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# THE SORT OF RADIOACTIVE WASTE TYPE MODEL: A METHOD TO SORT SINGLE-SHELL TANKS INTO CHARACTERISTIC GROUPS

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# The Sort On Radioactive Waste Type Model: A Method to Sort Single-Shell Tanks into Characteristic Groups

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## ABSTRACT

The Sort on Radioactive Waste Type (SORWT) Model is a method to categorize Hanford Site single-shell tanks (SSTs) into groups of tanks expected to exhibit similar chemical and physical characteristics based on their major waste types and processing histories. The model has identified 24 different waste-type groups encompassing 133 of the 149 SSTs and 93% of the total waste volume in SSTs. The remaining 16 SSTs and associated wastes could not be grouped according to the established criteria and were placed in an ungrouped category. A detailed statistical verification study has been conducted that employs analysis of variance (ANOVA) and the core sample analysis data collected since 1989. These data cover eight tanks and five SORWT groups. The verification study showed that these five SORWT groups are highly statistically significant; they represent approximately 10% of the total waste volume and 26% of the total sludge volume in SSTs. Future sampling recommendations based on the SORWT Model results include 32 core samples from 16 tanks and 18 auger samples from six tanks. Combining these data with the existing body of information will form the basis for characterizing 98 SSTs (66%). These 98 SSTs represent 78% of the total waste volume, 61% of the total sludge volume, and 88% of the salt cake volume.

## INTRODUCTION

Between 1943 and 1964, 149 SSTs were constructed to store liquid and solid radioactive wastes generated during the production of plutonium at the Hanford Site. Over 36 million gallons of wastes are currently stored in SSTs. Before the last tanks were removed from active service in November 1980, various waste volume reduction programs were undertaken to minimize the amount of occupied tank volume. These programs involved intertank transfers, evaporation, and chemical alterations of the waste. These actions, combined with the ongoing chemical and radiolytic in-tank processes, have changed the character of the waste in the SSTs over time. Characterization of these wastes is currently a top priority to alleviate safety concerns and to support the development of retrieval, pretreatment, and disposal systems for the tank wastes.

The wastes in the SSTs originated from a limited number of chemical processes and waste solidification schemes. However, because of the complex physical and chemical history of the tank waste, especially when several different waste types were mixed or processed together, the model does not attempt to predict the precise composition of a tank. Instead, the sorting method concentrates on the different types of waste introduced into each SST, each waste's distinct contribution to the known properties, the individual significance of each waste type, and the process history of each tank. Although the actual chemical reactions and phase equilibria may be unknown when two waste types are combined in an SST, it can be assumed that similar reactions and equilibria occur in other SSTs when the same two waste types are mixed. Therefore, tanks that received the same waste types in the same approximate proportion and had a similar processing history will be more similar to one another than SSTs that received several different waste types in varying amounts and had a relatively unique process history. This forms the basis of the SORWT Model. Validation of the SORWT Model indicates that a limited number of tanks (representatives of their corresponding SORWT groups) could provide sufficient information to begin developing pretreatment and disposal systems, assuming the selected tanks provide an accurate representation of the conditions within the SSTs.

## DATA SOURCES FOR THE SORWT MODEL

The principal source of information used by this model is *A History of the 200 Area Tank Farms*.(1) This document contains much of the available processing history for each of the 149 SSTs from 1944 until 1980. However, the historical records used to generate *A History of the 200 Area Tank Farms* were often inaccurate and/or incomplete. The methods used to measure accumulated solid and liquid volumes during the early history of the Hanford Site produced inconsistent inventories. Indeed, solids inventories were not routinely taken until the mid-1950s, and tank transfer information was often missing. Despite these inconsistencies, it is still one of the best sources of SST historical information, and it is believed a qualitative assessment of the principle solids-forming waste types contained in each SST can be accurately determined from this information.

The volume of waste contained in each SST was obtained from the *Tank Farm Surveillance and Waste Status Summary Report*.(2) These values include, on a per-tank-basis, total waste volume, volume of salt cake, volume of sludge, and volume of supernatant liquid. It is assumed that these values are more accurate than those final values found in *A History of the 200 Area Tank Farms* because they were obtained more recently; however, it is understood that these values have deficiencies because of the limited access to the tanks.

