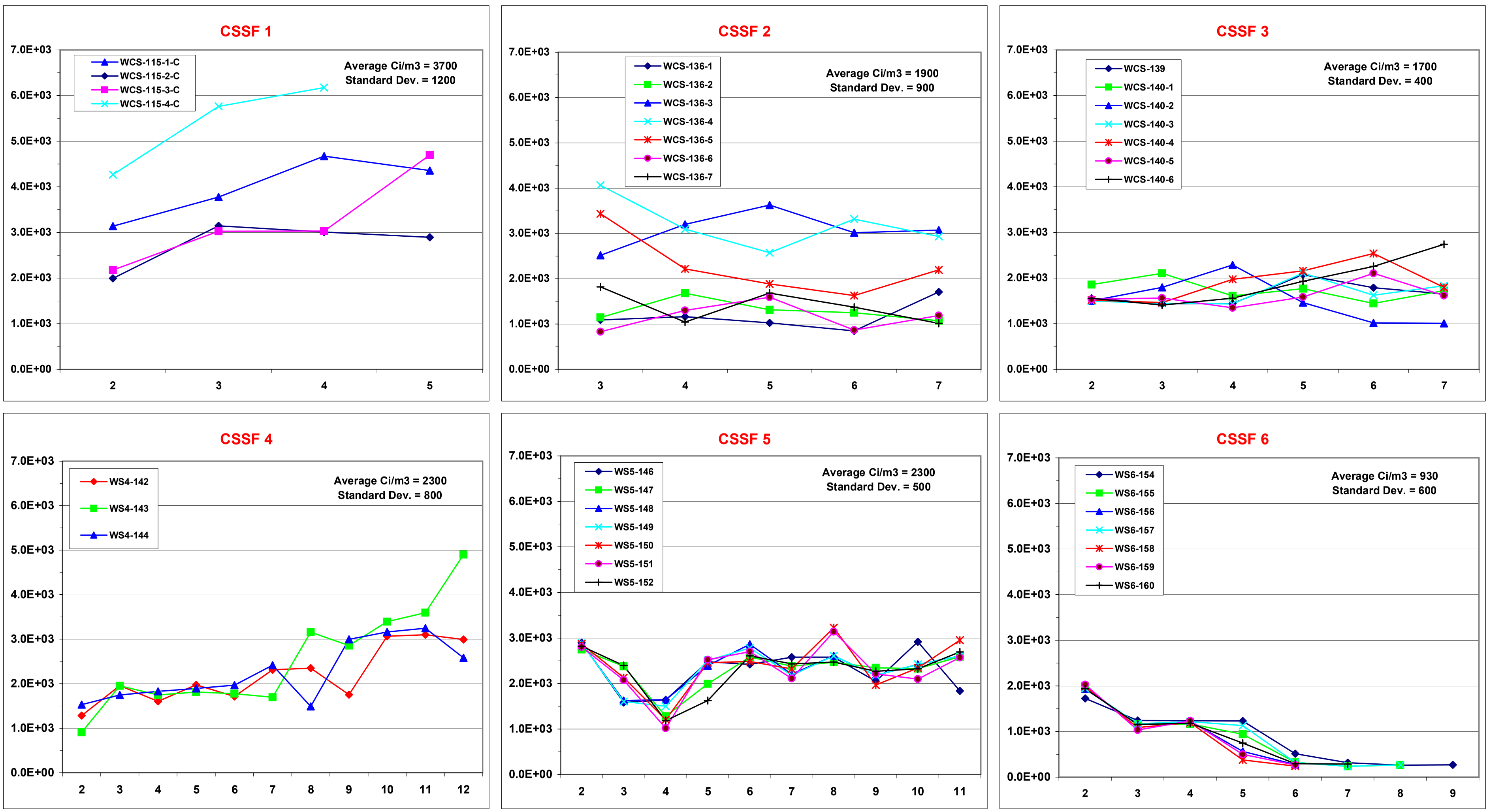


Figure B-9: nano-Curies of ^{231}Th per gram of calcine (TC Segments listed bottom to top)

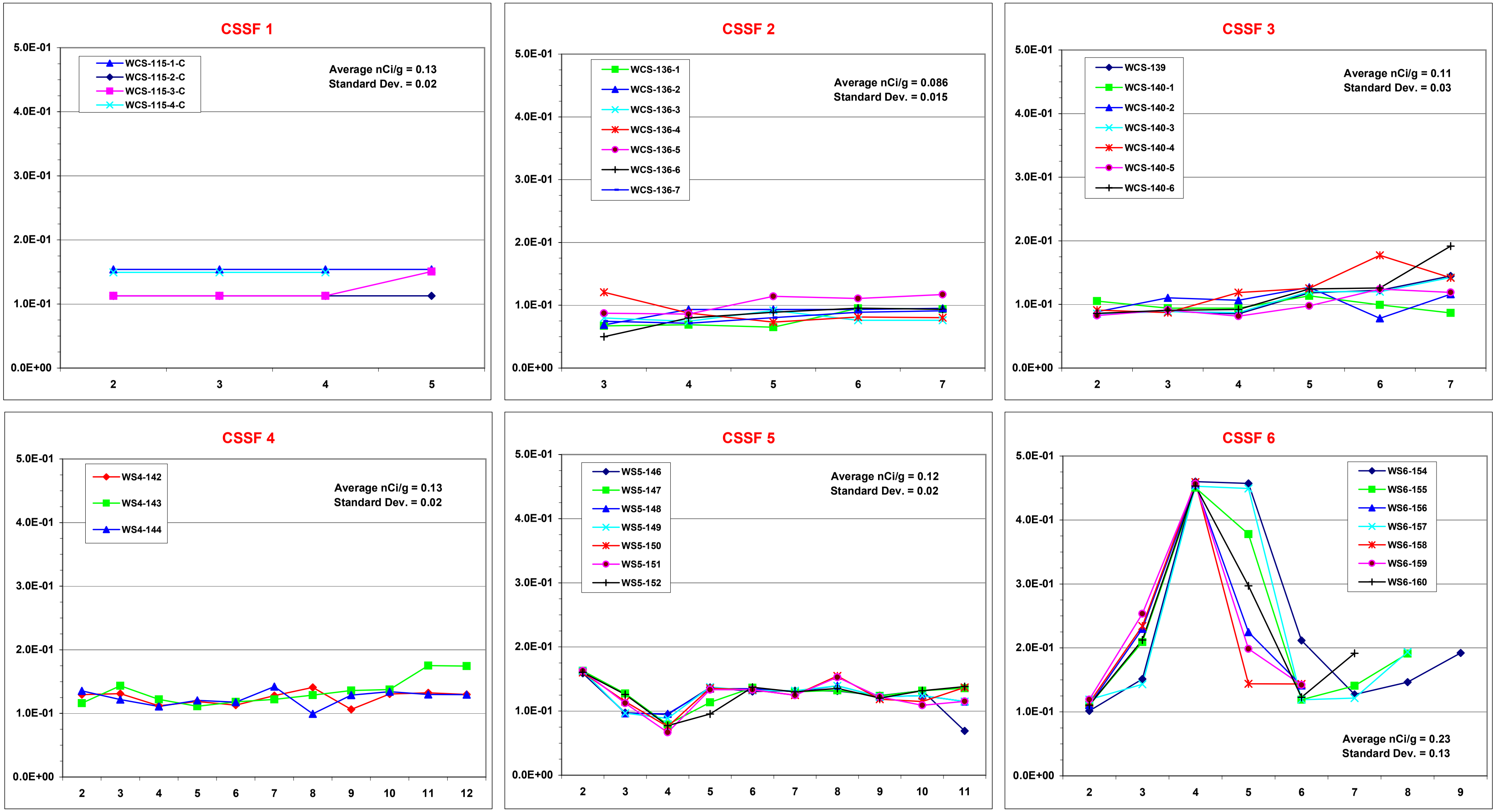


Figure B-10: nano-Curies of ^{233}Pa per gram of calcine (TC Segments listed bottom to top)

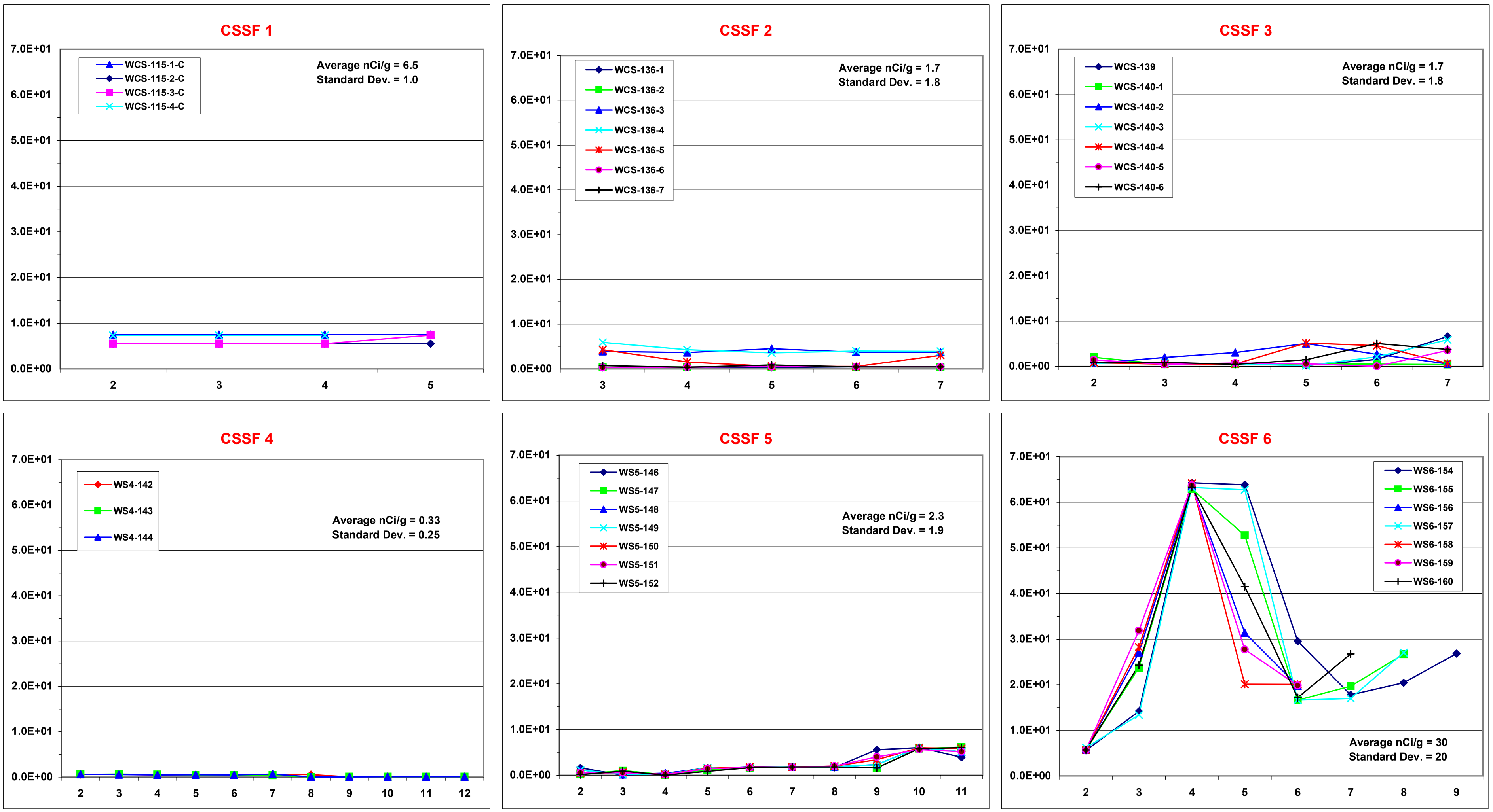


Figure B-11: nano-Curies of ^{237}Np per gram of calcine (TC Segments listed bottom to top)

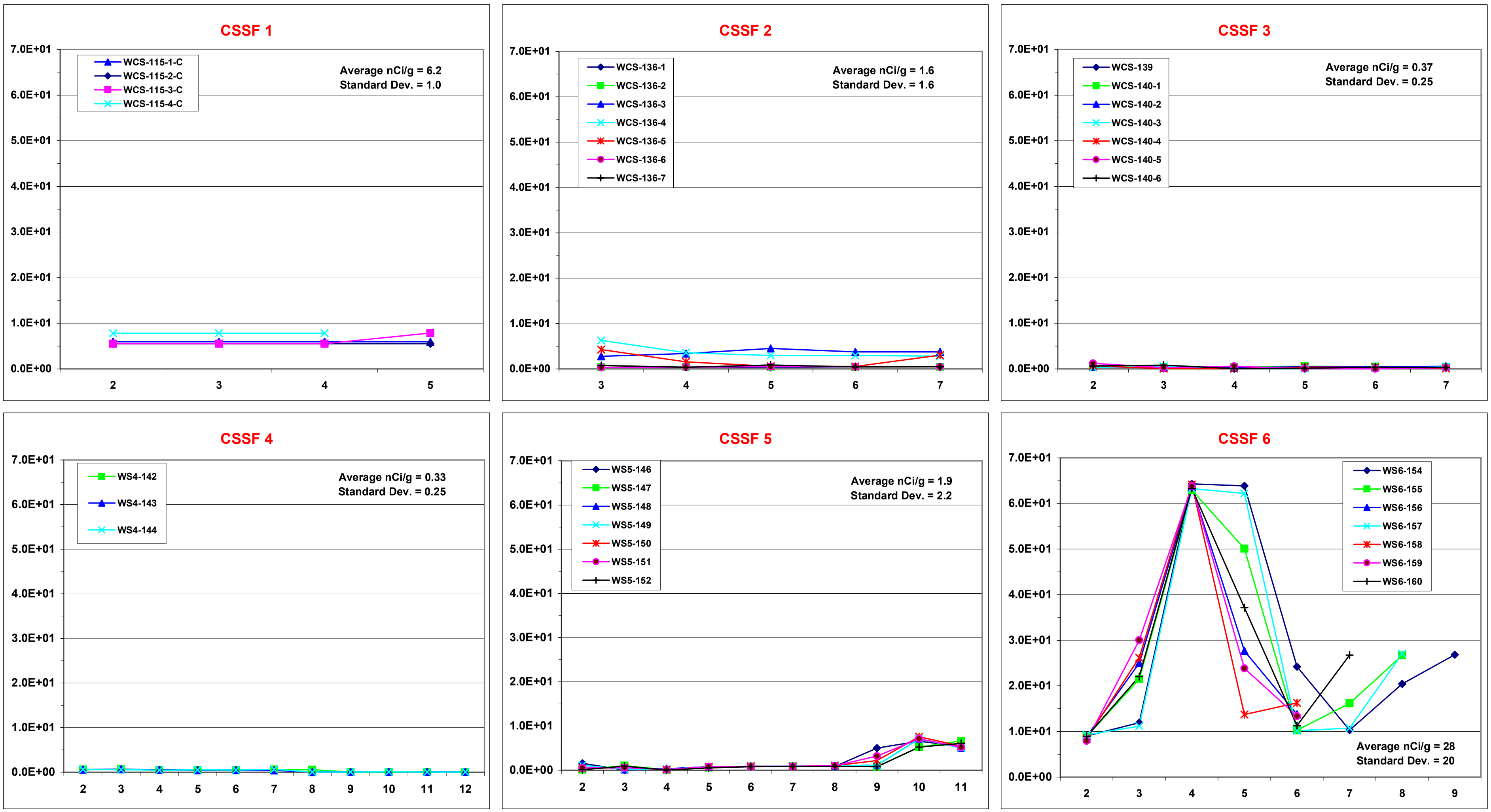


Figure B-12: nano-Curies of ^{238}Pu per gram of calcine (TC Segments listed bottom to top)

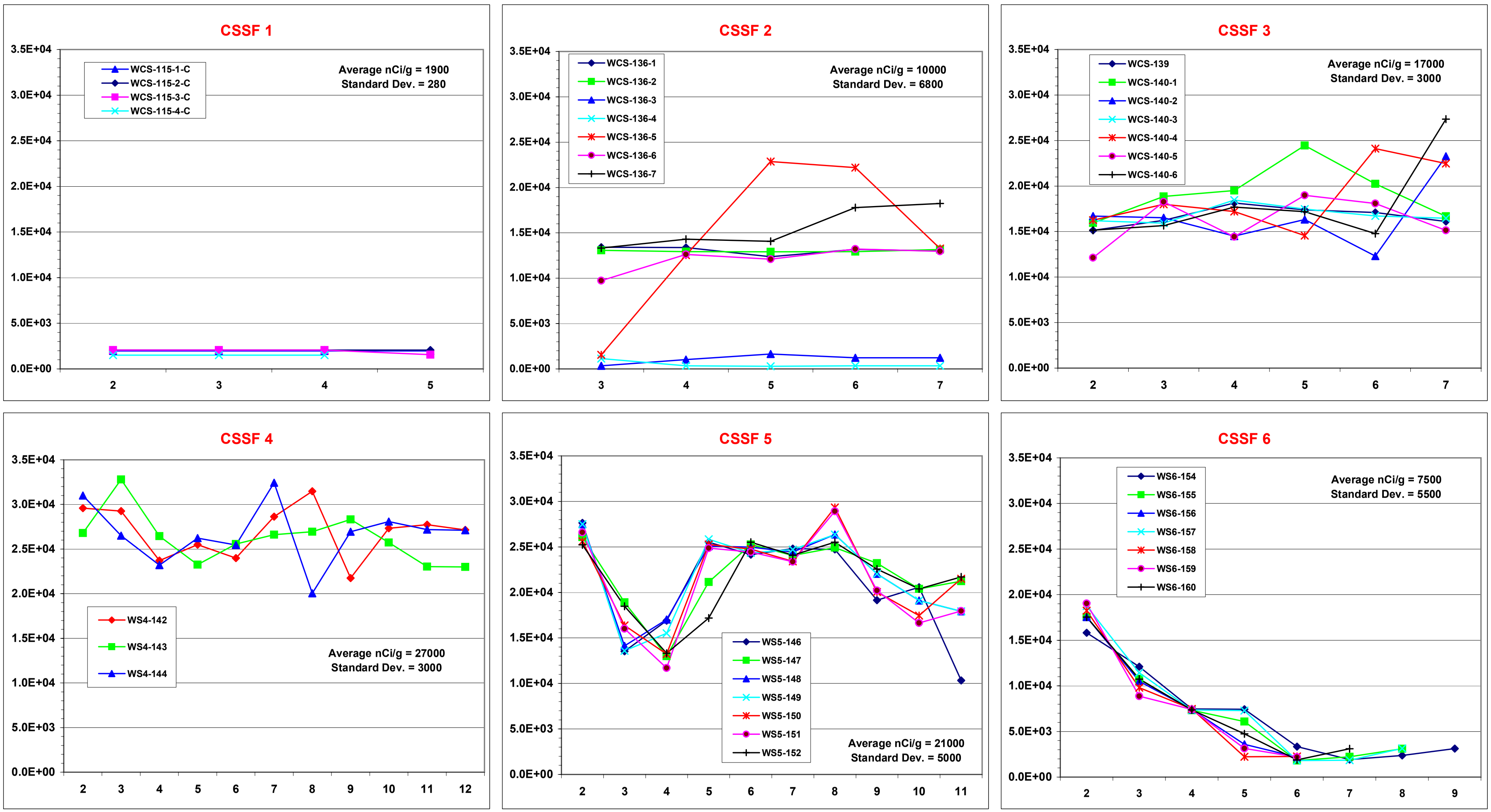


Figure B-13: nano-Curies of ^{239}Pu per gram of calcine (TC Segments listed bottom to top)

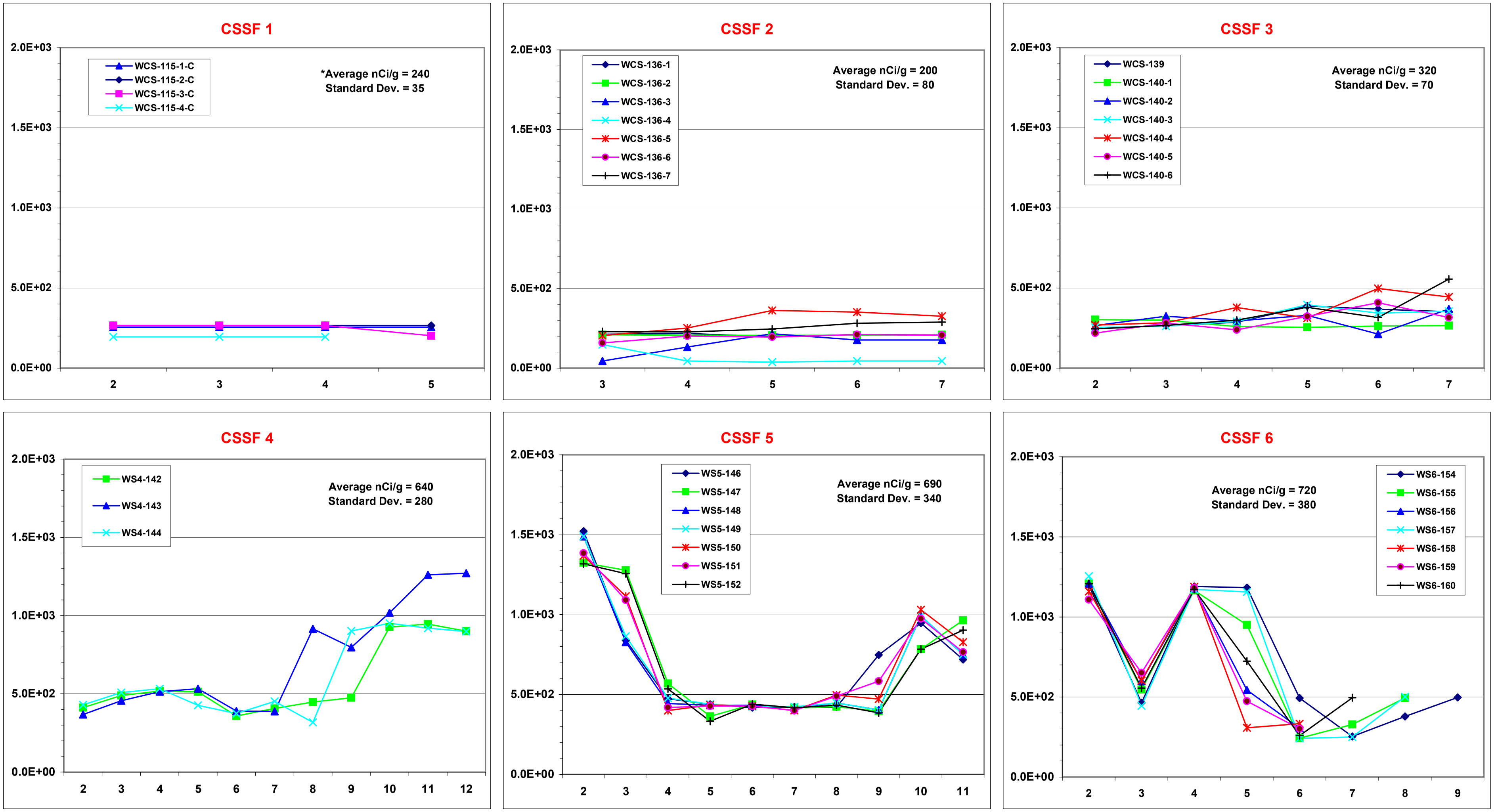


Figure B-14: nano-Curies of ^{240}Pu per gram of calcine (TC Segments listed bottom to top)

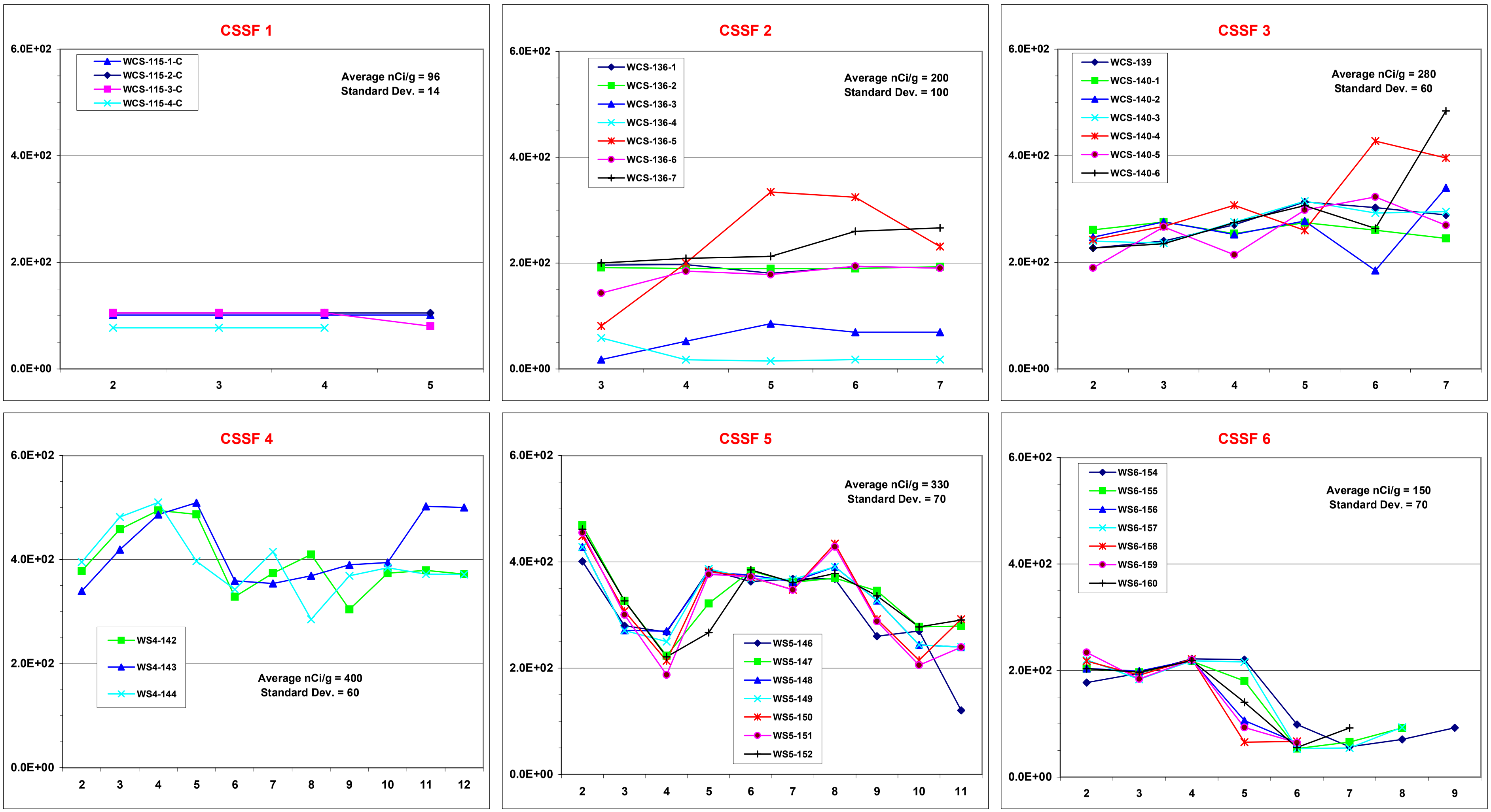
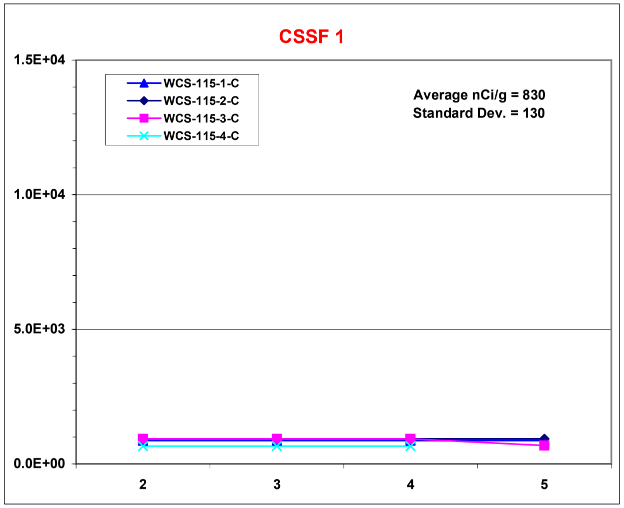
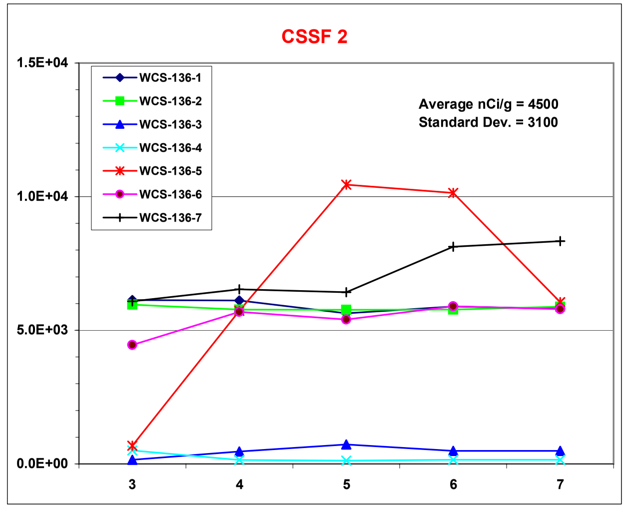
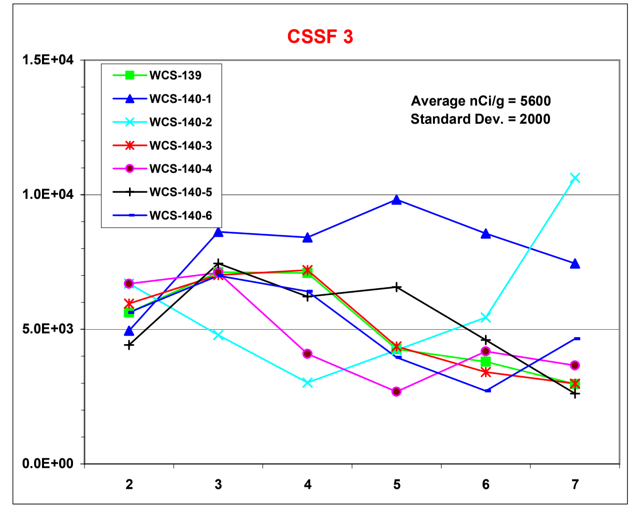
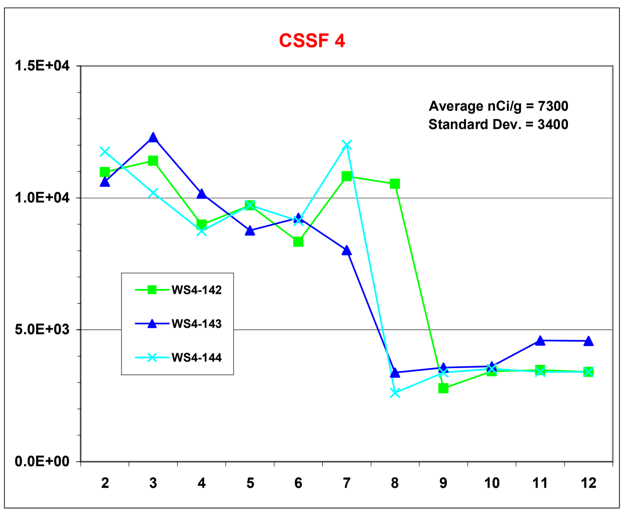


