5-1998

Design of a solvent extraction process to separate plutonium and neptunium

Donald Lee Marsh

Recommended Citation

Marsh, Donald Lee, "Design of a solvent extraction process to separate plutonium and neptunium. " Master's Thesis, University of Tennessee, 1998.
https://trace.tennessee.edu/utk_gradthes/10301

To the Graduate Council:

I am submitting herewith a thesis written by Donald Lee Marsh entitled "Design of a solvent extraction process to separate plutonium and neptunium." I have examined the final electronic copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Nuclear Engineering.

Laurence F. Miller, Major Professor

We have read this thesis and recommend its acceptance:

Lawrence Townsend, George Schweitzer

Accepted for the Council:
Carolyn R. Hodges

Vice Provost and Dean of the Graduate School

(Original signatures are on file with official student records.)

To the Graduate Council:

I am submitting herewith a thesis written by Donald Lee Marsh entitled "Design of a Solvent Extraction Process to Separate Plutonium and Neptunium." I have examined the final copy of this thesis for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Master of Science, with a major in Nuclear Engineering.

Laurence F. Miller
Laurence F. Miller, Major Professor

We have read this thesis and
recommend its acceptance:

Laurence W. Townsend
Geo. K. Schweitzer

Accepted for the Council:

C W Minkel
Associate Vice Chancellor and
Dean of The Graduate School

DESIGN OF A SOLVENT EXTRACTION PROCESS TO SEPARATE PLUTONIUM AND NEPTUNIUM

A Thesis
Presented for the
Master of Science
Degree
The University of Tennessee, Knoxville

Donald L. Marsh
May 1998

DEDICATION

I would like to dedicate this thesis to my parents, Donald R. and Judy A., for their continued support and knowledge they have given me throughout my life. Also, I would like to dedicate this thesis to my wife, Rebecca A., for always being there for me.

ACKNOWLEDGMENTS

I would like to express my gratitude to many people at the University of Tennessee and the Oak Ridge National Laboratory for without whose help this thesis would never have evolved. First off, I would like to thank my major professor, Dr. Laurence F. Miller, for guiding me through this project and for all the help with the mathematics and programming involved in this thesis. Thanks to the members of my thesis committee, Dr. George Schweitzer and Dr. Lawrence Townsend, for their input and advise on this thesis. I would also like to thank Dr. George Schweitzer for his help in the modeling of the distribution coefficients. Also, I would like to thank Mr. Kevin Felker, Dr. Walt Bond, Dr. Rodger Martin, and Dr. Robert Wham for their valuable input to this thesis. Finally, I would like to thank the Radiochemical Engineering Development Center of Oak Ridge National Laboratory for their financial support of this work.

ABSTRACT

This thesis describes the modifications of the computer code SEPHIS-MOD4 to incorporate a solvent extraction process using the mixer-settler model to separate neptunium and plutonium and the optimization of the two solvent extraction cycles required to achieve this neptunium and plutonium separation. The major modification to SEPHIS-MOD4 was a subroutine which models the distribution coefficients of nitric acid, neptunium(VI), and plutonium(IV) at temperatures from 20°C to 70°C and concentrations of tributyl phosphate from 1 to 50 volume percent.

After the modifications to SEPHIS were complete, an optimization of two solvent extraction cycles was performed in order to separate the plutonium and neptunium. A sensitivity analysis was conducted in order to identify the most sensitive parameters of each solvent extraction cycle for the optimization routine. The first solvent extraction cycle was optimized to separate the plutonium and neptunium from the fission products and other actinides. The second solvent extraction cycle was optimized to separate the plutonium and neptunium. Other designs were performed in order to study the effects on the original design if the distribution coefficients for neptunium(VI) and plutonium(IV) were off by ±50%.

TABLE OF CONTENTS

CHAPTER PAGE

LIST OF TABLES

LIST OF FIGURES

FIGURE PAGE

LIST OF ABBREVIATIONS

ABBREVIATIONS	DEFINITIONS
AQ	Aqueous Phase
CBCF	Carbon-Bonded Carbon Fiber
CVS	Clad Vent Sets
GPHS	General Purpose Heat Source
HAN	Hydroxylamine Nitrate
HFIR	High Flux Isotope Reactor
HNO_3	Nitric Acid
LANL	Los Alamos National Laboratory
LMES	Lockheed Martin Energy Systems, Inc.
Np(VI)	Neptunium(VI)
ORG	Organic Phase
ORNL	Oak Ridge National Laboratory
Pu(IV)	Plutonium(IV)
RDF	Radiochemical Development Facility
REDC	Radiochemical Engineering Development Center
RTG	Radioisotope Thermoelectric Generator
SEPHIS	Solvent Extraction Process Having Interacting Solutes
SNM	Special Nuclear Material
SX	Solvent Extraction
TBP	Tributyl Phosphate

1. Introduction

1.1 Background

The Radioisotope Facilities Task Force was established in November 1991 by the Deputy Assistant Secretary for Space and Defense Power Systems to evaluate alternative facilities that could be used to produce, assemble, and test future radioisotope thermoelectric generators (RTG). The Task Force was responsible for identifying options for the future supply of plutonium-238 (^{238}Pu), which is one radioisotope used in making RTGs. On June 23 and 24, 1994, the transuranic isotope production and processing capabilities of the Radiochemical Engineering Development Center (REDC) and the High Flux Isotope Reactor (HFIR) at the Oak Ridge National Laboratory (ORNL) were evaluated by the Task Force. The Task Force found that these facilities along with ORNL's Building 3019 provided a potential capability for the domestic production of ^{238}Pu.

The U.S. Department of Energy (USDOE) employs the use of several facilities in the country to produce, assemble, and test radioisotope power systems for both civilian and military applications. There are several components that are involved in making a functional RTG. The components needed to make an RTG are as follows: the converter is made by Lockheed Martin Astro Space, the aeroshell is made by industrial vendors, the carbon-bonded carbon fiber (CBCF) insulator sleeve and the iridium encapsulation components are made by Lockheed Martin Energy Systems (LMES). In the past, Westinghouse Savannah River Company (WSR) has produced the ^{238}Pu and prepared the plutonium oxide powder. The plutonium oxide powder is then sent to Los Alamos National Laboratory (LANL) where it is processed into pellets. These pellets are then put into iridium alloy clad vent sets (CVS).

1.2 Processing of ^{238}Pu

There are several steps involved in going from ^{237}Np, the source material, to ^{238}Pu, the material used in making a functional RTG. First, there must be an adequate storage space to store the ^{237}Np. After the storage site is selected, the ^{237}Np must be fabricated into targets for irradiation. Next, a suitable reactor must be selected to irradiate the ^{237}Np. ^{238}Pu is produced from ^{237}Np absorbing a neutron in an (n,γ) reaction and going to ^{238}Np. ^{238}Np then beta decays to ^{238}Pu with a half life of 2.1 days. Finally, the neptunium targets have to be chemically processed to separate the plutonium and neptunium.

1.2.1 Storage of ^{237}Np Source Material

A major concern in the future of ^{238}Pu production is the storage of the source material, ^{237}Np. The storage facility must posses all the safeguards and security systems required for storage of Category I quantities of special nuclear material. Also, the storage facility must have adequate alpha radiation containment and monitoring systems as well as shielding for high energy gamma rays. The current inventory of ^{237}Np is stored at the Savannah River site in the form of a nitrate.

1.2.2 Neptunium Target Fabrication

Researchers at both the ORNL and Y-12 plants have considered several processes and manufacturing techniques for dispersing the NpO_2 in an aluminum matrix to fabricate the targets. One option considered was to pelletize the NpO_2 in an aluminum matrix and to insert these pellets into aluminum cladding tubes. The advantages of this approach were its simplicity and its established manufacturing experience. However, this target process was not chosen because of its low surface to volume ratio, which results in poor thermal performance, and the lack of expertise and technology available in determining the homogeneity of the NpO_2 in the aluminum matrix. Extrusion was another process considered. Again, this process was not chosen for several reasons. First, extrusion has poor thermal performance resulting from a single diameter tube containing the necessary loading of NpO_2. Second, there is a high degree of difficulty involved in making the nested tube configurations required for extrusion. Finally, there is a lack of inspection technology for detecting dispersion homogeneity of the NpO_2. Another process investigated was plates with NpO_2 dispersed in an aluminum matrix and clad with aluminum much like the fuel plates in research reactors. This form is advantageous because it is based on a proven process that has been used to fabricate fuel plates at a greater than 95% success rate for more than 30 years.

Neptunium targets must be fabricated in facilities licensed to handle special nuclear material. Light shielding of approximately 1 in. of lead equivalent material will be required to process the NpO_2. After the NpO_2 has been fabricated into the target, inspection operations will be accomplished by direct handling with minimal shielding.

1.2.3 Production of ^{238}Pu

Once the ^{237}Np has been fabricated into targets, these targets will then be irradiated at a suitable reactor facility. Originally, the reactor of choice was the high flux isotope reactor, HFIR, at ORNL. Because neptunium has a high neutron capture cross section, 170 barns, the neptunium is going to decrease the neutron flux in the beam tubes. Currently, the advanced test reactor, ATR, at Idaho National Engineering Laboratory is being considered to irradiate the neptunium targets.

The ATR began operation in 1967 and is expected to be in operation for the next several decades. The ATR was design to study the effects of intense radiation from neutrons and gamma rays on materials. The ATR has nine flux traps in its core. It has a high thermal neutron flux and large test volumes for performing irradiation experiments. The neutron flux can be adjusted at the various flux traps to meet irradiation requirements. The maximum total power is 250 MWt.

1.2.4 Neptunium Target Processing

There are several steps involved in the processing of irradiated neptunium targets. These steps include target dissolution, feed solution clarification and adjustment, solvent extraction, and oxide conversion.

After the targets are removed from the reactor, they are stored for approximately 100 days in order for the radioiodine to decay. When the cooling off period is complete, target dissolution can take place. Target dissolution is a two-step process. The first step is a caustic dissolution of the aluminum cladding to expose the core material consisting of neptunium, plutonium, fission products, and activation products. After the dissolution of the aluminum cladding takes place, the waste is filtered to allow minimal losses of the neptunium and plutonium. The second step is an acid dissolution of the oxides. The acid solution is composed of nitric acid and fluoride ions. Fluoride ions promote the acid dissolution of the refractory ions.

Following target dissolution, the feed solution to the solvent extraction process is clarified. Clarification removes the insoluble fission and activation products thus avoiding problems with the fission and activation products interfering with the separation of neptunium and plutonium. Filtration methods are used to clarify the feed solution. The acid concentration and valence states of the neptunium and plutonium are also adjusted. The valence states of neptunium and plutonium as well as the nitric acid concentration must be properly adjusted to achieve maximum separation from the fission products.

The process of separating the neptunium and plutonium is accomplished by solvent extraction using a Purex type flowsheet. The organic extractant used is tributyl phosphate, TBP. There are two solvent extraction cycles required for the separation process. The first cycle separates the neptunium and plutonium from the fission products. After the neptunium and plutonium have been separated from the fission products, the plutonium is reduced from Pu(IV) to Pu(III). The second cycle separates the neptunium from the plutonium on the basis that the distribution coefficient for Pu(III) is essentially zero, meaning that the Pu(III) is not extracted while the distribution coefficient for Np(VI) is high enough so that the Np(VI) is extracted, thus causing the separation of neptunium and plutonium. A third solvent extraction cycle may be necessary to further purify the neptunium(VI). Hydroxylamine nitrate (HAN) is introduced into the solvent extraction process to ensure that the valence states of the neptunium and plutonium remain constant throughout the separation process. The TBP is recycled by scrubbing it with a sodium carbonate solution to remove any radiolytic degradation products.

After the separation process, the plutonium and neptunium are converted to oxides. The plutonium product is converted to PuO_2 by the oxalate precipitation method. The neptunium product solution is converted back to powder by the resin-bead loading/calcination process. The neptunium powder is then fabricated into targets for additional irradiations.

1.3 Goals of the Thesis

There were two primary objectives for this thesis. The first objective was to modify an existing code, SEPHIS-MOD4, which models uranium and plutonium separation by solvent extraction methods, to include the modeling of neptunium and plutonium separations. The second objective was to optimize the solvent extraction cycles to get the maximum neptunium and plutonium concentration in the product stream while minimizing the neptunium and plutonium concentrations in the waste streams.

The first objective was accomplished by modifying several of the existing subroutines in SEPHIS to include neptunium and plutonium separations. This required modification to a subroutine which models the distribution coefficients for nitric acid, neptunium(VI), and plutonium(IV). The second objective was accomplished by first performing a sensitivity analysis to determine which parameters most effect the output. The parameters examined in the sensitivity analysis included flow rates of the various input and output streams, concentrations of the solutes within the system, and physical location of the streams (stage location). With these parameters identified, SEPHIS was run several times until the optimal design of the solvent extraction cycles was achieved. Additional designs were performed in order to account for any irregularities in the distribution coefficients of neptunium(VI) and plutonium(IV).

1.4 Organization of the Thesis

This thesis is organized into five chapters. Chapter 1 discusses background material. It also summarizes the steps on how ^{238}Pu is produced from ^{237}Np. Chapter 2 addresses the SEPHIS code. It discusses the conceptual and mathematical basis of the model, the organization of the code, the approximations and assumptions of the code, and the expected results of the code. Chapter 3 discusses the modification made to the code to incorporate the neptunium and plutonium separations. Chapter 4 examines the optimization and results of the two solvent extraction cycles needed to separate plutonium and neptunium. Finally, Chapter 5 discusses the conclusions of this thesis.

2. The SEPHIS Code

2.1 Conceptual and Mathematical Basis for SEPHIS

The SEPHIS computer program is used to model the operations of mixer-settlers in a solvent extraction process. The solutes simulated by the old version, SEPHIS-MOD4, are nitric acid, uranium(VI), plutonium(IV), plutonium(III), a plutonium reductant, and inextractable nitrate salts. The new version, SEPHIS-MOD7, includes the subroutines necessary to simulate the neptunium and plutonium separation process. The solutes considered by SEPHIS-MOD7 include all the components from SEPHIS-MOD4 with the exception of neptunium(VI) replacing uranium(VI) for the plutonium and neptunium separation process.

The flow of solutes through the model is described by differential equations with empirical correlations used to calculate the distribution coefficients. An idealized model of a mixer-settler system is depicted in Figure 1. Solutes enter each mixer from one of three streams. These streams are the aqueous and organic feed streams (Af_j and Of_j), the aqueous stream from the preceding stage (A_{j-1}), and the organic stream from the succeeding stage (O_{j+1}). Once in the mixer, the streams are mixed so that the solutes come to an equilibrium distribution between the aqueous and organic phases. After the streams leave the mixer, they enter the first of three consecutive settler zones. The solutes are homogeneously mixed in each settler zone with each zone overflowing into the next. After the streams exit the third settler zone, they either leave the system as a product stream (Ap_j and Op_j) or enter the next mixer as an interstage flow stream.

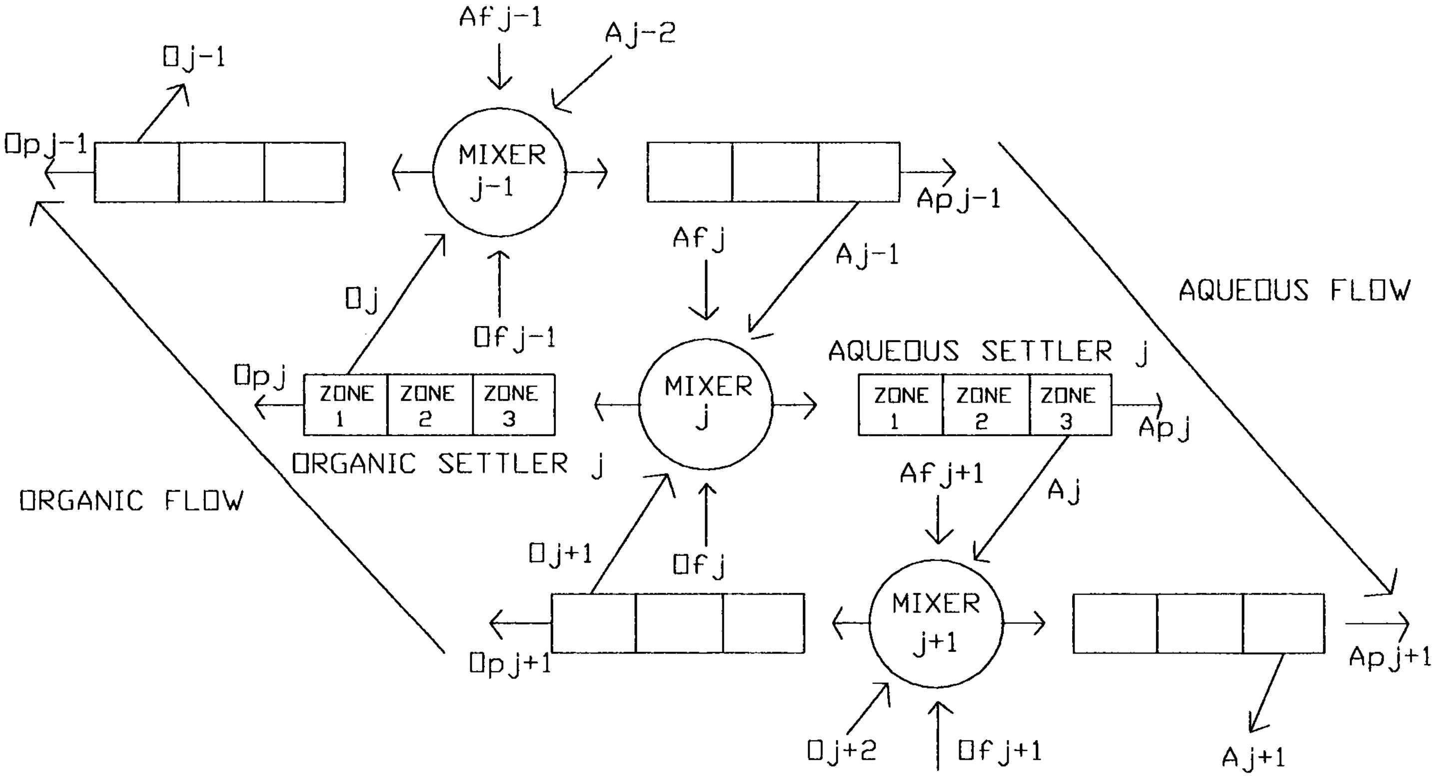

Figure 1. The Idealized Model for Mixer-Settlers

The flow of solutes through the mixer-settler system is modeled using differential equations. The following mathematical development of these differential equations is derived in "SEPHIS-MOD4: A User's Manual To A Revised Model Of The PUREX Solvent Extraction System" by A.D. Mitchell. The primary differential equation used in modeling the solvent extraction process is an unsteady-state mass balance around a mixer. The streams entering the mixer are the aqueous stream from the settler of the preceding stage, A_{j-1}, the organic stream from the settler of the succeeding stage, O_{j+1}, and the feed streams to the stage, A_{fj} and O_{fj}. The streams which exit the mixer are the aqueous, A_j and A_{pj}, and organic, O_j and O_{pj}, streams to the settlers. Any change in the amount of a particular solute i, in stage j, is equal to the difference between the amount that flows into and the amount that leaves the mixer. The differential equation that describes this change is listed in Equation 1.

$$\frac{d(V_{maj}\, x_{i,j} + V_{moj}\, y_{i,j})}{dt} = A_{j-1}\, x_{i,j-1} + O_{j+1}\, y_{i,j+1} + A_{fj}\, x_{fi,j} + O_{fj}\, y_{fi,j} - (A_j + A_{pj})\, x_{i,j} - (O_j + O_{pj})\, y_{i,j} \tag{1}$$

where: V_{maj} and V_{moj} are the aqueous and organic volumes of stage j, L
$x_{i,j}$ and $y_{i,j}$ are the aqueous and organic concentrations of solute i in stage j, g/L

To simplify this equation, the volumes and flow rates are assumed to be constant and the solutes in the mixer are assumed to be at an equilibrium distribution between the phases, thus,

$$y_{i,j} = D_i \, x_{i,j} \qquad (2)$$

where: D_i is the distribution coefficient of solute i

Applying these assumptions to Equation 1, yields

$$\frac{dx_{i,j}}{dt} = [A_{j-1} \, x_{i,j-1} + O_{j+1} \, y_{i,j+1} + A_{fj} \, x_{fj,j} + O_{fj} \, y_{fi,j} \qquad (3)$$

$$- [A_j + A_{pj} + D_i \, (O_j + O_{pj})] \, x_{i,j}] \, / \, (V_{maj} + D_i \, V_{moj})$$

Because each of the concentrations can vary during any time interval with the exception of the feed stream concentrations, a method of evaluating these concentrations must be chosen. All flow rates, volumes, and feed streams are considered to be constant over a particular interval of time. Thus, the remaining unknown variables are $x_{i,j}$, D_i, $y_{i,j+1}$, and $x_{i,j-1}$. The fourth order Runge-Kutta integration method is used to determine the value for $x_{i,j}$. The value of D_i is calculated once $x_{i.j}$ is known. Assuming that $x_{i,j-1}$ and $y_{i,j+1}$ will vary by only small amounts during the time interval, these values are estimated by averaging the concentrations at the start of the time interval and the concentration at the end of the time interval. Now that all the variables have been specified, Equation 3 can be evaluated by an iterative procedure. The iterative procedure used by SEPHIS can be thought of as a grid of points in Cartesian coordinates, with the horizontal axis being stage number and the vertical axis indicating the progression of time. Each point in the grid represents a time when the concentration in that stage needs to be calculated.

The differential in Equation 3 can now be solved by the fourth order Runge-Kutta integration method used by the program. The result of the integration is a new concentration, $x_{i,j,t+\Delta t}$, for the point in question. The iterative procedure then moves onto the next stage where the procedure is repeated. After all of the stages have values for the concentration, the next row of points can be considered. The stages in the next row are computed in the opposite direction to help offset any biasing in the approximations. The iterative procedure continues to scan the column in this manner until all the desired time intervals have been completed.

The settler between the mixers is also considered. After the concentrations have been calculated for the mixer, the concentrations in the settler of the stage are evaluated. Because there is no mass that changes phase in the settler for this model, the calculation simply propagates the concentration changes through the settler. A time delay is added between when a solute exits a mixer and when it enters the next mixer. The equations used in describing the solutes in the settler are contrived in the same manner as those of the mixers. Each settler is divided into three equal volume, perfectly mixed zones. There is only one stream which enters a settler, that being the phase flow out of the mixer. After this stream has passed through the settler, it either leaves as a product stream or continues to the next stage. The mass balance for solute i in zone k of stage j is defined in Equation 4.

$$\frac{V_{saj}}{3}\frac{dx_{i,j,k}}{dt} = A_{sj}\,x_{i,j,k-1} - A_{sj}\,x_{i,j,k} \tag{4}$$

This differential is put into a finite difference form and the concentrations are evaluated in the same manner as in the mixers to yield Equation 5.

$$\frac{V_{saj}}{3}\left(\frac{x_{i,j,k,t+\Delta t} - x_{i,j,k,t}}{\Delta t}\right) = A_{sj}\left(\frac{x_{i,j,k-1,t+\Delta t} + x_{i,j,k-1,t}}{2} - \frac{x_{i,j,k,t+\Delta t} + x_{i,j,k,t}}{2}\right) \tag{5}$$

The only unknown variable is $x_{i,j,k,t+\Delta t}$, thus solving Equation 5 for this variable yields,

$$x_{i,j,k,t+\Delta t} = \frac{2V_{saj}x_{i,j,k,t} + 3A_{sj}\Delta t(x_{i,j,k-1,t+\Delta t} + x_{i,j,k-1,t} - x_{i,j,k,t})}{2V_{saj} + 3A_{sj}\Delta t} \tag{6}$$

With these equations, the mixer concentrations are computed and then propagated through each of the three settler zones. Before moving on to the next stage, all the unknown concentrations for each solute are calculated. After all the stages have been completed, time is incremented and the next point in time is evaluated. This procedure is continued until the user specifies that it should stop.

The fourth order Runge-Kutta integration method appears to be a very accurate method when used to calculate the concentrations and very stable with the equations which are used. One disadvantage of using this method is that it takes a considerable amount of computer time to obtain the desired results (Mitchell, 1979). To avoid this problem, a second integration method was added to the program. The equation for the mixer used by the second integration method starts with Equation 3. The differential is substituted with a finite difference form. The concentration variables are evaluated in the same manner as with the Runge-Kutta integration method. The only unknown variable remaining in the equation is $x_{i,j,t+\Delta t}$, which is solved in Equation 7.

$$\begin{aligned} x_{i,j,t+\Delta t} = {} & [V_{maj}\, x_{i,j,t} + V_{moj}\, y_{i,j,t} + \Delta t\, [A_{j-1}\, x_{i,j-1} + O_{j+1}\, y_{i,j+1} \\ & + A_{fj}\, x_{fi,j} + O_{fj}\, y_{fi,j} - (A_j + A_{pj})\, x_{i,j,t}/2 - (O_j + O_{pj})\, y_{i,j,t}/2]]/ \qquad (7) \\ & [V_{maj} + D_i\, V_{moj} + \frac{\Delta t}{2}\, (A_j + A_{pj} + D_i\, (O_j + O_{pj}))] \end{aligned}$$

Calculations in the settlers and the iterative procedure are not affected. This integration method is twice as fast as the Runge-Kutta method, however, it is only recommended for use when only steady-state results are desired or when the concentrations are slowly changing (Mitchell, 1979).

The distribution coefficients, D_i, which appear in the mixer equations, Equations 3 and 7, are determined by using a set of correlations based on the aqueous concentrations. The solutes in the organic phase are considered to have reacted with TBP. The correlations are determined from the experimental distribution coefficient data.

Chemical reactions between the components are handled by special subroutines in the program. Ordinarily, a chemical reaction would be used as a generation or depletion term in Equation 1. Such a term could require that the time increment for a calculation be limited by the reaction rate rather than by the residence time for a stage. Since residence time for a stage is generally more important, the chemical reactions are considered to be essentially independent of the unsteady state mass balance equations (Mitchell, 1979).

Chemical reactions in the mixer are assumed to take place only in the aqueous phase. The solute in the organic phase acts as a buffer for the aqueous concentration by an approximation that the distribution coefficients change only slightly due to the reaction. The extent of reaction is determined by putting the aqueous concentrations into an integrated rate equation. According to the specified stoichiometry of the reaction, the extent of reaction is factored into the amount of solute in the mixer. The distribution of the resulting solutes between the phases is adjusted to account for the altered concentrations.

Chemical reactions occurring in the settlers are much easier to handle. Because there is only one phase present in each settler, no interphase approximations are necessary. The extent of reaction is determined by the concentrations in the zones with the extent of reaction factored directly into the concentrations.

The stage operations are separated into a series of discrete steps by SEPHIS. The contents of the mixer and all the streams flowing into that mixer are combined and reacted. The resulting solutions are mixed again to account for the change in the distribution coefficients due to the reaction. A portion of the mixer contents is separated and mixed into the first settler zone. The first zone overflows into the second, and the second overflows into the third. The overflow from the third zone is removed as a product stream or directed to the next mixer.

2.2 Organization of SEPHIS

SEPHIS-MOD7 includes the main program, eight subroutines for the Purex process, eight subroutines for the Thorex process, and eight subroutines for the neptunium-plutonium separation process. The main program directs the operation and serves as the administrator. Each subroutine has a specific task. The eight subroutines for each process are as follows: STARTS, CONVRT, MOLAL, STAGES, UCOR, MCHEM, SCHEM, and PRTOUT. The function of STARTS is to handle most of the input to the program. The conversion of units in the input data to units used in the calculations is done by CONVRT. MOLAL provides the conversion factors between molar and molal units on a solute free basis. After the input data has been read into the program, the job of STAGES is to perform the stagewise calculations which model the changes in concentrations. The distribution coefficients are calculated in UCOR. MCHEM and SCHEM perform any required chemical reactions in the mixers and settlers, respectively. PRTOUT reconverts the units and prints the concentration profiles for each solute.

The organization of the program can be broken down in two ways. First, SEPHIS is divided into segments which perform general functions. For example, STARTS does most of the input, STAGES calculates the changes in concentration, and the main program does most of the output. Second, SEPHIS separates the portions of the program dealing exclusively with solvent extraction from those which limit the program to the Purex process. The main program, STARTS, and STAGES are general routines. They can be used in many different solvent extraction processes. The remaining subroutines perform various functions or provide the needed correlations which limit the program to a specific solvent extraction process. To change the program in order to work with another system, only the subroutines CONVRT, MOLAL, UCOR, MCHEM, SCHEM, and PRTOUT need to be modified.

2.3 Approximations and Assumptions Used by SEPHIS

Several assumptions and approximations are incorporated into the SEPHIS code to significantly simplify the system being studied and to save large amounts of computer time. These approximations are as follows: concentrations in the contactor change relatively slowly, volumes and flow rates remain constant until changed by the user, mechanical operation of the contactor conforms with the idealities of the model, certain chemical effects or conditions are assumed to exist or not exist, and many heat effects are neglected. These approximations lead to minor differences between the calculated concentrations and experimental results, however, these differences can generally be localized to specific portions of a contactor.

If the concentrations in the contactor change relatively slowly, the approximations made in order to numerically integrate the differential equations become more exact. However, this does not mean that the results of SEPHIS are erroneous when the concentrations are changing rapidly. The correct implication is that the largest integration errors will occur just after a step change has been made in the contactor conditions.

The solvent extraction system being studied has solution nonidealities which cause the flow rates and volumes in the system to vary with changes in concentration. The flow rates and volumes were assumed to be constant in deriving the differential equations. These approximations are not strictly applied to the system in the sense that the calculations with the flow rates and concentrations are performed in molal units in order to bypass this problem because molal units are not a function of volumes unlike molar units. Before the calculations are made, the volumes are also converted to molal units. The molal concentrations and flow rates do not change due to the nature of molal units, but the volumes do change since the volume in liters is assumed to be constant. These changes in the molal volume lead to accumulation in the differential equation since:

$$\frac{d(Vx)}{dt} = V\frac{dx}{dt} + x\frac{dV}{dt} \tag{8}$$

A comparison was made, in order to justify this approximation, between these accumulation terms for a number of situations. Generally, V(dx/dt), which is the term kept by the program, was 100 times larger than x(dV/dt), the term neglected by the program. The neglected term was important only when the concentration of one component was held constant while the other concentrations were changing. Even in the most extreme case, the neglected term accounted for less than 10% of the total accumulation term. Thus, neglecting these solution nonidealities should not lead to problems with the predicted concentrations (Mitchell, 1979).

The mechanical operation of the contactor is assumed to be ideal in many different aspects. Any change in the feed stream flow rates or stage volumes is assumed to occur instantaneously. This assumption is necessary in order to limit the model to changes in concentration rather than fluid dynamics-type changes. Attempting to accurately describe the fluid flow characteristic would essentially allow calculations to be performed for only one mixer-settler design.

Other approximations involving the chemistry of the system were made to simplify the process. The solutes in the mixers are always assumed to be at an equilibrium distribution between the phases because equilibrium is desired in the stages so that the experimental results can be compared with results using ideal conditions. Non-equilibrium conditions could have been simulated by the insertion of an efficiency in the distribution relation between the aqueous and organic concentrations. Plutonium(III), the reductant, and the inextractable nitrate salts are assumed to remain in the aqueous phase which means that the distribution coefficients for these solutes are set equal to zero. Plutonium(IV) is reduced to plutonium(III) to remove it from the organic phase because its distribution coefficient is essentially zero. The reductant is assumed to be inextractable in order to simplify the process. Inextractable nitrates are generally added to the system to improve the extraction process by increasing the distribution coefficients of the solutes. If the inextractable nitrates entered the organic phase in significant amounts, the extraction would be hindered, and the nitrates would not have been added to the system.

No solvent degradation products are modeled by SEPHIS. HDBP and H_2MBP are formed by radiolysis and by reactions of TBP with nitric acid. These products tend to hold the uranium, plutonium, thorium, and neptunium in the organic phase. The solvent degradation products could be simulated by knowing their formation rate and behavior as extractants. However, if the solvent degradation products were an important factor in a particular system, the process would probably be too poor to use in practice (Mitchell, 1979).

Thus, attempts to experimentally demonstrate the feasibility of the process would fail.

All nonideal heat effects are neglected. Temperature profiles are calculated using approximate heat capacities for the phases. No heats of mixing, contributions due to radiation, or gains or losses to the surroundings are considered.

2.4 Expected Results from SEPHIS

Computational models are made to approximate results that would occur under actual conditions. In actual situations, changes in the feed stream flow rates or concentrations will lead to transient conditions in the contactor. Solutes will pass through the contactor as discrete waves. It is important to know what the maximum solute concentration is likely to be and where in the process it will occur. SEPHIS is designed to produce these types of results. Experimental steady-state data demonstrate the ability of the SEPHIS program to predict concentrations in various sections of a contactor. Steady-state concentrations are influenced primarily by the flow rates and the distribution coefficients (Mitchell, 1979).

SEPHIS is intended to predict both transient and steady-state concentrations in solvent extraction contactors. Experimental transient results demonstrate the ability of the program to predict the timing of waves of solutes passing through the contactor. Steady-state results indicate which sections of the contactor are satisfactorily simulated by the program (Mitchell, 1979).

3. Modifications Made to SEPHIS to Incorporate Plutonium and Neptunium Separations

There were several changes made to the original SEPHIS-MOD4 program to incorporate the plutonium and neptunium separation process. The first change that was made was to write all output data to an output file, whose name is specified by the user, for ease of analyzing the output results. This can be done by setting the variable IPNCH in the third input deck equal to one. There are three processes simulated in SEPHIS-MOD7. These solvent extraction processes include the Purex, the Thorex, and the plutonium and neptunium separation process. The user can select which solvent extraction process to run by setting the variable IPROCE in the first input deck equal to zero for the Purex, one for the Thorex, and two for the plutonium and neptunium separation. The solutes for the Purex process include the following: uranium(VI), plutonium(IV), plutonium(III), nitric acid, a plutonium reductant, and an inextractable nitrate ion. The solutes for the Thorex process are the same as for the Purex process with the exception of thorium taking the place of uranium(VI). For the plutonium and neptunium separation process, neptunium(VI) takes the place of uranium(VI) with the rest of the solutes remaining the same. After these changes are made, the rest of the input decks are the same for each of the three processes simulated by SEPHIS-MOD7. All of the variables used in the input decks are tabulated in Appendix I.

There were several subroutines added to SEPHIS-MOD4 to include the plutonium and neptunium separation process. The names of the subroutines added to simulate the plutonium and neptunium separations are as follows: PRTNP, CONVNP, UCORNP, MOLALN, MCHEMN, and SCHEMN. No changes were made to subroutines STARTS or STAGES.

3.1 Subroutine UCORNP

UCORNP computes the value of the distribution coefficients for nitric acid, neptunium(VI), and plutonium(IV). The distribution coefficient for any element can be defined as the ratio of the concentration of the element in the organic phase to the concentration of the element in the aqueous phase, where the organic phase is in equilibrium with the aqueous phase. Distribution coefficients for nitric acid, neptunium(VI), and plutonium(IV), were modeled for temperatures which range from 20°C to 70°C and concentrations of tributyl phosphate which range from 1 to 50 volume percent.

The distribution coefficients for nitric acid, neptunium(VI), and plutonium(IV) were modeled in a similar manner. The three chemical reactions which apply to this system of nitric acid, neptunium(VI), plutonium(IV), and TBP are listed in Equations 10 through 12 (Bond, 1997).

$$H^{+}_{aq} + {NO_3^{-}}_{aq} + TBP_{org} \leftrightarrow {HNO_3 \cdot TBP}_{org} \tag{10}$$

$$NpO_2^{2+}{}_{aq} + 2{NO_3^{-}}_{aq} + 2TBP_{org} \leftrightarrow {NpO_2(NO_3)_2 \cdot 2TBP}_{org} \tag{11}$$

$$Pu^{4+}{}_{aq} + 4{NO_3^{-}}_{aq} + 2TBP_{org} \leftrightarrow {Pu(NO_3)_4 \cdot 2TBP}_{org} \tag{12}$$

The aq and the org from Equations 10 through 12 represent the aqueous and organic phases, respectively. The parameters required by the SEPHIS code to compute the distribution coefficients included the following: the concentration of nitric acid (M), the concentration of neptunium(VI) (g/L), the concentration of plutonium(IV) (g/L), the temperature (°C), and the volume percent of TBP. The first step was to convert the units of neptunium(VI) and plutonium(IV) from grams per liter to molar units. This was achieved by dividing both neptunium(VI) and plutonium(IV) by their atomic weights, 237.04 amu and 238 amu, respectively. The next step was to calculate the equilibrium nitrate ion concentration, also in molar units (Equation 13).

$$[NO_3^-] = [H^+] + 2[NpO_2^{2+}] + 4[Pu^{4+}] + [Na^+] \tag{13}$$

The Na^+ in Equation 13 is the concentration of the inextractable nitrate ion which is also considered to be the salting agent. The purpose of the salting agent is to increase the concentration of the equilibrium nitrate ion concentrations thus increasing or decreasing the value of the distribution coefficient.

Next, the equilibrium constants for nitric acid, neptunium(VI), and plutonium(IV) were estimated as a function of the equilibrium nitrate ion concentration and the temperature. The equilibrium constants, with the activity coefficient ratios included, for each of the three components are defined in Equations 14 through 16.

$$K_{HNO_3} = \frac{HNO_3{\cdot}TBP_{org}}{[H^+]_{aq}[NO_3^-]_{aq}[TBP]_{org}} \qquad (14)$$

$$K_{Np(VI)} = \frac{[NpO_2(NO_3)_2{\cdot}2TBP]_{org}}{[NpO_2^{2+}]_{aq}[NO_3^-]_{aq}^{2}[TBP]_{org}^{2}} \qquad (15)$$

$$K_{Pu(IV)} = \frac{[Pu(NO_3)_4{\cdot}2TBP]_{org}}{[Pu^{4+}]_{aq}[NO_3^-]_{aq}^{4}[TBP]_{org}^{2}} \qquad (16)$$

The least squares method was used to fit the experimental equilibrium constants for each of the three components to the following equation:

$$\begin{aligned}
\mathrm{Ln}(K_I) = {} & a_0 + a_1 / [NO_3^-] + a_2 [NO_3^-] + a_3 / T + a_4 T + a_5 T / [NO_3^-] + a_6 [NO_3^-] / T \\
& + a_7 T [NO_3^-] + a_8 / [NO_3^-]^2 + a_9 [NO_3^-]^2 + a_{10} / T^2 + a_{11} T^2 + \\
& a_{12} [NO_3^-]^2 T + a_{13} [NO_3^-] T^2 + a_{14} T / [NO_3^-]^2 + a_{15} T^2 / [NO_3^-]^2 \\
& a_{16} [NO_3^-] / T^2 + a_{17} [NO_3^-]^2 / T^2 + a_{18} T^2 / [NO_3^-] + a_{19} [NO_3^-]^2 / T \\
& + a_{20} [NO_3^-]^2 T^2 \qquad (17)
\end{aligned}$$

where: K_I is the equilibrium constant for each of the three components
$[NO_3^-]$ is the equilibrium nitrate ion concentration, M
T is the temperature, °C

The experimental equilibrium constants were obtained by manipulating the experimental distribution coefficients from the following sources: (Akatsu, 1965), (Alcock, 1958), (Best, 1957), (Miles, 1975), (Patil, 1973), (Petrich, 1981). The natural log of the equilibrium constants was used to get a better fit to the experimental data. The constants in Equation 17 were determined by using a program called Data_Fit written by Dr. Laurence Miller of the University of Tennessee. These constants were then checked by hand calculations and were found to be in close agreement with the constants from the computer program. The constants used in Equation 17 for each component are listed in Appendix II.

Plots of the equilibrium constant versus nitrate ion concentration for all temperatures are illustrated in Figures 2 through 4. From Figures 2 through 4, it is apparent that the experimental and calculated equilibrium constants for each solute agree well. The increase in the equilibrium constant in Figure 2 between three and five molar nitrate ion concentration is due to different temperatures and TBP concentrations being plotted on the same graph. If the equilibrium constant versus nitrate ion concentration were plotted for one temperature and one TBP concentration, the curve is smooth as illustrated in Figure 5. The increase in the equilibrium constant between three and five molar nitrate ion concentration in Figure 3 can be attributed to the corresponding increase in the nitric acid equilibrium constant in the same range of nitrate ion concentration. Because there were no experimentally determined nitric acid distribution coefficients listed with the experimental neptunium(VI) distribution coefficients, the nitric acid distribution coefficients had to be calculated using the model described in this section of the thesis. The nitric acid distribution coefficients are needed to calculate the free TBP concentration, which is then used to calculate the distribution coefficient for neptunium(VI). This distribution coefficient is the only factor used in determining the free TBP concentration because the neptunium(VI) concentration was

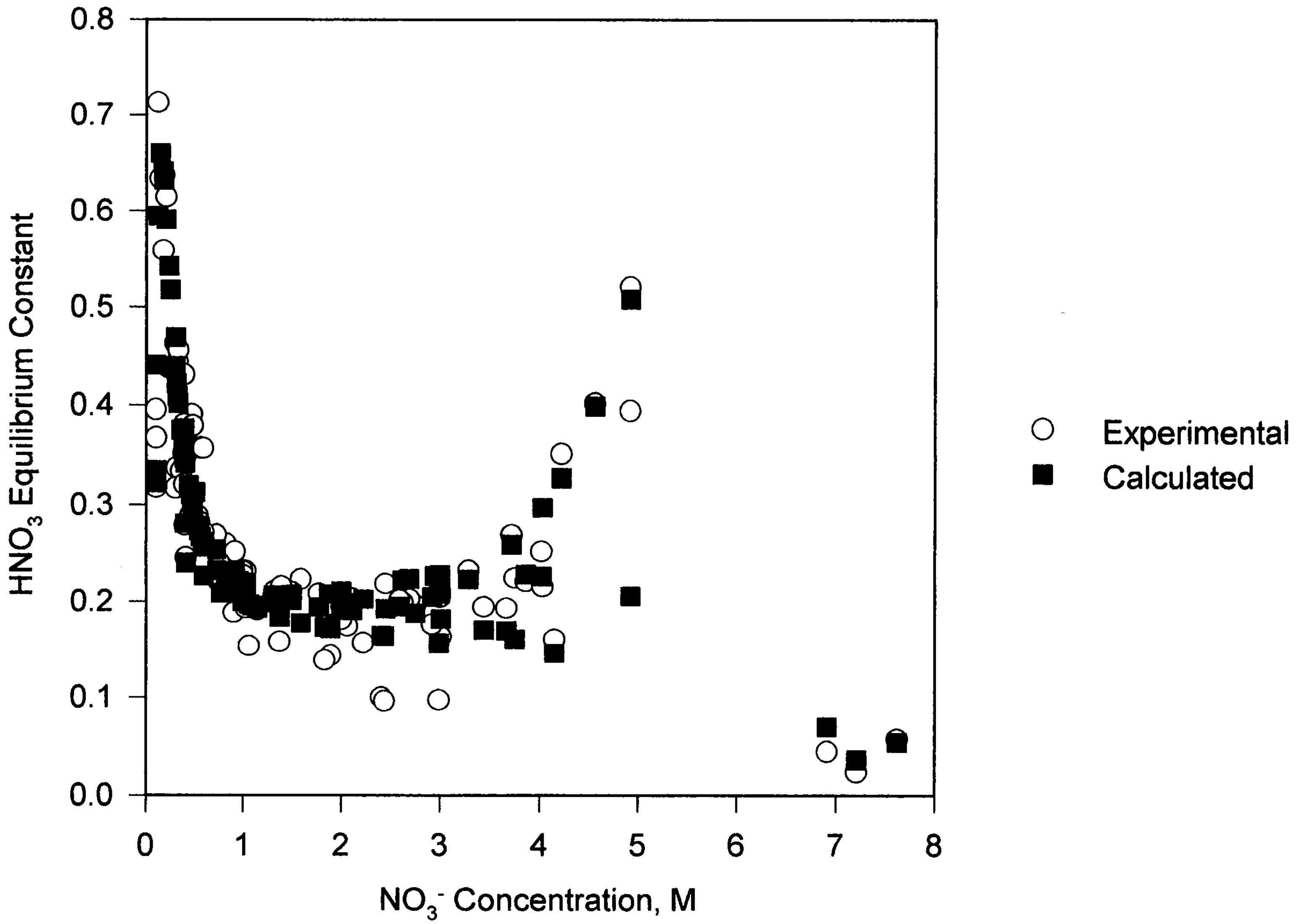

Figure 2. HNO_3 Equil. Const. vs. NO_3^- Conc. for all Temperatures

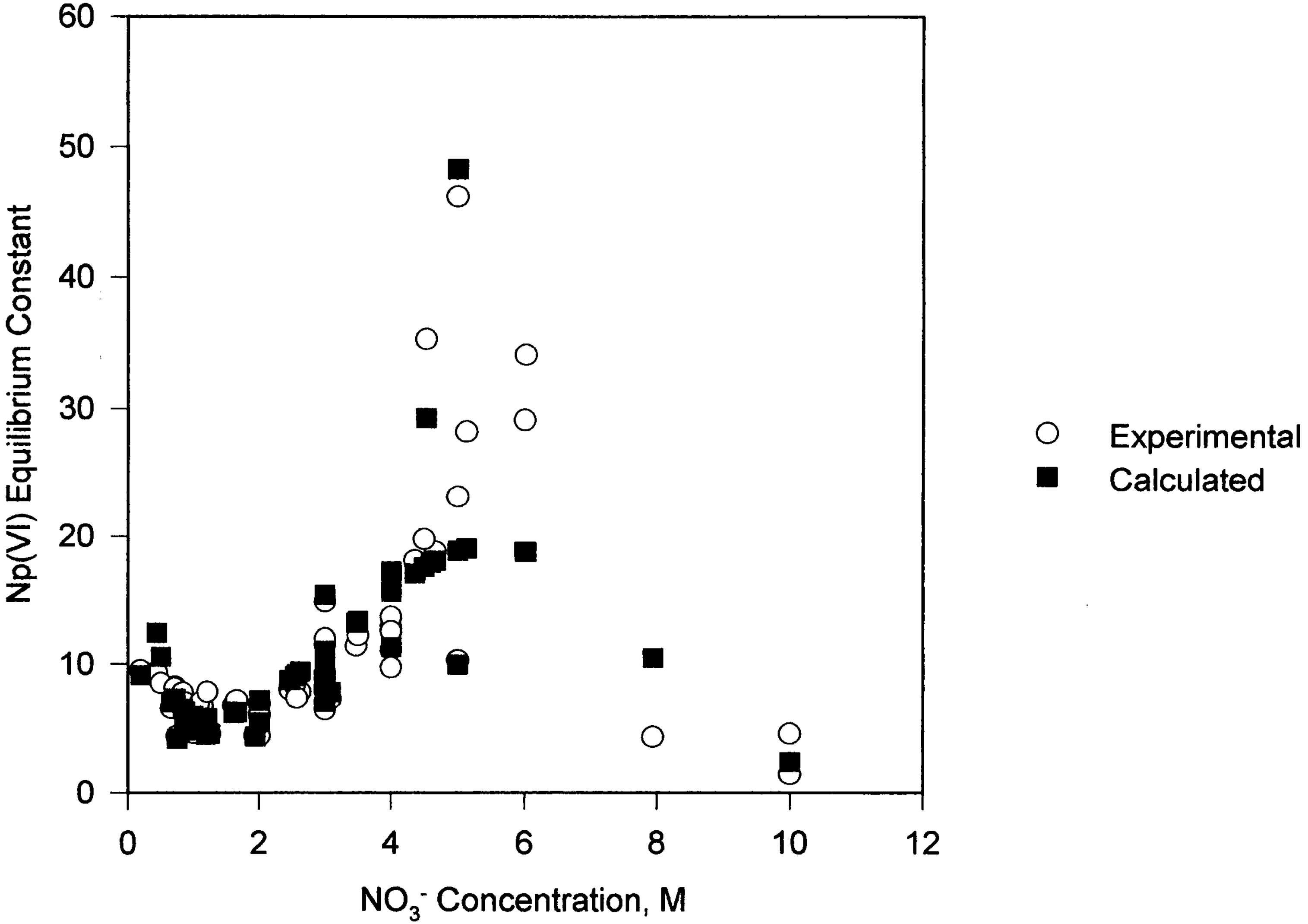

Figure 3. Np(VI) Equil. Const. vs. NO$_3^-$ Conc. for all Temperatures

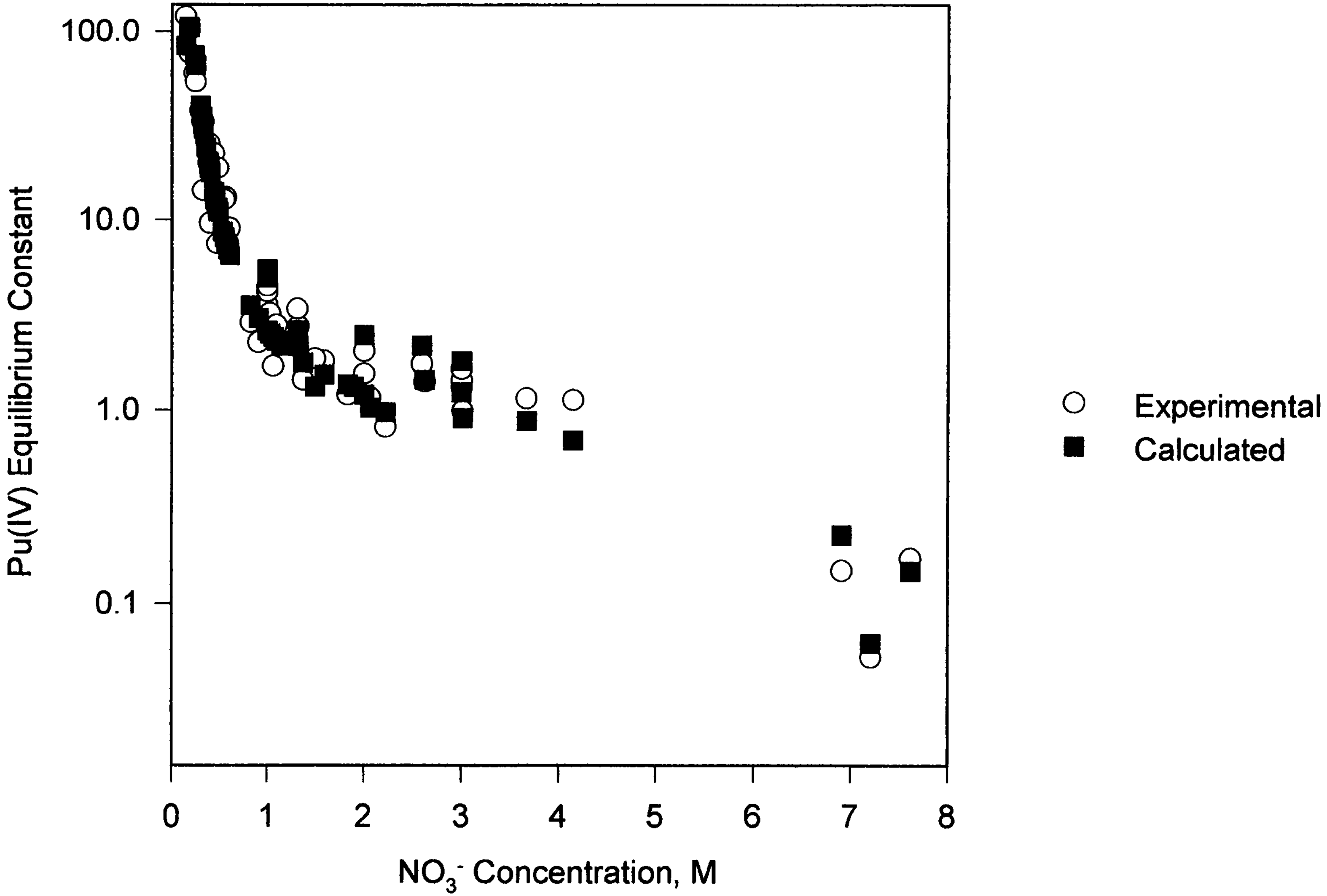

Figure 4. Pu(IV) Equil. Const. vs. NO_3^- Conc. for all Temperatures

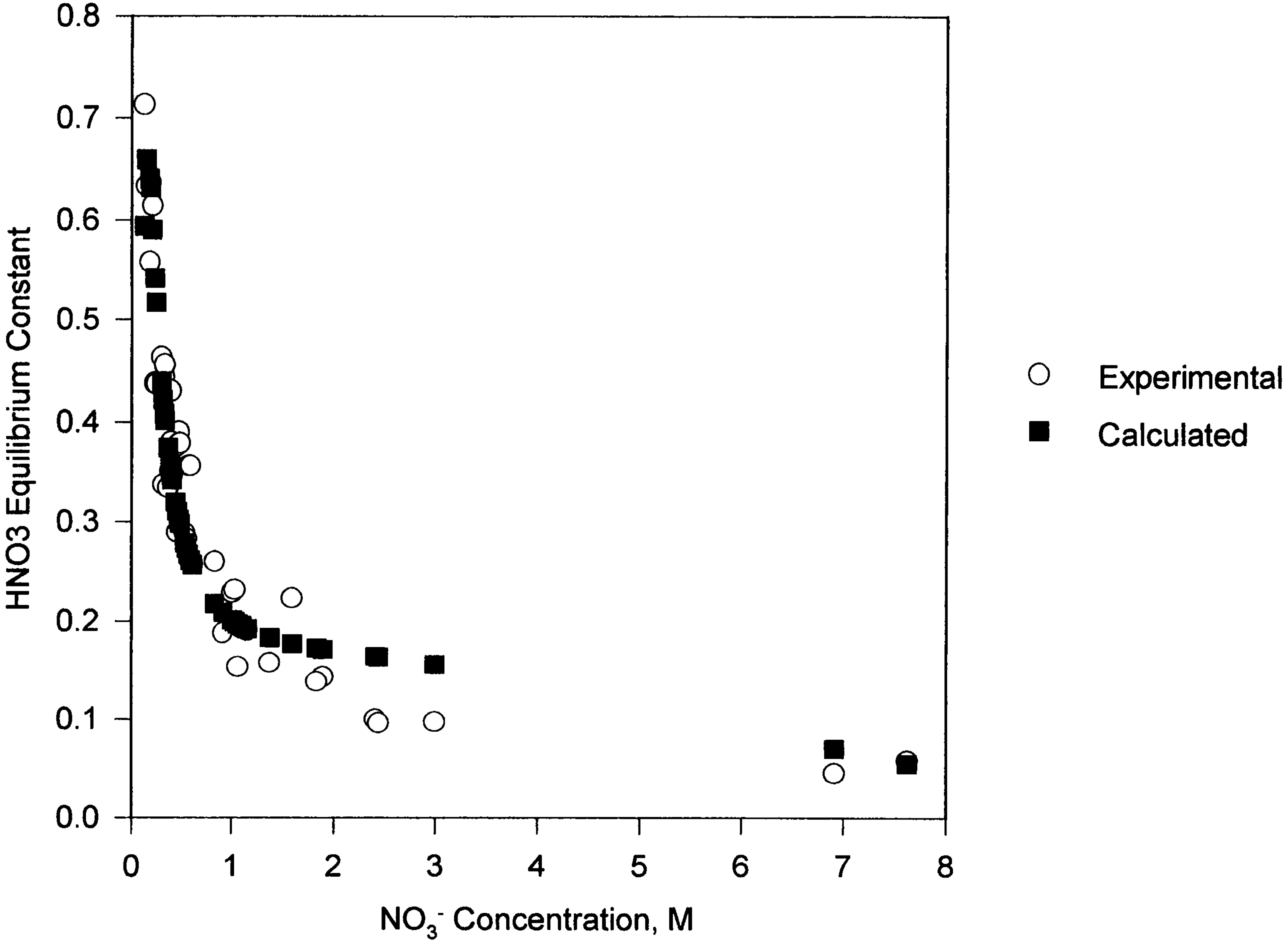

Figure 5. HNO_3 Equil. Const. vs. NO_3^- Conc. for 25°C and 30% TBP

assumed to be negligible in the experimental data. The Y-axis on Figure 4 is set on a log scale because of the wide range of the equilibrium constants for plutonium(IV). Results of the least squares fitting procedure are defined in terms of average percent error (Equation 18) and are listed in Table 1.

Table 1. Average Percent Error in the Equilibrium Constants

Component	Average % Error
HNO_3	13.53
Np(VI)	17.74
Pu(IV)	25.54

$$Avg.\%Err. = \frac{\sum |(\frac{X_e - X_c}{X_e})|}{N} \tag{18}$$

where: X_e is the experiment value
X_c is the calculated value
N is the number of data points

Next, the free TBP, or uncomplexed TBP, was calculated. The free TBP is defined in Equation 19.

$$[TBP]_{org} = T_C - 2[NpO_2(NO_3)_2{\cdot}2TBP]_{org} - 2[Pu(NO_3)_4{\cdot}2TBP]_{org} - [HNO_3{\cdot}TBP]_{org} \tag{19}$$

where: T_C is the equilibrium molar concentration of the total amount of TBP in the organic phase

$$T_C = \frac{1000\,\rho_{TBP}(T)F}{266.32} \tag{20}$$

where: $\rho_{TBP}(T)$ is the density of TBP as a function of temperature, g/cm^3
F is the vol. % of TBP
1000 is a units conversion factor to go from cm^3 to Liters
266.32 is the atomic weight of TBP, g/mol

The density of TBP as a function of temperature was calculated using Equation 21 (Bond, 1997).

$$\rho_{TBP}(T) = 0.992486 - 7.6489X10^{-4}T - 1.05X10^{-6}T^2 \tag{21}$$

Solving Equations 14 through 16 for the organic product and substituting them into Equation 19 yields the following quadratic equation.

$$[2K_{Np(VI)}[NpO_2^{\,2+}][NO_3^{\,-}]^2 + 2K_{Pu(IV)}[Pu^{4+}][NO_3^{\,-}]^4][TBP]^2 + [1 + K_{HNO_3}[H^+][NO_3]][TBP] - T_c = 0 \tag{22}$$

Equation 22 was then solved by the quadratic formula for the free TBP, taking only the positive root. The negative root of the quadratic equation yields negative values for the free TBP. Thus, it was discarded.