## SORWT MODEL ASSUMPTIONS

The underlying assumptions used by the SORWT Model are as follows:

- The information contained within *A History of the 200 Area Tank Farms* is sufficient to qualitatively identify and rank, relative to one another, the waste types that contributed to the accumulated solids in each SST.

- Primary solids-forming and secondary solids-forming waste types were responsible for the majority of the physical characteristics and chemical compositions of the waste remaining in each SST.

- Supernatant wastes that were not allowed to remain in a tank for a long period of time and were later pumped out of the SST had less influence on the physical and chemical character of the waste than did the insoluble solid waste types that remained in the tank.

- Tanks were often sluiced at some time during their processing history. Sluicing involves removing solids from waste tanks using high-pressure water jets. Waste types present in the tank prior to the most recent sluicing were not considered relevant by this model.

- Using a broad-ranging, less descriptive waste type such as noncomplexed waste (NCPLX), complex concentrate (CCPLX), evaporator feed (EVAP), and/or double-shell slurry feed (DSSF) was avoided whenever possible. Process-specific nomenclature was preferred, if available; however, a broad category identifying the tank waste as either noncomplexed, complexed, or ferrocyanide-scavenged waste has been included in the SORWT Model to aid in evaluating the results of the model.

## SUMMARY OF SORWT MODEL RESULTS

The SORWT Model has predicted the existence of 24 groups ranging from a high of 22 tanks per group to a low of two tanks per group. These 24 groups encompass 133 tanks and 93% of the total waste volume. An additional group contains the 16 SSTs which could not be grouped with any other tanks based on their primary and secondary waste types. Table I presents a summary of the SST groups predicted by the SORWT Model.

A review of Table I quickly reveals that Group I is by far the most significant group. This group includes 22 tanks, 37% of the total salt cake volume, and over one quarter of the total waste in all 149 SSTs.

Table I
Summary of SORWT Model Results

| Group Number | Primary and Secondary Waste-Type Groups[a] | | Number of Tanks in Group | Total Saltcake Volume | Total Sludge Volume | Total Supernate Volume | Total Interstitial Liquid Volume | Total Waste Volume |
|---|---|---|---|---|---|---|---|---|
| I | R | EB | 22 | 37% | 12% | 21% | 42% | 28% |
| II | EB | 1C | 10 | 20% | 0% | 0% | 3% | 13% |
| III | TBP-F | EB-ITS | 10 | 14% | 5% | 0% | 11% | 11% |
| IV | R | | 10 | 0% | 10% | 1% | 1% | 3% |
| V | TBP | CW | 9 | 0% | 5% | 5% | 1% | 2% |
| VI | EB | CW | 8 | 8% | 3% | 20% | 11% | 6% |
| VII | 224 | | 8 | 0% | 2% | 1% | 0% | 1% |
| VIII | 1C | EB | 6 | 1% | 6% | 0% | 1% | 3% |
| IX | EB | R | 5 | 8% | 1% | 8% | 8% | 6% |
| X | 1C | CW | 5 | 0% | 6% | 2% | 1% | 2% |
| XI | DSSF | NCPLX | 4 | 7% | 3% | 2% | 12% | 6% |
| XII | 1C | TBP | 4 | 0% | 6% | 0% | 1% | 2% |
| XIII | TBP-F | 1C | 4 | 0% | 2% | 1% | 1% | 1% |
| XIV | HS | | 4 | 0% | 0% | 0% | 0% | 0% |
| XV | 2C | 224 | 3 | 0% | 7% | 2% | 1% | 2% |
| XVI | 2C | 5-6 | 3 | 0% | 4% | 1% | 1% | 1% |
| XVII | CW | MIX | 3 | 0% | 1% | 3% | 0% | 0% |
| XVIII | CW | | 3 | 0% | 0% | 1% | 0% | 0% |
| XIX | TBP | EB-ITS | 2 | 3% | 1% | 0% | 2% | 2% |
| XX | SRS | SR-Wash | 2 | 0% | 2% | 29% | 0% | 1% |
| XXI | TBP | EB | 2 | 0% | 2% | 0% | 0% | 1% |
| XXII | TBP | 1C-F | 2 | 0% | 2% | 1% | 0% | 1% |
| XXIII | CCPLX | DSSF | 2 | 1% | 0% | 1% | 1% | 0% |
| XXIV | R | DIA | 2 | 0% | 1% | 0% | 0% | 0% |
| | Total | | 133 | 99% | 82% | 98% | 97% | 93% |
| XXV | Ungrouped Tanks | | 16 | 1% | 18% | 2% | 3% | 7% |

(a) Waste types are based on process history. Definitions of waste types can be found in Ref. 3.