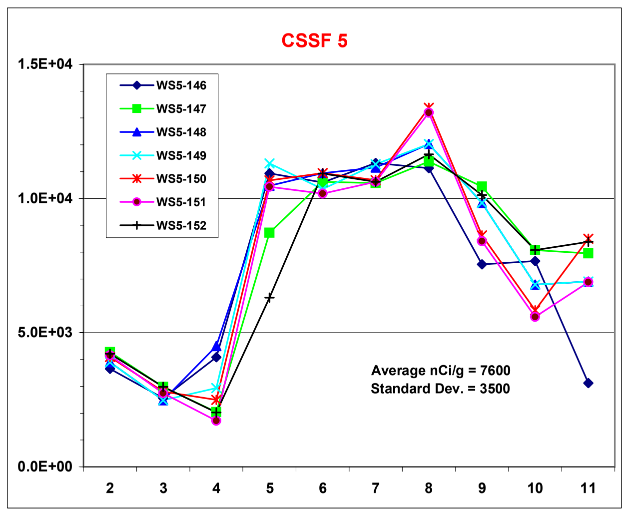
Figure B-15: nano-Curies of ^{241}Pu per gram of calcine (TC Segments listed bottom to top)











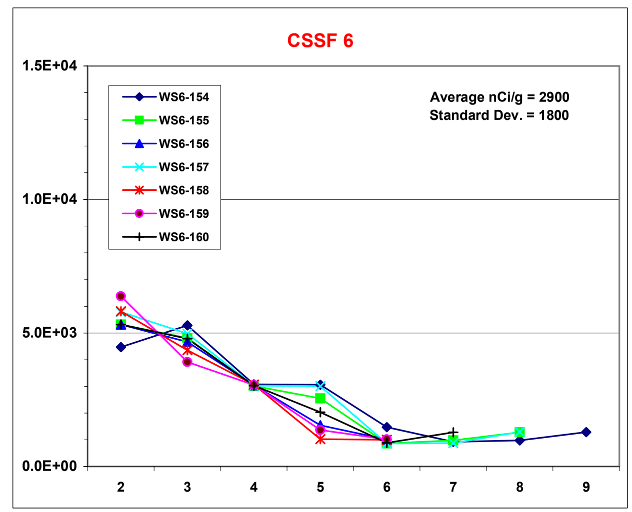
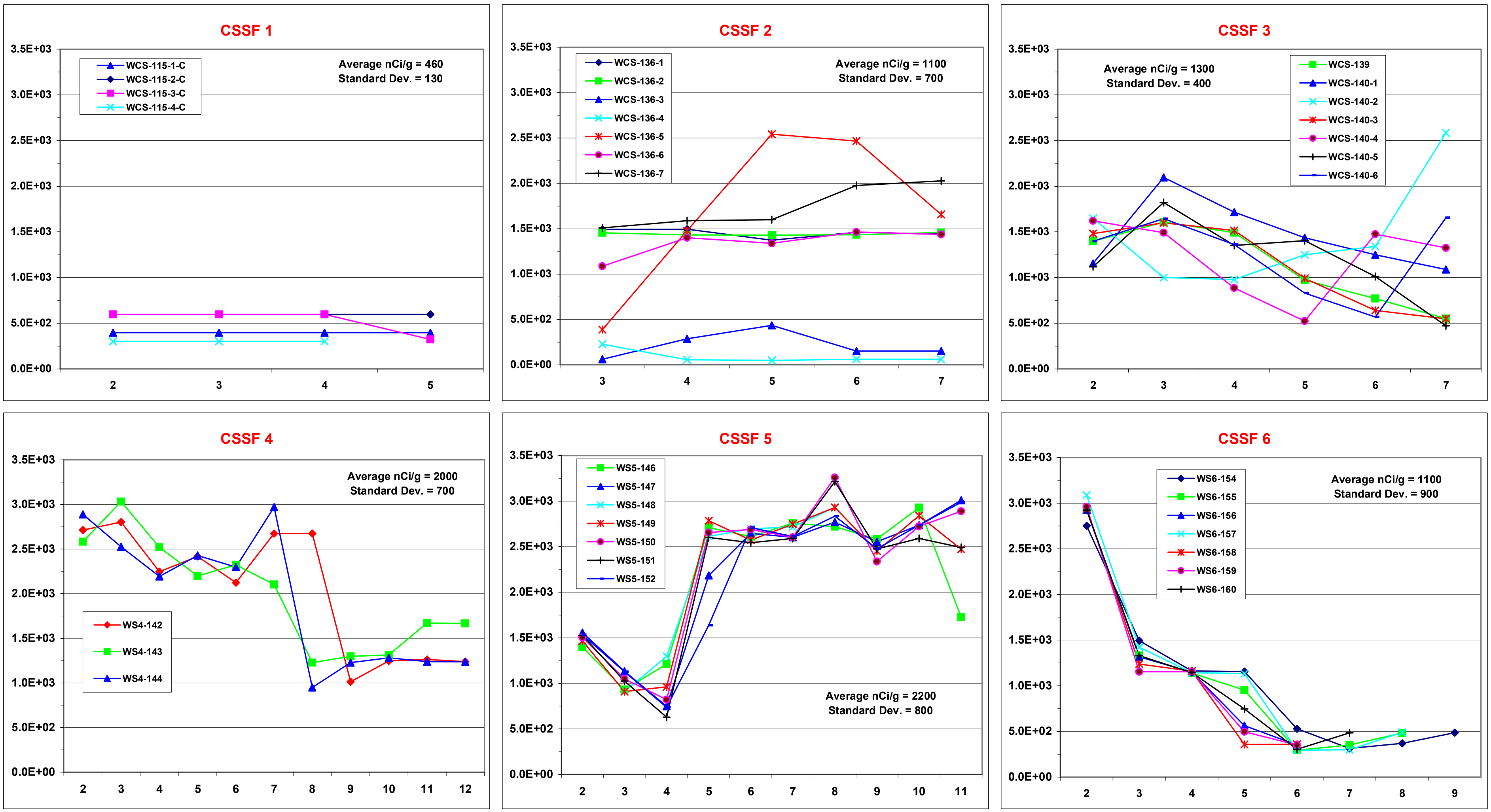


Figure B-16: nano-Curies of ^{241}Am per gram of calcine (TC Segments listed bottom to top)



Appendix C

Chemical and Radionuclide Content of CSSF Bin Segments Tabular Data

Appendix C

Chemical and Radionuclide Content of CSSF Bin Segments Tabular Data

Contents

Table C-1: Selected Elemental Species in CSSF 1 wt%

			Aluminium (wt%)									
Vessel	WCS-115-1-A	WCS-115-1-B	WCS-115-1-C	WCS-115-2-A	WCS-115-2-B	WCS-115-2-C	WCS-115-3-A	WCS-115-3-B	WCS-115-3-C	WCS-115-4-A	WCS-115-4-B	WCS-115-4-C
Segment												
1	51.2			51.2			51.2			51.0		
2	51.2	48.2	48.2	48.7	48.2	46.9	48.7	46.9	46.9	48.2	47.3	47.8
3	51.2	48.2	48.2	48.2	48.2	46.9	48.2	46.9	46.9	47.7	47.8	47.8
4	50.3	48.2	48.2	48.2	48.0	46.9	48.2	46.9	46.9	46.9	47.8	47.8
5	48.2	48.2	48.2	48.2	46.9	46.9	48.0	46.9	46.9	46.9	48.8	47.8
6	48.2	48.2	48.2	46.9	46.9	46.9	46.9	46.9	47.8	47.8	47.8	
7	48.2	48.2	48.2	46.9	46.9	46.9	47.8	46.9	47.8		47.8	
	Average wt% =		48	Standard Dev =		1						
			Boron (wt%)									
Vessel	WCS-115-1-A	WCS-115-1-B	WCS-115-1-C	WCS-115-2-A	WCS-115-2-B	WCS-115-2-C	WCS-115-3-A	WCS-115-3-B	WCS-115-3-C	WCS-115-4-A	WCS-115-4-B	WCS-115-4-C
Segment												
1	0.118			0.118			0.118			0.127		
2	0.118	0.244	0.244	0.220	0.244	0.253	0.223	0.253	0.253	0.244	0.255	0.258
3	0.118	0.244	0.244	0.244	0.244	0.253	0.244	0.253	0.253	0.247	0.258	0.258
4	0.158	0.244	0.244	0.244	0.245	0.253	0.244	0.253	0.253	0.253	0.258	0.258
5	0.244	0.244	0.244	0.244	0.253	0.253	0.245	0.253	0.253	0.253	0.251	0.258
6	0.244	0.244	0.244	0.253	0.253	0.253	0.253	0.253	0.260	0.258	0.258	
7	0.244	0.244	0.244	0.253	0.253	0.253	0.258	0.253	0.258		0.258	
	Average wt% =		0.24	Standard Dev =		0.03						
			Cadmium (wt%)									
Vessel	WCS-115-1-A	WCS-115-1-B	WCS-115-1-C	WCS-115-2-A	WCS-115-2-B	WCS-115-2-C	WCS-115-3-A	WCS-115-3-B	WCS-115-3-C	WCS-115-4-A	WCS-115-4-B	WCS-115-4-C
Segment												
1			0.0			0.0			0.0			0.0
2			0.0			0.0			0.0			0.0
3			0.0			0.0			0.0			0.0
4			0.0			0.0			0.0			0.0
5			0.0			0.0			0.0			0.0
6			0.0			0.0			0.0			0.0
7			0.0			0.0			0.0			0.0
	Average wt% =		0	Standard Dev =		0						
			Calcium (wt%)									
Vessel	WCS-115-1-A	WCS-115-1-B	WCS-115-1-C	WCS-115-2-A	WCS-115-2-B	WCS-115-2-C	WCS-115-3-A	WCS-115-3-B	WCS-115-3-C	WCS-115-4-A	WCS-115-4-B	WCS-115-4-C
Segment												
1			0.0			0.0			0.0			0.0
2			0.0			0.0			0.0			0.0
3			0.0			0.0			0.0			0.0
4			0.0			0.0			0.0			0.0
5			0.0			0.0			0.0			0.0
6			0.0			0.0			0.0			0.0
7			0.0			0.0			0.0			0.0
	Average wt% =		0	Standard Dev =		0						

Table C-1: Selected Elemental Species in CSSF 1 wt%

Carbonate (wt%)

Vessel	WCS-115-1-A	WCS-115-1-B	WCS-115-1-C	WCS-115-2-A	WCS-115-2-B	WCS-115-2-C	WCS-115-3-A	WCS-115-3-B	WCS-115-3-C	WCS-115-4-A	WCS-115-4-B	WCS-115-4-C
Segment												
1			0.0			0.0			0.0			0.0
2			0.0			0.0			0.0			0.0
3			0.0			0.0			0.0			0.0
4			0.0			0.0			0.0			0.0
5			0.0			0.0			0.0			0.0
6			0.0			0.0			0.0			0.0
7			0.0			0.0			0.0			0.0
	Average wt% =		0	Standard Dev =		0						

Cesium (wt%)

Vessel	WCS-115-1-A	WCS-115-1-B	WCS-115-1-C	WCS-115-2-A	WCS-115-2-B	WCS-115-2-C	WCS-115-3-A	WCS-115-3-B	WCS-115-3-C	WCS-115-4-A	WCS-115-4-B	WCS-115-4-C
Segment												
1	0.0000			0.0000			0.0000			0.0026		
2	0.0000	0.0363	0.0363	0.0295	0.0363	0.0265	0.0302	0.0265	0.0265	0.0363	0.0305	0.0352
3	0.0000	0.0363	0.0363	0.0363	0.0363	0.0265	0.0363	0.0265	0.0265	0.0330	0.0352	0.0352
4	0.0114	0.0363	0.0363	0.0363	0.0352	0.0265	0.0363	0.0265	0.0265	0.0265	0.0352	0.0352
5	0.0363	0.0363	0.0363	0.0363	0.0265	0.0265	0.0347	0.0265	0.0265	0.0265	0.0252	0.0352
6	0.0363	0.0363	0.0363	0.0265	0.0265	0.0265	0.0265	0.0265	0.0355	0.0352	0.0352	
7	0.0363	0.0363	0.0363	0.0265	0.0265	0.0265	0.0352	0.0265	0.0352		0.0352	
	Average wt% =		0.030	Standard Dev =		0.007						

Chloride (wt%)

Vessel	WCS-115-1-A	WCS-115-1-B	WCS-115-1-C	WCS-115-2-A	WCS-115-2-B	WCS-115-2-C	WCS-115-3-A	WCS-115-3-B	WCS-115-3-C	WCS-115-4-A	WCS-115-4-B	WCS-115-4-C
Segment												
1			0.0			0.0			0.0			0.0
2			0.0			0.0			0.0			0.0
3			0.0			0.0			0.0			0.0
4			0.0			0.0			0.0			0.0
5			0.0			0.0			0.0			0.0
6			0.0			0.0			0.0			0.0
7			0.0			0.0			0.0			0.0
	Average wt% =		0	Standard Dev =		0						

Chromium (wt%)

Vessel	WCS-115-1-A	WCS-115-1-B	WCS-115-1-C	WCS-115-2-A	WCS-115-2-B	WCS-115-2-C	WCS-115-3-A	WCS-115-3-B	WCS-115-3-C	WCS-115-4-A	WCS-115-4-B	WCS-115-4-C
Segment												
1			0.0			0.0			0.0			0.0
2			0.0			0.0			0.0			0.0
3			0.0			0.0			0.0			0.0
4			0.0			0.0			0.0			0.0
5			0.0			0.0			0.0			0.0
6			0.0			0.0			0.0			0.0
7			0.0			0.0			0.0			0.0
	Average wt% =		0	Standard Dev =		0						

Table C-1: Selected Elemental Species in CSSF 1 wt%

			Fluoride (wt%)									
Vessel	WCS-115-1-A	WCS-115-1-B	WCS-115-1-C	WCS-115-2-A	WCS-115-2-B	WCS-115-2-C	WCS-115-3-A	WCS-115-3-B	WCS-115-3-C	WCS-115-4-A	WCS-115-4-B	WCS-115-4-C
Segment												
1			0.0			0.0			0.0			0.0
2			0.0			0.0			0.0			0.0
3			0.0			0.0			0.0			0.0
4			0.0			0.0			0.0			0.0
5			0.0			0.0			0.0			0.0
6			0.0			0.0			0.0			0.0
7			0.0			0.0			0.0			0.0
	Average wt% =		0	Standard Dev =		0						
			Iron (wt%)									
Vessel	WCS-115-1-A	WCS-115-1-B	WCS-115-1-C	WCS-115-2-A	WCS-115-2-B	WCS-115-2-C	WCS-115-3-A	WCS-115-3-B	WCS-115-3-C	WCS-115-4-A	WCS-115-4-B	WCS-115-4-C
Segment												
1	0.0			0.0			0.0			0.0		
2	0.0	0.7	0.7	0.6	0.7	1.4	0.6	1.4	1.4	0.7	0.9	0.3
3	0.0	0.7	0.7	0.7	0.7	1.4	0.7	1.4	1.4	0.9	0.3	0.3
4	0.2	0.7	0.7	0.7	0.8	1.4	0.7	1.4	1.4	1.4	0.3	0.3
5	0.7	0.7	0.7	0.7	1.4	1.4	0.8	1.4	1.4	1.4	0.2	0.3
6	0.7	0.7	0.7	1.4	1.4	1.4	1.4	1.4	0.4	0.3	0.3	
7	0.7	0.7	0.7	1.4	1.4	1.4	0.3	1.4	0.3		0.3	
	Average wt% =		0.84	Standard Dev =		0.43						
			Magnesium (wt%)									
Vessel	WCS-115-1-A	WCS-115-1-B	WCS-115-1-C	WCS-115-2-A	WCS-115-2-B	WCS-115-2-C	WCS-115-3-A	WCS-115-3-B	WCS-115-3-C	WCS-115-4-A	WCS-115-4-B	WCS-115-4-C
Segment												
1			0.0			0.0			0.0			0.0
2			0.0			0.0			0.0			0.0
3			0.0			0.0			0.0			0.0
4			0.0			0.0			0.0			0.0
5			0.0			0.0			0.0			0.0
6			0.0			0.0			0.0			0.0
7			0.0			0.0			0.0			0.0
	Average wt% =		0	Standard Dev =		0						
			Manganese (wt%)									
Vessel	WCS-115-1-A	WCS-115-1-B	WCS-115-1-C	WCS-115-2-A	WCS-115-2-B	WCS-115-2-C	WCS-115-3-A	WCS-115-3-B	WCS-115-3-C	WCS-115-4-A	WCS-115-4-B	WCS-115-4-C
Segment												
1			0.0			0.0			0.0			0.0
2			0.0			0.0			0.0			0.0
3			0.0			0.0			0.0			0.0
4			0.0			0.0			0.0			0.0
5			0.0			0.0			0.0			0.0
6			0.0			0.0			0.0			0.0
7			0.0			0.0			0.0			0.0
	Average wt% =		0	Standard Dev =		0						

Table C-1: Selected Elemental Species in CSSF 1 wt%												
			Mercury (wt%)									
Vessel	WCS-115-1-A	WCS-115-1-B	WCS-115-1-C	WCS-115-2-A	WCS-115-2-B	WCS-115-2-C	WCS-115-3-A	WCS-115-3-B	WCS-115-3-C	WCS-115-4-A	WCS-115-4-B	WCS-115-4-C
Segment												
1	0.00			0.00			0.00			0.15		
2	0.00	2.06	2.06	1.68	2.06	1.80	1.72	1.80	1.80	2.06	1.90	2.01
3	0.00	2.06	2.06	2.06	2.06	1.80	2.06	1.80	1.80	1.98	2.01	2.01
4	0.65	2.06	2.06	2.06	2.03	1.80	2.06	1.80	1.80	1.80	2.01	2.01
5	2.06	2.06	2.06	2.06	1.80	1.80	2.02	1.80	1.80	1.80	2.04	2.01
6	2.06	2.06	2.06	1.80	1.80	1.80	1.80	1.80	2.02	2.01	2.01	
7	2.06	2.06	2.06	1.80	1.80	1.80	2.01	1.80	2.01		2.01	
	Average wt% =		1.9	Standard Dev =		0.4						
			Nickel (wt%)									
Vessel	WCS-115-1-A	WCS-115-1-B	WCS-115-1-C	WCS-115-2-A	WCS-115-2-B	WCS-115-2-C	WCS-115-3-A	WCS-115-3-B	WCS-115-3-C	WCS-115-4-A	WCS-115-4-B	WCS-115-4-C
Segment												
1			0.0			0.0			0.0			0.0
2			0.0			0.0			0.0			0.0
3			0.0			0.0			0.0			0.0
4			0.0			0.0			0.0			0.0
5			0.0			0.0			0.0			0.0
6			0.0			0.0			0.0			0.0
7			0.0			0.0			0.0			0.0
	Average wt% =		0	Standard Dev =		0						
			Nitrate (wt%)									
Vessel	WCS-115-1-A	WCS-115-1-B	WCS-115-1-C	WCS-115-2-A	WCS-115-2-B	WCS-115-2-C	WCS-115-3-A	WCS-115-3-B	WCS-115-3-C	WCS-115-4-A	WCS-115-4-B	WCS-115-4-C
Segment												
1	1.74			1.74			1.74			1.75		
2	1.74	1.80	1.80	1.79	1.80	2.86	1.79	2.86	2.86	1.80	2.67	2.44
3	1.74	1.80	1.80	1.80	1.80	2.86	1.80	2.86	2.86	2.16	2.44	2.44
4	1.76	1.80	1.80	1.80	1.92	2.86	1.80	2.86	2.86	2.86	2.44	2.44
5	1.80	1.80	1.80	1.80	2.86	2.86	1.97	2.86	2.86	2.86	1.42	2.44
6	1.80	1.80	1.80	2.86	2.86	2.86	2.86	2.86	2.47	2.44	2.44	
7	1.80	1.80	1.80	2.86	2.86	2.86	2.44	2.86	2.44		2.44	
	Average wt% =		2.3	Standard Dev =		0.5						
			Oxide (wt%)									
Vessel	WCS-115-1-A	WCS-115-1-B	WCS-115-1-C	WCS-115-2-A	WCS-115-2-B	WCS-115-2-C	WCS-115-3-A	WCS-115-3-B	WCS-115-3-C	WCS-115-4-A	WCS-115-4-B	WCS-115-4-C
Segment												
1	45.9			45.9			45.9			45.8		
2	45.9	43.5	43.5	43.9	43.5	42.6	43.9	42.6	42.6	43.5	42.8	43.1
3	45.9	43.5	43.5	43.5	43.5	42.6	43.5	42.6	42.6	43.2	43.1	43.1
4	45.2	43.5	43.5	43.5	43.4	42.6	43.5	42.6	42.6	42.6	43.1	43.1
5	43.5	43.5	43.5	43.5	42.6	42.6	43.3	42.6	42.6	42.6	43.8	43.1
6	43.5	43.5	43.5	42.6	42.6	42.6	42.6	42.6	43.0	43.1	43.1	
7	43.5	43.5	43.5	42.6	42.6	42.6	43.1	42.6	43.1		43.1	
	Average wt% =		43	Standard Dev =		1						

Table C-1: Selected Elemental Species in CSSF 1 wt%

			Phosphate (wt%)									
Vessel	WCS-115-1-A	WCS-115-1-B	WCS-115-1-C	WCS-115-2-A	WCS-115-2-B	WCS-115-2-C	WCS-115-3-A	WCS-115-3-B	WCS-115-3-C	WCS-115-4-A	WCS-115-4-B	WCS-115-4-C
Segment												
1	0.00			0.00			0.00			0.08		
2	0.00	1.10	1.10	0.89	1.10	1.13	0.91	1.13	1.13	1.10	1.14	1.15
3	0.00	1.10	1.10	1.10	1.10	1.13	1.10	1.13	1.13	1.11	1.15	1.15
4	0.35	1.10	1.10	1.10	1.10	1.13	1.10	1.13	1.13	1.13	1.15	1.15
5	1.10	1.10	1.10	1.10	1.13	1.13	1.10	1.13	1.13	1.13	1.12	1.15
6	1.10	1.10	1.10	1.13	1.13	1.13	1.13	1.13	1.16	1.15	1.15	
7	1.10	1.10	1.10	1.13	1.13	1.13	1.15	1.13	1.15		1.15	
	Average wt% =		1.1	Standard Dev =		0.2						
			Potassium (wt%)									
Vessel	WCS-115-1-A	WCS-115-1-B	WCS-115-1-C	WCS-115-2-A	WCS-115-2-B	WCS-115-2-C	WCS-115-3-A	WCS-115-3-B	WCS-115-3-C	WCS-115-4-A	WCS-115-4-B	WCS-115-4-C
Segment												
1			0.0			0.0			0.0			0.0
2			0.0			0.0			0.0			0.0
3			0.0			0.0			0.0			0.0
4			0.0			0.0			0.0			0.0
5			0.0			0.0			0.0			0.0
6			0.0			0.0			0.0			0.0
7			0.0			0.0			0.0			0.0
	Average wt% =		0	Standard Dev =		0						
			Sodium (wt%)									
Vessel	WCS-115-1-A	WCS-115-1-B	WCS-115-1-C	WCS-115-2-A	WCS-115-2-B	WCS-115-2-C	WCS-115-3-A	WCS-115-3-B	WCS-115-3-C	WCS-115-4-A	WCS-115-4-B	WCS-115-4-C
Segment												
1	1.0			1.0			1.0			1.0		
2	1.0	1.0	1.0	1.0	1.0	1.6	1.0	1.6	1.6	1.0	1.5	1.4
3	1.0	1.0	1.0	1.0	1.0	1.6	1.0	1.6	1.6	1.2	1.4	1.4
4	1.0	1.0	1.0	1.0	1.1	1.6	1.0	1.6	1.6	1.6	1.4	1.4
5	1.0	1.0	1.0	1.0	1.6	1.6	1.1	1.6	1.6	1.6	0.8	1.4
6	1.0	1.0	1.0	1.6	1.6	1.6	1.6	1.6	1.4	1.4	1.4	
7	1.0	1.0	1.0	1.6	1.6	1.6	1.4	1.6	1.4		1.4	
	Average wt% =		1.29	Standard Dev =		0.3						
			Strontium (wt%)									
Vessel	WCS-115-1-A	WCS-115-1-B	WCS-115-1-C	WCS-115-2-A	WCS-115-2-B	WCS-115-2-C	WCS-115-3-A	WCS-115-3-B	WCS-115-3-C	WCS-115-4-A	WCS-115-4-B	WCS-115-4-C
Segment												
1	0.0000			0.0000			0.0000			0.0009		
2	0.0000	0.0124	0.0124	0.0101	0.0124	0.0091	0.0103	0.0091	0.0091	0.0124	0.0104	0.0120
3	0.0000	0.0124	0.0124	0.0124	0.0124	0.0091	0.0124	0.0091	0.0091	0.0113	0.0120	0.0120
4	0.0039	0.0124	0.0124	0.0124	0.0120	0.0091	0.0124	0.0091	0.0091	0.0091	0.0120	0.0120
5	0.0124	0.0124	0.0124	0.0124	0.0091	0.0091	0.0119	0.0091	0.0091	0.0091	0.0086	0.0120
6	0.0124	0.0124	0.0124	0.0091	0.0091	0.0091	0.0091	0.0091	0.0121	0.0120	0.0120	
7	0.0124	0.0124	0.0124	0.0091	0.0091	0.0091	0.0120	0.0091	0.0120		0.0120	
	Average wt% =		0.010	Standard Dev =		0.003						