With the equilibrium constant for each component, the equilibrium nitrate ion concentration, and the free TBP known, the distribution coefficient for each component was then calculated. The distribution coefficient for each component is defined in Equations 23 through 25.

$$D_{HNO_3} = \frac{[HNO_3{\cdot}TBP]_{org}}{[H^+]_{aq}} = K_{HNO_3}[NO_3^-]_{aq}[TBP]_{org} \tag{23}$$

$$D_{Np(VI)} = \frac{[NpO_2(NO_3)_2{\cdot}2TBP]_{org}}{[NpO_2^{2+}]_{aq}} = K_{Np(VI)}[NO_3^-]_{aq}^{2}[TBP]_{org}^{2} \tag{24}$$

$$D_{Pu(IV)} = \frac{[Pu(NO_3)_4{\cdot}2TBP]_{org}}{[Pu^{4+}]_{aq}} = K_{Pu(IV)}[NO_3^-]_{aq}^{4}[TBP]_{org}^{2} \tag{25}$$

Plots of the distribution coefficients versus total equilibrium nitrate ion concentration for all temperatures and concentrations of TBP considered are illustrated in Figures 6 through 8. Again, it is apparent that the experimental and calculated distribution coefficients are in agreement. In Figure 6, deviations from the smooth curve can be attributed to the differences in temperature and TBP concentration as well as by the addition of plutonium(IV) to the system. A smooth curve is obtained by plotting the nitric acid distribution coefficient versus nitrate ion concentration for one temperature, one concentration of TBP, and no plutonium(IV) present in the system as illustrated in Figure 9. In Figure 7, the experimental and calculated distribution coefficients for neptunium(VI) tend to deviate above 4 M nitrate ion concentration. This can be attributed to the least squares fitting of the equilibrium constants for neptunium(VI) not being accurate because the nitric acid distribution

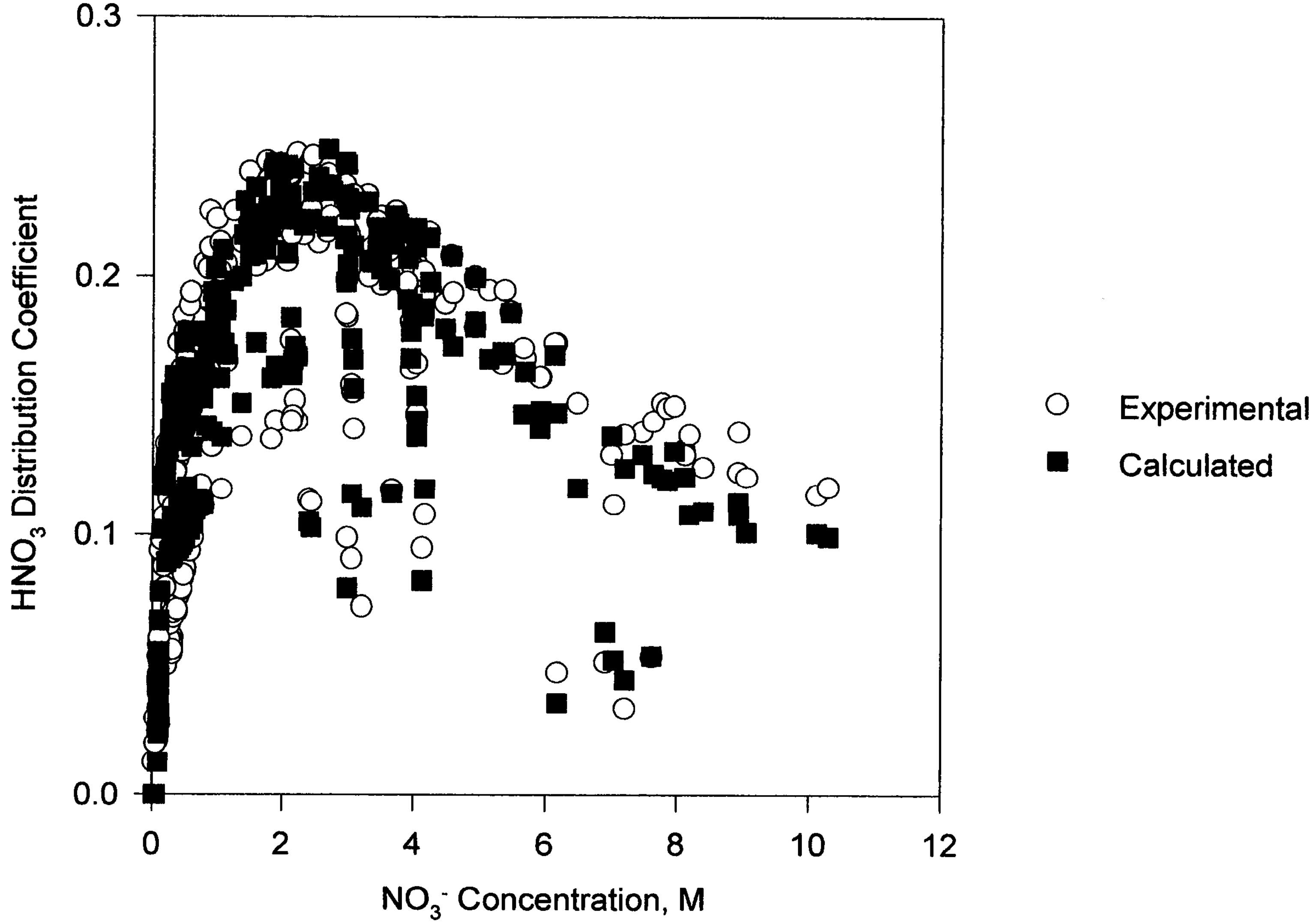

Figure 6. HNO$_3$ Dist. Coeff. vs. NO$_3^-$ Conc. for all Temperatures

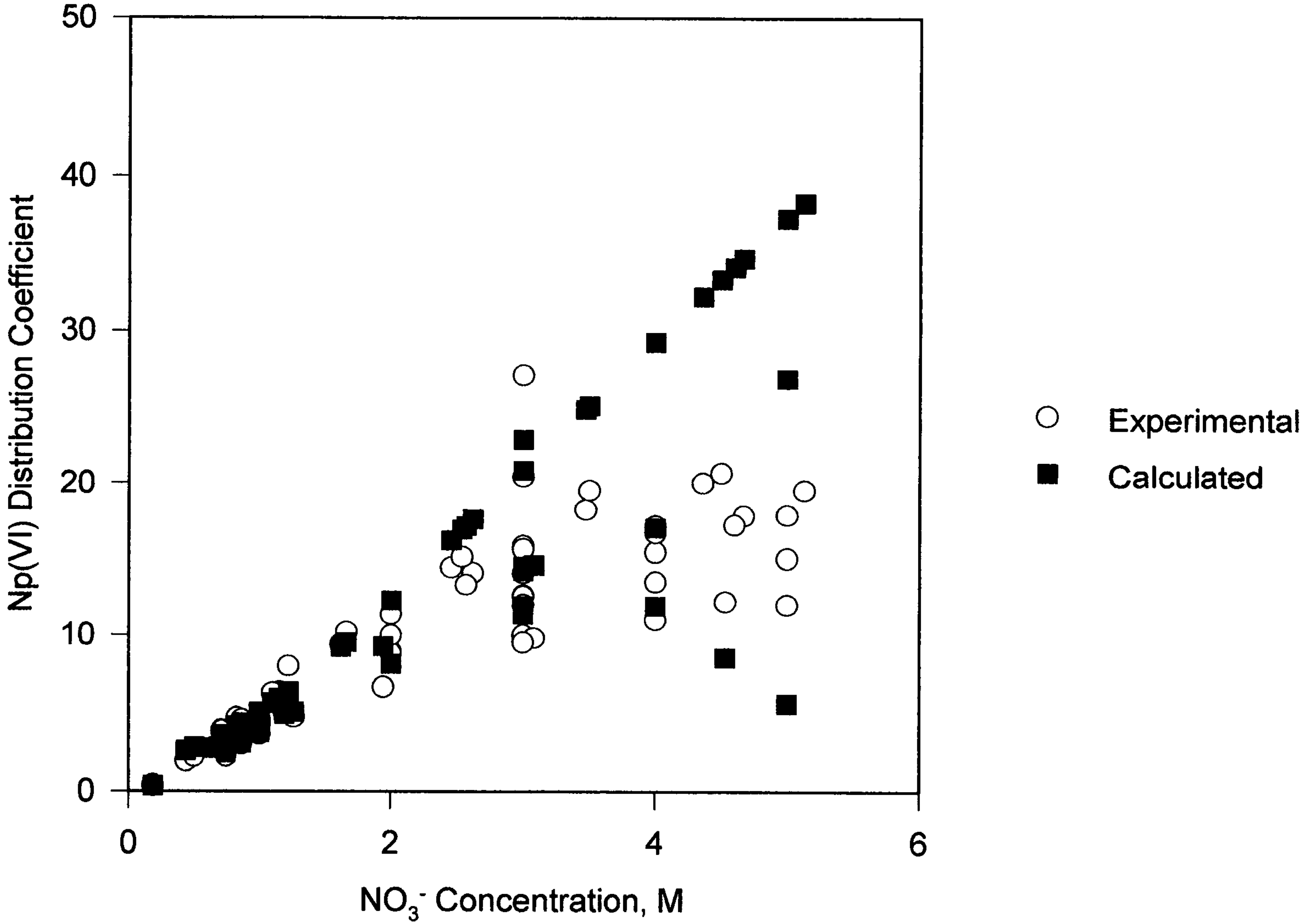

Figure 7. Np(VI) Dist. Coeff. vs. NO$_3^-$ Conc. for all Temperatures

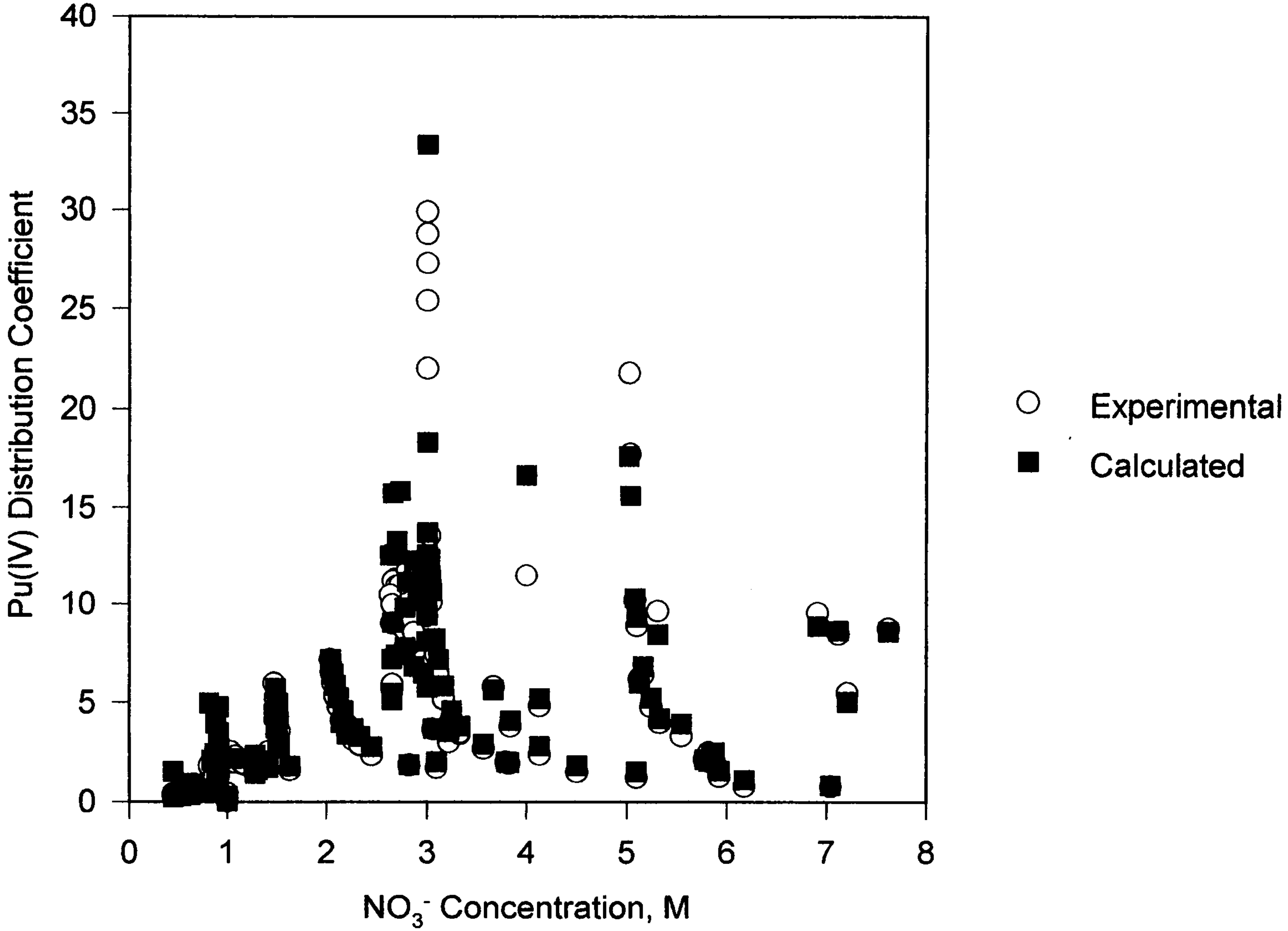

Figure 8. Pu(IV) Dist. Coeff. vs. NO$_3^-$ Conc. for all Temperatures

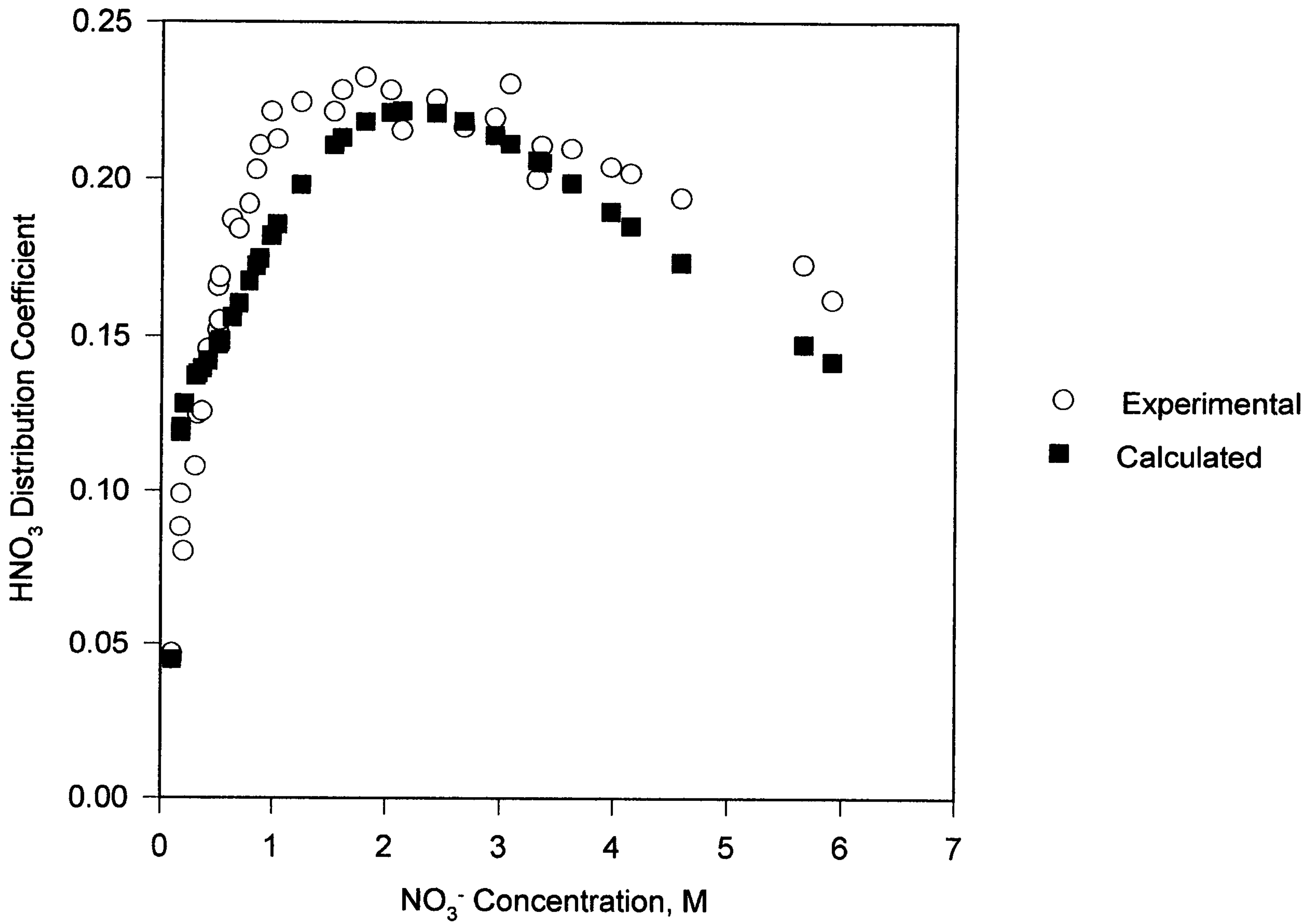

Figure 9. HNO_3 Dist. Coeff. vs. NO_3^- Conc. at 25°C, 30% TBP, no Pu(IV)

coefficient were not known, which lead to problems in calculating the free TBP concentration. The spikes in Figure 8 are due to the plutonium(IV) loading which cause an increase in the distribution coefficient at the same nitrate ion concentration. Referring to Figure 8, there are several values for the distribution coefficient of plutonium(IV) at 3 M nitrate ion concentration. The differences in the values for the distribution coefficients are due to the different concentrations of plutonium(IV) corresponding to 3 M nitrate ion concentration. At a constant plutonium(IV) concentration, with the same temperature and concentration of TBP, the distribution coefficient curve is smooth as illustrated in Figures 10 and 11. The average percent error for each component is listed in Table 2. A table of experimental and calculated distribution coefficients for nitric acid, neptunium(VI), and plutonium(IV), at the various conditions is listed in Appendix III.

Table 2. Average Percent Error in the Distribution Coefficients

Component	Average % Error
HNO_3	15.00
Np(VI)	37.94
Pu(IV)	23.81

There are several reasons why the average percent errors appear high in Table 2. First, the way in which the free TBP was calculated (Equation 22) is only an approximation and could introduce large errors in the final calculation of the distribution coefficient for each component. The least squares equation (Equation 17) used to fit the equilibrium

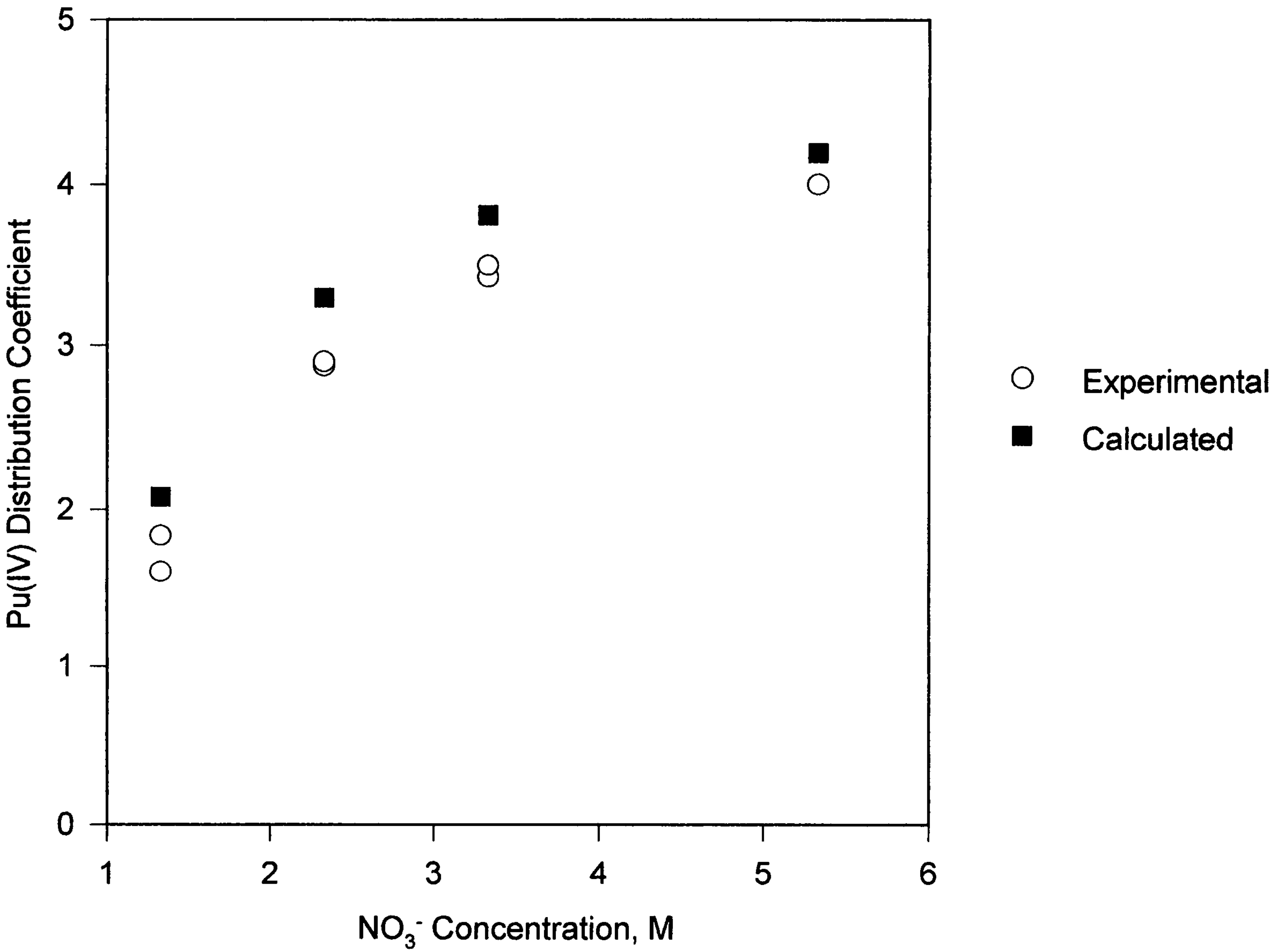

Figure 10. Pu(IV) Dist. Coeff. vs. NO_3^- Conc. at 25°C, 30% TBP, 20 g Pu(IV)/L

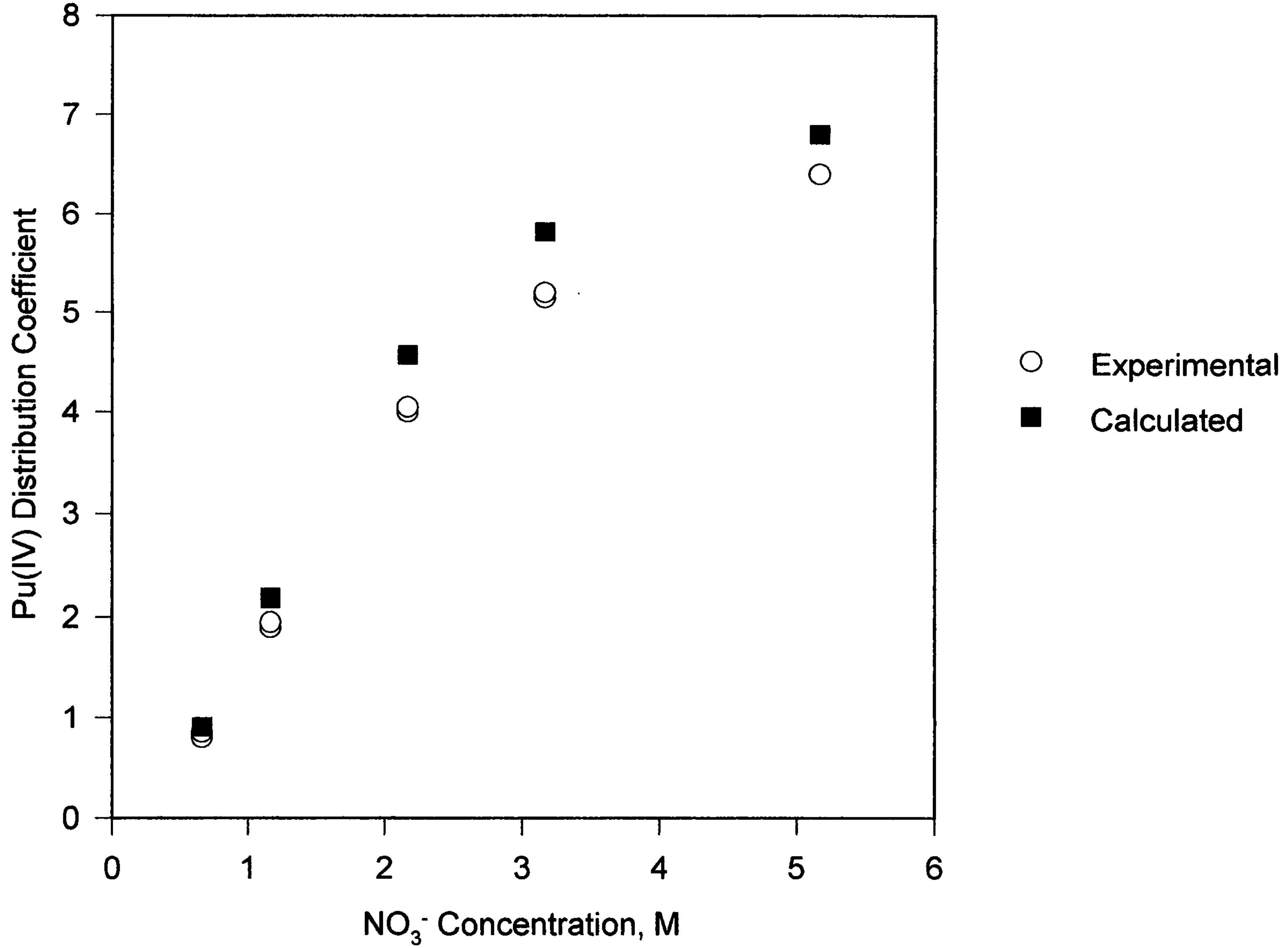

Figure 11. Pu(IV) Dist. Coeff. vs. NO_3^- Conc. at 25°C, 30% TBP, 10 g Pu(IV)/L

constants and the equation used to determine the density of TBP as a function of temperature (Equation 21) are only approximations of the experimental values. Thus, the equation used to calculate the free TBP is also only an approximation to the actual free TBP. Second, some of the experimental distribution coefficients were estimated by reading the numerical values off of a graph because there were no numerical values for the distribution coefficients available. Also, some of the experimental distribution coefficients could be considered outliers which would also make the average percent errors appear high. Most of the experimental data classified as outliers were discarded. The way in which an experimental distribution coefficient was classified as an outlier was to plot the distribution coefficients versus nitric acid concentration for one specified temperature and concentration of TBP. Experimental data which had a large deviation from the smooth curve was classified as an outlier and was discarded.

3.2 Subroutines PRTNP and CONVNP

There were only minor modifications to these subroutines to incorporate the plutonium and neptunium separation process. PRTNP reconverts the units from molal to molar and prints the concentration profiles for the solutes. CONVNP prints the feed stream information and converts the units of the input data to the units used during the calculations.

Both subroutines were modified in the same way. In the original SEPHIS-MOD4, the subroutine MOLALP was called in PRTPU and CONVPU to get the conversion factors needed to go from molar to molal units on a solute free basis. SEPHIS-MOD7 now calls the subroutine MOLALN to get these conversion factors. Because PRTPU and CONVPU in

SEPHIS-MOD4 were used to simulate the solvent extraction part of the Purex process, the atomic weights of uranium and plutonium, 238 and 239 respectively, were used to convert from grams per liter to molar units. These atomic weights were changed in both PRTNP and CONVNP to incorporate neptunium into the system. The new atomic weights are 237 and 238 for the neptunium and plutonium, respectively. The final change made to these two subroutines deals with the way the output data is written. Again, because SEPHIS-MOD4 was used to simulate the Purex process, uranium and plutonium are the solutes of interest. In the output data for SEPHIS-MOD7, the uranium is replaced with neptunium when the concentration profiles are printed to the output file for the neptunium and plutonium separation process.

3.3 Subroutines MCHEMN and SCHEMN

The subroutines MCHEMN and SCHEMN perform any required chemical reactions in the mixer and settlers, respectively. The subroutines assume that the reaction is totally in the aqueous phase, but that the solute in the organic phase also aids in maintaining the aqueous concentration. The integrated rate equation for the reaction is used to determine the extent of the reaction. The subroutines then split the resulting solutes between the phases using the subroutine UCORNP. In SEPHIS-MOD4, there are three chemical reactions considered, all of which deal with the reduction of plutonium(IV) to plutonium(III). These three reactions are listed as follows: instantaneous reduction of plutonium, reduction by uranium(IV), and reduction by hydroxylamine. In the subroutines MCHEMN and SCHEMN of SEPHIS-MOD7, the chemical reactions include the instantaneous reduction of plutonium and the reduction by hydroxylamine. Thus, the only difference between the subroutines of the two versions of SEPHIS is that the chemical reaction for the reduction of plutonium(IV) by uranium(IV) has been deleted in SEPHIS-MOD7 when using the neptunium and plutonium separation process.

3.4 Subroutine MOLALN

In SEPHIS-MOD4, MOLALP was designed to calculate the molar to molal conversion factors, CONVA and CONVO, in a solute free system. Because SEPHIS-MOD7 did not use a solute free system for the plutonium and neptunium separation process, the conversion factors, CONVA and CONVO, in the subroutine MOLALN were both set equal to one.

4. Optimization of the Solvent Extraction Cycles for Plutonium and Neptunium Separations

A sensitivity analysis was performed in order to determine which input parameters needed to be adjusted to perform the optimization routine. Once the parameters for each cycle were identified, the two solvent extraction cycles were optimized to determine the values for the parameters to maximize the separation of plutonium and neptunium. After a baseline design was performed with the distribution coefficients for neptunium(VI) and plutonium(IV) assumed to be correct, eight additional designs were completed in order to account for any irregularities occurring when the distribution coefficients for neptunium(VI) and plutonium(IV) were not correct. In these eight designs, the distribution coefficients were modified in the following ways: 1) Np(VI) distribution coefficient modified by +50%, 2) Np(VI) distribution coefficient modified by -50%, 3) Pu(IV) distribution coefficient modified by +50%, 4) Pu(IV) distribution coefficient modified by -50%, 5) Np(VI) distribution coefficient modified by +50% and Pu(IV) distribution coefficient modified by +50%, 6) Np(VI) distribution coefficient modified by -50% and Pu(IV) distribution coefficient modified by -50%, 7) Np(VI) distribution coefficient modified by +50% and Pu(IV) distribution coefficient modified by -50%, 8) Np(VI) distribution coefficient modified by -50% and Pu(IV) distribution coefficient modified by +50%.

4.1 Sensitivity Analysis

A sensitivity analysis was performed in order to identify the eight most sensitive parameters for each solvent extraction cycle. The parameters adjusted in the sensitivity analysis included the following: the flow rates of each stream, the concentration of nitric acid, the concentration of neptunium(VI), the concentration of plutonium(IV), the concentration of hydroxylamine nitrate, the concentration of sodium nitrite, the temperature, the volume percent TBP, and the stage input or output location. After all the parameters that could be changed in the system were identified, a reference case was run in SEPHIS-MOD7 for each cycle. Each parameter was then increased by 5%, one parameter per run, or the stage location modified by one stage to introduce a perturbation into the system. For each perturbation to the system, a neptunium and plutonium ratio was calculated. These ratios for the first solvent extraction cycle are defined in Equations 26 and 27, respectively.

The first solvent extraction cycle was designed to separate the fission products and actinides from the neptunium and plutonium. The ratios in Equations 26 and 27 can be thought of as ratios of the product concentration to the waste concentration, where the goal is to maximize the product concentration and minimize the waste concentration.

$$NpRatio = \frac{(Aq.Np(VI)Conc., ProductStage)}{(Aq.Np(VI)Conc., WasteStage) + (Org.Np(VI)Conc., WasteStage)} \tag{26}$$

$$PuRatio = \frac{(Aq.Pu(IV)Conc., ProductStage)}{(Aq.Pu(IV)Conc., WasteStage) + (Org.Pu(IV)Conc., WasteStage)} \tag{27}$$

The second solvent extraction cycle was designed to separate the plutonium from neptunium by reducing the Pu(IV) to Pu(III). The distribution coefficient for Pu(III) is approximately zero. Thus, it was not absorbed in the organic phase and passes out of the system. The neptunium was absorbed in the organic phase and is carried to the second mixer settler bank, where it was stripped from the system. The neptunium ratio for the second solvent extraction cycle was the same as it was in the first solvent extraction cycle. The plutonium ratio for the second solvent extraction cycle is defined in Equation 28.

$$PuRatio = \frac{(Aq.Pu(III)Conc., ProductStage)}{(Aq.Pu(III)Conc., WasteStage) + (Org.Pu(III)Conc., WasteStage)} \tag{28}$$

With the neptunium and plutonium ratios determined from running SEPHIS-MOD7, a sensitivity coefficient for both neptunium and plutonium was calculated for each parameter perturbation using Equation 29. The average of the sensitivity coefficients for neptunium and plutonium was then calculated to determine which parameters where to be used in the optimization routine.

$$Sens.Coeff. = \left| \left[\frac{\frac{(Reference\,Ratio) - (Perturbation\,Ratio)}{(Reference\,Ratio)}}{\frac{(Reference\,Input) - (Perturbation\,Input)}{(Reference\,Input)}} \right] \right| \tag{29}$$

From the sensitivity analysis, the eight parameters chosen for the optimization routine on the first and second solvent extraction cycles for the baseline design are listed in Table 3. The sensitivity analysis for the eight designs with modified distribution coefficients were performed in the same manner as previously discussed. The parameters chosen for the eight designs are listed in Tables 4 through 11.

Table 3. Parameters for the Baseline Design

	1st Cycle	2nd Cycle
Name	Parameter	Parameter
V1	Volume Percent TBP	Volume Percent TBP
V2	Flow Rate of Stream 1AX	Stage Location of Stream 2AX
V3	Flow Rate of Stream 1AF	Stage Location of Stream 2AIS
V4	Stage Location of Stream 1AX	Flow Rate of Stream 2AX
V5	Stage Location of Stream 1AIS	Flow Rate of Stream 2BX
V6	HNO_3 Conc. in Stream 1BX	Stage Location of Stream 2AF
V7	Stage Location of Stream 1AW	Flow Rate of Stream 2AF
V8	Np(VI) Conc. in Stream 1AF	HNO_3 Conc. in Stream 2AF

Table 4. Parameters for Np Distribution Coefficient +50% Design

	1st Cycle	2nd Cycle
Name	Parameter	Parameter
V1	Stage Location of Stream 1A	Stage Location of Stream 2BU
V2	Stage Location of Stream 1AX	Stage Location of Stream 2AF

Table 4 (continued)

Name	Parameter	Parameter
V3	Volume Percent TBP	Volume Percent TBP
V4	Flow Rate of Stream 1BX	HNO_3 Conc. in Stream 2AIS
V5	HNO_3 Conc. in Stream 1BX	Flow Rate of Stream 2AF
V6	Stage Location of Stream 1BP	Temperature
V7	Flow Rate of Stream 1AX	Stage Location of Stream 2AIS
V8	Stage Location of Stream 1AIS	Flow Rate of Stream 2AS

Table 5. Parameters for Np Distribution Coefficient -50% Design

	1st Cycle	2nd Cycle
Name	Parameter	Parameter
V1	Stage Location of Stream 1AW	Stage Location of Stream 2BP
V2	Stage Location of Stream 1BU	Flow Rate of Stream 2BX
V3	Stage Location of Stream 1BX	Volume Percent TBP
V4	Stage Location of Stream 1BP	Flow Rate of Stream 2AX
V5	Volume Percent TBP	Flow Rate of Stream 2AF
V6	Stage Location of Stream 1AF	Np(VI) Conc. in Stream 2AF
V7	Flow Rate of Stream 1AX	Pu(III) Conc. in Stream 2AF
V8	Flow Rate of Stream 1AF	Flow Rate of Stream 2AS

Table 6. Parameters for Pu Distribution Coefficient +50% Design

	1st Cycle	2nd Cycle
Name	Parameter	Parameter
V1	Stage Location of Stream 1BU	Volume Percent TBP
V2	Temperature	Stage Location of Stream 2AX
V3	HNO_3 Conc. in Stream 1AX	Stage Location of Stream 2AIS
V4	Flow Rate of Stream 1AF	Flow Rate of Stream 2AX
V5	Volume Percent TBP	Flow Rate of Stream 2BX
V6	Flow Rate of Stream 1AX	Stage Location of Stream 2AF
V7	Stage Location of Stream 1AW	Flow Rate of Stream 2AF
V8	Np(VI) Conc. in Stream 1AF	HNO_3 Conc. in Stream 2AF

Table 7. Parameters for Pu Distribution Coefficient -50% Design

	1st Cycle	2nd Cycle
Name	Parameter	Parameter
V1	Stage Location of Stream 1BU	Volume Percent TBP
V2	Stage Location of Stream 1AW	Stage Location of Stream 2AX
V3	Np(VI) Conc. in Stream 1AF	Stage Location of Stream 2AIS
V4	Volume Percent TBP	Flow Rate of Stream 2AX
V5	Flow Rate of Stream 1AX	Flow Rate of Stream 2BX
V6	Stage Location of Stream 1AX	Stage Location of Stream 2AF
V7	Stage Location of Stream 1AF	Flow Rate of Stream 2AF
V8	HNO_3 Conc. in Stream 1BX	HNO_3 Conc. in Stream 2AF

Table 8. Parameters for Np Dist. Coeff. +50%, Pu Dist. Coeff. +50% Design

	1st Cycle	2nd Cycle
Name	Parameter	Parameter
V1	Stage Location of Stream 1BU	Stage Location of Stream 2BU
V2	Flow Rate of Stream 1BX	Stage Location of Stream 2AF
V3	Stage Location of Stream 1AX	Volume Percent TBP
V4	Stage Location of Stream 1AF	HNO_3 Conc. in Stream 2AIS
V5	Stage Location of Stream 1AIS	Flow Rate of Stream 2AF
V6	Stage Location of Stream 1BP	Temperature
V7	Temperature	Stage Location of Stream 2AIS
V8	Salting Agent in Stream 1A	Flow Rate of Stream 2AS

Table 9. Parameters for Np Dist. Coeff. -50%, Pu Dist. Coeff. -50% Design

	1st Cycle	2nd Cycle
Name	Parameter	Parameter
V1	Stage Location of Stream 1AW	Stage Location of Stream 2BP
V2	Stage Location of Stream 1BU	Flow Rate of Stream 2BX
V3	Stage Location of Stream 1BP	Volume Percent TBP
V4	Volume Percent TBP	Flow Rate of Stream 2AX
V5	Flow Rate of Stream 1AX	Flow Rate of Stream 2AF
V6	Flow Rate of Stream 1BX	Np(VI) Conc. in Stream 2AF
V7	HNO_3 Conc. in Stream 1BX	Pu(III) Conc. in Stream 2AF
V8	Np(VI) Conc. in Stream 1AF	Flow Rate of Stream 2AS

Table 10. Parameters for Np Dist. Coeff. +50%, Pu Dist. Coeff. -50% Design

	1st Cycle	2nd Cycle
Name	Parameter	Parameter
V1	Stage Location of Stream 1BU	Stage Location of Stream 2BU
V2	Volume Percent TBP	Stage Location of Stream 2AF
V3	HNO_3 Conc. in Stream 1AIS	Volume Percent TBP
V4	Pu(IV) Conc. in Stream 1AF	HNO_3 Conc. in Stream 2AIS
V5	Flow Rate of Stream 1AF	Flow Rate of Stream 2AF
V6	Flow Rate of Stream 1BX	Temperature
V7	Flow Rate of Stream 1AX	Stage Location of Stream 2AIS
V8	Stage Location of Stream 1BP	Flow Rate of Stream 2AS

Table 11. Parameters for Np Dist. Coeff. -50%, Pu Dist. Coeff. +50% Design

	1st Cycle	2nd Cycle
Name	Parameter	Parameter
V1	Stage Location of Stream 1AW	Stage Location of Stream 2BP
V2	Stage Location of Stream 1BU	Flow Rate of Stream 2BX
V3	Stage Location of Stream 1AX	Volume Percent TBP
V4	Pu(IV) Conc. in Stream 1AF	Flow Rate of Stream 2AX
V5	HNO_3 Conc. in Stream 1AIS	Flow Rate of Stream 2AF
V6	Stage Location of Stream 1BX	Np(VI) Conc. in Stream 2AF
V7	HNO_3 Conc. in Stream 1AX	Pu(III) Conc. in Stream 2AF
V8	Flow Rate of Stream 1AF	Flow Rate of Stream 2AS

Because the plutonium(III) distribution coefficient is negligible for the second solvent extraction cycle, the neptunium(VI) distribution coefficient controlled the results of the second cycle. For example, the modified plutonium +50% and -50% distribution coefficient designs for second cycle were equivalent to the baseline design second cycle. The modified neptunium +50%, plutonium +50% and neptunium +50%, plutonium -50% distribution coefficient designs for the second cycle were equivalent to the neptunium +50% distribution coefficient design. The modified neptunium -50%, plutonium +50% and neptunium -50%, plutonium -50% distribution coefficient designs for the second cycle were equivalent to the modified neptunium -50% distribution coefficient design. The data for the sensitivity analysis of the nine designs is compiled in Appendix IV.

4.2 Optimization Routine

The neptunium and plutonium ratios as defined in Equations 26 and 27 were optimized in the first solvent extraction cycle. For the second solvent extraction cycle, the values optimized were the neptunium and plutonium ratios as defined in Equations 26 and 28, respectively. The optimization procedure was the same for both cycles. First, the neptunium and plutonium ratios were optimized by perturbing only the first parameter, V1, and keeping the parameters V2 through V8 constant. When the ratios were at their maximum value, the next parameter, V2, was perturbed, keeping V1 and V3 through V8 constant. This procedure was repeated, going through all eight parameters, until the maximum values for the neptunium and plutonium ratios were achieved.

Both solvent extraction cycles employ 32 stages per cycle, as illustrated in Figures 12 and 13 by a schematic drawing of the first and second solvent extraction cycles. For the first solvent extraction cycle, the feed stream (Stream 1AF) was fed into stage 23, the fission products and other actinides product stream (Stream 1AW) was removed at stage 32, the neptunium and plutonium product stream (Stream 1BP) was removed from stage 16, and the organic recycle product stream (Stream 1BU) was removed from stage 1. The organic solvent, TBP, was introduced into the system via stream 1AX. Sodium nitrite, a compound used to increase the equilibrium nitrate ion concentration, entered the system in Stream 1A. The nitric acid concentrations were adjusted using Streams 1AS and 1AIS. Hydroxylamine nitrate entered the system through Stream 1BX and was used for maintaining the proper valence states for the plutonium and neptunium. Stream 1AP was used to connect mixer-settler bank 1A to mixer-settler bank 1B. For the second cycle, the feed stream (Stream 2AF) was fed into stage 22, the plutonium product stream (Stream 2AP) was removed from stage 32, the neptunium product stream (Stream 2BP) was removed from stage 16, and the organic recycle product stream (Stream 2BU) was removed from stage 1. The organic solvent, TBP, was introduced into the system via stream 2AX. The nitric acid concentrations were adjusted using Streams 2AS and 2AIS. Hydroxylamine nitrate entered the system through Stream 2BX and was used for maintaining the proper valence states for the plutonium and neptunium. Stream 2AU was used to connect mixer-settler bank 2A to mixer-settler bank 2B

The flow rates and concentrations for each stream illustrated in Figures 12 and 13 are listed in Table 12. Plots of the concentration profiles for nitric acid, neptunium(VI) and

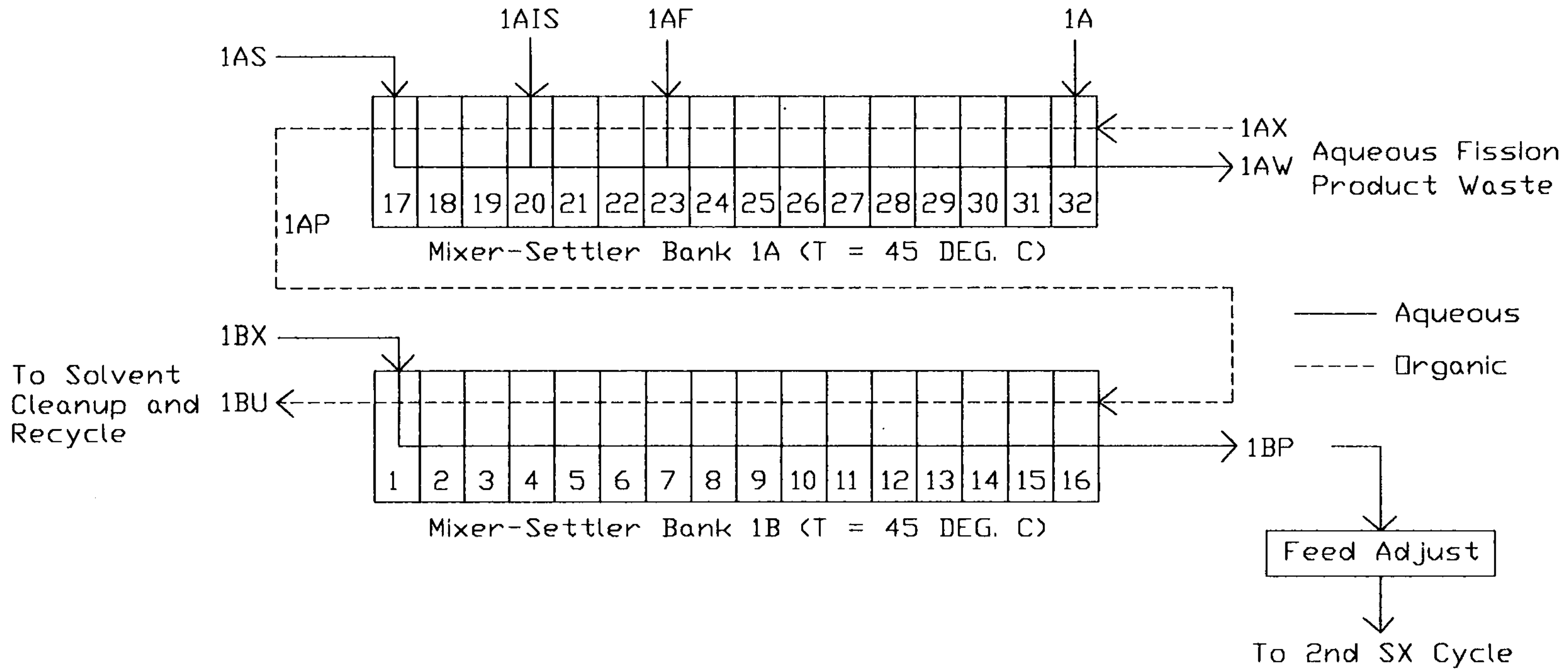

Figure 12. 1st SX Cycle, Baseline Design

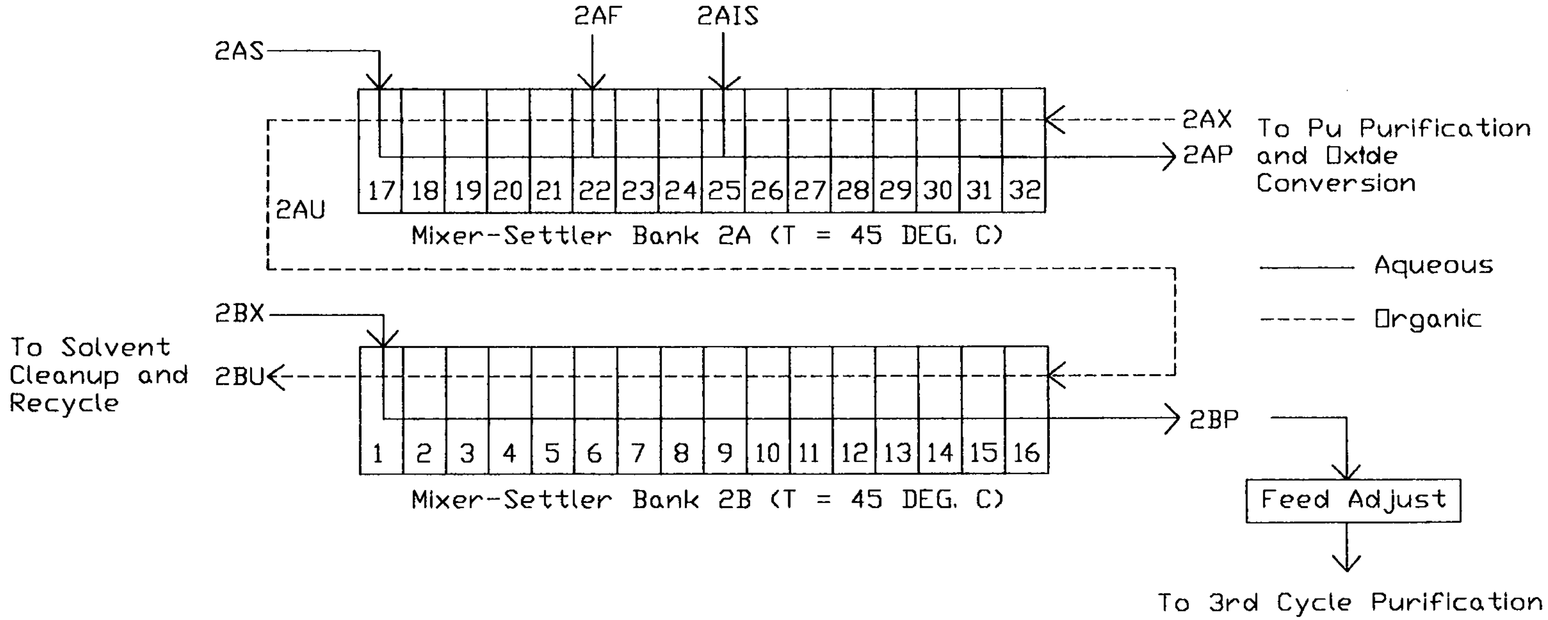

Figure 13. 2nd SX Cycle, Baseline Design

Table 12. Flow Rates and Concentrations for Each Stream in the 1st and 2nd SX Cycles

1st Cycle								
Coextraction								
Stream	Flow, L/min	HNO3, M	Np(VI), g/L	Pu(IV), g/L	HAN, M	NaNO2, M	vol % TBP	Stage Loc.
1AF	0.001	3.5	173	23				23
1AS	0.00217	0.5						17
1AIS	0.001	5						20
1A	0.00033					0.2		32
1AX	0.014	0.001					0.3	32
1AW	0.0085	1.05						32
Costrip								
1BX	0.014	0.03			0.1			1
1BP	0.014	0.3772	12.36	1.613	0.1			16
1BU	0.014	0.00085						1
Feed Adjust								
HNO3		15.8						
2nd Cycle								
Partition Pu								
Stream	Flow, L/min	HNO3, M	Np(VI), g/L	Pu(III), g/L	HAN, M	NaNO2, M	vol % TBP	Stage Loc.
2AF	0.008	0.5	43.51	8.01				22
2AS	0.00217	0.1			0.1	0.03		17
2AIS	0.00133	8						25
2AX	0.02	0.001					0.36	32
2AP	0.0115	1.209		5.572	0.025			32
Strip, Np								
2BX	0.014	0.2			0.1			1
2BP	0.014	0.2458	24.86					16
2BU	0.014	0.0166						1
Feed Adjust								
HNO3		15.8						

plutonium(IV) in the aqueous and organic phases for both cycles are illustrated in Figures 14 through 19. The important information to gain from these figures is what stage the maximum aqueous concentration for the neptunium and plutonium occur because this is the stage where the output streams are likely to be taken from. From Figures 15 and 16, the output stage to take the neptunium and plutonium for the first cycle is stage 16. From Figure 18, the neptunium needs to be taken from stage 16 for the second cycle. The plutonium for the second cycle appears to have a higher concentration in stages 22 through 24, as illustrated in Figure 19, but is taken out at stage 32 because stage 32 has a higher flow rate. Thus, the actual amount of plutonium in terms of grams per minute is higher. The reason there is no organic contribution from the plutonium in Figure 19 is because the distribution coefficient for the plutonium is zero. Thus, the plutonium remains in the aqueous phase throughout the cycle.

Results from the optimization routine are listed in Appendix V. For the first cycle, the feed stream solute concentrations of 173.0 g/L neptunium(VI) and 23.0 g/L plutonium(IV) with a flow rate of 0.001 L/min at stage 23 resulted in output stream solute concentrations of 12.36 g/L neptunium(VI) and 1.613 g/L plutonium(IV) with a flow rate of 0.014 L/min at stage 16. For the second cycle, the input concentrations for stage 22 were 43.51 g/L neptunium(VI) and 8.01 g/L plutonium(III) with a flow rate of 0.008 L/min. The output concentration of plutonium(III) for stage 32 was 5.572 g/L with a flow rate of 0.0115 L/min. For stage 16, the concentration of neptunium(VI) was 24.86 g/L with a flow rate of 0.014 L/min. The input decks for the optimized first and second solvent extraction cycles as well as the output data are listed in Appendix VI.