The first three groups represent over one-half of the total waste volume in all 149 SSTs. This categorization demonstrates the potential usefulness of the SORWT Model in making management decisions. Table I also identifies groups that have relatively no significance, such as Groups XIV and XVIII, which contain almost no waste. This information can be used in allocating time and resources for characterization activities, pretreatment, and immobilization development.

Larger families of related tank groups may exist. Examples of potential families are Group I (R, EB) and Group IX (EB, R). The relative differences between these two groups are due to their respective designation of which of the two waste types is primary and secondary. These differences may be small when compared with the overall group variability. Identifying larger families of tanks will reduce the overall number of different groups being evaluated and the corresponding number of sampling and analysis events. The existence of families will be tested and reported at a later time.

## STATISTICAL VERIFICATION OF THE SORWT MODEL

### Approach to Verification of the SORWT Model

First, the analytical results were arranged into groups as predicted by the SORWT Model, then an ANOVA was performed on the grouped data for a selected number of analytes. An ANOVA is a quantitative method to test the significance of the effect a particular treatment has on the response or dependent variable. In the SORWT Model verification study, the treatment being studied is SORWT groups, and the dependent variable is analyte concentration. The ANOVA method was used to test whether the mean concentration of a particular SORWT group is statistically significantly different from the mean concentration of other SORWT groups. The null hypothesis tested by this statistical model was as follows:

> The deviations between the means of the different groups were due only to random variation within the entire data set.

If the null hypothesis was proved valid, then no group effects were present, and the SORWT Model would be discredited. However, if the null hypothesis was proved incorrect, then the converse would be true (i.e., group effects are present and the SORWT Model methodology is supported by the data). If significant group effects were observed, a Tukey pairwise comparison was conducted to investigate the groups that differed significantly from one another.

### Analytical Data Sources for the Verification Study

The analytical results data used in the SORWT Model verification study were obtained from the official core sample data packages produced by the Hanford analytical laboratories in support of the Westinghouse Hanford Company Tank Waste Characterization Program. The SSTs and SORWT groups that were used in the verification study are presented in Table II.

Table II
SORWT Groups and Tanks Included in Verification Study

| Group No. | Tank No. | Primary Waste Type | Secondary Waste Type |
|---|---|---|---|
| VII | B-201<br>B-202 | 224 | |
| IV | S-104 | R | |
| XII | C-110<br>BX-107 | 1C | TBP |
| XV | T-111 | 2C | 224 |
| XVI | B-110<br>B-111 | 2C | 5-6 |

The core sample data packages contain a great deal of analytical data measured using several alternative digestion methods and analytical instrumentation. These measurements were often taken both on segment level aliquots and on core composites, which represent the nominal or average composition of an entire core. Because the SORWT Model verification study compares the differences between the mean nominal compositions of one group and the mean nominal composition of other groups, only core composite data for the analytes that significantly contribute to the overall character of the waste were considered. The analytes included in the verification study, along with the sample preparation method and analytical instrumentation, are presented in Table III.