Table C-1: Selected Elemental Species in CSSF 1 wt%

			Sulfate (wt%)									
Vessel	WCS-115-1-A	WCS-115-1-B	WCS-115-1-C	WCS-115-2-A	WCS-115-2-B	WCS-115-2-C	WCS-115-3-A	WCS-115-3-B	WCS-115-3-C	WCS-115-4-A	WCS-115-4-B	WCS-115-4-C
Segment												
1	0.00			0.00			0.00			0.10		
2	0.00	1.40	1.40	1.14	1.40	1.45	1.17	1.45	1.45	1.40	1.46	1.48
3	0.00	1.40	1.40	1.40	1.40	1.45	1.40	1.45	1.45	1.42	1.48	1.48
4	0.44	1.40	1.40	1.40	1.41	1.45	1.40	1.45	1.45	1.45	1.48	1.48
5	1.40	1.40	1.40	1.40	1.45	1.45	1.41	1.45	1.45	1.45	1.54	1.48
6	1.40	1.40	1.40	1.45	1.45	1.45	1.45	1.45	1.49	1.48	1.48	
7	1.40	1.40	1.40	1.45	1.45	1.45	1.48	1.45	1.48		1.48	
	Average wt% =		1.4	Standard Dev =		0.3						
			Tin (wt%)									
Vessel	WCS-115-1-A	WCS-115-1-B	WCS-115-1-C	WCS-115-2-A	WCS-115-2-B	WCS-115-2-C	WCS-115-3-A	WCS-115-3-B	WCS-115-3-C	WCS-115-4-A	WCS-115-4-B	WCS-115-4-C
Segment												
1			0.0			0.0			0.0			0.0
2			0.0			0.0			0.0			0.0
3			0.0			0.0			0.0			0.0
4			0.0			0.0			0.0			0.0
5			0.0			0.0			0.0			0.0
6			0.0			0.0			0.0			0.0
7			0.0			0.0			0.0			0.0
	Average wt% =		0	Standard Dev =		0						
			Uranium (wt%)									
Vessel	WCS-115-1-A	WCS-115-1-B	WCS-115-1-C	WCS-115-2-A	WCS-115-2-B	WCS-115-2-C	WCS-115-3-A	WCS-115-3-B	WCS-115-3-C	WCS-115-4-A	WCS-115-4-B	WCS-115-4-C
Segment												
1	0.00000			0.00000			0.00000			0.00054		
2	0.00000	0.00762	0.00762	0.00619	0.00762	0.00741	0.00635	0.00741	0.00741	0.00762	0.00851	0.00988
3	0.00000	0.00762	0.00762	0.00762	0.00762	0.00741	0.00762	0.00741	0.00741	0.00755	0.00988	0.00988
4	0.00240	0.00762	0.00762	0.00762	0.00759	0.00741	0.00762	0.00741	0.00741	0.00741	0.00988	0.00988
5	0.00762	0.00762	0.00762	0.00762	0.00741	0.00741	0.00758	0.00741	0.00741	0.00741	0.00529	0.00988
6	0.00762	0.00762	0.00762	0.00741	0.00741	0.00741	0.00741	0.00741	0.00970	0.00988	0.00988	
7	0.00762	0.00762	0.00762	0.00741	0.00741	0.00741	0.00988	0.00741	0.00988		0.00988	
	Average wt% =		0.0076	Standard Dev =		0.0018						
			Zirconium (wt%)									
Vessel	WCS-115-1-A	WCS-115-1-B	WCS-115-1-C	WCS-115-2-A	WCS-115-2-B	WCS-115-2-C	WCS-115-3-A	WCS-115-3-B	WCS-115-3-C	WCS-115-4-A	WCS-115-4-B	WCS-115-4-C
Segment												
1			0.0			0.0			0.0			0.0
2			0.0			0.0			0.0			0.0
3			0.0			0.0			0.0			0.0
4			0.0			0.0			0.0			0.0
5			0.0			0.0			0.0			0.0
6			0.0			0.0			0.0			0.0
7			0.0			0.0			0.0			0.0
	Average wt% =		0	Standard Dev =		0						

Table C-1: Selected Radionuclides CSSF 1 Ci/m^3

Antimony-126

Vessel	WCS-115-1-A	WCS-115-1-B	WCS-115-1-C	WCS-115-2-A	WCS-115-2-B	WCS-115-2-C	WCS-115-3-A	WCS-115-3-B	WCS-115-3-C	WCS-115-4-A	WCS-115-4-B	WCS-115-4-C
Segment												
1	0.0000	0.0069	0.0042	0.0000	0.0521	0.0031	0.0000	0.0060	0.0085	0.0018	0.0076	0.0084
2	0.0000	0.0083	0.0060	0.0066	0.0044	0.0038	0.0073	0.0062	0.0041	0.0079	0.0071	0.0081
3	0.0000	0.0078	0.0072	0.0077	0.0066	0.0060	0.0074	0.0069	0.0058	0.0087	0.0081	0.0110
4	0.0033	0.0095	0.0089	0.0081	0.0060	0.0057	0.0083	0.0054	0.0058	0.0069	0.0054	0.0117
5	0.0087	0.0095	0.0083	0.0129	0.0049	0.0055	0.0116	0.0048	0.0089	0.0058	0.0117	
6	0.0099	0.0074	0.0068	0.0150	0.0043	0.0110	0.0073	0.0057	0.0207	0.0114	0.0116	
7	0.0111											
	Average Ci/m^3 =		0.0071	Standard Dev =		0.0022						

Antimony-126-m

Vessel	WCS-115-1-A	WCS-115-1-B	WCS-115-1-C	WCS-115-2-A	WCS-115-2-B	WCS-115-2-C	WCS-115-3-A	WCS-115-3-B	WCS-115-3-C	WCS-115-4-A	WCS-115-4-B	WCS-115-4-C
Segment												
1		0.0493	0.0298	0.0000	0.3720	0.0222	0.0000	0.0432	0.0605	0.0130	0.0541	0.0599
2		0.0591	0.0426	0.0471	0.0317	0.0271	0.0525	0.0443	0.0296	0.0566	0.0507	0.0580
3		0.0559	0.0513	0.0550	0.0469	0.0427	0.0528	0.0492	0.0411	0.0619	0.0581	0.0782
4	0.0237	0.0679	0.0634	0.0579	0.0427	0.0409	0.0590	0.0385	0.0412	0.0489	0.0388	0.0838
5	0.0620	0.0678	0.0591	0.0924	0.0349	0.0393	0.0831	0.0345	0.0638	0.0415	0.0838	
6	0.0704	0.0531	0.0486	0.1072	0.0309	0.0785	0.0521	0.0407	0.1476	0.0817	0.0829	
7	0.0796											
	Average Ci/m^3 =		0.051	Standard Dev =		0.016						

Barium-137m

Vessel	WCS-115-1-A	WCS-115-1-B	WCS-115-1-C	WCS-115-2-A	WCS-115-2-B	WCS-115-2-C	WCS-115-3-A	WCS-115-3-B	WCS-115-3-C	WCS-115-4-A	WCS-115-4-B	WCS-115-4-C
Segment												
1		3437	2073	0	25922	1545	0	3010	4218	906	3770	4173
2		4121	2968	3284	2207	1885	3657	3086	2060	3941	3530	4039
3		3892	3573	3836	3265	2974	3677	3431	2865	4312	4050	5452
4	1649	4734	4421	4037	2978	2847	4114	2680	2868	3411	2706	5842
5	4321	4727	4121	6438	2435	2739	5792	2401	4445	2895	5842	
6	4909	3703	3385	7469	2151	5468	3627	2836	10287	5691	5778	
7	5545											
	Average Ci/m^3 =		3500	Standard Dev =		1100						

Cesium-137

Vessel	WCS-115-1-A	WCS-115-1-B	WCS-115-1-C	WCS-115-2-A	WCS-115-2-B	WCS-115-2-C	WCS-115-3-A	WCS-115-3-B	WCS-115-3-C	WCS-115-4-A	WCS-115-4-B	WCS-115-4-C
Segment												
1		3633	2192	0	27402	1633	0	3182	4459	958	3985	4411
2		4357	3138	3471	2333	1993	3866	3262	2178	4166	3731	4269
3		4115	3777	4055	3452	3143	3887	3627	3028	4558	4282	5763
4	1743	5004	4674	4268	3148	3010	4349	2833	3031	3606	2860	6176
5	4567	4997	4356	6806	2574	2895	6123	2538	4699	3060	6176	
6	5189	3914	3578	7895	2274	5781	3834	2998	10874	6016	6108	
7	5861											
	Average Ci/m^3 =		3700	Standard Dev =		1200						

Table C-1: Selected Radionuclides CSSF 1 Ci/m^3

			Nickel-63		(no values for nickel)							
Vessel	WCS-115-1-A	WCS-115-1-B	WCS-115-1-C	WCS-115-2-A	WCS-115-2-B	WCS-115-2-C	WCS-115-3-A	WCS-115-3-B	WCS-115-3-C	WCS-115-4-A	WCS-115-4-B	WCS-115-4-C
Segment												
1		0	0	0	0	0	0	0	0	0	0	0
2		0	0	0	0	0	0	0	0	0	0	0
3		0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	0	0	0	0	
6	0	0	0	0	0	0	0	0	0	0	0	
7	0											
	Average Ci/m3 =		0.0	Standard Dev =		0.0						

			Strontium-90									
Vessel	WCS-115-1-A	WCS-115-1-B	WCS-115-1-C	WCS-115-2-A	WCS-115-2-B	WCS-115-2-C	WCS-115-3-A	WCS-115-3-B	WCS-115-3-C	WCS-115-4-A	WCS-115-4-B	WCS-115-4-C
Segment												
1		3107	1874	0	23432	1481	0	2886	4044	819	3451	3656
2		3725	2683	2969	1995	1807	3306	2959	1975	3563	3092	3538
3		3519	3229	3467	2967	2851	3323	3289	2746	3961	3548	4776
4	1491	4279	3996	3649	2855	2730	3719	2569	2750	3270	2370	5118
5	3906	4273	3725	5820	2335	2626	5274	2302	3900	2776	5118	
6	4438	3347	3060	7161	2062	5243	3478	2719	9011	4985	5061	
7	5012											
	Average Ci/m^3 =		3200	Standard Dev =		900						

			Technetium-99									
Vessel	WCS-115-1-A	WCS-115-1-B	WCS-115-1-C	WCS-115-2-A	WCS-115-2-B	WCS-115-2-C	WCS-115-3-A	WCS-115-3-B	WCS-115-3-C	WCS-115-4-A	WCS-115-4-B	WCS-115-4-C
Segment												
1		1.9	1.1	0.0	14.2	0.8	0.0	1.7	2.3	0.5	2.1	2.3
2		2.3	1.6	1.8	1.2	1.0	2.0	1.7	1.1	2.2	1.9	2.2
3		2.1	2.0	2.1	1.8	1.6	2.0	1.9	1.6	2.4	2.2	3.0
4	0.9	2.6	2.4	2.2	1.6	1.6	2.3	1.5	1.6	1.9	1.5	3.2
5	2.4	2.6	2.3	3.5	1.3	1.5	3.2	1.3	2.4	1.6	3.2	
6	2.7	2.0	1.9	4.1	1.2	3.0	2.0	1.6	5.7	3.1	3.2	
7	3.0											
	Average Ci/m^3 =		1.9	Standard Dev =		0.6						

			Yttrium-90									
Vessel	WCS-115-1-A	WCS-115-1-B	WCS-115-1-C	WCS-115-2-A	WCS-115-2-B	WCS-115-2-C	WCS-115-3-A	WCS-115-3-B	WCS-115-3-C	WCS-115-4-A	WCS-115-4-B	WCS-115-4-C
Segment												
1		3107	1874	0	23432	1481	0	2886	4044	819	3451	3656
2		3725	2683	2969	1995	1807	3306	2959	1975	3563	3092	3538
3		3519	3229	3467	2967	2851	3323	3289	2746	3961	3548	4776
4	1491	4279	3996	3649	2855	2730	3719	2569	2750	3270	2370	5118
5	3906	4273	3725	5820	2335	2626	5274	2302	3900	2776	5118	
6	4438	3347	3060	7161	2062	5243	3478	2719	9011	4985	5061	
7	5012											
	Average Ci/m3 =		3200	Standard Dev =		900						

Table C-1: Selected Radionuclides CSSF 1 nano-Ci/g

Americium-241

Vessel	WCS-115-1-A	WCS-115-1-B	WCS-115-1-C	WCS-115-2-A	WCS-115-2-B	WCS-115-2-C	WCS-115-3-A	WCS-115-3-B	WCS-115-3-C	WCS-115-4-A	WCS-115-4-B	WCS-115-4-C
Segment												
1		396	396	0	396	597	0	597	597	28	466	302
2		396	396	322	396	597	330	597	597	396	302	302
3		396	396	396	418	597	396	597	597	463	302	302
4	125	396	396	396	597	597	396	597	597	597	184	302
5	396	396	396	396	597	597	428	597	323	597	302	
6	396	396	396	597	597	597	597	597	302	302	302	
7	396											
	Average nCi/g =		460		Standard Dev =	130						

Neptunuim-237

Vessel	WCS-115-1-A	WCS-115-1-B	WCS-115-1-C	WCS-115-2-A	WCS-115-2-B	WCS-115-2-C	WCS-115-3-A	WCS-115-3-B	WCS-115-3-C	WCS-115-4-A	WCS-115-4-B	WCS-115-4-C
Segment												
1		5.9	5.9		5.9	5.5		5.5	5.5	0.4	6.6	7.8
2		5.9	5.9	4.8	5.9	5.5	5.0	5.5	5.5	5.9	7.8	7.8
3		5.9	5.9	5.9	5.9	5.5	5.9	5.5	5.5	5.8	7.8	7.8
4	1.9	5.9	5.9	5.9	5.5	5.5	5.9	5.5	5.5	5.5	4.6	7.8
5	5.9	5.9	5.9	5.9	5.5	5.5	5.9	5.5	7.9	5.5	7.8	
6	5.9	5.9	5.9	5.5	5.5	5.5	5.5	5.5	7.8	7.8	7.8	
7	5.9											
	Average nCi/g =		6.2		Standard Dev =	1.0						

Plutonium-238

Vessel	WCS-115-1-A	WCS-115-1-B	WCS-115-1-C	WCS-115-2-A	WCS-115-2-B	WCS-115-2-C	WCS-115-3-A	WCS-115-3-B	WCS-115-3-C	WCS-115-4-A	WCS-115-4-B	WCS-115-4-C
Segment												
1		1979	1979	0	1979	2067	0	2067	2067	140	1823	1509
2		1979	1979	1609	1979	2067	1649	2067	2067	1979	1509	1509
3		1979	1979	1979	1989	2067	1979	2067	2067	2008	1509	1509
4	623	1979	1979	1979	2067	2067	1979	2067	2067	2067	918	1509
5	1979	1979	1979	1979	2067	2067	1993	2067	1568	2067	1509	
6	1979	1979	1979	2067	2067	2067	2067	2067	1509	1509	1509	
7	1979											
	Average nCi/g =		1900		Standard Dev =	280						

Plutonium-239

Vessel	WCS-115-1-A	WCS-115-1-B	WCS-115-1-C	WCS-115-2-A	WCS-115-2-B	WCS-115-2-C	WCS-115-3-A	WCS-115-3-B	WCS-115-3-C	WCS-115-4-A	WCS-115-4-B	WCS-115-4-C
Segment												
1		255	255	0	255	265	0	265	265	18	234	195
2		255	255	207	255	265	213	265	265	255	195	195
3		255	255	255	256	265	255	265	265	258	195	195
4	80	255	255	255	265	265	255	265	265	265	118	195
5	255	255	255	255	265	265	257	265	202	265	195	
6	255	255	255	265	265	265	265	265	195	195	195	
7	255											
	Average nCi/g =		240		Standard Dev =	35						

Table C-1: Selected Radionuclides CSSF 1 nano-Ci/g

Plutonium-240

Vessel	WCS-115-1-A	WCS-115-1-B	WCS-115-1-C	WCS-115-2-A	WCS-115-2-B	WCS-115-2-C	WCS-115-3-A	WCS-115-3-B	WCS-115-3-C	WCS-115-4-A	WCS-115-4-B	WCS-115-4-C
Segment												
1		101	101	0	101	105	0	105	105	7	93	77
2		101	101	82	101	105	84	105	105	101	77	77
3		101	101	101	102	105	101	105	105	102	77	77
4	32	101	101	101	105	105	101	105	105	105	47	77
5	101	101	101	101	105	105	102	105	80	105	77	
6	101	101	101	105	105	105	105	105	77	77	77	
7	101											
		Average nCi/g =	96		Standard Dev =	14						

Plutonium-241

Vessel	WCS-115-1-A	WCS-115-1-B	WCS-115-1-C	WCS-115-2-A	WCS-115-2-B	WCS-115-2-C	WCS-115-3-A	WCS-115-3-B	WCS-115-3-C	WCS-115-4-A	WCS-115-4-B	WCS-115-4-C
Segment												
1		865	865	0	865	927	0	927	927	61	810	660
2		865	865	703	865	927	720	927	927	865	660	660
3		865	865	865	872	927	865	927	927	885	660	660
4	272	865	865	865	927	927	865	927	927	927	401	660
5	865	865	865	865	927	927	874	927	686	927	660	
6	865	865	865	927	927	927	927	927	660	660	660	
7	865											
		Average nCi/g =	830		Standard Dev =	130						

Protactinium-233

Vessel	WCS-115-1-A	WCS-115-1-B	WCS-115-1-C	WCS-115-2-A	WCS-115-2-B	WCS-115-2-C	WCS-115-3-A	WCS-115-3-B	WCS-115-3-C	WCS-115-4-A	WCS-115-4-B	WCS-115-4-C
Segment												
1		7.5	7.5		7.5	5.5		5.5	5.5	0.5	6.3	7.3
2		7.5	7.5	6.1	7.5	5.5	6.3	5.5	5.5	7.5	7.3	7.3
3		7.5	7.5	7.5	7.3	5.5	7.5	5.5	5.5	6.9	7.3	7.3
4	2.4	7.5	7.5	7.5	5.5	5.5	7.5	5.5	5.5	5.5	5.2	7.3
5	7.5	7.5	7.5	7.5	5.5	5.5	7.2	5.5	7.4	5.5	7.3	
6	7.5	7.5	7.5	5.5	5.5	5.5	5.5	5.5	7.3	7.3	7.3	
7	7.5											
		Average nCi/g =	6.5		Standard Dev =	1.0						

Thoruim-231

Vessel	WCS-115-1-A	WCS-115-1-B	WCS-115-1-C	WCS-115-2-A	WCS-115-2-B	WCS-115-2-C	WCS-115-3-A	WCS-115-3-B	WCS-115-3-C	WCS-115-4-A	WCS-115-4-B	WCS-115-4-C
Segment												
1		0.15	0.15		0.15	0.11		0.11	0.11	0.01	0.13	0.15
2		0.15	0.15	0.13	0.15	0.11	0.13	0.11	0.11	0.15	0.15	0.15
3		0.15	0.15	0.15	0.15	0.11	0.15	0.11	0.11	0.14	0.15	0.15
4	0.05	0.15	0.15	0.15	0.11	0.11	0.15	0.11	0.11	0.11	0.11	0.15
5	0.15	0.15	0.15	0.15	0.11	0.11	0.15	0.11	0.15	0.11	0.15	
6	0.15	0.15	0.15	0.11	0.11	0.11	0.11	0.11	0.15	0.15	0.15	
7	0.15											
		Average nCi/g =	0.13		Standard Dev =	0.02						

Table C-2: Selected Elemental Species in CSSF 2 wt%

			Aluminium (wt%)				
Vessel	WCS-136-1	WCS-136-2	WCS-136-3	WCS-136-4	WCS-136-5	WCS-136-6	WCS-136-7
Segment							
1	38.1	35.7	48.2	51.2	44.5	36.0	35.0
2	52.7	52.7	45.7	51.2	44.5	11.4	41.8
3	12.8	11.4	48.3	48.1	47.5	20.2	14.3
4	9.9	7.1	40.9	47.3	21.2	9.1	9.1
5	11.0	7.1	46.6	48.0	9.5	8.5	13.0
6	7.3	7.1	44.5	48.1	9.3	7.3	10.5
7	7.2	7.3	44.5	48.2	24.9	7.2	10.6
		Average wt% =	26		Standard Dev =	18	
			Boron (wt%)				
Vessel	WCS-136-1	WCS-136-2	WCS-136-3	WCS-136-4	WCS-136-5	WCS-136-6	WCS-136-7
Segment							
1	0.11	0.11	0.25	0.12	0.26	0.39	0.43
2	0.16	0.16	0.24	0.12	0.26	0.28	0.33
3	0.74	0.75	0.25	0.25	0.27	0.59	0.71
4	0.75	0.85	0.22	0.25	0.54	0.80	0.82
5	0.75	0.85	0.26	0.23	0.87	0.80	0.81
6	0.87	0.85	0.26	0.25	0.84	0.87	1.03
7	0.86	0.87	0.26	0.25	0.53	0.86	1.06
		Average wt% =	0.56		Standard Dev =	0.30	
			Cadmium (wt%)				
Vessel	WCS-136-1	WCS-136-2	WCS-136-3	WCS-136-4	WCS-136-5	WCS-136-6	WCS-136-7
Segment							
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Average wt% =	0		Standard Dev =	0	
			Calcium (wt%)				
Vessel	WCS-136-1	WCS-136-2	WCS-136-3	WCS-136-4	WCS-136-5	WCS-136-6	WCS-136-7
Segment							
1	6.24	7.25	0.00	0.00	0.00	8.89	9.22
2	0	0	0	0	0	19	7
3	25	25	0	0	0	20	23
4	26	31	3	0	19	28	28
5	25	31	0	0	28	29	23
6	30	30	0	0	30	30	25
7	30	30	0	0	21	30	25
		Average wt% =	16		Standard Dev =	13	

Table C-2: Selected Elemental Species in CSSF 2 wt%

			Carbonate (wt%)				
Vessel	WCS-136-1	WCS-136-2	WCS-136-3	WCS-136-4	WCS-136-5	WCS-136-6	WCS-136-7
Segment							
1	18.0	20.9	0.0	0.0	0.0	2.0	1.4
2	0.0	0.0	0.0	0.0	0.0	38.1	0.0
3	2.2	1.6	0.0	0.0	0.0	1.6	4.2
4	0.0	0.0	9.9	0.0	8.1	1.2	0.0
5	2.3	0.0	1.2	0.0	0.0	2.1	5.4
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Average wt% =	1.9		Standard Dev =	6.1	
			Cesium (wt%)				
Vessel	WCS-136-1	WCS-136-2	WCS-136-3	WCS-136-4	WCS-136-5	WCS-136-6	WCS-136-7
Segment							
1	0.000	0.000	0.019	0.000	0.018	0.017	0.015
2	0.000	0.000	0.023	0.000	0.018	0.002	0.028
3	0.005	0.005	0.019	0.028	0.021	0.004	0.007
4	0.005	0.007	0.018	0.021	0.010	0.006	0.005
5	0.005	0.007	0.022	0.017	0.008	0.007	0.008
6	0.007	0.007	0.018	0.019	0.008	0.007	0.006
7	0.007	0.007	0.018	0.019	0.018	0.007	0.007
		Average wt% =	0.011		Standard Dev =	0.008	
			Chloride (wt%)				
Vessel	WCS-136-1	WCS-136-2	WCS-136-3	WCS-136-4	WCS-136-5	WCS-136-6	WCS-136-7
Segment							
1	0.000	0.000	0.000	0.000	0.000	0.007	0.007
2	0.000	0.000	0.000	0.000	0.000	0.005	0.006
3	0.020	0.021	0.000	0.000	0.000	0.016	0.018
4	0.022	0.025	0.000	0.000	0.013	0.023	0.024
5	0.020	0.026	0.000	0.000	0.024	0.024	0.018
6	0.025	0.025	0.000	0.000	0.025	0.025	0.021
7	0.025	0.025	0.000	0.000	0.018	0.025	0.021
		Average wt% =	0.013		Standard Dev =	0.011	
			Chromium (wt%)				
Vessel	WCS-136-1	WCS-136-2	WCS-136-3	WCS-136-4	WCS-136-5	WCS-136-6	WCS-136-7
Segment							
1	0.00	0.00	0.00	0.00	0.00	0.07	0.07
2	0.00	0.00	0.00	0.00	0.00	0.06	0.05
3	0.21	0.24	0.00	0.00	0.00	0.20	0.19
4	0.27	0.24	0.00	0.00	0.12	0.24	0.23
5	0.25	0.24	0.00	0.00	0.23	0.22	0.20
6	0.24	0.24	0.00	0.00	0.23	0.24	0.24
7	0.24	0.24	0.00	0.00	0.12	0.24	0.25
		Average wt% =	0.13		Standard Dev =	0.11	

Table C-2: Selected Elemental Species in CSSF 2 wt%

			Fluoride (wt%)				
Vessel	WCS-136-1	WCS-136-2	WCS-136-3	WCS-136-4	WCS-136-5	WCS-136-6	WCS-136-7
Segment							
1	0	0	0	0	0	7	8
2	0	0	0	0	0	6	6
3	23	24	0	0	0	18	21
4	25	27	0	0	13	25	27
5	23	27	0	0	25	25	22
6	28	27	0	0	24	28	27
7	27	27	0	0	13	27	26
		Average wt% =	14		Standard Dev =	12	
			Iron (wt%)				
Vessel	WCS-136-1	WCS-136-2	WCS-136-3	WCS-136-4	WCS-136-5	WCS-136-6	WCS-136-7
Segment							
1	0.00	0.00	0.07	0.00	0.06	0.09	0.10
2	0.00	0.00	0.06	0.00	0.06	0.09	0.04
3	0.18	0.17	0.07	0.25	0.07	0.15	0.16
4	0.20	0.11	0.05	0.07	0.11	0.14	0.22
5	0.17	0.11	0.06	0.06	0.17	0.10	0.25
6	0.11	0.11	0.06	0.07	0.16	0.11	0.33
7	0.11	0.11	0.06	0.07	0.09	0.11	0.36
		Average wt% =	0.12		Standard Dev =	0.08	
			Magnesium (wt%)				
Vessel	WCS-136-1	WCS-136-2	WCS-136-3	WCS-136-4	WCS-136-5	WCS-136-6	WCS-136-7
Segment							
1	3.50	4.06	0.00	0.00	0.00	0.45	0.34
2	0.00	0.00	0.00	0.00	0.00	7.46	0.05
3	0.59	0.48	0.00	0.00	0.00	0.45	0.96
4	0.18	0.21	1.93	0.00	1.68	0.42	0.19
5	0.61	0.21	0.24	0.00	0.19	0.61	1.19
6	0.20	0.21	0.00	0.00	0.20	0.20	0.17
7	0.21	0.20	0.00	0.00	0.14	0.21	0.17
		Average wt% =	0.47		Standard Dev =	1.19	
			Manganese (wt%)				
Vessel	WCS-136-1	WCS-136-2	WCS-136-3	WCS-136-4	WCS-136-5	WCS-136-6	WCS-136-7
Segment							
1	0.000	0.000	0.000	0.000	0.000	0.026	0.027
2	0.000	0.000	0.000	0.000	0.000	0.019	0.022
3	0.075	0.077	0.000	0.000	0.000	0.059	0.069
4	0.081	0.096	0.000	0.000	0.050	0.086	0.089
5	0.076	0.096	0.000	0.000	0.089	0.089	0.066
6	0.093	0.096	0.000	0.000	0.093	0.093	0.078
7	0.095	0.093	0.000	0.000	0.066	0.095	0.077
		Average wt% =	0.048		Standard Dev =	0.041	