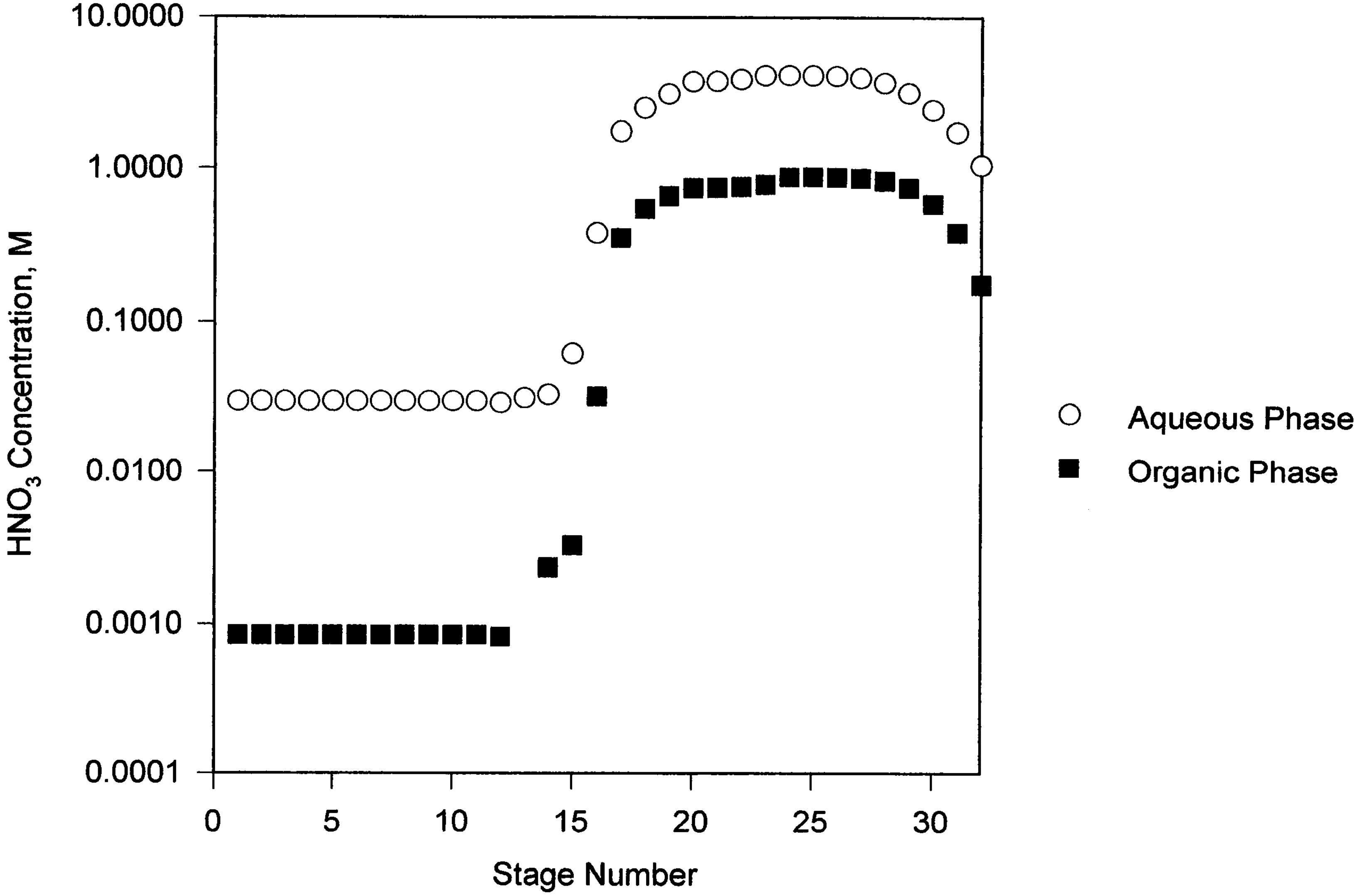

Figure 14. 1st SX Cycle, HNO_3 Concentration Profile

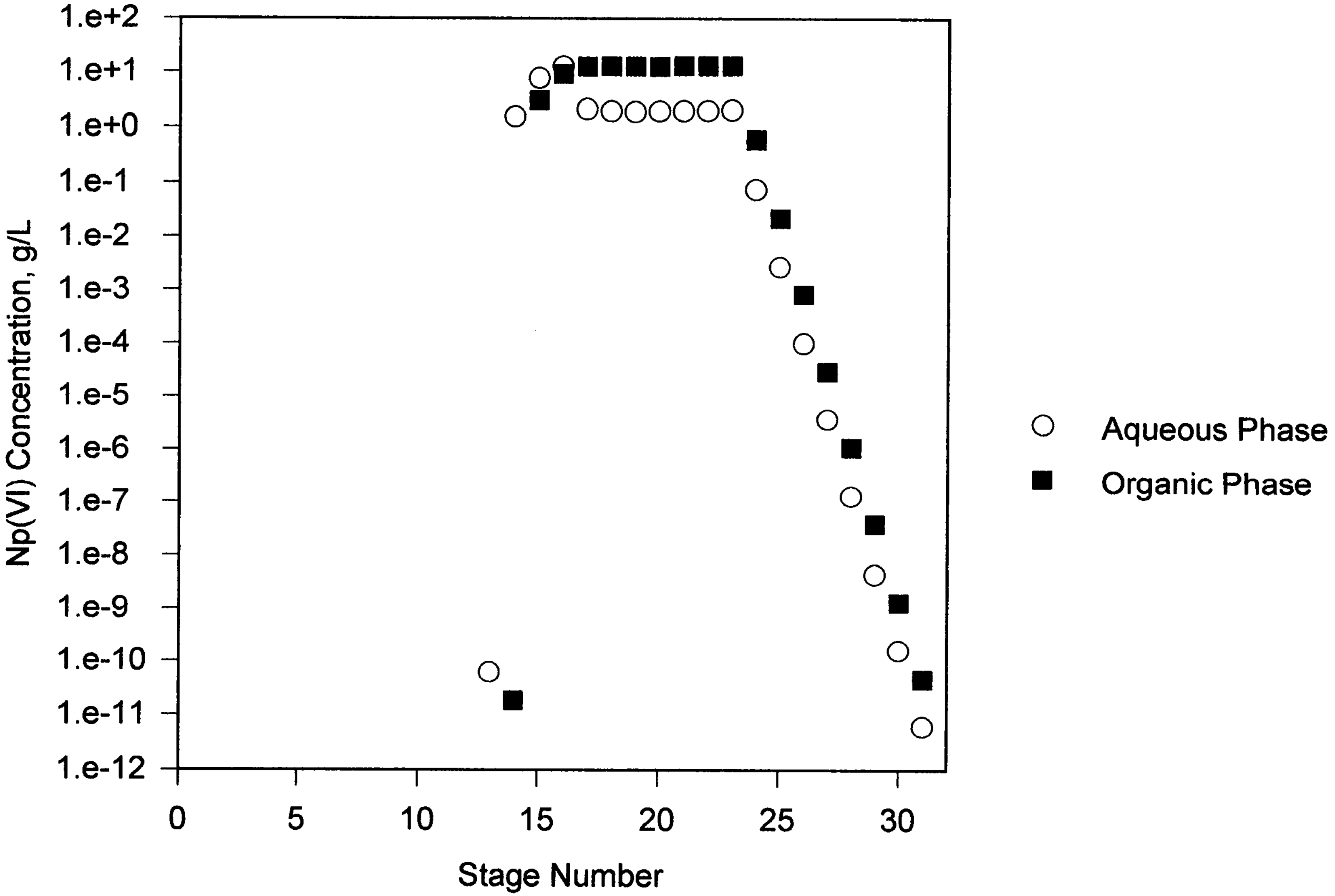

Figure 15. 1st SX Cycle, Np(VI) Concentration Profile

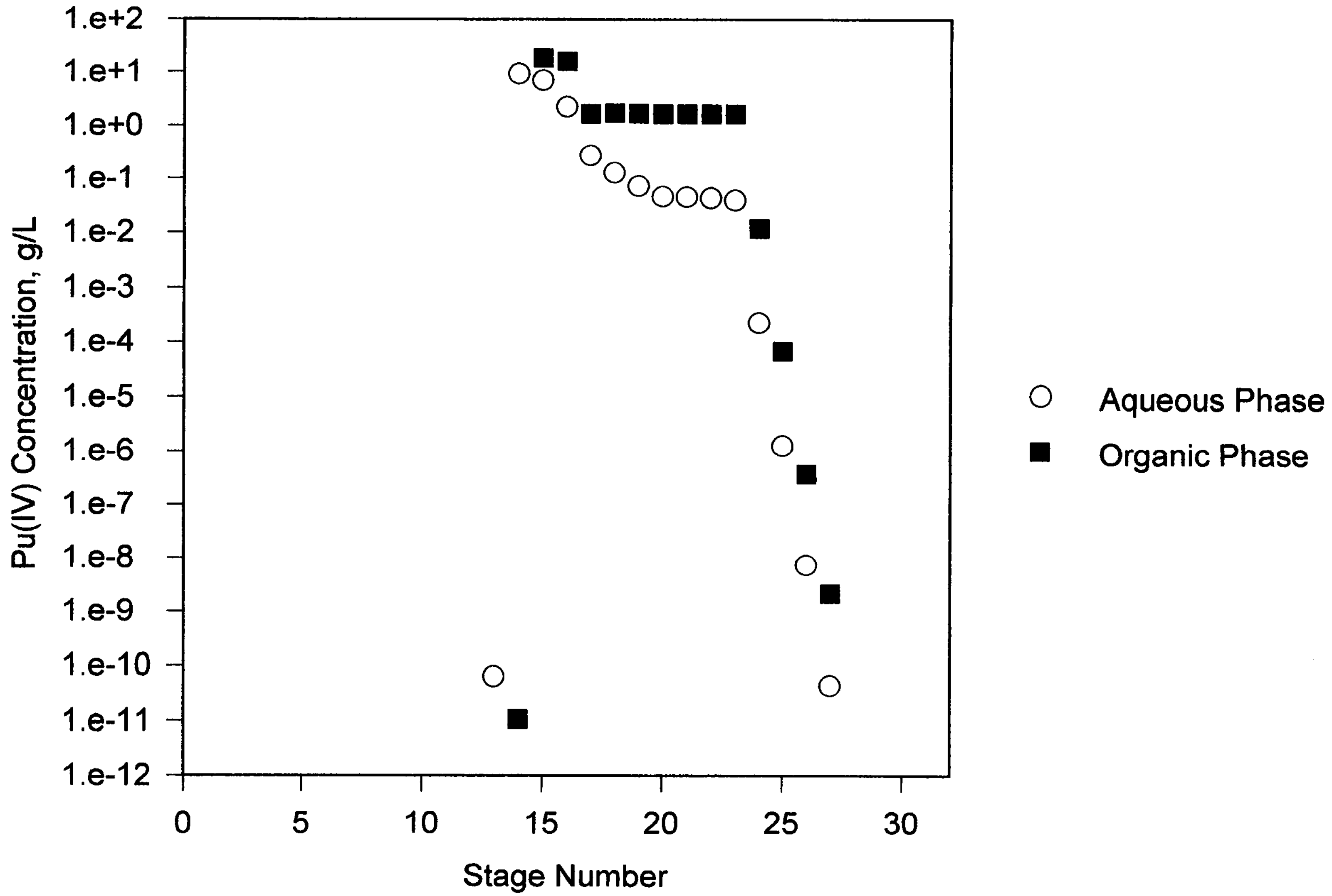

Figure 16. 1st SX Cycle, Pu(IV) Concentration Profile

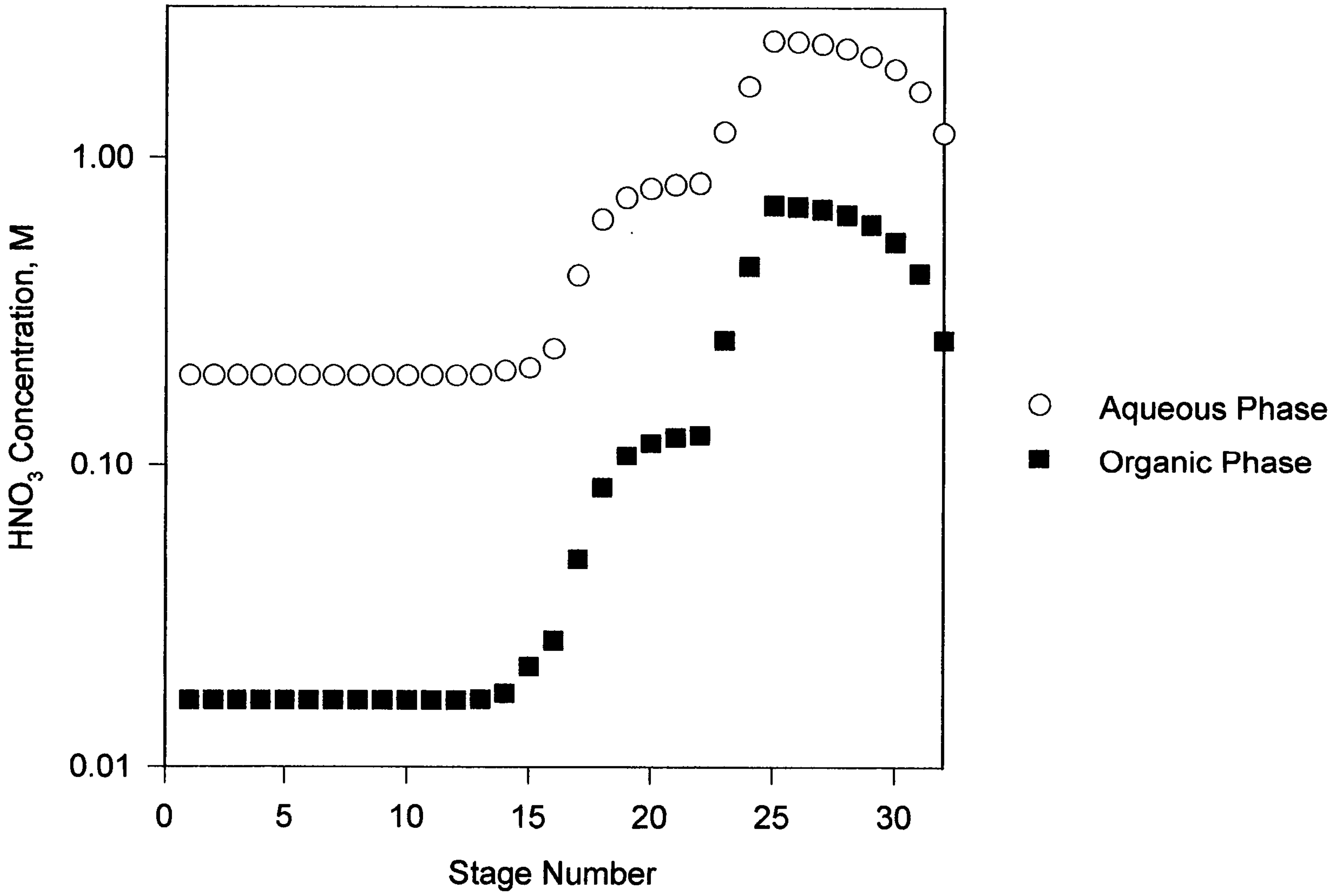

Figure 17. 2nd SX Cycle, HNO$_3$ Concentration Profile

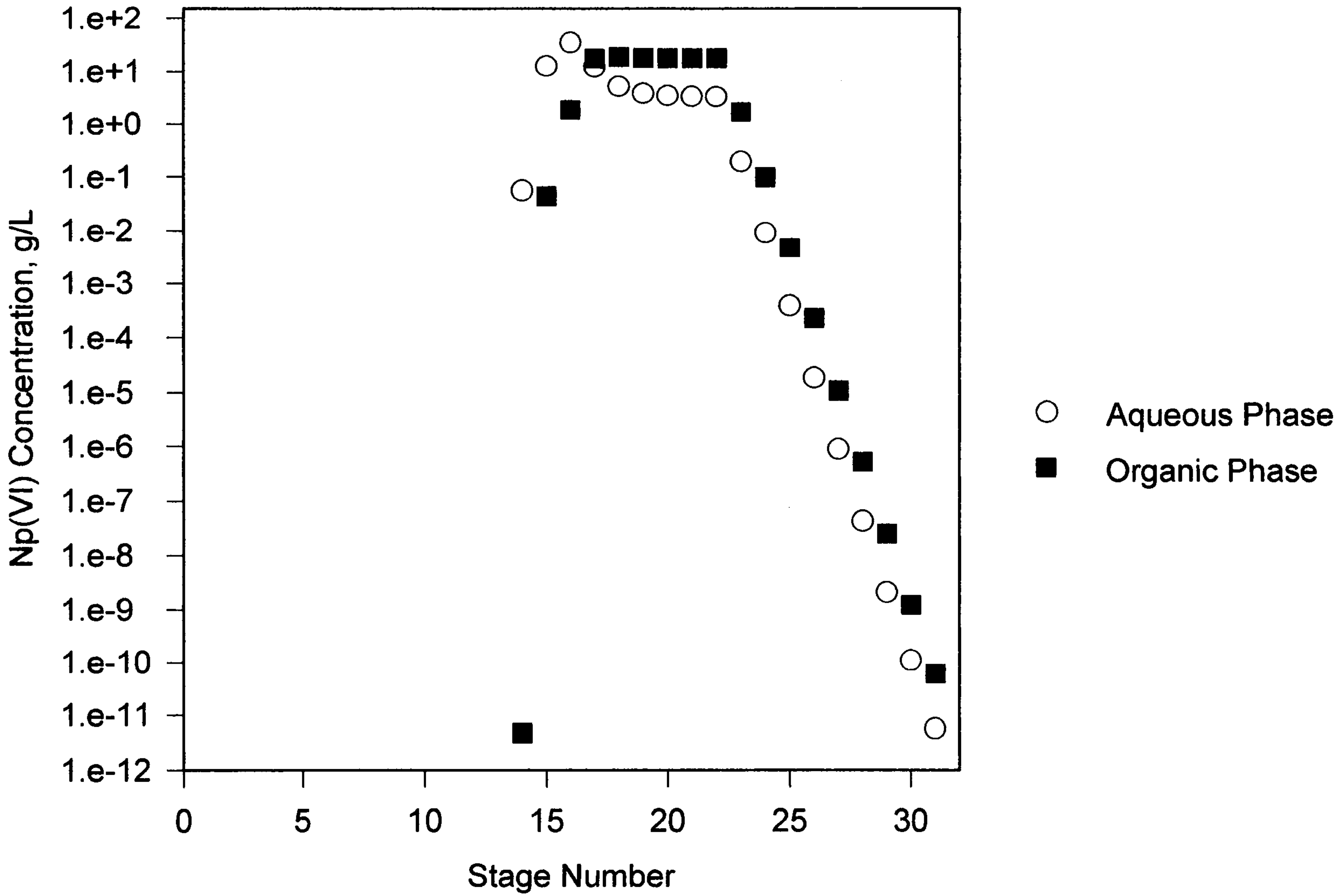

Figure 18. 2nd SX Cycle, Np(VI) Concentration Profile

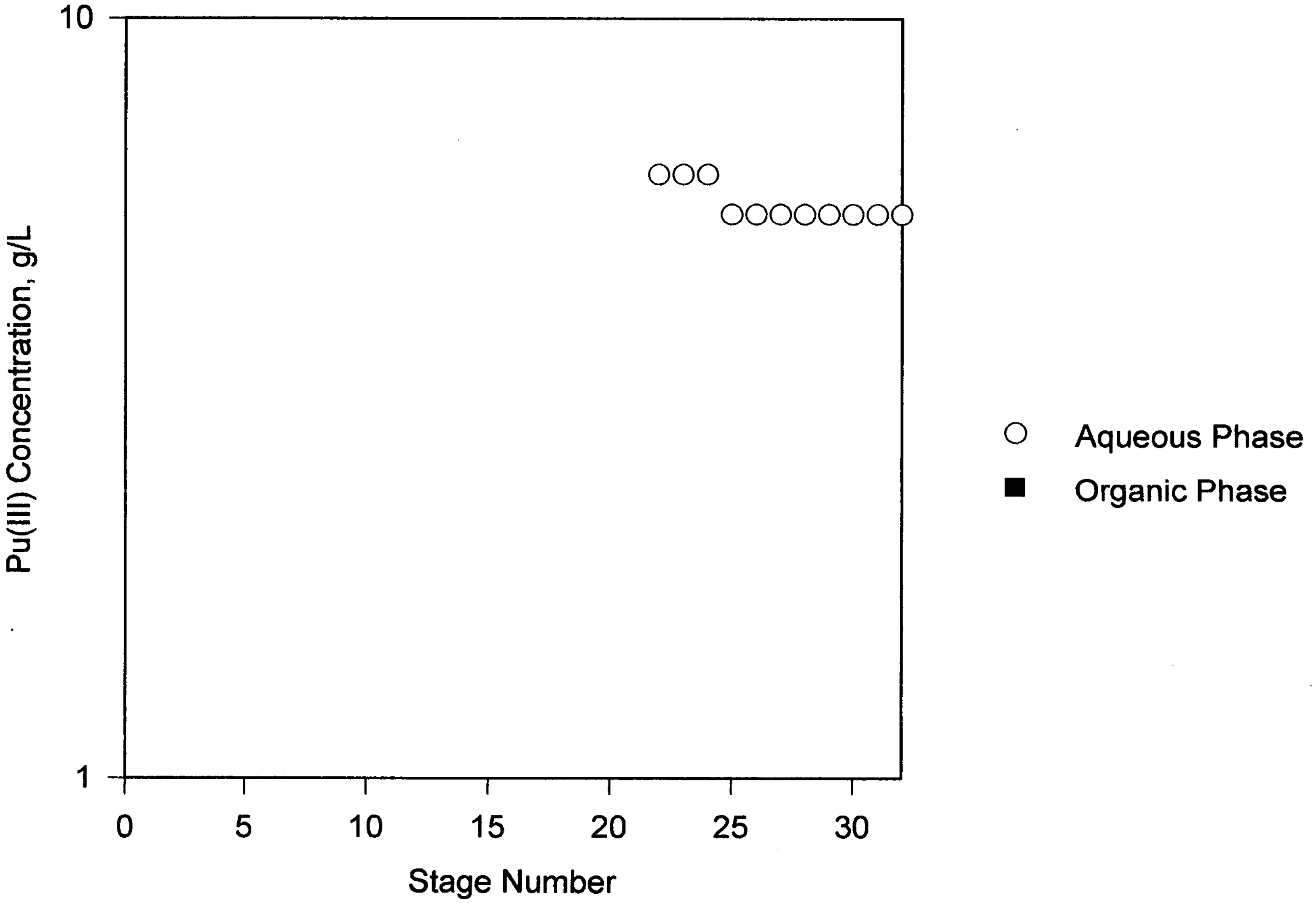

Figure 19. 2nd SX Cycle, Pu(III) Concentration Profile

After the baseline design was performed with the distribution coefficients for neptunium and plutonium assumed to be correct, eight additional designs were evaluated in order to account for any irregularities occurring if the distribution coefficients for neptunium(VI) and plutonium(IV) were not correct. If the neptunium(VI) distribution coefficient was modified by +50%, several parameters change for both solvent extraction cycles. For the first cycle, the volume percent TBP changed to 23%, the flow rate of stream 1BX changed to 0.17 L/min., the stage location of stream 1BP changed to stage 20, and the stage location of stream 1AIS changed to stage 21. A schematic drawing of this design is illustrated in Figure 20. The following parameters changed for the second cycle: stage location of stream 2AF is stage 25, the volume percent TBP is 28%, the HNO_3 concentration in stream 2AIS is 10.6 M, the flow rate of stream 2AF is 0.0003 L/min., the temperature is 60°C, and the flow rate of 2AS is 0.0005 L/min. A schematic drawing of this cycle is illustrated in Figure 21.

If the neptunium(VI) distribution coefficient was modified by -50%, the following changes occur in the first cycle: the stage location of stream 1BU is stage 2, the volume percent TBP is 25%, the stage location of 1AF is stage 21, and the flow rate of 1AF is 0.0001 L/min. A schematic drawing of this cycle is illustrated in Figure 22. The parameters that changed in the second cycle were the stage location of stream 1BP is stage 17, the flow rate of stream 2BX is 0.012 L/min., the volume percent TBP is 48%, the flow rate of stream 2AF is 0.003 L/min., and the neptunium(VI) concentration in stream 1AF is 48.8 g/L. A schematic drawing of this cycle is illustrated in Figure 23.

If the plutonium distribution coefficient was modified by +50%, the changes in the

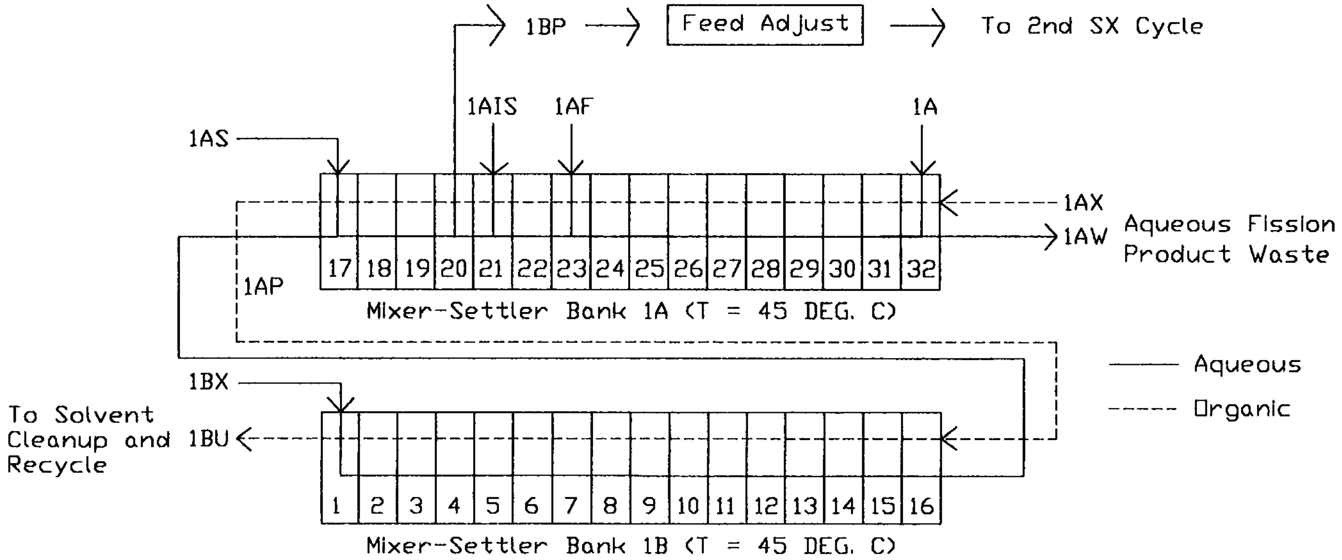

Figure 20. 1st SX Cycle, Np(VI) Distribution Coefficient Modified by +50%

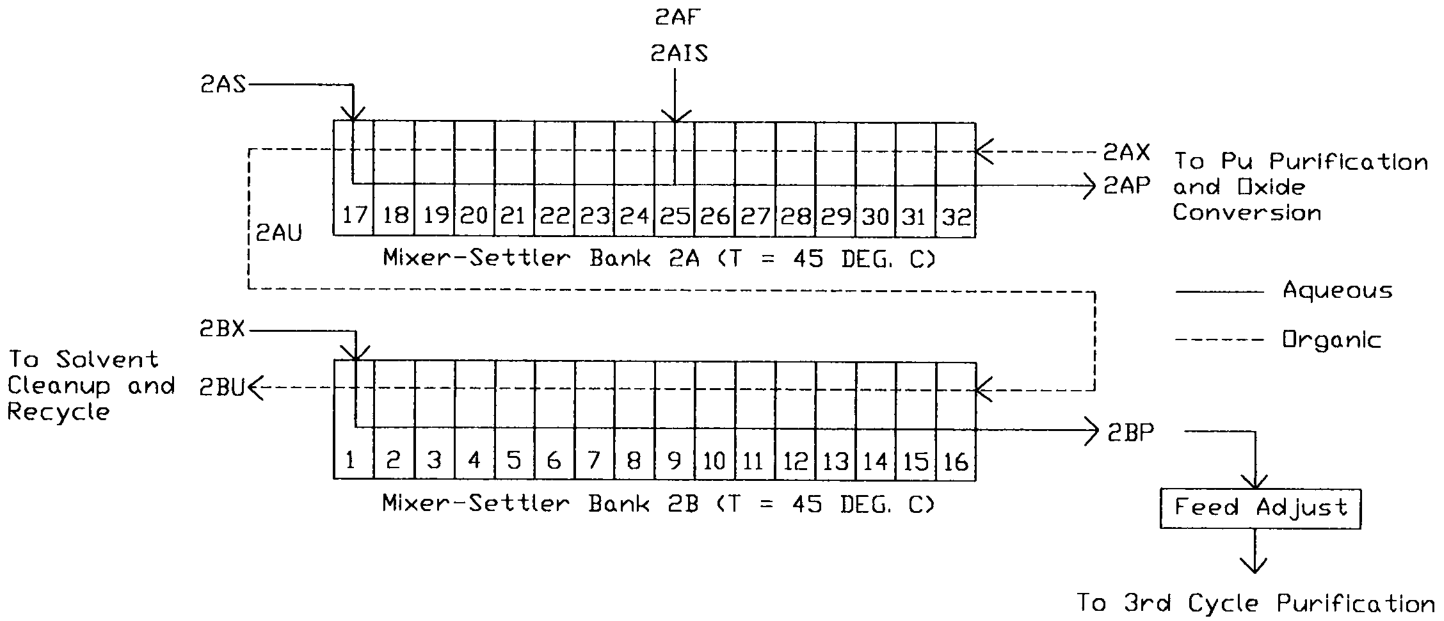

Figure 21. 2nd SX Cycle, Np(VI) Distribution Coefficient Modified by +50%

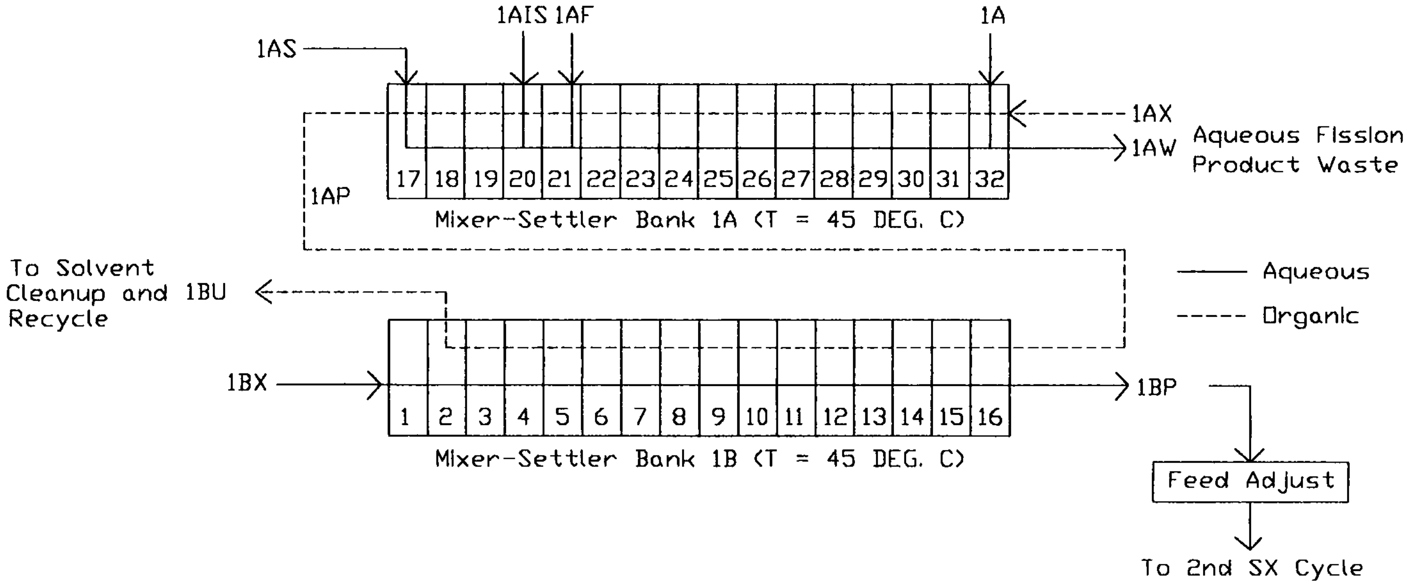

Figure 22. 1st SX Cycle, Np(VI) Distribution Coefficient Modified by -50%

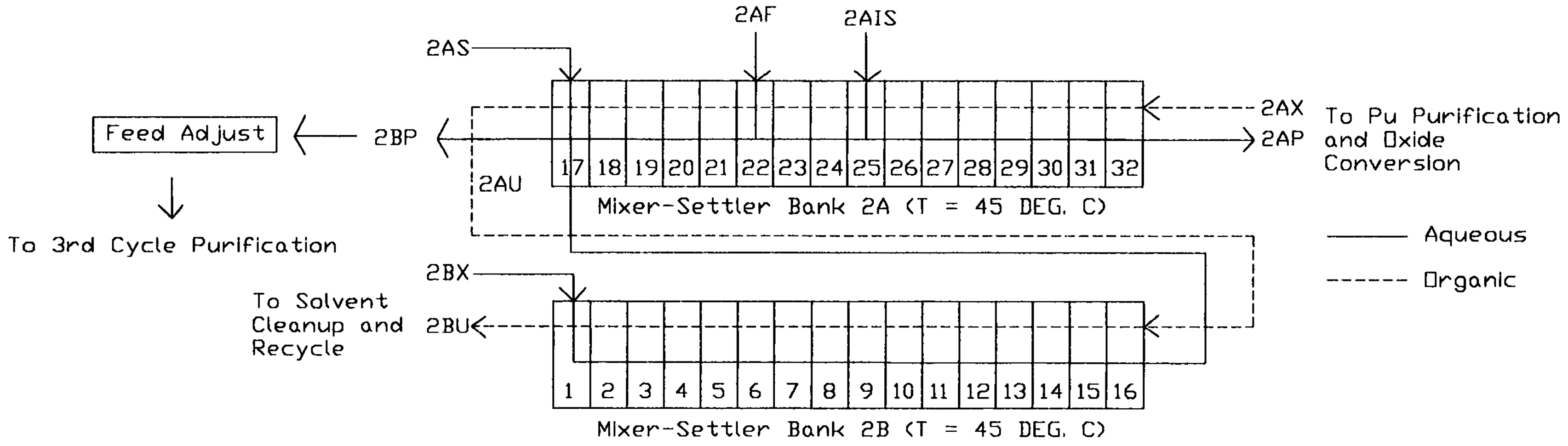

Figure 23. 2nd SX Cycle, Np(VI) Distribution Coefficient Modified by -50%

parameters for the first cycle were the temperature changed 28°C and the neptunium(VI) concentration in stream 1AF changed to 135 g/L. Because the distribution coefficient for plutonium(III) is zero, the second cycle was the same as the baseline design second cycle. A schematic drawing of first cycle is illustrated in Figure 24.

Deviations from the baseline design if the distribution coefficients for plutonium were modified by - 50% were the neptunium concentration in stream 1AF changed to 111 g/L, the stage location of stream 1AF changed to stage 21, and the HNO_3 concentration in stream 1BX changed to 0.1 M. A schematic drawing of this cycle is illustrated in Figure 25. The second cycle was the same as the second cycle for the baseline design.

If the distribution coefficients for neptunium and plutonium were both modified by +50%, the following changes occur in the first cycle: the stage location of stream 1BU is stage 2, the flow rate of stream 1BX is 0.024 L/min., the stage location of stream 1AF is stage 20, the stage location of stream 1AIS is stage 18, and the temperature is 50°C. A schematic of this cycle is illustrated in Figure 26. The second cycle was the same as the second cycle for the distribution coefficient of neptunium +50% design.

If the distribution coefficients for neptunium and plutonium were both modified by -50%, the following changes occur in the first cycle: the stage location of 1BU is stage 3, the volume percent TBP is 25%, the HNO_3 concentration in stream 1BX is 0.13 M, and the neptunium concentration in stream 1AF is 10 g/L. A schematic drawing of this cycle is illustrated in Figure 27. The second cycle was the same as the second cycle for the distribution coefficient of neptunium -50% design.

Deviations from the baseline design if the distribution coefficient for neptunium was

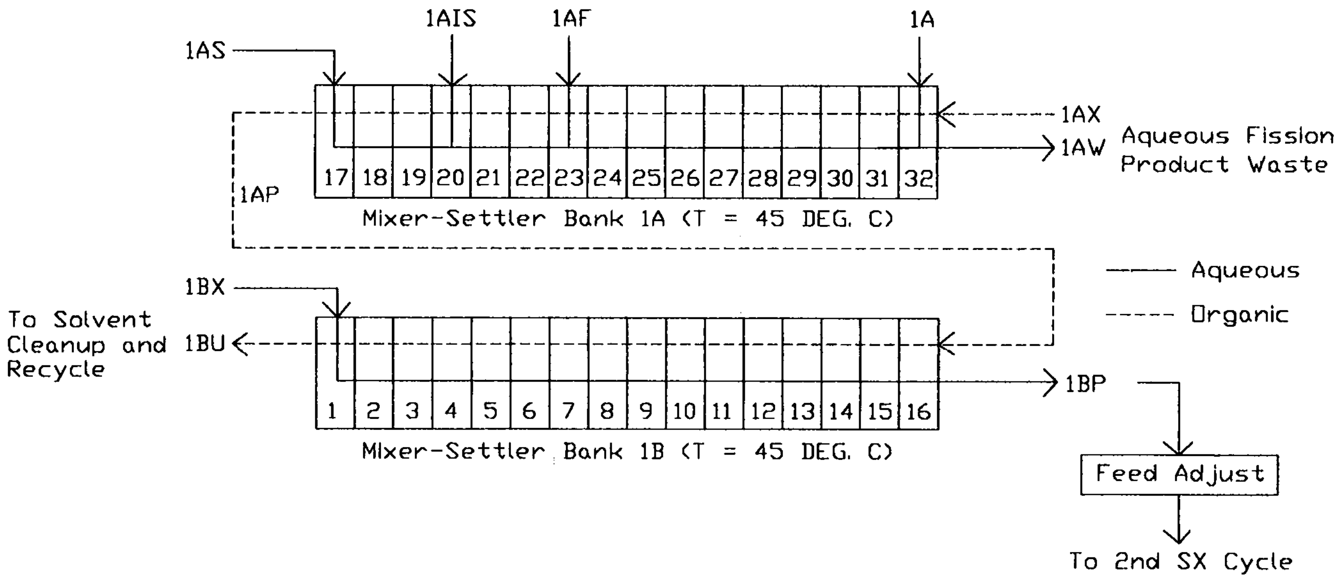

Figure 24. 1st SX Cycle, Pu(IV) Distribution Coefficient Modified by +50%

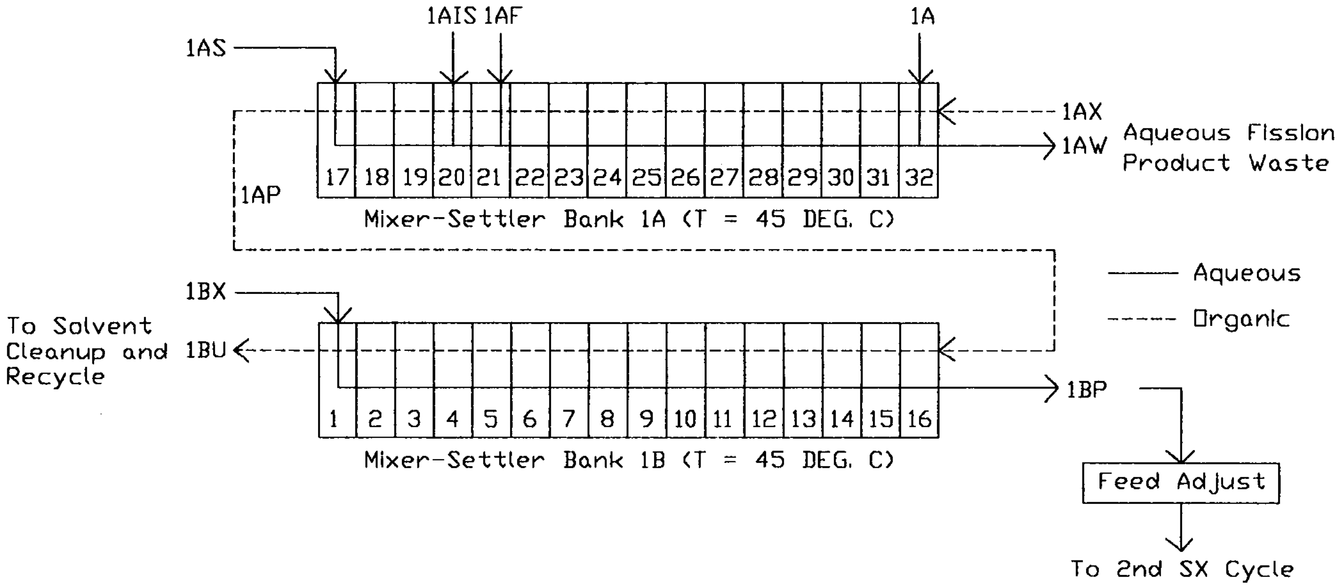

Figure 25. 1st SX Cycle, Pu(IV) Distribution Coefficient Modified by -50%

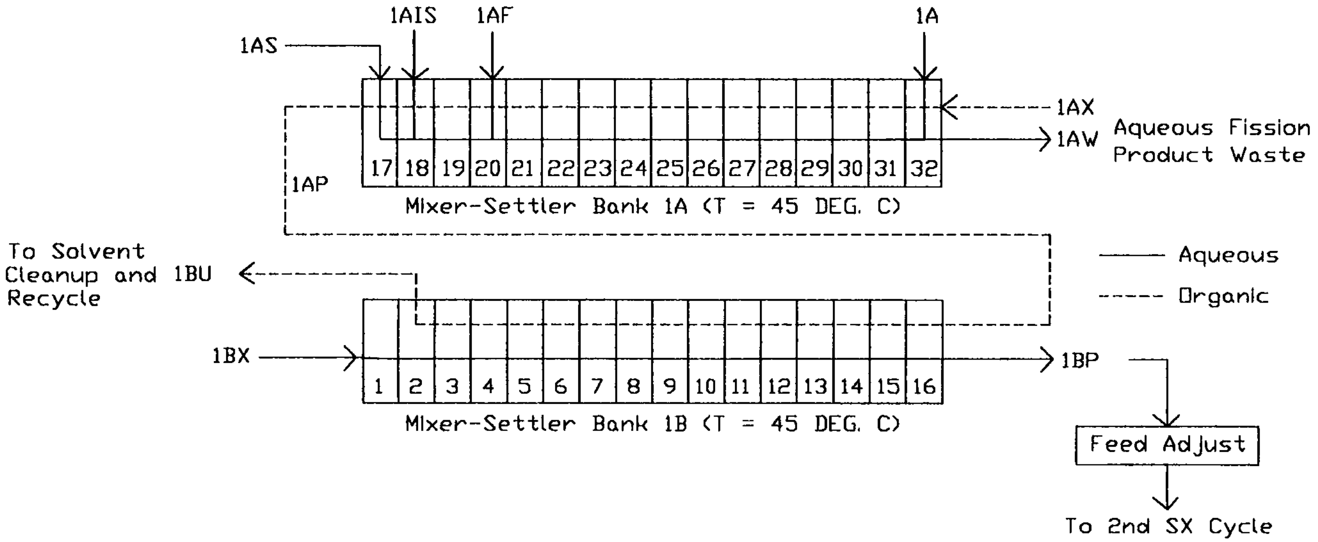

Figure 26. 1st SX Cycle, Np(VI) D.C. Modified by +50%, Pu(IV) D.C. Modified by +50%

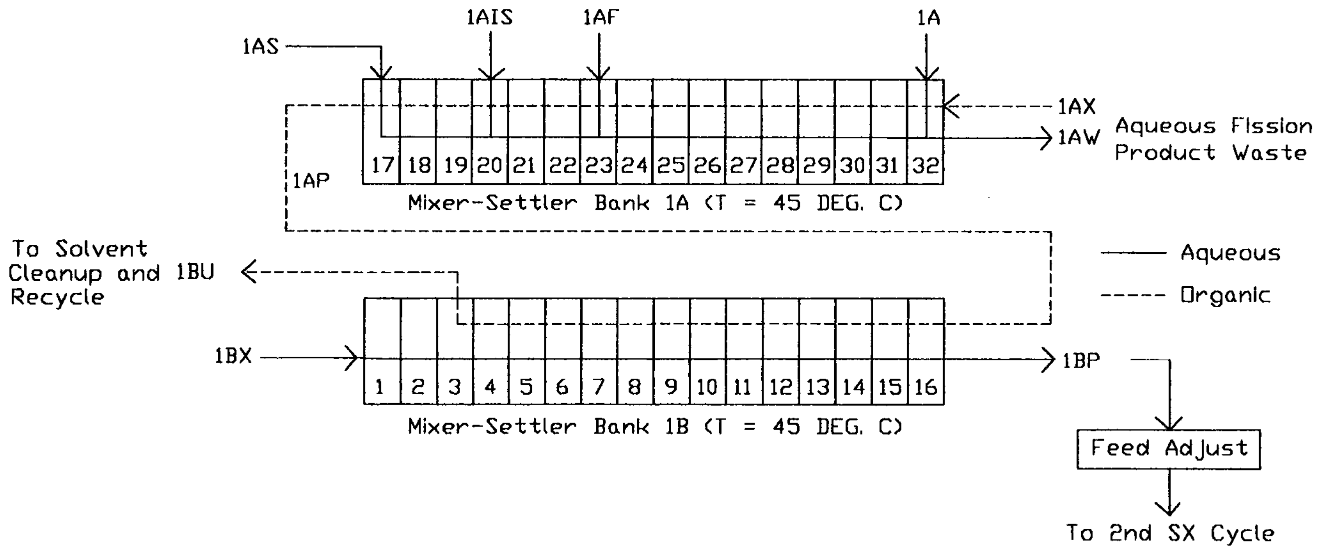

Figure 27. 1st SX Cycle, Np(VI) D.C. Modified by -50%, Pu(IV) D.C. Modified by -50%

modified by +50% and the distribution coefficient for plutonium was modified by - 50% were the volume percent TBP changed to 22%, the HNO_3 concentration in stream 1AIS changed to 7.0 M, the plutonium(IV) concentration in stream 1AF changed to 10 g/L, the flow rate of stream 1AF changed to 0.001 L/min., the flow rate of stream 1BX changed to 0.011 L/min., and the flow rate of stream 1AX changed to 0.019 L/min. A schematic drawing of this cycle is illustrated in Figure 28. The second cycle was the same as the second cycle for the distribution coefficient of neptunium +50% design.

If the distribution coefficient for neptunium was modified by -50% and the distribution coefficient for plutonium was modified by +50%, the following parameters changed for the first cycle: the stage location of stream 1BU changed to stage 2, the stage location of stream 1AX changed to stage 30, the plutonium concentration in stream 1AF changed to 35 g/L, and the flow rate of stream 1AF changed to 0.001 L/min. A schematic drawing of this cycle is illustrated in Figure 29. The second cycle was the same as the second cycle for the distribution coefficient of neptunium -50% design.

From these additional solvent extraction designs, it is important to know with certainty the value of the distribution coefficients for neptunium and plutonium in the system. Changes in these distribution coefficients have a tremendous impact on the design of both solvent extraction cycles. Table 13 summarizes the parameter changes for each design modification previously discussed.

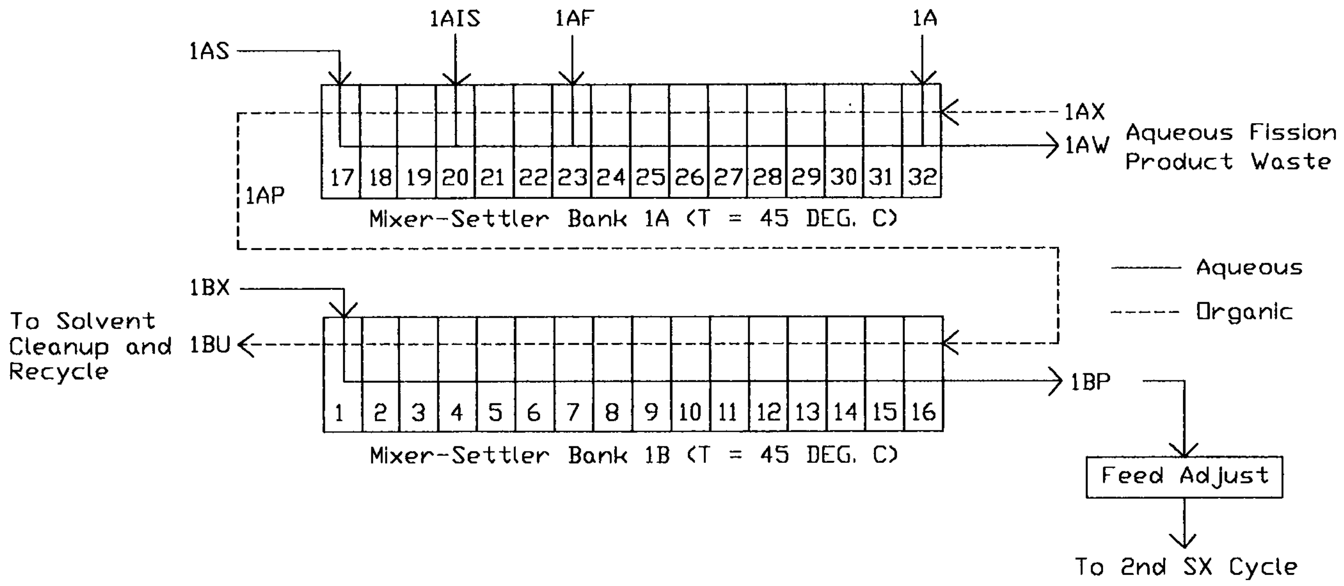

Figure 28. 1st SX Cycle, Np(VI) D.C. Modified by +50%, Pu(IV) D.C. Modified by -50%

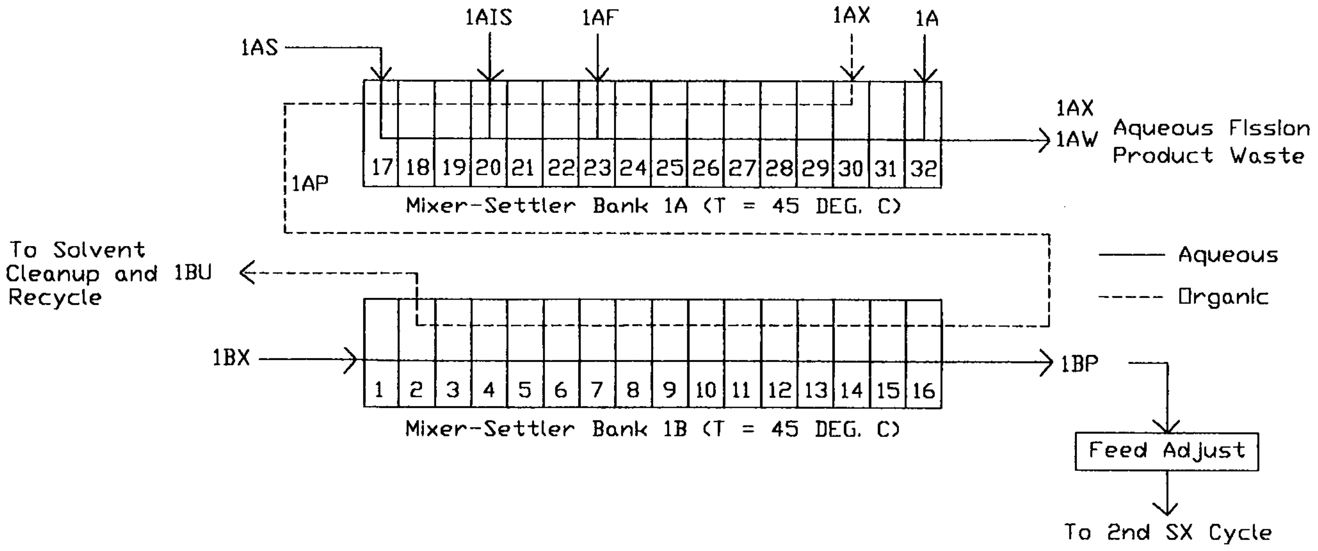

Figure 29. 1st SX Cycle, Np(VI) D.C. Modified by -50%, Pu(IV) D.C. Modified by +50%

Table 13. Summary of Parameter Modifications for Each Design

Design	Parameter Modification
1st Cycle, Np(VI) D.C. +50%	Volume Percent TBP = 23%
	Flow Rate of Stream 1BX = 0.17 L/min
	Stage Location of Stream 1BP = 20
	Stage Location of Stream 1AIS = 21
2nd Cycle, Np(VI) D.C. +50%	Stage Location of Stream 2AF = 25
	Volume Percent TBP = 28%
	HNO_3 Conc. In Stream 2AIS = 10.6 M
	Flow Rate of Stream 2AF = 0.0003 L/min
	Temperature = 60°C
	Flow Rate of Stream 2AS = 0.0005 L/min
1st Cycle, Np(VI) D.C. -50%	Stage Location of Stream 1BU = 2
	Volume Percent TBP = 25%
	Stage Location of Stream 1AF = 21
	Flow Rate of Stream 1AF = 0.0001 L/min
2nd Cycle, Np(VI) D.C. -50%	Stage Location of Stream 2BP = 17
	Flow Rate of Stream 2BX = 0.012 L/min
	Volume Percent TBP = 48%
	Flow Rate of Stream 2AF = 0.003 L/min
	Np(VI) Conc. In Stream 2AF = 48.8 g/L
1st Cycle, Pu(IV) D.C. +50%	Temperature = 28°C
	Np(VI) Conc. In Stream 1AF = 135 g/L
1st Cycle, Pu(IV) D.C. -50%	Np(VI) Conc. In Stream 2AF = 111 g/L

Table 13. (continued)

Design	Parameter Modification
1st Cycle, Pu(IV) D.C. -50%	Stage Location of Stream 1AF = 21
	HNO_3 Conc. In Stream 1BX = 0.1 M
1st Cycle, Np(VI) D.C. +50%, Pu(IV) D.C. +50%	Stage Location of Stream 1BU = 2
	Flow Rate of Stream 1BX = 0.024 L/min
	Stage Location of Stream 1AF = 20
	Stage Location of Stream 1AIS = 18
	Temperature = 50°C
1st Cycle, Np(VI) D.C. -50%, Pu(IV) D.C. -50%	Stage Location of Stream 1BU = 3
	Volume Percent TBP = 25%
	HNO_3 Conc. In Stream 1BX = 0.13 M
	Np(VI) Conc. In Stream 2AF = 10 g/L
1st Cycle, Np(VI) D.C. +50%, Pu(IV) D.C. -50%	Volume Percent TBP = 22%
	HNO_3 Conc. In Stream 1AIS = 7.0 M
	Pu(IV) Conc. In Stream 1AF = 10 g/L
	Flow Rate of Stream 1AF = 0.001 L/min
	Flow Rate of Stream 1BX = 0.011 L/min
	Flow Rate of Stream 1AX = 0.019 L/min
1st Cycle, Np(VI) D.C. -50%, Pu(IV) D.C. +50%	Stage Location of Stream 1BU = 2
	Stage Location of Stream 1AX = 30
	Pu(IV) Conc. In Stream 1AF = 35 g/L
	Flow Rate of Stream 1AF = 0.001 L/min

5. Conclusions

SEPHIS-MOD4 is a computer code which models the solvent extraction process using a mixer-settler type system. It was modified to include the plutonium and neptunium separations process. The major modification to the code was the addition of the subroutine UCORNP. UCORNP calculates the distribution coefficients of nitric acid, neptunium(VI), and plutonium(IV).

The calculated results for the distribution coefficients for nitric acid differed from the experimental results by 15.0%, for neptunium(VI) the difference was 37.94%, and for plutonium(IV) the difference was 23.81%. There were several reasons why the average percent errors appear high. First, the way in which the free TBP was calculated (Equation 22) was only an approximation and could introduce large errors in the final calculation of the distribution coefficient for each component. The least squares equation (Equation 17) used to fit the equilibrium constants and the equation used to determine the density of TBP as a function of temperature (Equation 21) were only approximations of the experimental values. Thus, the equation used to calculate the free TBP is also only an approximation to the actual free TBP. Second, some of the experimental distribution coefficients are estimated by reading the numerical values off of a graph because there were not numeric values for the distribution coefficients available. Also, some of the experimental distribution coefficients could be considered outliers which would also make the average percent errors appear high.

With the use of SEPHIS-MOD7, a sensitivity analysis was performed in order to determine which input parameters need to be adjusted to perform the optimization routine.

Once the most sensitive parameters for each cycle were identified, the two solvent extraction cycles were optimized to determine the maximum values for the parameters to accomplish the separation of plutonium and neptunium.

For the first cycle, which was designed to separate the plutonium and neptunium from the fission products and other actinides, the feed stream solute concentrations of 173.0 g/L neptunium(VI) and 23.0 g/L plutonium(IV) with a flow rate of 0.001 L/min at stage 23 resulted in output stream solute concentrations of 12.36 g/L neptunium(VI) and 1.613 g/L plutonium(IV) with a flow rate of 0.014 L/min at stage 31. For the second cycle, which was designed to separate the plutonium from the neptunium, the input concentrations for stage 22 were 43.51 g/L neptunium(VI) and 8.01 g/L plutonium(III). The output concentration of plutonium(III) for stage 32 was 5.572 g/L with a flow rate of 0.0115 L/min. For stage 16, the concentration of neptunium(VI) was 24.86 g/L with a flow rate of 0.014 L/min. Assuming the solvent extraction process will run for 180 days per year, the production of ^{238}Pu would be 16.6 kg per year, which exceeds the current need of approximately 3 kg per year.

After a baseline design was performed with the distribution coefficients for neptunium(VI) and plutonium(IV) assumed to be correct, eight additional designs were completed in order to account for any irregularities occurring if the distribution coefficients for neptunium(VI) and plutonium(IV) were not correct. In these eight designs, the distribution coefficients were modified in the following ways: 1) Np(VI) distribution coefficient modified by +50%, 2) Np(VI) distribution coefficient modified by -50%, 3) Pu(IV) distribution coefficient modified by +50%, 4) Pu(IV) distribution coefficient modified by -50%, 5) Np(VI) distribution coefficient modified by +50% and Pu(IV) distribution coefficient modified by +50%, 6) Np(VI) distribution coefficient modified by -50% and Pu(IV) distribution coefficient modified by -50%, 7) Np(VI) distribution coefficient modified by +50% and Pu(IV) distribution coefficient modified by -50%, 8) Np(VI) distribution coefficient modified by -50% and Pu(IV) distribution coefficient modified by +50%.

From these additional solvent extraction designs, it is important to know with certainty the value of the distribution coefficients for neptunium and plutonium in the system. Changes in these distribution coefficients have a tremendous impact on the design of both solvent extraction cycles.

There are a couple of areas of interest that need to be examined in the future. A small scale solvent extraction process needs to be performed in order to verify the theoretical results of the baseline design presented in this thesis. Also, work needs to be done on the stabilization of valence states for neptunium and plutonium to verify that they will remain in their proper valence states throughout the solvent extraction process. Finally, the equation used to fit the equilibrium constants as a function of temperature and nitrate ion concentration (Equation 17) could possibly be improved to obtain a more precise fit to the experimental equilibrium constants.

REFERENCES

REFERENCES

Akatsu, E., Radiochemical Studies of Neptunium, JAERI-1099, 1965.

Alcock, K., Best, G.F., Hesford, E., McKay, H.A.C., Tri-*n*- butyl Phosphate as an Extraction Solvent for Inorganic Nitrates-V, J. Inorg. Nucl. Chem., **6**, 1958, pp. 328-333.

Best, G.F., McKay, H.A.C., Woodgate, P.R., Tri-*n*- butyl Phosphate as an Extraction Solvent for Inorganic Nitrates-III, J. Inorg. Nucl. Chem., **4**, 1957, pp. 315-320.

Bond, W., Oak Ridge National Laboratory, Private Communication.

Felker, L.K., Oak Ridge National Laboratory, Private Communication.

Groenier, W.S., Mitchell, A.D., Jubin, R.T., Computational techniques used in the development of coprocessing flowsheets, Fast reactor fuel reprocessing symposium, Dounreay, UK, 1979.

Lee, J.H., A Mathematical Model for Equilibrium Distribution of Uranium(VI), Plutonium(IV), and Nitric Acid in Purex Solvent Extraction Processes, M.S. Thesis for UTK, 1987.

Martin, R., Oak Ridge National Laboratory, Private Communication.

Miles, J.H., Sharpe, B.P.K., The Distribution of HNO_3 at Low Concentrations Between H_2O and TBP OK, AERE-M2635, 1975.

Miller, L.F., The University of Tennessee, Private Communication.

Mitchell, A.D., SEPHIS-MOD4: A User's Manual to a Revised Model of the Purex Solvent Extraction System, ORNL-5471, 1979.

Patil, Ramakrishna, V.V., Avadhany, G.V.N., Ramaniah, M.V., Some Studies on the TBP Extraction of Actinides, J. Inorg. Nucl. Chem., **35**, 1973, pp. 2537-2545.

Petrich, G., Kolarik, Z., The 1981 Purex Distribution Data Index, KfK 3080, 1981.

ORNL, Y-12, Plutonium-238 Production Capabilities Of Martin Marietta Energy Systems, Inc., In The Oak Ridge Complex: Preliminary Considerations, USDOE Contract DE-AC05-84OR21400, 1994.

Schweitzer, G.K., The University of Tennessee, Private Communication.

Wham, B., Oak Ridge National Laboratory, Private Communication.

APPENDICES

APPENDIX I - INPUT VARIABLES USED IN SEPHIS-MOD7

APPENDIX I - INPUT VARIABLES USED IN SEPHIS-MOD7

Appendix I lists all the variables in the input decks necessary to run SEPHIS-MOD7. Each input deck consist of one or more rows on a data file.

A1. Description of Input Deck Variables

Input Deck #	Column #	Variable	Format
1	1-2	NTTL - Number of Title Decks	I2
	3-4	NTOST - Number of Stages	I2
	5-12	CTBP- Volume Fraction of TBP in Organic Phase	F8.0
	13-20	TEMPI - Intial Temperature	F8.0
	21-22	NSTR - Special Piping = 1 For Special Routing Indicated by ISTR and JSTR = 0 Otherwise	I2
	23-24	ISTR - Stage Number	I2
	25-26	JSTR - Stage Number	I2
	27-28	IRXN - Reaction Indicator = 0 For No Reaction = 1 For Instantaneous Reduction of Pu(IV) = 2 For Reduction of Pu(IV) by U(IV) (not available for Pu-Np separation process) = 3 For Reduction of Pu(IV) by Hydroxylamine	I2
	29-30	IPROCE - Process Indicator = 0 For Purex Process = 1 For Thorex Process = 2 For Pu-Np Process	I2

A1. (continued)

Input Deck #	Column #	Variable	Format
2	1-80	Title of the Run. The title can be up to 10 rows in length.	10A80
3	1-8	DTHETA - Time Increment in minutes	F8.0
	9-16	DPRINT - Time Between Printings of the Concentration Profiles	F8.0
	17-24	TSTOP - Time When the Calculation Will Be Stopped or a New Deck 3 will be read	F8.0
	25-32	TOL - Tolerance in Percent per minute. After the tolerance has been achieved for each stage, a new deck 3 will be read.	F8.0
	34	NEWIN = 1 For new feed streams to be specified = 0 For present feed streams to be continued	I2
	36	NEWOUT = 1 Same as NEWIN = 0 Same as NEWIN	I2
	38	IVOLM - Specifies How Mixer Volumes Will Be Given = 0 For the present mixer volumes to be continued = 1 For the new volumes to be given by phase = 2 For the new volumes to be given as total volume = 3 For the new volumes to be given by phase flow multiplied by unit time	I2
	40	IVOLS - Specifies How Mixer Volume Will Be Given. Same as IVOLM.	I2

A1. (continued)

Input Deck #	Column #	Variable	Format
	42	IPRO - Indicates How Concentration Profile Is Handled = 0 For the present concentration profile to be continued = 1 For a new initial profile to be read	I2
	44	IFAST - Integration Technique Indicator = 0 For Runge-Kutta integration = 1 For fast integration	I2
	46	IPNCH - Specifies How the Output Data is Handled = 1 For writing output results to a file	I2
4	1-2	I - Stage Number Where Stream Will Enter	I2
	4	JHAS - Phase Indicator = 0 For organic stream = 1 For aqueous stream	I2
	5-12	FDRT - Flow Rate (L/min.)	F8.0
	13-20	CON1 - Concentration of Nitric Acid (M)	F8.0
	21-28	CON2 - Concentration of Uranium(VI), Thorium(VI), or Neptunium(VI) Depending On Which Process Is Selected (g/L)	F8.0
	29-36	CON3 - Concentration of Pu(IV) (g/L)	F8.0
	37-44	CON4 - Concentration of Pu(III) (g/L)	F8.0
	45-52	CON5 - Concentration of Plutonium Reductant (M)	F8.0

A1. (continued)

Input Deck #	Column #	Variable	Format
	53-60	CON6 - Concentration of Inextractable Nitrate Ion (M)	F8.0
	61-68	TEMP - Stream Temperature (°C)	F8.0
	70	INDEX = 0 For last feed stream = 1 For more feed streams	I2
5	1-2	I - Stage Number Where Stream Will Exit	I2
	4	JHAS - Same as for deck 4	I2
	5-12	OTRT - Flow Rate of Product Stream	F8.0
	14	INDEX - Same as for deck 4	I2
6	1-10	CON1 - Same as for deck 4	F10.0
	11-20	CON2 - Same as for deck 4	F10.0
	21-30	CON3 - Same as for deck 4	F10.0
	31-40	CON4 - Same as for deck 4	F10.0
	41-50	CON5 - Same as for deck 4	F10.0
	51-60	CON6 - Same as for deck 4	F10.0
	61-70	TPROF - Stage Temperature (°C)	F10.0
7	1-10	CON1 - Same as for deck 4	F10.0
	11-20	CON2 - Same as for deck 4	F10.0
	21-30	CON3 - Same as for deck 4	F10.0
	31-40	CON4 - Same as for deck 4	F10.0
	41-50	CON5 - Same as for deck 4	F10.0
	51-60	CON6 - Same as for deck 4	F10.0

A1. (continued)

Input Deck #	Column #	Variable	Format
	61-70	EQCKDG - Check On How the Profile Decks Were Created. The user should leave this column blank.	F10.0
8	2	ISEC = 1 For mixer volumes = 2 For settler volumes	I2
	3-4	I = Stage Number	I2
	5-12	VOLA - If IVOLM and ISEC = 1 or If IVOLS = 1 and ISEC = 2, VOLA is the aqueous volume. If IVOLM = 2 and ISEC = 1 or If IVOLS = 2 and ISEC = 2, VOLA is the total volume	F8.0
	13-20	VOLO - Organic volume if IVOLM = 1 and ISEC = 1 or IVOLS = 1 and ISEC = 2	F8.0
	22	INDEX = 0 For last volume deck = 1 For more volume decks	I2

Source: Mitchell, A.D., SEPHIS-MOD4: A User's Manual to a Revised Model of the Purex Solvent Extraction System, ORNL-5471, 1979.

After the title decks have been read, a new case is started and all volumes, flow rates, and concentrations are set to zero. Deck 4 will be read only if the variable NEWIN is equal to one. Deck 5 will be read only if the variable NEWOUT is equal to one. Deck 6 will be read only if the variable IPRO is equal to one. An aqueous deck 6 followed by an organic deck 7 is required for every stage. Deck 8 will be read only if the variables IVOLM or IVOLS is equal to one or two.