Table III
Analytes, Sample Preparation, and Analytical Method Used in the SORWT Model Verification Study

| Analyte | Sample Digestion Method | Analytical Method |
|---|---|---|
| Al | Fusion Dissolution | ICP/AES |
| Bi | Fusion Dissolution | ICP/AES |
| Cr | Fusion Dissolution | ICP/AES |
| Fe | Fusion Dissolution | ICP/AES |
| La | Fusion Dissolution | ICP/AES |
| Mn | Fusion Dissolution | ICP/AES |
| Na | Fusion Dissolution | ICP/AES |
| Pb | Fusion Dissolution | ICP/AES |
| Si | Fusion Dissolution | ICP/AES |
| Zr | Fusion Dissolution | ICP/AES |
| U | Fusion Dissolution | Laser Fluorimetry |
| $PO_4$ | Water Digestion | Ion Chromatography |
| $NO_3$ | Water Digestion | Ion Chromatography |
| $NO_2$ | Water Digestion | Ion Chromatography |
| F | Water Digestion | Ion Chromatography |
| Cl | Water Digestion | Ion Chromatography |
| TOC | Water Digestion | Furnace Combustion |
| | Direct Sample | Persulfate Oxidation |
| $^{137}Cs$ | Fusion Dissolution | Gamma Energy Analysis (GEA) |
| $^{90}Sr$ | Fusion Dissolution | Chemical Separations and Beta Counting |
| $^{239/240}Pu$ | Fusion Dissolution | Alpha Energy Analysis |

## Graphical Description of the Verification Data Set

The data set used in the SORWT Model verification study consists of 109 separate cases with 22 total measurements per case for a total of 2,398 pieces of information. This is a rather large amount of information to comprehend and only a small subset of the total data available. A useful tool for summarizing and understanding large data sets is a box plot, which is a graphical representation of the spread or variance in a given data set. Figure I is an example box plot for sodium (Na).

The example box plot shows the spread in the Na data for the five different SORWT groups to be tested in the verification study. The vertical axis is Na concentration presented in units of $\mu g/g$. The horizontal axis represents the five different SORWT groups. The spread in the data is depicted by a box and whiskers plot. The median of a set of data is marked by a horizontal line in the box. The lower and upper hinges are the edges of the central box. The median splits the ordered set of data in half such that 50% of the values are above the median and 50% of the numbers are below. The hinges split the remaining halves in half again such that the interior of the box represents 50% of the data. If we define the hinge spread as the absolute value of the difference between the two values of the upper and lower hinges, the whiskers show the range in values that fall within 1.5 hinge spreads of the hinges. Any data farther than 1.5 hinge spreads from the hinges are outliers and plotted as asterisks (*). Values that are more than three hinge spreads away from the hinges are considered far outliers and plotted as open circles. Examples of both of these outliers can be seen in Figure I.

As can be clearly seen in the figure, the median value and range of values for Na in some of the SORWT groups are substantially different from other SORWT groups. It is also clear that not all groups are necessarily different from one another. It appears that Groups XII and XVI show comparable Na concentrations and that Groups VII and XV are indistinguishable from one another. However, the spread of values from Groups XII and XVI does not approach the spread of values in Groups VII and XV. Group IV appears to be different from all the other groups presented.

Similar box plots were generated for each analyte included in the SORWT Model verification study and are included in *The Sort On Radioactive Waste Type Model: A Method to Sort Single-Shell Tanks into Characteristic Groups*.(3)