Table C-2: Selected Elemental Species in CSSF 2 wt%

			Mercury (wt%)				
Vessel	WCS-136-1	WCS-136-2	WCS-136-3	WCS-136-4	WCS-136-5	WCS-136-6	WCS-136-7
Segment							
1	0.00	0.00	2.30	0.00	2.00	1.17	1.30
2	0.00	0.00	2.59	0.00	2.00	0.01	0.90
3	0.00	0.00	2.28	1.76	2.08	0.00	0.07
4	0.00	0.00	1.85	2.41	0.85	0.00	0.00
5	0.00	0.00	2.19	2.02	0.00	0.00	0.10
6	0.00	0.00	2.00	2.31	0.00	0.00	0.00
7	0.0000	0.0000	1.9961	2.2881	0.4501	0.0000	0.0000
		Average wt% =	0.72		Standard Dev =	0.99	
			Nickel (wt%)				
Vessel	WCS-136-1	WCS-136-2	WCS-136-3	WCS-136-4	WCS-136-5	WCS-136-6	WCS-136-7
Segment							
1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0024	0.0027
2	0.0000	0.0000	0.0000	0.0000	0.0000	0.0023	0.0020
3	0.0078	0.0087	0.0000	0.0000	0.0000	0.0071	0.0072
4	0.0098	0.0088	0.0000	0.0000	0.0046	0.0089	0.0086
5	0.0090	0.0088	0.0000	0.0000	0.0086	0.0082	0.0075
6	0.0090	0.0088	0.0000	0.0000	0.0084	0.0090	0.0091
7	0.0089	0.0090	0.0000	0.0000	0.0046	0.0088	0.0092
		Average wt% =	0.0048		Standard Dev =	0.0042	
			Nitrate (wt%)				
Vessel	WCS-136-1	WCS-136-2	WCS-136-3	WCS-136-4	WCS-136-5	WCS-136-6	WCS-136-7
Segment							
1	0.0	0.0	2.1	1.8	7.5	1.7	2.1
2	0.0	0.0	4.3	1.7	7.5	0.0	0.0
3	0.1	0.0	2.0	2.6	3.8	0.0	0.1
4	0.0	0.0	2.3	2.9	0.9	0.0	0.1
5	0.0	0.0	3.9	2.6	0.0	0.0	0.2
6	0.0	0.0	7.5	2.2	0.0	0.0	0.1
7	0.0	0.0	7.5	2.0	0.0	0.0	0.1
		Average wt% =	1.3		Standard Dev =	2.2	
			Oxide (wt%)				
Vessel	WCS-136-1	WCS-136-2	WCS-136-3	WCS-136-4	WCS-136-5	WCS-136-6	WCS-136-7
Segment							
1	34	32	43	46	41	35	34
2	47	47	41	46	41	12	40
3	19	18	43	43	43	24	19
4	17	15	37	42	24	17	16
5	18	15	42	43	18	16	18
6	15	15	41	43	18	15	17
7	15	15	41	43	29	15	17
		Average wt% =	28		Standard Dev =	13	

Table C-2: Selected Elemental Species in CSSF 2 wt%							
			Phosphate (wt%)				
Vessel	WCS-136-1	WCS-136-2	WCS-136-3	WCS-136-4	WCS-136-5	WCS-136-6	WCS-136-7
Segment							
1	0.00	0.00	0.91	0.00	0.16	0.37	0.43
2	0.00	0.00	1.90	0.00	0.16	0.03	0.17
3	0.11	0.10	0.85	1.06	0.17	0.08	0.11
4	0.11	0.09	0.39	1.27	0.10	0.09	0.12
5	0.09	0.09	0.16	1.03	0.10	0.08	0.12
6	0.09	0.09	0.16	0.94	0.10	0.09	0.13
7	0.09	0.09	0.16	0.87	0.13	0.09	0.13
		Average wt% =	0.28		Standard Dev =	0.41	
			Potassium (wt%)				
Vessel	WCS-136-1	WCS-136-2	WCS-136-3	WCS-136-4	WCS-136-5	WCS-136-6	WCS-136-7
Segment							
1	0.00	0.00	0.00	0.00	0.71	0.28	0.19
2	0.00	0.00	0.00	0.00	0.71	0.03	0.00
3	0.06	0.02	0.00	0.00	0.85	0.00	0.07
4	0.00	0.00	0.09	0.00	0.77	0.00	0.06
5	0.00	0.00	0.28	0.00	0.00	0.00	0.17
6	0.00	0.00	0.71	0.00	0.00	0.00	0.06
7	0.00	0.00	0.71	0.00	0.00	0.00	0.06
		Average wt% =	0.11		Standard Dev =	0.25	
			Sodium (wt%)				
Vessel	WCS-136-1	WCS-136-2	WCS-136-3	WCS-136-4	WCS-136-5	WCS-136-6	WCS-136-7
Segment							
1	0.00	0.00	1.18	1.00	3.79	0.80	1.09
2	0.00	0.00	2.41	0.98	3.79	0.00	0.00
3	0.00	0.00	1.11	1.44	1.65	0.00	0.00
4	0.00	0.00	1.26	1.63	0.05	0.00	0.00
5	0.00	0.00	2.02	1.48	0.00	0.00	0.00
6	0.00	0.00	3.79	1.22	0.00	0.00	0.00
7	0.00	0.00	3.79	1.14	0.00	0.00	0.00
		Average wt% =	0.66		Standard Dev =	1.11	
			Strontium (wt%)				
Vessel	WCS-136-1	WCS-136-2	WCS-136-3	WCS-136-4	WCS-136-5	WCS-136-6	WCS-136-7
Segment							
1	0.01	0.01	0.01	0.00	0.01	0.10	0.10
2	0.00	0.00	0.01	0.00	0.01	0.09	0.08
3	0.26	0.27	0.01	0.01	0.01	0.21	0.24
4	0.28	0.33	0.01	0.01	0.18	0.30	0.31
5	0.27	0.33	0.01	0.01	0.31	0.31	0.23
6	0.32	0.33	0.01	0.01	0.32	0.32	0.27
7	0.33	0.32	0.01	0.01	0.23	0.33	0.27
		Average wt% =	0.17		Standard Dev =	0.14	

Table C-2: Selected Elemental Species in CSSF 2 wt%

			Sulfate (wt%)				
Vessel	WCS-136-1	WCS-136-2	WCS-136-3	WCS-136-4	WCS-136-5	WCS-136-6	WCS-136-7
Segment							
1	0.00	0.00	1.76	0.00	0.26	0.66	0.76
2	0.00	0.00	1.97	0.00	0.26	0.12	0.35
3	0.43	0.43	1.75	1.30	0.28	0.33	0.42
4	0.45	0.47	0.65	1.84	0.34	0.44	0.50
5	0.42	0.47	0.27	1.55	0.47	0.44	0.43
6	0.46	0.47	0.26	1.77	0.48	0.46	0.48
7	0.47	0.46	0.26	1.76	0.44	0.47	0.48
		Average wt% =	0.60		Standard Dev =	0.53	
			Tin (wt%)				
Vessel	WCS-136-1	WCS-136-2	WCS-136-3	WCS-136-4	WCS-136-5	WCS-136-6	WCS-136-7
Segment							
1	0.00	0.00	0.00	0.00	0.00	0.08	0.08
2	0.00	0.00	0.00	0.00	0.00	0.07	0.06
3	0.24	0.27	0.00	0.00	0.00	0.22	0.22
4	0.31	0.27	0.00	0.00	0.14	0.28	0.26
5	0.28	0.27	0.00	0.00	0.27	0.25	0.23
6	0.28	0.27	0.00	0.00	0.26	0.28	0.28
7	0.27	0.28	0.00	0.00	0.14	0.27	0.29
		Average wt% =	0.15		Standard Dev =	0.13	
			Uranium (wt%)				
Vessel	WCS-136-1	WCS-136-2	WCS-136-3	WCS-136-4	WCS-136-5	WCS-136-6	WCS-136-7
Segment							
1	0.0000	0.0000	0.0017	0.0000	0.0070	0.0036	0.0031
2	0.0000	0.0000	0.0028	0.0000	0.0070	0.0011	0.0013
3	0.0030	0.0021	0.0017	0.0076	0.0075	0.0014	0.0030
4	0.0020	0.0001	0.0029	0.0021	0.0028	0.0008	0.0036
5	0.0016	0.0001	0.0050	0.0017	0.0012	0.0002	0.0042
6	0.0001	0.0001	0.0070	0.0018	0.0011	0.0001	0.0039
7	0.0001	0.0001	0.0070	0.0017	0.0011	0.0001	0.0045
		Average wt% =	0.0023		Standard Dev =	0.0023	
			Zirconium (wt%)				
Vessel	WCS-136-1	WCS-136-2	WCS-136-3	WCS-136-4	WCS-136-5	WCS-136-6	WCS-136-7
Segment							
1	0.0	0.0	0.0	0.0	0.0	4.8	5.2
2	0.0	0.0	0.0	0.0	0.0	4.4	3.9
3	15.3	17.1	0.0	0.0	0.0	14.0	14.1
4	19.2	17.2	0.0	0.0	8.9	17.4	16.7
5	17.6	17.2	0.0	0.0	16.9	16.1	14.7
6	17.6	17.2	0.0	0.0	16.4	17.6	17.7
7	17.3	17.5	0.0	0.0	9.0	17.3	18.1
		Average wt% =	9.4		Standard Dev =	8.1	

Table C-2: Selected Radionuclides CSSF 2 Ci/m^3

			Antimony-126				
Vessel	WCS-136-1	WCS-136-2	WCS-136-3	WCS-136-4	WCS-136-5	WCS-136-6	WCS-136-7
Segment							
1	0.0000	0.0000	0.1310	0.0000	0.1337	0.0071	0.0066
2	0.0000	0.0000	0.0040	0.0000	0.0155	0.0033	0.0321
3	0.0013	0.0013	0.0048	0.0077	0.0065	0.0010	0.0024
4	0.0014	0.0019	0.0061	0.0059	0.0034	0.0015	0.0012
5	0.0012	0.0015	0.0069	0.0049	0.0022	0.0019	0.0023
6	0.0010	0.0014	0.0057	0.0063	0.0019	0.0010	0.0016
7	0.0020	0.0012	0.0058	0.0056	0.0037	0.0014	0.0012
		Average Ci/m^3 =	0.0031		Standard Dev =	0.0022	
			Antimony-126m				
Vessel	WCS-136-1	WCS-136-2	WCS-136-3	WCS-136-4	WCS-136-5	WCS-136-6	WCS-136-7
Segment							
1	0.000	0.000	0.936	0.000	0.955	0.051	0.047
2	0.000	0.000	0.029	0.000	0.111	0.024	0.230
3	0.009	0.010	0.034	0.055	0.047	0.007	0.017
4	0.010	0.014	0.043	0.042	0.024	0.011	0.009
5	0.008	0.011	0.049	0.035	0.016	0.014	0.016
6	0.007	0.010	0.041	0.045	0.013	0.007	0.011
7	0.014	0.009	0.042	0.040	0.026	0.010	0.008
		Average Ci/m^3 =	0.022		Standard Dev =	0.015	
			Barium-137m				
Vessel	WCS-136-1	WCS-136-2	WCS-136-3	WCS-136-4	WCS-136-5	WCS-136-6	WCS-136-7
Segment							
1	0	0	65201	0	66560	3723	3550
2	0	0	1990	0	7710	2541	16533
3	1031	1084	2383	3843	3250	785	1721
4	1100	1590	3027	2927	2097	1230	987
5	969	1245	3431	2437	1782	1506	1591
6	804	1183	2852	3138	1540	820	1298
7	1617	1016	2909	2775	2078	1125	962
		Average Ci/m^3 =	1800		Standard Dev =	900	
			Cesium-137				
Vessel	WCS-136-1	WCS-136-2	WCS-136-3	WCS-136-4	WCS-136-5	WCS-136-6	WCS-136-7
Segment							
1	0	0	68923	0	70359	3936	3752
2	0	0	2104	0	8150	2686	17477
3	1090	1146	2519	4063	3435	829	1819
4	1163	1680	3200	3094	2216	1300	1043
5	1024	1316	3627	2576	1884	1592	1682
6	850	1251	3014	3317	1628	867	1372
7	1709	1074	3076	2933	2197	1189	1017
		Average Ci/m^3 =	1900		Standard Dev =	900	

Table C-2: Selected Radionuclides CSSF 2 Ci/m^3

			Nickel-63				
Vessel	WCS-136-1	WCS-136-2	WCS-136-3	WCS-136-4	WCS-136-5	WCS-136-6	WCS-136-7
Segment							
1	0.00	0.00	0.00	0.00	0.00	0.55	0.83
2	0.00	0.00	0.00	0.00	0.00	2.64	1.58
3	1.19	1.21	0.00	0.00	0.00	0.84	1.48
4	1.16	1.83	0.00	0.00	1.15	1.42	1.14
5	1.12	1.44	0.00	0.00	2.06	1.65	1.30
6	0.93	1.36	0.00	0.00	1.78	0.95	1.50
7	1.86	1.17	0.00	0.00	0.71	1.30	1.11
		Average Ci/m^3 =	0.90		Standard Dev =	0.68	
			Strontium-90				
Vessel	WCS-136-1	WCS-136-2	WCS-136-3	WCS-136-4	WCS-136-5	WCS-136-6	WCS-136-7
Segment							
1	0	0	61959	0	68741	3201	3109
2	0	0	2025	0	7962	2350	9511
3	959	1098	2253	3416	3284	828	1451
4	1165	1598	2885	2863	1612	1254	871
5	1010	1252	3305	2373	949	1510	1467
6	808	1189	2945	2990	820	824	1195
7	1625	1021	3005	2629	1175	1131	890
		Average Ci/m^3 =	1700		Standard Dev =	900	
			Technetium-99				
Vessel	WCS-136-1	WCS-136-2	WCS-136-3	WCS-136-4	WCS-136-5	WCS-136-6	WCS-136-7
Segment							
1	0.0	0.0	35.8	0.0	36.6	1.9	1.8
2	0.0	0.0	1.1	0.0	4.2	0.9	8.8
3	0.3	0.4	1.3	2.1	1.8	0.3	0.7
4	0.4	0.5	1.7	1.6	0.9	0.4	0.3
5	0.3	0.4	1.9	1.3	0.6	0.5	0.6
6	0.3	0.4	1.6	1.7	0.5	0.3	0.4
7	0.5	0.3	1.6	1.5	1.0	0.4	0.3
		Average Ci/m^3 =	1.0		Standard Dev =	0.6	
			Yttrium-90				
Vessel	WCS-136-1	WCS-136-2	WCS-136-3	WCS-136-4	WCS-136-5	WCS-136-6	WCS-136-7
Segment							
1	0	0	61959	0	68741	3201	3109
2	0	0	2025	0	7962	2350	9511
3	959	1098	2253	3416	3284	828	1451
4	1165	1598	2885	2863	1612	1254	871
5	1010	1252	3305	2373	949	1510	1467
6	808	1189	2945	2990	820	824	1195
7	1625	1021	3005	2629	1175	1131	890
		Average Ci/m^3 =	1700		Standard Dev =	900	

Table C-2: Selected Radionuclides CSSF 2 nano-Ci/g

			Americium-241				
Vessel	WCS-136-1	WCS-136-2	WCS-136-3	WCS-136-4	WCS-136-5	WCS-136-6	WCS-136-7
Segment							
1	0	0	61	0	152	782	922
2	0	0	48	0	152	502	1181
3	1491	1454	62	227	389	1087	1508
4	1495	1432	286	56	1478	1400	1588
5	1374	1430	434	49	2541	1340	1598
6	1461	1433	152	61	2467	1464	1976
7	1441	1458	152	62	1657	1436	2026
		Average nCi/g =	1100		Standard Dev =	700	

			Neptunium-237				
Vessel	WCS-136-1	WCS-136-2	WCS-136-3	WCS-136-4	WCS-136-5	WCS-136-6	WCS-136-7
Segment							
1	0.0	0.0	2.9	0.0	3.7	3.1	2.6
2	0.0	0.0	4.8	0.0	3.7	0.2	5.6
3	0.3	0.4	2.8	6.3	4.3	0.3	0.7
4	0.5	0.5	3.4	3.6	1.6	0.4	0.4
5	0.3	0.5	4.5	2.9	0.6	0.5	0.9
6	0.5	0.5	3.7	3.0	0.6	0.5	0.4
7	0.5	0.5	3.7	2.8	3.0	0.5	0.5
		Average nCi/g =	1.6		Standard Dev =	1.6	

			Plutonim-238				
Vessel	WCS-136-1	WCS-136-2	WCS-136-3	WCS-136-4	WCS-136-5	WCS-136-6	WCS-136-7
Segment							
1	0	0	347	0	1220	5863	7699
2	0	0	332	0	1220	4489	7342
3	13425	13070	348	1146	1550	9737	13323
4	13383	12931	1030	341	12549	12626	14296
5	12375	12915	1648	290	22871	12100	14071
6	13188	12937	1220	346	22203	13218	17788
7	13009	13168	1220	347	13272	12966	18240
		Average nCi/g =	10,000		Standard Dev =	6800	

			Plutonium-239				
Vessel	WCS-136-1	WCS-136-2	WCS-136-3	WCS-136-4	WCS-136-5	WCS-136-6	WCS-136-7
Segment							
1	0	0	45	0	176	194	189
2	0	0	43	0	176	73	347
3	213	209	45	148	205	158	229
4	217	206	132	44	252	201	227
5	196	206	216	37	363	195	246
6	210	206	176	45	352	211	282
7	207	210	176	45	326	207	289
		Average nCi/g =	200		Standard Dev =	80	

Table C-2: Selected Radionuclides CSSF 2 nano-Ci/g

			Plutonium-240				
Vessel	WCS-136-1	WCS-136-2	WCS-136-3	WCS-136-4	WCS-136-5	WCS-136-6	WCS-136-7
Segment							
1	0	0	18	0	69	118	134
2	0	0	17	0	69	66	182
3	196	192	18	59	81	143	200
4	197	190	52	17	200	185	209
5	181	190	85	15	334	178	213
6	194	190	69	18	324	194	260
7	191	193	69	18	231	190	267
		Average nCi/g =	200		Standard Dev =	100	

			Plutonium-241				
Vessel	WCS-136-1	WCS-136-2	WCS-136-3	WCS-136-4	WCS-136-5	WCS-136-6	WCS-136-7
Segment							
1	0	0	152	0	490	2666	3505
2	0	0	145	0	490	2051	3337
3	6133	5957	152	501	679	4448	6085
4	6113	5773	461	149	5729	5691	6531
5	5637	5766	727	127	10448	5402	6426
6	5888	5776	490	152	10143	5901	8126
7	5808	5879	490	152	6054	5789	8332
		Average nCi/g =	4500		Standard Dev =	3100	

			Protactinium-233				
Vessel	WCS-136-1	WCS-136-2	WCS-136-3	WCS-136-4	WCS-136-5	WCS-136-6	WCS-136-7
Segment							
1	0.0	0.0	4.0	0.0	3.7	3.3	2.8
2	0.0	0.0	4.9	0.0	3.7	0.2	5.6
3	0.3	0.4	3.9	5.9	4.3	0.3	0.7
4	0.5	0.5	3.6	4.3	1.6	0.4	0.4
5	0.3	0.5	4.5	3.6	0.6	0.5	0.9
6	0.5	0.5	3.7	4.0	0.6	0.5	0.4
7	0.5	0.5	3.7	3.9	3.0	0.5	0.5
		Average nCi/g =	1.7		Standard Dev =	1.8	

			Thorium-231				
Vessel	WCS-136-1	WCS-136-2	WCS-136-3	WCS-136-4	WCS-136-5	WCS-136-6	WCS-136-7
Segment							
1	0.00	0.00	0.08	0.00	0.08	0.09	0.09
2	0.00	0.00	0.10	0.00	0.08	0.02	0.14
3	0.07	0.07	0.08	0.12	0.09	0.05	0.07
4	0.07	0.09	0.07	0.09	0.09	0.08	0.07
5	0.07	0.09	0.09	0.07	0.11	0.09	0.08
6	0.10	0.09	0.08	0.08	0.11	0.10	0.09
7	0.09	0.10	0.08	0.08	0.12	0.09	0.09
		Average nCi/g =	0.086		Standard Dev =	0.015	

Table C-3: Selected Elemental Species in CSSF 3 wt%

			Aluminium (wt%)				
Vessel	WCS-139	WCS-140-1	WCS-140-2	WCS-140-3	WCS-140-4	WCS-140-5	WCS-140-6
Segment							
1	28	7	27	27	23	28	28
2	14	12	12	13	13	20	14
3	12	14	10	12	10	9	14
4	10	11	11	10	9	14	10
5	9	9	8	9	9	9	8
6	9	9	11	9	11	8	9
7	8	9	17	8	9	9	9
		Average wt% =	11		Standard Dev =	3	
			Boron (wt%)				
Vessel	WCS-139	WCS-140-1	WCS-140-2	WCS-140-3	WCS-140-4	WCS-140-5	WCS-140-6
Segment							
1	0.60	0.88	0.61	0.57	0.63	0.60	0.61
2	0.79	0.76	0.82	0.84	0.83	0.69	0.79
3	0.82	0.84	0.78	0.81	0.82	0.88	0.80
4	0.79	0.86	0.63	0.81	0.83	0.76	0.81
5	0.85	0.97	0.72	0.86	0.66	0.83	0.83
6	0.81	0.97	0.51	0.77	0.85	0.90	0.65
7	0.72	0.86	1.03	0.74	0.93	0.69	0.96
		Average wt% =	0.81		Standard Dev =	0.10	
			Cadmium (wt%)				
Vessel	WCS-139	WCS-140-1	WCS-140-2	WCS-140-3	WCS-140-4	WCS-140-5	WCS-140-6
Segment							
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	0.0	0.0	0.0	0.0	0.0	0.0	0.0
5	0.0	0.0	0.0	0.0	0.0	0.0	0.0
6	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	0.0	0.0	0.0	0.0	0.0	0.0	0.0
		Average wt% =	0		Standard Dev =	0	
			Calcium (wt%)				
Vessel	WCS-139	WCS-140-1	WCS-140-2	WCS-140-3	WCS-140-4	WCS-140-5	WCS-140-6
Segment							
1	14	29	15	14	17	14	14
2	24	26	26	26	26	20	24
3	26	19	27	26	27	29	25
4	27	24	27	27	28	24	27
5	28	26	29	28	27	28	28
6	28	26	26	28	24	28	27
7	28	25	15	28	28	28	25
		Average wt% =	26		Standard Dev =	3	

Table C-3: Selected Elemental Species in CSSF 3 wt%

			Carbonate (wt%)				
Vessel	WCS-139	WCS-140-1	WCS-140-2	WCS-140-3	WCS-140-4	WCS-140-5	WCS-140-6
Segment							
1	7.2	0.0	7.4	9.7	8.1	7.1	7.3
2	4.2	3.4	3.9	2.9	3.1	6.2	4.2
3	4.3	7.2	2.4	4.6	4.8	3.0	3.8
4	4.9	5.4	2.7	4.3	1.4	6.0	4.6
5	1.6	0.0	0.0	1.2	3.9	3.2	0.6
6	1.0	0.0	5.5	1.5	2.8	0.1	4.6
7	0.0	0.0	0.0	0.0	0.0	2.1	0.0
		Average wt% =	2.8		Standard Dev =	2.1	
			Cesium (wt%)				
Vessel	WCS-139	WCS-140-1	WCS-140-2	WCS-140-3	WCS-140-4	WCS-140-5	WCS-140-6
Segment							
1	0.0142	0.0070	0.0136	0.0133	0.0106	0.0145	0.0139
2	0.0081	0.0085	0.0073	0.0070	0.0081	0.0098	0.0081
3	0.0076	0.0069	0.0086	0.0077	0.0065	0.0066	0.0083
4	0.0063	0.0069	0.0076	0.0065	0.0101	0.0073	0.0072
5	0.0103	0.0083	0.0081	0.0105	0.0082	0.0077	0.0101
6	0.0099	0.0072	0.0048	0.0094	0.0131	0.0109	0.0083
7	0.0091	0.0063	0.0085	0.0093	0.0121	0.0085	0.0148
		Average wt% =	0.0085		Standard Dev =	0.0019	
			Chloride (wt%)				
Vessel	WCS-139	WCS-140-1	WCS-140-2	WCS-140-3	WCS-140-4	WCS-140-5	WCS-140-6
Segment							
1	0.010	0.024	0.010	0.009	0.012	0.010	0.010
2	0.034	0.067	0.031	0.037	0.031	0.021	0.034
3	0.020	0.028	0.060	0.020	0.024	0.037	0.020
4	0.026	0.038	0.143	0.025	0.038	0.018	0.025
5	0.029	0.059	0.205	0.029	0.135	0.029	0.058
6	0.061	0.080	0.106	0.073	0.140	0.032	0.133
7	0.162	0.099	0.030	0.146	0.131	0.095	0.135
		Average wt% =	0.065		Standard Dev =	0.050	
			Chromium (wt%)				
Vessel	WCS-139	WCS-140-1	WCS-140-2	WCS-140-3	WCS-140-4	WCS-140-5	WCS-140-6
Segment							
1	0.10	0.25	0.10	0.11	0.13	0.10	0.10
2	0.19	0.19	0.21	0.19	0.20	0.16	0.19
3	0.21	0.18	0.20	0.20	0.22	0.22	0.20
4	0.21	0.19	0.14	0.21	0.23	0.19	0.22
5	0.24	0.24	0.17	0.25	0.16	0.22	0.23
6	0.22	0.24	0.11	0.20	0.17	0.25	0.16
7	0.18	0.24	0.22	0.18	0.21	0.17	0.20
		Average wt% =	0.20		Standard Dev =	0.03	

Table C-3: Selected Elemental Species in CSSF 3 wt%

			Fluoride (wt%)				
Vessel	WCS-139	WCS-140-1	WCS-140-2	WCS-140-3	WCS-140-4	WCS-140-5	WCS-140-6
Segment							
1	11	28	12	10	13	11	11
2	20	19	22	22	21	16	20
3	20	17	20	20	22	24	19
4	22	19	15	22	23	18	22
5	23	22	17	24	17	23	22
6	22	24	12	20	17	25	16
7	18	24	21	19	21	18	19
		Average wt% =	20		Standard Dev =	3	
			Iron (wt%)				
Vessel	WCS-139	WCS-140-1	WCS-140-2	WCS-140-3	WCS-140-4	WCS-140-5	WCS-140-6
Segment							
1	0.18	0.11	0.17	0.25	0.23	0.18	0.18
2	0.24	0.24	0.26	0.19	0.24	0.30	0.24
3	0.23	0.13	0.20	0.24	0.16	0.20	0.27
4	0.17	0.24	0.38	0.16	0.20	0.22	0.16
5	0.20	0.24	0.52	0.21	0.21	0.17	0.21
6	0.21	0.26	0.33	0.20	0.53	0.22	0.23
7	0.22	0.29	0.14	0.22	0.34	0.19	0.51
		Average wt% =	0.25		Standard Dev =	0.09	
			Magnesium (wt%)				
Vessel	WCS-139	WCS-140-1	WCS-140-2	WCS-140-3	WCS-140-4	WCS-140-5	WCS-140-6
Segment							
1	1.48	0.20	1.52	1.96	1.67	1.46	1.50
2	0.97	0.83	0.93	0.73	0.77	1.33	0.97
3	1.01	1.52	0.65	1.07	1.10	0.77	0.91
4	1.13	1.20	0.70	1.02	0.45	1.31	1.07
5	0.49	0.19	0.23	0.42	0.93	0.80	0.31
6	0.37	0.23	1.26	0.47	0.74	0.21	1.06
7	0.19	0.26	0.10	0.19	0.21	0.58	0.22
		Average wt% =	0.71		Standard Dev =	0.39	
			Manganese (wt%)				
Vessel	WCS-139	WCS-140-1	WCS-140-2	WCS-140-3	WCS-140-4	WCS-140-5	WCS-140-6
Segment							
1	0.04	0.09	0.04	0.03	0.05	0.04	0.04
2	0.07	0.11	0.08	0.08	0.08	0.06	0.07
3	0.08	0.05	0.11	0.07	0.08	0.09	0.07
4	0.08	0.07	0.14	0.08	0.09	0.07	0.08
5	0.09	0.08	0.20	0.09	0.18	0.09	0.11
6	0.11	0.09	0.12	0.12	0.19	0.09	0.17
7	0.21	0.09	0.05	0.20	0.11	0.14	0.18
		Average wt% =	0.11		Standard Dev =	0.04	