APPENDIX II - CONSTANTS USED IN EQUATION 17

APPENDIX II - CONSTANTS USED IN EQUATION 17

Constants for HNO_3:

$a_0 = 72.19487$
$a_1 = -0.2238327$
$a_2 = -4.210904$
$a_3 = -1512.604$
$a_4 = -1.595873$
$a_5 = 0.05232612$
$a_6 = -0.8077916$
$a_7 = 0.215524$
$a_8 = 0.0162929$
$a_9 = -3.961013$
$a_{10} = 11363.88$
$a_{11} = 0.0124245$
$a_{12} = 0.05957543$
$a_{13} = -0.002623366$
$a_{14} = -0.003938755$
$a_{15} = 0.00006520745$
$a_{16} = 423.7596$
$a_{17} = -743.8411$
$a_{18} = -0.0008556247$
$a_{19} = 94.28416$
$a_{20} = -0.0002340483$

Constants for Np(VI):

$a_0 = -29.86232$
$a_1 = -7.800776$
$a_2 = 13.53559$
$a_3 = -84.56807$
$a_4 = 0.7924156$
$a_5 = 0.4818631$
$a_6 = 26.08377$
$a_7 = -0.274043$
$a_8 = -0.001932932$
$a_9 = 0.2480607$
$a_{10} = 10265.63$

Constants for Np(VI) (continued)

a_{11} = -0.006301722
a_{12} = -0.0320547
a_{13} = 0.001043368
a_{14} = 0.03413454
a_{15} = -0.001742249
a_{16} = -4457.717
a_{17} = 561.0553
a_{18} = -0.003864386
a_{19} = -21.10663
a_{20} = 0.0006263125

Constants for Pu(IV):

a_0 = -33.51877
a_1 = -16.76609
a_2 = -22.38786
a_3 = -105.5576
a_4 = 1.250248
a_5 = 0.79444
a_6 = 1620.61
a_7 = -0.548046
a_8 = 3.885108
a_9 = -5.131427
a_{10} = 11095.54
a_{11} = -0.01980451
a_{12} = 0.3592142
a_{13} = 0.01346773
a_{14} = -0.1615469
a_{15} = -0.0000236749
a_{16} = -23017.89
a_{17} = 3774.782
a_{18} = -0.001810966
a_{19} = -175.859
a_{20} = -0.004664264

APPENDIX III - EXPERIMENTAL AND CALCULATED DISTRIBUTION COEFFICIENTS FOR NITRIC ACID, NEPTUNIUM(VI), AND PLUTONIUM(IV)

A3. Experimental and Calculated Distribution Coefficients

HNO3							
					Exp.	Calc.	
Data Pt.	HNO3, M	Pu(IV), g/L	Temp, C	TBP, vol. %	Dist Coeff.	Dist Coeff	% Error
1	0.084	0	25	0.2	0.0212	0.0127	40.09434
2	0.0953	0	25	0.2	0.0231	0.0246	6.4935065
3	0.115	0	25	0.2	0.0279	0.0462	65.591398
4	0.279	0	25	0.2	0.056	0.0908	62.142857
5	0.3014	0	25	0.2	0.0591	0.0915	54.822335
6	0.3056	0	25	0.2	0.0559	0.0916	63.864043
7	0.3123	0	25	0.2	0.0613	0.0918	49.755302
8	0.377	0	25	0.2	0.0708	0.0937	32.344633
9	0.408	0	25	0.2	0.077	0.0947	22.987013
10	0.4468	0	25	0.2	0.0793	0.0962	21.311475
11	0.4696	0	25	0.2	0.0837	0.0971	16.009558
12	0.5016	0	25	0.2	0.0863	0.0984	14.020857
13	0.0989	0	20	0.216	0.0305	0.034	11.47541
14	0.1045	0	20	0.216	0.0321	0.0408	27.102804
15	0.2948	0	20.1	0.216	0.0729	0.1056	44.855967
16	0.3184	0	20.1	0.216	0.0768	0.107	39.322917
17	0.476	0	20.1	0.216	0.1001	0.1161	15.984016
18	0.5214	0	20.1	0.216	0.1044	0.1189	13.888889
19	0.0928	0	24.9	0.216	0.0274	0.0235	14.233577
20	0.0936	0	25	0.216	0.0273	0.0245	10.25641
21	0.1015	0	24.9	0.216	0.0293	0.0341	16.382253
22	0.104	0	24.9	0.216	0.0292	0.0371	27.054795
23	0.2966	0	25	0.2	0.0596	0.0914	53.355705
24	0.2968	0	25	0.2	0.0594	0.0914	53.872054
25	0.3019	0	25	0.2	0.0599	0.0915	52.754591
26	0.3034	0	25	0.2	0.06	0.0916	52.666667
27	0.4708	0	25	0.216	0.0901	0.1049	16.426193
28	0.099	0	25	0.207	0.0274	0.0298	8.7591241
29	0.1067	0	25.1	0.207	0.0296	0.0389	31.418919
30	0.1067	0	25.1	0.207	0.0289	0.0389	34.602076
31	0.1067	0	25.1	0.207	0.0293	0.0389	32.764505
32	0.2097	0	24.9	0.207	0.0506	0.0896	77.075099
33	0.2617	0	24.9	0.207	0.0578	0.0932	61.245675
34	0.2664	0	24.9	0.207	0.0604	0.0934	54.635762
35	0.2671	0	24.9	0.207	0.0663	0.0934	40.874811
36	0.3172	0	24.9	0.207	0.069	0.095	37.681159
37	0.3181	0	24.9	0.207	0.0707	0.095	34.37058
38	0.4031	0	24.9	0.207	0.0841	0.0977	16.171225
39	0.4548	0	25	0.207	0.0893	0.0998	11.758119
40	0.5212	0	25.1	0.207	0.0948	0.1029	8.5443038
41	0.598	0	24.9	0.207	0.1027	0.1062	3.4079844
42	0.6588	0	25	0.207	0.1141	0.1095	4.0315513
43	0.748	0	24.9	0.207	0.1197	0.1138	4.9289891
44	0.3795	0	25	0.2	0.0718	0.0938	30.640669

A3. (continued)

					Exp.	Calc.	
Data Pt.	HNO3, M	Pu(IV), g/L	Temp, C	TBP, vol. %	Dist Coeff.	Dist Coeff	% Error
45	0.4394	0	25	0.2	0.0795	0.0959	20.628931
46	0.4473	0	25	0.2	0.0796	0.0962	20.854271
47	0.5067	0	25	0.2	0.0874	0.0986	12.814645
48	0.5749	0	25	0.2	0.0938	0.1017	8.4221748
49	0.6245	0	25	0.2	0.0989	0.1041	5.2578362
50	0.7771	0	25	0.2	0.1112	0.1117	0.4496403
51	0.0939	0	29.9	0.216	0.025	0.0264	5.6
52	0.0957	0	29.9	0.216	0.0256	0.0287	12.109375
53	0.1036	0	29.9	0.216	0.0271	0.0393	45.01845
54	0.1037	0	30.1	0.216	0.0269	0.0394	46.468401
55	0.3009	0	30.1	0.2	0.0549	0.0981	78.688525
56	0.3025	0	30	0.2	0.0566	0.0982	73.498233
57	0.4728	0	29.9	0.216	0.0848	0.1126	32.783019
58	0.102	0	19.9	0.314	0.0583	0.0556	4.6312178
59	0.1094	0	20	0.314	0.0611	0.0676	10.638298
60	0.2795	0	19.9	0.314	0.1252	0.1553	24.041534
61	0.3313	0	19.8	0.314	0.1403	0.1621	15.538133
62	0.4764	0	19.8	0.314	0.1731	0.1749	1.0398614
63	0.522	0	19.8	0.314	0.181	0.1791	1.0497238
64	0.0879	0	25.1	0.314	0.0455	0.0261	42.637363
65	0.1042	0	25.1	0.314	0.0525	0.0546	4
66	0.2652	0	24.9	0.314	0.1048	0.1415	35.019084
67	0.3161	0	24.9	0.314	0.1195	0.144	20.502092
68	0.4676	0	24.8	0.314	0.1571	0.1517	3.4373011
69	0.5188	0	24.9	0.314	0.1661	0.1554	6.4419025
70	0.3068	0	30	0.314	0.1108	0.1544	39.350181
71	0.4852	0	30.1	0.314	0.1491	0.1646	10.395708
72	0.1	0	20	0.3	0.053	0.0491	7.3584906
73	0.02	0	22	0.3	0.013	2.61E-34	100
74	0.046	0	22	0.3	0.03	4.39E-06	99.985369
75	0.092	0	22	0.3	0.054	0.0312	42.222222
76	0.1	0	30	0.3	0.043	0.0479	11.395349
77	0.048	0	40	0.3	0.02	1.64E-05	99.91776
78	0.2	0	22	0.3	0.095	0.1226	29.052632
79	0.2	0	23	0.3	0.1	0.1229	22.9
80	0.101	0	30	0.3	0.045	0.0497	10.444444
81	0.101	0	40	0.3	0.04	0.0364	9
82	0.101	0	60	0.3	0.034	0.0345	1.4705882
83	0.3	0	20	0.3	0.12	0.1487	23.916667
84	0.364	0	22	0.3	0.151	0.1369	9.3377483
85	0.413	0	22	0.3	0.159	0.1399	12.012579
86	0.44	0	23	0.3	0.136	0.1403	3.1617647
87	0.3	0	30	0.3	0.101	0.1472	45.742574
88	0.389	0	30	0.3	0.13	0.1512	16.307692
89	0.394	0	40	0.3	0.114	0.1146	0.5263158

A3. (continued)

Data Pt.	HNO3, M	Pu(IV), g/L	Temp, C	TBP, vol. %	Exp. Dist Coeff.	Calc. Dist Coeff	% Error
90	0.407	0	60	0.3	0.102	0.0997	2.254902
91	0.5	0	20	0.3	0.165	0.1651	0.0606061
92	0.5	0	30	0.3	0.142	0.1583	11.478873
93	0.593	0	40	0.3	0.159	0.1346	15.345912
94	0.64	0	20	0.3	0.175	0.1773	1.3142857
95	0.663	0	20	0.3	0.166	0.1792	7.9518072
96	0.787	0	22	0.3	0.205	0.1669	18.585366
97	0.873	0	22	0.3	0.225	0.1731	23.066667
98	0.7	0	23	0.3	0.171	0.1583	7.4269006
99	0.727	0	30	0.3	0.187	0.1772	5.2406417
100	0.765	0	40	0.3	0.174	0.1537	11.666667
101	0.729	0	60	0.3	0.154	0.16	3.8961039
102	0.96	0	20	0.3	0.187	0.2031	8.6096257
103	1.06	0	20	0.3	0.21	0.21	0
104	0.93	0	23	0.3	0.194	0.1749	9.8453608
105	0.919	0	30	0.3	0.208	0.194	6.7307692
106	0.995	0	40	0.3	0.203	0.1792	11.724138
107	1.02	0	45	0.3	0.186	0.1614	13.225806
108	0.952	0	60	0.3	0.179	0.1867	4.301676
109	1.03	0	60	0.3	0.175	0.1938	10.742857
110	1.42	0	20	0.3	0.215	0.2287	6.372093
111	1.58	0	20	0.3	0.222	0.234	5.4054054
112	1.49	0	22	0.3	0.24	0.2076	13.5
113	1.75	0	22	0.3	0.244	0.2156	11.639344
114	1.12	0	23	0.3	0.205	0.1872	8.6829268
115	1.36	0	23	0.3	0.213	0.1999	6.1502347
116	1.57	0	23	0.3	0.217	0.2083	4.0092166
117	1.7	0	23	0.3	0.218	0.2122	2.6605505
118	1.49	0	40	0.3	0.226	0.2236	1.0619469
119	1.731	0	50	0.3	0.206	0.2101	1.9902913
120	1.39	0	60	0.3	0.225	0.2156	4.1777778
121	1.47	0	60	0.3	0.222	0.2187	1.4864865
122	1.77	0	60	0.3	0.237	0.2265	4.4303797
123	1.98	0	20	0.3	0.217	0.2406	10.875576
124	1.86	0	30	0.3	0.242	0.2408	0.4958678
125	2.06	0	30	0.3	0.225	0.2422	7.6444444
126	1.87	0	40	0.3	0.234	0.2433	3.974359
127	1.87	0	40	0.3	0.235	0.2433	3.5319149
128	1.95	0	45	0.3	0.243	0.2332	4.0329218
129	2	0	60	0.3	0.223	0.2298	3.0493274
130	2	13.46	31	0.3	0.145	0.1696	16.965517
131	2.15	0	20	0.3	0.223	0.2409	8.0269058
132	2.72	0	20	0.3	0.223	0.2348	5.2914798
133	2.54	0	20	0.3	0.215	0.2377	10.55814
134	2.54	0	20	0.3	0.213	0.2377	11.596244

A3. (continued)

					Exp.	Calc.	
Data Pt.	HNO3, M	Pu(IV), g/L	Temp, C	TBP, vol. %	Dist Coeff.	Dist Coeff	% Error
135	2.21	0	22	0.3	0.247	0.2215	10.323887
136	2.4	0	22	0.3	0.243	0.2215	8.8477366
137	2.31	0	23	0.3	0.216	0.2194	1.5740741
138	2.75	0	30	0.3	0.237	0.2325	1.8987342
139	2.69	0	40	0.3	0.239	0.2484	3.9330544
140	2.11	0	60	0.3	0.238	0.2308	3.0252101
141	2.11	0	60	0.3	0.239	0.2308	3.4309623
142	2.45	0	60	0.3	0.246	0.2321	5.6504065
143	2.74	19.5	37	0.3	0.091	0.1162	27.692308
144	2.99	0	20	0.3	0.217	0.2295	5.7603687
145	2.94	0	25	0.3	0.22	0.2143	2.5909091
146	3.01	0	30	0.3	0.216	0.2254	4.3518519
147	2.95	0	40	0.3	0.235	0.2434	3.5744681
148	2.98	0	45	0.3	0.228	0.2425	6.3596491
149	2.92	0	60	0.3	0.218	0.231	5.9633028
150	2.88	20.55	34	0.3	0.073	0.1107	51.643836
151	3.45	0	20	0.3	0.209	0.2185	4.5454545
152	3.69	0	20	0.3	0.207	0.2123	2.5603865
153	3.5	0	22	0.3	0.223	0.2055	7.8475336
154	3.5	0	23	0.3	0.197	0.2028	2.9441624
155	3.44	0	30	0.3	0.221	0.2118	4.1628959
156	3.75	0	40	0.3	0.221	0.22	0.4524887
157	3.29	0	60	0.3	0.231	0.2283	1.1688312
158	3.72	0	60	0.3	0.225	0.2232	0.8
159	3.49	10.78	31	0.3	0.118	0.1164	1.3559322
160	3.9	0	20	0.3	0.195	0.2068	6.0512821
161	3.86	0	40	0.3	0.215	0.2165	0.6976744
162	4.02	0	40	0.3	0.216	0.2112	2.2222222
163	4	0	45	0.3	0.207	0.2183	5.4589372
164	4.03	0	60	0.3	0.205	0.2183	6.4878049
165	3.88	15.27	34	0.3	0.095	0.0826	13.052632
166	4.24	0	20	0.3	0.195	0.1979	1.4871795
167	4.92	0	20	0.3	0.181	0.1809	0.0552486
168	4.47	0	23	0.3	0.19	0.1803	5.1052632
169	4.15	0	30	0.3	0.193	0.1879	2.642487
170	4.92	0	40	0.3	0.199	0.1831	7.9899497
171	4.22	0	60	0.3	0.217	0.2148	1.0138249
172	4.56	0	60	0.3	0.208	0.2078	0.0961538
173	4.92	0	60	0.3	0.2	0.1996	0.2
174	4.56	98.47	45	0.3	0.048	0.036	25
175	5.33	0	20	0.3	0.167	0.1714	2.6347305
176	5.68	0	20	0.3	0.169	0.1639	3.0177515
177	7	0	20	0.3	0.132	0.1393	5.530303
178	7.47	0	20	0.3	0.141	0.132	6.3829787
179	8.11	0	20	0.3	0.134	0.123	8.2089552
180	8.12	0	20	0.3	0.132	0.1229	6.8939394
181	8.93	0	20	0.3	0.125	0.1129	9.68
182	10.12	0	20	0.3	0.116	0.1007	13.189655
183	10.29	0	20	0.3	0.119	0.0992	16.638655
184	5.13	0	22	0.3	0.195	0.1687	13.487179
185	6.16	0	22	0.3	0.175	0.1482	15.314286
186	7.64	0	22	0.3	0.145	0.1243	14.275862
187	7.77	0	22	0.3	0.152	0.1225	19.407895
188	7.85	0	22	0.3	0.15	0.1214	19.066667

A3. (continued)

Data Pt.	HNO3, M	Pu(IV), g/L	Temp, C	TBP, vol. %	Exp. Dist Coeff.	Calc. Dist Coeff	% Error
189	8.94	0	22	0.3	0.141	0.1078	23.546099
190	5.92	0	23	0.3	0.162	0.149	8.0246914
191	7.2	0	23	0.3	0.14	0.1265	9.6428571
192	8.4	0	23	0.3	0.127	0.1093	13.937008
193	9.06	0	23	0.3	0.123	0.101	17.886179
194	6.48	0	30	0.3	0.152	0.1184	22.105263
195	5.37	0	40	0.3	0.195	0.1703	12.666667
196	8.19	0	40	0.3	0.14	0.1079	22.928571
197	5.46	0	60	0.3	0.187	0.1865	0.2673797
198	6.13	0	60	0.3	0.175	0.1702	2.7428571
199	7.96	0	60	0.3	0.151	0.1333	11.721854
200	6.97	14.6	31	0.3	0.034	0.045	32.352941
201	5.18	113.52	45	0.3	0.112	0.0527	52.946429
202	0.1	0	25	0.3	0.045	0.0449	0.2222222
203	0.1	0	25	0.3	0.047	0.0449	4.4680851
204	0.17	0	25	0.3	0.088	0.119	35.227273
205	0.174	0	25	0.3	0.099	0.1207	21.919192
206	0.2	0	25	0.3	0.08	0.1284	60.5
207	0.3	0	25	0.3	0.108	0.1372	27.037037
208	0.321	0	25	0.3	0.125	0.1381	10.48
209	0.359	0	25	0.3	0.126	0.1397	10.873016
210	0.41	0	25	0.3	0.146	0.1422	2.6027397
211	0.499	0	25	0.3	0.166	0.1474	11.204819
212	0.5	0	25	0.3	0.152	0.1475	2.9605263
213	0.51	0	25	0.3	0.155	0.1481	4.4516129
214	0.517	0	25	0.3	0.169	0.1486	12.071006
215	0.625	0	25	0.3	0.187	0.1561	16.524064
216	0.685	0	25	0.3	0.184	0.1606	12.717391
217	0.78	0	25	0.3	0.192	0.1677	12.65625
218	0.843	0	25	0.3	0.203	0.1724	15.073892
219	0.874	0	25	0.3	0.211	0.1746	17.251185
220	0.976	0	25	0.3	0.222	0.1818	18.108108
221	1.03	0	25	0.3	0.213	0.1855	12.910798
222	1.24	0	25	0.3	0.225	0.1981	11.955556
223	1.53	0	25	0.3	0.222	0.2112	4.8648649
224	1.6	0	25	0.3	0.229	0.2135	6.768559
225	1.805	0	25	0.3	0.233	0.2187	6.1373391
226	2.03	0	25	0.3	0.229	0.2217	3.1877729
227	2.13	0	25	0.3	0.216	0.2223	2.9166667
228	2.43	0	25	0.3	0.226	0.2215	1.9911504
229	2.67	0	25	0.3	0.217	0.2189	0.875576
230	2.94	0	25	0.3	0.22	0.2143	2.5909091
231	3.07	0	25	0.3	0.231	0.2116	8.3982684
232	3.31	0	25	0.3	0.2	0.2062	3.1
233	3.35	0	25	0.3	0.211	0.2053	2.7014218
234	3.615	0	25	0.3	0.21	0.1987	5.3809524

A3. (continued)

					Exp.	Calc.	
Data Pt.	HNO3, M	Pu(IV), g/L	Temp, C	TBP, vol. %	Dist Coeff.	Dist Coeff	% Error
235	3.965	0	25	0.3	0.204	0.1896	7.0588235
236	4.14	0	25	0.3	0.202	0.185	8.4158416
237	4.585	0	25	0.3	0.194	0.1735	10.56701
238	5.655	0	25	0.3	0.173	0.1477	14.624277
239	5.91	0	25	0.3	0.162	0.1421	12.283951
240	0.088	7.12	25	0.3	0.136	0.1298	4.5588235
241	0.106	0.94	25	0.3	0.094	0.0784	16.595745
242	0.16	1.38	25	0.3	0.125	0.124	0.8
243	0.203	1.66	25	0.3	0.108	0.1329	23.055556
244	0.112	1.87	25	0.3	0.098	0.102	4.0816327
245	0.193	3.1	25	0.3	0.114	0.1341	17.631579
246	0.112	3.98	25	0.3	0.107	0.1224	14.392523
247	0.215	4.92	25	0.3	0.144	0.1367	5.0694444
248	0.172	9.12	25	0.3	0.151	0.1372	9.1390728
249	0.166	13.7	25	0.3	0.175	0.1386	20.8
250	0.178	17.75	25	0.3	0.185	0.1403	24.162162
251	0.32	0.47	25	0.3	0.156	0.1383	11.346154
252	0.375	0.6	25	0.3	0.136	0.1408	3.5294118
253	0.298	0.72	25	0.3	0.111	0.1376	23.963964
254	0.378	1.2	25	0.3	0.143	0.1413	1.1888112
255	0.335	1.29	25	0.3	0.125	0.1394	11.52
256	0.352	2.29	25	0.3	0.153	0.1407	8.0392157
257	0.375	3.62	25	0.3	0.165	0.1426	13.575758
258	0.396	5.02	25	0.3	0.179	0.1444	19.329609
259	0.29	5.41	25	0.3	0.138	0.1397	1.2318841
260	0.438	7.58	25	0.3	0.189	0.148	21.693122
261	0.3	9.26	25	0.3	0.133	0.1419	6.6917293
262	0.31	16.6	25	0.3	0.194	0.1449	25.309278
263	0.34	29.5	25	0.3	0.176	0.143	18.75
264	0.37	32.7	25	0.3	0.135	0.1408	4.2962963
265	0.52	0.45	25	0.3	0.154	0.1491	3.1818182
266	0.52	1.41	25	0.3	0.154	0.1497	2.7922078
267	0.53	4.28	25	0.3	0.151	0.1518	0.5298013
268	0.51	33.5	25	0.3	0.118	0.1385	17.372881
269	0.99	0.63	25	0.3	0.202	0.182	9.9009901
270	0.99	2.27	25	0.3	0.202	0.1797	11.039604
271	1	5.73	25	0.3	0.17	0.1746	2.7058824
272	1.01	8.3	25	0.3	0.168	0.1703	1.3690476
273	1.08	17.6	25	0.3	0.139	0.1518	9.2086331
274	1.47	7.1	25	0.3	0.204	0.1748	14.313725
275	1.76	8.03	25	0.3	0.145	0.166	14.482759
276	1.67	9.7	25	0.3	0.138	0.1613	16.884058
277	1.93	29	25	0.3	0.114	0.105	7.8947368
278	1.94	30.3	25	0.3	0.113	0.1026	9.2035398
279	2.33	40.3	25	0.3	0.099	0.0798	19.393939
280	6.79	7.34	25	0.3	0.052	0.0634	21.923077

A3. (continued)

Data Pt.	HNO3, M	Pu(IV), g/L	Temp, C	TBP, vol. %	Exp. Dist Coeff.	Calc. Dist Coeff	% Error
281	7.49	7.93	25	0.3	0.054	0.0542	0.3703704
282	2.02	0.02	26	0.3	0.223	0.2252	0.9865471
283	2.04	1.44	26	0.3	0.206	0.2088	1.3592233
284	2.05	4.33	26	0.3	0.176	0.1845	4.8295455
285	2.09	5.9	26	0.3	0.153	0.1734	13.333333
286	2.04	7.1	26	0.3	0.147	0.1682	14.421769
287	2	8.5	26	0.3	0.145	0.1625	12.068966
288	2.97	0.01	26	0.3	0.199	0.2154	8.241206
289	2.98	0.5	26	0.3	0.185	0.2045	10.540541
290	2.95	0.9	26	0.3	0.186	0.1979	6.3978495
291	3.01	2.29	26	0.3	0.159	0.1764	10.943396
292	3.02	2.99	26	0.3	0.156	0.1684	7.9487179
293	3.02	4.2	26	0.3	0.142	0.1573	10.774648
294	3.89	0.01	26	0.3	0.198	0.1914	3.3333333
295	3.98	0.132	26	0.3	0.188	0.1856	1.2765957
296	3.94	0.45	26	0.3	0.183	0.1791	2.1311475
297	3.93	0.98	26	0.3	0.165	0.1689	2.3636364
298	4.01	1.77	26	0.3	0.167	0.1546	7.4251497
299	4	2.6	26	0.3	0.147	0.1449	1.4285714
300	3.99	3.26	26	0.3	0.148	0.1387	6.2837838
301	4.07	5.9	26	0.3	0.108	0.1181	9.3518519
							15.001595

A3. (continued)

Pu(IV)					Exp.	Calc.	
Data Pt.	HNO3, M	Pu(IV), g/L	Temp.	% TBP	Pu(IV) Dist.	Dist Coeff	% Error
1	0.78	7.77	50	0.3	1.9	4.7645	150.7632
2	0.78	7.93	41	0.3	1.89	3.4759	83.91005
3	0.74	7.96	36	0.3	1.88	2.4097	28.17553
4	0.78	8.03	30	0.3	1.89	1.5768	16.57143
5	0.68	8.08	47	0.3	1.83	4.9461	170.2787
6	0.78	8.13	60	0.3	1.77	2.7044	52.79096
7	0.74	8.48	56	0.3	1.71	3.949	130.9357
8	0.75	8.58	64	0.3	1.6	1.2809	19.94375
9	0.86	24.62	60	0.3	1.6	2.004	25.25
10	0.86	25.57	50	0.3	1.576	2.3654	50.08883
11	0.87	25.67	40	0.3	1.57	1.9312	23.00637
12	0.87	26.29	31	0.3	1.53	1.6142	5.503268
13	1.42	2.89	61	0.3	5.95	4.4134	25.82521
14	1.43	3.25	49	0.3	5.24	5.6867	8.524809
15	1.43	3.58	40	0.3	4.76	3.7176	21.89916
16	1.44	3.92	31	0.3	4.33	3.0501	29.55889
17	1.4	5.5	60	0.3	4.65	4.2784	7.991398
18	1.41	5.97	50	0.3	4.38	4.9545	13.11644
19	1.4	6.48	40	0.3	3.96	3.3184	16.20202
20	1.41	7.05	31	0.3	3.59	2.7946	22.15599
21	1.14	29.88	31	0.3	1.608	1.8059	12.30721
22	2	13.46	31	0.3	3.464	3.379	2.453811
23	1.97	10.66	28	0.3	4.07	3.9869	2.041769
24	2.64	2.17	60	0.3	11.31	12.5904	11.32095
25	2.62	2.2	55	0.3	11.21	15.7241	40.26851
26	2.66	2.25	46	0.3	10.97	13.2673	20.94166
27	2.69	2.25	51	0.3	11.02	15.8384	43.72414
28	2.59	2.34	46	0.3	10.49	12.5293	19.44042
29	2.61	2.46	40	0.3	9.96	9.0174	9.463855
30	2.64	2.72	31	0.3	8.97	7.3813	17.71126
31	2.6	2.72	35	0.3	9	7.1805	20.21667
32	2.69	5.19	61	0.3	8.69	7.777	10.50633
33	2.68	5.81	50	0.3	7.73	9.8041	26.83182
34	2.74	19.5	37	0.3	3.66	3.7054	1.240437
35	2.3	48.28	40	0.3	1.728	2.019	16.84028
36	2.87	2.55	60	0.3	11.92	10.2559	13.96057
37	2.76	2.58	60	0.3	11.78	11.1371	5.457555
38	2.94	3.27	31	0.3	9.37	8.0745	13.82604
39	2.81	3.82	55	0.3	9.76	12.2859	25.88012
40	2.79	4.06	46	0.3	9.19	11.1968	21.83678
41	2.79	4.68	31	0.3	8.53	6.7911	20.3857
42	2.9	5.71	45	0.3	7.83	9.5676	22.19157
43	2.86	6.21	35	0.3	7.14	6.4758	9.302521
44	2.88	20.55	34	0.3	3.01	3.5453	17.78405
45	3.05	31.55	37	0.3	2.69	2.9129	8.286245
46	3.49	10.78	31	0.3	5.79	5.6094	3.119171
47	3.51	19.84	34	0.3	3.82	4.0887	7.034031
48	3.54	36.09	37	0.3	2.384	2.816	18.12081

A3. (continued)

					Exp.	Calc.	
Data Pt.	HNO3, M	Pu(IV), g/L	Temp.	% TBP	Pu(IV) Dist.	Dist Coeff	% Error
49	3.48	62.38	40	0.3	1.521	1.8423	21.12426
50	3.88	15.27	34	0.3	4.84	5.1924	7.280992
51	3.81	78.39	40	0.3	1.241	1.5297	23.2635
52	4.92	12.31	31	0.3	6.18	5.9598	3.563107
53	5.1	47.32	37	0.3	2	2.4861	24.305
54	5.05	48.52	37	0.3	2	2.4264	21.32
55	4.64	78.39	40	0.3	1.293	1.5579	20.48724
56	4.56	98.47	45	0.3	0.794	1.1086	39.62217
57	6.97	14.6	31	0.3	5.48	5.0377	8.071168
58	5.12	26.05	34	0.3	3.33	3.9328	18.1021
59	5.18	113.52	45	0.3	0.785	0.8392	6.904459
60	3	0	20	0.3	22	9.3875	57.32955
61	3	0	30	0.3	25.4	12.5877	50.44213
62	3	0	40	0.3	27.3	18.3173	32.90366
63	3	0	50	0.3	28.8	33.3517	15.80451
64	3	0	60	0.3	29.9	13.7336	54.06823
65	0.44	0	25	0.19	0.39	0.2185	43.97436
66	0.52	0	25	0.19	0.41	2.73E-01	33.41463
67	0.62	0	25	0.19	0.72	0.3565	50.48611
68	0.82	0	25	0.19	1.01	0.5832	42.25743
69	0.84	0	25	0.19	1.14	0.6106	46.4386
70	0.86	0	25	0.19	1.2	0.6388	46.76667
71	0.91	0	25	0.19	1.3	0.7133	45.13077
72	1.28	0	25	0.19	2.2	1.4331	34.85909
73	1.41	0	25	0.19	2.37	1.7502	26.1519
74	2.65	0	25	0.19	5.7	5.4486	4.410526
75	0.44	0	40	0.19	0.33	1.5179	359.9697
76	0.84	0	40	0.19	1.01	2.087	106.6337
77	0.86	0	40	0.19	1.19	2.0387	71.31933
78	1.41	0	40	0.19	2.54	1.7362	31.64567
79	2.65	0	40	0.19	5.9	5.1281	13.08305
80	2.2	0	21.5	0.19	3.9	3.4155	12.42308
81	3	0	21.5	0.19	6.8	5.764	15.23529
82	4	0	21.5	0.19	11.5	16.6433	44.72435
83	1	0	21.5	0.019	0.015	0.0116	22.66667
84	1	0	21.5	0.048	0.13	0.0737	43.30769
85	1	0	21.5	0.095	0.43	0.2888	32.83721
86	1	2.5	25	0.3	2	2.1749	8.745
87	1	5	25	0.3	2	2.1878	9.39
88	1	10	25	0.3	1.9	2.1793	14.7
89	1	20	25	0.3	1.835	2.0763	13.14986
90	2	2.5	25	0.3	6.5	6.8931	6.047692
91	2	5	25	0.3	5.3	5.8426	10.23774
92	2	10	25	0.3	4	4.5764	14.41
93	2	20	25	0.3	2.875	3.2938	14.56696
94	3	2.5	25	0.3	10.08	10.6392	5.547619
95	3	5	25	0.3	7.44	8.217	10.44355
96	3	10	25	0.3	5.15	5.819	12.99029
97	3	20	25	0.3	3.425	3.8099	11.23796

A3. (continued)

Data Pt.	HNO3, M	Pu(IV), g/L	Temp.	% TBP	Exp. Pu(IV) Dist.	Calc. Dist Coeff	% Error
98	1	2.2	25	0.3	2.273	2.1724	4.425869
99	1	9.5	25	0.3	1.916	2.1819	13.87787
100	1	20	25	0.3	1.6	2.0763	29.76875
101	2	3.5	25	0.3	6	6.4196	6.993333
102	2	7	25	0.3	4.814	5.2438	8.928126
103	2	16	25	0.3	3.125	3.6956	18.2592
104	2	27.2	25	0.3	2.379	2.7711	16.48172
105	3	1.4	25	0.3	13.571	12.3804	8.773119
106	3	6.75	25	0.3	6.444	7.1504	10.96214
107	3	15	25	0.3	4.167	4.5818	9.954404
108	3	48.5	25	0.3	1.994	2.0186	1.233701
109	5	1.4	25	0.3	21.786	17.6202	19.12145
110	5	6	25	0.3	8.867	9.2987	4.868614
111	5	14.7	25	0.3	4.796	5.2375	9.205588
112	5	47.5	25	0.3	2.147	2.1308	0.754541
113	1	2	25	0.3	2.55	2.1706	14.87843
114	1	5	25	0.3	2.3	2.1878	4.878261
115	1	10	25	0.3	1.95	2.1793	11.75897
116	1	20	25	0.3	1.6	2.0763	29.76875
117	2	2	25	0.3	7.15	7.1655	0.216783
118	2	5	25	0.3	5.35	5.8426	9.207477
119	2	10	25	0.3	4.05	4.5764	12.99753
120	2	20	25	0.3	2.9	3.2938	13.57931
121	2	50	25	0.3	1.85	1.876	1.405405
122	3	2	25	0.3	11.15	11.3524	1.815247
123	3	5	25	0.3	7.45	8.217	10.2953
124	3	10	25	0.3	5.2	5.819	11.90385
125	3	20	25	0.3	3.5	3.8099	8.854286
126	3	50	25	0.3	1.95	1.9717	1.112821
127	5	2	25	0.3	17.75	15.6248	11.97296
128	5	5	25	0.3	10.2	10.2901	0.883333
129	5	10	25	0.3	6.4	6.8009	6.264063
130	5	20	25	0.3	4	4.1935	4.8375
131	5	50	25	0.3	2.5	2.0427	18.292
132	0.5	2.5	25	0.3	0.8	0.7096	11.3
133	0.5	5	25	0.3	0.8	0.7759	3.0125
134	0.5	7.5	25	0.3	0.8	0.8422	5.275
135	0.5	10	25	0.3	0.8	0.9073	13.4125
136	0.5	5	25	0.3	0.86	0.7759	9.77907
137	0.5	9.5	25	0.3	0.895	0.8944	0.067039
138	0.5	2	25	0.3	0.85	0.6964	18.07059
139	0.5	5	25	0.3	0.85	0.7759	8.717647
140	0.5	10	25	0.3	0.85	0.9073	6.741176
141	5	20	25	0.3	4	4.1935	4.8375
142	7.49	7.93	25	0.3	8.735	8.5782	1.795077
143	5.19	7.22	25	0.3	9.636	8.4218	12.60066
144	6.79	7.34	25	0.3	9.544	8.8584	7.183571
145	6.99	7.74	25	0.3	8.457	8.6085	1.791415
							23.80617

A3. (continued)

Np(VI)					Exp Np(VI)	Calc.	
Data Pt.	HNO3, M	Np(VI), g/L	Temp.	% TBP	Dist Coeff.	Dist Coeff.	% Error
1	3	0	20	0.3	27.1	23.60791	12.885942
2	3	0	30	0.3	20.4	14.82827	27.312403
3	3	0	40	0.3	15.8	9.315996	41.038
4	3	0	50	0.3	12.6	8.3484856	33.742178
5	3	0	60	0.3	10	8.7421638	12.578362
6	0.711	0	25	0.3	3.84	3.5489535	7.5793356
7	1.15	0	25	0.3	6.27	5.8413246	6.8369276
8	2	0	25	0.3	11.36	12.214494	7.521957
9	2.62	0	25	0.3	14.07	17.475112	24.201225
10	3	0	25	0.3	15.59	20.719627	32.903318
11	4	0	25	0.3	17.12	29.083281	69.87898
12	4.67	0	25	0.3	17.78	34.456097	93.791322
13	0.654	0	35	0.3	2.72	2.8911511	6.2923195
14	1.19	0	35	0.3	5	4.3953969	12.092063
15	2	0	35	0.3	8.9	7.4140453	16.696121
16	3	0	35	0.3	12.54	11.168717	10.935274
17	4	0	35	0.3	15.42	13.758602	10.774304
18	0.746	0	50	0.3	2.2	2.2499137	2.2688041
19	0.864	0	50	0.3	2.96	3.2920567	11.218131
20	1.26	0	50	0.3	4.68	5.2804489	12.830105
21	1.94	0	50	0.3	6.57	6.7848157	3.269646
22	3.08	0	50	0.3	9.78	8.4475229	13.62451
23	4.53	0	50	0.3	12.2	10.067288	17.481246
24	1	0	35	0.3	4.2	3.8363595	8.6581079
25	2	0	35	0.3	8.8	7.4140453	15.749486
26	3	0	35	0.3	12	11.168717	6.9273617
27	4	0	35	0.3	13.5	13.758602	1.9155733
28	5	0	35	0.3	15	14.379622	4.1358539
29	1	0	50	0.3	3.6	4.1960022	16.555617
30	3	0	50	0.3	9.5	8.3484856	12.121205
31	4	0	50	0.3	11	9.4911068	13.717211
32	5	0	50	0.3	12	10.592555	11.728706
33	10	0	25	0.16	6.03	10.644778	76.530309
34	10	0	25	0.2	9.67	16.632465	72.000672
35	0.184	0	25	0.3	0.376	0.355976	5.3255231
36	0.437	0	25	0.3	1.9	2.5366607	33.50846
37	0.5	0	25	0.3	2.2	2.7645969	25.663496
38	0.71	0	25	0.3	3.78	3.5448166	6.2217825
39	0.83	0	25	0.3	4.61	4.0771348	11.558899
40	0.87	0	25	0.3	4.47	4.2707981	4.4564183
41	1	0	25	0.3	4.52	4.9548154	9.6198092
42	1.1	0	25	0.3	6.21	5.5349004	10.87117
43	1.22	0	25	0.3	7.949	6.2874876	20.902157
44	1.62	0	25	0.3	9.3815	9.1547561	2.4169262
45	1.66	0	25	0.3	10.2	9.4651344	7.2045645

A3. (continued)

Data Pt.	HNO3, M	Np(VI), g/L	Temp.	% TBP	Exp Np(VI) Dist Coeff.	Calc. Dist Coeff.	% Error
46	2	0	25	0.3	9.977	12.214494	22.426524
47	2.46	0	25	0.3	14.423	16.10648	11.67219
48	2.54	0	25	0.3	15.1	16.790603	11.196043
49	2.57	0	25	0.3	13.3	17.047275	28.175001
50	3	0	25	0.3	14.067	20.719627	47.292438
51	3.47	0	25	0.3	18.2	24.689723	35.65782
52	3.5	0	25	0.3	19.5	24.940984	27.902484
53	4	0	25	0.3	16.667	29.083281	74.496198
54	4.36	0	25	0.3	20	32.001552	60.007761
55	4.5	0	25	0.3	20.65	33.117766	60.376593
56	4.6	0	25	0.3	17.2	33.907456	97.136369
57	5	0	25	0.3	17.82	36.988962	107.56993
58	5.13	0	25	0.3	19.5	37.958307	94.657985
59	6	0	25	0.3	14.525	43.841293	201.83334
60	6.02	0	25	0.3	16.2	43.960666	171.36214
61	7.94	0	25	0.3	10	49.693914	396.93914
							37.938422

APPENDIX IV - RESULTS OF THE SENSITIVITY ANALYSIS

A4. Results of the Sensitivity Analysis

Sensitivity	**Analysis**	**Baseline Design**							
1st SX	Cycle	Flow Rate							
Stream	Flow(L/m), Ref	Flow(L/m), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	0.005	0.00525	1.08E+09	5.76E+08	5.53E+02	1.05E+03	9.317254174	17.95102246	13.63413832
1AS	0.00217	0.00228	1.08E+09	1.20E+09	5.53E+02	4.16E+02	2.287485242	4.861527997	3.57450662
1AIS	0.001	0.00105	1.08E+09	9.90E+08	5.53E+02	5.38E+02	1.640074212	0.512000058	1.076037135
1AX	0.014	0.0147	1.08E+09	4.52E+02	5.53E+02	1.71E+00	19.99999161	19.93810392	19.96904776
1AW	0.0085	0.00893	1.08E+09	1.08E+09	5.53E+02	5.53E+02	0	0	0
1A	0.00033	0.00035	1.08E+09	1.08E+09	5.53E+02	5.53E+02	0.015306122	0.019679154	0.017492638
1BX	0.014	0.0147	1.08E+09	1.83E+09	5.53E+02	5.84E+02	13.87755102	1.149855485	7.513703253
1BP	0.014	0.0147	1.08E+09	1.08E+09	5.53E+02	5.53E+02	0	0	0
1BU	0.014	0.0147	1.08E+09	1.08E+09	5.53E+02	5.53E+02	0	0	0
1st SX	Cycle	HNO3 Conc.							
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	3.5	3.675	1.08E+09	1.04E+09	5.53E+02	5.53E+02	0.723562152	0.017736305	0.370649228
1AS	0.5	0.525	1.08E+09	1.06E+09	5.53E+02	6.26E+02	0.38961039	2.66272607	1.52616823
1AIS	5	5.25	1.08E+09	9.67E+08	5.53E+02	5.97E+02	2.05380334	1.60571471	1.829759025
1BX	0.2	0.21	1.08E+09	8.54E+07	5.53E+02	6.78E+02	18.41502783	4.524458907	11.46974337
1AX	0.001	0.00105	1.08E+09	1.08E+09	5.53E+02	5.53E+02	0	0	0
1st SX	Cycle	Np(VI) Conc.							
Stream	Conc. (g/L),Ref	Conc. (g/L), Pe	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	125	131.25	1.08E+09	4.18E+08	5.53E+02	7.27E+02	12.2541744	6.322341047	9.288257722
1st SX	Cycle	Pu(IV) Conc.							
Stream	Conc. (g/L),Ref	Conc. (g/L), Pe	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	23	24.15	1.08E+09	1.30E+09	5.53E+02	7.07E+02	4.174397032	5.606518273	4.890457652
1st SX	Cycle	HAN Conc.							
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1BX	0.1	0.105	1.08E+09	1.08E+09	5.53E+02	5.53E+02	0	0	0
1st SX	Cycle	Salting Agent	Conc.						
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1A	0.2	0.21	1.08E+09	1.08E+09	5.53E+02	5.53E+02	0	0.002171792	0.001085896

A4. (continued)

1st SX	Cycle	TBP vol. %							
Stream	Vol. %, Ref.	Vol %, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AX	0.3	0.315	1.08E+09	1.36E+01	5.53E+02	4.36E-01	19.99999975	19.98421831	19.99210903
1st SX	Cycle	Temp., deg. C							
	Temp , Ref.	Temp, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
	45	47.25	1.08E+09	1.08E+09	5.53E+02	5.46E+02	0.055658627	0.248272068	0.151965347
1st SX	Cycle	Stages							
Stream	Stage, Ref	Stage, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	24	25	1.08E+09	1.99E+08	5.53E+02	5.27E+02	19.57847866	1.116127549	10.34730311
1A	32	31	1.08E+09	1.07E+09	5.53E+02	5.52E+02	0.26716141	0.002490322	0.134825866
1BU	1	2	1.08E+09	3.18E+09	5.53E+02	1.35E+15	1.947124304	2.43965E+12	1.21982E+12
1AW	32	31	1.08E+09	1.64E+09	5.53E+02	5.51E+02	16.71243043	0.101118654	8.40677454
1AX	32	31	1.08E+09	2.08E+08	5.53E+02	5.51E+02	25.83747681	0.116581816	12.97702931
1BP	16	17	1.08E+09	7.27E+08	5.53E+02	351.415	5.211131725	5.823994324	5.517563025
1AIS	19	20	1.08E+09	1.97E+09	5.53E+02	336.823	15.65120594	7.417764176	11.53448506
1BX	17	16	1.08E+09	1.06E+09	5.53E+02	581.669	0.236549165	0.896244428	0.566396797
2nd SX	Cycle	Flow Rate							
Stream	Flow(L/m), Ref	Flow(L/m), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AF	0.014	0.0147	4.49E+04	2.44E+04	3.20E+15	3.24E+15	9.147562876	0.193508115	4.670535495
2AS	0.00217	0.00228	4.49E+04	3.88E+04	3.20E+15	3.18E+15	2.678307671	0.123141528	1.400724599
2AIS	0.00133	0.0014	4.49E+04	5.03E+04	3.20E+15	3.19E+15	2.25817939	0.077091136	1.167635263
2AP	0.0175	0.01838	4.49E+04	4.49E+04	3.20E+15	3.20E+15	0	0	0
2BX	0.014	0.0147	4.49E+04	1.80E+04	3.20E+15	3.08E+15	11.9964389	0.767790262	6.382114584
2BP	0.014	0.0147	4.49E+04	4.49E+04	3.20E+15	3.20E+15	0	0	0
2BU	0.014	0.0147	4.49E+04	4.49E+04	3.20E+15	3.20E+15	0	0	0
2AX	0.014	0.0147	4.49E+04	8.56E+04	3.20E+15	3.20E+15	18.09036279	0	9.045181393
2nd SX	Cycle	HNO3 Conc.							
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AF	0.5	0.525	4.49E+04	6.10E+04	3.20E+15	3.20E+15	7.162252393	0	3.581126196
2AS	0.1	0.105	4.49E+04	4.52E+04	3.20E+15	3.20E+15	0.129089695	0	0.064544848
2AIS	8	8.4	4.49E+04	5.20E+04	3.20E+15	3.20E+15	3.151569108	0	1.575784554
2BX	0.2	0.21	4.49E+04	4.49E+04	3.20E+15	3.20E+15	0	0	0
2AX	0.001	0.00105	4.49E+04	4.49E+04	3.20E+15	3.20E+15	0.004451369	0	0.002225684

A4. (continued)

2nd SX	Cycle	Np(VI) Conc.							
Stream	Conc. (g/L),Ref	Conc. (g/L), Pe	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AF	43.51	45.6855	4.49E+04	4.19E+04	3.20E+15	3.20E+15	1.33095927	0	0.665479635
2nd SX	Cycle	Pu(III) Conc.							
Stream	Conc. (g/L),Ref	Conc. (g/L), Pe	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AF	8.01	8.4105	4.49E+04	4.49E+04	3.20E+15	3.36E+15	0	0.998751561	0.49937578
2nd SX	Cycle	Nitrate Ion Co.							
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AS	0.13	0.1365	4.49E+04	4.49E+04	3.20E+15	3.20E+15	0	0	0
2BX	0.1	0.105	4.49E+04	4.49E+04	3.20E+15	3.20E+15	0	0	0
2nd SX	Cycle	TBP vol. %							
Stream	Vol. %, Ref.	Vol %, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AX	0.3	0.315	4.49E+04	1.29E+05	3.20E+15	3.20E+15	37.20008903	0	18.60004451
2nd SX	Cycle	Temp., deg. C							
	Temp , Ref.	Temp, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
	45	47.25	4.49E+04	4.50E+04	3.20E+15	3.20E+15	0.03561095	0	0.017805475
2nd SX	Cycle	Stages							
Stream	Stage, Ref	Stage, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AF	24	25	4.49E+04	2.48E+04	3.20E+15	3.20E+15	10.76875139	0	5.384375696
2BP	16	17	4.49E+04	4.20E+04	3.20E+15	3.20E+15	1.036278656	0	0.518139328
2AIS	27	28	4.49E+04	1.46E+04	3.20E+15	3.20E+15	18.21433341	0	9.107166704
2AX	32	31	4.49E+04	9.20E+03	3.20E+15	3.20E+15	25.44972179	0	12.72486089
2BU	1	2	4.49E+04	4.49E+04	3.20E+15	3.20E+15	0.000222568	0	0.000111284

A4. (continued)

Sensitivity	**Analysis**	**Np(VI) D.C. +50% Design**						
1st SX	Cycle	Flow Rate						
Stream	Flow(L/m), Ref	Flow(L/m), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	0.005	0.00525	4.57E+00	4.17E+00	3.04E-01	3.14E-01	1.749398644	0.657894737	1.203646691
1AS	0.00217	0.00228	4.57E+00	4.89E+00	3.04E-01	2.97E-01	1.376120709	0.454246411	0.91518356
1AIS	0.001	0.00105	4.57E+00	4.53E+00	3.04E-01	3.05E-01	0.179313361	0.065789474	0.122551417
1AX	0.014	0.0147	4.57E+00	3.63E+00	3.04E-01	2.90E-01	4.119833807	0.921052632	2.520443219
1AW	0.0085	0.00893	4.57E+00	4.57E+00	3.04E-01	3.04E-01	0	0	0
1A	0.00033	0.00035	4.57E+00	4.57E+00	3.04E-01	3.04E-01	0	0	0
1BX	0.014	0.0147	4.57E+00	8.64E+00	3.04E-01	2.90E-01	17.76514323	0.921052632	9.343097932
1BP	0.014	0.0147	4.57E+00	4.57E+00	3.04E-01	3.04E-01	0	0	0
1BU	0.014	0.0147	4.57E+00	4.57E+00	3.04E-01	3.04E-01	0	0	0
1st SX	Cycle	HNO3 Conc.							
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	3.5	3.675	4.57E+00	4.57E+00	3.04E-01	3.04E-01	0.004373497	0	0.002186748
1AS	0.5	0.525	4.57E+00	4.50E+00	3.04E-01	3.05E-01	0.323638749	0.065789474	0.194714111
1AIS	5	5.25	4.57E+00	4.46E+00	3.04E-01	3.06E-01	0.507325607	0.131578947	0.319452277
1BX	0.2	0.21	4.57E+00	1.07E+00	3.04E-01	2.57E-01	15.31598513	3.092105263	9.204045197
1AX	0.001	0.00105	4.57E+00	4.57E+00	3.04E-01	3.04E-01	0	0	0
1st SX	Cycle	Np(VI) Conc.							
Stream	Conc. (g/L),Ref	Conc. (g/L), Pe	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	125	131.25	4.57E+00	4.20E+00	3.04E-01	3.12E-01	1.613820249	0.526315789	1.070068019
1st SX	Cycle	Pu(IV) Conc.							
Stream	Conc. (g/L),Ref	Conc. (g/L), Pe	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	23	24.15	4.57E+00	4.54E+00	3.04E-01	3.06E-01	0.161819375	0.131578947	0.146699161
1st SX	Cycle	HAN Conc.							
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1BX	0.1	0.105	4.57E+00	4.57E+00	3.04E-01	3.04E-01	0	0	0
1st SX	Cycle	Salting Agent	Conc.						
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1A	0.2	0.21	4.57E+00	4.57E+00	3.04E-01	3.04E-01	0	0	0

A4. (continued)

1st SX	Cycle	TBP vol. %							
Stream	Vol. %, Ref.	Vol %, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AX	0.3	0.315	4.57E+00	8.41E-01	3.04E-01	2.22E-01	16.32188935	5.394736842	10.8583131
1st SX	Cycle	Temp., deg. C							
	Temp , Ref.	Temp, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
	45	47.25	4.57E+00	4.57E+00	3.04E-01	3.04E-01	0	0	0
1st SX	Cycle	Stages							
Stream	Stage, Ref	Stage, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	24	25	4.57E+00	4.58E+00	3.04E-01	3.04E-01	0.041985567	0	0.020992784
1A	32	31	4.57E+00	1.09E+00	3.04E-01	2.51E-01	24.3866171	5.578947368	14.98278223
1BU	1	2	4.57E+00	1.60E+11	3.04E-01	8.83E+14	34900502951	2.90395E+15	1.45199E+15
1AW	32	31	4.57E+00	4.57E+00	3.04E-01	3.04E-01	0	0	0
1AX	32	31	4.57E+00	1.09E+00	3.04E-01	2.51E-01	24.3866171	5.578947368	14.98278223
1BP	16	17	4.57E+00	6.05E+00	3.04E-01	0.281	5.181718784	1.210526316	3.19612255
1AIS	19	20	4.57E+00	5.33E+00	3.04E-01	0.29	3.136890444	0.875	2.005945222
1BX	17	16	4.57E+00	4.56E+00	3.04E-01	0.304	0.040892193	0	0.020446097
2nd SX	Cycle	Flow Rate							
Stream	Flow(L/m), Ref	Flow(L/m), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AF	0.014	0.0147	9.37E+00	3.95E+00	3.20E+15	3.24E+15	11.57647561	0.193508115	5.884991863
2AS	0.00217	0.00228	9.37E+00	1.27E+01	3.20E+15	3.18E+15	6.986347626	0.123141528	3.554744577
2AIS	0.00133	0.0014	9.37E+00	1.09E+01	3.20E+15	3.19E+15	3.068310385	0.077091136	1.572700761
2AP	0.0175	0.01838	9.37E+00	9.37E+00	3.20E+15	3.20E+15	0	0	0
2BX	0.014	0.0147	9.37E+00	9.94E+00	3.20E+15	3.08E+15	1.212509339	0.767790262	0.990149801
2BP	0.014	0.0147	9.37E+00	9.37E+00	3.20E+15	3.20E+15	0	0	0
2BU	0.014	0.0147	9.37E+00	9.37E+00	3.20E+15	3.20E+15	0	0	0
2AX	0.014	0.0147	9.37E+00	8.49E+00	3.20E+15	3.20E+15	1.872131497	0	0.936065749
2nd SX	Cycle	HNO3 Conc.							
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AF	0.5	0.525	9.37E+00	9.84E+00	3.20E+15	3.20E+15	1.003308784	0	0.501654392
2AS	0.1	0.105	9.37E+00	1.00E+01	3.20E+15	3.20E+15	1.411036397	0	0.705518198
2AIS	8	8.4	9.37E+00	1.59E+01	3.20E+15	3.20E+15	14.01430249	0	7.007151243
2BX	0.2	0.21	9.37E+00	7.42E+00	3.20E+15	3.20E+15	4.169068204	0	2.084534102
2AX	0.001	0.00105	9.37E+00	8.06E+00	3.20E+15	3.20E+15	2.787917601	0	1.3939588

A4. (continued)

2nd SX	Cycle	Np(VI) Conc.							
Stream	Conc. (g/L),Ref	Conc. (g/L), Pe	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AF	43.51	45.6855	9.37E+00	8.98E+00	3.20E+15	3.20E+15	0.826128722	0	0.413064361
2nd SX	Cycle	Pu(III) Conc.							
Stream	Conc. (g/L),Ref	Conc. (g/L), Pe	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AF	8.01	8.4105	9.37E+00	9.37E+00	3.20E+15	3.36E+15	0	0.998751561	0.49937578
2nd SX	Cycle	Nitrate Ion Co.							
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AS	0.13	0.1365	9.37E+00	9.37E+00	3.20E+15	3.20E+15	0	0	0
2BX	0.1	0.105	9.37E+00	9.37E+00	3.20E+15	3.20E+15	0	0	0
2nd SX	Cycle	TBP vol. %							
Stream	Vol. %, Ref.	Vol %, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AX	0.3	0.315	9.37E+00	1.97E+01	3.20E+15	3.20E+15	22.05358096	0	11.02679048
2nd SX	Cycle	Temp., deg. C							
	Temp , Ref.	Temp, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
	45	47.25	9.37E+00	1.27E+01	3.20E+15	3.20E+15	7.187533355	0	3.593766677
2nd SX	Cycle	Stages							
Stream	Stage, Ref	Stage, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AF	24	25	9.37E+00	7.12E+01	3.20E+15	3.20E+15	158.3477426	0	79.17387128
2BP	16	17	9.37E+00	9.15E+00	3.20E+15	3.20E+15	0.3722916	0	0.1861458
2AIS	27	28	9.37E+00	1.18E+01	3.20E+15	3.20E+15	7.141210375	0	3.570605187
2AX	32	31	9.37E+00	1.04E+01	3.20E+15	3.20E+15	3.39502615	0	1.697513075
2BU	1	2	9.37E+00	2.07E+06	3.20E+15	3.20E+15	220620.1976	0	110310.0988

A4. (continued)

Sensitivity	**Analysis**	**Np(VI) D.C. -50% Design**						
1st SX	Cycle	Flow Rate						
Stream	Flow(L/m), Ref	Flow(L/m), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	0.005	0.00525	8.93E-01	8.08E-01	4.57E+01	2.58E+00	1.903695409	18.87327023	10.38848282
1AS	0.00217	0.00228	8.93E-01	8.75E-01	4.57E+01	5.16E+00	0.397638196	17.50367965	8.950658923
1AIS	0.001	0.00105	8.93E-01	8.87E-01	4.57E+01	4.75E+01	0.134378499	0.776075028	0.455226764
1AX	0.014	0.0147	8.93E-01	1.08E+00	4.57E+01	5.29E+00	4.210526316	17.68882671	10.94967651
1AW	0.0085	0.00893	8.93E-01	8.93E-01	4.57E+01	4.57E+01	0	0	0
1A	0.00033	0.00035	8.93E-01	8.96E-01	4.57E+01	4.57E+01	0.055431131	0.000360711	0.027895921
1BX	0.014	0.0147	8.93E-01	7.76E-01	4.57E+01	1.92E+01	2.620380739	11.60352404	7.111952388
1BP	0.014	0.0147	8.93E-01	8.93E-01	4.57E+01	4.57E+01	0	0	0
1BU	0.014	0.0147	8.93E-01	8.93E-01	4.57E+01	4.57E+01	0	0	0
1st SX	Cycle	HNO3 Conc.							
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	3.5	3.675	8.93E-01	8.92E-01	4.57E+01	4.16E+01	0.022396417	1.822792558	0.922594487
1AS	0.5	0.525	8.93E-01	8.94E-01	4.57E+01	4.46E+01	0.022396417	0.489692412	0.256044414
1AIS	5	5.25	8.93E-01	8.94E-01	4.57E+01	4.66E+00	0.022396417	17.96296701	8.992681714
1BX	0.2	0.21	8.93E-01	8.94E-01	4.57E+01	1.19E+01	0.022396417	14.78171524	7.402055826
1AX	0.001	0.00105	8.93E-01	8.93E-01	4.57E+01	4.20E+01	0	1.627352819	0.81367641
1st SX	Cycle	Np(VI) Conc.							
Stream	Conc. (g/L),Ref	Conc. (g/L), Pe	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	125	131.25	8.93E-01	7.97E-01	4.57E+01	4.44E+01	2.150055991	0.569267429	1.35966171
1st SX	Cycle	Pu(IV) Conc.							
Stream	Conc. (g/L),Ref	Conc. (g/L), Pe	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	23	24.15	8.93E-01	8.81E-01	4.57E+01	2.57E+00	0.268756999	18.87501913	9.571888064
1st SX	Cycle	HAN Conc.							
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1BX	0.1	0.105	8.93E-01	8.93E-01	4.57E+01	4.57E+01	0	0	0
1st SX	Cycle	Salting Agent	Conc.						
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1A	0.2	0.21	8.93E-01	8.93E-01	4.57E+01	4.61E+01	0	0.153466104	0.076733052

A4. (continued)

1st SX	Cycle	TBP vol. %							
Stream	Vol. %, Ref.	Vol %, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AX	0.3	0.315	8.93E-01	1.13E+00	4.57E+01	4.27E+00	5.263157895	18.13261045	11.69788417
1st SX	Cycle	Temp., deg. C							
	Temp , Ref.	Temp, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
	45	47.25	8.93E-01	8.94E-01	4.57E+01	4.72E+00	0.022396417	17.93542181	8.978909115
1st SX	Cycle	Stages							
Stream	Stage, Ref	Stage, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	24	25	8.93E-01	8.68E-01	4.57E+01	4.67E+00	0.671892497	21.54978904	11.11084077
1A	32	31	8.93E-01	8.93E-01	4.57E+01	4.45E+01	0	0.901034038	0.450517019
1BU	1	2	8.93E-01	8.93E-01	4.57E+01	9.12E+07	0	1992653.614	996326.8069
1AW	32	31	8.93E-01	1.33E+16	4.57E+01	4.54E+01	4.76237E+17	0.27352819	2.38119E+17
1AX	32	31	8.93E-01	8.93E-01	4.57E+01	4.57E+01	0	0	0
1BP	16	17	8.93E-01	4.53E-01	4.57E+01	349.091	7.883538634	106.1051527	56.99434567
1AIS	19	20	8.93E-01	9.19E-01	4.57E+01	89.647	0.553191489	18.23614542	9.394668455
1BX	17	16	8.93E-01	8.82E-01	4.57E+01	1310.453	0.209406495	470.0188007	235.1141036
2nd SX	Cycle	Flow Rate							
Stream	Flow(L/m), Ref	Flow(L/m), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AF	0.014	0.0147	1.31E+00	2.44E+04	3.20E+15	3.24E+15	373333.7519	0.193508115	186666.9727
2AS	0.00217	0.00228	1.31E+00	3.88E+04	3.20E+15	3.18E+15	586511.6663	0.123141528	293255.8947
2AIS	0.00133	0.0014	1.31E+00	5.03E+04	3.20E+15	3.19E+15	731320.9694	0.077091136	365660.5232
2AP	0.0175	0.01838	1.31E+00	4.49E+04	3.20E+15	3.20E+15	684125.8397	0	342062.9198
2BX	0.014	0.0147	1.31E+00	1.80E+04	3.20E+15	3.08E+15	275324.5636	0.767790262	137662.6657
2BP	0.014	0.0147	1.31E+00	4.49E+04	3.20E+15	3.20E+15	688035.1302	0	344017.5651
2BU	0.014	0.0147	1.31E+00	4.49E+04	3.20E+15	3.20E+15	688035.1302	0	344017.5651
2AX	0.014	0.0147	1.31E+00	8.56E+04	3.20E+15	3.20E+15	1310393.476	0	655196.7381
2nd SX	Cycle	HNO3 Conc.							
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AF	0.5	0.525	1.31E+00	6.10E+04	3.20E+15	3.20E+15	934436.3553	0	467218.1776
2AS	0.1	0.105	1.31E+00	4.52E+04	3.20E+15	3.20E+15	692476.1715	0	346238.0858
2AIS	8	8.4	1.31E+00	5.20E+04	3.20E+15	3.20E+15	796457.7948	0	398228.8974
2BX	0.2	0.21	1.31E+00	4.49E+04	3.20E+15	3.20E+15	688035.1302	0	344017.5651
2AX	0.001	0.00105	1.31E+00	4.49E+04	3.20E+15	3.20E+15	688188.2695	0	344094.1348

A4. (continued)

