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ISPO TASK F.9
DEVELOPMENT AND APPLICATION OF
ISOTOPE CORRELATION TECHNIQUES

ISOTOPIC SAFEGUARDS DATA BANK (ISTLIB) AND
CONTROL PROGRAM (MISTY)

SEPTEMBER 1978

USA
IAEA

**PROGRAM FOR
TECHNICAL ASSISTANCE
TO IAEA SAFEGUARDS**

Department of Energy
Safeguards & Security

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PACIFIC NORTHWEST LABORATORY

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AND CONTROL PROGRAM (MISTY)

C. L. Timmerman

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SUMMARY

As part of the U.S. program to provide technical assistance to the International Atomic Energy Agency (IAEA), the Pacific Northwest Laboratory (PNL) has developed a computer code and data bank to aid in the safeguards verification of spent fuel content at the head end of a reprocessing facility. A description and user instructions that uses isotopic safeguards techniques are presented for MISTY, a computer program for analyzing an isotopic data base (ISTLIB). The input, operating procedures, and output from MISTY are explained in detail. An output listing of an example computer run is provided to illustrate the program's operation. The contents of the data bank are summarized, and show the isotopic data sets that are available.

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ISOTOPIC SAFEGUARDS DATA BANK (ISTLIB) AND CONTROL PROGRAM (MISTY)

INTRODUCTION

Work in heavy element isotopic safeguards techniques is being carried out at Pacific Northwest Laboratory (PNL) to provide technical assistance to the International Atomic Energy Agency (IAEA). Isotopic concentration data are first collected and stored in the data bank ISTLIB, and then analyzed with the computer program MISTY. This report describes the data bank and program used in PNL's isotopic safeguards studies.

The data bank is organized by reactor data set, data type, and reactor type. These three groups constitute the key words by which the data can be retrieved. A single or combination of key words can be used to retrieve any specific data set or group of data sets. A listing of the data deck name, reactor, reactor type, location, data classification (measured, calculated, etc.) and stored data units is provided in Appendix A.

This report will describe the data collection and storage procedures first. Creation of a random access data base from the actual data bank follows the data bank description. The procedures to initiate data analysis are then presented with a discussion of the specified input to the program. The equations used to form isotopic variables and the isotopic ratios obtained when the isotopic functions are formed are discussed in detail. The next section discusses the program output. Sample data deck, program input, and program output are provided along with summary tables of input parameter variables to help the reader understand the use of the control program MISTY. The final section discusses additional program information that may prove useful to the user.

DATA COLLECTION AND STORAGE

Various sources are used to accumulate necessary information for storage in the data bank. These sources include reprocessing plant reports, utility reports, computer burnup codes, personal communications, and public

literature. The data represent reprocessing measurements of isotopic nuclear material quantities at input to the plant, remeasurements of reprocessing input samples, measurements from small sample burnup experiments, and calculated data from burnup codes. A listing of these data types and the entire isotopic safeguards data base is provided in Table 1. The quantities of uranium and plutonium and their isotopic data are collected from these sources. The data is then processed for the data bank, keypunched onto cards, and stored into ISTLIB on magnetic tape or disk. A sample data deck listing of data set YNR002 from the Yankee Rowe reactor is given in Figure 1. The card images in Figure 1 illustrate the data set that will be used as the example throughout this report.

The information stored in the data bank can be retrieved via any combination of the following three key words:

- key word 1 - specific data set name (e.g., YNR002)
- key word 2 - data classification (e.g., MEAS)
- key word 3 - reactor type (e.g., PWR)

The key words, along with reactor name, location, and the data units, are listed in Appendix A for each data set.

The first key word or the data set deck name can be separated into two parts — the alphabetic portion and the numeric portion. The alphabetic portion is an abbreviation of the reactor name (e.g., YNRO for Yankee Rowe, DRE1 for Dresden 1), while the numeric portion or the last two digits indicates which data deck for that particular reactor is desired for retrieval (i.e., 01 indicates the first data set, 02 the second etc). Using our example, YNR002 will retrieve the second set of Yankee Rowe reactor data.

The second key word on the data classification defines whether the data were measured (MEAS) at a reprocessing plant, remeasured (REMD) at an independent laboratory, measured as a small sample in a burnup (BURN) experiment, calculated (CALC) using various burnup codes, or calculated using Combustion Engineering's ISOCHECK⁽¹⁾ (ISOC) burnup code. The capitalized acronyms in parentheses are the actual key words for retrieving the various data-type classifications.