Table C-3: Selected Elemental Species in CSSF 3 wt%							
			Mercury (wt%)				
Vessel	WCS-139	WCS-140-1	WCS-140-2	WCS-140-3	WCS-140-4	WCS-140-5	WCS-140-6
Segment							
1	0.00192	0.00000	0.00179	0.00178	0.00118	0.00196	0.00185
2	0.00039	0.00060	0.00018	0.00014	0.00026	0.00083	0.00039
3	0.00019	0.00000	0.00043	0.00021	0.00006	0.00001	0.00029
4	0.00008	0.00000	0.00081	0.00008	0.00049	0.00024	0.00015
5	0.00050	0.00050	0.00146	0.00051	0.00065	0.00019	0.00053
6	0.00051	0.00304	0.00288	0.00049	0.00113	0.00049	0.00067
7	0.00074	0.00485	0.00000	0.00072	0.00060	0.00059	0.00121
		Average wt% =	0.00067		Standard Dev =	0.00092	
			Nickel (wt%)				
Vessel	WCS-139	WCS-140-1	WCS-140-2	WCS-140-3	WCS-140-4	WCS-140-5	WCS-140-6
Segment							
1	0.004	0.009	0.004	0.017	0.013	0.004	0.004
2	0.015	0.012	0.018	0.009	0.016	0.024	0.015
3	0.016	0.028	0.009	0.016	0.008	0.009	0.020
4	0.008	0.007	0.010	0.008	0.009	0.016	0.008
5	0.009	0.009	0.018	0.009	0.007	0.008	0.008
6	0.008	0.009	0.017	0.007	0.006	0.009	0.007
7	0.007	0.009	0.036	0.007	0.008	0.006	0.007
		Average wt% =	0.012		Standard Dev =	0.006	
			Nitrate (wt%)				
Vessel	WCS-139	WCS-140-1	WCS-140-2	WCS-140-3	WCS-140-4	WCS-140-5	WCS-140-6
Segment							
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	2.1	0.0	0.0	0.0	0.0	0.0
3	0.0	4.7	2.0	0.0	0.2	0.0	0.0
4	0.3	3.9	4.3	0.2	0.7	0.0	0.2
5	0.2	2.9	6.5	0.1	5.8	0.3	1.8
6	1.9	1.7	3.4	2.7	5.8	0.2	5.7
7	7.3	1.3	5.7	6.5	2.5	3.9	5.1
		Average wt% =	2.1		Standard Dev =	2.4	
			Oxide (wt%)				
Vessel	WCS-139	WCS-140-1	WCS-140-2	WCS-140-3	WCS-140-4	WCS-140-5	WCS-140-6
Segment							
1	29	15	28	28	25	29	29
2	20	19	18	19	19	23	20
3	19	19	18	19	17	17	20
4	17	18	19	17	17	20	17
5	17	18	18	17	17	17	17
6	17	17	15	17	18	17	17
7	18	16	20	18	18	17	18
		Average wt% =	18		Standard Dev =	1	

Table C-3: Selected Elemental Species in CSSF 3 wt%

			Phosphate (wt%)				
Vessel	WCS-139	WCS-140-1	WCS-140-2	WCS-140-3	WCS-140-4	WCS-140-5	WCS-140-6
Segment							
1	0.12	0.09	0.11	0.11	0.10	0.12	0.12
2	0.09	1.27	0.09	0.09	0.10	0.10	0.09
3	0.10	0.07	1.00	0.10	0.09	0.09	0.11
4	0.09	0.08	4.64	0.09	1.02	0.10	0.09
5	0.09	0.11	0.25	0.09	1.60	0.10	1.18
6	1.77	0.12	11.73	2.64	0.21	0.09	1.68
7	0.26	0.13	0.08	0.24	0.15	4.14	0.20
		Average wt% =	0.87		Standard Dev =	2.01	

			Potassium (wt%)				
Vessel	WCS-139	WCS-140-1	WCS-140-2	WCS-140-3	WCS-140-4	WCS-140-5	WCS-140-6
Segment							
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.23	0.00	0.00	0.00	0.00	0.00
3	0.00	0.01	0.24	0.00	0.02	0.00	0.00
4	0.03	0.00	0.47	0.03	0.07	0.00	0.03
5	0.02	0.08	0.76	0.02	0.71	0.04	0.20
6	0.21	0.50	0.43	0.29	0.80	0.00	0.71
7	0.91	0.79	0.01	0.81	0.15	0.49	0.69
		Average wt% =	0.23		Standard Dev =	0.30	

			Sodium (wt%)				
Vessel	WCS-139	WCS-140-1	WCS-140-2	WCS-140-3	WCS-140-4	WCS-140-5	WCS-140-6
Segment							
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	1.1	0.0	0.0	0.0	0.0	0.0
3	0.0	2.6	1.0	0.0	0.1	0.0	0.0
4	0.1	2.2	2.1	0.1	0.4	0.0	0.1
5	0.1	1.6	3.2	0.1	2.9	0.2	0.9
6	1.0	0.6	1.7	1.3	2.8	0.1	2.8
7	3.6	0.2	3.2	3.2	1.3	1.9	2.5
		Average wt% =	1.1		Standard Dev =	1.2	

			Strontium (wt%)				
Vessel	WCS-139	WCS-140-1	WCS-140-2	WCS-140-3	WCS-140-4	WCS-140-5	WCS-140-6
Segment							
1	0.14	0.32	0.14	0.13	0.17	0.13	0.14
2	0.25	0.26	0.27	0.28	0.27	0.20	0.25
3	0.27	0.19	0.28	0.26	0.28	0.30	0.26
4	0.28	0.24	0.26	0.28	0.30	0.24	0.28
5	0.30	0.28	0.32	0.30	0.28	0.29	0.30
6	0.29	0.25	0.19	0.29	0.25	0.31	0.27
7	0.31	0.23	0.17	0.31	0.31	0.28	0.28
		Average wt% =	0.27		Standard Dev =	0.03	

Table C-3: Selected Elemental Species in CSSF 3 wt%

			Sulfate (wt%)				
Vessel	WCS-139	WCS-140-1	WCS-140-2	WCS-140-3	WCS-140-4	WCS-140-5	WCS-140-6
Segment							
1	0.32	0.46	0.32	1.40	1.04	0.32	0.32
2	0.96	0.81	1.18	0.41	0.79	1.56	0.96
3	0.83	0.62	0.54	0.86	0.42	0.54	1.04
4	0.42	0.37	1.18	0.42	0.47	0.80	0.42
5	0.44	0.70	1.28	0.44	0.73	0.44	0.53
6	0.54	1.97	2.18	0.57	2.92	0.45	0.84
7	0.76	2.88	0.72	0.73	1.51	0.66	3.26
		Average wt% =	0.96		Standard Dev =	0.71	
			Tin (wt%)				
Vessel	WCS-139	WCS-140-1	WCS-140-2	WCS-140-3	WCS-140-4	WCS-140-5	WCS-140-6
Segment							
1	0.11	0.28	0.12	0.10	0.13	0.11	0.11
2	0.20	0.21	0.22	0.22	0.22	0.16	0.20
3	0.23	0.20	0.23	0.22	0.25	0.24	0.21
4	0.24	0.22	0.17	0.25	0.27	0.21	0.25
5	0.28	0.28	0.20	0.28	0.18	0.26	0.26
6	0.25	0.28	0.12	0.23	0.20	0.29	0.18
7	0.20	0.28	0.25	0.21	0.25	0.20	0.22
		Average wt% =	0.23		Standard Dev =	0.04	
			Uranium (wt%)				
Vessel	WCS-139	WCS-140-1	WCS-140-2	WCS-140-3	WCS-140-4	WCS-140-5	WCS-140-6
Segment							
1	0.0008	0.0001	0.0007	0.0008	0.0006	0.0008	0.0007
2	0.0004	0.0013	0.0004	0.0003	0.0003	0.0006	0.0004
3	0.0003	0.0007	0.0014	0.0003	0.0004	0.0003	0.0003
4	0.0005	0.0035	0.0019	0.0005	0.0019	0.0003	0.0007
5	0.0018	0.0026	0.0025	0.0020	0.0022	0.0007	0.0021
6	0.0019	0.0013	0.0012	0.0017	0.0037	0.0022	0.0023
7	0.0028	0.0008	0.0006	0.0025	0.0017	0.0017	0.0036
		Average wt% =	0.0014		Standard Dev =	0.0010	
			Zirconium (wt%)				
Vessel	WCS-139	WCS-140-1	WCS-140-2	WCS-140-3	WCS-140-4	WCS-140-5	WCS-140-6
Segment							
1	7	18	7	7	8	7	7
2	13	13	14	14	14	10	13
3	14	13	15	14	16	15	13
4	15	14	10	15	17	13	16
5	17	18	12	18	12	16	16
6	16	18	8	14	12	18	11
7	13	18	16	13	16	12	14
		Average wt% =	14		Standard Dev =	2	

Table C-3: Selected Radionuclides CSSF 3 Ci/m^3

			Antimony-126				
Vessel	WCS-139	WCS-140-1	WCS-140-2	WCS-140-3	WCS-140-4	WCS-140-5	WCS-140-6
TC Segment							
1	0.01309	0.00872	0.00896	0.00677	0.00419	0.01350	0.01257
2	0.00212	0.00278	0.00190	0.00188	0.00200	0.00236	0.00212
3	0.00185	0.00243	0.00274	0.00188	0.00181	0.00180	0.00189
4	0.00181	0.00186	0.00366	0.00180	0.00326	0.00179	0.00210
5	0.00343	0.00204	0.00225	0.00348	0.00354	0.00220	0.00318
6	0.00295	0.00167	0.00123	0.00268	0.00418	0.00347	0.00370
7	0.00272	0.00199	0.00116	0.00301	0.00296	0.00266	0.00452
		Average Ci/m^3 =	0.0025		Standard Dev =	0.0008	
			Antimony-126m				
Vessel	WCS-139	WCS-140-1	WCS-140-2	WCS-140-3	WCS-140-4	WCS-140-5	WCS-140-6
TC Segment							
1	0.09349	0.06228	0.06398	0.04836	0.02990	0.09644	0.08978
2	0.01513	0.01989	0.01355	0.01342	0.01430	0.01683	0.01515
3	0.01324	0.01736	0.01960	0.01341	0.01294	0.01287	0.01349
4	0.01290	0.01328	0.02617	0.01284	0.02325	0.01277	0.01503
5	0.02449	0.01458	0.01605	0.02486	0.02531	0.01568	0.02271
6	0.02106	0.01192	0.00879	0.01913	0.02987	0.02480	0.02641
7	0.01940	0.01422	0.00831	0.02153	0.02116	0.01902	0.03226
		Average Ci/m^3 =	0.018		Standard Dev =	0.006	
			Barium-137m				
Vessel	WCS-139	WCS-140-1	WCS-140-2	WCS-140-3	WCS-140-4	WCS-140-5	WCS-140-6
TC Segment							
1	7172	7148	4947	3722	2453	7378	6913
2	1472	1757	1420	1415	1435	1452	1474
3	1361	1993	1699	1369	1384	1477	1332
4	1364	1524	2166	1356	1866	1276	1476
5	1965	1673	1384	1995	2043	1499	1824
6	1692	1368	962	1537	2402	1990	2133
7	1563	1633	953	1734	1698	1530	2592
		Average Ci/m^3 =	1600		Standard Dev =	300	
			Cesium-137				
Vessel	WCS-139	WCS-140-1	WCS-140-2	WCS-140-3	WCS-140-4	WCS-140-5	WCS-140-6
TC Segment							
1	7582	7556	5229	3934	2593	7799	7308
2	1556	1857	1501	1496	1517	1535	1558
3	1439	2107	1796	1447	1463	1562	1408
4	1442	1611	2289	1433	1973	1349	1560
5	2078	1769	1463	2109	2160	1585	1928
6	1788	1446	1017	1625	2539	2104	2254
7	1652	1726	1008	1833	1795	1617	2740
		Average Ci/m^3 =	1700		Standard Dev =	400	

Table C-3: Selected Radionuclides CSSF 3 Ci/m^3							
			Nickel-63				
Vessel	WCS-139	WCS-140-1	WCS-140-2	WCS-140-3	WCS-140-4	WCS-140-5	WCS-140-6
TC Segment							
1	1.93	8.25	1.43	1.03	1.08	1.93	1.93
2	1.22	2.29	1.40	1.41	1.29	0.82	1.23
3	1.29	2.30	2.51	1.28	1.73	1.70	1.15
4	1.73	1.76	3.60	1.72	3.25	1.13	2.04
5	3.43	1.93	2.17	3.48	3.46	2.14	3.17
6	2.94	1.58	1.15	2.66	4.13	3.48	3.61
7	2.64	1.88	1.10	2.94	2.96	2.62	4.48
		Average Ci/m^3 =	2.3		Standard Dev =	1.0	
			Strontium-90				
Vessel	WCS-139	WCS-140-1	WCS-140-2	WCS-140-3	WCS-140-4	WCS-140-5	WCS-140-6
TC Segment							
1	6965	7185	4808	3610	2370	7162	6716
2	1470	1662	1359	1431	1394	1444	1472
3	1276	2492	1626	1279	1248	1393	1239
4	1192	1496	1782	1200	1774	1231	1336
5	1830	1639	1134	1871	2024	1318	1761
6	1640	1334	793	1506	1945	1892	2078
7	1564	1551	1207	1736	1398	1534	2097
		Average Ci/m^3 =	1500		Standard Dev =	300	
			Technetium-99				
Vessel	WCS-139	WCS-140-1	WCS-140-2	WCS-140-3	WCS-140-4	WCS-140-5	WCS-140-6
TC Segment							
1	3.58	2.40	2.45	1.85	1.15	3.70	3.44
2	0.58	0.74	0.52	0.52	0.55	0.65	0.58
3	0.51	0.67	0.72	0.52	0.49	0.50	0.52
4	0.49	0.51	0.95	0.49	0.85	0.49	0.56
5	0.89	0.56	0.58	0.90	0.91	0.59	0.82
6	0.76	0.46	0.33	0.69	1.08	0.90	0.95
7	0.69	0.55	0.32	0.77	0.77	0.68	1.17
		Average Ci/m^3 =	0.66		Standard Dev =	0.19	
			Yttrium-90				
Vessel	WCS-139	WCS-140-1	WCS-140-2	WCS-140-3	WCS-140-4	WCS-140-5	WCS-140-6
TC Segment							
1	6965	7185	4808	3610	2370	7162	6716
2	1470	1662	1359	1431	1394	1444	1472
3	1276	2492	1626	1279	1248	1393	1239
4	1192	1496	1782	1200	1774	1231	1336
5	1830	1639	1134	1871	2024	1318	1761
6	1640	1334	793	1506	1945	1892	2078
7	1564	1551	1207	1736	1398	1534	2097
		Average Ci/m^3 =	1500		Standard Dev =	300	

Table C-3: Selected Radionuclides CSSF 3 nano-Ci/g

			Americium-241				
Vessel	WCS-139	WCS-140-1	WCS-140-2	WCS-140-3	WCS-140-4	WCS-140-5	WCS-140-6
Segment							
1	645	1481	660	635	851	639	653
2	1397	1155	1650	1482	1620	1119	1398
3	1608	2096	1001	1599	1491	1821	1645
4	1492	1716	978	1515	886	1352	1362
5	972	1436	1251	992	524	1405	831
6	771	1250	1341	641	1476	1011	569
7	551	1089	2584	548	1326	471	1654
		Average nCi/g =	1300		Standard Dev =	400	
			Neptunium-237				
Vessel	WCS-139	WCS-140-1	WCS-140-2	WCS-140-3	WCS-140-4	WCS-140-5	WCS-140-6
Segment							
1	2.6	0.5	2.4	2.4	1.6	2.6	2.5
2	0.6	0.5	0.5	0.3	0.7	1.2	0.6
3	0.6	0.5	0.3	0.6	0.1	0.3	0.8
4	0.1	0.5	0.3	0.1	0.1	0.6	0.1
5	0.0	0.6	0.5	0.0	0.4	0.1	0.1
6	0.1	0.5	0.4	0.2	0.4	0.0	0.4
7	0.5	0.4	0.6	0.4	0.1	0.3	0.3
		Average nCi/g =	0.37		Standard Dev =	0.25	
			Plutonim-238				
Vessel	WCS-139	WCS-140-1	WCS-140-2	WCS-140-3	WCS-140-4	WCS-140-5	WCS-140-6
Segment							
1	5844	13371	5984	5750	8587	5790	5913
2	15141	15940	16698	16190	16242	12132	15149
3	16224	18867	16519	15919	17989	18267	15647
4	18134	19515	14503	18455	17205	14434	17696
5	17391	24453	16315	17470	14557	18979	17189
6	17101	20248	12306	16713	24117	18083	14768
7	16102	16683	23261	16472	22467	15125	27352
		Average nCi/g =	17,000		Standard Dev =	3000	
			Plutonium-239				
Vessel	WCS-139	WCS-140-1	WCS-140-2	WCS-140-3	WCS-140-4	WCS-140-5	WCS-140-6
Segment							
1	150	213	148	144	168	150	149
2	245	302	265	253	268	218	245
3	266	299	324	263	283	281	267
4	286	259	294	291	378	238	300
5	387	254	329	395	312	323	379
6	367	262	212	343	497	408	316
7	351	266	369	354	444	316	556
		Average wt% =	320		Standard Dev =	70	

Table C-3: Selected Radionuclides CSSF 3 nano-Ci/g

			Plutonium-240				
Vessel	WCS-139	WCS-140-1	WCS-140-2	WCS-140-3	WCS-140-4	WCS-140-5	WCS-140-6
Segment							
1	104	196	105	101	138	104	104
2	227	261	247	240	243	190	227
3	240	276	276	236	267	267	235
4	271	254	252	276	307	214	274
5	313	274	278	315	260	298	306
6	303	260	185	293	428	323	264
7	289	245	340	295	396	270	484
		Average nCi/g =	280		Standard Dev =	60	
			Plutonium-241				
Vessel	WCS-139	WCS-140-1	WCS-140-2	WCS-140-3	WCS-140-4	WCS-140-5	WCS-140-6
Segment							
1	2605	5970	2668	2567	3446	2581	2637
2	5622	4946	6699	5959	6690	4420	5627
3	7120	8619	4790	7018	7102	7447	6993
4	7089	8412	3021	7198	4089	6216	6407
5	4267	9817	4223	4363	2683	6570	3959
6	3798	8562	5442	3415	4180	4606	2716
7	2968	7446	10626	2979	3661	2616	4646
		Average nCi/g =	5600		Standard Dev =	2000	
			Protactinium-233				
Vessel	WCS-139	WCS-140-1	WCS-140-2	WCS-140-3	WCS-140-4	WCS-140-5	WCS-140-6
Segment							
1	2.6	0.5	2.4	2.4	1.7	2.6	2.5
2	0.9	2.0	0.7	0.6	0.8	1.4	0.9
3	0.7	0.5	2.0	0.8	0.5	0.5	0.9
4	0.6	0.5	3.1	0.5	0.6	0.8	0.5
5	0.2	0.6	5.0	0.2	5.2	0.6	1.5
6	1.5	0.5	2.7	2.1	4.6	0.1	5.1
7	6.6	0.4	0.6	5.9	0.7	3.6	3.8
		Average nCi/g =	1.7		Standard Dev =	1.8	
			Thorium-231				
Vessel	WCS-139	WCS-140-1	WCS-140-2	WCS-140-3	WCS-140-4	WCS-140-5	WCS-140-6
Segment							
1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
2	0.1	0.1	0.1	0.1	0.1	0.1	0.1
3	0.1	0.1	0.1	0.1	0.1	0.1	0.1
4	0.1	0.1	0.1	0.1	0.1	0.1	0.1
5	0.1	0.1	0.1	0.1	0.1	0.1	0.1
6	0.1	0.1	0.1	0.1	0.2	0.1	0.1
7	0.1	0.1	0.1	0.1	0.1	0.1	0.2
		Average nCi/g =	0.11		Standard Dev =	0.03	

Table C-4: Selected Elemental Species in CSSF 4 wt%

			Aluminium (wt%)				
Vessel	WS4-142	WS4-143	WS4-144				
Segment							
1	27.0	27.2	25.7				
2	13.6	18.7	11.2				
3	8.2	7.8	8.4				
4	8.4	8.5	8.6				
5	8.5	8.6	8.6				
6	9.0	8.7	8.8				
7	8.3	9.9	7.8				
8	8.0	9.1	13.0				
9	12.0	9.0	9.0				
10	9.2	9.1	9.4				
11	9.3	9.1	9.1				
12	9.1	9.2	9.0				
		Average wt% =	9.5		Standard Dev =	2.1	
			Boron (wt%)				
Vessel	WS4-142	WS4-143	WS4-144				
Segment							
1	0.12	0.12	0.11				
2	1.06	0.99	1.10				
3	1.02	1.14	0.93				
4	0.83	0.93	0.81				
5	0.89	0.82	0.88				
6	0.76	0.84	0.83				
7	0.97	0.91	1.13				
8	1.08	0.88	0.68				
9	0.73	0.93	0.88				
10	0.90	0.88	0.92				
11	0.91	0.92	0.89				
12	0.89	0.92	0.89				
		Average wt% =	0.91		Standard Dev =	0.11	
			Cadmium (wt%)				
Vessel	WS4-142	WS4-143	WS4-144				
Segment							
1	0.0	0.0	0.0				
2	0.0	0.0	0.0				
3	0.0	0.0	0.0				
4	0.0	0.0	0.0				
5	0.0	0.0	0.0				
6	0.0	0.0	0.0				
7	0.0	0.0	0.0				
8	0.0	0.0	0.0				
9	0.0	0.0	0.0				
10	0.0	0.0	0.0				
11	0.0	0.0	0.0				
12	0.0	0.0	0.0				
		Average wt% =	0		Standard Dev =	0	

Table C-4: Selected Elemental Species in CSSF 4 wt%

			Calcium (wt%)				
Vessel	WS4-142	WS4-143	WS4-144				
Segment							
1	11	11	11				
2	24	20	26				
3	29	29	29				
4	30	29	30				
5	29	30	29				
6	29	29	29				
7	29	27	29				
8	29	28	23				
9	25	28	28				
10	28	29	26				
11	27	30	28				
12	28	30	28				
		Average wt% =	28		Standard Dev =	2	
			Carbonate (wt%)				
Vessel	WS4-142	WS4-143	WS4-144				
Segment							
1	31.47	31.29	33.11				
2	0.00	0.00	0.00				
3	0.00	0.00	0.00				
4	0.00	0.00	0.00				
5	0.00	0.00	0.00				
6	0.00	0.00	0.00				
7	0.00	3.89	0.00				
8	0.00	0.00	10.26				
9	7.98	0.00	0.00				
10	0.00	0.00	0.00				
11	0.00	0.00	0.00				
12	0.00	0.00	0.00				
		Average wt% =	0.67		Standard Dev =	2.30	
			Cesium (wt%)				
Vessel	WS4-142	WS4-143	WS4-144				
Segment							
1	0.0000	0.0000	0.0000				
2	0.0096	0.0085	0.0100				
3	0.0097	0.0106	0.0091				
4	0.0085	0.0091	0.0084				
5	0.0089	0.0084	0.0091				
6	0.0087	0.0090	0.0089				
7	0.0095	0.0096	0.0106				
8	0.0108	0.0113	0.0087				
9	0.0093	0.0119	0.0113				
10	0.0114	0.0121	0.0118				
11	0.0116	0.0154	0.0114				
12	0.0114	0.0153	0.0114				
		Average wt% =	0.010		Standard Dev =	0.002	

Table C-4: Selected Elemental Species in CSSF 4 wt%

			Chloride (wt%)			
Vessel	WS4-142	WS4-143	WS4-144			
Segment						
1	0.00	0.00	0.00			
2	0.02	0.02	0.02			
3	0.06	0.02	0.09			
4	0.11	0.09	0.12			
5	0.10	0.11	0.08			
6	0.10	0.09	0.09			
7	0.06	0.04	0.02			
8	0.03	0.21	0.04			
9	0.08	0.16	0.21			
10	0.21	0.24	0.22			
11	0.22	0.29	0.21			
12	0.21	0.29	0.21			
		Average wt% =	0.12		Standard Dev =	0.08
			Chromium (wt%)			
Vessel	WS4-142	WS4-143	WS4-144			
Segment						
1	0.00	0.00	0.00			
2	0.22	0.19	0.23			
3	0.25	0.24	0.25			
4	0.24	0.25	0.25			
5	0.25	0.25	0.25			
6	0.26	0.25	0.25			
7	0.25	0.22	0.24			
8	0.24	0.26	0.18			
9	0.20	0.26	0.26			
10	0.27	0.25	0.28			
11	0.27	0.21	0.27			
12	0.26	0.22	0.26			
		Average wt% =	0.24		Standard Dev =	0.02
			Fluoride (wt%)			
Vessel	WS4-142	WS4-143	WS4-144			
Segment						
1	0	0	0			
2	23	21	24			
3	23	25	21			
4	19	21	19			
5	21	19	20			
6	18	20	19			
7	22	20	25			
8	24	19	15			
9	16	20	19			
10	19	19	20			
11	19	19	19			
12	19	19	19			
		Average wt% =	20		Standard Dev =	2

Table C-4: Selected Elemental Species in CSSF 4 wt%

			Iron (wt%)				
Vessel	WS4-142	WS4-143	WS4-144				
Segment							
1	0.00	0.00	0.00				
2	0.15	0.12	0.15				
3	0.28	0.16	0.37				
4	0.44	0.38	0.47				
5	0.41	0.47	0.42				
6	0.55	0.46	0.48				
7	0.33	0.29	0.17				
8	0.23	0.60	0.36				
9	0.40	0.53	0.59				
10	0.60	0.61	0.62				
11	0.61	0.60	0.60				
12	0.59	0.60	0.59				
		Average wt% =	0.43		Standard Dev =	0.16	
			Magnesium (wt%)				
Vessel	WS4-142	WS4-143	WS4-144				
Segment							
1	6.12	6.09	6.44				
2	0.17	0.14	0.18				
3	0.19	0.20	0.20				
4	0.20	0.19	0.20				
5	0.19	0.20	0.19				
6	0.19	0.19	0.19				
7	0.20	0.93	0.20				
8	0.20	0.19	2.13				
9	1.70	0.19	0.19				
10	0.18	0.19	0.17				
11	0.18	0.20	0.18				
12	0.19	0.20	0.19				
		Average wt% =	0.32		Standard Dev =	0.44	
			Manganese (wt%)				
Vessel	WS4-142	WS4-143	WS4-144				
Segment							
1	0.00	0.00	0.00				
2	0.08	0.06	0.08				
3	0.09	0.09	0.09				
4	0.09	0.09	0.09				
5	0.09	0.09	0.09				
6	0.09	0.09	0.09				
7	0.09	0.08	0.09				
8	0.09	0.09	0.06				
9	0.07	0.08	0.09				
10	0.08	0.09	0.08				
11	0.08	0.09	0.08				
12	0.09	0.09	0.09				
		Average wt% =	0.08		Standard Dev =	0.01	