2nd	Cycle	Np(VI) Conc.							
Stream	Conc. (g/L),Ref	Conc. (g/L), Pe	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AF	43.51	45.6855	1.31E+00	4.19E+04	3.20E+15	3.20E+15	642246.4625	0	321123.2312
2nd SX	Cycle	Pu(III) Conc.							
Stream	Conc. (g/L),Ref	Conc. (g/L), Pe	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AF	8.01	8.4105	1.31E+00	4.49E+04	3.20E+15	3.36E+15	688035.1302	0.998751561	344018.0645
2nd SX	Cycle	Nitrate Ion Co.							
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AS	0.13	0.1365	1.31E+00	4.49E+04	3.20E+15	3.20E+15	688035.1302	0	344017.5651
2BX	0.1	0.105	1.31E+00	4.49E+04	3.20E+15	3.20E+15	688035.1302	0	344017.5651
2nd SX	Cycle	TBP vol. %							
Stream	Vol. %, Ref.	Vol %, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AX	0.3	0.315	1.31E+00	1.29E+05	3.20E+15	3.20E+15	1967820.735	0	983910.3675
2nd SX	Cycle	Temp., deg. C							
	Temp , Ref.	Temp, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
	45	47.25	1.31E+00	4.50E+04	3.20E+15	3.20E+15	689260.245	0	344630.1225
2nd SX	Cycle	Stages							
Stream	Stage, Ref	Stage, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AF	24	25	1.31E+00	2.48E+04	3.20E+15	3.20E+15	455167.4242	0	227583.7121
2BP	16	17	1.31E+00	4.20E+04	3.20E+15	3.20E+15	514777.2619	0	257388.6309
2AIS	27	28	1.31E+00	1.46E+04	3.20E+15	3.20E+15	302224.1485	0	151112.0743
2AX	32	31	1.31E+00	9.20E+03	3.20E+15	3.20E+15	225315.6263	0	112657.8132
2BU	1	2	1.31E+00	4.49E+04	3.20E+15	3.20E+15	34394.09954	0	17197.04977

A4. (continued)

Sensitivity	**Analysis**	**Pu(IV) D.C. +50% Design**							
1st SX	Cycle	Flow Rate							
Stream	Flow(L/m), Ref	Flow(L/m), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	0.005	0.00525	1.74E+09	1.19E+09	6.58E+03	1.77E+04	6.329113924	33.70004559	20.01457975
1AS	0.00217	0.00228	1.74E+09	1.95E+09	6.58E+03	4.60E+03	2.406318653	5.929272976	4.167795814
1AIS	0.001	0.00105	1.74E+09	1.78E+09	6.58E+03	7.72E+03	0.471806674	3.452362863	1.962084769
1AX	0.014	0.0147	1.74E+09	2.57E+02	6.58E+03	6.03E-01	19.99999704	19.99816745	19.99908225
1AW	0.0085	0.00893	1.74E+09	1.74E+09	6.58E+03	6.58E+03	0	0	0
1A	0.00033	0.00035	1.74E+09	1.74E+09	6.58E+03	6.58E+03	0	0.005014435	0.002507218
1BX	0.014	0.0147	1.74E+09	2.00E+09	6.58E+03	8.99E+00	3.049482163	19.97269108	11.51108662
1BP	0.014	0.0147	1.74E+09	1.74E+09	6.58E+03	6.58E+03	0	0	0
1BU	0.014	0.0147	1.74E+09	1.74E+09	6.58E+03	6.58E+03	0	0	0
1st SX	Cycle	HNO3 Conc.							
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	3.5	3.675	1.74E+09	1.65E+09	6.58E+03	6.57E+03	0.966628308	0.021273363	0.493950836
1AS	0.5	0.525	1.74E+09	1.79E+09	6.58E+03	8.75E+03	0.632911392	6.582586233	3.607748813
1AIS	5	5.25	1.74E+09	1.78E+09	6.58E+03	8.59E+03	0.529344074	6.10849415	3.318919112
1BX	0.2	0.21	1.74E+09	1.05E+08	6.58E+03	4.88E+03	18.78941312	5.184622398	11.98701776
1AX	0.001	0.00105	1.74E+09	2.08E+09	6.58E+03	2.42E+04	3.935558113	53.42349187	28.67952499
1st SX	Cycle	Np(VI) Conc.							
Stream	Conc. (g/L),Ref	Conc. (g/L), Pe	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	125	131.25	1.74E+09	1.01E+09	6.58E+03	1.35E+04	8.377445339	20.996809	14.68712717
1st SX	Cycle	Pu(IV) Conc.							
Stream	Conc. (g/L),Ref	Conc. (g/L), Pe	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	23	24.15	1.74E+09	2.25E+09	6.58E+03	1.14E+04	5.880322209	14.67558122	10.27795171
1st SX	Cycle	HAN Conc.							
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1BX	0.1	0.105	1.74E+09	1.74E+09	6.58E+03	6.58E+03	0	0	0
1st SX	Cycle	Salting Agent	Conc.						
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1A	0.2	0.21	1.74E+09	1.74E+09	6.58E+03	6.59E+03	0.01150748	0.021273363	0.016390421

A4. (continued)

1st SX	Cycle	TBP vol. %							
Stream	Vol. %, Ref.	Vol %, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AX	0.3	0.315	1.74E+09	1.15E+01	6.58E+03	2.42E-01	19.99999987	19.99926455	19.99963221
1st SX	Cycle	Temp., deg. C							
	Temp , Ref.	Temp, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
	45	47.25	1.74E+09	2.44E+09	6.58E+03	2.37E+04	8.112773303	51.964747	30.03876015
1st SX	Cycle	Stages							
Stream	Stage, Ref	Stage, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	24	25	1.74E+09	2.39E+08	6.58E+03	6.54E+03	20.69413119	0.160461936	10.42729656
1A	32	31	1.74E+09	1.72E+09	6.58E+03	6.58E+03	0.386651323	0	0.193325662
1BU	1	2	1.74E+09	3.58E+09	6.58E+03	8.83E+14	1.061565017	1.34159E+11	67079471205
1AW	32	31	1.74E+09	3.38E+09	6.58E+03	6.57E+03	30.21403913	0.043762346	15.12890074
1AX	32	31	1.74E+09	2.48E+08	6.58E+03	6.58E+03	27.44119678	0.009724966	13.72546087
1BP	16	17	1.74E+09	2.13E+09	6.58E+03	6.91E+03	3.590333717	0.809603404	2.19996856
1AIS	19	20	1.74E+09	2.41E+09	6.58E+03	2.54E+03	7.379171461	11.66099377	9.520082616
1BX	17	16	1.74E+09	1.72E+09	6.58E+03	6.76E+03	0.13693901	0.454642152	0.295790581
2nd SX	Cycle	Flow Rate							
Stream	Flow(L/m), Ref	Flow(L/m), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AF	0.014	0.0147	4.49E+04	2.44E+04	3.20E+15	3.24E+15	9.147562876	0.193508115	4.670535495
2AS	0.00217	0.00228	4.49E+04	3.88E+04	3.20E+15	3.18E+15	2.678307671	0.123141528	1.400724599
2AIS	0.00133	0.0014	4.49E+04	5.03E+04	3.20E+15	3.19E+15	2.25817939	0.077091136	1.167635263
2AP	0.0175	0.01838	4.49E+04	4.49E+04	3.20E+15	3.20E+15	0	0	0
2BX	0.014	0.0147	4.49E+04	1.80E+04	3.20E+15	3.08E+15	11.9964389	0.767790262	6.382114584
2BP	0.014	0.0147	4.49E+04	4.49E+04	3.20E+15	3.20E+15	0	0	0
2BU	0.014	0.0147	4.49E+04	4.49E+04	3.20E+15	3.20E+15	0	0	0
2AX	0.014	0.0147	4.49E+04	8.56E+04	3.20E+15	3.20E+15	18.09036279	0	9.045181393
2nd SX	Cycle	HNO3 Conc.							
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AF	0.5	0.525	4.49E+04	6.10E+04	3.20E+15	3.20E+15	7.162252393	0	3.581126196
2AS	0.1	0.105	4.49E+04	4.52E+04	3.20E+15	3.20E+15	0.129089695	0	0.064544848
2AIS	8	8.4	4.49E+04	5.20E+04	3.20E+15	3.20E+15	3.151569108	0	1.575784554
2BX	0.2	0.21	4.49E+04	4.49E+04	3.20E+15	3.20E+15	0	0	0
2AX	0.001	0.00105	4.49E+04	4.49E+04	3.20E+15	3.20E+15	0.004451369	0	0.002225684

A4. (continued)

2nd SX	Cycle	Np(VI) Conc.								
Stream	Conc. (g/L),Ref	Conc. (g/L), Pe	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.	
2AF	43.51	45.6855	4.49E+04	4.19E+04	3.20E+15	3.20E+15	1.33095927	0	0.665479635	
2nd SX	Cycle	Pu(III) Conc.								
Stream	Conc. (g/L),Ref	Conc. (g/L), Pe	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.	
2AF	8.01	8.4105	4.49E+04	4.49E+04	3.20E+15	3.36E+15	0	0.998751561	0.49937578	
2nd SX	Cycle	Nitrate Ion Co.								
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.	
2AS	0.13	0.1365	4.49E+04	4.49E+04	3.20E+15	3.20E+15	0	0	0	
2BX	0.1	0.105	4.49E+04	4.49E+04	3.20E+15	3.20E+15	0	0	0	
2nd SX	Cycle	TBP vol. %								
Stream	Vol. %, Ref.	Vol %, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.	
2AX	0.3	0.315	4.49E+04	1.29E+05	3.20E+15	3.20E+15	37.20008903	0	18.60004451	
2nd SX	Cycle	Temp., deg. C								
	Temp , Ref.	Temp, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.	
	45	47.25	4.49E+04	4.50E+04	3.20E+15	3.20E+15	0.03561095	0	0.017805475	
2nd SX	Cycle	Stages								
Stream	Stage, Ref	Stage, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.	
2AF	24	25	4.49E+04	2.48E+04	3.20E+15	3.20E+15	10.76875139	0	5.384375696	
2BP	16	17	4.49E+04	4.20E+04	3.20E+15	3.20E+15	1.036278656	0	0.518139328	
2AIS	27	28	4.49E+04	1.46E+04	3.20E+15	3.20E+15	18.21433341	0	9.107166704	
2AX	32	31	4.49E+04	9.20E+03	3.20E+15	3.20E+15	25.44972179	0	12.72486089	
2BU	1	2	4.49E+04	4.49E+04	3.20E+15	3.20E+15	0.000222568	0	0.000111284	

A4. (continued)

Sensitivity	**Analysis**	**Pu(IV) D.C. -50% Design**							
1st SX	Cycle	Flow Rate							
Stream	Flow(L/m), Ref	Flow(L/m), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	0.005	0.00525	1.61E+09	8.48E+08	3.62E+01	4.67E+01	9.472049689	5.822372057	7.647210873
1AS	0.00217	0.00228	1.61E+09	1.64E+09	3.62E+01	4.45E+01	0.392094862	4.525694103	2.458894482
1AIS	0.001	0.00105	1.61E+09	1.58E+09	3.62E+01	4.72E+01	0.397515528	6.060019896	3.228767712
1AX	0.014	0.0147	1.61E+09	1.08E+05	3.62E+01	6.05E+01	19.99866335	13.46302642	16.73084489
1AW	0.0085	0.00893	1.61E+09	1.61E+09	3.62E+01	3.62E+01	0	0	0
1A	0.00033	0.00035	1.61E+09	1.68E+09	3.62E+01	4.62E+01	0.717391304	4.57912844	2.648259872
1BX	0.014	0.0147	1.61E+09	1.05E+09	3.62E+01	3.56E+01	7.00621118	0.343207693	3.674709437
1BP	0.014	0.0147	1.61E+09	1.61E+09	3.62E+01	3.62E+01	0	0	0
1BU	0.014	0.0147	1.61E+09	1.61E+09	3.62E+01	3.62E+01	0	0	0
1st SX	Cycle	HNO3 Conc.							
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	3.5	3.675	1.61E+09	1.53E+09	3.62E+01	4.62E+01	0.968944099	5.547142699	3.258043399
1AS	0.5	0.525	1.61E+09	1.60E+09	3.62E+01	4.34E+01	0.074534161	3.989720349	2.032127255
1AIS	5	5.25	1.61E+09	1.59E+09	3.62E+01	4.61E+01	0.298136646	5.459268266	2.878702456
1BX	0.2	0.21	1.61E+09	2.78E+08	3.62E+01	2.86E+01	16.55031056	4.188681331	10.36949594
1AX	0.001	0.00105	1.61E+09	1.67E+09	3.62E+01	4.54E+01	0.782608696	5.113297226	2.947952961
1st SX	Cycle	Np(VI) Conc.							
Stream	Conc. (g/L),Ref	Conc. (g/L), Pe	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	125	131.25	1.61E+09	1.86E+07	3.62E+01	7.90E-01	19.7684472	19.56339118	19.66591919
1st SX	Cycle	Pu(IV) Conc.							
Stream	Conc. (g/L),Ref	Conc. (g/L), Pe	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	23	24.15	1.61E+09	1.68E+09	3.62E+01	5.59E+01	0.881987578	10.88758705	5.884787312
1st SX	Cycle	HAN Conc.							
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1BX	0.1	0.105	1.61E+09	1.61E+09	3.62E+01	3.62E+01	0	0	0
1st SX	Cycle	Salting Agent	Conc.						
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1A	0.2	0.21	1.61E+09	1.67E+09	3.62E+01	4.54E+01	0.782608696	5.112191887	2.947400291

A4. (continued)

1st SX	Cycle	TBP vol. %							
Stream	Vol. %, Ref.	Vol %, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AX	0.3	0.315	1.61E+09	2.44E+02	3.62E+01	4.19E+00	19.99999697	17.6832099	18.84160344
1st SX	Cycle	Temp., deg. C							
	Temp , Ref.	Temp, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
	45	47.25	1.61E+09	1.63E+09	3.62E+01	3.87E+01	0.248447205	1.367304079	0.807875642
1st SX	Cycle	Stages							
Stream	Stage, Ref	Stage, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	24	25	1.61E+09	1.43E+08	3.62E+01	4.51E+01	21.86534161	5.917762794	13.8915522
1A	32	31	1.61E+09	1.65E+09	3.62E+01	4.62E+01	0.735403727	8.880733945	4.808068836
1BU	1	2	1.61E+09	2.00E+09	3.62E+01	2.56E+15	0.240372671	7.07693E+13	3.53847E+13
1AW	32	31	1.61E+09	1.07E+10	3.62E+01	4.73E+01	181.2670807	9.822482591	95.54478167
1AX	32	31	1.61E+09	1.48E+08	3.62E+01	3.86E+01	29.06037267	2.154084227	15.60722845
1BP	16	17	1.61E+09	1.54E+09	3.62E+01	1.79E+01	0.695652174	8.106554659	4.401103416
1AIS	19	20	1.61E+09	1.86E+09	3.62E+01	4.76E+01	2.914906832	5.986984636	4.450945734
1BX	17	16	1.61E+09	1.63E+09	3.62E+01	4.70E+01	0.200621118	5.060821267	2.630721192
2nd SX	Cycle	Flow Rate							
Stream	Flow(L/m), Ref	Flow(L/m), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AF	0.014	0.0147	4.49E+04	2.44E+04	3.20E+15	3.24E+15	9.147562876	0.193508115	4.670535495
2AS	0.00217	0.00228	4.49E+04	3.88E+04	3.20E+15	3.18E+15	2.678307671	0.123141528	1.400724599
2AIS	0.00133	0.0014	4.49E+04	5.03E+04	3.20E+15	3.19E+15	2.25817939	0.077091136	1.167635263
2AP	0.0175	0.01838	4.49E+04	4.49E+04	3.20E+15	3.20E+15	0	0	0
2BX	0.014	0.0147	4.49E+04	1.80E+04	3.20E+15	3.08E+15	11.9964389	0.767790262	6.382114584
2BP	0.014	0.0147	4.49E+04	4.49E+04	3.20E+15	3.20E+15	0	0	0
2BU	0.014	0.0147	4.49E+04	4.49E+04	3.20E+15	3.20E+15	0	0	0
2AX	0.014	0.0147	4.49E+04	8.56E+04	3.20E+15	3.20E+15	18.09036279	0	9.045181393
2nd SX	Cycle	HNO3 Conc.							
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AF	0.5	0.525	4.49E+04	6.10E+04	3.20E+15	3.20E+15	7.162252393	0	3.581126196
2AS	0.1	0.105	4.49E+04	4.52E+04	3.20E+15	3.20E+15	0.129089695	0	0.064544848
2AIS	8	8.4	4.49E+04	5.20E+04	3.20E+15	3.20E+15	3.151569108	0	1.575784554
2BX	0.2	0.21	4.49E+04	4.49E+04	3.20E+15	3.20E+15	0	0	0
2AX	0.001	0.00105	4.49E+04	4.49E+04	3.20E+15	3.20E+15	0.004451369	0	0.002225684

A4. (continued)

2nd SX	Cycle	Np(VI) Conc.							
Stream	Conc. (g/L),Ref	Conc. (g/L), Pe	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AF	43.51	45.6855	4.49E+04	4.19E+04	3.20E+15	3.20E+15	1.33095927	0	0.665479635
2nd SX	Cycle	Pu(III) Conc.							
Stream	Conc. (g/L),Ref	Conc. (g/L), Pe	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AF	8.01	8.4105	4.49E+04	4.49E+04	3.20E+15	3.36E+15	0	0.998751561	0.49937578
2nd SX	Cycle	Nitrate Ion Co.							
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AS	0.13	0.1365	4.49E+04	4.49E+04	3.20E+15	3.20E+15	0	0	0
2BX	0.1	0.105	4.49E+04	4.49E+04	3.20E+15	3.20E+15	0	0	0
2nd SX	Cycle	TBP vol. %							
Stream	Vol. %, Ref.	Vol %, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AX	0.3	0.315	4.49E+04	1.29E+05	3.20E+15	3.20E+15	37.20008903	0	18.60004451
2nd SX	Cycle	Temp., deg. C							
	Temp , Ref.	Temp, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
	45	47.25	4.49E+04	4.50E+04	3.20E+15	3.20E+15	0.03561095	0	0.017805475
2nd SX	Cycle	Stages							
Stream	Stage, Ref	Stage, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AF	24	25	4.49E+04	2.48E+04	3.20E+15	3.20E+15	10.76875139	0	5.384375696
2BP	16	17	4.49E+04	4.20E+04	3.20E+15	3.20E+15	1.036278656	0	0.518139328
2AIS	27	28	4.49E+04	1.46E+04	3.20E+15	3.20E+15	18.21433341	0	9.107166704
2AX	32	31	4.49E+04	9.20E+03	3.20E+15	3.20E+15	25.44972179	0	12.72486089
2BU	1	2	4.49E+04	4.49E+04	3.20E+15	3.20E+15	0.000222568	0	0.000111284

A4. (continued)

Sensitivity	**Analysis**	**Np(VI) D.C +50%, Pu(IV) D.C. +50% Design**							
1st SX	Cycle	Flow Rate							
Stream	Flow(L/m), Ref	Flow(L/m), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	0.005	0.00525	9.98E-01	4.27E+00	1.48E-01	1.78E-01	65.61122244	4.054054054	34.83263825
1AS	0.00217	0.00228	9.98E-01	5.10E+00	1.48E-01	1.70E-01	80.98460557	2.932432432	41.958519
1AIS	0.001	0.00105	9.98E-01	4.68E+00	1.48E-01	1.74E-01	73.80761523	3.513513514	38.66056437
1AX	0.014	0.0147	9.98E-01	3.70E+00	1.48E-01	1.68E-01	54.04809619	2.702702703	28.37539945
1AW	0.0085	0.00893	9.98E-01	9.98E-01	1.48E-01	1.48E-01	0	0	0
1A	0.00033	0.00035	9.98E-01	9.98E-01	1.48E-01	1.48E-01	0	0	0
1BX	0.014	0.0147	9.98E-01	9.56E+00	1.48E-01	1.65E-01	171.6432866	2.297297297	86.97029194
1BP	0.014	0.0147	9.98E-01	9.98E-01	1.48E-01	1.48E-01	0	0	0
1BU	0.014	0.0147	9.98E-01	9.98E-01	1.48E-01	1.48E-01	0	0	0
1st SX	Cycle	HNO3 Conc.							
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	3.5	3.675	9.98E-01	4.73E+00	1.48E-01	1.73E-01	74.70941884	3.378378378	39.04389861
1AS	0.5	0.525	9.98E-01	4.65E+00	1.48E-01	1.74E-01	73.08617234	3.513513514	38.29984293
1AIS	5	5.25	9.98E-01	4.60E+00	1.48E-01	1.75E-01	72.08416834	3.648648649	37.86640849
1BX	0.2	0.21	9.98E-01	3.77E+00	1.48E-01	1.70E-01	55.63126253	2.972972973	29.30211775
1AX	0.001	0.00105	9.98E-01	4.73E+00	1.48E-01	1.73E-01	74.76953908	3.378378378	39.07395873
1st SX	Cycle	Np(VI) Conc.							
Stream	Conc. (g/L),Ref	Conc. (g/L), Pe	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	125	131.25	9.98E-01	4.30E+00	1.48E-01	1.77E-01	66.13226453	3.918918919	35.02559172
1st SX	Cycle	Pu(IV) Conc.							
Stream	Conc. (g/L),Ref	Conc. (g/L), Pe	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	23	24.15	9.98E-01	4.69E+00	1.48E-01	1.74E-01	74.06813627	3.513513514	38.79082489
1st SX	Cycle	HAN Conc.							
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1BX	0.1	0.105	9.98E-01	9.98E-01	1.48E-01	1.48E-01	0	0	0
1st SX	Cycle	Salting Agent	Conc.						
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1A	0.2	0.21	9.98E-01	4.73E+00	1.48E-01	1.73E-01	74.76953908	3.378378378	39.07395873

A4. (continued)

1st SX	Cycle	TBP vol. %							
Stream	Vol. %, Ref.	Vol %, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AX	0.3	0.315	9.98E-01	3.27E+00	1.48E-01	1.50E-01	45.59118236	0.27027027	22.93072632
1st SX	Cycle	Temp., deg. C							
	Temp , Ref.	Temp, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
	45	47.25	9.98E-01	4.73E+00	1.48E-01	1.73E-01	74.76953908	3.378378378	39.07395873
1st SX	Cycle	Stages							
Stream	Stage, Ref	Stage, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	24	25	9.98E-01	4.74E+00	1.48E-01	1.73E-01	89.91583166	4.054054054	46.98494286
1A	32	31	9.98E-01	9.98E-01	1.48E-01	1.48E-01	0	0	0
1BU	1	2	9.98E-01	1.66E+11	1.48E-01	5.64E+14	1.65932E+11	3.81284E+15	1.9065E+15
1AW	32	31	9.98E-01	9.98E-01	1.48E-01	1.48E-01	0	0	0
1AX	32	31	9.98E-01	4.73E+00	1.48E-01	1.73E-01	119.6312625	5.405405405	62.51833397
1BP	16	17	9.98E-01	6.36E+00	1.48E-01	1.60E-01	86.01202405	1.297297297	43.65466067
1AIS	19	20	9.98E-01	5.57E+00	1.48E-01	1.66E-01	87.0991984	2.310810811	44.7050046
1BX	17	16	9.98E-01	4.72E+00	1.48E-01	1.73E-01	63.46893788	2.871621622	33.17027975
2nd SX	Cycle	Flow Rate							
Stream	Flow(L/m), Ref	Flow(L/m), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AF	0.014	0.0147	9.37E+00	3.95E+00	3.20E+15	3.24E+15	11.57647561	0.193508115	5.884991863
2AS	0.00217	0.00228	9.37E+00	1.27E+01	3.20E+15	3.18E+15	6.986347626	0.123141528	3.554744577
2AIS	0.00133	0.0014	9.37E+00	1.09E+01	3.20E+15	3.19E+15	3.068310385	0.077091136	1.572700761
2AP	0.0175	0.01838	9.37E+00	9.37E+00	3.20E+15	3.20E+15	0	0	0
2BX	0.014	0.0147	9.37E+00	9.94E+00	3.20E+15	3.08E+15	1.212509339	0.767790262	0.990149801
2BP	0.014	0.0147	9.37E+00	9.37E+00	3.20E+15	3.20E+15	0	0	0
2BU	0.014	0.0147	9.37E+00	9.37E+00	3.20E+15	3.20E+15	0	0	0
2AX	0.014	0.0147	9.37E+00	8.49E+00	3.20E+15	3.20E+15	1.872131497	0	0.936065749
2nd SX	Cycle	HNO3 Conc.							
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AF	0.5	0.525	9.37E+00	9.84E+00	3.20E+15	3.20E+15	1.003308784	0	0.501654392
2AS	0.1	0.105	9.37E+00	1.00E+01	3.20E+15	3.20E+15	1.411036397	0	0.705518198
2AIS	8	8.4	9.37E+00	1.59E+01	3.20E+15	3.20E+15	14.01430249	0	7.007151243
2BX	0.2	0.21	9.37E+00	7.42E+00	3.20E+15	3.20E+15	4.169068204	0	2.084534102
2AX	0.001	0.00105	9.37E+00	8.06E+00	3.20E+15	3.20E+15	2.787917601	0	1.3939588

A4. (continued)

2nd SX	Cycle	Np(VI) Conc.							
Stream	Conc. (g/L),Ref	Conc. (g/L), Pe	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AF	43.51	45.6855	9.37E+00	8.98E+00	3.20E+15	3.20E+15	0.826128722	0	0.413064361
2nd SX	Cycle	Pu(III) Conc.							
Stream	Conc. (g/L),Ref	Conc. (g/L), Pe	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AF	8.01	8.4105	9.37E+00	9.37E+00	3.20E+15	3.36E+15	0	0.998751561	0.49937578
2nd SX	Cycle	Nitrate Ion Co.							
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AS	0.13	0.1365	9.37E+00	9.37E+00	3.20E+15	3.20E+15	0	0	0
2BX	0.1	0.105	9.37E+00	9.37E+00	3.20E+15	3.20E+15	0	0	0
2nd SX	Cycle	TBP vol. %							
Stream	Vol. %, Ref.	Vol %, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AX	0.3	0.315	9.37E+00	1.97E+01	3.20E+15	3.20E+15	22.05358096	0	11.02679048
2nd SX	Cycle	Temp., deg. C							
	Temp , Ref.	Temp, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
	45	47.25	9.37E+00	1.27E+01	3.20E+15	3.20E+15	7.187533355	0	3.593766677
2nd SX	Cycle	Stages							
Stream	Stage, Ref	Stage, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AF	24	25	9.37E+00	7.12E+01	3.20E+15	3.20E+15	158.3477426	0	79.17387128
2BP	16	17	9.37E+00	9.15E+00	3.20E+15	3.20E+15	0.3722916	0	0.1861458
2AIS	27	28	9.37E+00	1.18E+01	3.20E+15	3.20E+15	7.141210375	0	3.570605187
2AX	32	31	9.37E+00	1.04E+01	3.20E+15	3.20E+15	3.39502615	0	1.697513075
2BU	1	2	9.37E+00	2.07E+06	3.20E+15	3.20E+15	220513.4626	0	110256.7313

A4. (continued)

Sensitivity	**Analysis**	**Np(VI) D.C. -50%, Pu(IV) D.C. -50% Design**						
1st SX	Cycle	Flow Rate						
Stream	Flow(L/m), Ref	Flow(L/m), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	0.005	0.00525	6.51E-01	5.91E-01	4.65E+01	4.92E+01	1.843317972	1.162595502	1.502956737
1AS	0.00217	0.00228	6.51E-01	6.36E-01	4.65E+01	4.64E+01	0.454545455	0.026322843	0.240434149
1AIS	0.001	0.00105	6.51E-01	6.48E-01	4.65E+01	4.67E+01	0.092165899	0.11148176	0.10182383
1AX	0.014	0.0147	6.51E-01	7.81E-01	4.65E+01	2.34E+01	3.993855607	9.923167976	6.958511791
1AW	0.0085	0.00893	6.51E-01	6.51E-01	4.65E+01	4.65E+01	0	0	0
1A	0.00033	0.00035	6.51E-01	6.53E-01	4.65E+01	4.49E+01	0.050691244	0.552900032	0.301795638
1BX	0.014	0.0147	6.51E-01	5.58E-01	4.65E+01	2.37E+01	2.857142857	9.800064565	6.328603711
1BP	0.014	0.0147	6.51E-01	6.51E-01	4.65E+01	4.65E+01	0	0	0
1BU	0.014	0.0147	6.51E-01	6.51E-01	4.65E+01	4.65E+01	0	0	0
1st SX	Cycle	HNO3 Conc.							
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	3.5	3.675	6.51E-01	6.51E-01	4.65E+01	4.68E+01	0	0.14849887	0.074249435
1AS	0.5	0.525	6.51E-01	6.52E-01	4.65E+01	4.49E+01	0.030721966	0.666738405	0.348730186
1AIS	5	5.25	6.51E-01	6.53E-01	4.65E+01	4.49E+01	0.061443932	0.664155816	0.362799874
1BX	0.2	0.21	6.51E-01	6.51E-01	4.65E+01	3.28E+01	0	5.888733455	2.944366728
1AX	0.001	0.00105	6.51E-01	6.51E-01	4.65E+01	4.22E+01	0	1.837512106	0.918756053
1st SX	Cycle	Np(VI) Conc.							
Stream	Conc. (g/L),Ref	Conc. (g/L), Pe	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	125	131.25	6.51E-01	5.91E-01	4.65E+01	4.22E+01	1.843317972	1.840955558	1.842136765
1st SX	Cycle	Pu(IV) Conc.							
Stream	Conc. (g/L),Ref	Conc. (g/L), Pe	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	23	24.15	6.51E-01	6.32E-01	4.65E+01	4.99E+01	0.583717358	1.459593242	1.0216553
1st SX	Cycle	HAN Conc.							
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1BX	0.1	0.105	6.51E-01	6.51E-01	4.65E+01	4.65E+01	0	0	0
1st SX	Cycle	Salting Agent	Conc.						
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1A	0.2	0.21	6.51E-01	6.51E-01	4.65E+01	4.65E+01	0	0.036156247	0.018078123

A4. (continued)

1st SX	Cycle	TBP vol. %							
Stream	Vol. %, Ref.	Vol %, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AX	0.3	0.315	6.51E-01	8.11E-01	4.65E+01	2.54E+01	4.915514593	9.083396105	6.999455349
1st SX	Cycle	Temp., deg. C							
	Temp , Ref.	Temp, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
	45	47.25	6.51E-01	6.51E-01	4.65E+01	4.49E+01	0	0.686538255	0.343269127
1st SX	Cycle	Stages							
Stream	Stage, Ref	Stage, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	24	25	6.51E-01	6.34E-01	4.65E+01	4.79E+01	0.626728111	0.747917788	0.687322949
1A	32	31	6.51E-01	6.51E-01	4.65E+01	4.48E+01	0	1.13565049	0.567825245
1BU	1	2	6.51E-01	6.51E-01	4.65E+01	2.86E+05	0	6160.627031	3080.313516
1AW	32	31	6.51E-01	1.16E+16	4.65E+01	4.22E+01	5.67742E+17	2.905584849	2.83871E+17
1AX	32	31	6.51E-01	6.51E-01	4.65E+01	4.64E+01	0	0.019972022	0.009986011
1BP	16	17	6.51E-01	3.00E-01	4.65E+01	87.708	8.626728111	14.20182933	11.41427872
1AIS	19	20	6.51E-01	6.70E-01	4.65E+01	50.074	0.55453149	1.475755945	1.015143718
1BX	17	16	6.51E-01	6.41E-01	4.65E+01	48.048	0.261136713	0.579167115	0.420151914
2nd SX	Cycle	Flow Rate							
Stream	Flow(L/m), Ref	Flow(L/m), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AF	0.014	0.0147	1.31E+00	1.23E+00	3.20E+15	3.24E+15	1.163859112	0.193508115	0.678683613
2AS	0.00217	0.00228	1.31E+00	1.25E+00	3.20E+15	3.18E+15	0.860991229	0.123141528	0.492066378
2AIS	0.00133	0.0014	1.31E+00	1.31E+00	3.20E+15	3.19E+15	0.087289433	0.077091136	0.082190285
2AP	0.0175	0.01838	1.31E+00	1.31E+00	3.20E+15	3.20E+15	0	0	0
2BX	0.014	0.0147	1.31E+00	9.93E-01	3.20E+15	3.08E+15	4.793261868	0.767790262	2.780526065
2BP	0.014	0.0147	1.31E+00	1.31E+00	3.20E+15	3.20E+15	0	0	0
2BU	0.014	0.0147	1.31E+00	1.31E+00	3.20E+15	3.20E+15	0	0	0
2AX	0.014	0.0147	1.31E+00	1.53E+00	3.20E+15	3.20E+15	3.384379786	0	1.692189893
2nd SX	Cycle	HNO3 Conc.							
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AF	0.5	0.525	1.31E+00	1.34E+00	3.20E+15	3.20E+15	0.581929556	0	0.290964778
2AS	0.1	0.105	1.31E+00	1.31E+00	3.20E+15	3.20E+15	0.061255743	0	0.030627871
2AIS	8	8.4	1.31E+00	1.31E+00	3.20E+15	3.20E+15	0.015313936	0	0.007656968
2BX	0.2	0.21	1.31E+00	1.31E+00	3.20E+15	3.20E+15	0	0	0
2AX	0.001	0.00105	1.31E+00	1.31E+00	3.20E+15	3.20E+15	0	0	0

A4. (continued)

2nd SX	Cycle	Np(VI) Conc.							
Stream	Conc. (g/L),Ref	Conc. (g/L), Pe	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AF	43.51	45.6855	1.31E+00	1.24E+00	3.20E+15	3.20E+15	1.087289433	0	0.543644717
2nd SX	Cycle	Pu(III) Conc.							
Stream	Conc. (g/L),Ref	Conc. (g/L), Pe	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AF	8.01	8.4105	1.31E+00	1.31E+00	3.20E+15	3.36E+15	0	0.998751561	0.49937578
2nd SX	Cycle	Nitrate Ion Co.							
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AS	0.13	0.1365	1.31E+00	1.31E+00	3.20E+15	3.20E+15	0	0	0
2BX	0.1	0.105	1.31E+00	1.31E+00	3.20E+15	3.20E+15	0	0	0
2nd SX	Cycle	TBP vol. %							
Stream	Vol. %, Ref.	Vol %, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AX	0.3	0.315	1.31E+00	1.60E+00	3.20E+15	3.20E+15	4.532924962	0	2.266462481
2nd SX	Cycle	Temp., deg. C							
	Temp , Ref.	Temp, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
	45	47.25	1.31E+00	1.31E+00	3.20E+15	3.20E+15	0	0	0
2nd SX	Cycle	Stages							
Stream	Stage, Ref	Stage, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AF	24	25	1.31E+00	1.34E+00	3.20E+15	3.20E+15	0.606431853	0	0.303215926
2BP	16	17	1.31E+00	3.67E-02	3.20E+15	3.20E+15	15.55038285	0	7.775191424
2AIS	27	28	1.31E+00	1.30E+00	3.20E+15	3.20E+15	0.206738132	0	0.103369066
2AX	32	31	1.31E+00	1.31E+00	3.20E+15	3.20E+15	0	0	0
2BU	1	2	1.31E+00	1.31E+00	3.20E+15	3.20E+15	0	0	0

A4. (continued)

Sensitivity	**Analysis**	**Np(VI) D.C. +50%, Pu(IV) D.C. -50% Design**							
1st SX	Cycle	Flow Rate							
Stream	Flow(L/m), Ref	Flow(L/m), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	0.005	0.00525	5.04E+00	1.32E+00	1.12E+00	9.22E-01	14.77362986	3.476702509	9.125166187
1AS	0.00217	0.00228	5.04E+00	5.30E+00	1.12E+00	1.09E+00	1.014567839	0.494949495	0.754758667
1AIS	0.001	0.00105	5.04E+00	5.00E+00	1.12E+00	1.12E+00	0.138999206	0.089605735	0.11430247
1AX	0.014	0.0147	5.04E+00	4.01E+00	1.12E+00	9.87E-01	4.070691025	2.311827957	3.191259491
1AW	0.0085	0.00893	5.04E+00	5.04E+00	1.12E+00	1.12E+00	0	0	0
1A	0.00033	0.00035	5.04E+00	5.04E+00	1.12E+00	1.12E+00	0	0	0
1BX	0.014	0.0147	5.04E+00	8.13E+00	1.12E+00	1.10E+00	12.27561557	0.322580645	6.299098107
1BP	0.014	0.0147	5.04E+00	5.04E+00	1.12E+00	1.12E+00	0	0	0
1BU	0.014	0.0147	5.04E+00	5.04E+00	1.12E+00	1.12E+00	0	0	0
1st SX	Cycle	HNO3 Conc.							
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	3.5	3.675	5.04E+00	5.04E+00	1.12E+00	1.12E+00	0.003971406	0	0.001985703
1AS	0.5	0.525	5.04E+00	4.97E+00	1.12E+00	1.12E+00	0.262112788	0.143369176	0.202740982
1AIS	5	5.25	5.04E+00	1.30E+00	1.12E+00	8.36E-01	14.85702939	5.017921147	9.937475268
1BX	0.2	0.21	5.04E+00	4.07E+00	1.12E+00	1.07E+00	3.84432089	0.752688172	2.298504531
1AX	0.001	0.00105	5.04E+00	5.04E+00	1.12E+00	1.12E+00	0	0	0
1st SX	Cycle	Np(VI) Conc.							
Stream	Conc. (g/L),Ref	Conc. (g/L), Pe	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	125	131.25	5.04E+00	4.73E+00	1.12E+00	1.17E+00	1.219221604	1.021505376	1.12036349
1st SX	Cycle	Pu(IV) Conc.							
Stream	Conc. (g/L),Ref	Conc. (g/L), Pe	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	23	24.15	5.04E+00	1.34E+00	1.12E+00	8.52E-01	14.69023034	4.731182796	9.710706569
1st SX	Cycle	HAN Conc.							
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1BX	0.1	0.105	5.04E+00	5.04E+00	1.12E+00	1.12E+00	0	0	0
1st SX	Cycle	Salting Agent	Conc.						
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1A	0.2	0.21	5.04E+00	5.04E+00	1.12E+00	1.12E+00	0	0	0

A4. (continued)

1st SX	Cycle	TBP vol. %						
Stream	Vol. %, Ref.	Vol %, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AX	0.3	0.315	5.04E+00	1.02E+00	1.12E+00	6.76E-01	15.95313741	7.885304659	11.91922104
1st SX	Cycle	Temp., deg. C							
	Temp , Ref.	Temp, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
	45	47.25	5.04E+00	5.04E+00	1.12E+00	1.12E+00	0	0	0
1st SX	Cycle	Stages							
Stream	Stage, Ref	Stage, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	24	25	5.04E+00	5.04E+00	1.12E+00	1.12E+00	0.028594122	0	0.014297061
1A	32	31	5.04E+00	5.04E+00	1.12E+00	1.12E+00	0	0	0
1BU	1	2	5.04E+00	1.24E+11	1.12E+00	1.99E+15	24523431294	1.78674E+15	8.93381E+14
1AW	32	31	5.04E+00	5.04E+00	1.12E+00	1.12E+00	0	0	0
1AX	32	31	5.04E+00	5.04E+00	1.12E+00	1.12E+00	0	0	0
1BP	16	17	5.04E+00	6.33E+00	1.12E+00	1.05E+00	4.098490866	1.003584229	2.551037548
1AIS	19	20	5.04E+00	5.70E+00	1.12E+00	1.05E+00	2.516481334	1.123655914	1.820068624
1BX	17	16	5.04E+00	5.01E+00	1.12E+00	1.12E+00	0.10127085	0.0609319	0.081101375
2nd SX	Cycle	Flow Rate							
Stream	Flow(L/m), Ref	Flow(L/m), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AF	0.014	0.0147	9.37E+00	3.95E+00	3.20E+15	3.24E+15	11.57647561	0.193508115	5.884991863
2AS	0.00217	0.00228	9.37E+00	1.27E+01	3.20E+15	3.18E+15	6.986347626	0.123141528	3.554744577
2AIS	0.00133	0.0014	9.37E+00	1.09E+01	3.20E+15	3.19E+15	3.068310385	0.077091136	1.572700761
2AP	0.0175	0.01838	9.37E+00	9.37E+00	3.20E+15	3.20E+15	0	0	0
2BX	0.014	0.0147	9.37E+00	9.94E+00	3.20E+15	3.08E+15	1.212509339	0.767790262	0.990149801
2BP	0.014	0.0147	9.37E+00	9.37E+00	3.20E+15	3.20E+15	0	0	0
2BU	0.014	0.0147	9.37E+00	9.37E+00	3.20E+15	3.20E+15	0	0	0
2AX	0.014	0.0147	9.37E+00	8.49E+00	3.20E+15	3.20E+15	1.872131497	0	0.936065749
2nd SX	Cycle	HNO3 Conc.							
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AF	0.5	0.525	9.37E+00	9.84E+00	3.20E+15	3.20E+15	1.003308784	0	0.501654392
2AS	0.1	0.105	9.37E+00	1.00E+01	3.20E+15	3.20E+15	1.411036397	0	0.705518198
2AIS	8	8.4	9.37E+00	1.59E+01	3.20E+15	3.20E+15	14.01430249	0	7.007151243
2BX	0.2	0.21	9.37E+00	7.42E+00	3.20E+15	3.20E+15	4.169068204	0	2.084534102
2AX	0.001	0.00105	9.37E+00	8.06E+00	3.20E+15	3.20E+15	2.787917601	0	1.3939588

A4. (continued)

2nd SX	Cycle	Np(VI) Conc.							
Stream	Conc. (g/L),Ref	Conc. (g/L), Pe	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AF	43.51	45.6855	9.37E+00	8.98E+00	3.20E+15	3.20E+15	0.826128722	0	0.413064361
2nd SX	Cycle	Pu(III) Conc.							
Stream	Conc. (g/L),Ref	Conc. (g/L), Pe	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AF	8.01	8.4105	9.37E+00	9.37E+00	3.20E+15	3.36E+15	0	0.998751561	0.49937578
2nd SX	Cycle	Nitrate Ion Co.							
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AS	0.13	0.1365	9.37E+00	9.37E+00	3.20E+15	3.20E+15	0	0	0
2BX	0.1	0.105	9.37E+00	9.37E+00	3.20E+15	3.20E+15	0	0	0
2nd SX	Cycle	TBP vol. %							
Stream	Vol. %, Ref.	Vol %, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AX	0.3	0.315	9.37E+00	1.97E+01	3.20E+15	3.20E+15	22.05358096	0	11.02679048
2nd SX	Cycle	Temp., deg. C							
	Temp , Ref.	Temp, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
	45	47.25	9.37E+00	1.27E+01	3.20E+15	3.20E+15	7.187533355	0	3.593766677
2nd SX	Cycle	Stages							
Stream	Stage, Ref	Stage, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AF	24	25	9.37E+00	7.12E+01	3.20E+15	3.20E+15	158.3477426	0	79.17387128
2BP	16	17	9.37E+00	9.15E+00	3.20E+15	3.20E+15	0.3722916	0	0.1861458
2AIS	27	28	9.37E+00	1.18E+01	3.20E+15	3.20E+15	7.141210375	0	3.570605187
2AX	32	31	9.37E+00	1.04E+01	3.20E+15	3.20E+15	3.39502615	0	1.697513075
2BU	1	2	9.37E+00	2.07E+06	3.20E+15	3.20E+15	220513.4626	0	110256.7313

A4. (continued)

Sensitivity	**Analysis**	**Np(VI) D.C. -50%, Pu(IV) D.C. +50% Design**						
1st SX	Cycle	Flow Rate						
Stream	Flow(L/m), Ref	Flow(L/m), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	0.005	0.00525	9.90E-01	8.92E-01	2.91E-01	6.02E+03	1.97979798	413519.5189	206760.7493
1AS	0.00217	0.00228	9.90E-01	9.64E-01	2.91E-01	7.80E+00	0.518089991	508.7060294	254.6120597
1AIS	0.001	0.00105	9.90E-01	9.83E-01	2.91E-01	2.29E+00	0.141414141	137.4570447	68.79922941
1AX	0.014	0.0147	9.90E-01	1.20E+00	2.91E-01	9.33E-01	4.262626263	44.12371134	24.1931688
1AW	0.0085	0.00893	9.90E-01	9.90E-01	2.91E-01	2.91E-01	0	0	0
1A	0.00033	0.00035	9.90E-01	9.91E-01	2.91E-01	7.55E+02	0.016666667	42803.09794	21401.5573
1BX	0.014	0.0147	9.90E-01	8.54E-01	2.91E-01	8.35E+01	2.747474747	5716.013746	2859.38061
1BP	0.014	0.0147	9.90E-01	9.90E-01	2.91E-01	2.91E-01	0	0	0
1BU	0.014	0.0147	9.90E-01	9.90E-01	2.91E-01	2.91E-01	0	0	0
1st SX	Cycle	HNO3 Conc.							
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	3.5	3.675	9.90E-01	9.89E-01	2.91E-01	3.16E+01	0.02020202	2152.302405	1076.161304
1AS	0.5	0.525	9.90E-01	9.88E-01	2.91E-01	1.82E+03	0.04040404	124722.268	62361.15422
1AIS	5	5.25	9.90E-01	9.91E-01	2.91E-01	1.72E+04	0.02020202	1182110.584	591055.3022
1BX	0.2	0.21	9.90E-01	9.90E-01	2.91E-01	4.18E+01	0	2855.120275	1427.560137
1AX	0.001	0.00105	9.90E-01	9.91E-01	2.91E-01	1.03E+04	0.02020202	705821.9244	352910.9723
1st SX	Cycle	Np(VI) Conc.							
Stream	Conc. (g/L),Ref	Conc. (g/L), Pe	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	125	131.25	9.90E-01	8.77E-01	2.91E-01	7.91E+00	2.282828283	523.9175258	263.100177
1st SX	Cycle	Pu(IV) Conc.							
Stream	Conc. (g/L),Ref	Conc. (g/L), Pe	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	23	24.15	9.90E-01	9.81E-01	2.91E-01	2.01E+04	0.181818182	1382797.869	691399.0256
1st SX	Cycle	HAN Conc.							
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1BX	0.1	0.105	9.90E-01	9.90E-01	2.91E-01	2.91E-01	0	0	0
1st SX	Cycle	Salting Agent	Conc.						
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1A	0.2	0.21	9.90E-01	9.90E-01	2.91E-01	3.23E+00	0	201.7869416	100.8934708

A4. (continued)

1st SX	Cycle	TBP vol. %							
Stream	Vol. %, Ref.	Vol %, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AX	0.3	0.315	9.90E-01	1.26E+00	2.91E-01	6.23E+00	5.414141414	408.3848797	206.8995106
1st SX	Cycle	Temp., deg. C							
	Temp , Ref.	Temp, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
	45	47.25	9.90E-01	9.85E-01	2.91E-01	5.91E+03	0.101010101	406028.11	203014.1055
1st SX	Cycle	Stages							
Stream	Stage, Ref	Stage, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
1AF	24	25	9.90E-01	9.61E-01	2.91E-01	4.44E+00	0.703030303	342.4329897	171.56801
1A	32	31	9.90E-01	9.89E-01	2.91E-01	1.24E-01	0.032323232	18.36426117	9.1982922
1BU	1	2	9.90E-01	9.89E-01	2.91E-01	2.67E+09	0.001010101	9158075600	4579037800
1AW	32	31	9.90E-01	1.39E+16	2.91E-01	5.10E-02	4.48E+17	26.39175258	2.24E+17
1AX	32	31	9.90E-01	9.88E-01	2.91E-01	1.51E+04	0.064646465	1663748.069	831874.0667
1BP	16	17	9.90E-01	5.14E-01	2.91E-01	0.265	7.692929293	1.429553265	4.561241279
1AIS	19	20	9.90E-01	1.02E+00	2.91E-01	173.528	0.556565657	11311.00687	5655.781719
1BX	17	16	9.90E-01	9.76E-01	2.91E-01	17350	0.24040404	1013556.883	506778.5618
2nd SX	Cycle	Flow Rate							
Stream	Flow(L/m), Ref	Flow(L/m), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AF	0.014	0.0147	1.31E+00	1.23E+00	3.20E+15	3.24E+15	1.163859112	0.193508115	0.678683613
2AS	0.00217	0.00228	1.31E+00	1.25E+00	3.20E+15	3.18E+15	0.860991229	0.123141528	0.492066378
2AIS	0.00133	0.0014	1.31E+00	1.31E+00	3.20E+15	3.19E+15	0.087289433	0.077091136	0.082190285
2AP	0.0175	0.01838	1.31E+00	1.31E+00	3.20E+15	3.20E+15	0	0	0
2BX	0.014	0.0147	1.31E+00	9.93E-01	3.20E+15	3.08E+15	4.793261868	0.767790262	2.780526065
2BP	0.014	0.0147	1.31E+00	1.31E+00	3.20E+15	3.20E+15	0	0	0
2BU	0.014	0.0147	1.31E+00	1.31E+00	3.20E+15	3.20E+15	0	0	0
2AX	0.014	0.0147	1.31E+00	1.53E+00	3.20E+15	3.20E+15	3.384379786	0	1.692189893
2nd SX	Cycle	HNO3 Conc.							
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AF	0.5	0.525	1.31E+00	1.34E+00	3.20E+15	3.20E+15	0.581929556	0	0.290964778
2AS	0.1	0.105	1.31E+00	1.31E+00	3.20E+15	3.20E+15	0.061255743	0	0.030627871
2AIS	8	8.4	1.31E+00	1.31E+00	3.20E+15	3.20E+15	0.015313936	0	0.007656968
2BX	0.2	0.21	1.31E+00	1.31E+00	3.20E+15	3.20E+15	0	0	0
2AX	0.001	0.00105	1.31E+00	1.31E+00	3.20E+15	3.20E+15	0	0	0

A4. (continued)

2nd SX	Cycle	Np(VI) Conc.							
Stream	Conc. (g/L),Ref	Conc. (g/L), Pe	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AF	43.51	45.6855	1.31E+00	1.24E+00	3.20E+15	3.20E+15	1.087289433	0	0.543644717
2nd SX	Cycle	Pu(III) Conc.							
Stream	Conc. (g/L),Ref	Conc. (g/L), Pe	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AF	8.01	8.4105	1.31E+00	1.31E+00	3.20E+15	3.36E+15	0	0.998751561	0.49937578
2nd SX	Cycle	Nitrate Ion Co.							
Stream	Conc. (M),Ref.	Conc. (M), Per	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AS	0.13	0.1365	1.31E+00	1.31E+00	3.20E+15	3.20E+15	0	0	0
2BX	0.1	0.105	1.31E+00	1.31E+00	3.20E+15	3.20E+15	0	0	0
2nd SX	Cycle	TBP vol. %							
Stream	Vol. %, Ref.	Vol %, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AX	0.3	0.315	1.31E+00	1.60E+00	3.20E+15	3.20E+15	4.532924962	0	2.266462481
2nd SX	Cycle	Temp., deg. C							
	Temp , Ref.	Temp, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
	45	47.25	1.31E+00	1.31E+00	3.20E+15	3.20E+15	0	0	0
2nd SX	Cycle	Stages							
Stream	Stage, Ref	Stage, Per.	Np Ratio, Ref.	Np Ratio, Per.	Pu Ratio, Ref.	Pu Ratio, Per.	Np Sens. Coef	Pu Sens. Coef	Avg. Sens. Co.
2AF	24	25	1.31E+00	1.34E+00	3.20E+15	3.20E+15	0.606431853	0	0.303215926
2BP	16	17	1.31E+00	3.67E-02	3.20E+15	3.20E+15	15.55038285	0	7.775191424
2AIS	27	28	1.31E+00	1.30E+00	3.20E+15	3.20E+15	0.206738132	0	0.103369066
2AX	32	31	1.31E+00	1.31E+00	3.20E+15	3.20E+15	0	0	0
2BU	1	2	1.31E+00	1.31E+00	3.20E+15	3.20E+15	0	0	0

APPENDIX V - RESULTS OF THE OPTIMIZATION ROUTINE

A5. Results of the Optimization Routine

Optimization of the 1st Cycle			**Baseline Design**							
Run	V1	V2	V3	V4	V5	V6	V7	V8	R1	R2
1	0.3	0.014	0.005	32	19	0.2	24	125	1.08E+09	552.539
2	0.2	0.014	0.005	32	19	0.2	24	125	1.588	13.802
3	0.25	0.014	0.005	32	19	0.2	24	125	3.90E+07	10.037
4	0.35	0.014	0.005	32	19	0.2	24	125	1.97E+00	0.2806
5	0.32	0.014	0.005	32	19	0.2	24	125	9.737	0.4122
6	0.31	0.014	0.005	32	19	0.2	24	125	2784.019	5.986
7	0.3	0.01	0.005	32	19	0.2	24	125	6.41E+00	14.79
8	0.3	0.02	0.005	32	19	0.2	24	125	3.65E+00	0.419
9	0.3	0.012	0.005	32	19	0.2	24	125	4.58E+08	15.499
10	0.3	0.013	0.005	32	19	0.2	24	125	1.34E+09	21.328
11	0.3	0.015	0.005	32	19	0.2	24	125	1.32E+01	0.484
12	0.3	0.014	0.001	32	19	0.2	24	125	1.33E+12	2.61E+14
13	0.3	0.014	0.0005	32	19	0.2	24	125	1.78E+11	2.58E+14
14	0.3	0.014	0.0008	32	19	0.2	24	125	6.86E+09	0.0415
15	0.3	0.014	0.0009	32	19	0.2	24	125	6.46E+09	0.0401
16	0.3	0.014	0.007	32	19	0.2	24	125	4.11E+06	2482.773
17	0.3	0.014	0.001	31	19	0.2	24	125	5.54E+10	2.61E+14
18	0.3	0.014	0.001	30	19	0.2	24	125	2.02E+09	144.472
19	0.3	0.014	0.001	32	20	0.2	24	125	1.49E+12	2.75E+14
20	0.3	0.014	0.001	32	21	0.2	24	125	1.54E+12	164.179
21	0.3	0.014	0.001	32	18	0.2	24	125	9.68E+11	297.576
22	0.3	0.014	0.001	32	17	0.2	24	125	5.43E+07	2.06E+14
23	0.3	0.014	0.001	32	20	0.1	24	125	1.48E+12	6.12E+14
24	0.3	0.014	0.001	32	20	0.05	24	125	1.49E+12	6.64E+14
25	0.3	0.014	0.001	32	20	0.03	24	125	1.49E+12	8.21E+14
26	0.3	0.014	0.001	32	20	0.01	24	125	1.49E+12	8.21E+14
27	0.3	0.014	0.001	32	20	0.005	24	125	1.49E+12	8.21E+15
28	0.3	0.014	0.001	32	20	0.001	24	125	1.49E+12	8.21E+15
29	0.3	0.014	0.001	32	20	0.3	24	125	1.22E+11	3.64E-02
30	0.3	0.014	0.001	32	20	0.03	25	125	5.42E+10	8.21E+14
31	0.3	0.014	0.001	32	20	0.03	26	125	1.97E+09	8.21E+14
32	0.3	0.014	0.001	32	20	0.03	23	125	4.46E+15	8.21E+14
33	0.3	0.014	0.001	32	20	0.03	22	125	4.46E+15	8.21E+14

A5. (continued)

Run	V1	V2	V3	V4	V5	V6	V7	V8	R1	R2
34	0.3	0.014	0.001	32	20	0.03	23	120	4.29E+15	8.21E+14
35	0.3	0.014	0.001	32	20	0.03	23	130	4.64E+15	8.21E+14
36	0.3	0.014	0.001	32	20	0.03	23	140	5.00E+15	8.21E+14
37	0.3	0.014	0.001	32	20	0.03	23	150	5.40E+15	1.12E+15
38	0.3	0.014	0.001	32	20	0.03	23	180	6.43E+15	7.24E+14
39	0.3	0.014	0.001	32	20	0.03	23	170	6.12E+15	1.12E+15
40	0.3	0.014	0.001	32	20	0.03	23	175	6.25E+15	7.37E+14
41	0.3	0.014	0.001	32	20	0.03	23	172	6.19E+15	1.12E+15
42	0.3	0.014	0.001	32	20	0.03	23	173	6.23E+15	1.12E+15
43	0.3	0.014	0.001	32	20	0.03	23	174	6.21E+15	7.39E+14
44	0.3	0.014	0.001	32	20	0.03	23	173	6.23E+15	1.12E+15
Optimization of the 2nd Cycle										
Run	V1	V2	V3	V4	V5	V6	V7	V8	R1	R2
45	0.3	32	27	0.014	0.014	24	0.014	0.5	4.49E+03	3.20E+15
46	0.25	32	27	0.014	0.014	24	0.014	0.5	1.53E+01	3.20E+15
47	0.35	32	27	0.014	0.014	24	0.014	0.5	5.12E+05	3.20E+15
48	0.4	32	27	0.014	0.014	24	0.014	0.5	4.79E+00	3.20E+15
49	0.38	32	27	0.014	0.014	24	0.014	0.5	9.509	3.20E+15
50	0.33	32	27	0.014	0.014	24	0.014	0.5	3.32E+05	3.20E+15
51	0.34	32	27	0.014	0.014	24	0.014	0.5	5.93E+05	3.20E+15
52	0.36	32	27	0.014	0.014	24	0.014	0.5	1.79E+06	3.20E+15
53	0.37	32	27	0.014	0.014	24	0.014	0.5	1.67E+01	3.20E+15
54	0.36	31	27	0.014	0.014	24	0.014	0.5	1.50E+01	3.20E+15
55	0.36	30	27	0.014	0.014	24	0.014	0.5	3.44E+04	3.20E+15
56	0.36	29	27	0.014	0.014	24	0.014	0.5	4747.897	3.20E+15
57	0.36	32	28	0.014	0.014	24	0.014	0.5	15.715	3.20E+15
58	0.36	32	29	0.014	0.014	24	0.014	0.5	9.52E+04	3.20E+15
59	0.36	32	30	0.014	0.014	24	0.014	0.5	1.82E+04	3.20E+15
60	0.36	32	26	0.014	0.014	24	0.014	0.5	14.959	3.20E+15
61	0.36	32	25	0.014	0.014	24	0.014	0.5	1.50E+07	3.20E+15
62	0.36	32	24	0.014	0.014	24	0.014	0.5	0	0.00E+00
63	0.36	32	23	0.014	0.014	24	0.014	0.5	13.968	3.20E+15
64	0.36	32	25	0.01	0.014	24	0.014	0.5	1.48E+05	3.20E+15
65	0.36	32	25	0.02	0.014	24	0.014	0.5	5.59E+07	3.20E+15
66	0.36	32	25	0.03	0.014	24	0.014	0.5	425.13	3.20E+15
67	0.36	32	25	0.025	0.014	24	0.014	0.5	39.528	3.20E+15
68	0.36	32	25	0.023	0.014	24	0.014	0.5	55.755	3.20E+15

A5. (continued)

Run	V1	V2	V3	V4	V5	V6	V7	V8	R1	R2
69	0.36	32	25	0.022	0.014	24	0.014	0.5	4.75E+02	3.20E+15
70	0.36	32	25	0.021	0.014	24	0.014	0.5	22.041	3.20E+15
71	0.36	32	25	0.018	0.014	24	0.014	0.5	2.23E+04	3.20E+15
72	0.36	32	25	0.02	0.01	24	0.014	0.5	1.30E+00	3.20E+15
73	0.36	32	25	0.02	0.02	24	0.014	0.5	3.76E+06	2.39E+15
74	0.36	32	25	0.02	0.03	24	0.014	0.5	1.41E+01	1.67E+15
75	0.36	32	25	0.02	0.025	24	0.014	0.5	5.38E+04	1.97E+15
76	0.36	32	25	0.02	0.015	24	0.014	0.5	9.90E+00	3.03E+15
77	0.36	32	25	0.02	0.018	24	0.014	0.5	1.67E+01	2.61E+15
78	0.36	32	25	0.02	0.014	25	0.014	0.5	0.00E+00	0.00E+00
79	0.36	32	25	0.02	0.014	26	0.014	0.5	2.31E+00	3.20E+15
80	0.36	32	25	0.02	0.014	23	0.014	0.5	5.23E+09	3.20E+15
81	0.36	32	25	0.02	0.014	22	0.014	0.5	1.76E+10	3.20E+15
82	0.36	32	25	0.02	0.014	21	0.014	0.5	3.36E+01	3.20E+15
83	0.36	32	25	0.02	0.014	22	0.01	0.5	4.24E+12	2.97E+15
84	0.36	32	25	0.02	0.014	22	0.005	0.5	1.31E+00	2.36E+15
85	0.36	32	25	0.02	0.014	22	0.008	0.5	1.73E+16	2.79E+15
86	0.36	32	25	0.02	0.014	22	0.009	0.5	8.14E+12	2.88E+15
87	0.36	32	25	0.02	0.014	22	0.007	0.5	7.32E+15	2.67E+15
88	0.36	32	25	0.02	0.014	22	0.008	0.4	1.71E+16	2.79E+15
89	0.36	32	25	0.02	0.014	22	0.008	0.6	1.69E+16	2.79E+15
90	0.36	32	25	0.02	0.014	22	0.008	0.45	7.37E+15	2.79E+15
91	0.36	32	25	0.02	0.014	22	0.008	0.48	1.73E+16	2.79E+15
92	0.36	32	25	0.02	0.014	22	0.008	0.49	1.73E+16	2.79E+15
93	0.36	32	25	0.02	0.014	22	0.008	0.55	1.73E+16	2.79E+15
94	0.36	32	25	0.02	0.014	22	0.008	0.52	7.31E+15	2.79E+15
95	0.36	32	25	0.02	0.014	22	0.008	0.5	1.73E+16	2.79E+15