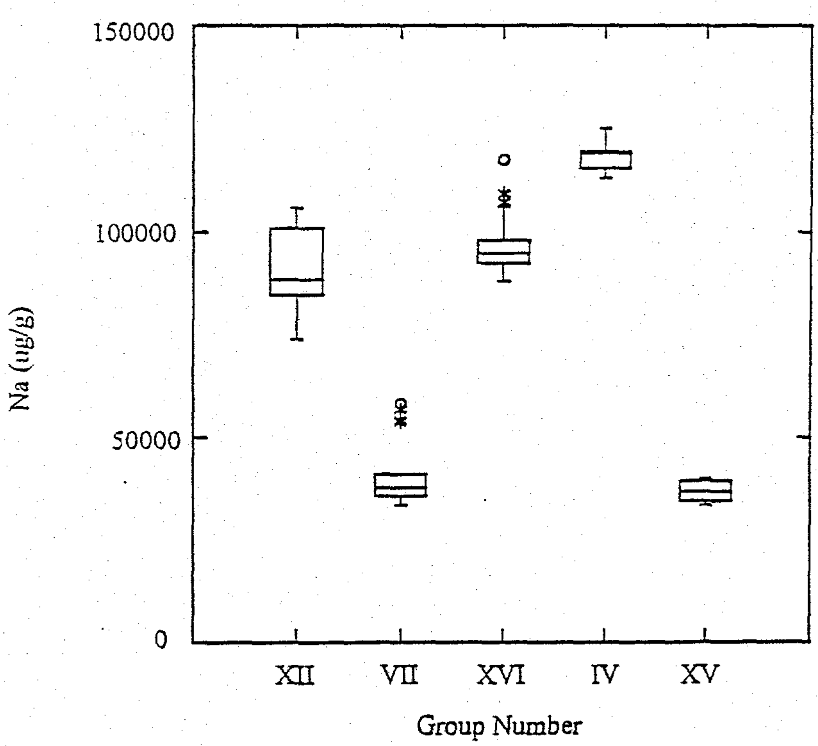


Fig. 1. Box Plot of Sodium Concentration by SORWT Group

Analysis of Variance (ANOVA) of SORWT Groups

The ANOVA performed for each analyte included in the SORWT Model verification study used the general linear model of the SYSTAT for Windows[a] statistical data analysis software package. If a significant grouping effect was observed, then a Tukey pairwise comparison was also conducted for each analyte to determine which groups were significantly different from the others. The output reports generated by the statistical software for each analyte are presented in *The Sort On Radioactive Waste Type Model: A Method to Sort Single-Shell Tanks into Characteristic Groups*.(3)

The ANOVA provides two estimates for the variance, one between groups and one within groups. If the null hypothesis (i.e., no differences among SORWT groups) is accurate, then the estimate for the between-group variance should be similar in magnitude to the within-group estimate of the variance. Conversely, if the between-group estimate of the variance is significantly greater than the within-group estimate, the null hypothesis would be untenable, and some of the between-group variation must be caused by real differences between treatment groups.

A summary of the ANOVA results for each of the analytes tested is presented in Table IV. The F-Ratio is defined as the ratio of the between-treatment variance (mean sum of the squares) and the within-treatment variance. This ratio should follow an F distribution for the appropriate numbers of degrees of freedom. The significance of the F-Ratio is called a P-value and can be determined from the relevant F distribution. The significance is the fractional probability of the F-Test ratio occurring only by random chance. The benchmark probabilities typically used to test the significance of differences between means are 5% and 1%, which correspond to significances of 0.05 and 0.01. For the purposes of the SORWT Model verification study, the 5% benchmark was selected. If the significance is greater than the benchmarks, then the differences between treatment means can be explained by random chance. If the significances are below the benchmarks, then the discrepancies between treatment means cannot be explained by random chance, and real differences exist between the subject groups.

As shown in Table IV, all 22 analytes and measurements listed have a significance well below the benchmark 5% level. In fact, all but two analytes have a significance below 0.1%. Table IV indicates there is virtually no probability that the differences between the means of the SORWT groups are due only to random chance. Therefore, the null hypothesis is invalid, and the data strongly support the premise that SORWT groups exist.

Because a significant grouping effect was observed, a Tukey pairwise comparison was performed to identify the groups that were significantly different from one another. The Tukey pairwise comparison first generates a matrix of pairwise mean differences. These are the differences between the mean concentration of a pair of groups. The routine then compares this difference to the mean square error for the analyte calculated from the ANOVA table and calculates a P-value (probability) that the difference between the mean concentration of any two groups is due to random chance.

(a) SYSTAT for Windows is a registered trademark of SYSTAT, Inc.