Table C-4: Selected Elemental Species in CSSF 4 wt%

			Mercury (wt%)				
Vessel	WS4-142	WS4-143	WS4-144				
Segment							
1	0.00000	0.00000	0.00000				
2	0.00005	0.00000	0.00004				
3	0.00008	0.00005	0.00014				
4	0.00018	0.00014	0.00020				
5	0.00016	0.00020	0.00016				
6	0.00023	0.00018	0.00019				
7	0.00010	0.00021	0.00006				
8	0.00015	0.00077	0.00042				
9	0.00051	0.00073	0.00077				
10	0.00078	0.00089	0.00080				
11	0.00080	0.00124	0.00078				
12	0.00077	0.00124	0.00077				
		Average wt% =	0.00042		Standard Dev =	0.00037	
			Nickel (wt%)				
Vessel	WS4-142	WS4-143	WS4-144				
Segment							
1	0.000	0.000	0.000				
2	0.008	0.007	0.008				
3	0.027	0.009	0.038				
4	0.048	0.039	0.052				
5	0.044	0.052	0.045				
6	0.062	0.051	0.052				
7	0.033	0.021	0.009				
8	0.014	0.047	0.023				
9	0.026	0.036	0.045				
10	0.047	0.048	0.048				
11	0.048	0.043	0.047				
12	0.045	0.044	0.045				
		Average wt% =	0.037		Standard Dev =	0.016	
			Nitrate (wt%)				
Vessel	WS4-142	WS4-143	WS4-144				
Segment							
1	0.0	0.0	0.0				
2	0.4	0.3	0.4				
3	2.2	0.4	3.4				
4	4.5	3.6	4.9				
5	4.0	4.9	3.9				
6	5.5	4.5	4.6				
7	2.7	1.8	0.4				
8	1.1	4.5	2.4				
9	2.7	3.6	4.4				
10	4.5	4.9	4.6				
11	4.6	5.4	4.5				
12	4.4	5.5	4.3				
		Average wt% =	3.4		Standard Dev =	1.7	

Table C-4: Selected Elemental Species in CSSF 4 wt%

			Oxide (wt%)			
Vessel	WS4-142	WS4-143	WS4-144			
Segment						
1	24	24	23			
2	20	23	19			
3	17	17	18			
4	19	18	19			
5	18	19	18			
6	19	19	19			
7	18	18	17			
8	17	19	19			
9	19	19	19			
10	19	19	19			
11	19	19	19			
12	19	19	19			
		Average wt% =	19		Standard Dev =	1
			Phosphate (wt%)			
Vessel	WS4-142	WS4-143	WS4-144			
Segment						
1	0.000	0.000	0.000			
2	0.080	0.070	0.084			
3	0.090	0.090	0.090			
4	0.089	0.090	0.090			
5	0.090	0.090	0.089			
6	0.089	0.089	0.089			
7	0.089	0.082	0.090			
8	0.091	0.098	0.068			
9	0.075	0.098	0.098			
10	0.099	0.103	0.100			
11	0.099	0.122	0.098			
12	0.098	0.122	0.098			
		Average wt% =	0.092		Standard Dev =	0.011
			Potassium (wt%)			
Vessel	WS4-142	WS4-143	WS4-144			
Segment						
1	0.00	0.00	0.00			
2	0.06	0.04	0.06			
3	0.26	0.06	0.40			
4	0.51	0.41	0.56			
5	0.46	0.56	0.47			
6	0.67	0.54	0.56			
7	0.33	0.22	0.06			
8	0.13	0.53	0.28			
9	0.32	0.43	0.52			
10	0.54	0.59	0.55			
11	0.55	0.67	0.54			
12	0.52	0.68	0.52			
		Average wt% =	0.41		Standard Dev =	0.20

Table C-4: Selected Elemental Species in CSSF 4 wt%

			Sodium (wt%)			
Vessel	WS4-142	WS4-143	WS4-144			
Segment						
1	0.0	0.0	0.0			
2	0.2	0.1	0.2			
3	1.1	0.2	1.7			
4	2.2	1.8	2.4			
5	2.0	2.4	1.9			
6	2.7	2.2	2.2			
7	1.3	0.9	0.2			
8	0.5	2.2	1.2			
9	1.3	1.8	2.1			
10	2.2	2.4	2.3			
11	2.3	2.7	2.2			
12	2.1	2.7	2.1			
		Average wt% =	1.7		Standard Dev =	0.8
			Strontium (wt%)			
Vessel	WS4-142	WS4-143	WS4-144			
Segment						
1	0.021	0.021	0.022			
2	0.265	0.222	0.286			
3	0.312	0.316	0.312			
4	0.319	0.309	0.312			
5	0.310	0.312	0.311			
6	0.304	0.309	0.308			
7	0.315	0.281	0.320			
8	0.315	0.299	0.220			
9	0.241	0.297	0.301			
10	0.293	0.305	0.280			
11	0.286	0.319	0.296			
12	0.298	0.318	0.299			
		Average wt% =	0.30		Standard Dev =	0.03
			Sulfate (wt%)			
Vessel	WS4-142	WS4-143	WS4-144			
Segment						
1	0.00	0.00	0.00			
2	0.39	0.33	0.42			
3	0.45	0.46	0.45			
4	0.46	0.45	0.45			
5	0.45	0.45	0.45			
6	0.44	0.45	0.45			
7	0.46	0.41	0.46			
8	0.46	0.45	0.32			
9	0.35	0.45	0.46			
10	0.45	0.47	0.44			
11	0.44	0.51	0.45			
12	0.45	0.51	0.45			
		Average wt% =	0.44		Standard Dev =	0.04

Table C-4: Selected Elemental Species in CSSF 4 wt%							
			Tin (wt%)				
Vessel	WS4-142	WS4-143	WS4-144				
Segment							
1	0.00	0.00	0.00				
2	0.25	0.22	0.26				
3	0.25	0.28	0.23				
4	0.20	0.23	0.20				
5	0.22	0.20	0.22				
6	0.20	0.21	0.21				
7	0.24	0.23	0.27				
8	0.27	0.23	0.18				
9	0.19	0.24	0.23				
10	0.23	0.21	0.23				
11	0.23	0.17	0.23				
12	0.23	0.17	0.23				
		Average wt% =	0.22		Standard Dev =	0.03	
			Uranium (wt%)				
Vessel	WS4-142	WS4-143	WS4-144				
Segment							
1	0.00	0.00	0.00				
2	0.00	0.00	0.00				
3	0.00	0.00	0.00				
4	0.01	0.00	0.01				
5	0.01	0.01	0.01				
6	0.01	0.01	0.01				
7	0.00	0.00	0.00				
8	0.00	0.01	0.00				
9	0.00	0.01	0.01				
10	0.01	0.01	0.01				
11	0.01	0.01	0.01				
12	0.01	0.01	0.01				
		Average wt% =	0.005		Standard Dev =	0.002	
			Zirconium (wt%)				
Vessel	WS4-142	WS4-143	WS4-144				
Segment	2	3	4				
1	0	0	0				
2	16	14	16				
3	16	17	14				
4	13	14	13				
5	14	13	14				
6	13	13	13				
7	15	14	17				
8	17	14	11				
9	12	15	14				
10	14	13	15				
11	15	11	14				
12	14	11	14				
		Average wt% =	14		Standard Dev =	2	

Table C-4: Selected Radionuclides CSSF 4 Ci/m3						
			Antimony-126			
Vessel	WS4-142	WS4-143	WS4-144			
Segment						
1	0.00000	0.00000	0.00000			
2	0.00155	0.00105	0.00182			
3	0.00232	0.00234	0.00212			
4	0.00199	0.00212	0.00229			
5	0.00242	0.00227	0.00234			
6	0.00221	0.00223	0.00248			
7	0.00279	0.00229	0.00292			
8	0.00301	0.00521	0.00246			
9	0.00290	0.00471	0.00494			
10	0.00506	0.00560	0.00522			
11	0.00511	0.00594	0.00536			
12	0.00494	0.00809	0.00426			
		Average Ci/m3 =	0.0034		Standard Dev =	0.0016
			Antimony-126m			
Vessel	WS4-142	WS4-143	WS4-144			
Segment						
1	0.00000	0.00000	0.00000			
2	0.01106	0.00748	0.01300			
3	0.01660	0.01671	0.01516			
4	0.01422	0.01517	0.01634			
5	0.01730	0.01621	0.01674			
6	0.01580	0.01592	0.01772			
7	0.01994	0.01637	0.02083			
8	0.02152	0.03723	0.01757			
9	0.02069	0.03366	0.03532			
10	0.03617	0.04000	0.03728			
11	0.03652	0.04241	0.03826			
12	0.03528	0.05778	0.03041			
		Average Ci/m3 =	0.024		Standard Dev =	0.012
			Barium-137m			
Vessel	WS4-142	WS4-143	WS4-144			
Segment						
1	0	0	0			
2	1214	859	1447			
3	1851	1847	1653			
4	1517	1652	1729			
5	1866	1716	1792			
6	1622	1679	1861			
7	2186	1604	2284			
8	2222	2987	1410			
9	1660	2701	2834			
10	2902	3210	2992			
11	2930	3403	3070			
12	2831	4637	2440			
		Average Ci/m3 =	2200		Standard Dev =	800

Table C-4: Selected Radionuclides CSSF 4 Ci/m^3

			Cesium-137			
Vessel	WS4-142	WS4-143	WS4-144			
Segment						
1	0	0	0			
2	1284	908	1530			
3	1956	1952	1748			
4	1604	1746	1827			
5	1973	1814	1895			
6	1715	1775	1967			
7	2311	1695	2414			
8	2349	3158	1490			
9	1755	2855	2996			
10	3068	3393	3163			
11	3098	3597	3245			
12	2992	4901	2579			
		Average Ci/m3 =	2300		Standard Dev =	800
			Nickel-63			
Vessel	WS4-142	WS4-143	WS4-144			
Segment						
1	0.00	0.00	0.00			
2	1.48	0.99	1.73			
3	2.21	2.23	2.03			
4	1.91	2.03	2.20			
5	2.32	2.18	2.25			
6	2.13	2.14	2.38			
7	2.66	2.23	2.78			
8	2.91	5.22	2.46			
9	2.90	4.72	4.95			
10	5.07	5.61	5.23			
11	5.12	5.94	5.36			
12	4.95	8.10	4.26			
		Average Ci/m3 =	3.4		Standard Dev =	1.7
			Protactinium-233			
Vessel	WS4-142	WS4-143	WS4-144			
Segment						
1	0.00000	0.00000	0.00000			
2	0.00045	0.00035	0.00055			
3	0.00070	0.00069	0.00060			
4	0.00052	0.00059	0.00058			
5	0.00065	0.00057	0.00062			
6	0.00049	0.00055	0.00061			
7	0.00080	0.00041	0.00084			
8	0.00069	0.00010	0.00005			
9	0.00006	0.00009	0.00010			
10	0.00010	0.00011	0.00010			
11	0.00010	0.00011	0.00010			
12	0.00009	0.00016	0.00008			
		Average Ci/m3 =	0.00038		Standard Dev =	0.00027

Table C-4: Selected Radionuclides CSSF 4 Ci/m^3

			Strontium-90			
Vessel	WS4-142	WS4-143	WS4-144			
Segment						
1	0	0	0			
2	1244	904	1495			
3	1937	1899	1722			
4	1573	1720	1789			
5	1934	1776	1791			
6	1529	1637	1797			
7	2206	1500	2337			
8	2176	2393	1080			
9	1294	2144	2268			
10	2324	2759	2396			
11	2348	3389	2458			
12	2265	4617	1952			
		Average Ci/m3 =	2000		Standard Dev =	700
			Technetium-99			
Vessel	WS4-142	WS4-143	WS4-144			
Segment						
1	0.00	0.00	0.00			
2	0.42	0.29	0.50			
3	0.64	0.64	0.58			
4	0.54	0.58	0.62			
5	0.66	0.62	0.64			
6	0.60	0.60	0.67			
7	0.76	0.61	0.80			
8	0.81	1.35	0.64			
9	0.75	1.22	1.29			
10	1.32	1.46	1.36			
11	1.33	1.54	1.39			
12	1.28	2.10	1.11			
		Average Ci/m3 =	0.90		Standard Dev =	0.42
			Yttrium-90			
Vessel	WS4-142	WS4-143	WS4-144			
Segment						
1	0	0	0			
2	1244	904	1495			
3	1937	1899	1722			
4	1573	1720	1789			
5	1934	1776	1791			
6	1529	1637	1797			
7	2206	1500	2337			
8	2176	2393	1080			
9	1294	2144	2268			
10	2324	2759	2396			
11	2348	3389	2458			
12	2265	4617	1952			
		Average Ci/m3 =	2000		Standard Dev =	700

Table C-4: Selected Radionuclides CSSF 4 nano-Ci/g						
			Americium-241			
Vessel	WS4-142	WS4-143	WS4-144			
Segment						
1	0	0	0			
2	2712	2582	2889			
3	2802	3031	2525			
4	2246	2519	2194			
5	2417	2199	2428			
6	2123	2324	2299			
7	2674	2103	2969			
8	2675	1228	950			
9	1014	1298	1228			
10	1245	1314	1280			
11	1263	1672	1239			
12	1238	1666	1237			
		Average nCi/g =	2000		Standard Dev =	700
			Neptunium-237			
Vessel	WS4-142	WS4-143	WS4-144			
Segment						
1	0.00	0.00	0.00			
2	0.59	0.58	0.63			
3	0.61	0.66	0.54			
4	0.47	0.54	0.46			
5	0.51	0.46	0.51			
6	0.42	0.48	0.47			
7	0.58	0.39	0.64			
8	0.54	0.05	0.04			
9	0.04	0.06	0.05			
10	0.05	0.06	0.06			
11	0.06	0.07	0.05			
12	0.05	0.07	0.05			
		Average nCi/g =	0.33		Standard Dev =	0.25
			Plutonim-238			
Vessel	WS4-142	WS4-143	WS4-144			
Segment						
1	0	0	0			
2	29577	26794	30997			
3	29258	32805	26502			
4	23707	26452	23206			
5	25484	23260	26230			
6	23981	25570	25455			
7	28631	26622	32427			
8	31468	26950	20037			
9	21740	28312	26939			
10	27324	25726	28087			
11	27725	23034	27185			
12	27150	23000	27109			
		Average nCi/g =	27,000		Standard Dev =	3000

Table C-4: Selected Radionuclides CSSF 4 nano-Ci/g

			Plutonium-239			
Vessel	WS4-142	WS4-143	WS4-144			
Segment						
1	0	0	0			
2	412	369	430			
3	489	456	509			
4	518	514	533			
5	513	532	427			
6	359	390	374			
7	407	388	452			
8	448	916	318			
9	475	797	902			
10	927	1018	952			
11	947	1261	919			
12	901	1271	898			
		Average nCi/g =	640		Standard Dev =	280
			Plutonium-240			
Vessel	WS4-142	WS4-143	WS4-144			
Segment						
1	0	0	0			
2	378	340	395			
3	458	419	482			
4	494	487	510			
5	487	509	397			
6	329	359	343			
7	374	354	415			
8	410	369	285			
9	305	390	369			
10	374	395	385			
11	379	502	372			
12	372	500	371			
		Average nCi/g =	400		Standard Dev =	60
			Plutonium-241			
Vessel	WS4-142	WS4-143	WS4-144			
Segment						
1	0	0	0			
2	10979	10617	11754			
3	11409	12301	10194			
4	8985	10162	8741			
5	9712	8765	9725			
6	8333	9248	9126			
7	10819	8022	12010			
8	10528	3376	2610			
9	2787	3569	3377			
10	3424	3611	3519			
11	3473	4597	3406			
12	3404	4579	3399			
		Average nCi/g =	7300		Standard Dev =	3400

Table C-4: Selected Radionuclides CSSF 4 nano-Ci/g

			Protactinium-233			
Vessel	WS4-142	WS4-143	WS4-144			
Segment						
1	0.00	0.00	0.00			
2	0.59	0.58	0.63			
3	0.61	0.66	0.54			
4	0.47	0.54	0.46			
5	0.51	0.46	0.51			
6	0.42	0.48	0.47			
7	0.58	0.39	0.64			
8	0.54	0.05	0.04			
9	0.04	0.06	0.05			
10	0.05	0.06	0.06			
11	0.06	0.07	0.05			
12	0.05	0.07	0.05			
		Average nCi/g =	0.33		Standard Dev =	0.25
			Thorium-231			
Vessel	WS4-142	WS4-143	WS4-144			
Segment						
1	0.00	0.00	0.00			
2	0.13	0.12	0.14			
3	0.13	0.14	0.12			
4	0.11	0.12	0.11			
5	0.12	0.11	0.12			
6	0.11	0.12	0.12			
7	0.13	0.12	0.14			
8	0.14	0.13	0.10			
9	0.11	0.14	0.13			
10	0.13	0.14	0.13			
11	0.13	0.18	0.13			
12	0.13	0.17	0.13			
		Average nCi/g =	0.13		Standard Dev =	0.02

Table C-5: Selected Elemental Species in CSSF 5 wt%

			Aluminium (wt%)				
Vessel	WS5-146	WS5-147	WS5-148	WS5-149	WS5-150	WS5-151	WS5-152
Segment							
1	10	10	10	10	10	10	10
2	15	9	13	13	11	11	10
3	14	16	14	15	15	15	16
4	14	14	15	15	16	18	13
5	6	11	6	5	6	6	14
6	5	6	5	6	5	6	6
7	7	5	6	6	8	7	5
8	8	8	7	7	5	5	8
9	15	11	11	11	13	14	11
10	15	13	15	15	16	16	13
11	19	13	15	15	14	15	13
		Average wt% =	11		Standard Dev =	4	
			Boron (wt%)				
Vessel	WS5-146	WS5-147	WS5-148	WS5-149	WS5-150	WS5-151	WS5-152
Segment							
1	1.06	1.05	1.06	1.06	1.04	1.05	1.04
2	0.81	0.95	0.88	0.88	0.97	0.95	0.97
3	1.25	1.04	1.20	1.22	1.11	1.09	1.06
4	0.86	1.18	0.81	0.87	0.99	1.03	1.22
5	0.85	0.76	0.86	0.84	0.86	0.85	0.78
6	0.81	0.86	0.82	0.82	0.81	0.84	0.85
7	0.82	0.81	0.81	0.82	0.79	0.79	0.81
8	0.81	0.82	0.86	0.86	0.94	0.93	0.84
9	0.69	0.78	0.74	0.74	0.68	0.70	0.76
10	0.83	0.70	0.76	0.76	0.76	0.74	0.70
11	0.51	0.84	0.71	0.71	0.82	0.72	0.83
		Average wt% =	0.86		Standard Dev =	0.14	
			Cadmium (wt%)				
Vessel	WS5-146	WS5-147	WS5-148	WS5-149	WS5-150	WS5-151	WS5-152
Segment							
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	0.0	0.0	0.0	0.0	0.0	0.0	0.0
4	1.0	0.0	1.3	0.4	0.4	0.0	0.0
5	4.6	3.6	4.3	4.8	4.4	4.3	2.4
6	4.6	4.4	4.6	4.3	4.7	4.2	4.6
7	5.0	4.6	5.0	5.0	4.8	4.7	4.6
8	4.6	5.0	5.1	5.1	5.6	5.5	5.0
9	2.7	4.3	4.0	4.0	3.4	3.2	4.1
10	2.7	3.0	2.3	2.3	1.9	1.8	3.0
11	0.9	2.8	2.5	2.5	3.1	2.5	3.0
		Average wt% =	2.7		Standard Dev =	2.0	

Table C-5: Selected Elemental Species in CSSF 5 wt%

			Calcium (wt%)				
Vessel	WS5-146	WS5-147	WS5-148	WS5-149	WS5-150	WS5-151	WS5-152
Segment							
1	28	28	28	28	29	28	29
2	23	28	25	25	27	27	28
3	25	23	25	24	24	24	24
4	25	25	23	24	24	23	26
5	27	25	27	27	27	27	23
6	27	26	27	27	27	26	26
7	26	27	27	27	26	26	27
8	25	26	26	26	28	28	26
9	19	24	23	23	21	21	23
10	19	20	18	18	17	17	20
11	15	20	18	18	20	18	20
		Average wt% =	24		Standard Dev =	3	

			Carbonate (wt%)				
Vessel	WS5-146	WS5-147	WS5-148	WS5-149	WS5-150	WS5-151	WS5-152
Segment							
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
3	2.6	0.0	2.1	2.5	2.2	2.8	0.0
4	3.1	4.5	3.8	3.5	3.2	3.7	3.7
5	0.0	1.7	0.0	0.0	0.0	0.0	4.0
6	0.6	0.0	0.0	0.6	0.5	0.0	0.0
7	0.0	0.5	0.7	0.0	0.0	0.5	0.5
8	5.5	0.0	0.0	0.0	0.0	0.0	0.0
9	5.1	5.4	5.7	5.7	6.3	5.4	5.9
10	3.1	5.9	5.6	5.6	7.1	8.7	5.9
11	19.6	4.5	8.3	8.3	2.4	8.1	4.0
		Average wt% =	2.7		Standard Dev =	3.4	

			Cesium (wt%)				
Vessel	WS5-146	WS5-147	WS5-148	WS5-149	WS5-150	WS5-151	WS5-152
Segment							
1	0.013	0.014	0.013	0.013	0.014	0.014	0.014
2	0.018	0.014	0.017	0.017	0.015	0.015	0.014
3	0.009	0.014	0.009	0.009	0.012	0.011	0.014
4	0.008	0.007	0.008	0.008	0.007	0.006	0.007
5	0.010	0.008	0.010	0.010	0.010	0.010	0.008
6	0.009	0.010	0.009	0.009	0.009	0.009	0.010
7	0.009	0.009	0.009	0.009	0.009	0.009	0.009
8	0.009	0.009	0.010	0.010	0.011	0.011	0.009
9	0.010	0.009	0.008	0.008	0.008	0.009	0.008
10	0.012	0.011	0.012	0.012	0.012	0.011	0.011
11	0.0077	0.0121	0.0098	0.0098	0.0112	0.0099	0.0118
		Average wt% =	0.010		Standard Dev =	0.002	

Table C-5: Selected Elemental Species in CSSF 5 wt%

			Chloride (wt%)				
Vessel	WS5-146	WS5-147	WS5-148	WS5-149	WS5-150	WS5-151	WS5-152
Segment							
1	0.34	0.33	0.34	0.34	0.32	0.33	0.32
2	0.22	0.26	0.24	0.24	0.27	0.25	0.28
3	0.24	0.27	0.23	0.24	0.27	0.26	0.28
4	0.11	0.18	0.09	0.11	0.12	0.14	0.17
5	0.10	0.07	0.09	0.09	0.09	0.09	0.07
6	0.12	0.10	0.12	0.11	0.12	0.11	0.10
7	0.13	0.12	0.13	0.14	0.13	0.13	0.13
8	0.13	0.13	0.14	0.14	0.15	0.15	0.14
9	0.13	0.12	0.12	0.12	0.12	0.12	0.12
10	0.13	0.13	0.13	0.13	0.13	0.12	0.13
11	0.08	0.14	0.11	0.11	0.13	0.12	0.14
		Average wt% =	0.15		Standard Dev =	0.06	
			Chromium (wt%)				
Vessel	WS5-146	WS5-147	WS5-148	WS5-149	WS5-150	WS5-151	WS5-152
Segment							
1	0.21	0.21	0.21	0.21	0.21	0.21	0.21
2	0.17	0.22	0.19	0.19	0.21	0.21	0.22
3	0.14	0.16	0.13	0.14	0.16	0.15	0.16
4	0.12	0.11	0.12	0.12	0.10	0.08	0.10
5	0.09	0.09	0.10	0.08	0.10	0.10	0.10
6	0.09	0.10	0.09	0.10	0.08	0.10	0.09
7	0.07	0.09	0.08	0.08	0.07	0.07	0.09
8	0.08	0.07	0.08	0.08	0.08	0.08	0.08
9	0.09	0.07	0.08	0.08	0.08	0.08	0.07
10	0.11	0.09	0.10	0.10	0.10	0.10	0.09
11	0.07	0.11	0.09	0.09	0.10	0.09	0.10
		Average wt% =	0.11		Standard Dev =	0.04	
			Fluoride (wt%)				
Vessel	WS5-146	WS5-147	WS5-148	WS5-149	WS5-150	WS5-151	WS5-152
Segment							
1	18	18	18	18	19	18	19
2	18	20	19	19	20	20	20
3	15	15	15	15	15	15	15
4	15	15	15	15	14	13	15
5	19	16	19	19	19	19	15
6	18	19	18	18	18	19	19
7	18	18	19	19	18	18	18
8	15	18	18	18	18	18	18
9	12	14	14	14	13	13	14
10	12	13	10	10	9	9	13
11	5	12	11	11	13	11	13
		Average wt% =	16		Standard Dev =	3	

Table C-5: Selected Elemental Species in CSSF 5 wt%

			Iron (wt%)				
Vessel	WS5-146	WS5-147	WS5-148	WS5-149	WS5-150	WS5-151	WS5-152
Segment							
1	0.77	0.74	0.75	0.75	0.72	0.74	0.72
2	0.59	0.58	0.59	0.59	0.62	0.58	0.61
3	0.73	0.74	0.73	0.74	0.74	0.72	0.75
4	0.41	0.69	0.34	0.43	0.51	0.61	0.70
5	0.28	0.22	0.27	0.27	0.27	0.26	0.27
6	0.30	0.28	0.29	0.28	0.29	0.28	0.28
7	0.31	0.30	0.31	0.32	0.30	0.30	0.30
8	0.29	0.31	0.32	0.32	0.34	0.34	0.31
9	0.40	0.27	0.27	0.27	0.29	0.34	0.26
10	0.49	0.42	0.51	0.51	0.52	0.50	0.42
11	0.36	0.50	0.39	0.39	0.44	0.40	0.47
		Average wt% =	0.42		Standard Dev =	0.16	
			Magnesium (wt%)				
Vessel	WS5-146	WS5-147	WS5-148	WS5-149	WS5-150	WS5-151	WS5-152
Segment							
1	0.20	0.20	0.20	0.20	0.20	0.20	0.20
2	0.16	0.19	0.17	0.17	0.18	0.18	0.19
3	0.72	0.19	0.63	0.70	0.62	0.74	0.19
4	0.78	1.09	0.91	0.87	0.82	0.93	0.96
5	0.18	0.49	0.18	0.18	0.18	0.19	0.93
6	0.29	0.18	0.18	0.29	0.27	0.18	0.18
7	0.18	0.29	0.32	0.18	0.17	0.28	0.28
8	1.23	0.18	0.18	0.18	0.19	0.19	0.18
9	1.10	1.20	1.25	1.25	1.35	1.17	1.30
10	0.72	1.26	1.21	1.21	1.49	1.79	1.27
11	3.87	1.00	1.72	1.72	0.59	1.68	0.90
		Average wt% =	0.69		Standard Dev =	0.63	
			Manganese (wt%)				
Vessel	WS5-146	WS5-147	WS5-148	WS5-149	WS5-150	WS5-151	WS5-152
Segment							
1	0.085	0.086	0.085	0.085	0.086	0.086	0.086
2	0.079	0.095	0.085	0.085	0.089	0.091	0.093
3	0.073	0.070	0.074	0.071	0.071	0.069	0.071
4	0.081	0.071	0.079	0.073	0.071	0.065	0.074
5	0.140	0.113	0.136	0.140	0.136	0.134	0.091
6	0.153	0.139	0.152	0.146	0.152	0.145	0.141
7	0.149	0.153	0.153	0.155	0.148	0.147	0.153
8	0.134	0.149	0.150	0.150	0.159	0.159	0.149
9	0.132	0.126	0.127	0.127	0.124	0.128	0.123
10	0.133	0.139	0.128	0.128	0.119	0.112	0.139
11	0.071	0.136	0.117	0.117	0.139	0.117	0.139
		Average wt% =	0.12		Standard Dev =	0.03	