A5. (continued)

Optimization of the 1st Cycle			Np(VI) D.C. +50% Design							
Run	V1	V2	V3	V4	V5	V6	V7	V8	R1	R2
96	32	32	0.3	0.014	0.2	16	0.014	19	4.57E+00	0.304
97	31	32	0.3	0.014	0.2	16	0.014	19	1.088	0.251
98	30	32	0.3	0.014	0.2	16	0.014	19	4.57E+00	0.304
99	29	32	0.3	0.014	0.2	16	0.014	19	4.57E+00	0.304
100	32	31	0.3	0.014	0.2	16	0.014	19	1.088	0.251
101	32	30	0.3	0.014	0.2	16	0.014	19	4.573	0.304
102	32	32	0.25	0.014	0.2	16	0.014	19	1.16E+01	0.576
103	32	32	0.2	0.014	0.2	16	0.014	19	6.91E+07	17.835
104	32	32	0.1	0.014	0.2	16	0.014	19	1.57E-01	767.03
105	32	32	0.15	0.014	0.2	16	0.014	19	1.45E+00	5.72E+04
106	32	32	0.17	0.014	0.2	16	0.014	19	7.28E+00	14.043
107	32	32	0.16	0.014	0.2	16	0.014	19	2.64E+00	4.64E+00
108	32	32	0.18	0.014	0.2	16	0.014	19	1.63E+06	2.74E+01
109	32	32	0.19	0.014	0.2	16	0.014	19	1.78E+07	15.445
110	32	32	0.21	0.014	0.2	16	0.014	19	2.11E+08	23.465
111	32	32	0.22	0.014	0.2	16	0.014	19	5.72E+08	50.068
112	32	32	0.23	0.014	0.2	16	0.014	19	1.97E+08	1.31E+02
113	32	32	0.24	0.014	0.2	16	0.014	19	3.02E+01	0.754
114	32	32	0.35	0.014	0.2	16	0.014	19	1.60E+00	1.89E-01
115	32	32	0.32	0.014	0.2	16	0.014	19	2.90E+00	0.245
116	32	32	0.23	0.01	0.2	16	0.014	19	4.63E+00	0.698
117	32	32	0.23	0.02	0.2	16	0.014	19	2.80E+00	2.33E+00
118	32	32	0.23	0.017	0.2	16	0.014	19	6.30E+07	1.08E+01
119	32	32	0.23	0.018	0.2	16	0.014	19	1.58E+05	8.37E+00
120	32	32	0.23	0.016	0.2	16	0.014	19	2.26E+08	2.54E+01
121	32	32	0.23	0.015	0.2	16	0.014	19	5.97E+08	2.50E+01
122	32	32	0.23	0.013	0.2	16	0.014	19	1.06E+01	7.59E-01
123	32	32	0.23	0.012	0.2	16	0.014	19	1.10E+01	8.08E-01
124	32	32	0.23	0.014	0.1	16	0.014	19	1.43E+09	8.87E+00
125	32	32	0.23	0.014	0.3	16	0.014	19	5.52E+00	8.53E-01
126	32	32	0.23	0.014	0.15	16	0.014	19	1.43E+09	1.09E+02
127	32	32	0.23	0.014	0.18	16	0.014	19	1.39E+09	7.12E+01
128	32	32	0.23	0.014	0.17	16	0.014	19	1.43E+09	4.19E+02

A5. (continued)

Run	V1	V2	V3	V4	V5	V6	V7	V8	R1	R2
129	32	32	0.23	0.014	0.16	16	0.014	19	1.42E+09	4.41E+01
130	32	32	0.23	0.014	0.19	16	0.014	19	1.13E+09	9.51E+01
131	32	32	0.23	0.014	0.25	16	0.014	19	1.08E+01	8.19E-01
132	32	32	0.23	0.014	0.17	15	0.014	19		
133	32	32	0.23	0.014	0.17	14	0.014	19		
134	32	32	0.23	0.014	0.17	17	0.014	19	1.44E+09	3.44E+01
135	32	32	0.23	0.014	0.17	18	0.014	19	1.58E+09	3.10E+02
136	32	32	0.23	0.014	0.17	19	0.014	19	1.61E+09	7.34E+04
137	32	32	0.23	0.014	0.17	20	0.014	19	1.57E+09	2.08E+12
138	32	32	0.23	0.014	0.17	21	0.014	19	1.52E+09	1.59E+12
139	32	32	0.23	0.014	0.17	20	0.01	19	5.18E+00	3.72E+01
140	32	32	0.23	0.014	0.17	20	0.02	19	0.999	0.875
141	32	32	0.23	0.014	0.17	20	0.012	19	1.92E+08	1.14E+11
142	32	32	0.23	0.014	0.17	20	0.013	19	6.42E+08	5.59E+11
143	32	32	0.23	0.014	0.17	20	0.015	19	9.889	2.44
144	32	32	0.23	0.014	0.17	20	0.014	20	1.61E+09	1.75E+12
145	32	32	0.23	0.014	0.17	20	0.014	21	1.58E+09	4.38E+15
146	32	32	0.23	0.014	0.17	20	0.014	22	1.51E+09	2.81E+11
147	32	32	0.23	0.014	0.17	20	0.014	18	3.15E+05	24.22
148	32	32	0.23	0.014	0.17	20	0.014	21	1.58E+09	4.38E+15
Optimization of 2nd Cycle										
Run	V1	V2	V3	V4	V5	V6	V7	V8	R1	R2
149	1	24	0.3	8	0.014	45	27	0.00217	9.37E+00	3.20E+15
150	2	24	0.3	8	0.014	45	27	0.00217	9.20E+00	3.20E+15
151	3	24	0.3	8	0.014	45	27	0.00217	9.02E+00	3.20E+15
152	1	25	0.3	8	0.014	45	27	0.00217	7.12E+01	3.20E+15
153	1	26	0.3	8	0.014	45	27	0.00217	8.56	3.20E+15
154	1	23	0.3	8	0.014	45	27	0.00217	8.20E+00	3.20E+15
155	1	22	0.3	8	0.014	45	27	0.00217	7.80E+00	3.20E+15
156	1	25	0.2	8	0.014	45	27	0.00217	3.26E+02	3.20E+15
157	1	25	0.15	8	0.014	45	27	0.00217	2.04E+00	3.20E+15
158	1	25	0.25	8	0.014	45	27	0.00217	4.64E+04	3.20E+15
159	1	25	0.28	8	0.014	45	27	0.00217	3.15E+05	3.20E+15
160	1	25	0.29	8	0.014	45	27	0.00217	816.278	3.20E+15
161	1	25	0.27	8	0.014	45	27	0.00217	1.72E+05	3.20E+15
162	1	25	0.26	8	0.014	45	27	0.00217	9.10E+04	3.20E+15
163	1	25	0.22	8	0.014	45	27	0.00217	4.13E+03	3.20E+15
164	1	25	0.33	8	0.014	45	27	0.00217	7.915	3.20E+15
165	1	25	0.28	7.5	0.014	45	27	0.00217	1.24E+01	3.20E+15
166	1	25	0.28	7.8	0.014	45	27	0.00217	2.91E+05	3.20E+15
167	1	25	0.28	7.9	0.014	45	27	0.00217	3.04E+05	3.20E+15
168	1	25	0.28	7.2	0.014	45	27	0.00217	2.26E+05	3.20E+15
169	1	25	0.28	7	0.014	45	27	0.00217	2.07E+05	3.20E+15
170	1	25	0.28	7.3	0.014	45	27	0.00217	2.38E+05	3.20E+15
171	1	25	0.28	7.4	0.014	45	27	0.00217	2.46E+05	3.20E+15
172	1	25	0.28	7.6	0.014	45	27	0.00217	2.68E+05	3.20E+15

A5. (continued)

Run	V1	V2	V3	V4	V5	V6	V7	V8	R1	R2
173	1	25	0.28	7.7	0.014	45	27	0.00217	2.79E+05	3.20E+15
174	1	25	0.28	8.1	0.014	45	27	0.00217	1.28E+03	3.20E+15
175	1	25	0.28	8.3	0.014	45	27	0.00217	3.49E+05	3.20E+15
176	1	25	0.28	8.4	0.014	45	27	0.00217	1.46E+01	3.20E+15
177	1	25	0.28	8.5	0.014	45	27	0.00217	3.81E+05	3.20E+15
178	1	25	0.28	8.7	0.014	45	27	0.00217	4.05E+05	3.20E+15
179	1	25	0.28	9	0.014	45	27	0.00217	4.47E+05	3.20E+15
180	1	25	0.28	9.5	0.014	45	27	0.00217	5.30E+05	3.20E+15
181	1	25	0.28	10	0.014	45	27	0.00217	6.16E+05	3.20E+15
182	1	25	0.28	11	0.014	45	27	0.00217	1.38E+01	3.20E+15
183	1	25	0.28	10.5	0.014	45	27	0.00217	7.05E+05	3.20E+15
184	1	25	0.28	10.7	0.014	45	27	0.00217	9.44E+02	3.20E+15
185	1	25	0.28	10.6	0.014	45	27	0.00217	7.31E+05	3.20E+15
186	1	25	0.28	10.3	0.014	45	27	0.00217	6.73E+05	3.20E+15
187	1	25	0.28	6	0.014	45	27	0.00217	1.56E+01	3.20E+15
188	1	25	0.28	10.6	0.01	45	27	0.00217	2.43E+07	2.97E+15
189	1	25	0.28	10.6	0.005	45	27	0.00217	4.71E+09	2.36E+15
190	1	25	0.28	10.6	0.001	45	27	0.00217	4.37E+11	8.90E+14
191	1	25	0.28	10.6	0.0005	45	27	0.00217	6.44E+11	5.01E+14
192	1	25	0.28	10.6	0.0001	45	27	0.00217	1.55E+14	1.11E+14
193	1	25	0.28	10.6	0.0003	45	27	0.00217	4.66E+14	3.16E+14
194	1	25	0.28	10.6	0.0004	45	27	0.00217	6.77E+11	4.11E+14
195	1	25	0.28	10.6	0.0007	45	27	0.00217	5.65E+11	6.68E+14
196	1	25	0.28	10.6	0.02	45	27	0.00217	1.62E+01	3.41E+15
197	1	25	0.28	10.6	0.017	45	27	0.00217	1.89E+01	3.32E+15
198	1	25	0.28	10.6	0.0003	42	27	0.00217	4.66E+14	3.16E+14
199	1	25	0.28	10.6	0.0003	40	27	0.00217	4.66E+14	3.16E+14
200	1	25	0.28	10.6	0.0003	35	27	0.00217	4.66E+14	3.16E+14
201	1	25	0.28	10.6	0.0003	48	27	0.00217	4.66E+14	3.16E+14
202	1	25	0.28	10.6	0.0003	55	27	0.00217	4.66E+14	3.16E+14
203	1	25	0.28	10.6	0.0003	60	27	0.00217	4.66E+14	3.16E+14
204	1	25	0.28	10.6	0.0003	60	26	0.00217	4.66E+14	3.16E+14
205	1	25	0.28	10.6	0.0003	60	25	0.00217	0	0.00E+00
206	1	25	0.28	10.6	0.0003	60	24	0.00217	4.66E+14	3.16E+14
207	1	25	0.28	10.6	0.0003	60	28	0.00217	4.66E+14	3.16E+14
208	1	25	0.28	10.6	0.0003	60	29	0.00217	4.66E+14	3.16E+14
209	1	25	0.28	10.6	0.0003	60	27	0.0015	4.66E+14	3.84E+14
210	1	25	0.28	10.6	0.0003	60	27	0.001	4.66E+14	4.57E+14
211	1	25	0.28	10.6	0.0003	60	27	0.0005	4.66E+14	5.64E+14
212	1	25	0.28	10.6	0.0003	60	27	0.0001		
213	1	25	0.28	10.6	0.0003	60	27	0.003	4.67E+14	2.60E+14
214	1	25	0.28	10.6	0.0003	60	27	0.005	4.66E+14	5.64E+14

A5. (continued)

Optimization of the 1st Cycle			Np(VI) D.C. -50% Design							
Run	V1	V2	V3	V4	V5	V6	V7	V8	R1	R2
215	32	1	1	16	0.3	24	0.014	0.005	8.93E-01	45.743
216	31	1	1	16	0.3	24	0.014	0.005	0.859	45.352
217	30	1	1	16	0.3	24	0.014	0.005		
218	29	1	1	16	0.3	24	0.014	0.005		
219	32	2	1	16	0.3	24	0.014	0.005	0.893	100.877
220	32	3	1	16	0.3	24	0.014	0.005	0.894	12.656
221	32	2	2	16	0.3	24	0.014	0.005		
222	32	2	3	16	0.3	24	0.014	0.005		
223	32	2	1	15	0.3	24	0.014	0.005		
224	32	2	1	14	0.3	24	0.014	0.005		
225	32	2	1	17	0.3	24	0.014	0.005	8.84E-01	4.463
226	32	2	1	18	0.3	24	0.014	0.005	8.70E-01	3.41E+00
227	32	2	1	16	0.25	24	0.014	0.005	4.38E-01	2.05E+07
228	32	2	1	16	0.2	24	0.014	0.005	2.08E-01	3.08E+06
229	32	2	1	16	0.35	24	0.014	0.005	2.15E+00	1.779
230	32	2	1	16	0.28	24	0.014	0.005	6.67E-01	38.075
231	32	2	1	16	0.27	24	0.014	0.005	5.80E-01	4.80E+01
232	32	2	1	16	0.26	24	0.014	0.005	5.04E-01	3514.422
233	32	2	1	16	0.24	24	0.014	0.005	3.81E-01	7.97E+01
234	32	2	1	16	0.22	24	0.014	0.005	2.85E-01	7.05E+06
235	32	2	1	16	0.32	24	0.014	0.005	1.23E+00	27.509
236	32	2	1	16	0.25	23	0.014	0.005	4.54E-01	1.63E+08
237	32	2	1	16	0.25	22	0.014	0.005	4.77E-01	1.33E+09
238	32	2	1	16	0.25	21	0.014	0.005	5.11E-01	9.16E+09
239	32	2	1	16	0.25	20	0.014	0.005	5.68E-01	4.33E+00
240	32	2	1	16	0.25	25	0.014	0.005	4.27E-01	2.60E+01
241	32	2	1	16	0.25	21	0.01	0.005	2.14E-01	4.37E+01
242	32	2	1	16	0.25	21	0.02	0.005	2.08E+00	3.10E+03
243	32	2	1	16	0.25	21	0.03	0.005	2.17E+10	1.81E+01
244	32	2	1	16	0.25	21	0.025	0.005	1.00E+09	9.40E+01
245	32	2	1	16	0.25	21	0.027	0.005	9.13E+09	1.95E+01
246	32	2	1	16	0.25	21	0.022	0.005	4.60E+00	4.88E+00
247	32	2	1	16	0.25	21	0.015	0.005	6.27E-01	2.49E+02

A5. (continued)

Run	V1	V2	V3	V4	V5	V6	V7	V8	R1	R2
248	32	2	1	16	0.25	21	0.013	0.005	4.16E-01	5.37E+09
249	32	2	1	16	0.25	21	0.014	0.001	9.73E+10	1.03E+15
250	32	2	1	16	0.25	21	0.014	0.0005	4.22E+11	4.11E+14
251	32	2	1	16	0.25	21	0.014	0.0001	4.46E+14	8.21E+13
252	32	2	1	16	0.25	21	0.014	0.007	3.34E-01	5.59E+02
253	32	2	1	16	0.25	21	0.014	0.01	2.35E-01	3.07E-01
254	32	2	1	16	0.25	21	0.014	0.0001	4.46E+14	8.21E+13

Optimization of the 2nd Cycle

Run	V1	V2	V3	V4	V5	V6	V7	V8	R1	R2
255	16	0.014	0.3	0.014	0.014	43.51	8.01	0.00217	1.31E+00	3.20E+15
256	15	0.014	0.3	0.014	0.014	43.51	8.01	0.00217		
257	14	0.014	0.3	0.014	0.014	43.51	8.01	0.00217		
258	17	0.014	0.3	0.014	0.014	43.51	8.01	0.00217	1.37E+00	3.20E+15
259	18	0.014	0.3	0.014	0.014	43.51	8.01	0.00217	1.366	3.20E+15
260	19	0.014	0.3	0.014	0.014	43.51	8.01	0.00217	1.37E+00	3.20E+15
261	17	0.01	0.3	0.014	0.014	43.51	8.01	0.00217		
262	17	0.02	0.3	0.014	0.014	43.51	8.01	0.00217	0.00E+00	2.39E+15
263	17	0.025	0.3	0.014	0.014	43.51	8.01	0.00217	0.00E+00	1.97E+15
264	17	0.017	0.3	0.014	0.014	43.51	8.01	0.00217	3.92E-01	2.74E+15
265	17	0.015	0.3	0.014	0.014	43.51	8.01	0.00217	9.43E-01	3.03E+15
266	17	0.013	0.3	0.014	0.014	43.51	8.01	0.00217	1.95	3.40E+15
267	17	0.012	0.3	0.014	0.014	43.51	8.01	0.00217	2.59E+00	3.62E+15
268	17	0.011	0.3	0.014	0.014	43.51	8.01	0.00217		
269	17	0.012	0.25	0.014	0.014	43.51	8.01	0.00217	1.31E+00	3.62E+15
270	17	0.012	0.2	0.014	0.014	43.51	8.01	0.00217	0.716	3.62E+15
271	17	0.012	0.35	0.014	0.014	43.51	8.01	0.00217	7.16E+00	3.62E+15
272	17	0.012	0.4	0.014	0.014	43.51	8.01	0.00217	2.18E+04	3.62E+15
273	17	0.012	0.45	0.014	0.014	43.51	8.01	0.00217	1.26E+06	3.62E+15
274	17	0.012	0.5	0.014	0.014	43.51	8.01	0.00217	1.50E+01	3.62E+15
275	17	0.012	0.47	0.014	0.014	43.51	8.01	0.00217	3.63E+05	3.62E+15
276	17	0.012	0.48	0.014	0.014	43.51	8.01	0.00217	5.88E+06	3.62E+15
277	17	0.012	0.49	0.014	0.014	43.51	8.01	0.00217	2.01E+01	3.62E+15
278	17	0.012	0.6	0.014	0.014	43.51	8.01	0.00217	3.35E+01	3.62E+15

A5. (continued)

Run	V1	V2	V3	V4	V5	V6	V7	V8	R1	R2
279	17	0.012	0.48	0.01	0.014	43.51	8.01	0.00217	1.51E+01	3.62E+15
280	17	0.012	0.48	0.02	0.014	43.51	8.01	0.00217	3.35E+01	3.62E+15
281	17	0.012	0.48	0.017	0.014	43.51	8.01	0.00217	2.74E+01	3.62E+15
282	17	0.012	0.48	0.015	0.014	43.51	8.01	0.00217	1.41E+01	3.62E+15
283	17	0.012	0.48	0.013	0.014	43.51	8.01	0.00217	2.00E+06	3.62E+15
284	17	0.012	0.48	0.012	0.014	43.51	8.01	0.00217	4.94E+05	3.62E+15
285	17	0.012	0.48	0.014	0.01	43.51	8.01	0.00217	1.01E+09	3.48E+15
286	17	0.012	0.48	0.014	0.005	43.51	8.01	0.00217	5.89E+11	3.08E+15
287	17	0.012	0.48	0.014	0.001	43.51	8.01	0.00217	1.61E+15	1.60E+15
288	17	0.012	0.48	0.014	0.0005	43.51	8.01	0.00217	7.76E+14	1.00E+15
289	17	0.012	0.48	0.014	0.0007	43.51	8.01	0.00217	1.09E+15	1.27E+15
290	17	0.012	0.48	0.014	0.0008	43.51	8.01	0.00217	1.24E+15	1.39E+15
291	17	0.012	0.48	0.014	0.0009	43.51	8.01	0.00217	1.40E+15	1.50E+15
292	17	0.012	0.48	0.014	0.002	43.51	8.01	0.00217	2.90E+15	2.29E+15
293	17	0.012	0.48	0.014	0.003	43.51	8.01	0.00217	3.92E+15	2.67E+15
294	17	0.012	0.48	0.014	0.004	43.51	8.01	0.00217	1.77E+12	2.91E+15
295	17	0.012	0.48	0.014	0.02	43.51	8.01	0.00217	6.28E+00	3.73E+15
296	17	0.012	0.48	0.014	0.003	40	8.01	0.00217	3.71E+15	2.67E+15
297	17	0.012	0.48	0.014	0.003	37	8.01	0.00217	3.55E+15	2.67E+15
298	17	0.012	0.48	0.014	0.003	45	8.01	0.00217	3.96E+15	2.67E+15
299	17	0.012	0.48	0.014	0.003	48	8.01	0.00217	4.17E+15	2.67E+15
300	17	0.012	0.48	0.014	0.003	60	8.01	0.00217	4.11E+00	2.67E+15
301	17	0.012	0.48	0.014	0.003	55	8.01	0.00217	5.15E+00	2.67E+15
302	17	0.012	0.48	0.014	0.003	50	8.01	0.00217	8.71E+12	2.67E+15
303	17	0.012	0.48	0.014	0.003	49	8.01	0.00217	4.24E+15	2.67E+15
304	17	0.012	0.48	0.014	0.003	48.5	8.01	0.00217	4.22E+15	2.67E+15
305	17	0.012	0.48	0.014	0.003	48.7	8.01	0.00217	4.24E+15	2.67E+15
306	17	0.012	0.48	0.014	0.003	48.8	8.01	0.00217	4.25E+15	2.67E+15
307	17	0.012	0.48	0.014	0.003	48.9	8.01	0.00217	4.24E+15	2.67E+15
308	17	0.012	0.48	0.014	0.003	48.8	7.5	0.00217	4.25E+15	2.50E+15
309	17	0.012	0.48	0.014	0.003	48.8	8.5	0.00217	4.25E+15	2.83E+15
310	17	0.012	0.48	0.014	0.003	48.8	10	0.00217	4.25E+15	3.33E+15
311	17	0.012	0.48	0.014	0.003	48.8	15	0.00217	4.25E+15	5.00E+15
312	17	0.012	0.48	0.014	0.003	48.8	30	0.00217	4.25E+15	1.00E+16
313	17	0.012	0.48	0.014	0.003	48.8	50	0.00217	4.25E+15	1.67E+16
314	17	0.012	0.48	0.014	0.003	48.8	100	0.00217	4.25E+15	3.33E+16
315	17	0.012	0.48	0.014	0.003	48.8	200	0.00217	4.25E+15	6.67E+16
316	17	0.012	0.48	0.014	0.003	48.8	500	0.00217	4.25E+15	1.67E+17
317	17	0.012	0.48	0.014	0.003	48.8	8.01	0.002		
318	17	0.012	0.48	0.014	0.003	48.8	8.01	0.003	2.47E+12	2.25E+15
319	17	0.012	0.48	0.014	0.003	48.8	8.01	0.004	1.04E+12	1.90E+15
320	17	0.012	0.48	0.014	0.003	48.8	8.01	0.001		
321	17	0.012	0.48	0.014	0.003	48.8	8.01	0.00215	4.24E+15	2.68E+15
322	17	0.012	0.48	0.014	0.003	48.8	8.01	0.0021		
323	17	0.012	0.48	0.014	0.003	48.8	8.01	0.00217	4.25E+15	2.67E+15

A5. (continued)

Optimization of the 1st Cycle			**Pu(IV) D.C. +50% Design**							
Run	V1	V2	V3	V4	V5	V6	V7	V8	R1	R2
324	1	45	0.001	0.005	0.3	0.014	32	125	1.74E+09	6581.15
325	2	45	0.001	0.005	0.3	0.014	32	125	6.06E+08	1.70E+04
326	3	45	0.001	0.005	0.3	0.014	32	125	2.22E+08	1.96E+04
327	1	40	0.001	0.005	0.3	0.014	32	125	1.20E+10	1.32E+15
328	1	35	0.001	0.005	0.3	0.014	32	125	2.35E+11	2.33E+15
329	1	25	0.001	0.005	0.3	0.014	32	125	1.64E+16	4.11E+15
330	1	20	0.001	0.005	0.3	0.014	32	125	2.33E+12	2.14E+15
331	1	50	0.001	0.005	0.3	0.014	32	125	1.31E+10	5.43E+14
332	1	60	0.001	0.005	0.3	0.014	32	125	2.23E+16	0.0114
333	1	23	0.001	0.005	0.3	0.014	32	125	1.09E+16	4.11E+15
334	1	24	0.001	0.005	0.3	0.014	32	125	1.41E+16	4.11E+15
335	1	26	0.001	0.005	0.3	0.014	32	125	1.80E+16	4.11E+15
336	1	30	0.001	0.005	0.3	0.014	32	125	8.96E+12	4.04E+15
337	1	28	0.001	0.005	0.3	0.014	32	125	1.95E+16	4.11E+15
338	1	27	0.001	0.005	0.3	0.014	32	125	1.90E+16	4.11E+15
339	1	29	0.001	0.005	0.3	0.014	32	125	1.82E+13	4.10E+15
340	1	28	0.0005	0.005	0.3	0.014	32	125	1.95E+16	4.11E+15
341	1	28	0.002	0.005	0.3	0.014	32	125	1.95E+16	4.11E+15
342	1	28	0.0015	0.005	0.3	0.014	32	125	1.95E+16	4.11E+15
343	1	28	0.00105	0.005	0.3	0.014	32	125	1.95E+16	4.11E+15
344	1	28	0.003	0.005	0.3	0.014	32	125	1.95E+16	4.11E+15
345	1	28	0.001	0.001	0.3	0.014	32	125	4.00E+15	8.21E+14
346	1	28	0.001	0.01	0.3	0.014	32	125	4.63E+00	5.17E+00
347	1	28	0.001	0.003	0.3	0.014	32	125	1.11E+16	2.46E+15
348	1	28	0.001	0.007	0.3	0.014	32	125	3.53E+12	1.03E+13
349	1	28	0.001	0.004	0.3	0.014	32	125	1.53E+16	3.29E+15
350	1	28	0.001	0.005	0.25	0.014	32	125	8.21E+11	2.50E+12
351	1	28	0.001	0.005	0.35	0.014	32	125	1.43E+16	3.91E+15
352	1	28	0.001	0.005	0.32	0.014	32	125	1.76E+16	4.10E+15
353	1	28	0.001	0.005	0.4	0.014	32	125	1.03E+16	3.01E+15
354	1	28	0.001	0.005	0.31	0.014	32	125	1.86E+16	4.10E+15
355	1	28	0.001	0.005	0.29	0.014	32	125	1.80E+13	4.11E+15
356	1	28	0.001	0.005	0.3	0.01	32	125	4.30E+11	1.44E+12

A5. (continued)

Run	V1	V2	V3	V4	V5	V6	V7	V8	R1	R2
357	1	28	0.001	0.005	0.3	0.02	32	125	3.15E+01	4916.641
358	1	28	0.001	0.005	0.3	0.017	32	125	1.44E+03	5.66E+06
359	1	28	0.001	0.005	0.3	0.012	32	125	6.18E+12	4.11E+15
360	1	28	0.001	0.005	0.3	0.013	32	125	1.56E+13	4.11E+15
361	1	28	0.001	0.005	0.3	0.014	31	125	8.74E+11	2.50E+12
362	1	28	0.001	0.005	0.3	0.014	30	125		
363	1	28	0.001	0.005	0.3	0.014	32	115	1.78E+16	4.11E+15
364	1	28	0.001	0.005	0.3	0.014	32	135	2.13E+16	4.11E+15
365	1	28	0.001	0.005	0.3	0.014	32	150	3.12E+13	4.11E+15
366	1	28	0.001	0.005	0.3	0.014	32	142	3.14E+13	4.11E+15
367	1	28	0.001	0.005	0.3	0.014	32	138	3.36E+13	4.11E+15
368	1	28	0.001	0.005	0.3	0.014	32	130	2.04E+16	4.11E+15
369	1	28	0.001	0.005	0.3	0.014	32	136	3.46E+13	4.11E+15
370	1	28	0.001	0.005	0.3	0.014	32	133	2.09E+16	4.11E+15
371	1	28	0.001	0.005	0.3	0.014	32	134	2.11E+16	4.11E+15
372	1	28	0.001	0.005	0.3	0.014	32	135	2.13E+16	4.11E+15

Optimization of the 2nd Cycle

Run	V1	V2	V3	V4	V5	V6	V7	V8	R1	R2
373	0.3	32	27	0.014	0.014	24	0.014	0.5	4.49E+03	3.20E+15
374	0.25	32	27	0.014	0.014	24	0.014	0.5	1.53E+01	3.20E+15
375	0.35	32	27	0.014	0.014	24	0.014	0.5	5.12E+05	3.20E+15
376	0.4	32	27	0.014	0.014	24	0.014	0.5	4.79E+00	3.20E+15
377	0.38	32	27	0.014	0.014	24	0.014	0.5	9.509	3.20E+15
378	0.33	32	27	0.014	0.014	24	0.014	0.5	3.32E+05	3.20E+15
379	0.34	32	27	0.014	0.014	24	0.014	0.5	5.93E+05	3.20E+15
380	0.36	32	27	0.014	0.014	24	0.014	0.5	1.79E+06	3.20E+15
381	0.37	32	27	0.014	0.014	24	0.014	0.5	1.67E+01	3.20E+15
382	0.36	31	27	0.014	0.014	24	0.014	0.5	1.50E+01	3.20E+15
383	0.36	30	27	0.014	0.014	24	0.014	0.5	3.44E+04	3.20E+15
384	0.36	29	27	0.014	0.014	24	0.014	0.5	4747.897	3.20E+15
385	0.36	32	28	0.014	0.014	24	0.014	0.5	15.715	3.20E+15
386	0.36	32	29	0.014	0.014	24	0.014	0.5	9.52E+04	3.20E+15
387	0.36	32	30	0.014	0.014	24	0.014	0.5	1.82E+04	3.20E+15
388	0.36	32	26	0.014	0.014	24	0.014	0.5	14.959	3.20E+15
389	0.36	32	25	0.014	0.014	24	0.014	0.5	1.50E+07	3.20E+15
390	0.36	32	24	0.014	0.014	24	0.014	0.5	0	0.00E+00
391	0.36	32	23	0.014	0.014	24	0.014	0.5	13.968	3.20E+15
392	0.36	32	25	0.01	0.014	24	0.014	0.5	1.48E+05	3.20E+15
393	0.36	32	25	0.02	0.014	24	0.014	0.5	5.59E+07	3.20E+15
394	0.36	32	25	0.03	0.014	24	0.014	0.5	425.13	3.20E+15
395	0.36	32	25	0.025	0.014	24	0.014	0.5	39.528	3.20E+15
396	0.36	32	25	0.023	0.014	24	0.014	0.5	55.755	3.20E+15

A5. (continued)

Run	V1	V2	V3	V4	V5	V6	V7	V8	R1	R2
397	0.36	32	25	0.022	0.014	24	0.014	0.5	4.75E+02	3.20E+15
398	0.36	32	25	0.021	0.014	24	0.014	0.5	22.041	3.20E+15
399	0.36	32	25	0.018	0.014	24	0.014	0.5	2.23E+04	3.20E+15
400	0.36	32	25	0.02	0.01	24	0.014	0.5	1.30E+00	3.20E+15
401	0.36	32	25	0.02	0.02	24	0.014	0.5	3.76E+06	2.39E+15
402	0.36	32	25	0.02	0.03	24	0.014	0.5	1.41E+01	1.67E+15
403	0.36	32	25	0.02	0.025	24	0.014	0.5	5.38E+04	1.97E+15
404	0.36	32	25	0.02	0.015	24	0.014	0.5	9.90E+00	3.03E+15
405	0.36	32	25	0.02	0.018	24	0.014	0.5	1.67E+01	2.61E+15
406	0.36	32	25	0.02	0.014	25	0.014	0.5	0.00E+00	0.00E+00
407	0.36	32	25	0.02	0.014	26	0.014	0.5	2.31E+00	3.20E+15
408	0.36	32	25	0.02	0.014	23	0.014	0.5	5.23E+09	3.20E+15
409	0.36	32	25	0.02	0.014	22	0.014	0.5	1.76E+10	3.20E+15
410	0.36	32	25	0.02	0.014	21	0.014	0.5	3.36E+01	3.20E+15
411	0.36	32	25	0.02	0.014	22	0.01	0.5	4.24E+12	2.97E+15
412	0.36	32	25	0.02	0.014	22	0.005	0.5	1.31E+00	2.36E+15
413	0.36	32	25	0.02	0.014	22	0.008	0.5	1.73E+16	2.79E+15
414	0.36	32	25	0.02	0.014	22	0.009	0.5	8.14E+12	2.88E+15
415	0.36	32	25	0.02	0.014	22	0.007	0.5	7.32E+15	2.67E+15
416	0.36	32	25	0.02	0.014	22	0.008	0.4	1.71E+16	2.79E+15
417	0.36	32	25	0.02	0.014	22	0.008	0.6	1.69E+16	2.79E+15
418	0.36	32	25	0.02	0.014	22	0.008	0.45	7.37E+15	2.79E+15
419	0.36	32	25	0.02	0.014	22	0.008	0.48	1.73E+16	2.79E+15
420	0.36	32	25	0.02	0.014	22	0.008	0.49	1.73E+16	2.79E+15
421	0.36	32	25	0.02	0.014	22	0.008	0.55	1.73E+16	2.79E+15
422	0.36	32	25	0.02	0.014	22	0.008	0.52	7.31E+15	2.79E+15
423	0.36	32	25	0.02	0.014	22	0.008	0.5	1.73E+16	2.79E+15

A5. (continued)

Optimization of the 1st Cycle			**Pu(IV) D.C. -50% Design**							
Run	V1	V2	V3	V4	V5	V6	V7	V8	R1	R2
424	1	32	125	0.3	0.014	32	24	0.2	1.61E+09	36.188
425	2	32	125	0.3	0.014	32	24	0.2	8.10E+08	4.47E+01
426	3	32	125	0.3	0.014	32	24	0.2	1.58E+08	4.02E+01
427	1	31	125	0.3	0.014	32	24	0.2	1.43E+08	4.73E+01
428	1	30	125	0.3	0.014	32	24	0.2		
429	1	32	120	0.3	0.014	32	24	0.2	2.14E+09	4.93E+01
430	1	32	115	0.3	0.014	32	24	0.2	2.49E+09	4.71E+01
431	1	32	110	0.3	0.014	32	24	0.2	1.14E+09	5.72E-01
432	1	32	130	0.3	0.014	32	24	0.2	1.08E+09	45.205
433	1	32	140	0.3	0.014	32	24	0.2	1.22E+08	2.80E+01
434	1	32	117	0.3	0.014	32	24	0.2	2.35E+09	4.80E+01
435	1	32	116	0.3	0.014	32	24	0.2	2.42E+09	4.75E+01
436	1	32	114	0.3	0.014	32	24	0.2	2.55E+09	4.73E+01
437	1	32	113	0.3	0.014	32	24	0.2	2.61E+09	5.08E+01
438	1	32	112	0.3	0.014	32	24	0.2	2.68E+09	4.77E+01
439	1	32	111	0.3	0.014	32	24	0.2	2.74E+09	4.78E+01
440	1	32	111	0.25	0.014	32	24	0.2	9.83E+06	1.91E+00
441	1	32	111	0.35	0.014	32	24	0.2	8.46E+00	9.93E-01
442	1	32	111	0.28	0.014	32	24	0.2	6.03E+08	3.06E+01
443	1	32	111	0.29	0.014	32	24	0.2	1.33E+09	3.85E+01
444	1	32	111	0.2	0.014	32	24	0.2	9.08E-01	4.90E+03
445	1	32	111	0.31	0.014	32	24	0.2	1.80E+08	6.41E+01
446	1	32	111	0.4	0.014	32	24	0.2	9.03E-01	4.74E-01
447	1	32	111	0.3	0.01	32	24	0.2	2.63E+00	5.70E+00
448	1	32	111	0.3	0.02	32	24	0.2	1.30E+00	9.33E-01
449	1	32	111	0.3	0.012	32	24	0.2	3.18E+08	2.08E+01
450	1	32	111	0.3	0.013	32	24	0.2	1.10E+09	3.26E+01
451	1	32	111	0.3	0.015	32	24	0.2	4.34E+02	6.42E-01
452	1	32	111	0.3	0.014	31	24	0.2	1.84E+08	5.82E-01
453	1	32	111	0.3	0.014	30	24	0.2	1.49E+07	5.82E-01
454	1	32	111	0.3	0.014	29	24	0.2	1.09E+06	5.82E-01
455	1	32	111	0.3	0.014	32	25	0.2	2.00E+08	4.78E+01
456	1	32	111	0.3	0.3	32	26	0.2	1.45E+07	4.78E+01

A5. (continued)

Run	V1	V2	V3	V4	V5	V6	V7	V8	R1	R2
457	1	32	111	0.3	0.014	32	23	0.2	3.35E+10	47.773
458	1	32	111	0.3	0.014	32	22	0.2	1.75E+11	4.78E+01
459	1	32	111	0.3	0.014	32	21	0.2	2.27E+11	4.77E+01
460	1	32	111	0.3	0.014	32	20	0.2	1.82E+11	5.09E+01
461	1	32	111	0.3	0.014	32	21	0.1	7.31E+12	3.81E+02
462	1	32	111	0.3	0.014	32	21	0.05	7.32E+12	8.62E+01
463	1	32	111	0.3	0.014	32	21	0.07	7.32E+12	1.81E+02
464	1	32	111	0.3	0.014	32	21	0.15	7.07E+12	3.93E+02
465	1	32	111	0.3	0.014	32	21	0.25	8.02E+01	1.72E+00
466	1	32	111	0.3	0.014	32	21	0.12	7.28E+12	4.29E+02
467	1	32	111	0.3	0.014	32	21	0.11	1.33E+12	6.79E-01
468	1	32	111	0.3	0.014	32	21	0.13	5.64E+11	5.97E-01
469	1	32	111	0.3	0.014	32	21	0.1	7.31E+12	3.81E+02
Optimization of the 2nd Cycle										
Run	V1	V2	V3	V4	V5	V6	V7	V8	R1	R2
470	0.3	32	27	0.014	0.014	24	0.014	0.5	4.49E+03	3.20E+15
471	0.25	32	27	0.014	0.014	24	0.014	0.5	1.53E+01	3.20E+15
472	0.35	32	27	0.014	0.014	24	0.014	0.5	5.12E+05	3.20E+15
473	0.4	32	27	0.014	0.014	24	0.014	0.5	4.79E+00	3.20E+15
474	0.38	32	27	0.014	0.014	24	0.014	0.5	9.509	3.20E+15
475	0.33	32	27	0.014	0.014	24	0.014	0.5	3.32E+05	3.20E+15
476	0.34	32	27	0.014	0.014	24	0.014	0.5	5.93E+05	3.20E+15
477	0.36	32	27	0.014	0.014	24	0.014	0.5	1.79E+06	3.20E+15
478	0.37	32	27	0.014	0.014	24	0.014	0.5	1.67E+01	3.20E+15
479	0.36	31	27	0.014	0.014	24	0.014	0.5	1.50E+01	3.20E+15
480	0.36	30	27	0.014	0.014	24	0.014	0.5	3.44E+04	3.20E+15
481	0.36	29	27	0.014	0.014	24	0.014	0.5	4747.897	3.20E+15
482	0.36	32	28	0.014	0.014	24	0.014	0.5	15.715	3.20E+15
483	0.36	32	29	0.014	0.014	24	0.014	0.5	9.52E+04	3.20E+15
484	0.36	32	30	0.014	0.014	24	0.014	0.5	1.82E+04	3.20E+15
485	0.36	32	26	0.014	0.014	24	0.014	0.5	14.959	3.20E+15
486	0.36	32	25	0.014	0.014	24	0.014	0.5	1.50E+07	3.20E+15
487	0.36	32	24	0.014	0.014	24	0.014	0.5	0	0.00E+00
488	0.36	32	23	0.014	0.014	24	0.014	0.5	13.968	3.20E+15
489	0.36	32	25	0.01	0.014	24	0.014	0.5	1.48E+05	3.20E+15
490	0.36	32	25	0.02	0.014	24	0.014	0.5	5.59E+07	3.20E+15
491	0.36	32	25	0.03	0.014	24	0.014	0.5	425.13	3.20E+15
492	0.36	32	25	0.025	0.014	24	0.014	0.5	39.528	3.20E+15
493	0.36	32	25	0.023	0.014	24	0.014	0.5	55.755	3.20E+15

A5. (continued)

Run	V1	V2	V3	V4	V5	V6	V7	V8	R1	R2
494	0.36	32	25	0.022	0.014	24	0.014	0.5	4.75E+02	3.20E+15
495	0.36	32	25	0.021	0.014	24	0.014	0.5	22.041	3.20E+15
496	0.36	32	25	0.018	0.014	24	0.014	0.5	2.23E+04	3.20E+15
497	0.36	32	25	0.02	0.01	24	0.014	0.5	1.30E+00	3.20E+15
498	0.36	32	25	0.02	0.02	24	0.014	0.5	3.76E+06	2.39E+15
499	0.36	32	25	0.02	0.03	24	0.014	0.5	1.41E+01	1.67E+15
500	0.36	32	25	0.02	0.025	24	0.014	0.5	5.38E+04	1.97E+15
501	0.36	32	25	0.02	0.015	24	0.014	0.5	9.90E+00	3.03E+15
502	0.36	32	25	0.02	0.018	24	0.014	0.5	1.67E+01	2.61E+15
503	0.36	32	25	0.02	0.014	25	0.014	0.5	0.00E+00	0.00E+00
504	0.36	32	25	0.02	0.014	26	0.014	0.5	2.31E+00	3.20E+15
505	0.36	32	25	0.02	0.014	23	0.014	0.5	5.23E+09	3.20E+15
506	0.36	32	25	0.02	0.014	22	0.014	0.5	1.76E+10	3.20E+15
507	0.36	32	25	0.02	0.014	21	0.014	0.5	3.36E+01	3.20E+15
508	0.36	32	25	0.02	0.014	22	0.01	0.5	4.24E+12	2.97E+15
509	0.36	32	25	0.02	0.014	22	0.005	0.5	1.31E+00	2.36E+15
510	0.36	32	25	0.02	0.014	22	0.008	0.5	1.73E+16	2.79E+15
511	0.36	32	25	0.02	0.014	22	0.009	0.5	8.14E+12	2.88E+15
512	0.36	32	25	0.02	0.014	22	0.007	0.5	7.32E+15	2.67E+15
513	0.36	32	25	0.02	0.014	22	0.008	0.4	1.71E+16	2.79E+15
514	0.36	32	25	0.02	0.014	22	0.008	0.6	1.69E+16	2.79E+15
515	0.36	32	25	0.02	0.014	22	0.008	0.45	7.37E+15	2.79E+15
516	0.36	32	25	0.02	0.014	22	0.008	0.48	1.73E+16	2.79E+15
517	0.36	32	25	0.02	0.014	22	0.008	0.49	1.73E+16	2.79E+15
518	0.36	32	25	0.02	0.014	22	0.008	0.55	1.73E+16	2.79E+15
519	0.36	32	25	0.02	0.014	22	0.008	0.52	7.31E+15	2.79E+15
520	0.36	32	25	0.02	0.014	22	0.008	0.5	1.73E+16	2.79E+15

A5. (continued)

Optimization of the 1st Cycle			Np(VI) D.C. +50%, Pu(IV) D.C. +50% Design							
Run	V1	V2	V3	V4	V5	V6	V7	V8	R1	R2
521	1	0.014	32	24	19	16	45	0.2	9.98E-01	0.148
522	2	0.014	32	24	19	16	45	0.2	4.729	0.173
523	3	0.014	32	24	19	16	45	0.2	4.73E+00	0.173
524	4	0.014	32	24	19	16	45	0.2	4.73E+00	0.173
525	2	0.01	32	24	19	16	45	0.2	1.159	0.162
526	2	0.02	32	24	19	16	45	0.2	1.15E+09	0.849
527	2	0.025	32	24	19	16	45	0.2	1.30E+07	1.10E+06
528	2	0.023	32	24	19	16	45	0.2	1.55E+08	6.51E+05
529	2	0.024	32	24	19	16	45	0.2	5.94E+07	6.64E+06
530	2	0.03	32	24	19	16	45	0.2	2.95E+00	3.26E+00
531	2	0.024	31	24	19	16	45	0.2	7.19E+06	8.35E+05
532	2	0.024	30	24	19	16	45	0.2	8.51E+05	1.02E+05
533	2	0.024	32	25	19	16	45	0.2	7.30E+06	8.46E+05
534	2	0.024	32	26	19	16	45	0.2	8.82E+05	2.717
535	2	0.024	32	23	19	16	45	0.2	4.70E+08	213.852
536	2	0.024	32	22	19	16	45	0.2	3.61E+09	3.78E+08
537	2	0.024	32	21	19	16	45	0.2	2.64E+10	2.72E+09
538	2	0.024	32	20	19	16	45	0.2	1.87E+11	1.87E+10
539	2	0.024	32	19	19	16	45	0.2	5.12E+11	2.74E+00
540	2	0.024	32	20	20	16	45	0.2	9.14E+10	4.86E+09
541	2	0.024	32	20	21	16	45	0.2	1.36E+11	1.54E+10
542	2	0.024	32	20	22	16	45	0.2	1.32E+11	1.37E+10
543	2	0.024	32	20	18	16	45	0.2	2.55E+11	2.06E+10
544	2	0.024	32	20	17	16	45	0.2	3.49E+12	3.10E+08
545	2	0.024	32	20	16	16	45	0.2	1.84E+10	2.24E+00
546	2	0.024	32	20	18	17	45	0.2	2.09E+11	1.82E+10
547	2	0.024	32	20	18	18	45	0.2	6.58E+10	6.13E+09
548	2	0.024	32	20	18	15	45	0.2	1.98E+11	1.19E+01
549	2	0.024	32	20	18	16	40	0.2	1.39E+04	5.89E+00
550	2	0.024	32	20	18	16	50	0.2	1.41E+10	4.41E+11
551	2	0.024	32	20	18	16	55	0.2	8.46E+00	8.96E+07
552	2	0.024	32	20	18	16	48	0.2	8.06E+10	2.15E+01
553	2	0.024	32	20	18	16	49	0.2	3.88E+10	3.03E+11

A5. (continued)

Run	V1	V2	V3	V4	V5	V6	V7	V8	R1	R2
554	2	0.024	32	20	18	16	52	0.2	4.14E+08	3.88E+11
555	2	0.024	32	20	18	16	51	0.2	3.46E+09	4.14E+02
556	2	0.024	32	20	18	16	50	0.1	1.41E+10	4.40E+11
557	2	0.024	32	20	18	16	50	0.3	1.41E+10	4.42E+11
558	2	0.024	32	20	18	16	50	0.4	1.42E+10	4.44E+11
559	2	0.024	32	20	18	16	50	1	1.43E+10	4.47E+11
560	2	0.024	32	20	18	16	50	10	1.60E+10	5.35E+11
561	2	0.024	32	20	18	16	50	0.2	1.41E+10	4.41E+11
Optimization of the 2nd Cycle										
Run	V1	V2	V3	V4	V5	V6	V7	V8	R1	R2
562	1	24	0.3	8	0.014	45	27	0.00217	9.37E+00	3.20E+15
563	2	24	0.3	8	0.014	45	27	0.00217	9.20E+00	3.20E+15
564	3	24	0.3	8	0.014	45	27	0.00217	9.02E+00	3.20E+15
565	1	25	0.3	8	0.014	45	27	0.00217	7.12E+01	3.20E+15
566	1	26	0.3	8	0.014	45	27	0.00217	8.56	3.20E+15
567	1	23	0.3	8	0.014	45	27	0.00217	8.20E+00	3.20E+15
568	1	22	0.3	8	0.014	45	27	0.00217	7.80E+00	3.20E+15
569	1	25	0.2	8	0.014	45	27	0.00217	3.26E+02	3.20E+15
570	1	25	0.15	8	0.014	45	27	0.00217	2.04E+00	3.20E+15
571	1	25	0.25	8	0.014	45	27	0.00217	4.64E+04	3.20E+15
572	1	25	0.28	8	0.014	45	27	0.00217	3.15E+05	3.20E+15
573	1	25	0.29	8	0.014	45	27	0.00217	816.278	3.20E+15
574	1	25	0.27	8	0.014	45	27	0.00217	1.72E+05	3.20E+15
575	1	25	0.26	8	0.014	45	27	0.00217	9.10E+04	3.20E+15
576	1	25	0.22	8	0.014	45	27	0.00217	4.13E+03	3.20E+15
577	1	25	0.33	8	0.014	45	27	0.00217	7.915	3.20E+15
578	1	25	0.28	7.5	0.014	45	27	0.00217	1.24E+01	3.20E+15
579	1	25	0.28	7.8	0.014	45	27	0.00217	2.91E+05	3.20E+15
580	1	25	0.28	7.9	0.014	45	27	0.00217	3.04E+05	3.20E+15
581	1	25	0.28	7.2	0.014	45	27	0.00217	2.26E+05	3.20E+15
582	1	25	0.28	7	0.014	45	27	0.00217	2.07E+05	3.20E+15
583	1	25	0.28	7.3	0.014	45	27	0.00217	2.38E+05	3.20E+15
584	1	25	0.28	7.4	0.014	45	27	0.00217	2.46E+05	3.20E+15
585	1	25	0.28	7.6	0.014	45	27	0.00217	2.68E+05	3.20E+15

A5. (continued)

Run	V1	V2	V3	V4	V5	V6	V7	V8	R1	R2
586	1	25	0.28	7.7	0.014	45	27	0.00217	2.79E+05	3.20E+15
587	1	25	0.28	8.1	0.014	45	27	0.00217	1.28E+03	3.20E+15
588	1	25	0.28	8.3	0.014	45	27	0.00217	3.49E+05	3.20E+15
589	1	25	0.28	8.4	0.014	45	27	0.00217	1.46E+01	3.20E+15
590	1	25	0.28	8.5	0.014	45	27	0.00217	3.81E+05	3.20E+15
591	1	25	0.28	8.7	0.014	45	27	0.00217	4.05E+05	3.20E+15
592	1	25	0.28	9	0.014	45	27	0.00217	4.47E+05	3.20E+15
593	1	25	0.28	9.5	0.014	45	27	0.00217	5.30E+05	3.20E+15
594	1	25	0.28	10	0.014	45	27	0.00217	6.16E+05	3.20E+15
595	1	25	0.28	11	0.014	45	27	0.00217	1.38E+01	3.20E+15
596	1	25	0.28	10.5	0.014	45	27	0.00217	7.05E+05	3.20E+15
597	1	25	0.28	10.7	0.014	45	27	0.00217	9.44E+02	3.20E+15
598	1	25	0.28	10.6	0.014	45	27	0.00217	7.31E+05	3.20E+15
599	1	25	0.28	10.3	0.014	45	27	0.00217	6.73E+05	3.20E+15
600	1	25	0.28	6	0.014	45	27	0.00217	1.56E+01	3.20E+15
601	1	25	0.28	10.6	0.01	45	27	0.00217	2.43E+07	2.97E+15
602	1	25	0.28	10.6	0.005	45	27	0.00217	4.71E+09	2.36E+15
603	1	25	0.28	10.6	0.001	45	27	0.00217	4.37E+11	8.90E+14
604	1	25	0.28	10.6	0.0005	45	27	0.00217	6.44E+11	5.01E+14
605	1	25	0.28	10.6	0.0001	45	27	0.00217	1.55E+14	1.11E+14
606	1	25	0.28	10.6	0.0003	45	27	0.00217	4.66E+14	3.16E+14
607	1	25	0.28	10.6	0.0004	45	27	0.00217	6.77E+11	4.11E+14
608	1	25	0.28	10.6	0.0007	45	27	0.00217	5.65E+11	6.68E+14
609	1	25	0.28	10.6	0.02	45	27	0.00217	1.62E+01	3.41E+15
610	1	25	0.28	10.6	0.017	45	27	0.00217	1.89E+01	3.32E+15
611	1	25	0.28	10.6	0.0003	42	27	0.00217	4.66E+14	3.16E+14
612	1	25	0.28	10.6	0.0003	40	27	0.00217	4.66E+14	3.16E+14
613	1	25	0.28	10.6	0.0003	35	27	0.00217	4.66E+14	3.16E+14
614	1	25	0.28	10.6	0.0003	48	27	0.00217	4.66E+14	3.16E+14
615	1	25	0.28	10.6	0.0003	55	27	0.00217	4.66E+14	3.16E+14
616	1	25	0.28	10.6	0.0003	60	27	0.00217	4.66E+14	3.16E+14
617	1	25	0.28	10.6	0.0003	60	26	0.00217	4.66E+14	3.16E+14
618	1	25	0.28	10.6	0.0003	60	25	0.00217	0	0.00E+00
619	1	25	0.28	10.6	0.0003	60	24	0.00217	4.66E+14	3.16E+14
620	1	25	0.28	10.6	0.0003	60	28	0.00217	4.66E+14	3.16E+14
621	1	25	0.28	10.6	0.0003	60	29	0.00217	4.66E+14	3.16E+14
622	1	25	0.28	10.6	0.0003	60	27	0.0015	4.66E+14	3.84E+14
623	1	25	0.28	10.6	0.0003	60	27	0.001	4.66E+14	4.57E+14
624	1	25	0.28	10.6	0.0003	60	27	0.0005	4.66E+14	5.64E+14
625	1	25	0.28	10.6	0.0003	60	27	0.0001		
626	1	25	0.28	10.6	0.0003	60	27	0.003	4.67E+14	2.60E+14
627	1	25	0.28	10.6	0.0003	60	27	0.005	4.66E+14	5.64E+14

A5. (continued)

Optimization of the 1st Cycle			**Np(VI) D.C. -50%, Pu(IV) D.C. -50% Design**							
Run	V1	V2	V3	V4	V5	V6	V7	V8	R1	R2
628	32	1	16	0.3	0.014	0.014	0.2	125	6.51E-01	46.465
629	31	1	16	0.3	0.014	0.014	0.2	125	0.626	42.22
630	30	1	16	0.3	0.014	0.014	0.2	125		
631	32	2	16	0.3	0.014	0.014	0.2	125	6.51E-01	45.668
632	32	3	16	0.3	0.014	0.014	0.2	125	0.651	48.959
633	32	4	16	0.3	0.014	0.014	0.2	125	0.651	47.546
634	32	3	15	0.3	0.014	0.014	0.2	125		
635	32	3	17	0.3	0.014	0.014	0.2	125	6.39E-01	46.339
636	32	3	18	0.3	0.014	0.014	0.2	125	6.18E-01	51.16
637	32	3	19	0.3	0.014	0.014	0.2	125	5.12E-01	5.13E+00
638	32	3	16	0.25	0.014	0.014	0.2	125	3.16E-01	5.52E+04
639	32	3	16	0.2	0.014	0.014	0.2	125	1.35E-01	5.07E+03
640	32	3	16	0.35	0.014	0.014	0.2	125	1.43E+00	4.95E+01
641	32	3	16	0.28	0.014	0.014	0.2	125	4.90E-01	1.94E+01
642	32	3	16	0.26	0.014	0.014	0.2	125	3.67E-01	5.999
643	32	3	16	0.23	0.014	0.014	0.2	125	2.32E-01	2.52E+04
644	32	3	16	0.22	0.014	0.014	0.2	125	1.96E-01	1.53E+04
645	32	3	16	0.24	0.014	0.014	0.2	125	2.72E-01	3.85E+04
646	32	3	16	0.25	0.01	0.014	0.2	125	1.12E-01	2.31E+03
647	32	3	16	0.25	0.02	0.014	0.2	125	1.14E+00	6.23E+01
648	32	3	16	0.25	0.017	0.014	0.2	125	5.92E-01	41.391
649	32	3	16	0.25	0.015	0.014	0.2	125	3.92E-01	2.30E+00
650	32	3	16	0.25	0.013	0.014	0.2	125	2.53E-01	3.05E+04
651	32	3	16	0.25	0.014	0.01	0.2	125	4.43E-01	4.52E+01
652	32	3	16	0.25	0.014	0.02	0.2	125	4.91E-02	6.08E-01
653	32	3	16	0.25	0.014	0.015	0.2	125	2.47E-01	7.89E+03
654	32	3	16	0.25	0.014	0.013	0.2	125	3.41E-01	8.62E+00
655	32	3	16	0.25	0.014	0.012	0.2	125	3.70E-01	3.64E+01
656	32	3	16	0.25	0.014	0.014	0.1	125	3.17E-01	6.19E+04
657	32	3	16	0.25	0.014	0.014	0.05	125	3.07E-01	4.48E+04
658	32	3	16	0.25	0.014	0.014	0.15	125	3.17E-01	5.94E+04
659	32	3	16	0.25	0.014	0.014	0.25	125	3.17E-01	2.89E+00
660	32	3	16	0.25	0.014	0.014	0.16	125	3.17E-01	5.94E+04

A5. (continued)

Run	V1	V2	V3	V4	V5	V6	V7	V8	R1	R2
661	32	3	16	0.25	0.014	0.014	0.12	125	3.17E-01	6.39E+04
662	32	3	16	0.25	0.014	0.014	0.11	125	3.17E-01	6.19E+04
663	32	3	16	0.25	0.014	0.014	0.13	125	3.17E-01	6.43E+04
664	32	3	16	0.25	0.014	0.014	0.14	125	3.17E-01	5.96E+04
665	32	3	16	0.25	0.014	0.014	0.13	120	3.37E-01	7.35E+04
666	32	3	16	0.25	0.014	0.014	0.13	110	3.86E-01	9.81E+04
667	32	3	16	0.25	0.014	0.014	0.13	100	4.51E-01	1.36E+05
668	32	3	16	0.25	0.014	0.014	0.13	50	3.04E+00	3.57E+06
669	32	3	16	0.25	0.014	0.014	0.13	1	8.85E+06	6.27E+11
670	32	3	16	0.25	0.014	0.014	0.13	130	0.299	5.66E+04
671	32	3	16	0.25	0.014	0.014	0.13	150	0.244	3.55E+04
672	32	3	16	0.25	0.014	0.014	0.13	10	6.66E+05	7.91E+11

Optimization of the 2nd Cycle

Run	V1	V2	V3	V4	V5	V6	V7	V8	R1	R2
673	16	0.014	0.3	0.014	0.014	43.51	8.01	0.00217	1.31E+00	3.20E+15
674	15	0.014	0.3	0.014	0.014	43.51	8.01	0.00217		
675	14	0.014	0.3	0.014	0.014	43.51	8.01	0.00217		
676	17	0.014	0.3	0.014	0.014	43.51	8.01	0.00217	1.37E+00	3.20E+15
677	18	0.014	0.3	0.014	0.014	43.51	8.01	0.00217	1.366	3.20E+15
678	19	0.014	0.3	0.014	0.014	43.51	8.01	0.00217	1.37E+00	3.20E+15
679	17	0.01	0.3	0.014	0.014	43.51	8.01	0.00217		
680	17	0.02	0.3	0.014	0.014	43.51	8.01	0.00217	0.00E+00	2.39E+15
681	17	0.025	0.3	0.014	0.014	43.51	8.01	0.00217	0.00E+00	1.97E+15
682	17	0.017	0.3	0.014	0.014	43.51	8.01	0.00217	3.92E-01	2.74E+15
683	17	0.015	0.3	0.014	0.014	43.51	8.01	0.00217	9.43E-01	3.03E+15
684	17	0.013	0.3	0.014	0.014	43.51	8.01	0.00217	1.95	3.40E+15
685	17	0.012	0.3	0.014	0.014	43.51	8.01	0.00217	2.59E+00	3.62E+15
686	17	0.011	0.3	0.014	0.014	43.51	8.01	0.00217		
687	17	0.012	0.25	0.014	0.014	43.51	8.01	0.00217	1.31E+00	3.62E+15
688	17	0.012	0.2	0.014	0.014	43.51	8.01	0.00217	0.716	3.62E+15
689	17	0.012	0.35	0.014	0.014	43.51	8.01	0.00217	7.16E+00	3.62E+15
690	17	0.012	0.4	0.014	0.014	43.51	8.01	0.00217	2.18E+04	3.62E+15
691	17	0.012	0.45	0.014	0.014	43.51	8.01	0.00217	1.26E+06	3.62E+15
692	17	0.012	0.5	0.014	0.014	43.51	8.01	0.00217	1.50E+01	3.62E+15
693	17	0.012	0.47	0.014	0.014	43.51	8.01	0.00217	3.63E+05	3.62E+15
694	17	0.012	0.48	0.014	0.014	43.51	8.01	0.00217	5.88E+06	3.62E+15
695	17	0.012	0.49	0.014	0.014	43.51	8.01	0.00217	2.01E+01	3.62E+15
696	17	0.012	0.6	0.014	0.014	43.51	8.01	0.00217	3.35E+01	3.62E+15