Table IV
Summary of ANOVA for SORWT Verification Study

| Analyte | F-Test Ratio | Significance (p-value) | Group VII Mean (μg/g) | Group IV Mean (μg/g) | Group XII Mean (μg/g) | Group XV Mean (μg/g) | Group XVI Mean (μg/g) |
|---|---|---|---|---|---|---|---|
| Al | 5514.85 | 0.000 | 3490 | 117000 | 14323 | 570 | 1425 |
| Bi | 45.15 | 0.000 | 61753 | 39 | 17356 | 23563 | 19354 |
| Cr | 199.78 | 0.000 | 2835 | 2353 | 685 | 1799 | 854 |
| Fe | 75.35 | 0.000 | 10156 | 1424 | 10812 | 18038 | 17486 |
| La | 2284.41 | 0.000 | 13592 | 9 | 8 | 4108 | 74 |
| Mn | 64.67 | 0.000 | 14508 | 1150 | 58 | 6283 | 97 |
| Na | 385.20 | 0.000 | 41364 | 118250 | 91133 | 36950 | 96359 |
| Pb | 15.11 | 0.000 | 1125 | 39 | 181 | 365 | 750 |
| Si | 5.58 | 0.000 | 15648 | 1326 | 6933 | 5565 | 10173 |
| Zr | 3.76 | 0.007 | 29 | 21 | 153 | 4 | 134 |
| U | 11.95 | 0.000 | 414 | 6685 | 4249 | 2555 | 209 |
| $PO_4$ | 59.63 | 0.000 | 1706 | 1310 | 22256 | 15538 | 24555 |
| $NO_3$ | 47.38 | 0.000 | 56589 | 186300 | 121261 | 41238 | 145000 |
| $NO_2$ | 21.38 | 0.000 | 719 | 25730 | 7638 | 897 | 22910 |
| F | 206.39 | 0.000 | 6134 | 132 | 8261 | 2301 | 1761 |
| Cl | 106.63 | 0.000 | 1225 | 3162 | 1116 | 450 | 1153 |
| TOC | 5.38 | 0.001 | NA | 1606 | 739 | 3119 | 634 |
| | | | (μCi/g) | (μCi/g) | (μCi/g) | (μCi/g) | (μCi/g) |
| $^{137}Cs$ | 7.34 | 0.000 | 0.403 | 62.308 | 18.533 | 0.166 | 40.638 |
| $^{90}Sr$ | 64.54 | 0.000 | 60.423 | 309.583 | 7.188 | 5.414 | 133.436 |
| $^{239/240}Pu$ | 13.92 | 0.000 | 0.606 | 0.282 | 0.07 | 0.139 | 0.107 |
| | | | (g/ml) | (g/ml) | (g/ml) | (g/ml) | (g/ml) |
| Density | 13.89 | 0.000 | 1.171 | 1.64 | 1.286 | 1.235 | 1.271 |
| pH | 84.88 | 0.000 | NA | 12.803 | 10.631 | 11.65 | **8.221** |

Table V presents a summary of the Tukey pairwise comparisons. The analytes that vary significantly between groups and the total number of significantly different analytes are listed. As shown in Table V, 18 out of 20 analytes were significantly different in Group IV than in Group VII. The smallest number of analyte differences between groups was eight between Groups XVI and XII. More than half the analytes considered in this study were significantly different for 7 of the 10 pairwise comparisons. This is another strong indication that the grouping methodology used by the SORWT Model predicts real differences between the characteristics of tank groups. Density and pH were not included in these Tukey summary tables.

Table V
Analytes Showing Significant Concentration Differences Between Groups

| Group No. | VII | IV | XII | XV |
|---|---|---|---|---|
| IV | Al, Bi, Cr, Fe, La, Mn, Na, Pb, Si, $^{137}Cs$, $^{90}Sr$, $^{239/240}Pu$, U, $NO_3$, $NO_2$, F, Cl, TOC Total: 18 | | | |
| XII | Al, Bi, Cr, La, Mn, Na, Pb, Si, $^{239/240}Pu$, U, $PO_4$, $NO_3$, F, TOC Total: 14 | Al, Bi, Cr, Fe, Na, $^{137}Cs$, $^{90}Sr$, $PO_4$, $NO_3$, $NO_2$, F, Cl Total: 12 | | |
| XV | Bi, Cr, Fe, La, Mn, Pb, $^{239/240}Pu$, $PO_4$, F, Cl Total: 10 | Al, Bi, Cr, Fe, La, Mn, Na, $^{137}Cs$, $^{90}Sr$, $PO_4$, $NO_3$, $NO_2$, F, Cl Total: 14 | Al, Cr, Fe, La, Mn, Na, $NO_3$, F, Cl Total: 9 | |
| XVI | Al, Bi, Cr, Fe, La, Mn, Na, Pb, $^{137}Cs$, $^{239/240}Pu$, $PO_4$, $NO_3$, $NO_2$, F, TOC Total: 15 | Al, Bi, Cr, Fe, Na, Pb, Si, $^{90}Sr$, U, $PO_4$, $NO_3$, F, Cl Total: 13 | Al, Fe, Na, Pb, $^{90}Sr$, U, $NO_2$, F Total: 8 | Cr, La, Mn, Na, $^{90}Sr$, $PO_4$, $NO_3$, $NO_2$, Cl Total: 9 |