Table C-5: Selected Elemental Species in CSSF 5 wt%

			Mercury (wt%)				
Vessel	WS5-146	WS5-147	WS5-148	WS5-149	WS5-150	WS5-151	WS5-152
Segment							
1	0.00115	0.00116	0.00116	0.00116	0.00116	0.00116	0.00116
2	0.00302	0.00109	0.00248	0.00249	0.00152	0.00158	0.00110
3	0.00095	0.00234	0.00119	0.00115	0.00167	0.00163	0.00218
4	0.00094	0.00124	0.00083	0.00107	0.00107	0.00126	0.00120
5	0.00018	0.00018	0.00021	0.00015	0.00019	0.00020	0.00048
6	0.00016	0.00021	0.00017	0.00020	0.00016	0.00023	0.00019
7	0.00010	0.00016	0.00011	0.00011	0.00011	0.00011	0.00016
8	0.00012	0.00010	0.00010	0.00010	0.00011	0.00011	0.00010
9	0.00065	0.00011	0.00016	0.00016	0.00029	0.00043	0.00011
10	0.00085	0.00067	0.00093	0.00093	0.00099	0.00094	0.00067
11	0.00072	0.00086	0.00065	0.00065	0.00070	0.00067	0.00078
		Average wt% =	0.00071		Standard Dev =	0.00068	
			Nickel (wt%)				
Vessel	WS5-146	WS5-147	WS5-148	WS5-149	WS5-150	WS5-151	WS5-152
Segment							
1	0.080	0.075	0.078	0.078	0.072	0.075	0.072
2	0.023	0.054	0.035	0.035	0.054	0.048	0.059
3	0.036	0.036	0.030	0.034	0.039	0.038	0.038
4	0.008	0.013	0.009	0.006	0.005	0.003	0.009
5	0.023	0.018	0.022	0.023	0.022	0.021	0.013
6	0.025	0.023	0.026	0.024	0.025	0.024	0.024
7	0.024	0.025	0.025	0.026	0.024	0.024	0.025
8	0.021	0.024	0.024	0.024	0.025	0.025	0.024
9	0.014	0.020	0.019	0.019	0.016	0.016	0.019
10	0.015	0.015	0.014	0.014	0.014	0.013	0.015
11	0.008	0.015	0.013	0.013	0.015	0.013	0.016
		Average wt% =	0.023		Standard Dev =	0.011	
			Nitrate (wt%)				
Vessel	WS5-146	WS5-147	WS5-148	WS5-149	WS5-150	WS5-151	WS5-152
Segment							
1	6.3	6.1	6.2	6.2	6.0	6.1	6.0
2	5.5	5.6	5.7	5.7	5.7	5.5	5.7
3	5.8	6.1	5.7	5.8	6.0	5.8	6.2
4	3.7	5.1	3.5	3.6	4.1	4.5	5.1
5	6.1	4.3	5.7	5.8	5.6	5.3	3.7
6	6.7	6.1	7.0	6.6	6.8	6.6	6.2
7	6.1	6.6	6.3	6.4	6.1	6.0	6.6
8	5.8	6.1	6.2	6.2	6.7	6.7	6.1
9	8.3	5.5	5.8	5.8	6.2	7.0	5.3
10	9.3	8.6	9.4	9.4	9.4	8.9	8.6
11	6.2	9.5	7.8	7.8	8.9	7.9	9.2
		Average wt% =	6.4		Standard Dev =	1.5	

Table C-5: Selected Elemental Species in CSSF 5 wt%

			Oxide (wt%)				
Vessel	WS5-146	WS5-147	WS5-148	WS5-149	WS5-150	WS5-151	WS5-152
Segment							
1	19	19	19	19	19	19	19
2	21	18	20	20	19	19	18
3	22	24	22	22	22	22	23
4	22	22	21	22	23	24	22
5	15	19	15	15	15	16	21
6	15	15	15	15	15	15	15
7	16	15	15	15	16	16	15
8	16	16	16	16	15	15	16
9	21	18	18	18	19	20	18
10	21	19	21	21	21	21	19
11	21	19	20	20	20	20	19
		Average wt% =	19		Standard Dev =	3	
			Phosphate (wt%)				
Vessel	WS5-146	WS5-147	WS5-148	WS5-149	WS5-150	WS5-151	WS5-152
Segment							
1	0.13	0.13	0.13	0.13	0.13	0.13	0.13
2	0.14	0.15	0.14	0.14	0.14	0.14	0.14
3	0.15	0.13	0.15	0.15	0.14	0.14	0.14
4	0.12	0.15	0.11	0.11	0.13	0.13	0.15
5	0.21	0.16	0.20	0.21	0.20	0.19	0.13
6	0.24	0.22	0.24	0.23	0.24	0.23	0.22
7	0.23	0.24	0.24	0.24	0.23	0.23	0.24
8	0.21	0.23	0.23	0.23	0.25	0.25	0.23
9	0.21	0.20	0.20	0.20	0.19	0.20	0.19
10	0.23	0.22	0.22	0.22	0.22	0.20	0.22
11	0.14	0.23	0.19	0.19	0.23	0.20	0.23
		Average wt% =	0.19		Standard Dev =	0.04	
			Potassium (wt%)				
Vessel	WS5-146	WS5-147	WS5-148	WS5-149	WS5-150	WS5-151	WS5-152
Segment							
1	1.01	0.96	0.99	0.99	0.93	0.96	0.93
2	0.78	0.75	0.80	0.80	0.81	0.76	0.79
3	0.61	0.80	0.62	0.63	0.71	0.70	0.79
4	0.41	0.56	0.38	0.39	0.43	0.51	0.55
5	0.64	0.44	0.59	0.62	0.58	0.55	0.38
6	0.74	0.65	0.77	0.71	0.75	0.70	0.66
7	0.72	0.74	0.73	0.74	0.71	0.69	0.74
8	0.71	0.72	0.74	0.74	0.82	0.81	0.73
9	0.62	0.67	0.65	0.65	0.59	0.62	0.65
10	0.66	0.65	0.66	0.66	0.64	0.60	0.65
11	0.41	0.67	0.57	0.57	0.65	0.57	0.67
		Average wt% =	0.65		Standard Dev =	0.11	

Table C-5: Selected Elemental Species in CSSF 5 wt%

			Sodium (wt%)				
Vessel	WS5-146	WS5-147	WS5-148	WS5-149	WS5-150	WS5-151	WS5-152
Segment							
1	3.0	2.9	2.9	2.9	2.8	2.9	2.8
2	2.6	2.7	2.7	2.7	2.7	2.6	2.7
3	2.9	3.0	2.8	2.9	2.9	2.9	3.0
4	1.9	2.5	1.7	1.8	2.0	2.2	2.5
5	3.0	2.2	2.8	2.9	2.8	2.7	1.9
6	3.3	3.1	3.5	3.3	3.4	3.3	3.1
7	3.0	3.3	3.1	3.2	3.0	3.0	3.3
8	2.9	3.0	3.1	3.1	3.3	3.3	3.0
9	4.3	2.7	2.9	2.9	3.2	3.6	2.6
10	4.9	4.5	4.9	4.9	4.9	4.6	4.5
11	3.3	4.9	4.0	4.0	4.6	4.1	4.8
		Average wt% =	3.2		Standard Dev =	0.8	
			Strontium (wt%)				
Vessel	WS5-146	WS5-147	WS5-148	WS5-149	WS5-150	WS5-151	WS5-152
Segment							
1	0.30	0.30	0.30	0.30	0.30	0.30	0.30
2	0.24	0.30	0.26	0.26	0.29	0.28	0.30
3	0.26	0.25	0.26	0.25	0.25	0.24	0.25
4	0.25	0.25	0.24	0.25	0.24	0.23	0.26
5	0.29	0.26	0.29	0.30	0.29	0.30	0.24
6	0.29	0.28	0.29	0.29	0.29	0.29	0.29
7	0.28	0.29	0.29	0.29	0.28	0.28	0.29
8	0.26	0.28	0.29	0.29	0.30	0.30	0.28
9	0.19	0.24	0.23	0.23	0.21	0.21	0.23
10	0.19	0.20	0.18	0.18	0.16	0.16	0.20
11	0.10	0.20	0.17	0.17	0.21	0.17	0.21
		Average wt% =	0.25		Standard Dev =	0.04	
			Sulfate (wt%)				
Vessel	WS5-146	WS5-147	WS5-148	WS5-149	WS5-150	WS5-151	WS5-152
Segment							
1	0.5	0.5	0.5	0.5	0.5	0.5	0.5
2	0.5	0.6	0.5	0.5	0.5	0.5	0.6
3	0.5	0.5	0.5	0.5	0.5	0.5	0.5
4	1.0	0.5	1.2	0.7	0.6	0.4	0.5
5	3.3	2.6	3.2	3.5	3.2	3.2	1.9
6	3.5	3.2	3.5	3.2	3.5	3.1	3.3
7	3.8	3.5	3.9	3.9	3.7	3.7	3.6
8	3.1	3.7	3.7	3.7	3.8	3.8	3.7
9	1.9	2.9	2.6	2.6	2.1	2.1	2.8
10	2.1	2.0	2.0	2.0	1.9	1.9	2.0
11	1.2	2.2	1.8	1.8	2.1	1.8	2.2
		Average wt% =	2.2		Standard Dev =	1.2	

Table C-5: Selected Elemental Species in CSSF 5 wt%

			Tin (wt%)				
Vessel	WS5-146	WS5-147	WS5-148	WS5-149	WS5-150	WS5-151	WS5-152
Segment							
1	0.15	0.15	0.15	0.15	0.15	0.15	0.15
2	0.18	0.19	0.18	0.18	0.18	0.19	0.18
3	0.10	0.12	0.10	0.10	0.11	0.11	0.12
4	0.15	0.10	0.16	0.15	0.12	0.09	0.10
5	0.22	0.19	0.22	0.21	0.22	0.22	0.17
6	0.20	0.22	0.21	0.21	0.20	0.22	0.22
7	0.18	0.20	0.19	0.19	0.18	0.18	0.20
8	0.15	0.18	0.18	0.18	0.18	0.18	0.18
9	0.11	0.15	0.14	0.14	0.13	0.12	0.14
10	0.13	0.12	0.11	0.11	0.11	0.11	0.12
11	0.07	0.13	0.11	0.11	0.13	0.11	0.13
		Average wt% =	0.16		Standard Dev =	0.04	
			Uranium (wt%)				
Vessel	WS5-146	WS5-147	WS5-148	WS5-149	WS5-150	WS5-151	WS5-152
Segment							
1	0.035	0.032	0.034	0.034	0.030	0.032	0.030
2	0.010	0.023	0.015	0.015	0.024	0.021	0.026
3	0.008	0.007	0.009	0.008	0.007	0.007	0.007
4	0.008	0.010	0.008	0.008	0.009	0.009	0.010
5	0.016	0.011	0.015	0.016	0.015	0.014	0.009
6	0.017	0.016	0.018	0.017	0.017	0.017	0.016
7	0.014	0.016	0.015	0.015	0.014	0.014	0.016
8	0.013	0.014	0.014	0.014	0.015	0.015	0.014
9	0.014	0.012	0.012	0.012	0.011	0.012	0.012
10	0.017	0.014	0.017	0.017	0.018	0.017	0.014
11	0.013	0.017	0.013	0.013	0.015	0.014	0.016
		Average wt% =	0.014		Standard Dev =	0.004	
			Zirconium (wt%)				
Vessel	WS5-146	WS5-147	WS5-148	WS5-149	WS5-150	WS5-151	WS5-152
Segment							
1	9.4	9.6	9.5	9.5	9.7	9.6	9.7
2	11.1	11.8	11.5	11.5	11.3	11.7	11.4
3	6.2	7.6	6.4	6.1	6.9	6.7	7.5
4	9.7	6.2	10.1	9.2	7.8	5.7	6.2
5	13.7	12.0	14.0	13.5	13.9	13.8	10.4
6	12.5	13.9	13.0	13.2	12.7	13.6	13.7
7	11.5	12.5	11.9	12.1	11.4	11.5	12.4
8	9.8	11.3	11.2	11.2	11.6	11.6	11.2
9	7.2	9.2	8.9	8.9	7.9	7.9	9.0
10	8.0	7.5	7.2	7.2	6.8	6.7	7.5
11	4.1	8.2	6.9	6.9	8.2	6.9	8.3
		Average wt% =	9.8		Standard Dev =	2.6	

Table C-5: Selected Radionuclides CSSF 5 Ci/m^3

			Antimony-126				
Vessel	WS5-146	WS5-147	WS5-148	WS5-149	WS5-150	WS5-151	WS5-152
Segment							
1	0.0064	0.0078	0.0071	0.0071	0.0084	0.0077	0.0084
2	0.0050	0.0045	0.0049	0.0050	0.0048	0.0047	0.0047
3	0.0026	0.0041	0.0027	0.0027	0.0036	0.0035	0.0041
4	0.0025	0.0021	0.0025	0.0024	0.0019	0.0017	0.0020
5	0.0030	0.0025	0.0030	0.0030	0.0030	0.0031	0.0022
6	0.0029	0.0032	0.0034	0.0034	0.0029	0.0033	0.0032
7	0.0030	0.0028	0.0026	0.0025	0.0027	0.0024	0.0029
8	0.0030	0.0029	0.0030	0.0030	0.0037	0.0036	0.0029
9	0.0030	0.0027	0.0026	0.0026	0.0025	0.0030	0.0027
10	0.0044	0.0033	0.0038	0.0038	0.0038	0.0034	0.0033
11	0.0031	0.0039	0.0038	0.0038	0.0042	0.0038	0.0040
		Average Ci/m^3 =	0.0032		Standard Dev =	0.0008	
			Antimony-126m				
Vessel	WS5-146	WS5-147	WS5-148	WS5-149	WS5-150	WS5-151	WS5-152
Segment							
1	0.046	0.056	0.050	0.050	0.060	0.055	0.060
2	0.036	0.032	0.035	0.035	0.034	0.034	0.033
3	0.019	0.029	0.019	0.019	0.026	0.025	0.029
4	0.018	0.015	0.018	0.017	0.014	0.012	0.014
5	0.021	0.018	0.021	0.021	0.021	0.022	0.016
6	0.021	0.023	0.024	0.024	0.021	0.024	0.023
7	0.021	0.020	0.018	0.018	0.019	0.017	0.021
8	0.022	0.020	0.022	0.022	0.027	0.026	0.020
9	0.021	0.020	0.019	0.019	0.018	0.021	0.019
10	0.031	0.024	0.027	0.027	0.027	0.024	0.024
11	0.022	0.028	0.027	0.027	0.030	0.027	0.028
		Average Ci/m^3 =	0.023		Standard Dev =	0.006	
			Barium-137m				
Vessel	WS5-146	WS5-147	WS5-148	WS5-149	WS5-150	WS5-151	WS5-152
Segment							
1	3653	4455	4040	4040	4788	4426	4813
2	2737	2600	2724	2729	2714	2651	2666
3	1496	2250	1536	1515	2013	1964	2264
4	1550	1211	1554	1417	1141	961	1120
5	2344	1883	2261	2372	2321	2383	1539
6	2289	2441	2707	2631	2350	2554	2467
7	2439	2251	2087	2060	2194	1996	2298
8	2437	2332	2465	2465	3049	2969	2336
9	1939	2218	2060	2060	1859	2092	2148
10	2759	2201	2290	2290	2215	1984	2198
11	1737	2449	2463	2463	2793	2433	2548
		Average Ci/m^3 =	2200		Standard Dev =	500	

Table C-5: Selected Radionuclides CSSF 5 Ci/m^3

			Cesium-137				
Vessel	WS5-146	WS5-147	WS5-148	WS5-149	WS5-150	WS5-151	WS5-152
Segment							
1	3862	4710	4270	4270	5061	4679	5088
2	2893	2748	2880	2885	2869	2803	2818
3	1581	2378	1624	1602	2128	2076	2393
4	1638	1280	1642	1498	1206	1016	1183
5	2478	1991	2391	2507	2454	2520	1626
6	2419	2580	2861	2781	2484	2700	2607
7	2578	2380	2206	2178	2320	2109	2429
8	2576	2465	2605	2605	3223	3138	2470
9	2050	2345	2177	2177	1965	2211	2270
10	2917	2327	2421	2421	2342	2098	2323
11	1836	2589	2604	2604	2953	2572	2693
		Average Ci/m^3 =	2300		Standard Dev =	500	
			Nickel-63				
Vessel	WS5-146	WS5-147	WS5-148	WS5-149	WS5-150	WS5-151	WS5-152
Segment							
1	6.35	7.75	7.03	7.03	8.33	7.70	8.38
2	3.01	4.53	3.48	3.48	4.29	4.13	4.64
3	2.61	2.65	2.48	2.42	2.74	2.67	2.78
4	2.34	2.00	2.26	2.24	1.81	1.55	1.96
5	2.86	2.37	2.82	2.84	2.86	2.96	1.96
6	2.73	3.02	3.23	3.23	2.78	3.18	3.01
7	2.81	2.68	2.40	2.37	2.52	2.30	2.73
8	2.84	2.68	2.84	2.84	3.51	3.42	2.69
9	1.39	2.59	2.35	2.35	1.90	1.90	2.51
10	1.70	1.60	1.24	1.24	1.03	0.93	1.60
11	0.63	1.53	1.66	1.66	2.02	1.61	1.73
		Average Ci/m^3 =	2.5		Standard Dev =	0.8	
			Strontium-90				
Vessel	WS5-146	WS5-147	WS5-148	WS5-149	WS5-150	WS5-151	WS5-152
Segment							
1	3633	4432	4018	4018	4764	4403	4789
2	2550	2645	2608	2612	2696	2635	2704
3	1495	2074	1518	1479	1897	1850	2099
4	1480	1245	1445	1441	1166	1003	1179
5	1661	1394	1651	1637	1673	1730	1244
6	1944	1769	1921	1950	1833	1878	1748
7	2504	2033	2182	2155	2295	2088	2133
8	2361	2378	2456	2456	2971	2909	2357
9	2003	2151	2020	2020	1872	2119	2084
10	2860	2272	2378	2378	2305	2066	2269
11	1813	2539	2549	2549	2887	2519	2636
		Average Ci/m^3 =	2100		Standard Dev =	500	

Table C-5: Selected Radionuclides CSSF 5 Ci/m^3							
			Technetium-99				
Vessel	WS5-146	WS5-147	WS5-148	WS5-149	WS5-150	WS5-151	WS5-152
Segment							
1	1.66	2.02	1.83	1.83	2.17	2.01	2.18
2	1.34	1.18	1.31	1.31	1.26	1.23	1.21
3	0.68	1.09	0.71	0.70	0.96	0.93	1.09
4	0.66	0.56	0.65	0.63	0.51	0.44	0.51
5	0.82	0.67	0.80	0.82	0.82	0.84	0.59
6	0.79	0.86	0.93	0.92	0.81	0.91	0.86
7	0.82	0.77	0.70	0.69	0.74	0.67	0.79
8	0.83	0.78	0.83	0.83	1.02	1.00	0.78
9	0.80	0.75	0.71	0.71	0.68	0.81	0.73
10	1.19	0.91	1.02	1.02	1.02	0.91	0.90
11	0.83	1.06	1.04	1.04	1.15	1.03	1.07
		Average Ci/m^3 =	0.87		Standard Dev =	0.20	
			Yttrium-90				
Vessel	WS5-146	WS5-147	WS5-148	WS5-149	WS5-150	WS5-151	WS5-152
Segment							
1	3633	4432	4018	4018	4764	4403	4789
2	2550	2645	2608	2612	2696	2635	2704
3	1495	2074	1518	1479	1897	1850	2099
4	1480	1245	1445	1441	1166	1003	1179
5	1661	1394	1651	1637	1673	1730	1244
6	1944	1769	1921	1950	1833	1878	1748
7	2504	2033	2182	2155	2295	2088	2133
8	2361	2378	2456	2456	2971	2909	2357
9	2003	2151	2020	2020	1872	2119	2084
10	2860	2272	2378	2378	2305	2066	2269
11	1813	2539	2549	2549	2887	2519	2636
		Average Ci/m^3 =	2100		Standard Dev =	500	

Table C-5: Selected Radionuclides CSSF 5 nano-Ci/g

			Americium-241				
Vessel	WS5-146	WS5-147	WS5-148	WS5-149	WS5-150	WS5-151	WS5-152
Segment							
1	1435	1467	1451	1451	1489	1468	1488
2	1396	1557	1467	1466	1505	1527	1534
3	931	1132	909	910	1048	1025	1127
4	1211	748	1296	962	821	629	737
5	2710	2185	2614	2785	2655	2602	1638
6	2610	2646	2696	2572	2689	2544	2709
7	2757	2602	2716	2747	2603	2591	2612
8	2720	2770	2930	2930	3259	3214	2836
9	2583	2554	2451	2451	2337	2476	2478
10	2929	2737	2840	2840	2724	2591	2737
11	1728	3010	2472	2472	2888	2492	2988
		Average nCi/g =	2200		Standard Dev =	800	
			Neptunium-237				
Vessel	WS5-146	WS5-147	WS5-148	WS5-149	WS5-150	WS5-151	WS5-152
Segment							
1	0.1	0.1	0.1	0.1	0.1	0.1	0.0757
2	1.6	0.1	1.1	1.1	0.4	0.5	0.1
3	0.0	1.0	0.2	0.2	0.6	0.6	0.9
4	0.3	0.1	0.3	0.2	0.2	0.1	0.0
5	0.8	0.6	0.8	0.8	0.8	0.7	0.5
6	0.9	0.8	0.9	0.8	0.9	0.8	0.8
7	0.9	0.9	0.9	0.9	0.9	0.8	0.9
8	0.9	0.9	0.9	0.9	1.0	1.0	0.9
9	5.0	0.8	1.2	1.2	2.2	3.2	0.8
10	6.5	5.2	7.1	7.1	7.6	7.1	5.2
11	5.4	6.6	5.1	5.1	5.5	5.2	6.1
		Average Ci/m^3 =	1.9		Standard Dev =	2.2	
			Plutonim-238				
Vessel	WS5-146	WS5-147	WS5-148	WS5-149	WS5-150	WS5-151	WS5-152
Segment							
1	20438	20736	20586	20586	20944	20743	20935
2	27644	26082	27493	27488	25600	26600	25229
3	13528	18920	14132	13586	16376	16011	18485
4	16898	12998	17019	15515	13229	11691	13310
5	25525	21152	25084	25835	25266	24870	17179
6	24157	25261	24972	24345	24755	24435	25511
7	24809	24067	24439	24715	23420	23370	24089
8	24728	24922	26360	26360	29324	28921	25512
9	19141	23220	22044	22044	20043	20212	22562
10	20573	20383	19110	19110	17448	16652	20386
11	10326	21239	17921	17921	21495	17962	21709
			Average nCi/g =	21,000		Standard Dev =	5000

Table C-5: Selected Radionuclides CSSF 5 nano-Ci/g

			Plutonium-239				
Vessel	WS5-146	WS5-147	WS5-148	WS5-149	WS5-150	WS5-151	WS5-152
Segment							
1	1258	1244	1252	1252	1237	1244	1237
2	1522	1325	1489	1490	1369	1385	1318
3	839	1278	828	864	1116	1091	1257
4	473	569	444	477	400	419	535
5	439	364	433	440	434	427	333
6	419	437	432	424	427	428	439
7	423	417	418	423	401	400	417
8	421	424	447	447	496	490	434
9	748	396	403	403	472	584	385
10	947	784	993	993	1030	974	784
11	719	964	750	750	828	766	903
		Average nCi/g =	690		Standard Dev =	340	
			Plutonium-240				
Vessel	WS5-146	WS5-147	WS5-148	WS5-149	WS5-150	WS5-151	WS5-152
Segment							
1	431	440	436	436	447	441	447
2	401	469	428	428	449	455	461
3	280	327	271	271	307	300	327
4	268	223	270	250	214	187	221
5	385	322	381	387	382	377	267
6	363	383	375	369	371	372	385
7	368	361	363	367	348	347	361
8	368	370	391	391	434	428	378
9	260	346	327	327	292	288	336
10	270	278	244	244	215	206	278
11	121	279	240	240	292	240	291
		Average nCi/g =	330		Standard Dev =	70	
			Plutonium-241				
Vessel	WS5-146	WS5-147	WS5-148	WS5-149	WS5-150	WS5-151	WS5-152
Segment							
1	3942	4031	3986	3986	4091	4033	4089
2	3651	4280	3903	3900	4097	4152	4216
3	2560	2983	2481	2479	2809	2746	2985
4	4086	2044	4505	2937	2501	1715	2025
5	10938	8723	10473	11307	10674	10439	6303
6	10601	10620	10945	10353	10945	10183	10933
7	11322	10572	11152	11278	10687	10625	10620
8	11128	11374	12030	12030	13383	13199	11643
9	7550	10443	9836	9836	8626	8408	10128
10	7672	8076	6790	6790	5831	5589	8078
11	3125	7958	6910	6910	8502	6884	8383
		Average nCi/g =	7600		Standard Dev =	3500	

Table C-5: Selected Radionuclides CSSF 5 nano-Ci/g

			Protactinium-233				
Vessel	WS5-146	WS5-147	WS5-148	WS5-149	WS5-150	WS5-151	WS5-152
Segment							
1	0.08	0.08	0.08	0.08	0.08	0.08	0.08
2	1.60	0.18	1.15	1.15	0.45	0.51	0.16
3	0.04	1.03	0.18	0.21	0.60	0.59	0.91
4	0.39	0.12	0.48	0.23	0.19	0.13	0.03
5	1.61	1.13	1.49	1.60	1.49	1.42	0.84
6	1.81	1.60	1.86	1.71	1.84	1.68	1.64
7	1.82	1.82	1.86	1.89	1.80	1.77	1.82
8	1.71	1.82	1.86	1.86	2.02	2.01	1.83
9	5.59	1.66	2.32	2.32	3.39	4.03	1.61
10	6.05	5.85	6.08	6.08	6.03	5.64	5.85
11	3.94	6.16	5.12	5.12	5.86	5.16	6.04
		Average Ci/m^3 =	2.3		Standard Dev =	1.9	
			Thorium-231				
Vessel	WS5-146	WS5-147	WS5-148	WS5-149	WS5-150	WS5-151	WS5-152
Segment							
1	0.15	0.15	0.15	0.15	0.16	0.15	0.16
2	0.16	0.16	0.16	0.16	0.16	0.16	0.16
3	0.10	0.13	0.10	0.10	0.11	0.11	0.13
4	0.09	0.08	0.10	0.09	0.08	0.07	0.08
5	0.14	0.11	0.14	0.14	0.14	0.13	0.10
6	0.13	0.14	0.13	0.13	0.13	0.13	0.14
7	0.13	0.13	0.13	0.13	0.12	0.12	0.13
8	0.13	0.13	0.14	0.14	0.15	0.15	0.14
9	0.12	0.12	0.12	0.12	0.12	0.12	0.12
10	0.13	0.13	0.12	0.12	0.11	0.11	0.13
11	0.07	0.14	0.11	0.11	0.14	0.12	0.14
		Average Ci/m^3 =	0.12		Standard Dev =	0.02	

Table C-6: Selected Elemental Species in CSSF 6 wt%

			Aluminium (wt%)				
Vessel	WS6-154	WS6-155	WS6-156	WS6-157	WS6-158	WS6-159	WS6-160
Segment							
1	18	26	26	26	26	26	26
2	22	20	20	19	20	18	20
3	24	26	26	24	27	28	26
4	33	33	33	33	33	33	33
5	33	33	34	33	35	34	33
6	34	35	36	34	36	36	35
7	36	36		36			37
8	34	37		37			
9	37						
		Average wt% =	31		Standard Dev =	6	
			Boron (wt%)				
Vessel	WS6-154	WS6-155	WS6-156	WS6-157	WS6-158	WS6-159	WS6-160
Segment							
1	0.87	0.39	0.39	0.40	0.39	0.39	0.39
2	0.67	0.69	0.69	0.73	0.69	0.70	0.69
3	0.57	0.55	0.54	0.56	0.54	0.52	0.55
4	0.44	0.43	0.42	0.44	0.42	0.42	0.43
5	0.42	0.44	0.45	0.43	0.43	0.46	0.44
6	0.44	0.43	0.32	0.44	0.29	0.29	0.42
7	0.43	0.28		0.35			0.15
8	0.22	0.12		0.13			
9	0.13						
		Average wt% =	0.45		Standard Dev =	0.16	
			Cadmium (wt%)				
Vessel	WS6-154	WS6-155	WS6-156	WS6-157	WS6-158	WS6-159	WS6-160
Segment							
1	1.24	0.58	0.58	0.58	0.57	0.57	0.58
2	1.33	1.71	1.71	1.85	1.94	2.20	1.71
3	1.93	1.62	1.51	1.82	1.37	1.14	1.60
4	0.36	0.35	0.35	0.35	0.36	0.35	0.35
5	0.35	0.28	0.17	0.35	0.10	0.15	0.21
6	0.14	0.08	0.11	0.08	0.13	0.11	0.09
7	0.08	0.13		0.08			0.22
8	0.17	0.22		0.23			
9	0.22						
		Average wt% =	0.69		Standard Dev =	0.72	