TABLE 1. Data Base for Isotopic
Safeguards Techniques

Reactors	Number of Input Batches Measured	Number of Input Batches Remeasured	Number of Burnup Samples	Number of Sets Calculated Data
I. Pressurized Water				
1. Connecticut Yankee				1
2. Diablo Canyon				1
3. Fort Calhoun				1
4. Indian Point 1	20	20		1
5. Point Beach 1				1
6. San Onofre 1			6	3
7. Saxton			67	1
8. Sena	27	29		
9. Trino	30	48	23	3
10. Yver			5	
11. Yankee Rowe	89	82	35	5
12. H. B. Robinson 2			3	
13. Reference PWR				4
Total	166	179	137	20
II. Graphite Moderated				
1. Calder Hall				1
2. Chapel Cross			24	
3. NPR	11			1
4. Windscale AGR	10			1
Total	21		24	3
III. Boiling Water				
1. Big Rock Point 1	23			3
2. Browns Ferry 1				2
3. Dodewaard	13	6	13	
4. Dresden 1	62	18		3
5. Garigliano	31		18	
6. Humboldt Bay	20	20		3
7. KRB	15	29		1
8. LaCross				1
9. NineMile Point 1				1
10. Oyster Creek 1				1
11. Vak	3	4	10	1
12. JPDR-1			24	
Total	167	77	71	16
IV. Heavy Water				
1. NPD (Candu)	9	9	6	1
2. Douglas Point	3	6		1
3. Gentilly 1			24	1
4. Pickering 1				1
Total	12	15	30	4
V. Fast Reactor				
1. EBR-11			18	
Total 33 Reactors	366	271	280	43 sets

```

*DECK YNROO2 REMD PWR
REMEASURED SET YANKEE ROWE (PWR 185MW) NBS CORES 5+6 015 US P
32 POINTS ENRICHMENT 2.902,.,.101,4.935 SS-CLAD 11/28/73
$INPUT
IQUAL(1)=6,6,30*0,
NGM=0, MB=32, MIN=3, IN(1)=1,2,18,
DI(1,1)=2*.019, 15*.02, 15*.016,
DI(1,2)=2*2.9020, 15*4.101, 15*4.935,
DI(1,3)=2*.013, 15*.032, 15*.056,
DI(1,4)=2*97.0656, 15*95.847, 15*94.993,
DI(1,6)=32*100.,
DI(1,10)=32*1.,
IDENT(1)=12302, 12302, 25616, 21418, 19722, 19912, 19004, 19004, 17008,
17008, 15810, 17014, 15806, 15906, 13920, 9701, 9701,
25713, 26521, 25315, 25105, 25105, 23111, 23107, 23107, 21719, 22009,
22317, 20124, 18603, 19603, 11226,
ICOR41=1,
T:MPRO(1)= 2*3.241,1.775,12*3.241,2*4.364,15*1.775,
ELE(1,1)= .0199, .02,
.0165, .0175, .0177, .0182, .0184, .0182, .0188, .0186, .0188,
.0188, .0186, .0188, .0193, 2*.0206,
.0123, .0122, .0128, .0126, .0125, .0132, .013,
.0129, .0126, .0126, .0132, .0129, .0136, .0135, .0131,
ELE(1,2)= 2*1.8735,
2.0405, 2.2608, 2.4643, 2.4733, 2.5068, 2.5059, 2.6373, 2.6343,
2.6363, 2.6511, 2.6639, 2.6669, 2.7944, 3.1777, 3.1797,
2.7895, 2.831, 2.827, 2.829, 2.829, 2.9555,