A5. (continued)

Run	V1	V2	V3	V4	V5	V6	V7	V8	R1	R2
697	17	0.012	0.48	0.01	0.014	43.51	8.01	0.00217	1.51E+01	3.62E+15
698	17	0.012	0.48	0.02	0.014	43.51	8.01	0.00217	3.35E+01	3.62E+15
699	17	0.012	0.48	0.017	0.014	43.51	8.01	0.00217	2.74E+01	3.62E+15
700	17	0.012	0.48	0.015	0.014	43.51	8.01	0.00217	1.41E+01	3.62E+15
701	17	0.012	0.48	0.013	0.014	43.51	8.01	0.00217	2.00E+06	3.62E+15
702	17	0.012	0.48	0.012	0.014	43.51	8.01	0.00217	4.94E+05	3.62E+15
703	17	0.012	0.48	0.014	0.01	43.51	8.01	0.00217	1.01E+09	3.48E+15
704	17	0.012	0.48	0.014	0.005	43.51	8.01	0.00217	5.89E+11	3.08E+15
705	17	0.012	0.48	0.014	0.001	43.51	8.01	0.00217	1.61E+15	1.60E+15
706	17	0.012	0.48	0.014	0.0005	43.51	8.01	0.00217	7.76E+14	1.00E+15
707	17	0.012	0.48	0.014	0.0007	43.51	8.01	0.00217	1.09E+15	1.27E+15
708	17	0.012	0.48	0.014	0.0008	43.51	8.01	0.00217	1.24E+15	1.39E+15
709	17	0.012	0.48	0.014	0.0009	43.51	8.01	0.00217	1.40E+15	1.50E+15
710	17	0.012	0.48	0.014	0.002	43.51	8.01	0.00217	2.90E+15	2.29E+15
711	17	0.012	0.48	0.014	0.003	43.51	8.01	0.00217	3.92E+15	2.67E+15
712	17	0.012	0.48	0.014	0.004	43.51	8.01	0.00217	1.77E+12	2.91E+15
713	17	0.012	0.48	0.014	0.02	43.51	8.01	0.00217	6.28E+00	3.73E+15
714	17	0.012	0.48	0.014	0.003	40	8.01	0.00217	3.71E+15	2.67E+15
715	17	0.012	0.48	0.014	0.003	37	8.01	0.00217	3.55E+15	2.67E+15
716	17	0.012	0.48	0.014	0.003	45	8.01	0.00217	3.96E+15	2.67E+15
717	17	0.012	0.48	0.014	0.003	48	8.01	0.00217	4.17E+15	2.67E+15
718	17	0.012	0.48	0.014	0.003	60	8.01	0.00217	4.11E+00	2.67E+15
719	17	0.012	0.48	0.014	0.003	55	8.01	0.00217	5.15E+00	2.67E+15
720	17	0.012	0.48	0.014	0.003	50	8.01	0.00217	8.71E+12	2.67E+15
721	17	0.012	0.48	0.014	0.003	49	8.01	0.00217	4.24E+15	2.67E+15
722	17	0.012	0.48	0.014	0.003	48.5	8.01	0.00217	4.22E+15	2.67E+15
723	17	0.012	0.48	0.014	0.003	48.7	8.01	0.00217	4.24E+15	2.67E+15
724	17	0.012	0.48	0.014	0.003	48.8	8.01	0.00217	4.25E+15	2.67E+15
725	17	0.012	0.48	0.014	0.003	48.9	8.01	0.00217	4.24E+15	2.67E+15
726	17	0.012	0.48	0.014	0.003	48.8	7.5	0.00217	4.25E+15	2.50E+15
727	17	0.012	0.48	0.014	0.003	48.8	8.5	0.00217	4.25E+15	2.83E+15
728	17	0.012	0.48	0.014	0.003	48.8	10	0.00217	4.25E+15	3.33E+15
729	17	0.012	0.48	0.014	0.003	48.8	15	0.00217	4.25E+15	5.00E+15
730	17	0.012	0.48	0.014	0.003	48.8	30	0.00217	4.25E+15	1.00E+16
731	17	0.012	0.48	0.014	0.003	48.8	50	0.00217	4.25E+15	1.67E+16
732	17	0.012	0.48	0.014	0.003	48.8	100	0.00217	4.25E+15	3.33E+16
733	17	0.012	0.48	0.014	0.003	48.8	200	0.00217	4.25E+15	6.67E+16
734	17	0.012	0.48	0.014	0.003	48.8	500	0.00217	4.25E+15	1.67E+17
735	17	0.012	0.48	0.014	0.003	48.8	8.01	0.002		
736	17	0.012	0.48	0.014	0.003	48.8	8.01	0.003	2.47E+12	2.25E+15
737	17	0.012	0.48	0.014	0.003	48.8	8.01	0.004	1.04E+12	1.90E+15
738	17	0.012	0.48	0.014	0.003	48.8	8.01	0.001		
739	17	0.012	0.48	0.014	0.003	48.8	8.01	0.00215	4.24E+15	2.68E+15
740	17	0.012	0.48	0.014	0.003	48.8	8.01	0.0021		
741	17	0.012	0.48	0.014	0.003	48.8	8.01	0.00217	4.25E+15	2.67E+15

A5. (continued)

Optimization of the 1st Cycle			Np(VI) D.C. +50%, Pu(IV) D.C. -50% Design							
Run	V1	V2	V3	V4	V5	V6	V7	V8	R1	R2
742	1	0.3	5	23	0.005	0.014	0.014	16	5.04E+00	1.116
743	2	0.3	5	23	0.005	0.014	0.014	16	1.313	0.824
744	3	0.3	5	23	0.005	0.014	0.014	16	5.04E+00	1.115
745	4	0.3	5	23	0.005	0.014	0.014	16	1.31E+00	0.823
746	1	0.25	5	23	0.005	0.014	0.014	16	8.926	3.16
747	1	0.2	5	23	0.005	0.014	0.014	16	40.416	2.27E+04
748	1	0.15	5	23	0.005	0.014	0.014	16	3.16E-01	24.191
749	1	0.35	5	23	0.005	0.014	0.014	16	1.79E+00	0.539
750	1	0.22	5	23	0.005	0.014	0.014	16	2.47E+08	3.66E+10
751	1	0.23	5	23	0.005	0.014	0.014	16	1.60E+06	5.48E+00
752	1	0.21	5	23	0.005	0.014	0.014	16	4.58E+07	7.08E+09
753	1	0.18	5	23	0.005	0.014	0.014	16	1.40E+00	5.87E+02
754	1	0.22	4	23	0.005	0.014	0.014	16	2.29E+08	1.66E+10
755	1	0.22	6	23	0.005	0.014	0.014	16	2.38E+08	6.73E+10
756	1	0.22	5.5	23	0.005	0.014	0.014	16	2.44E+08	5.06E+10
757	1	0.22	4.5	23	0.005	0.014	0.014	16	2.43E+08	2.54E+10
758	1	0.22	7	23	0.005	0.014	0.014	16	2.17E+08	1.08E+11
759	1	0.22	10	23	0.005	0.014	0.014	16	1.32E+08	2.14E+11
760	1	0.22	7	20	0.005	0.014	0.014	16	2.78E+08	1.28E+11
761	1	0.22	7	10	0.005	0.014	0.014	16	4.98E+08	1.75E+11
762	1	0.22	7	30	0.005	0.014	0.014	16	5.82E+07	3.74E+10
763	1	0.22	7	10	0.001	0.014	0.014	16	3.11E+11	3.57E+14
764	1	0.22	7	10	0.01	0.014	0.014	16	1.63E+00	5.47E+02
765	1	0.22	7	10	0.001	0.01	0.014	16	4.33E+11	3.56E+14
766	1	0.22	7	10	0.001	0.005	0.014	16	7.66E+01	7.88E+00
767	1	0.22	7	10	0.001	0.02	0.014	16	5.24E+07	1.09E+03
768	1	0.22	7	10	0.001	0.013	0.014	16	3.35E+11	3.85E+14
769	1	0.22	7	10	0.001	0.015	0.014	16	7.32E+10	3.57E+14
770	1	0.22	7	10	0.001	0.012	0.014	16	3.63E+11	4.17E+14
771	1	0.22	7	10	0.001	0.011	0.014	16	3.96E+11	4.54E+14
772	1	0.22	7	10	0.001	0.009	0.014	16	8.88E+00	5.32E-01
773	1	0.22	7	10	0.001	0.011	0.01	16	2.09E+10	4.55E+14
774	1	0.22	7	10	0.001	0.011	0.02	16	3.09E+15	1.42E+14

A5. (continued)

Run	V1	V2	V3	V4	V5	V6	V7	V8	R1	R2
775	1	0.22	7	10	0.001	0.011	0.03	16	2.70E+09	4.21E+08
776	1	0.22	7	10	0.001	0.011	0.025	16	6.19E+10	7.37E+08
777	1	0.22	7	10	0.001	0.011	0.022	16	2.22E+15	1.38E+14
778	1	0.22	7	10	0.001	0.011	0.021	16	2.54E+15	5.92E+13
779	1	0.22	7	10	0.001	0.011	0.019	16	3.62E+15	1.44E+14
780	1	0.22	7	10	0.001	0.011	0.018	16	2.37E+12	1.46E+14
781	1	0.22	7	10	0.001	0.011	0.019	15		
782	1	0.22	7	10	0.001	0.011	0.019	17		
783	1	0.22	7	10	0.001	0.011	0.019	18	2.33E+00	1.11E+00
784	1	0.22	7	10	0.001	0.011	0.019	16	3.62E+15	1.44E+14
Optimization of the 2nd Cycle										
Run	V1	V2	V3	V4	V5	V6	V7	V8	R1	R2
785	1	24	0.3	8	0.014	45	27	0.00217	9.37E+00	3.20E+15
786	2	24	0.3	8	0.014	45	27	0.00217	9.20E+00	3.20E+15
787	3	24	0.3	8	0.014	45	27	0.00217	9.02E+00	3.20E+15
788	1	25	0.3	8	0.014	45	27	0.00217	7.12E+01	3.20E+15
789	1	26	0.3	8	0.014	45	27	0.00217	8.56	3.20E+15
790	1	23	0.3	8	0.014	45	27	0.00217	8.20E+00	3.20E+15
791	1	22	0.3	8	0.014	45	27	0.00217	7.80E+00	3.20E+15
792	1	25	0.2	8	0.014	45	27	0.00217	3.26E+02	3.20E+15
793	1	25	0.15	8	0.014	45	27	0.00217	2.04E+00	3.20E+15
794	1	25	0.25	8	0.014	45	27	0.00217	4.64E+04	3.20E+15
795	1	25	0.28	8	0.014	45	27	0.00217	3.15E+05	3.20E+15
796	1	25	0.29	8	0.014	45	27	0.00217	816.278	3.20E+15
797	1	25	0.27	8	0.014	45	27	0.00217	1.72E+05	3.20E+15
798	1	25	0.26	8	0.014	45	27	0.00217	9.10E+04	3.20E+15
799	1	25	0.22	8	0.014	45	27	0.00217	4.13E+03	3.20E+15
800	1	25	0.33	8	0.014	45	27	0.00217	7.915	3.20E+15
801	1	25	0.28	7.5	0.014	45	27	0.00217	1.24E+01	3.20E+15
802	1	25	0.28	7.8	0.014	45	27	0.00217	2.91E+05	3.20E+15
803	1	25	0.28	7.9	0.014	45	27	0.00217	3.04E+05	3.20E+15
804	1	25	0.28	7.2	0.014	45	27	0.00217	2.26E+05	3.20E+15
805	1	25	0.28	7	0.014	45	27	0.00217	2.07E+05	3.20E+15
806	1	25	0.28	7.3	0.014	45	27	0.00217	2.38E+05	3.20E+15
807	1	25	0.28	7.4	0.014	45	27	0.00217	2.46E+05	3.20E+15
808	1	25	0.28	7.6	0.014	45	27	0.00217	2.68E+05	3.20E+15

A5. (continued)

Run	V1	V2	V3	V4	V5	V6	V7	V8	R1	R2
809	1	25	0.28	7.7	0.014	45	27	0.00217	2.79E+05	3.20E+15
810	1	25	0.28	8.1	0.014	45	27	0.00217	1.28E+03	3.20E+15
811	1	25	0.28	8.3	0.014	45	27	0.00217	3.49E+05	3.20E+15
812	1	25	0.28	8.4	0.014	45	27	0.00217	1.46E+01	3.20E+15
813	1	25	0.28	8.5	0.014	45	27	0.00217	3.81E+05	3.20E+15
814	1	25	0.28	8.7	0.014	45	27	0.00217	4.05E+05	3.20E+15
815	1	25	0.28	9	0.014	45	27	0.00217	4.47E+05	3.20E+15
816	1	25	0.28	9.5	0.014	45	27	0.00217	5.30E+05	3.20E+15
817	1	25	0.28	10	0.014	45	27	0.00217	6.16E+05	3.20E+15
818	1	25	0.28	11	0.014	45	27	0.00217	1.38E+01	3.20E+15
819	1	25	0.28	10.5	0.014	45	27	0.00217	7.05E+05	3.20E+15
820	1	25	0.28	10.7	0.014	45	27	0.00217	9.44E+02	3.20E+15
821	1	25	0.28	10.6	0.014	45	27	0.00217	7.31E+05	3.20E+15
822	1	25	0.28	10.3	0.014	45	27	0.00217	6.73E+05	3.20E+15
823	1	25	0.28	6	0.014	45	27	0.00217	1.56E+01	3.20E+15
824	1	25	0.28	10.6	0.01	45	27	0.00217	2.43E+07	2.97E+15
825	1	25	0.28	10.6	0.005	45	27	0.00217	4.71E+09	2.36E+15
826	1	25	0.28	10.6	0.001	45	27	0.00217	4.37E+11	8.90E+14
827	1	25	0.28	10.6	0.0005	45	27	0.00217	6.44E+11	5.01E+14
828	1	25	0.28	10.6	0.0001	45	27	0.00217	1.55E+14	1.11E+14
829	1	25	0.28	10.6	0.0003	45	27	0.00217	4.66E+14	3.16E+14
830	1	25	0.28	10.6	0.0004	45	27	0.00217	6.77E+11	4.11E+14
831	1	25	0.28	10.6	0.0007	45	27	0.00217	5.65E+11	6.68E+14
832	1	25	0.28	10.6	0.02	45	27	0.00217	1.62E+01	3.41E+15
833	1	25	0.28	10.6	0.017	45	27	0.00217	1.89E+01	3.32E+15
834	1	25	0.28	10.6	0.0003	42	27	0.00217	4.66E+14	3.16E+14
835	1	25	0.28	10.6	0.0003	40	27	0.00217	4.66E+14	3.16E+14
836	1	25	0.28	10.6	0.0003	35	27	0.00217	4.66E+14	3.16E+14
837	1	25	0.28	10.6	0.0003	48	27	0.00217	4.66E+14	3.16E+14
838	1	25	0.28	10.6	0.0003	55	27	0.00217	4.66E+14	3.16E+14
839	1	25	0.28	10.6	0.0003	60	27	0.00217	4.66E+14	3.16E+14
840	1	25	0.28	10.6	0.0003	60	26	0.00217	4.66E+14	3.16E+14
841	1	25	0.28	10.6	0.0003	60	25	0.00217	0	0.00E+00
842	1	25	0.28	10.6	0.0003	60	24	0.00217	4.66E+14	3.16E+14
843	1	25	0.28	10.6	0.0003	60	28	0.00217	4.66E+14	3.16E+14
844	1	25	0.28	10.6	0.0003	60	29	0.00217	4.66E+14	3.16E+14
845	1	25	0.28	10.6	0.0003	60	27	0.0015	4.66E+14	3.84E+14
846	1	25	0.28	10.6	0.0003	60	27	0.001	4.66E+14	4.57E+14
847	1	25	0.28	10.6	0.0003	60	27	0.0005	4.66E+14	5.64E+14
848	1	25	0.28	10.6	0.0003	60	27	0.0001		
849	1	25	0.28	10.6	0.0003	60	27	0.003	4.67E+14	2.60E+14
850	1	25	0.28	10.6	0.0003	60	27	0.005	4.66E+14	5.64E+14

A5. (continued)

Optimization of the 1st Cycle			Np(VI) D.C. -50%, Pu(IV) D.C. +50% Design							
Run	V1	V2	V3	V4	V5	V6	V7	V8	R1	R2
851	32	1	32	23	5	16	0.001	0.005	9.90E-01	0.291
852	31	1	32	23	5	16	0.001	0.005	0.952	0.051
853	30	1	32	23	5	16	0.001	0.005		
854	32	2	32	23	5	16	0.001	0.005	9.90E-01	17.661
855	32	3	32	23	5	16	0.001	0.005	0.991	0.116
856	32	4	32	23	5	16	0.001	0.005	0.99	14.646
857	32	2	31	23	5	16	0.001	0.005	9.91E-01	4.786
858	32	2	30	23	5	16	0.001	0.005	9.90E-01	100.581
859	32	2	29	23	5	16	0.001	0.005	9.90E-01	0.976
860	32	2	30	20	5	16	0.001	0.005	1.01E+00	2.09E+02
861	32	2	30	30	5	16	0.001	0.005	9.35E-01	1.26E+04
862	32	2	30	50	5	16	0.001	0.005	7.92E-01	1.66E+00
863	32	2	30	40	5	16	0.001	0.005	8.57E-01	5.51E+03
864	32	2	30	25	5	16	0.001	0.005	9.72E-01	1.37E+04
865	32	2	30	35	5	16	0.001	0.005	8.98E-01	2.76E+04
866	32	2	30	36	5	16	0.001	0.005	8.87E-01	27.302
867	32	2	30	34	5	16	0.001	0.005	9.05E-01	2.98E+01
868	32	2	30	35	4	16	0.001	0.005	8.83E-01	0.107
869	32	2	30	35	4.5	16	0.001	0.005	8.94E-01	2.09E+04
870	32	2	30	35	5.5	16	0.001	0.005	8.92E-01	2.02E+04
871	32	2	30	35	4.8	16	0.001	0.005	8.95E-01	24.003
872	32	2	30	35	4.9	16	0.001	0.005	8.96E-01	1.37E+04
873	32	2	30	35	5	15	0.001	0.005		
874	32	2	30	35	5	17	0.001	0.005	8.86E-01	1.43E+00
875	32	2	30	35	5	18	0.001	0.005	8.76E-01	8.80E+03
876	32	2	30	35	5	16	0.0005	0.005	8.97E-01	6.80E+01
877	32	2	30	35	5	16	0.005	0.005	8.96E-01	5.56E+03
878	32	2	30	35	5	16	0.003	0.005	8.96E-01	7.52E+03
879	32	2	30	35	5	16	0.002	0.005	8.97E-01	3.65E+01
880	32	2	30	35	5	16	0.001	0.001	1.56E+07	4.07E+14
881	32	2	30	35	5	16	0.001	0.0005	7.82E+06	1.36E+00
882	32	2	30	35	5	16	0.001	0.01	3.45E-01	1.22E+00
883	32	2	30	35	5	16	0.001	0.0008	1.84E+07	4.00E+14

A5. (continued)

Run	V1	V2	V3	V4	V5	V6	V7	V8	R1	R2
884	32	2	30	35	5	16	0.001	0.0009	1.72E+07	3.87E+14
885	32	2	30	35	5	16	0.001	0.0007	1.76E+07	3.94E+14
886	32	2	30	35	5	16	0.001	0.001	1.56E+07	4.07E+14
Optimization of the 2nd Cycle										
Run	V1	V2	V3	V4	V5	V6	V7	V8	R1	R2
887	16	0.014	0.3	0.014	0.014	43.51	8.01	0.00217	1.31E+00	3.20E+15
888	15	0.014	0.3	0.014	0.014	43.51	8.01	0.00217		
889	14	0.014	0.3	0.014	0.014	43.51	8.01	0.00217		
890	17	0.014	0.3	0.014	0.014	43.51	8.01	0.00217	1.37E+00	3.20E+15
891	18	0.014	0.3	0.014	0.014	43.51	8.01	0.00217	1.366	3.20E+15
892	19	0.014	0.3	0.014	0.014	43.51	8.01	0.00217	1.37E+00	3.20E+15
893	17	0.01	0.3	0.014	0.014	43.51	8.01	0.00217		
894	17	0.02	0.3	0.014	0.014	43.51	8.01	0.00217	0.00E+00	2.39E+15
895	17	0.025	0.3	0.014	0.014	43.51	8.01	0.00217	0.00E+00	1.97E+15
896	17	0.017	0.3	0.014	0.014	43.51	8.01	0.00217	3.92E-01	2.74E+15
897	17	0.015	0.3	0.014	0.014	43.51	8.01	0.00217	9.43E-01	3.03E+15
898	17	0.013	0.3	0.014	0.014	43.51	8.01	0.00217	1.95	3.40E+15
899	17	0.012	0.3	0.014	0.014	43.51	8.01	0.00217	2.59E+00	3.62E+15
900	17	0.011	0.3	0.014	0.014	43.51	8.01	0.00217		
901	17	0.012	0.25	0.014	0.014	43.51	8.01	0.00217	1.31E+00	3.62E+15
902	17	0.012	0.2	0.014	0.014	43.51	8.01	0.00217	0.716	3.62E+15
903	17	0.012	0.35	0.014	0.014	43.51	8.01	0.00217	7.16E+00	3.62E+15
904	17	0.012	0.4	0.014	0.014	43.51	8.01	0.00217	2.18E+04	3.62E+15
905	17	0.012	0.45	0.014	0.014	43.51	8.01	0.00217	1.26E+06	3.62E+15
906	17	0.012	0.5	0.014	0.014	43.51	8.01	0.00217	1.50E+01	3.62E+15
907	17	0.012	0.47	0.014	0.014	43.51	8.01	0.00217	3.63E+05	3.62E+15
908	17	0.012	0.48	0.014	0.014	43.51	8.01	0.00217	5.88E+06	3.62E+15
909	17	0.012	0.49	0.014	0.014	43.51	8.01	0.00217	2.01E+01	3.62E+15
910	17	0.012	0.6	0.014	0.014	43.51	8.01	0.00217	3.35E+01	3.62E+15

A5. (continued)

Run	V1	V2	V3	V4	V5	V6	V7	V8	R1	R2
911	17	0.012	0.48	0.01	0.014	43.51	8.01	0.00217	1.51E+01	3.62E+15
912	17	0.012	0.48	0.02	0.014	43.51	8.01	0.00217	3.35E+01	3.62E+15
913	17	0.012	0.48	0.017	0.014	43.51	8.01	0.00217	2.74E+01	3.62E+15
914	17	0.012	0.48	0.015	0.014	43.51	8.01	0.00217	1.41E+01	3.62E+15
915	17	0.012	0.48	0.013	0.014	43.51	8.01	0.00217	2.00E+06	3.62E+15
916	17	0.012	0.48	0.012	0.014	43.51	8.01	0.00217	4.94E+05	3.62E+15
917	17	0.012	0.48	0.014	0.01	43.51	8.01	0.00217	1.01E+09	3.48E+15
918	17	0.012	0.48	0.014	0.005	43.51	8.01	0.00217	5.89E+11	3.08E+15
919	17	0.012	0.48	0.014	0.001	43.51	8.01	0.00217	1.61E+15	1.60E+15
920	17	0.012	0.48	0.014	0.0005	43.51	8.01	0.00217	7.76E+14	1.00E+15
921	17	0.012	0.48	0.014	0.0007	43.51	8.01	0.00217	1.09E+15	1.27E+15
922	17	0.012	0.48	0.014	0.0008	43.51	8.01	0.00217	1.24E+15	1.39E+15
923	17	0.012	0.48	0.014	0.0009	43.51	8.01	0.00217	1.40E+15	1.50E+15
924	17	0.012	0.48	0.014	0.002	43.51	8.01	0.00217	2.90E+15	2.29E+15
925	17	0.012	0.48	0.014	0.003	43.51	8.01	0.00217	3.92E+15	2.67E+15
926	17	0.012	0.48	0.014	0.004	43.51	8.01	0.00217	1.77E+12	2.91E+15
927	17	0.012	0.48	0.014	0.02	43.51	8.01	0.00217	6.28E+00	3.73E+15
928	17	0.012	0.48	0.014	0.003	40	8.01	0.00217	3.71E+15	2.67E+15
929	17	0.012	0.48	0.014	0.003	37	8.01	0.00217	3.55E+15	2.67E+15
930	17	0.012	0.48	0.014	0.003	45	8.01	0.00217	3.96E+15	2.67E+15
931	17	0.012	0.48	0.014	0.003	48	8.01	0.00217	4.17E+15	2.67E+15
932	17	0.012	0.48	0.014	0.003	60	8.01	0.00217	4.11E+00	2.67E+15
933	17	0.012	0.48	0.014	0.003	55	8.01	0.00217	5.15E+00	2.67E+15
934	17	0.012	0.48	0.014	0.003	50	8.01	0.00217	8.71E+12	2.67E+15
935	17	0.012	0.48	0.014	0.003	49	8.01	0.00217	4.24E+15	2.67E+15
936	17	0.012	0.48	0.014	0.003	48.5	8.01	0.00217	4.22E+15	2.67E+15
937	17	0.012	0.48	0.014	0.003	48.7	8.01	0.00217	4.24E+15	2.67E+15
938	17	0.012	0.48	0.014	0.003	48.8	8.01	0.00217	4.25E+15	2.67E+15
939	17	0.012	0.48	0.014	0.003	48.9	8.01	0.00217	4.24E+15	2.67E+15
940	17	0.012	0.48	0.014	0.003	48.8	7.5	0.00217	4.25E+15	2.50E+15
941	17	0.012	0.48	0.014	0.003	48.8	8.5	0.00217	4.25E+15	2.83E+15
942	17	0.012	0.48	0.014	0.003	48.8	10	0.00217	4.25E+15	3.33E+15
943	17	0.012	0.48	0.014	0.003	48.8	15	0.00217	4.25E+15	5.00E+15
944	17	0.012	0.48	0.014	0.003	48.8	30	0.00217	4.25E+15	1.00E+16
945	17	0.012	0.48	0.014	0.003	48.8	50	0.00217	4.25E+15	1.67E+16
946	17	0.012	0.48	0.014	0.003	48.8	100	0.00217	4.25E+15	3.33E+16
947	17	0.012	0.48	0.014	0.003	48.8	200	0.00217	4.25E+15	6.67E+16
948	17	0.012	0.48	0.014	0.003	48.8	500	0.00217	4.25E+15	1.67E+17
949	17	0.012	0.48	0.014	0.003	48.8	8.01	0.002		
950	17	0.012	0.48	0.014	0.003	48.8	8.01	0.003	2.47E+12	2.25E+15
951	17	0.012	0.48	0.014	0.003	48.8	8.01	0.004	1.04E+12	1.90E+15
952	17	0.012	0.48	0.014	0.003	48.8	8.01	0.001		
953	17	0.012	0.48	0.014	0.003	48.8	8.01	0.00215	4.24E+15	2.68E+15
954	17	0.012	0.48	0.014	0.003	48.8	8.01	0.0021		
955	17	0.012	0.48	0.014	0.003	48.8	8.01	0.00217	4.25E+15	2.67E+15

APPENDIX VI - INPUT AND OUTPUT RESULTS OF THE OPTIMIZED FIRST AND SECOND SOLVENT EXTRACTION CYCLES

```
2 32 0.3  45.0   0    0 2
4/28/97
FIRST SX CYCLE NP-PU RECOVERY---COEXTRACT/COSTRIP
1.0   1000.0 1000.0 0.01   1 1 3 3 0 0 1
1  1 0.014 0.03            0.1     45.0   1
17 1 0.002170.5                    45.0   1
20 1 0.001 5.0                    45.0    1
23 1 0.001 3.5  173.0 23.0           45.0   1
32 1 0.00033                  0.2  45.0   1
32 0 0.014 0.001                   45.0   0
16 1 0.014  1
32 1 0.0085 1
1  0 0.014  0
0.0
```

```
1CALCULATIONS FOR A SOLVENT EXTRACTION PROCESS HAVING INTERACTING SOLUTES


 Np-Pu SEPERATION PROCESS
 4/28/97
 FIRST SX CYCLE NP-PU RECOVERY---COEXTRACT/COSTRIP
-DTHETA =   1.000 MINUTES PER TIME INCREMENT
 DPRINT = 1000.000 MINUTES BETWEEN PRINTING OF PROFILES
 IFAST = 0  THE RUNGE-KUTTA INTEGRATION WILL BE USED
 THIS TIME PERIOD WILL END WHEN TIME = TSTOP = 1000.000 MINUTES, OR A TOLERANCE OF TOL =  .0100 % PER MINUTE IS REACHED
 NUMBER OF STAGES = 32
 NEWIN = 1 NEW INPUT FLOWS WILL BE GIVEN
 NEWOUT = 1  NEW OUTPUT FLOWS WILL BE GIVEN
 IVOLM = 3 MIXER VOLUMES DETERMINED BY PHASE FLOW
 IVOLS = 3 SETTLER VOLUMES GIVEN BY PHASE FLOW
 IPRO = 0  A NEW INITIAL PROFILE WILL NOT BE READ
 IPNCH = 1  PROFILE DATA WILL BE STORED AT END OR TIME
 NSTR = 0  NO UNUSUAL ROUTING PATTERN
 TEMPI =  4.500E+01  INITIAL & DEFAULT TEMPERATURE
 IRXN = 0  NO REACTIONS WILL BE CONSIDERED
-FEED & PRODUCT      STAGE  NITRIC ACID   NEPTUNIUM    PU (IV)      PU (III)     REDUCTANT    NITRATE ION   FLOW RATE     TEMP
 STREAM DATA          NO.    (MOL/L)       (G/L)        (G/L)        (G/L)        (MOL/L)      (MOL/L)      (L/MIN)      (C)
        AQUEOUS  1   3.000E-02    0.000E+00    0.000E+00    0.000E+00    1.000E-01    0.000E+00    1.400E-02    45.0
        AQUEOUS  17   5.000E-01    0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00    2.170E-03    45.0
        AQUEOUS  20   5.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00    1.000E-03    45.0
        AQUEOUS  23   3.500E+00    1.730E+02    2.300E+01    0.000E+00    0.000E+00    0.000E+00    1.000E-03    45.0
        AQUEOUS  32   0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00    2.000E-01    3.300E-04    45.0
      30.0 % TBP  32   1.000E-03    0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00    1.400E-02    45.0
        ORGANIC  1    PRODUCT STREAM REMOVED (FLOW RATE IN MOLAL UNITS)                              1.400E-02
        AQUEOUS  16    PRODUCT STREAM REMOVED (FLOW RATE IN MOLAL UNITS)                              1.400E-02
        AQUEOUS  32    PRODUCT STREAM REMOVED (FLOW RATE IN MOLAL UNITS)                              8.500E-03


     STAGE ^   MIXER VOLUME BY PHASE    ^  SETTLER VOLUME BY PHASE  ^     MIXER FLOW RATE     ^  INTERSTAGE FLOW RATE
      NO. ^  AQUEOUS    ^  ORGANIC   ^  AQUEOUS   ^  ORGANIC    ^  AQUEOUS    ^  ORGANIC    ^  AQUEOUS   ^  ORGANIC
        ^          ^           ^          ^           ^           ^          ^          ^
       1 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  0.000E+00
       2 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02
       3 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02
       4 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02
       5 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02
       6 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02
       7 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02
       8 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02
       9 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02
      10 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02
      11 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02
      12 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02
      13 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02
      14 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02
      15 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02
      16 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  1.400E-02 ^  0.000E+00 ^  1.400E-02
      17 ^  2.170E-03 ^  1.400E-02 ^  2.170E-03 ^  1.400E-02 ^  2.170E-03 ^  1.400E-02 ^  2.170E-03 ^  1.400E-02
      18 ^  2.170E-03 ^  1.400E-02 ^  2.170E-03 ^  1.400E-02 ^  2.170E-03 ^  1.400E-02 ^  2.170E-03 ^  1.400E-02
      19 ^  2.170E-03 ^  1.400E-02 ^  2.170E-03 ^  1.400E-02 ^  2.170E-03 ^  1.400E-02 ^  2.170E-03 ^  1.400E-02
      20 ^  3.170E-03 ^  1.400E-02 ^  3.170E-03 ^  1.400E-02 ^  3.170E-03 ^  1.400E-02 ^  3.170E-03 ^  1.400E-02
      21 ^  3.170E-03 ^  1.400E-02 ^  3.170E-03 ^  1.400E-02 ^  3.170E-03 ^  1.400E-02 ^  3.170E-03 ^  1.400E-02
      22 ^  3.170E-03 ^  1.400E-02 ^  3.170E-03 ^  1.400E-02 ^  3.170E-03 ^  1.400E-02 ^  3.170E-03 ^  1.400E-02
      23 ^  4.170E-03 ^  1.400E-02 ^  4.170E-03 ^  1.400E-02 ^  4.170E-03 ^  1.400E-02 ^  4.170E-03 ^  1.400E-02
      24 ^  4.170E-03 ^  1.400E-02 ^  4.170E-03 ^  1.400E-02 ^  4.170E-03 ^  1.400E-02 ^  4.170E-03 ^  1.400E-02
      25 ^  4.170E-03 ^  1.400E-02 ^  4.170E-03 ^  1.400E-02 ^  4.170E-03 ^  1.400E-02 ^  4.170E-03 ^  1.400E-02
      26 ^  4.170E-03 ^  1.400E-02 ^  4.170E-03 ^  1.400E-02 ^  4.170E-03 ^  1.400E-02 ^  4.170E-03 ^  1.400E-02
      27 ^  4.170E-03 ^  1.400E-02 ^  4.170E-03 ^  1.400E-02 ^  4.170E-03 ^  1.400E-02 ^  4.170E-03 ^  1.400E-02
      28 ^  4.170E-03 ^  1.400E-02 ^  4.170E-03 ^  1.400E-02 ^  4.170E-03 ^  1.400E-02 ^  4.170E-03 ^  1.400E-02
      29 ^  4.170E-03 ^  1.400E-02 ^  4.170E-03 ^  1.400E-02 ^  4.170E-03 ^  1.400E-02 ^  4.170E-03 ^  1.400E-02
      30 ^  4.170E-03 ^  1.400E-02 ^  4.170E-03 ^  1.400E-02 ^  4.170E-03 ^  1.400E-02 ^  4.170E-03 ^  1.400E-02
      31 ^  4.170E-03 ^  1.400E-02 ^  4.170E-03 ^  1.400E-02 ^  4.170E-03 ^  1.400E-02 ^  4.170E-03 ^  1.400E-02
      32 ^  4.500E-03 ^  1.400E-02 ^  4.500E-03 ^  1.400E-02 ^  4.500E-03 ^  1.400E-02 ^ -1.746E-10 ^  1.400E-02
1TRANSIENT BEHAVIOR RESULTS   MIXER CONCENTRATION GIVEN
- TIME =    .00  MINUTES
   AQUEOUS PHASE
      STAGE ^ NITRIC ACID^ NEPTUNIUM  ^  PU (IV)   ^  PU (III)  ^ REDUCTANT  ^ NITRATE ION^  DENSITY   ^ MIXER FLOW ^TEMPERATURE
       NO.  ^  (MOL/L)  ^   (G/L)    ^   (G/L)    ^   (G/L)    ^  (MOL/L)   ^  (MOL/L)   ^   (G/ML)   ^  (L/MIN)   ^(CENTIGRADE)
         ^          ^           ^           ^            ^            ^            ^            ^            ^
        1 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 1.400E-02 ^ 4.500E+01
        2 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 1.400E-02 ^ 4.500E+01
        3 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 1.400E-02 ^ 4.500E+01
        4 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 1.400E-02 ^ 4.500E+01
        5 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 1.400E-02 ^ 4.500E+01
        6 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 1.400E-02 ^ 4.500E+01
        7 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 1.400E-02 ^ 4.500E+01
        8 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 1.400E-02 ^ 4.500E+01
        9 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 1.400E-02 ^ 4.500E+01
       10 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 1.400E-02 ^ 4.500E+01
       11 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 1.400E-02 ^ 4.500E+01
       12 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 1.400E-02 ^ 4.500E+01
```

```
        13 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  9.971E-01 ^  1.400E-02 ^  4.500E+01
        14 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  9.971E-01 ^  1.400E-02 ^  4.500E+01
        15 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  9.971E-01 ^  1.400E-02 ^  4.500E+01
        16 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  9.971E-01 ^  1.400E-02 ^  4.500E+01
        16 ^ PRODUCT STREAM                                                ^  1.400E-02 ^
        17 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  9.971E-01 ^  2.170E-03 ^  4.500E+01
        18 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  9.971E-01 ^  2.170E-03 ^  4.500E+01
        19 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  9.971E-01 ^  2.170E-03 ^  4.500E+01
        20 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  9.971E-01 ^  3.170E-03 ^  4.500E+01
        21 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  9.971E-01 ^  3.170E-03 ^  4.500E+01
        22 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  9.971E-01 ^  3.170E-03 ^  4.500E+01
        23 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  9.971E-01 ^  4.170E-03 ^  4.500E+01
        24 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  9.971E-01 ^  4.170E-03 ^  4.500E+01
        25 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  9.971E-01 ^  4.170E-03 ^  4.500E+01
        26 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  9.971E-01 ^  4.170E-03 ^  4.500E+01
        27 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  9.971E-01 ^  4.170E-03 ^  4.500E+01
        28 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  9.971E-01 ^  4.170E-03 ^  4.500E+01
        29 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  9.971E-01 ^  4.170E-03 ^  4.500E+01
        30 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  9.971E-01 ^  4.170E-03 ^  4.500E+01
        31 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  9.971E-01 ^  4.170E-03 ^  4.500E+01
        32 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  9.971E-01 ^  4.500E-03 ^  4.500E+01
        32 ^ PRODUCT STREAM                                                ^  4.500E-03 ^
0   ORGANIC PHASE
      STAGE ^ NITRIC ACID^  NEPTUNIUM ^  PU(IV)    ^ NP EXTRACT ^ PU EXTRACT ^HNO3 EXTRACT^  DENSITY   ^ FLOW RATE  ^ INVENTORY
       NO.  ^  (MOL/L)   ^   (G/L)   ^   (G/L)   ^   FACTOR   ^   FACTOR   ^   FACTOR   ^   (G/ML)   ^  (L/MIN)   ^ CHANGE (%)
         ^          ^          ^          ^          ^          ^          ^          ^          ^
         1 ^ PRODUCT STREAM                                                ^  1.400E-02 ^
         1 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  8.171E-01 ^  1.400E-02 ^  2.000E+02
         2 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  8.171E-01 ^  1.400E-02 ^  2.000E+02
         3 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  8.171E-01 ^  1.400E-02 ^  2.000E+02
         4 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  8.171E-01 ^  1.400E-02 ^  2.000E+02
         5 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  8.171E-01 ^  1.400E-02 ^  2.000E+02
         6 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  8.171E-01 ^  1.400E-02 ^  2.000E+02
         7 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  8.171E-01 ^  1.400E-02 ^  2.000E+02
         8 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  8.171E-01 ^  1.400E-02 ^  2.000E+02
         9 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  8.171E-01 ^  1.400E-02 ^  2.000E+02
        10 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  8.171E-01 ^  1.400E-02 ^  2.000E+02
        11 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  8.171E-01 ^  1.400E-02 ^  2.000E+02
        12 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  8.171E-01 ^  1.400E-02 ^  2.000E+02
        13 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  8.171E-01 ^  1.400E-02 ^  2.000E+02
        14 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  8.171E-01 ^  1.400E-02 ^  2.000E+02
        15 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  8.171E-01 ^  1.400E-02 ^  2.000E+02
        16 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  8.171E-01 ^  1.400E-02 ^  2.000E+02
        17 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  8.171E-01 ^  1.400E-02 ^  2.000E+02
        18 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  8.171E-01 ^  1.400E-02 ^  2.000E+02
        19 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  8.171E-01 ^  1.400E-02 ^  2.000E+02
        20 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  8.171E-01 ^  1.400E-02 ^  2.000E+02
        21 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  8.171E-01 ^  1.400E-02 ^  2.000E+02
        22 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  8.171E-01 ^  1.400E-02 ^  2.000E+02
        23 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  8.171E-01 ^  1.400E-02 ^  2.000E+02
        24 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  8.171E-01 ^  1.400E-02 ^  2.000E+02
        25 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  8.171E-01 ^  1.400E-02 ^  2.000E+02
        26 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  8.171E-01 ^  1.400E-02 ^  2.000E+02
        27 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  8.171E-01 ^  1.400E-02 ^  2.000E+02
        28 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  8.171E-01 ^  1.400E-02 ^  2.000E+02
        29 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  8.171E-01 ^  1.400E-02 ^  2.000E+02
        30 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  8.171E-01 ^  1.400E-02 ^  2.000E+02
        31 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  8.171E-01 ^  1.400E-02 ^  2.000E+02
        32 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  8.171E-01 ^  1.400E-02 ^  2.000E+02
 NP RATIO IS :   0.000000E+00
 PU RATIO IS :   0.000000E+00
- TIME = 1000.00  MINUTES
   AQUEOUS PHASE
      STAGE ^ NITRIC ACID^ NEPTUNIUM  ^  PU (IV)   ^  PU (III)  ^ REDUCTANT  ^ NITRATE ION^  DENSITY   ^ MIXER FLOW ^TEMPERATURE
       NO.  ^  (MOL/L)   ^   (G/L)    ^   (G/L)    ^   (G/L)    ^  (MOL/L)   ^  (MOL/L)   ^   (G/ML)   ^  (L/MIN)   ^(CENTIGRADE)
         ^          ^          ^          ^          ^          ^          ^          ^          ^
         1 ^  3.000E-02 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  1.000E-01 ^  0.000E+00 ^  9.980E-01 ^  1.400E-02 ^  4.500E+01
         2 ^  3.000E-02 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  1.000E-01 ^  0.000E+00 ^  9.980E-01 ^  1.400E-02 ^  4.500E+01
         3 ^  3.000E-02 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  1.000E-01 ^  0.000E+00 ^  9.980E-01 ^  1.400E-02 ^  4.500E+01
         4 ^  3.000E-02 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  1.000E-01 ^  0.000E+00 ^  9.980E-01 ^  1.400E-02 ^  4.500E+01
         5 ^  3.000E-02 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  1.000E-01 ^  0.000E+00 ^  9.980E-01 ^  1.400E-02 ^  4.500E+01
         6 ^  3.000E-02 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  1.000E-01 ^  0.000E+00 ^  9.980E-01 ^  1.400E-02 ^  4.500E+01
         7 ^  3.000E-02 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  1.000E-01 ^  0.000E+00 ^  9.980E-01 ^  1.400E-02 ^  4.500E+01
         8 ^  3.000E-02 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  1.000E-01 ^  0.000E+00 ^  9.980E-01 ^  1.400E-02 ^  4.500E+01
         9 ^  3.000E-02 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  1.000E-01 ^  0.000E+00 ^  9.980E-01 ^  1.400E-02 ^  4.500E+01
        10 ^  3.000E-02 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  1.000E-01 ^  0.000E+00 ^  9.980E-01 ^  1.400E-02 ^  4.500E+01
        11 ^  3.000E-02 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  1.000E-01 ^  0.000E+00 ^  9.980E-01 ^  1.400E-02 ^  4.500E+01
        12 ^  2.998E-02 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  1.000E-01 ^  0.000E+00 ^  9.980E-01 ^  1.400E-02 ^  4.500E+01
        13 ^  2.915E-02 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  1.000E-01 ^  0.000E+00 ^  9.980E-01 ^  1.400E-02 ^  4.500E+01
        14 ^  3.449E-02 ^  5.349E-02 ^  1.819E+00 ^  0.000E+00 ^  1.000E-01 ^  0.000E+00 ^  1.001E+00 ^  1.400E-02 ^  4.500E+01
        15 ^  6.242E-02 ^  8.546E+00 ^  1.174E+01 ^  0.000E+00 ^  1.000E-01 ^  0.000E+00 ^  1.029E+00 ^  1.400E-02 ^  4.500E+01
        16 ^  3.772E-01 ^  1.236E+01 ^  1.613E+00 ^  0.000E+00 ^  1.000E-01 ^  0.000E+00 ^  1.028E+00 ^  1.400E-02 ^  4.500E+01
        16 ^ PRODUCT STREAM                                                ^  1.400E-02 ^
        17 ^  1.741E+00 ^  2.065E+00 ^  2.702E-01 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  1.056E+00 ^  2.170E-03 ^  4.500E+01
        18 ^  2.478E+00 ^  1.898E+00 ^  1.286E-01 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  1.080E+00 ^  2.170E-03 ^  4.500E+01
        19 ^  3.051E+00 ^  1.856E+00 ^  7.252E-02 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  1.098E+00 ^  2.170E-03 ^  4.500E+01
        20 ^  3.685E+00 ^  1.902E+00 ^  4.625E-02 ^  0.000E+00 ^  0.000E+00 ^  0.000E+00 ^  1.118E+00 ^  3.170E-03 ^  4.500E+01
```

```
       21 ^ 3.733E+00 ^ 1.934E+00 ^ 4.523E-02 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 1.120E+00 ^ 3.170E-03 ^ 4.500E+01
       22 ^ 3.834E+00 ^ 1.951E+00 ^ 4.314E-02 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 1.123E+00 ^ 3.170E-03 ^ 4.500E+01
       23 ^ 4.074E+00 ^ 1.995E+00 ^ 3.952E-02 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 1.131E+00 ^ 4.170E-03 ^ 4.500E+01
       24 ^ 4.083E+00 ^ 7.396E-02 ^ 2.255E-04 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 1.129E+00 ^ 4.170E-03 ^ 4.500E+01
       25 ^ 4.069E+00 ^ 2.714E-03 ^ 1.281E-06 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 1.128E+00 ^ 4.170E-03 ^ 4.500E+01
       26 ^ 4.027E+00 ^ 9.916E-05 ^ 7.369E-09 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 1.127E+00 ^ 4.170E-03 ^ 4.500E+01
       27 ^ 3.911E+00 ^ 3.585E-06 ^ 4.397E-11 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 1.123E+00 ^ 4.170E-03 ^ 4.500E+01
       28 ^ 3.628E+00 ^ 1.269E-07 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 1.114E+00 ^ 4.170E-03 ^ 4.500E+01
       29 ^ 3.096E+00 ^ 4.405E-09 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 1.097E+00 ^ 4.170E-03 ^ 4.500E+01
       30 ^ 2.401E+00 ^ 1.572E-10 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 1.074E+00 ^ 4.170E-03 ^ 4.500E+01
       31 ^ 1.715E+00 ^ 6.089E-12 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 1.052E+00 ^ 4.170E-03 ^ 4.500E+01
       32 ^ 1.050E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 1.467E-02 ^ 1.034E+00 ^ 4.500E-03 ^ 4.500E+01
       32 ^ PRODUCT STREAM                                           ^ 4.500E-03 ^
 0   ORGANIC PHASE
     STAGE ^ NITRIC ACID^  NEPTUNIUM ^ PU(IV)   ^ NP EXTRACT ^ PU EXTRACT ^HNO3 EXTRACT^  DENSITY   ^ FLOW RATE  ^ INVENTORY
      NO.  ^ (MOL/L)  ^  (G/L)   ^  (G/L)   ^  FACTOR   ^  FACTOR   ^  FACTOR   ^  (G/ML)  ^  (L/MIN)  ^ CHANGE (%)
        ^        ^        ^         ^         ^          ^          ^          ^          ^
        1 ^ PRODUCT STREAM                                           ^ 1.400E-02 ^
        1 ^ 8.453E-04 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 2.818E-02 ^ 8.171E-01 ^ 1.400E-02 ^ 0.000E+00
        2 ^ 8.453E-04 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 2.818E-02 ^ 8.171E-01 ^ 1.400E-02 ^ 0.000E+00
        3 ^ 8.453E-04 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 2.818E-02 ^ 8.171E-01 ^ 1.400E-02 ^ 0.000E+00
        4 ^ 8.453E-04 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 2.818E-02 ^ 8.171E-01 ^ 1.400E-02 ^ 0.000E+00
        5 ^ 8.453E-04 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 2.818E-02 ^ 8.171E-01 ^ 1.400E-02 ^ 0.000E+00
        6 ^ 8.453E-04 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 2.818E-02 ^ 8.171E-01 ^ 1.400E-02 ^ 0.000E+00
        7 ^ 8.453E-04 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 2.818E-02 ^ 8.171E-01 ^ 1.400E-02 ^ 0.000E+00
        8 ^ 8.453E-04 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 2.818E-02 ^ 8.171E-01 ^ 1.400E-02 ^ 0.000E+00
        9 ^ 8.453E-04 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 2.818E-02 ^ 8.171E-01 ^ 1.400E-02 ^ 0.000E+00
       10 ^ 8.453E-04 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 2.818E-02 ^ 8.171E-01 ^ 1.400E-02 ^ 0.000E+00
       11 ^ 8.453E-04 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 2.818E-02 ^ 8.171E-01 ^ 1.400E-02 ^ 0.000E+00
       12 ^ 8.446E-04 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 2.818E-02 ^ 8.171E-01 ^ 1.400E-02 ^ 0.000E+00
       13 ^ 8.215E-04 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 2.818E-02 ^ 8.171E-01 ^ 1.400E-02 ^ 0.000E+00
       14 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 8.171E-01 ^ 1.400E-02 ^ 3.297E-01
       15 ^ 5.333E-03 ^ 4.810E-02 ^ 1.611E+00 ^ 5.628E-03 ^ 1.373E-01 ^ 8.545E-02 ^ 8.199E-01 ^ 1.400E-02 ^ 4.699E+00
       16 ^ 3.326E-02 ^ 8.551E+00 ^ 1.187E+01 ^ 6.921E-01 ^ 7.364E+00 ^ 8.817E-02 ^ 8.483E-01 ^ 1.400E-02 ^ 2.025E-02
       17 ^ 3.481E-01 ^ 1.236E+01 ^ 1.643E+00 ^ 3.861E+01 ^ 3.922E+01 ^ 1.289E+00 ^ 8.459E-01 ^ 1.400E-02 ^ 0.000E+00
       18 ^ 5.405E-01 ^ 1.268E+01 ^ 1.685E+00 ^ 4.309E+01 ^ 8.450E+01 ^ 1.407E+00 ^ 8.517E-01 ^ 1.400E-02 ^ 0.000E+00
       19 ^ 6.547E-01 ^ 1.265E+01 ^ 1.663E+00 ^ 4.399E+01 ^ 1.479E+02 ^ 1.384E+00 ^ 8.548E-01 ^ 1.400E-02 ^ 0.000E+00
       20 ^ 7.435E-01 ^ 1.264E+01 ^ 1.654E+00 ^ 2.937E+01 ^ 1.579E+02 ^ 8.910E-01 ^ 8.573E-01 ^ 1.400E-02 ^ 0.000E+00
       21 ^ 7.478E-01 ^ 1.279E+01 ^ 1.653E+00 ^ 2.920E+01 ^ 1.614E+02 ^ 8.849E-01 ^ 8.576E-01 ^ 1.400E-02 ^ 0.000E+00
       22 ^ 7.586E-01 ^ 1.280E+01 ^ 1.653E+00 ^ 2.896E+01 ^ 1.692E+02 ^ 8.739E-01 ^ 8.579E-01 ^ 1.400E-02 ^ 0.000E+00
       23 ^ 7.814E-01 ^ 1.280E+01 ^ 1.653E+00 ^ 2.154E+01 ^ 1.404E+02 ^ 6.440E-01 ^ 8.586E-01 ^ 1.400E-02 ^ 0.000E+00
       24 ^ 8.769E-01 ^ 5.941E-01 ^ 1.177E-02 ^ 2.697E+01 ^ 1.752E+02 ^ 7.211E-01 ^ 8.424E-01 ^ 1.400E-02 ^ 0.000E+00
       25 ^ 8.795E-01 ^ 2.203E-02 ^ 6.717E-05 ^ 2.725E+01 ^ 1.761E+02 ^ 7.257E-01 ^ 8.417E-01 ^ 1.400E-02 ^ 0.000E+00
       26 ^ 8.754E-01 ^ 8.083E-04 ^ 3.815E-07 ^ 2.737E+01 ^ 1.738E+02 ^ 7.298E-01 ^ 8.416E-01 ^ 1.400E-02 ^ 0.000E+00
       27 ^ 8.630E-01 ^ 2.953E-05 ^ 2.182E-09 ^ 2.766E+01 ^ 1.666E+02 ^ 7.408E-01 ^ 8.412E-01 ^ 1.400E-02 ^ 0.000E+00
       28 ^ 8.284E-01 ^ 1.068E-06 ^ 0.000E+00 ^ 2.825E+01 ^ 0.000E+00 ^ 7.667E-01 ^ 8.402E-01 ^ 1.400E-02 ^ 0.000E+00
       29 ^ 7.439E-01 ^ 3.780E-08 ^ 0.000E+00 ^ 2.881E+01 ^ 0.000E+00 ^ 8.067E-01 ^ 8.379E-01 ^ 1.400E-02 ^ 0.000E+00
       30 ^ 5.856E-01 ^ 1.310E-09 ^ 0.000E+00 ^ 2.799E+01 ^ 0.000E+00 ^ 8.190E-01 ^ 8.335E-01 ^ 1.400E-02 ^ 0.000E+00
       31 ^ 3.784E-01 ^ 4.500E-11 ^ 0.000E+00 ^ 2.481E+01 ^ 0.000E+00 ^ 7.408E-01 ^ 8.277E-01 ^ 1.400E-02 ^ 0.000E+00
       32 ^ 1.743E-01 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 5.162E-01 ^ 8.220E-01 ^ 1.400E-02 ^ 0.000E+00
 NP RATIO IS :  6.177830E+15
 PU RATIO IS :  8.062504E+14
```

```
2 32 0.36  45.0  0    0 2
5/5/97
2ND SX CYCLE---NP SELECTIVE EXTRACTION
1.0   1000.0  1000.0  0.01   1 1 3 3 0 0 1
1  1 0.014 0.2                  0.1         45.0   1
17 1 0.002170.1                   0.13        45.0   1
22 1 0.008 0.5    43.51        8.01             45.0   1
25 1 0.001338.0                            45.0   1
32 0 0.02  0.001                          45.0   0
16 1 0.014  1
32 1 0.0175  1
1  0 0.014  0
0.0
```

```
1CALCULATIONS FOR A SOLVENT EXTRACTION PROCESS HAVING INTERACTING SOLUTES


 Np-Pu SEPERATION PROCESS
 5/5/97
 2ND SX CYCLE—NP SELECTIVE EXTRACTION
-DTHETA =   1.000 MINUTES PER TIME INCREMENT
 DPRINT = 1000.000 MINUTES BETWEEN PRINTING OF PROFILES
 IFAST = 0  THE RUNGE-KUTTA INTEGRATION WILL BE USED
 THIS TIME PERIOD WILL END WHEN TIME = TSTOP = 1000.000 MINUTES, OR A TOLERANCE OF TOL =  .0100 % PER MINUTE IS REACHED
 NUMBER OF STAGES =  32
 NEWIN = 1 NEW INPUT FLOWS WILL BE GIVEN
 NEWOUT = 1  NEW OUTPUT FLOWS WILL BE GIVEN
 IVOLM = 3 MIXER VOLUMES DETERMINED BY PHASE FLOW
 IVOLS = 3 SETTLER VOLUMES GIVEN BY PHASE FLOW
 IPRO = 0  A NEW INITIAL PROFILE WILL NOT BE READ
 IPNCH = 1  PROFILE DATA WILL BE STORED AT END OR TIME
 NSTR = 0   NO UNUSUAL ROUTING PATTERN
 TEMPI =  4.500E+01  INITIAL & DEFAULT TEMPERATURE
 IRXN = 0  NO REACTIONS WILL BE CONSIDERED
-FEED & PRODUCT      STAGE  NITRIC ACID   NEPTUNIUM    PU (IV)     PU (III)    REDUCTANT   NITRATE ION   FLOW RATE    TEMP
 STREAM DATA          NO.    (MOL/L)       (G/L)        (G/L)       (G/L)       (MOL/L)      (MOL/L)      (L/MIN)      (C)
          AQUEOUS  1    2.000E-01    0.000E+00    0.000E+00    0.000E+00    1.000E-01    0.000E+00    1.400E-02    45.0
          AQUEOUS  17   1.000E-01    0.000E+00    0.000E+00    0.000E+00    1.300E-01    0.000E+00    2.170E-03    45.0
          AQUEOUS  22   5.000E-01    4.351E+01    0.000E+00    8.010E+00    0.000E+00    0.000E+00    8.000E-03    45.0
          AQUEOUS  25   8.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00    1.330E-03    45.0
        36.0 % TBP 32   1.000E-03    0.000E+00    0.000E+00    0.000E+00    0.000E+00    0.000E+00    2.000E-02    45.0
          ORGANIC  1    PRODUCT STREAM REMOVED (FLOW RATE IN MOLAL UNITS)                              1.400E-02
          AQUEOUS  16   PRODUCT STREAM REMOVED (FLOW RATE IN MOLAL UNITS)                              1.400E-02
          AQUEOUS  32   PRODUCT STREAM REMOVED (FLOW RATE IN MOLAL UNITS)                              1.750E-02


    STAGE ^  MIXER VOLUME BY PHASE  ^  SETTLER VOLUME BY PHASE  ^     MIXER FLOW RATE      ^  INTERSTAGE FLOW RATE
     NO. ^  AQUEOUS   ^  ORGANIC   ^  AQUEOUS   ^  ORGANIC   ^  AQUEOUS   ^  ORGANIC   ^  AQUEOUS   ^  ORGANIC
       ^         ^          ^          ^          ^          ^          ^          ^
      1 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  6.000E-03
      2 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02
      3 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02
      4 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02
      5 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02
      6 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02
      7 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02
      8 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02
      9 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02
     10 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02
     11 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02
     12 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02
     13 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02
     14 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02
     15 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02
     16 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02 ^  1.400E-02 ^  2.000E-02 ^  0.000E+00 ^  2.000E-02
     17 ^  2.170E-03 ^  2.000E-02 ^  2.170E-03 ^  2.000E-02 ^  2.170E-03 ^  2.000E-02 ^  2.170E-03 ^  2.000E-02
     18 ^  2.170E-03 ^  2.000E-02 ^  2.170E-03 ^  2.000E-02 ^  2.170E-03 ^  2.000E-02 ^  2.170E-03 ^  2.000E-02
     19 ^  2.170E-03 ^  2.000E-02 ^  2.170E-03 ^  2.000E-02 ^  2.170E-03 ^  2.000E-02 ^  2.170E-03 ^  2.000E-02
     20 ^  2.170E-03 ^  2.000E-02 ^  2.170E-03 ^  2.000E-02 ^  2.170E-03 ^  2.000E-02 ^  2.170E-03 ^  2.000E-02
     21 ^  2.170E-03 ^  2.000E-02 ^  2.170E-03 ^  2.000E-02 ^  2.170E-03 ^  2.000E-02 ^  2.170E-03 ^  2.000E-02
     22 ^  1.017E-02 ^  2.000E-02 ^  1.017E-02 ^  2.000E-02 ^  1.017E-02 ^  2.000E-02 ^  1.017E-02 ^  2.000E-02
     23 ^  1.017E-02 ^  2.000E-02 ^  1.017E-02 ^  2.000E-02 ^  1.017E-02 ^  2.000E-02 ^  1.017E-02 ^  2.000E-02
     24 ^  1.017E-02 ^  2.000E-02 ^  1.017E-02 ^  2.000E-02 ^  1.017E-02 ^  2.000E-02 ^  1.017E-02 ^  2.000E-02
     25 ^  1.150E-02 ^  2.000E-02 ^  1.150E-02 ^  2.000E-02 ^  1.150E-02 ^  2.000E-02 ^  1.150E-02 ^  2.000E-02
     26 ^  1.150E-02 ^  2.000E-02 ^  1.150E-02 ^  2.000E-02 ^  1.150E-02 ^  2.000E-02 ^  1.150E-02 ^  2.000E-02
     27 ^  1.150E-02 ^  2.000E-02 ^  1.150E-02 ^  2.000E-02 ^  1.150E-02 ^  2.000E-02 ^  1.150E-02 ^  2.000E-02
     28 ^  1.150E-02 ^  2.000E-02 ^  1.150E-02 ^  2.000E-02 ^  1.150E-02 ^  2.000E-02 ^  1.150E-02 ^  2.000E-02
     29 ^  1.150E-02 ^  2.000E-02 ^  1.150E-02 ^  2.000E-02 ^  1.150E-02 ^  2.000E-02 ^  1.150E-02 ^  2.000E-02
     30 ^  1.150E-02 ^  2.000E-02 ^  1.150E-02 ^  2.000E-02 ^  1.150E-02 ^  2.000E-02 ^  1.150E-02 ^  2.000E-02
     31 ^  1.150E-02 ^  2.000E-02 ^  1.150E-02 ^  2.000E-02 ^  1.150E-02 ^  2.000E-02 ^  1.150E-02 ^  2.000E-02
     32 ^  1.150E-02 ^  2.000E-02 ^  1.150E-02 ^  2.000E-02 ^  1.150E-02 ^  2.000E-02 ^  0.000E+00 ^  2.000E-02
1TRANSIENT BEHAVIOR RESULTS  MIXER CONCENTRATION GIVEN
- TIME =   .00  MINUTES
   AQUEOUS PHASE
     STAGE ^ NITRIC ACID^ NEPTUNIUM ^ PU (IV)  ^ PU (III) ^ REDUCTANT ^ NITRATE ION^ DENSITY  ^ MIXER FLOW ^TEMPERATURE
      NO.  ^  (MOL/L)  ^  (G/L)   ^  (G/L)   ^  (G/L)   ^  (MOL/L)  ^  (MOL/L)   ^  (G/ML)  ^  (L/MIN)   ^(CENTIGRADE)
        ^         ^         ^         ^         ^         ^         ^         ^         ^
        1 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 1.400E-02 ^ 4.500E+01
        2 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 1.400E-02 ^ 4.500E+01
        3 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 1.400E-02 ^ 4.500E+01
        4 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 1.400E-02 ^ 4.500E+01
        5 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 1.400E-02 ^ 4.500E+01
        6 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 1.400E-02 ^ 4.500E+01
        7 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 1.400E-02 ^ 4.500E+01
        8 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 1.400E-02 ^ 4.500E+01
        9 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 1.400E-02 ^ 4.500E+01
       10 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 1.400E-02 ^ 4.500E+01
       11 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 1.400E-02 ^ 4.500E+01
       12 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 1.400E-02 ^ 4.500E+01
       13 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 1.400E-02 ^ 4.500E+01
```

```
    14 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 1.400E-02 ^ 4.500E+01
    15 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 1.400E-02 ^ 4.500E+01
    16 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 1.400E-02 ^ 4.500E+01
    16 ^ PRODUCT STREAM                                           ^ 1.400E-02 ^
    17 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 2.170E-03 ^ 4.500E+01
    18 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 2.170E-03 ^ 4.500E+01
    19 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 2.170E-03 ^ 4.500E+01
    20 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 2.170E-03 ^ 4.500E+01
    21 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 2.170E-03 ^ 4.500E+01
    22 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 1.017E-02 ^ 4.500E+01
    23 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 1.017E-02 ^ 4.500E+01
    24 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 1.017E-02 ^ 4.500E+01
    25 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 1.150E-02 ^ 4.500E+01
    26 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 1.150E-02 ^ 4.500E+01
    27 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 1.150E-02 ^ 4.500E+01
    28 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 1.150E-02 ^ 4.500E+01
    29 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 1.150E-02 ^ 4.500E+01
    30 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 1.150E-02 ^ 4.500E+01
    31 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 1.150E-02 ^ 4.500E+01
    32 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 9.971E-01 ^ 1.150E-02 ^ 4.500E+01
    32 ^ PRODUCT STREAM                                           ^ 1.150E-02 ^
0   ORGANIC PHASE
   STAGE ^ NITRIC ACID^ NEPTUNIUM ^ PU(IV)   ^ NP EXTRACT ^ PU EXTRACT ^HNO3 EXTRACT^ DENSITY  ^ FLOW RATE ^ INVENTORY
    NO. ^ (MOL/L)  ^  (G/L)   ^  (G/L)   ^  FACTOR  ^  FACTOR   ^  FACTOR   ^ (G/ML)  ^ (L/MIN)  ^ CHANGE (%)
      ^        ^        ^        ^        ^        ^        ^        ^        ^
     1 ^ PRODUCT STREAM                                           ^ 1.400E-02 ^
     1 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 8.171E-01 ^ 2.000E-02 ^ 2.000E+02
     2 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 8.171E-01 ^ 2.000E-02 ^ 2.000E+02
     3 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 8.171E-01 ^ 2.000E-02 ^ 2.000E+02
     4 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 8.171E-01 ^ 2.000E-02 ^ 2.000E+02
     5 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 8.171E-01 ^ 2.000E-02 ^ 2.000E+02
     6 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 8.171E-01 ^ 2.000E-02 ^ 2.000E+02
     7 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 8.171E-01 ^ 2.000E-02 ^ 2.000E+02
     8 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 8.171E-01 ^ 2.000E-02 ^ 2.000E+02
     9 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 8.171E-01 ^ 2.000E-02 ^ 2.000E+02
    10 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 8.171E-01 ^ 2.000E-02 ^ 2.000E+02
    11 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 8.171E-01 ^ 2.000E-02 ^ 2.000E+02
    12 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 8.171E-01 ^ 2.000E-02 ^ 2.000E+02
    13 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 8.171E-01 ^ 2.000E-02 ^ 2.000E+02
    14 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 8.171E-01 ^ 2.000E-02 ^ 2.000E+02
    15 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 8.171E-01 ^ 2.000E-02 ^ 2.000E+02
    16 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 8.171E-01 ^ 2.000E-02 ^ 2.000E+02
    17 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 8.171E-01 ^ 2.000E-02 ^ 2.000E+02
    18 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 8.171E-01 ^ 2.000E-02 ^ 2.000E+02
    19 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 8.171E-01 ^ 2.000E-02 ^ 2.000E+02
    20 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 8.171E-01 ^ 2.000E-02 ^ 2.000E+02
    21 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 8.171E-01 ^ 2.000E-02 ^ 2.000E+02
    22 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 8.171E-01 ^ 2.000E-02 ^ 2.000E+02
    23 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 8.171E-01 ^ 2.000E-02 ^ 2.000E+02
    24 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 8.171E-01 ^ 2.000E-02 ^ 2.000E+02
    25 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 8.171E-01 ^ 2.000E-02 ^ 2.000E+02
    26 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 8.171E-01 ^ 2.000E-02 ^ 2.000E+02
    27 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 8.171E-01 ^ 2.000E-02 ^ 2.000E+02
    28 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 8.171E-01 ^ 2.000E-02 ^ 2.000E+02
    29 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 8.171E-01 ^ 2.000E-02 ^ 2.000E+02
    30 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 8.171E-01 ^ 2.000E-02 ^ 2.000E+02
    31 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 8.171E-01 ^ 2.000E-02 ^ 2.000E+02
    32 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 8.171E-01 ^ 2.000E-02 ^ 2.000E+02
- TIME = 359.00  MINUTES
  AQUEOUS PHASE
   STAGE ^ NITRIC ACID^ NEPTUNIUM  ^ PU (IV)  ^ PU (III) ^ REDUCTANT  ^ NITRATE ION^  DENSITY  ^ MIXER FLOW ^TEMPERATURE
    NO. ^ (MOL/L) ^  (G/L)   ^  (G/L)   ^  (G/L)   ^ (MOL/L)  ^ (MOL/L)  ^  (G/ML)  ^ (L/MIN)  ^(CENTIGRADE)
      ^        ^        ^        ^        ^        ^        ^        ^        ^
     1 ^ 2.000E-01 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 1.000E-01 ^ 0.000E+00 ^ 1.004E+00 ^ 1.400E-02 ^ 4.500E+01
     2 ^ 2.000E-01 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 1.000E-01 ^ 0.000E+00 ^ 1.004E+00 ^ 1.400E-02 ^ 4.500E+01
     3 ^ 2.000E-01 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 1.000E-01 ^ 0.000E+00 ^ 1.004E+00 ^ 1.400E-02 ^ 4.500E+01
     4 ^ 2.000E-01 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 1.000E-01 ^ 0.000E+00 ^ 1.004E+00 ^ 1.400E-02 ^ 4.500E+01
     5 ^ 2.000E-01 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 1.000E-01 ^ 0.000E+00 ^ 1.004E+00 ^ 1.400E-02 ^ 4.500E+01
     6 ^ 2.000E-01 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 1.000E-01 ^ 0.000E+00 ^ 1.004E+00 ^ 1.400E-02 ^ 4.500E+01
     7 ^ 2.000E-01 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 1.000E-01 ^ 0.000E+00 ^ 1.004E+00 ^ 1.400E-02 ^ 4.500E+01
     8 ^ 2.000E-01 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 1.000E-01 ^ 0.000E+00 ^ 1.004E+00 ^ 1.400E-02 ^ 4.500E+01
     9 ^ 1.999E-01 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 1.000E-01 ^ 0.000E+00 ^ 1.004E+00 ^ 1.400E-02 ^ 4.500E+01
    10 ^ 1.992E-01 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 1.000E-01 ^ 0.000E+00 ^ 1.003E+00 ^ 1.400E-02 ^ 4.500E+01
    11 ^ 1.958E-01 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 1.000E-01 ^ 0.000E+00 ^ 1.003E+00 ^ 1.400E-02 ^ 4.500E+01
    12 ^ 1.763E-01 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 1.000E-01 ^ 0.000E+00 ^ 1.003E+00 ^ 1.400E-02 ^ 4.500E+01
    13 ^ 2.025E-01 ^ 3.015E-08 ^ 0.000E+00 ^ 0.000E+00 ^ 1.000E-01 ^ 0.000E+00 ^ 1.004E+00 ^ 1.400E-02 ^ 4.500E+01
    14 ^ 2.094E-01 ^ 1.875E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 1.000E-01 ^ 0.000E+00 ^ 1.006E+00 ^ 1.400E-02 ^ 4.500E+01
    15 ^ 2.147E-01 ^ 1.902E+01 ^ 0.000E+00 ^ 0.000E+00 ^ 1.000E-01 ^ 0.000E+00 ^ 1.030E+00 ^ 1.400E-02 ^ 4.500E+01
    16 ^ 2.458E-01 ^ 2.486E+01 ^ 0.000E+00 ^ 0.000E+00 ^ 1.000E-01 ^ 0.000E+00 ^ 1.039E+00 ^ 1.400E-02 ^ 4.500E+01
    16 ^ PRODUCT STREAM                                           ^ 1.400E-02 ^
    17 ^ 4.268E-01 ^ 1.233E+01 ^ 0.000E+00 ^ 0.000E+00 ^ 1.300E-01 ^ 0.000E+00 ^ 1.028E+00 ^ 2.170E-03 ^ 4.500E+01
    18 ^ 6.430E-01 ^ 5.239E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 1.300E-01 ^ 0.000E+00 ^ 1.025E+00 ^ 2.170E-03 ^ 4.500E+01
    19 ^ 7.517E-01 ^ 3.842E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 1.300E-01 ^ 0.000E+00 ^ 1.026E+00 ^ 2.170E-03 ^ 4.500E+01
    20 ^ 8.017E-01 ^ 3.495E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 1.300E-01 ^ 0.000E+00 ^ 1.028E+00 ^ 2.170E-03 ^ 4.500E+01
    21 ^ 8.238E-01 ^ 3.376E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 1.300E-01 ^ 0.000E+00 ^ 1.028E+00 ^ 2.170E-03 ^ 4.500E+01
    22 ^ 8.335E-01 ^ 3.329E+00 ^ 0.000E+00 ^ 6.301E+00 ^ 2.774E-02 ^ 0.000E+00 ^ 1.038E+00 ^ 1.017E-02 ^ 4.500E+01
    23 ^ 1.217E+00 ^ 1.930E-01 ^ 0.000E+00 ^ 6.301E+00 ^ 2.774E-02 ^ 0.000E+00 ^ 1.046E+00 ^ 1.017E-02 ^ 4.500E+01
```

```
    24 ^ 1.722E+00 ^ 9.220E-03 ^ 0.000E+00 ^ 6.301E+00 ^ 2.774E-02 ^ 0.000E+00 ^ 1.062E+00 ^ 1.017E-02 ^ 4.500E+01
    25 ^ 2.434E+00 ^ 3.893E-04 ^ 0.000E+00 ^ 5.572E+00 ^ 2.453E-02 ^ 0.000E+00 ^ 1.084E+00 ^ 1.150E-02 ^ 4.500E+01
    26 ^ 2.409E+00 ^ 1.863E-05 ^ 0.000E+00 ^ 5.572E+00 ^ 2.453E-02 ^ 0.000E+00 ^ 1.083E+00 ^ 1.150E-02 ^ 4.500E+01
    27 ^ 2.364E+00 ^ 8.958E-07 ^ 0.000E+00 ^ 5.572E+00 ^ 2.453E-02 ^ 0.000E+00 ^ 1.082E+00 ^ 1.150E-02 ^ 4.500E+01
    28 ^ 2.288E+00 ^ 4.345E-08 ^ 0.000E+00 ^ 5.572E+00 ^ 2.453E-02 ^ 0.000E+00 ^ 1.079E+00 ^ 1.150E-02 ^ 4.500E+01
    29 ^ 2.161E+00 ^ 2.144E-09 ^ 0.000E+00 ^ 5.572E+00 ^ 2.453E-02 ^ 0.000E+00 ^ 1.075E+00 ^ 1.150E-02 ^ 4.500E+01
    30 ^ 1.961E+00 ^ 1.093E-10 ^ 0.000E+00 ^ 5.572E+00 ^ 2.453E-02 ^ 0.000E+00 ^ 1.069E+00 ^ 1.150E-02 ^ 4.500E+01
    31 ^ 1.662E+00 ^ 5.679E-12 ^ 0.000E+00 ^ 5.572E+00 ^ 2.453E-02 ^ 0.000E+00 ^ 1.059E+00 ^ 1.150E-02 ^ 4.500E+01
    32 ^ 1.209E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 5.572E+00 ^ 2.453E-02 ^ 0.000E+00 ^ 1.044E+00 ^ 1.150E-02 ^ 4.500E+01
    32 ^ PRODUCT STREAM                                     ^ 1.150E-02 ^
0  ORGANIC PHASE
   STAGE ^ NITRIC ACID^ NEPTUNIUM ^ PU(IV)   ^ NP EXTRACT ^ PU EXTRACT ^HNO3 EXTRACT^ DENSITY  ^ FLOW RATE ^ INVENTORY
    NO. ^ (MOL/L)  ^  (G/L)  ^  (G/L)  ^  FACTOR  ^  FACTOR  ^  FACTOR  ^ (G/ML)  ^ (L/MIN)  ^ CHANGE (%)
     ^       ^        ^        ^        ^         ^         ^         ^         ^
     1 ^ PRODUCT STREAM                                     ^ 1.400E-02 ^
     1 ^ 1.656E-02 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 1.183E-01 ^ 8.176E-01 ^ 2.000E-02 ^ 0.000E+00
     2 ^ 1.656E-02 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 1.183E-01 ^ 8.176E-01 ^ 2.000E-02 ^ 0.000E+00
     3 ^ 1.656E-02 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 1.183E-01 ^ 8.176E-01 ^ 2.000E-02 ^ 0.000E+00
     4 ^ 1.656E-02 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 1.183E-01 ^ 8.176E-01 ^ 2.000E-02 ^ 0.000E+00
     5 ^ 1.656E-02 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 1.183E-01 ^ 8.176E-01 ^ 2.000E-02 ^ 0.000E+00
     6 ^ 1.656E-02 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 1.183E-01 ^ 8.176E-01 ^ 2.000E-02 ^ 0.000E+00
     7 ^ 1.656E-02 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 1.183E-01 ^ 8.176E-01 ^ 2.000E-02 ^ 0.000E+00
     8 ^ 1.656E-02 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 1.183E-01 ^ 8.176E-01 ^ 2.000E-02 ^ 0.000E+00
     9 ^ 1.654E-02 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 1.183E-01 ^ 8.176E-01 ^ 2.000E-02 ^ 0.000E+00
    10 ^ 1.647E-02 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 1.181E-01 ^ 8.176E-01 ^ 2.000E-02 ^ 0.000E+00
    11 ^ 1.603E-02 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 1.170E-01 ^ 8.176E-01 ^ 2.000E-02 ^ 0.000E+00
    12 ^ 1.359E-02 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 1.101E-01 ^ 8.175E-01 ^ 2.000E-02 ^ 0.000E+00
    13 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 8.171E-01 ^ 2.000E-02 ^ 5.150E-05
    14 ^ 1.835E-02 ^ 2.113E-08 ^ 0.000E+00 ^ 1.610E-08 ^ 0.000E+00 ^ 1.251E-01 ^ 8.176E-01 ^ 2.000E-02 ^ 9.572E-03
    15 ^ 2.316E-02 ^ 1.313E+00 ^ 0.000E+00 ^ 9.859E-02 ^ 0.000E+00 ^ 1.541E-01 ^ 8.195E-01 ^ 2.000E-02 ^ 2.448E-03
    16 ^ 2.688E-02 ^ 1.332E+01 ^ 0.000E+00 ^ 7.652E-01 ^ 0.000E+00 ^ 1.562E-01 ^ 8.356E-01 ^ 2.000E-02 ^ 8.019E-04
    17 ^ 4.863E-02 ^ 1.740E+01 ^ 0.000E+00 ^ 1.301E+01 ^ 0.000E+00 ^ 1.050E+00 ^ 8.416E-01 ^ 2.000E-02 ^ 4.600E-04
    18 ^ 8.408E-02 ^ 1.874E+01 ^ 0.000E+00 ^ 3.297E+01 ^ 0.000E+00 ^ 1.205E+00 ^ 8.444E-01 ^ 2.000E-02 ^ 4.829E-04
    19 ^ 1.075E-01 ^ 1.797E+01 ^ 0.000E+00 ^ 4.311E+01 ^ 0.000E+00 ^ 1.319E+00 ^ 8.440E-01 ^ 2.000E-02 ^ 3.831E-04
    20 ^ 1.193E-01 ^ 1.782E+01 ^ 0.000E+00 ^ 4.700E+01 ^ 0.000E+00 ^ 1.372E+00 ^ 8.441E-01 ^ 2.000E-02 ^ 2.967E-04
    21 ^ 1.248E-01 ^ 1.778E+01 ^ 0.000E+00 ^ 4.855E+01 ^ 0.000E+00 ^ 1.396E+00 ^ 8.442E-01 ^ 2.000E-02 ^ 2.225E-04
    22 ^ 1.272E-01 ^ 1.777E+01 ^ 0.000E+00 ^ 1.050E+01 ^ 0.000E+00 ^ 3.000E-01 ^ 8.443E-01 ^ 2.000E-02 ^ 1.313E-04
    23 ^ 2.616E-01 ^ 1.693E+00 ^ 0.000E+00 ^ 1.724E+01 ^ 0.000E+00 ^ 4.229E-01 ^ 8.267E-01 ^ 2.000E-02 ^ 2.264E-04
    24 ^ 4.565E-01 ^ 9.816E-02 ^ 0.000E+00 ^ 2.094E+01 ^ 0.000E+00 ^ 5.214E-01 ^ 8.300E-01 ^ 2.000E-02 ^ 3.541E-04
    25 ^ 7.134E-01 ^ 4.688E-03 ^ 0.000E+00 ^ 2.094E+01 ^ 0.000E+00 ^ 5.097E-01 ^ 8.370E-01 ^ 2.000E-02 ^ 4.612E-04
    26 ^ 7.054E-01 ^ 2.238E-04 ^ 0.000E+00 ^ 2.090E+01 ^ 0.000E+00 ^ 5.093E-01 ^ 8.368E-01 ^ 2.000E-02 ^ 5.318E-04
    27 ^ 6.909E-01 ^ 1.071E-05 ^ 0.000E+00 ^ 2.080E+01 ^ 0.000E+00 ^ 5.082E-01 ^ 8.364E-01 ^ 2.000E-02 ^ 3.169E-04
    28 ^ 6.653E-01 ^ 5.151E-07 ^ 0.000E+00 ^ 2.062E+01 ^ 0.000E+00 ^ 5.058E-01 ^ 8.357E-01 ^ 2.000E-02 ^ 4.394E-04
    29 ^ 6.212E-01 ^ 2.498E-08 ^ 0.000E+00 ^ 2.026E+01 ^ 0.000E+00 ^ 5.000E-01 ^ 8.345E-01 ^ 2.000E-02 ^ 5.568E-04
    30 ^ 5.482E-01 ^ 1.230E-09 ^ 0.000E+00 ^ 1.957E+01 ^ 0.000E+00 ^ 4.862E-01 ^ 8.324E-01 ^ 2.000E-02 ^ 6.641E-04
    31 ^ 4.334E-01 ^ 5.957E-11 ^ 0.000E+00 ^ 1.824E+01 ^ 0.000E+00 ^ 4.535E-01 ^ 8.292E-01 ^ 2.000E-02 ^ 7.261E-04
    32 ^ 2.614E-01 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 0.000E+00 ^ 3.761E-01 ^ 8.244E-01 ^ 2.000E-02 ^ 7.422E-04
```