Table C-6: Selected Elemental Species in CSSF 6 wt%

			Calcium (wt%)				
Vessel	WS6-154	WS6-155	WS6-156	WS6-157	WS6-158	WS6-159	WS6-160
Segment							
1	18.32	11.53	11.53	11.56	11.52	11.51	11.53
2	13.28	14.69	14.70	15.39	15.45	16.47	14.69
3	14.52	12.59	11.96	14.06	11.37	10.21	12.49
4	4.89	5.22	5.24	5.10	5.23	5.27	5.23
5	5.29	4.56	4.32	5.05	3.81	4.12	4.64
6	4.25	3.81	3.36	3.78	3.46	3.43	3.65
7	3.26	3.73		3.54			2.90
8	4.61	3.17		3.03			
9	3.04						
		Average wt% =	7.3		Standard Dev =	4.7	
			Carbonate (wt%)				
Vessel	WS6-154	WS6-155	WS6-156	WS6-157	WS6-158	WS6-159	WS6-160
Segment							
1	7.5	19.7	19.7	19.5	19.8	19.8	19.7
2	6.0	5.3	5.3	3.3	4.8	4.4	5.3
3	6.1	4.7	4.3	6.6	4.4	4.3	4.6
4	0.0	0.8	0.6	0.7	0.5	0.6	0.7
5	0.7	0.0	2.3	0.0	2.2	2.3	2.2
6	2.7	2.7	2.0	2.7	3.1	2.3	2.3
7	0.7	4.1		3.4			0.5
8	7.4	1.4		0.9			
9	0.9						
		Average wt% =	2.8		Standard Dev =	2.0	
			Cesium (wt%)				
Vessel	WS6-154	WS6-155	WS6-156	WS6-157	WS6-158	WS6-159	WS6-160
Segment							
1	0.0000	0.0049	0.0049	0.0050	0.0049	0.0048	0.0049
2	0.0124	0.0129	0.0129	0.0135	0.0127	0.0126	0.0129
3	0.0055	0.0049	0.0050	0.0053	0.0047	0.0045	0.0050
4	0.0053	0.0052	0.0052	0.0052	0.0053	0.0052	0.0052
5	0.0052	0.0043	0.0026	0.0051	0.0017	0.0023	0.0034
6	0.0024	0.0014	0.0016	0.0014	0.0016	0.0016	0.0014
7	0.0015	0.0016		0.0014			0.0022
8	0.0017	0.0022		0.0022			
9	0.0022						
		Average wt% =	0.0049		Standard Dev =	0.0038	

Table C-6: Selected Elemental Species in CSSF 6 wt%

			Chloride (wt%)				
Vessel	WS6-154	WS6-155	WS6-156	WS6-157	WS6-158	WS6-159	WS6-160
Segment							
1	0.183	0.044	0.044	0.045	0.044	0.043	0.044
2	0.100	0.103	0.103	0.113	0.104	0.105	0.103
3	0.116	0.131	0.135	0.114	0.137	0.140	0.132
4	0.180	0.177	0.178	0.178	0.180	0.179	0.178
5	0.179	0.203	0.221	0.187	0.257	0.229	0.207
6	0.218	0.262	0.302	0.263	0.292	0.306	0.266
7	0.285	0.284		0.266			0.356
8	0.272	0.355		0.360			
9	0.357						
		Average wt% =	0.20		Standard Dev =	0.08	
			Chromium (wt%)				
Vessel	WS6-154	WS6-155	WS6-156	WS6-157	WS6-158	WS6-159	WS6-160
Segment							
1	0.42	0.04	0.04	0.04	0.04	0.04	0.04
2	0.09	0.09	0.09	0.10	0.09	0.09	0.09
3	0.08	0.11	0.12	0.08	0.12	0.13	0.11
4	0.23	0.22	0.23	0.23	0.23	0.23	0.23
5	0.23	0.19	0.12	0.22	0.08	0.10	0.15
6	0.11	0.07	0.08	0.07	0.08	0.08	0.07
7	0.07	0.07		0.07			0.09
8	0.07	0.09		0.09			
9	0.09						
		Average wt% =	0.12		Standard Dev =	0.06	
			Fluoride (wt%)				
Vessel	WS6-154	WS6-155	WS6-156	WS6-157	WS6-158	WS6-159	WS6-160
Segment							
1	9.8	2.9	2.9	3.0	2.9	2.9	2.9
2	6.7	8.0	8.0	8.8	8.8	9.7	8.0
3	7.9	6.7	6.3	7.4	5.8	4.9	6.6
4	2.0	2.0	2.0	2.0	2.0	2.0	2.0
5	2.0	1.7	1.2	2.0	1.0	1.2	1.4
6	1.1	0.9	1.2	0.9	1.2	1.1	1.0
7	1.0	1.2		1.0			1.8
8	1.3	1.7		1.8			
9	1.8						
		Average wt% =	3.4		Standard Dev =	2.9	

Table C-6: Selected Elemental Species in CSSF 6 wt%

			Iron (wt%)				
Vessel	WS6-154	WS6-155	WS6-156	WS6-157	WS6-158	WS6-159	WS6-160
Segment							
1	0.47	0.23	0.23	0.23	0.23	0.23	0.23
2	0.58	0.59	0.59	0.61	0.56	0.54	0.59
3	0.45	0.55	0.59	0.44	0.61	0.65	0.56
4	1.04	1.01	1.02	1.02	1.03	1.03	1.02
5	1.03	0.87	0.56	1.01	0.40	0.51	0.69
6	0.52	0.35	0.42	0.35	0.43	0.42	0.36
7	0.37	0.43		0.36			0.59
8	0.45	0.59		0.60			
9	0.59						
		Average wt% =	0.63		Standard Dev =	0.23	
			Magnesium (wt%)				
Vessel	WS6-154	WS6-155	WS6-156	WS6-157	WS6-158	WS6-159	WS6-160
Segment							
1	1.47	3.86	3.86	3.83	3.88	3.89	3.86
2	1.25	1.11	1.11	0.74	1.03	0.96	1.11
3	1.27	0.98	0.90	1.35	0.92	0.88	0.96
4	0.02	0.17	0.14	0.15	0.11	0.14	0.15
5	0.16	0.02	0.47	0.02	0.44	0.46	0.44
6	0.53	0.54	0.40	0.53	0.61	0.45	0.47
7	0.15	0.81		0.68			0.11
8	1.45	0.29		0.18			
9	0.19						
		Average wt% =	0.58		Standard Dev =	0.42	
			Manganese (wt%)				
Vessel	WS6-154	WS6-155	WS6-156	WS6-157	WS6-158	WS6-159	WS6-160
Segment							
1	0.061	0.042	0.042	0.043	0.042	0.042	0.042
2	0.095	0.102	0.102	0.114	0.106	0.112	0.102
3	0.102	0.088	0.082	0.101	0.078	0.069	0.087
4	0.009	0.009	0.009	0.009	0.009	0.009	0.009
5	0.009	0.072	0.096	0.022	0.158	0.099	0.111
6	0.134	0.157	0.148	0.159	0.095	0.159	0.146
7	0.184	0.087		0.153			0.004
8	0.003	0.004		0.004			
9	0.004						
		Average wt% =	0.079		Standard Dev =	0.056	

Table C-6: Selected Elemental Species in CSSF 6 wt%

			Mercury (wt%)				
Vessel	WS6-154	WS6-155	WS6-156	WS6-157	WS6-158	WS6-159	WS6-160
Segment							
1	0.0000	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
2	0.0012	0.0012	0.0012	0.0012	0.0011	0.0010	0.0012
3	0.0007	0.0008	0.0009	0.0007	0.0009	0.0010	0.0008
4	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015	0.0015
5	0.0015	0.0013	0.0010	0.0015	0.0008	0.0009	0.0011
6	0.0009	0.0008	0.0009	0.0008	0.0009	0.0009	0.0008
7	0.0008	0.0009		0.0008			0.0013
8	0.0010	0.0013		0.0013			
9	0.0013						
		Average wt% =	0.0011		Standard Dev =	0.0003	
			Nickel (wt%)				
Vessel	WS6-154	WS6-155	WS6-156	WS6-157	WS6-158	WS6-159	WS6-160
Segment							
1	0.000	0.005	0.005	0.005	0.005	0.005	0.005
2	0.011	0.012	0.012	0.013	0.012	0.012	0.012
3	0.027	0.043	0.048	0.025	0.050	0.056	0.044
4	0.108	0.106	0.107	0.107	0.108	0.107	0.107
5	0.108	0.088	0.043	0.106	0.022	0.035	0.069
6	0.045	0.013	0.013	0.014	0.008	0.014	0.012
7	0.016	0.007		0.013			0.000
8	0.000	0.000		0.000			
9	0.000						
		Average wt% =	0.041		Standard Dev =	0.039	
			Nitrate (wt%)				
Vessel	WS6-154	WS6-155	WS6-156	WS6-157	WS6-158	WS6-159	WS6-160
Segment							
1	6	4	4	4	4	4	4
2	9	9	9	10	9	9	9
3	8	9	9	7	9	10	9
4	14	13	14	14	14	14	14
5	14	14	13	14	12	13	14
6	13	12	9	12	8	9	11
7	12	8		10			7
8	7	6		6			
9	6.1						
		Average wt% =	10		Standard Dev =	3	

Table C-6: Selected Elemental Species in CSSF 6 wt%							
			Oxide (wt%)				
Vessel	WS6-154	WS6-155	WS6-156	WS6-157	WS6-158	WS6-159	WS6-160
Segment							
1	24	26	26	25	26	26	26
2	25	24	24	24	24	23	24
3	26	28	28	26	29	30	28
4	33	33	33	33	33	33	33
5	33	33	33	33	34	33	32
6	33	34	35	34	35	35	35
7	35	35		35			37
8	33	37		37			
9	37						
		Average wt% =	31		Standard Dev =	4	
			Phosphate (wt%)				
Vessel	WS6-154	WS6-155	WS6-156	WS6-157	WS6-158	WS6-159	WS6-160
Segment							
1	0.00	0.08	0.08	0.09	0.08	0.08	0.08
2	0.20	0.20	0.20	0.22	0.20	0.21	0.20
3	0.16	0.14	0.13	0.16	0.12	0.11	0.13
4	0.01	0.01	0.01	0.01	0.01	0.01	0.01
5	0.01	0.12	0.16	0.04	0.26	0.16	0.18
6	0.22	0.26	0.25	0.27	0.16	0.27	0.24
7	0.31	0.15		0.26			0.01
8	0.01	0.01		0.01			
9	0.01						
		Average wt% =	0.14		Standard Dev =	0.10	
			Potassium (wt%)				
Vessel	WS6-154	WS6-155	WS6-156	WS6-157	WS6-158	WS6-159	WS6-160
Segment							
1	0.6	0.3	0.3	0.3	0.2	0.2	0.3
2	0.6	0.6	0.6	0.6	0.6	0.6	0.6
3	0.8	1.1	1.2	0.8	1.2	1.3	1.1
4	2.1	2.1	2.1	2.1	2.1	2.1	2.1
5	2.1	2.0	1.6	2.1	1.6	1.6	1.9
6	1.7	1.6	1.7	1.6	1.6	1.8	1.6
7	1.7	1.6		1.6			1.9
8	1.4	1.8		1.9			
9	1.9						
		Average wt% =	1.5		Standard Dev =	0.5	

Table C-6: Selected Elemental Species in CSSF 6 wt%

			Sodium (wt%)				
Vessel	WS6-154	WS6-155	WS6-156	WS6-157	WS6-158	WS6-159	WS6-160
Segment							
1	2.9	2.0	2.0	2.0	2.0	2.0	2.0
2	4.8	4.8	4.8	5.2	4.7	4.7	4.8
3	3.7	4.3	4.4	3.7	4.5	4.6	4.3
4	6.5	6.3	6.4	6.4	6.5	6.4	6.4
5	6.4	6.8	6.5	6.6	7.1	6.5	6.7
6	6.5	7.1	8.0	7.1	7.5	8.1	7.1
7	7.7	7.3		7.1			8.6
8	6.6	8.6		8.7			
9	8.6						
		Average wt% =	6.3		Standard Dev =	1.4	

			Strontium (wt%)				
Vessel	WS6-154	WS6-155	WS6-156	WS6-157	WS6-158	WS6-159	WS6-160
Segment							
1	0.200	0.065	0.065	0.066	0.065	0.064	0.065
2	0.117	0.101	0.101	0.117	0.094	0.089	0.101
3	0.017	0.014	0.014	0.017	0.013	0.012	0.014
4	0.004	0.004	0.004	0.004	0.004	0.004	0.004
5	0.004	0.006	0.016	0.004	0.021	0.017	0.010
6	0.014	0.025	0.020	0.023	0.018	0.020	0.024
7	0.025	0.017		0.019			0.015
8	0.016	0.015		0.015			
9	0.015						
		Average wt% =	0.028		Standard Dev =	0.034	

			Sulfate (wt%)				
Vessel	WS6-154	WS6-155	WS6-156	WS6-157	WS6-158	WS6-159	WS6-160
Segment							
1	0.65	0.77	0.77	0.78	0.76	0.76	0.77
2	1.87	1.98	1.98	2.12	2.00	2.03	1.98
3	1.25	1.20	1.20	1.20	1.15	1.11	1.20
4	1.19	1.17	1.18	1.18	1.19	1.19	1.18
5	1.19	1.15	0.78	1.20	0.72	0.71	1.04
6	0.87	0.65	0.65	0.65	0.49	0.68	0.62
7	0.74	0.46		0.64			0.28
8	0.22	0.28		0.29			
9	0.28						
		Average wt% =	1.1		Standard Dev =	0.5	

Table C-6: Selected Elemental Species in CSSF 6 wt%

			Tin (wt%)				
Vessel	WS6-154	WS6-155	WS6-156	WS6-157	WS6-158	WS6-159	WS6-160
Segment							
1	0.119	0.040	0.040	0.040	0.040	0.039	0.040
2	0.091	0.095	0.095	0.107	0.098	0.102	0.095
3	0.059	0.050	0.047	0.056	0.043	0.036	0.050
4	0.013	0.013	0.013	0.013	0.013	0.013	0.013
5	0.013	0.011	0.010	0.013	0.008	0.010	0.008
6	0.007	0.008	0.011	0.008	0.013	0.011	0.009
7	0.008	0.013		0.009			0.021
8	0.016	0.021		0.022			
9	0.022						
		Average wt% =	0.032		Standard Dev =	0.032	
			Uranium (wt%)				
Vessel	WS6-154	WS6-155	WS6-156	WS6-157	WS6-158	WS6-159	WS6-160
Segment							
1	0.000	0.008	0.008	0.008	0.008	0.008	0.008
2	0.020	0.020	0.020	0.021	0.019	0.018	0.020
3	0.013	0.018	0.020	0.013	0.021	0.023	0.019
4	0.042	0.041	0.042	0.041	0.042	0.042	0.041
5	0.042	0.037	0.025	0.042	0.020	0.023	0.031
6	0.025	0.018	0.020	0.018	0.019	0.021	0.018
7	0.020	0.019		0.018			0.022
8	0.017	0.022		0.023			
9	0.022						
		Average wt% =	0.025		Standard Dev =	0.009	
			Zirconium (wt%)				
Vessel	WS6-154	WS6-155	WS6-156	WS6-157	WS6-158	WS6-159	WS6-160
Segment	2	3	4	5	6	7	8
1	7.5	2.5	2.5	2.6	2.5	2.5	2.5
2	5.7	6.0	6.0	6.7	6.2	6.5	6.0
3	3.7	3.2	3.0	3.5	2.7	2.3	3.1
4	0.8	0.8	0.8	0.8	0.8	0.8	0.8
5	0.8	0.7	0.6	0.8	0.5	0.6	0.5
6	0.5	0.5	0.7	0.5	0.8	0.7	0.6
7	0.5	0.8		0.5			1.4
8	1.0	1.4		1.4			
9	1.4						
		Average wt% =	2.0		Standard Dev =	2.0	

Table C-6: Selected Radionuclides CSSF 6 Ci/m^3

			Antimony-126				
Vessel	WS6-154	WS6-155	WS6-156	WS6-157	WS6-158	WS6-159	WS6-160
Segment							
1	0.0000	0.0013	0.0013	0.0014	0.0013	0.0013	0.0013
2	0.0029	0.0032	0.0032	0.0032	0.0033	0.0032	0.0032
3	0.0016	0.0015	0.0015	0.0015	0.0014	0.0014	0.0015
4	0.0019	0.0018	0.0019	0.0019	0.0018	0.0019	0.0018
5	0.0019	0.0014	0.0009	0.0017	0.0006	0.0008	0.0011
6	0.0008	0.0005	0.0004	0.0005	0.0004	0.0004	0.0005
7	0.0005	0.0004		0.0004			0.0004
8	0.0004	0.0004		0.0004			
9	0.0004						
		Average Ci/m^3 =	0.0014		Standard Dev =	0.0010	
			Antimony-126m				
Vessel	WS6-154	WS6-155	WS6-156	WS6-157	WS6-158	WS6-159	WS6-160
Segment							
1	0.0000	0.0096	0.0096	0.0099	0.0095	0.0094	0.0096
2	0.0210	0.0231	0.0231	0.0230	0.0232	0.0232	0.0231
3	0.0116	0.0107	0.0109	0.0110	0.0103	0.0101	0.0108
4	0.0136	0.0128	0.0134	0.0134	0.0131	0.0136	0.0130
5	0.0135	0.0103	0.0062	0.0124	0.0041	0.0055	0.0082
6	0.0056	0.0036	0.0030	0.0035	0.0027	0.0029	0.0032
7	0.0035	0.0026		0.0026			0.0031
8	0.0029	0.0029		0.0030			
9	0.0029						
		Average Ci/m^3 =	0.010		Standard Dev =	0.007	
			Barium-137m				
Vessel	WS6-154	WS6-155	WS6-156	WS6-157	WS6-158	WS6-159	WS6-160
Segment							
1	0	759	759	778	750	743	759
2	1633	1834	1833	1841	1879	1917	1834
3	1173	1093	1091	1107	1029	977	1094
4	1172	1102	1157	1150	1130	1166	1117
5	1164	888	531	1068	356	470	704
6	485	306	261	303	228	252	279
7	298	222		224			270
8	248	251		256			
9	253						
		Average Ci/m^3 =	880		Standard Dev =	560	

Table C-6: Selected Radionuclides CSSF 6 Ci/m^3

			Cesium-137				
Vessel	WS6-154	WS6-155	WS6-156	WS6-157	WS6-158	WS6-159	WS6-160
Segment							
1	0	802	802	822	793	785	802
2	1726	1938	1937	1946	1986	2026	1938
3	1240	1155	1153	1170	1087	1033	1156
4	1239	1164	1223	1216	1194	1232	1181
5	1231	939	562	1129	377	497	745
6	512	324	275	321	241	267	295
7	315	235		237			286
8	262	265		270			
9	267						
		Average Ci/m^3 =	930		Standard Dev =	600	
			Nickel-63				
Vessel	WS6-154	WS6-155	WS6-156	WS6-157	WS6-158	WS6-159	WS6-160
Segment							
1	0.00	0.26	0.26	0.27	0.26	0.26	0.26
2	0.51	0.67	0.67	0.71	0.78	0.90	0.67
3	1.13	1.11	1.09	1.05	1.03	0.95	1.11
4	0.95	0.89	0.94	0.93	0.92	0.95	0.91
5	0.95	0.72	0.43	0.87	0.29	0.38	0.57
6	0.39	0.25	0.21	0.25	0.19	0.20	0.23
7	0.24	0.18		0.18			0.22
8	0.20	0.20		0.21			
9	0.21						
		Average Ci/m^3 =	0.61		Standard Dev =	0.34	
			Protactinium-233				
Vessel	WS6-154	WS6-155	WS6-156	WS6-157	WS6-158	WS6-159	WS6-160
Segment							
1	0.0000	0.0026	0.0026	0.0027	0.0026	0.0025	0.0026
2	0.0051	0.0056	0.0056	0.0058	0.0057	0.0058	0.0056
3	0.0189	0.0328	0.0375	0.0177	0.0390	0.0440	0.0336
4	0.0972	0.0914	0.0960	0.0954	0.0937	0.0967	0.0927
5	0.0966	0.0737	0.0441	0.0886	0.0295	0.0390	0.0584
6	0.0402	0.0254	0.0216	0.0252	0.0189	0.0209	0.0231
7	0.0247	0.0185		0.0186			0.0224
8	0.0206	0.0208		0.0212			
9	0.0210						
		Average Ci/m^3 =	0.040		Standard Dev =	0.032	

Table C-6: Selected Radionuclides CSSF 6 Ci/m^3

			Strontium-90				
Vessel	WS6-154	WS6-155	WS6-156	WS6-157	WS6-158	WS6-159	WS6-160
Segment							
1	0	792	792	812	783	776	792
2	1708	1915	1914	1921	1959	1995	1915
3	1152	1025	1010	1087	942	874	1024
4	927	872	915	910	894	923	884
5	921	704	437	846	304	392	560
6	393	270	233	267	209	225	247
7	260	204		198			256
8	235	238		242			
9	240						
		Average Ci/m^3 =	810		Standard Dev =	580	
			Technetium-99				
Vessel	WS6-154	WS6-155	WS6-156	WS6-157	WS6-158	WS6-159	WS6-160
Segment							
1	0.00	0.37	0.37	0.37	0.36	0.36	0.37
2	0.80	0.88	0.88	0.88	0.88	0.88	0.88
3	0.41	0.35	0.35	0.39	0.32	0.30	0.35
4	0.33	0.31	0.33	0.33	0.32	0.33	0.32
5	0.33	0.25	0.15	0.30	0.10	0.13	0.20
6	0.14	0.09	0.07	0.09	0.06	0.07	0.08
7	0.08	0.06		0.06			0.08
8	0.07	0.07		0.07			
9	0.07						
		Average Ci/m^3 =	0.31		Standard Dev =	0.27	
			Yttrium-90				
Vessel	WS6-154	WS6-155	WS6-156	WS6-157	WS6-158	WS6-159	WS6-160
Segment							
1	0	792	792	812	783	776	792
2	1708	1915	1914	1921	1959	1995	1915
3	1152	1025	1010	1087	942	874	1024
4	927	872	915	910	894	923	884
5	921	704	437	846	304	392	560
6	393	270	233	267	209	225	247
7	260	204		198			256
8	235	238		242			
9	240						
		Average Ci/m^3 =	810		Standard Dev =	580	

Table C-6: Selected Radionuclides CSSF 6 nano-Ci/g

			Americium-241				
Vessel	WS6-154	WS6-155	WS6-156	WS6-157	WS6-158	WS6-159	WS6-160
Segment							
1	0	1098	1098	1117	1090	1083	1098
2	2752	2924	2925	3087	2939	2959	2924
3	1495	1331	1317	1423	1238	1154	1329
4	1163	1139	1150	1145	1161	1153	1145
5	1156	952	564	1134	357	497	746
6	529	294	351	294	359	352	304
7	313	352		300			484
8	370	483		489			
9	485						
		Average nCi/g =	1100		Standard Dev =	900	
			Neptunium-237				
Vessel	WS6-154	WS6-155	WS6-156	WS6-157	WS6-158	WS6-159	WS6-160
Segment							
1	0	3	3	4	3	3	3
2	9	9	9	9	8	8	9
3	12	21	25	11	26	30	22
4	64	63	64	63	64	64	63
5	64	50	28	62	14	24	37
6	24	10	14	10	16	13	11
7	10	16		11			27
8	20	27		27			
9	27						
		Average nCi/g =	28		Standard Dev =	20	
			Plutonium-238				
Vessel	WS6-154	WS6-155	WS6-156	WS6-157	WS6-158	WS6-159	WS6-160
Segment							
1	0	6488	6488	6596	6439	6395	6488
2	15820	17539	17543	18740	18240	19041	17539
3	12105	10779	10507	11448	9802	8880	10739
4	7477	7320	7396	7359	7462	7416	7362
5	7429	6089	3583	7288	2220	3151	4746
6	3338	1816	2186	1811	2265	2186	1887
7	1927	2222		1857			3113
8	2379	3104		3146			
9	3121						
		Average nCi/g =	7500		Standard Dev =	5500	

Table C-6: Selected Radionuclides CSSF 6 nano-Ci/g							
			Plutonium-239				
Vessel	WS6-154	WS6-155	WS6-156	WS6-157	WS6-158	WS6-159	WS6-160
Segment							
1	0	463	463	471	460	457	463
2	1197	1208	1207	1255	1160	1108	1208
3	463	547	600	445	603	651	555
4	1190	1165	1177	1171	1188	1181	1172
5	1183	950	543	1156	307	474	724
6	493	243	305	242	333	301	258
7	253	329		251			495
8	379	494		501			
9	497						
		Average wt% =	720		Standard Dev =	380	
			Plutonium-240				
Vessel	WS6-154	WS6-155	WS6-156	WS6-157	WS6-158	WS6-159	WS6-160
Segment							
1	0	75	75	76	74	74	75
2	177	204	204	220	218	234	204
3	195	197	199	184	191	184	197
4	222	217	220	218	222	220	219
5	221	181	106	216	66	93	141
6	99	54	65	53	67	64	56
7	57	66		55			92
8	71	92		93			
9	93						
		Average nCi/g =	150		Standard Dev =	70	
			Plutonium-241				
Vessel	WS6-154	WS6-155	WS6-156	WS6-157	WS6-158	WS6-159	WS6-160
Segment							
1	0	1924	1924	1957	1910	1896	1924
2	4473	5312	5314	5789	5814	6379	5312
3	5283	4809	4667	4971	4356	3912	4788
4	3076	3012	3043	3028	3070	3051	3029
5	3057	2552	1540	3008	1026	1365	2030
6	1468	860	1006	859	999	1014	880
7	925	976		874			1281
8	979	1277		1294			
9	1284						
		Average nCi/g =	2900		Standard Dev =	1800	

Table C-6: Selected Radionuclides CSSF 6 nano-Ci/g							
			Protactinium-233				
Vessel	WS6-154	WS6-155	WS6-156	WS6-157	WS6-158	WS6-159	WS6-160
Segment							
1	0	2	2	2	2	2	2
2	6	6	6	6	6	6	6
3	14	24	27	13	28	32	24
4	64	63	64	63	64	64	63
5	64	53	31	63	20	28	42
6	30	17	20	17	20	20	17
7	18	20		17			27
8	20	27		27			
9	27						
		Average nCi/g =	30		Standard Dev =	20	
			Thorium-231				
Vessel	WS6-154	WS6-155	WS6-156	WS6-157	WS6-158	WS6-159	WS6-160
Segment							
1	0.000	0.043	0.043	0.043	0.042	0.042	0.043
2	0.102	0.111	0.111	0.119	0.115	0.119	0.111
3	0.151	0.209	0.230	0.143	0.234	0.253	0.212
4	0.460	0.450	0.455	0.453	0.459	0.456	0.453
5	0.457	0.378	0.225	0.449	0.144	0.198	0.297
6	0.212	0.119	0.141	0.119	0.144	0.142	0.123
7	0.127	0.141		0.122			0.192
8	0.146	0.191		0.194			
9	0.192						
		Average nCi/g =	0.23		Standard Dev =	0.13	