2.9762, 2.9762, 2.992, 3.0059, 3.0088, 3.0879, 3.1709, 3.1719,
3.0532,
ELE(1,3)= .2107, .2199,
.4456, .4013, .3583, .3601, .3585, .3582, .3328, .3321, .3283,
.3309, .3243, .3253, .2999, .2213, .222,
.5052, .4958, .496, .4968, .4968, .4611, .4669,
.4664, .4623, .4609, .4609, .4436, .425, .4523, .4445,
ELE(1,4)= 2*97.887,
97.4974, 97.3203, 97.1597, 97.1485, 97.1163, 97.1178, 97.0111,
97.015, 97.0166, 96.9992, 96.9932, 96.9891, 96.8855, 96.5804, 96.5777,
96.693, 96.6611, 96.6642, 96.6617, 96.6618,
96.5703, 96.5439, 96.5445, 96.5331, 96.5207, 96.5171,
96.4557, 96.3906, 96.3623, 96.4792,
ELE(1,5)= 2*.315,
1.233, .919, .678, .678, 2*.662, 2*.544, 2*.539, 2*.523, .44,
2*.209, 1.069, 1.042, 1.028, 1.033, 1.033, .867, 2*.877, .85,
.853, .854, .789, 2*.717, .79,
.888, .916, .945, .938, .905, 1.053, 1.101, 1.142, 1.17, 1.283,
1.371, 1.447, .456, .431,
ELE(1,6)= 2*77.41,
69.458, 72.848, 75.28, 75.333, 2*75.87, 2*77.716, 77.702, 77.879,
2*78.216, 79.83, 2*85.324,
72.71, 73.016, 73.109, 73.066, 73.066, 75.027, 74.847,
74.847, 75.236, 75.225, 75.221, 76.123, 77.085,
77.085, 76.038,
ELE(1,7)= 2*14.861,
16.366, 15.46, 14.543, 14.537, 2*14.278, 2*13.48, 13.478, 13.433,
2*13.257, 12.576, 2*10.279,
14.826, 14.761, 14.706, 14.733, 14.733, 13.944,
2*14.05, 13.867, 13.871, 13.881, 13.56, 2*13.196, 13.621,
ELE(1,8)= 2*6.4689,
10.666, 9.021, 8.156, 8.11, 7.932, 7.932, 2*7.237, 7.239, 7.151,
2*7.037, 6.361, 2*3.864,
9.727, 9.557, 9.554, 2*9.56, 8.832, 8.878, 8.878,
2*8.749, 8.745, 8.345, 2*7.941, 8.35,
ELE(1,9)= 2*.945,
2.276, 1.751, 2*1.343, 2*1.258, 2*1.022, 1.041, .999, 2*.967,
.793, .324, .324,
1.668, 1.624, 1.604, 1.609, 1.609, 1.33, 1.348, 1.348,
1.298, 1.302, 1.299, 1.182, 2*1.06, 1.191,
ELE(1,10)=2*467800.,
1053376., 1045784., 531435., 1059897., 1081296., 1081296.,
1054889., 1054889., 1065294., 1065114., 1056390., 1056390., 1047457.,
2*533370.,
789749., 799544., 797490., 787352., 787352., 788115.,
789877., 789877., 796311., 793613., 792471., 536060.,
796337., 796337., 536060.,
ELE(1,11)=2*2787.,
11712., 10242., 4710., 9261., 9338., 9338., 2*8420., 8448.,
8446., 2*8199., 7441., 2*2650.,
8672., 8419., 8341., 2*8220., 7752., 7762., 7762.,
7767., 7697., 7672., 4875., 6842., 6842., 4875.,