## RECOMMENDED TANK WASTE SAMPLING

Tanks recommended for sampling based on the results of the SORWT Model are listed in Tables VI and VII. The list takes advantage of the SORWT Model groups to establish a substantial amount of characterization information from a relatively small number of core and auger samples. Thirty-two core samples and 18 auger samples are recommended. If this new sampling and analysis information is combined with the existing data, nominal compositions of 98 tanks (66% of the SSTs) could be established. This would represent approximately 78% of the total waste volume, 61% of the total sludge volume, and 88% of the salt cake volume.

## ADDITIONAL INFORMATION

Information included in *The Sort On Radioactive Waste Type Model: A Method to Sort Single-Shell Tanks into Characteristic Groups* (3) but not presented in this report includes the following:

- Descriptions of waste types used in the SORWT Model. The waste types are general categories based on process history rather than chemical or physical properties.

- Descriptions of the 24 groups predicted by the SORWT Model. A brief history of the tanks included in each group and general comments about similarities between them.

Table VI
List of Recommended Core Samples

| Tank No. | SORWT Group | No. of Core Samples | Watch-List Status | Total Waste Volume in Tank (kgal) |
|---|---|---|---|---|
| TX-105 | I | 2 | Organic | 609 |
| S-110 | I | 2 | NWL | 692 |
| S-108 | I | 2 | NWL | 604 |
| TX-112 | II | 2 | NWL | 649 |
| TX-116 | II | 2 | NWL | 631 |
| TX-117 | II | 2 | NWL | 626 |
| BY-106 | III | 2 | FeCN | 642 |
| BY-105 | III | 2 | FeCN | 503 |
| BY-104 | III | 2 | FeCN | 406 |
| SX-108 | IV | 2 | NWL | 115 |
| U-106 | IX | 2 | Organic | 226 |
| U-111 | IX | 2 | Organic | 329 |
| U-107 | VI | 2 | Organic | 406 |
| U-108 | VI | 2 | Organic | 468 |
| BX-112 | VIII | 2 | NWL | 167 |
| B-107 | VIII | 2 | NWL | 165 |
| Total | | 32 | | |

Table VII
List of Recommended Auger Samples

| Tank No. | SORWT Group | No. of Auger Samples | Watch-List Status | Total Waste Volume in Tank (kgal) |
|---|---|---|---|---|
| TX-107 | I | 3 | NWL | 69 |
| TX-104 | I | 3 | NWL | 35 |
| BX-106 | V | 3 | NWL | 46 |
| BX-101 | V | 3 | NWL | 43 |
| SX-112 | IV | 3 | NWL | 12 |
| U-101 | IV | 3 | NWL | 25 |
| Total | | 18 | | |

- Nominal compositions of the five SORWT groups included in the verification study. Mean concentrations of each analyte were calculated for each SORWT group included in the verification study. These mean concentrations, along with the current waste volume inventories, were used to project an inventory of each chemical analyte over the entire group.

- Results of a pairwise comparison of expected and observed analyte concentrations between groups. A semi-quantitative comparison of analyte concentrations between groups was made based on estimated analyte concentrations in various waste types. A similar comparison was made based on the projected nominal compositions of the groups.

## RELATED STUDIES

Two additional studies are currently underway to investigate the SORWT Model's effectiveness in grouping SSTs with similar waste types. One study focuses on the physical and rheological properties of the tank waste. It is assumed that tank waste with similar process histories will have similar physical and rheological properties and may therefore be grouped together. The other study is based on chemical analytes; however, the data set used for the verification study will be much more extensive than the one used in *The Sort On Radioactive Waste Type Model: A Method to Sort Single-Shell Tanks into Characteristic Groups*.(3)

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