APPENDIX VII - SUBROUTINE LISTINGS

```
      SUBROUTINE PRTNP
C
C
C  PRTOUT CONVERTS THE CONCENTRATIONS FROM THE MOLAL FORM USED BY THE
PROGRAM
C  TO THE MORE COMMON UNITS IN THE OUTPUT.  IN ORDER TO GET THE PROPER
C  HEADINGS FOR THE PUREX SYSTEM, THE SUBPROGRAM ALSO PRINTS THE PROFILES.
C
      COMMON/CONTRL/ NTOST,NSOLU,CTBP,NEWIN,NEWOUT,SPH,IPNCH,IFAST,IRXN,
     . DTHETA,IVOLM,IVOLS,IPRO,TEMPI,ISOL(6),NSTR,ISTR,JSTR,CODUM(100),
     . IPROCE
      COMMON/CONCS/ X(6,100,2),Y(6,100,2),XS(100,3,6,2),YS(100,3,6,2)
      COMMON/FLOWS/ A(100),O(100),AT(100),OT(100)
      COMMON/MOLALC/ AQ(6),OR(6),TEMP,CONVA,CONVO,TCONC
      COMMON/STREAM/ XFD(6,100),YFD(6,100),AFDRT(100),OFDRT(100),
     . AFDTEM(100),OFDTEM(100),ALVRT(100),OLVRT(100)
      COMMON/TEMPS/ TPROF(100,2),ATS(100,3,2),OTS(100,3,2)
      DIMENSION AOUT(100),OOUT(100)
      REAL NPR,PUR
      TCONC=1.0
      WRITE (6,1101)
      WRITE (25,1101)
      WRITE (6,1102)
      WRITE (25,1102)
      WRITE (6,1103)
      WRITE (25,1103)
      WRITE (6,1104)
      WRITE (25,1104)
      DO 20 J=1,NTOST
      DO 10 I=1,NSOLU
      AQ(I)=X(I,J,2)
      OR(I)=Y(I,J,2)
   10 CONTINUE
888      FORMAT(4D18.11)
      TEMP=TPROF(J,2)
      CALL MOLALN
      ADEN=(1000.-72.4*AQ(2)-130.*(AQ(3)+AQ(4))-30.9*AQ(1)-31.*AQ(6))/
     .  (1000./0.99707)+0.39404*AQ(2)+0.49202*(AQ(3)+AQ(4))
     .  +0.06301*AQ(1)+0.213*AQ(6)
      AOUT(J)=AT(J)*CONVA
      OOUT(J)=OT(J)*CONVO
      DO 15 I=1,NSOLU
      X(I,J,2)=AQ(I)/CONVA
      Y(I,J,2)=OR(I)/CONVO
   15 CONTINUE
      X(2,J,2)=X(2,J,2)*237.
      Y(2,J,2)=Y(2,J,2)*237.
      X(3,J,2)=X(3,J,2)*238.
      Y(3,J,2)=Y(3,J,2)*238.
      X(4,J,2)=X(4,J,2)*238.
      Y(4,J,2)=Y(4,J,2)*238.
      WRITE (6,1000)J,(X(I,J,2),I=1,6),ADEN,AOUT(J),TPROF(J,2)
```

```
      WRITE (25,1000)J,(X(I,J,2),I=1,6),ADEN,AOUT(J),TPROF(J,2)
      IF(ALVRT(J).EQ.0.0) GO TO 20
      CONVA=CONVA*ALVRT(J)
      WRITE (6,1001)J,CONVA
      WRITE (25,1001)J,CONVA
   20 CONTINUE
      WRITE (6,1105)
      WRITE (25,1105)
      WRITE (6,1106)
      WRITE (25,1106)
      WRITE (6,1107)
      WRITE (25,1107)
      WRITE (6,1104)
      WRITE (25,1104)
      DO 30 J=1,NTOST
      EXH=0.0
      EXU=0.0
      EXPU=0.0
      IF(AOUT(J).LE.0.0) GO TO 25
      EXH=OOUT(J)/AOUT(J)
      IF(X(2,J,2).GT.0.0) EXU=EXH*Y(2,J,2)/X(2,J,2)
      IF(X(3,J,2)+X(4,J,2).GT.0.0) EXPU=EXH*(Y(3,J,2)+Y(4,J,2))/
     .   (X(3,J,2)+X(4,J,2))
      IF(X(1,J,2).GT.0.0) EXH=EXH*Y(1,J,2)/X(1,J,2)
      IF(X(1,J,2).LE.0.0) EXH=0.0
   25 CONTINUE
      ODEN=(1000.-17.4*0.29-97.*Y(2,J,1)-139.*(Y(3,J,1)+Y(4,J,1))
     .   -43.*Y(1,J,1))*(1.0+1.8)/((273.6/266.32+227.5/170.34*1.8)
     .   *1000.)+0.01802*.29+.39404*Y(2,J,1)+.49202*(Y(3,J,1)
     .   +Y(4,J,1))+.06301*Y(1,J,1)
      IF(OLVRT(J).EQ.0.0) GO TO 28
      CONVO=OLVRT(J)*OOUT(J)/OT(J)
      WRITE (6,1001)J,CONVO
      WRITE (25,1001)J,CONVO
   28 WRITE(6,1000)J,(Y(I,J,2),I=1,3),EXU,EXPU,EXH,ODEN,OOUT(J),
     / CODUM(J)
      WRITE(25,1000)J,(Y(I,J,2),I=1,3),EXU,EXPU,EXH,ODEN,OOUT(J),
     / CODUM(J)
   30 CONTINUE
 1000 FORMAT(12X,I3,1X,9('^ ',1PE10.3,1X))
 1001 FORMAT(12X,I3,' ^ PRODUCT STREAM ',74X,'^ ',1PE10.3,' ^')
 1101 FORMAT(5X,'AQUEOUS PHASE')
 1102 FORMAT(10X,'STAGE ^ NITRIC ACID^ NEPTUNIUM  ^  PU (IV)   ^  PU (II
     .I)  ^ REDUCTANT  ^ NITRATE ION^  DENSITY   ^ MIXER FLOW ^TEMPERATU
     .RE')
 1103 FORMAT(11X,'NO.  ^   (MOL/L)  ^   (G/L)    ^   (G/L)    ^   (G/L)
     .   ^  (MOL/L)   ^  (MOL/L)   ^   (G/ML)   ^  (L/MIN)   ^(CENTIGRAD
     .E)')
 1104 FORMAT(16X,9('^',12X))
 1105 FORMAT('0    ORGANIC PHASE')
 1106 FORMAT(10X,'STAGE ^ NITRIC ACID^  NEPTUNIUM ^  PU(IV)    ^ NP EXTR
     .ACT ^ PU EXTRACT ^HNO3 EXTRACT^  DENSITY   ^ FLOW RATE  ^ INVENTOR
```

```
     .Y')
 1107 FORMAT(10X,' NO.  ^  (MOL/L)  ^  (G/L)   ^  (G/L)   ^  FACTO
     .R  ^  FACTOR  ^  FACTOR  ^  (G/ML)  ^ (L/MIN)  ^ CHANGE (
     .%)')

      IF (X(2,32,2).LE.1E-15) X(2,32,2)=1E-15
      IF (X(3,32,2).LE.1E-15) X(3,32,2)=1E-15
      IF (Y(2,1,2).LE.1E-15) Y(2,1,2)=1E-15
      IF (Y(3,1,2).LE.1E-15) Y(3,1,2)=1E-15
      NPR=X(2,16,2)/(X(2,32,2)+Y(2,1,2))
      PUR=X(3,16,2)/(X(3,32,2)+Y(3,1,2))
      WRITE (*,*) 'NP RATIO IS :',NPR
      WRITE (25,*) 'NP RATIO IS :',NPR
      WRITE (*,*) 'PU RATIO IS :',PUR
      WRITE (25,*) 'PU RATIO IS :',PUR

      RETURN
      END


      SUBROUTINE MCHEMN (J,AQVOL,ORVOL)
C
C
C  SUBROUTINE MCHEM HANDLES THE CHEMICAL REACTIONS IN THE SYSTEM.  PRESENTLY,
C  INSTANTANEOUS REDUCTION OF PLUTONIUM, REDUCTION BY U(IV), AND REDUCTION
C  BY HYDROXYLAMINE ARE AVAILABLE AS REACTIONS.  THE SUBROUTINE CAN EASILY
C  BE ADAPTED TO CONSIDER ANY INTEGRATED RATE EQUATION, WITH ANY DESIRED
C  STOICHIOMETRY.
C  THE SUBROUTINE ASSUMES THE REACTION IS TOTALLY IN THE AQUEOUS PHASE, BUT
C  THAT THE SOLUTE IN THE ORGANIC PHASE ALSO AIDS IN MAINTAINING THE
C  AQUEOUS CONCENTRATION.  THE INTEGRATED RATE EQUATION DETERMINES THE
C  EXTENT OF REACTION.  THE ROUTI,NE THEN SPLITS THE RESULTING SOLUTES,
C  BETWEEN THE PHASES.
C
C  IRXN INDICATES WHICH REACTION RATE IS TO BE USED.
C  SOLAMT IS THE TOTAL AMOUNT OF SOLUTE IN THE MIXER
C  SOLVOL IS A PSEUDO-VOLUME SO THAT THE SOLUTE IS ENTIRELY IN THE AQUEOUS PHASE
C  RX IS THE AQUEOUS COMPOSITION USED TO DETERMINE THE REACTION RATE
C  RXNAMT IS THE AMOUNT OF REACTED SOLUTE USING SOME COMPONENT AS A BASIS
C  RK IS A REACTION RATE CONSTANT
C  EXTENT = THE EXTENT OF REACTION, BASED ON THE FRACTION OF
C         SOME COMPONENT CONSUMED BY THE REACTION.
C
C
      COMMON/CONTRL/ NTOST,NSOLU,CTBP,NEWIN,NEWOUT,SPH,IPNCH,IFAST,IRXN,
     . DTHETA,IVOLM,IVOLS,IPRO,TEMPI,ISOL(6),NSTR,ISTR,JSTR,CODUM(100),
     . IPROCE
      COMMON/CONCS/ X(6,100,2),Y(6,100,2),XS(100,3,6,2),YS(100,3,6,2)
      COMMON/DISTRB/ TEMPC,ARY(6),DTRY(6)
      COMMON/TEMPS/ TPROF(100,2),ATS(100,3,2),OTS(100,3,2)
       COMMON/RXNS/ RXNTRM(6,100),AIN(6),OIN(6)
      DIMENSION RX(6),SOLAMT(6),SOLVOL(6)
```

```
C     REAL STOIC(6,3)/0.0,0.0,-1.0,1.0,-1.0,0.0,
C   .          2.0,0.5,-1.0,1.0,-0.5,0.0,
C   .          2.0,0.0,-1.0,1.0,-1.0,0.0/
        DIMENSION STOIC(6,3)
        DO 1 ISTOIC=1,6
        DO 1 JSTOIC=1,3
        STOIC(ISTOIC,JSTOIC)=0.0
1       CONTINUE
        STOIC(3,1)=-1.0
        STOIC(4,1)=1.0
        STOIC(5,1)=-1.0
     STOIC(1,2)=2.0
     STOIC(2,2)=0.5
     STOIC(3,2)=-1.0
     STOIC(4,2)=1.0
     STOIC(5,2)=-0.5
        STOIC(1,3)=2.0
        STOIC(3,3)=-1.0
        STOIC(4,3)=1.0
        STOIC(5,3)=-1.0
    IF(ISOL(5).EQ.0) GO TO 300
    DO 10 I=1,3
    SOLAMT(I)=AQVOL*X(I,J,2)+ORVOL*Y(I,J,2)
    SOLVOL(I)=AQVOL+DTRY(I)*ORVOL
    RX(I)=X(I,J,2)
  10 CONTINUE
    DO 11 I=4,6
    SOLAMT(I)=AQVOL*X(I,J,2)
    SOLVOL(I)=AQVOL
    RX(I)=X(I,J,2)
  11 CONTINUE
    GO TO (90,80,70,60,50,40,30,20),IRXN
  20 CONTINUE
  30 CONTINUE
  40 CONTINUE
  50 CONTINUE
  60 CONTINUE
    GO TO 90
  70 CONTINUE
C
C
C  IRXN = 3  REACTION BETWEEN PU(IV) AND HYDROXYLAMINE
C    FOR = RATIO OF PU(IV) TO REDUCTANT
C    RK = RATE CONSTANT
C    EXTMAX = MAXIMUM EXTENT OF REACTION (BASED ON PU (IV))
C    EXTINC = INCREMENT IN SEARCH FOR EXTENT
C    AMTINT = THE INTEGRATED CHANGE IN EXTENT (EQUAL TO RK)
C
    IF(RX(1).LT.1.0E-10.OR.RX(3).LT.1.0E-10.OR.RX(5).LT.1.0E-10)
    .  GO TO 90
    FOR=SOLAMT(3)/SOLAMT(5)
    TOTNIT=RX(1)+2.*RX(2)+4.*RX(3)+3.*RX(4)+RX(6)+0.33
```

```
      RK=1.74*EXP(31000./1.987*(1.0/303.16-1.0/(273.16+TPROF(J,2))))
      RK=RK*RX(3)*DTHETA*(RX(5)/(RX(1)*RX(1)*TOTNIT))**2.0
      EXTMAX=AMIN1(1.0,1.0/FOR)
C
C
C   THIS IS A BINARY SEARCH FOR THE CORRECT EXTENT OF REACTION
C
      EXTINC=0.25*EXTMAX
      EXTENT=0.5*EXTMAX
      B=SOLAMT(3)/SOLVOL(4)
      A=RX(4)+B
      AA=A*A
      BB=A*B
      CC=B*B
      DO 78 I=1,25
      A=1.0/(1.0-EXTENT)
      IF(FOR.GT.0.01) GO TO 72
C
C
C   THIS INTEGRATED FORM ASSUMES A LARGE EXCESS OF THE REDUCTANT
C
      AMTINT=AA*A*EXTENT-2.0*BB*ALOG(A)+CC*EXTENT
      GO TO 76
   72 IF(ABS(1.0-FOR).LT.0.01) GO TO 74
C
C
C   THIS INTEGRATED RATE EQUATION IS THE GENERAL CASE
C
      B=1.0-FOR*EXTENT
      C=1.0/(1.0-FOR)
      AMTINT=(FOR-A*EXTENT-FOR/B+2.0*C*FOR*ALOG(A*B))*AA*C*C
      AMTINT=AMTINT-2.0*BB*C*(FOR*EXTENT/B-C*ALOG(A*B))-CC*EXTENT/B
      AMTINT=-AMTINT
      GO TO 76
C
C
C   THIS INTEGRATED FORM ASSUMES A STOICHIOMETRIC AMOUNT OF REDUCTANT
C
   74 AMTINT=AA*(A*A*A-1.0)/3.0-BB*(A*A-1.0)+CC*(A-1.0)
   76 CONTINUE
C
C
C 5/2/90 ALTER DETERMAINATION OF EXTENT AND CLOSURE OF LOOP
C
      IF(AMTINT.GT.RK) EXTENT1=EXTENT-EXTINC
      IF(AMTINT.LT.RK) EXTENT1=EXTENT+EXTINC
      EXTINC=EXTINC/2.0
      EXDIF=(EXTENT1-EXTENT)/EXTENT
      EXTENT=EXTENT1
      IF(ABS(EXDIF) .GT. .0001) GO TO 79
   78 CONTINUE
   79 RXNAMT=EXTENT*SOLAMT(3)
```

```
   GO TO 100
  80 CONTINUE
C
C
C  IRXN = 2  REACTION BETWEEN PU (IV) AND U (IV)
C    RK = RATE CONSTANT
C    RCU = RATIO OF PU (IV) TO REDUCTANT
C    EXTMAX = MAXIMUM EXTENT BASED ON PU (IV) AND A TEN SECOND HALF TIME
C
C     IF(RX(3).LT.1.0E-10.OR.RX(5).LT.1.0E-10) GO TO 90
C     EXTMAX=AMIN1(1.0,1.0-0.5**(6.0*DTHETA),2.0*SOLAMT(5)/SOLAMT(3))
C     RK=170.0
C     RK=RK*DTHETA*RX(5)
C     RCU=SOLAMT(3)/(2.0*SOLAMT(5))
C     RHO=RX(1)*RX(1)
CC
C  2/23/90 CORRECT APPARENT ERROR IN REXP AND MULTIPLIER OF 100*RHO
C    REXP=1.020
C
C     REXP=1.0E30
C     IF(RK*(1.0-RCU).LT.70.0*RHO) REXP=EXP(RK*(1.0-RCU)/RHO)
C     EXTENT=RK/(RK+RHO)
C     IF(ABS(1.0-RCU).GT.0.05) EXTENT=(1.0-REXP)/(RCU-REXP)
C     EXTENT=AMIN1(EXTENT,EXTMAX)
C     RXNAMT=SOLAMT(3)*EXTENT
C     GO TO 100
  90 CONTINUE
C
C
C  IRXN = 1  INSTATANEOUS REDUCTION OF PU (IV)
C    THIS MECHANISM IS USED BY ALL REDUCTION REACTIONS WHEN THE
C    CONCENTRATIONS FALL BELOW A THRESHHOLD LEVEL
C
    RXNAMT=AMIN1(-SOLAMT(3)/STOIC(3,IRXN),-SOLAMT(5)/STOIC(5,IRXN))
    IF(IFAST.EQ.2) RXNAMT=DTHETA*AMIN1(-(AIN(3)+OIN(3))
   .  /STOIC(3,IRXN),-(AIN(5)+OIN(5))/STOIC(5,IRXN))
 100 DO 110 I=1,6
    SOLAMT(I)=SOLAMT(I)+RXNAMT*STOIC(I,IRXN)
    IF(SOLAMT(I).LT.0.0) SOLAMT(I)=0.0
    ARY(I)=SOLAMT(I)/SOLVOL(I)
    RXNTRM(I,J)=RXNAMT*STOIC(I,IRXN)/DTHETA
    IF(RXNTRM(I,J).NE.0.0) ISOL(I)=1
    IF(ISOL(I).EQ.1.AND.NSOLU.LT.I) NSOLU=I
 110 CONTINUE
    IF(IFAST.EQ.2) GO TO 130
C
C
C  DIVIDING THE RESULTING SOLUTES BETWEEN THE PHASES
C
    DO 125 ITRY=1,5
    ICK=0
    CALL UCORNP
```

```
      DO 120 I=1,NSOLU
      X(I,J,2)=SOLAMT(I)/(AQVOL+DTRY(I)*ORVOL)
      IF(ABS(X(I,J,2)-ARY(I)).GT.0.0001*X(I,J,2)) ICK=1
      ARY(I)=X(I,J,2)
      IF(X(I,J,2).LE.1.E-20) X(I,J,2)=0.0
      Y(I,J,2)=X(I,J,2)*DTRY(I)
  120 CONTINUE
      IF(ICK.EQ.0) GO TO 130
  125 CONTINUE
  130 CONTINUE
  300 RETURN
      END
      SUBROUTINE SCHEMN (J,AQSVOL,ORSVOL)
C
C
C  SUBROUTINE SCHEM WORKS SIMILAR TO MCHEM, BUT THE PHASES ARE KEPT SEPARATE
C  AT ALL TIMES.
C
C  IRXN INDICATES WHICH REACTION RATE IS TO BE USED.
C  RK IS A REACTION RATE CONSTANT
C  EXTENT = THE EXTENT OF REACTION, BASED ON THE FRACTION OF
C         SOME COMPONENT CONSUMED BY THE REACTION.
C
C
C
      COMMON/CONTRL/ NTOST,NSOLU,CTBP,NEWIN,NEWOUT,SPH,IPNCH,IFAST,IRXN,
     . DTHETA,IVOLM,IVOLS,IPRO,TEMPI,ISOL(6),NSTR,ISTR,JSTR,CODUM(100),
     . IPROCE
      COMMON/CONCS/ X(6,100,2),Y(6,100,2),XS(100,3,6,2),YS(100,3,6,2)
      COMMON/TEMPS/ TPROF(100,2),ATS(100,3,2),OTS(100,3,2)
C      REAL STOICX(6,3)/0.0,0.0,-1.0,1.0,-1.0,0.0,
C     .           2.0,0.5,-1.0,1.0,-0.5,0.0,
C     .           2.0,0.0,-1.0,1.0,-1.0,0.0/
C      REAL STOICY(6,3)/0.0,0.0,0.0,0.0,0.0,0.0,12*0.0/
      DIMENSION RX(6),RY(6),STOICX(6,3),STOICY(6,3)
      IF(ISOL(5).EQ.0) GO TO 300
      DO 150 KZ=1,3
      DO 10 I=1,6
      RX(I)=XS(J,KZ,I,2)
      RY(I)=YS(J,KZ,I,2)
      STOICX(I,KZ)=0.0
      STOICY(I,KZ)=0.0
   10 CONTINUE
           STOICX(3,1)=-1.0
           STOICX(4,1)=1.0
           STOICX(5,1)=-1.0
       STOICX(1,2)=2.0
       STOICX(2,2)=0.5
       STOICX(3,2)=-1.0
       STOICX(4,2)=1.0
       STOICX(5,2)=-0.5
           STOICX(1,3)=2.0
```

```
            STOICX(3,3)=-1.0
            STOICX(4,3)=1.0
            STOICX(5,3)=-1.0
      GO TO (90,80,70,60,50,40,30,20),IRXN
   20 CONTINUE
   30 CONTINUE
   40 CONTINUE
   50 CONTINUE
   60 CONTINUE
      GO TO 90
   70 CONTINUE
C
C
C  IRXN = 3  REACTION BETWEEN PU(IV) AND HYDROXYLAMINE
C    FOR = RATIO OF PU(IV) TO REDUCTANT
C    RK = RATE CONSTANT
C    EXTMAX = MAXIMUM EXTENT OF REACTION (BASED ON PU (IV))
C    EXTINC = INCREMENT IN SEARCH FOR EXTENT
C    AMTINT = THE INTEGRATED CHANGE IN EXTENT (EQUAL TO RK)
C
      IF(RX(1).LT.1.0E-10.OR.RX(3).LT.1.0E-10.OR.RX(5).LT.1.0E-10)
     .   GO TO 90
      FOR=RX(3)/RX(5)
      TOTNIT=RX(1)+2.*RX(2)+4.*RX(3)+3.*RX(4)+RX(6)+0.33
      RK=1.74*EXP(31000./1.987*(1.0/303.16-1.0/(273.16+TPROF(J,2))))
      RK=RK*RX(3)*DTHETA*(RX(5)/(RX(1)*RX(1)*TOTNIT))**2.0
      EXTMAX=AMIN1(1.0,1.0/FOR)
C
C
C    THIS IS A BINARY SEARCH FOR THE CORRECT EXTENT OF REACTION
C
      EXTINC=0.25*EXTMAX
      EXTENT=0.5*EXTMAX
      B=RX(3)
      A=RX(4)+B
      AA=A*A
      BB=A*B
      CC=B*B
      DO 78 I=1,25
      A=1.0/(1.0-EXTENT)
      IF(FOR.GT.0.01) GO TO 72
      AMTINT=AA*A*EXTENT-2.0*BB*ALOG(A)+CC*EXTENT
      GO TO 76
   72 IF(ABS(1.0-FOR).LT.0.01) GO TO 74
      B=1.0-FOR*EXTENT
      C=1.0/(1.0-FOR)
      AMTINT=(FOR-A*EXTENT-FOR/B+2.0*C*FOR*ALOG(A*B))*AA*C*C
      AMTINT=AMTINT-2.0*BB*C*(FOR*EXTENT/B-C*ALOG(A*B))-CC*EXTENT/B
      AMTINT=-AMTINT
      GO TO 76
   74 AMTINT=AA*(A*A*A-1.0)/3.0-BB*(A*A-1.0)+CC*(A-1.0)
   76 CONTINUE
```

```
C
C
C 5/2/90 ALTER DETERMAINATION OF EXTENT AND CLOSURE OF LOOP
C
      IF(AMTINT.GT.RK) EXTENT1=EXTENT-EXTINC
      IF(AMTINT.LT.RK) EXTENT1=EXTENT+EXTINC
      EXTINC=EXTINC/2.0
      EXDIF=(EXTENT1-EXTENT)/EXTENT
      EXTENT=EXTENT1
      IF(ABS(EXDIF) .GT. .0001) GO TO 79
   78 CONTINUE
   79 DELTAX=RX(3)*EXTENT
      DELTAY=0.0
      GO TO 100
   80 CONTINUE
C
C
C  IRXN = 2  REACTION BETWEEN PU (IV) AND U (IV)
C    RK = RATE CONSTANT
C    RCU = RATIO OF PU (IV) TO REDUCTANT
C    EXTMAX = MAXIMUM EXTENT BASED ON PU (IV) AND A TEN SECOND HALF TIME
C
C     IF(RX(3).LT.1.0E-10.OR.RX(5).LT.1.0E-10) GO TO 90
C     EXTMAX=AMIN1(1.0,1.0-0.5**(6.0*DTHETA),2.0*RX(5)/RX(3))
C     RK=170.0
C     RK=RK*DTHETA*RX(5)
C     RCU=RX(3)/(2.0*RX(5))
C     RHO=RX(1)*RX(1)
CC
C  2/23/90 CORRECT APPARENT ERROR IN REXP AND MULTIPLIER OF 100*RHO
C    REXP=1.0E20
C
C     REXP=1.0E30
C     IF(RK*(1.0-RCU).LT.70.0*RHO) REXP=EXP(RK*(1.0-RCU)/RHO)
C     EXTENT=RK/(RK+RHO)
C     IF(ABS(1.0-RCU).GT.0.05) EXTENT=(1.0-REXP)/(RCU-REXP)
C     EXTENT=AMIN1(EXTENT,EXTMAX)
C     DELTAX=RX(3)*EXTENT
C     DELTAY=0.0
C     GO TO 100
   90 CONTINUE
C
C
C  IRXN = 1  INSTATANEOUS REDUCTION OF PU (IV)
C    THIS MECHANISM IS USED BY ALL REDUCTION REACTIONS WHEN THE
C    CONCENTRATIONS FALL BELOW A THRESHHOLD LEVEL
C
      DELTAX=AMIN1(-RX(3)/STOICX(3,IRXN),-RX(5)/STOICX(5,IRXN))
      DELTAY=0.0
  100 CONTINUE
      DO 105 I=1,6
      XS(J,KZ,I,2)=XS(J,KZ,I,2)+STOICX(I,IRXN)*DELTAX
```

```
      YS(J,KZ,I,2)=YS(J,KZ,I,2)+STOICY(I,IRXN)*DELTAY
      IF(XS(J,KZ,I,2).LE.1.E-20) XS(J,KZ,I,2)=0.0
      IF(YS(J,KZ,I,2).LE.1.E-20) YS(J,KZ,I,2)=0.0
      IF(XS(J,KZ,I,2).NE.0.0) ISOL(I)=1
      IF(YS(J,KZ,I,2).NE.0.0) ISOL(I)=1
      IF(ISOL(I).EQ.1.AND.NSOLU.LT.I) NSOLU=I
  105 CONTINUE
  150 CONTINUE
  300 RETURN
      END

      SUBROUTINE CONVNP
C
C
C  SUBROUTINE CONVRT PRINTS THE FEED STREAM INFORMATION, AND CONVERTS THE
C  CONCENTRATIONS FROM THEIR ORIGINAL FORM TO THE MOLAL UNITS WHICH ARE
C  USED IN THE CALCULATIONS.
C
      COMMON/CONTRL/ NTOST,NSOLU,CTBP,NEWIN,NEWOUT,SPH,IPNCH,IFAST,IRXN,
     . DTHETA,IVOLM,IVOLS,IPRO,TEMPI,ISOL(6),NSTR,ISTR,JSTR,CODUM(100),
     . IPROCE
      COMMON/CONCS/ X(6,100,2),Y(6,100,2),XS(100,3,6,2),YS(100,3,6,2)
      COMMON/MOLALC/ AQ(6),OR(6),TEMP,CONVA,CONVO,TCONC
      COMMON/STREAM/ XFD(6,100),YFD(6,100),AFDRT(100),OFDRT(100),
     .  AFDTEM(100),OFDTEM(100),ALVRT(100),OLVRT(100)
      COMMON/TEMPS/ TPROF(100,2),ATS(100,3,2),OTS(100,3,2)
C
C
C  IF NEW INPUT STREAMS HAVE BEEN GIVEN (NEWIN = 1), THIS SECTION PRINTS
C  AND CONVERTS THEM.
C
      IF(NEWIN.EQ.0) GO TO 20
      WRITE (6,1100)
      WRITE (25,1100)
      WRITE (6,1101)
      WRITE (25,1101)
      DO 10  J=1,NTOST
      IF(AFDRT(J)+OFDRT(J).EQ.0.0) GO TO 7
      IF(AFDRT(J).NE.0.) WRITE (6,1000)J,(XFD(I,J),I=1,6),AFDRT(J),
     . AFDTEM(J)
      IF(AFDRT(J).NE.0.) WRITE (25,1000)J,(XFD(I,J),I=1,6),AFDRT(J),
     . AFDTEM(J)
      IF(OFDRT(J).NE.0.) WRITE (6,1001)CTBP,J,(YFD(I,J),I=1,6),
     . OFDRT(J),OFDTEM(J)
      IF(OFDRT(J).NE.0.) WRITE (25,1001)CTBP,J,(YFD(I,J),I=1,6),
     . OFDRT(J),OFDTEM(J)
C
C
C  CONVERSION TO MOLAR UNITS.
C
C
      XFD(2,J)=XFD(2,J)/237.
```

```
      YFD(2,J)=YFD(2,J)/237.
      XFD(3,J)=XFD(3,J)/238.
      YFD(3,J)=YFD(3,J)/238.
      XFD(4,J)=XFD(4,J)/238.
      YFD(4,J)=YFD(4,J)/238.
      DO 5 I=1,6
      AQ(I)=XFD(I,J)
      OR(I)=YFD(I,J)
    5 CONTINUE
      TEMP=OFDTEM(J)
C
C
C SUBROUTINE MOLAL CALCULATES THE MOLAR TO MOLAL CONVERSION FACTORS.
C
      CALL MOLALN
      AFDRT(J)=AFDRT(J)/CONVA
      OFDRT(J)=OFDRT(J)/CONVO
      DO 8 I=1,NSOLU
      XFD(I,J)=XFD(I,J)*CONVA
      YFD(I,J)=YFD(I,J)*CONVO
    8 CONTINUE
    7 CONTINUE
   10 CONTINUE
C
C
C IF AN INITIAL PROFILE HAS BEEN GIVEN (IPRO = 1), THIS SECTION
C CONVERTS THE CONCENTRATIONS AND INITIALIZES THE SETTLERS.
C
   20 IF(IPRO.EQ.0) GO TO 40
      DO 30 J=1,NTOST
      X(2,J,2)=X(2,J,2)/237.
      Y(2,J,2)=Y(2,J,2)/237.
      X(3,J,2)=X(3,J,2)/238.
      Y(3,J,2)=Y(3,J,2)/238.
      X(4,J,2)=X(4,J,2)/238.
      Y(4,J,2)=Y(4,J,2)/238.
      DO 22 I=1,NSOLU
      AQ(I)=X(I,J,2)
      OR(I)=Y(I,J,2)
   22 CONTINUE
      TEMP=TPROF(J,2)
      CALL MOLALN
      DO 25 I=1,6
      AQ(I)=AQ(I)*CONVA
      OR(I)=OR(I)*CONVO
      DO 25 L=1,2
      X(I,J,L)=AQ(I)
      Y(I,J,L)=OR(I)
      DO 25 K=1,3
      XS(J,K,I,L)=AQ(I)
      YS(J,K,I,L)=OR(I)
   25 CONTINUE
```

```
  30 CONTINUE
  40 RETURN
 1000 FORMAT(14X,'AQUEOUS ',I3,7(4X,1PE10.3),3X,0PF7.1)
 1001 FORMAT(9X,2PF6.1,' % TBP ',I3,7(4X,1PE10.3),3X,0PF7.1)
 1100 FORMAT('-FEED & PRODUCT      STAGE  NITRIC ACID    NEPTUNIUM
   .PU (IV)     PU (III)     REDUCTANT     NITRATE ION     FLOW RATE
   .    TEMP')
 1101 FORMAT(' STREAM DATA          NO.    (MOL/L)       (G/L)
   . (G/L)        (G/L)         (MOL/L)       (MOL/L)       (L/MIN)
   .    (C)')
    END
    SUBROUTINE MOLALN
C
C
C  SUBROUTINE MOLAL PROVIDES THE CONVERSION FACTORS (CONVA, CONVO) BETWEEN
C  MOLAR AND MOLAL UNITS.  AQ AND OR CONTAIN THE CONCENTRATIONS TO BE
C  CONVERTED.  TCONC SIGNALS THE UNITS OF THE CONCENTRATIONS BEING PASSED.
C           TCONC = -1.0 FOR MOLAR CONCENTRATIONS
C           TCONC =  1.0 FOR MOLAL CONCENTRATIONS
C
    COMMON/CONTRL/ NTOST,NSOLU,CTBP,NEWIN,NEWOUT,SPH,IPNCH,IFAST,IRXN,
   . DTHETA,IVOLM,IVOLS,IPRO,TEMPI,ISOL(6),NSTR,ISTR,JSTR,CODUM(100),
   . IPROCE
    COMMON/MOLALC/ AQ(6),OR(6),TEMP,CONVA,CONVO,TCONC
    CONVA=1.0
    CONVO=1.0

    RETURN
    END

    SUBROUTINE UCORNP
    COMMON/CONTRL/ NTOST,NSOLU,CTBP,NEWIN,NEWOUT,SPH,IPNCH,IFAST,IRXN,
   . DTHETA,IVOLM,IVOLS,IPRO,TEMPI,ISOL(6),NSTR,ISTR,JSTR,CODUM(100),
   . IPROCE
    COMMON/DISTRB/ TEMPC,ARY(6),DTRY(6)

    DOUBLE PRECISION HC,NC,PC,LNHEQ,HEQ,LNNEQ,NEQ,SALT
    DOUBLE PRECISION LNPEQ,PEQ,DENTBP,TC,A,B,C
    DOUBLE PRECISION FREETBP,NO,FREETBP1

C   HC IS THE HNO3 CONC., M
C   NC IS THE NP(VI) CONC., M
C   PC IS THE PU(IV) CONC., M
C   SALT IS THE INEXTRACTABLE NITRATE ION CONC., M
C   NO IS THE CONC. OF THE NITRATE ION AT EQUILIBRIUM, M

    HC=ARY(1)
    NC=ARY(2)
    PC=ARY(3)
    SALT=ARY(6)

    NO=HC+2.0*NC+4.0*PC+SALT
```

```
      IF (NO.LE.0.1) NO=.1
      IF (HC.LE.0.1) HC=.1
      IF (TEMPC.LE.18.0) TEMPC=18.0

C   LNHEQ IS THE LN OF THE HNO3 EQUILIBRIUM CONSTATN
C   HEQ IS THE HNO3 EQUILIBRIUM CONSTANT

      LNHEQ=72.19487-.2238327/NO-4.210904*NO-1512.604/TEMPC
     .-1.595973*TEMPC+.05232612*TEMPC/NO-.8077916*NO/TEMPC
     .+.215524*TEMPC*NO+.0162929/NO**2-3.961013*NO**2
     .+11363.88/TEMPC**2+.01242452*TEMPC**2+.05957543*NO**2*TEMPC
     .-.002623366*NO*TEMPC**2-.003938755*TEMPC/NO**2
     .+.00006520745*TEMPC**2/NO**2+423.7596*NO/TEMPC**2
     .-743.8411*NO**2/TEMPC**2-.0008556247*TEMPC**2/NO
     .+94.28416*NO**2/TEMPC-.0002340483*NO**2*TEMPC**2

      HEQ=EXP(LNHEQ)

C   LNNEQ IS THE LN OF THE NP(VI) EQUILIBRIUM CONSTANT
C   NEQ IS THE NP(VI) EQUILIBRIUM CONSTAN

      LNNEQ=-29.86232-7.800776/NO+13.53559*NO-84.56807/TEMPC
     .+.7924156*TEMPC+.4818631*TEMPC/NO+26.08377*NO/TEMPC
     .-.274043*TEMPC*NO-.001932932/NO**2+.2480607*NO**2
     .+10265.63/TEMPC**2-.006301722*TEMPC**2-.0320547*NO**2*TEMPC
     .+.001043368*NO*TEMPC**2+.03413454*TEMPC/NO**2
     .-.001742249*TEMPC**2/NO**2-4457.717*NO/TEMPC**2
     .+561.0553*NO**2/TEMPC**2-.003864386*TEMPC**2/NO
     .-21.10663*NO**2/TEMPC+.0006263125*NO**2*TEMPC**2

      NEQ=EXP(LNNEQ)

C   LNPEQ IS THE LN OF THE PU(IV) EQUILIBRIUM CONSTANT
C   PEQ IS THE PU(IV) EQUILIBRIUM CONSTANT

      LNPEQ=-33.51877-16.76609/NO-22.38786*NO-105.5576/TEMPC
     .+1.250248*TEMPC+.79444*TEMPC/NO+1620.61*NO/TEMPC
     .-.548046*TEMPC*NO+3.885108/NO**2-5.131427*NO**2
     .+11095.54/TEMPC**2-.01980451*TEMPC**2+.3592142*NO**2*TEMPC
     .+.01346773*NO*TEMPC**2-.1615469*TEMPC/NO**2
     .-.0000236749*TEMPC**2/NO**2-23017.89*NO/TEMPC**2
     .+3774.782*NO**2/TEMPC**2-.001810966*TEMPC**2/NO
     .-175.859*NO**2/TEMPC-.004664264*NO**2*TEMPC**2

      PEQ=EXP(LNPEQ)

C   DENTBP IS THE DENSITY OF TBP AS A FUNCTION OF TEMP.
C   TC IS THE INITIAL MOLAR CONC. OF TBP
C   FREETBP AND FREETBP1 IS THE UNCOMPLEXED FREE TBP

      DENTBP=.992486-7.6489E-4*TEMPC-1.05E-6*TEMPC**2
      TC=1000*DENTBP*CTBP/266.32
```

```
      A=2*PEQ*PC*NO**4+2*NEQ*NC*NO**2
      B=1+HEQ*HC*NO
      C=-TC

      FREETBP=-C/B
      IF (A.GT.0.0) FREETBP=(-B+SQRT(B**2-4*A*C))/(2*A)
      FREETBP1=-C/B

C     DTRY(1) IS THE DISTRIBUTION COEFFICIENT OF HNO3
C     DTRY(2) IS THE DISTRIBUTION COEFFICIENT OF NP(VI)
C     DTRY(3) IS THE DISTRIBUTION COEFFICIENT OF PU(IV)

      DTRY(1)=HEQ*NO*FREETBP
      DTRY(2)=NEQ*NO**2*FREETBP**2
      DTRY(3)=PEQ*NO**4*FREETBP**2



      DO  I=4,6
       DTRY(I)=0.0
      END DO
      RETURN
      END
```

VITA

Donald Lee Marsh was born on January 24, 1974 in San Angelo, Texas. He graduated from Halls High School in Knoxville, Tennessee. After graduating in May of 1992, he entered the University of Tennessee, Knoxville. In August of 1996, he received his Bachelor of Science degree in Nuclear Engineering. Upon receiving his degree, he entered the Masters Degree program in Nuclear Engineering at the University of Tennessee where he will graduate in May of 1998.