```

FIGURE 1. Sample Listing of Data Deck YNROO2 for the Yankee Rowe Reactor

The third key word tells what reactor type the data set represents. The data bank presently contains four types of reactors: Pressurized Water Reactors (PWR), Boiling Water Reactors (BWR), Heavy Water Reactors (HWR), and Graphite Moderator Reactors (GMR). Again the capitalized acronyms in parentheses are the actual key words that classify the data sets by reactor type.

The appropriate key words are assigned to the *DECK card that begins and identifies each data set. The sequence of this card is: *DECK, space, 6-character reactor data set name, space, 4-character data classification, space, and a 3-character reactor-type classification, which is illustrated in the top line of Figure 1. After the *DECK card, the input for each data set deck consists of two free-field case description cards followed by an input namelist, i.e., \$ INPUT . . . \$. This data base is organized into a random access data base by the program RANDOM. RANDOM must run to create a random access data base from ISTLIB for MISTY to use. The RANDOM program will be explained after the data storage in ISTLIB is described.

The number of batches or data points per deck is input through the parameter MB, with each batch or data point corresponding to an identification number in the array IDENT. These IDENT numbers have a special combined significance in that the two right-most digits indicate the batch or sample identification number, while the remaining digits give the exposure of that sample in 100 MWD/MT (e.g., IDENT number 12302 indicates sample number 2 with an exposure of 12300 MWD/MT). For each batch, the basic measured or calculated data are the four isotopic compositions of uranium (^{234}U , ^{235}U , ^{236}U , and ^{238}U) and the five of plutonium (^{238}Pu , ^{239}Pu , ^{240}Pu , ^{241}Pu , and ^{242}Pu) plus the totals (in grams or atoms) of the uranium and plutonium. Values for the isotopes and the totals are input for both initial and exposure (irradiated or final) concentrations. The input units of these numbers can be received in weight percent, grams, atoms per barn-centimeter, atoms per initial metal atom, kilograms, pounds, atoms per cubic centimeter, grams per cubic centimeter, weight ratio, atomic ratio, atomic percent, or atoms. The units are flagged by the parameter NGM as shown in Table 2.

TABLE 2. Coding of the Data Units

<u>NGM Value</u>	<u>Unit</u>
0	weight percent
1	grams
2	atoms/barn-cm
3	atoms/IMA
4	kilograms
5	pounds
6	atoms/cc
7	grams/cc
8	weight ratio
9	atomic ratio
10	atomic percent
11	atoms

The 11 isotopic and total values, which are used individually or in combination to form the isotopic variable values, are stored in the array ELE for the irradiated batch or sample data. The initial uranium and plutonium isotopics, along with their respective elemental totals, are contained in the DI array for each data point.

If the ^{241}Pu isotope needs to be decay corrected, the ICOR41 flag is set to calculate the correction back to reactor discharge, given the correction cooling times through the input TIMPRO array. Another available deck input option is flagging to ignore a particular batch, through the array SKIP, because of questions or inconsistencies with that batch. The IQUAL array is a quality or property index used to label the questionable data points. The coding and properties illustrated by this index are listed in Table 3. The parameter NIN gives the number of distinct sets of initial enrichment data for each set, and the array IN supplies the index of the batch starting the distinct set of initial values. A listing of all the aforementioned parameter variables and arrays, along with a brief description and their maximum and preset or default values, is given in Table 4.

TABLE 3. Quality Index Listing

Coding	Property Displayed
0	Normal data point
1	Exposure averaging
2	Enrichment averaging
3	Exposure and enrichment averaging
4	Fringe effects
5	Exposure averaging and fringe effects
6	Cladding differences
7	Unirradiated assembly
8	Uranium outlier
9	Plutonium outlier

TABLE 4. Deck Input Parameters

Name (Dimensions)	Description	Preset
IDENT (100)	Batch or data point identification number	--
ELE (100,11)	Irradiated batch data in the order: ^{235}U , ^{238}U , ^{235}U , ^{238}U , ^{239}Pu , ^{240}Pu , ^{241}Pu , ^{242}Pu , Total U and Total Pu.(a)	--
DI (100,11)	Initial values corresponding to the above irradiated data	DI (1,10) = 100% (initial total uranium)
NB	Number of batches in each deck (100 maximum)	--
NSM	Units flag for isotopic data.(b)	--
ICOR41	Flag for ^{241}Pu decay correction: 0 is no correction and 1 is decay corrected	0
TIMPRO (100)	Cooling times for ^{241}Pu decay in years	0
SKIP (100)	Flag for ignoring a particular batch: 1.0 is ignore and 0 is keep	0
NIN	Number of distinct sets of initial data	--
IN (50)	Indices of batches having distinct sets of values for initial data	--
IQUAL (100)	Quality index for various properties displayed by each data point.(c)	0

(a) Isotopic data units indicated in Table 2. Total values are grams or atoms.

(b) See Table 2 for unit coding and values.

(c) See Table 3 for the coding index and property displayed.

RANDOM ACCESS DATA BASE

The random access data base is created from ISTLIB with the program RANDOM. The specific input to this program is the namelist data base ISTLIB and the variable DCOUNT, which represents the number of data sets in the data bank. In the case of ISTLIB, this number (DCOUNT) is currently equal to 94, which is input with an I4 format (right-justified). At present the maximum upper limit is set at 100, but this value will increase as more data is accumulated and added to the data base. Tape unit 11 is used for reading ISTLIB, while tape unit 16 is used to create the random access isotopic data base RANBASE. The procedure for creating this random access data base (RANBASE) is illustrated in Figure 2.

```
'RUN MRAND,BCA605/TIMMERMAN,IST,10 .  
'IDENT . CRAIG TIMMERMAN/942-4658 SIGMA 3 BNW  
'PASSWD CLT  
'ASG,A RANBASE.,F40  
'USE 16.,RANBASE.  
'ASG,A ISTLIB.  
'USE 11.,ISTLIB.  
'ASG,A RANDOM.  
'XQT FANDOM,RANDOM  
  94  
'FIN
```

FIGURE 2. Procedure for Creating a Random Access
Data Base

RANDOM reads DCOUNT and checks whether it is within the limit (currently 100) of data sets RANDOM can handle. The program then calculates the amount of space required for the random access data base directory. This directory space size is reserved beginning with the second record on the file, while record one is used as a pointer to the first nondirectory record on the file. The various data sets are written to the random file immediately after the directory space. When all data sets have been placed on the random file, the directory (consisting of absolute starting record location, reactor data set name, measurement type, and reactor type for each data set) is written to the directory space.

The output from RANDOM provides a printed list of associated access key words, data set titles, and the absolute location of data within the data base. Following this listing, the directory including the location, data deck name, measurement type, and reactor type for all the data sets is printed. The random data base creation run is terminated at this point.

DATA ANALYSIS

The section on data analysis will describe the input parameters to the program, the procedures for proper program operation, and an example output obtained from a sample run as illustrated in Appendix B.

Input

The control program (MISTY) calculates and plots isotopic variables that depend on the chemical isotopic compositions of batches, samples, or calculated data points of irradiated fuel elements. These variables are selectively paired to form linear isotopic functions for study using isotopic safeguards techniques.

Certain parameters must be input to initiate desired computer runs for each data set or case. The parameters are illustrated in Figure 3 and tabulated in Table 5. These parameters define the desired isotopic variables and functions, and which options, such as plotting or statistical analysis, are to be used.

Isotopic Variables

The first operation during an actual computer run is the transfer from storage of the final and initial data input arrays (ELE and DI) for use in an array, $D_{mk\lambda}$, where m (1-100) is the batch data point index; k (1-11) is the index denoting the isotope (or element); and λ (1-2) is the index for the exposure status. Using the $D_{mk\lambda}$ array and applying numerical shifts and exponential powers, the isotopic variables, or Q values, can be calculated. The general formula for these variables may be written:

```

'RUN MISTY,BCA605/TIMMERMAN,IST,14 .
'IDENT. CRAIG TIMMERMAN/942-4658 SIGMA 3 BNW
'PASSWD CLT
'ASG,A MISTY.,F40
'ASG,A RANBASE.,F40
'USE 16.,RANBASE.
'ASG,A CALCOMP*LIB.
'TP,W PLOT*LI300./18
'XQT MISTY.MISTY
$INPUT
  II=10, MPLT=6, MPLOT(1)=2,1, 4,3, 2,5, 6,3, 7,8, 10,9,
  ISTAT=1, NCOMP=2, ICOMP(1)=1,2, 1,0, ISUM=2,
  IPLT1=-3, ISYM(1)=9,9,5, IUVST=1, IDFPT=3, DIST(1)=8.,6.5,
  DEL(4)=1., DEL(7)=1.,
  EN(3,1)=1.,
  EN(2,2)=1.,
  EN(10,3)=1.,1.,
  EN(2,4)=1.,
  EN(6,5)=2.2,
  EN(6,6)=1., AN(5,6)=100.,
  EN(2,7)=1., EN(6,7)=2.,
  EN(6,8)=1., AN(5,8)=100., ED(6,8)=-1.,
  EN(7,9)=1.,1.,
  EN(2,10)=1., EN(9,10)=1.,
$END
7
YNR002
YNR001 MEAS PWR
TRI001 ISOC
      CALC BWR
      REMD
      HWR
      BURN GMR
U-236
U-235
PU/U
D-235
(PU-239)**2.2
(100-PU-239)
DEL(U-235*PU-239**2)
PU-239*(100-PU-239)
PU-240*PU-241
U-235*PU-242
'TPSAV 18
'FIN

```

FIGURE 3. Sample Procedure for Making a Case Run

TABLE 5. Case Input Parameters

Name (Dimensions)	Description	Preset
II	Number of isotopic variables or Q values to be calculated (15 maximum)	--
MPLT	Number of isotopic functions formed	0
MPLT (50)	Pairs of Q indices to form the isotopic functions; Order: x_1, y_1, x_2, y_2 , etc.	--
IPLT1	Number of cases in a run to be plotted. If negative, cases are superimposed, (150 maximum, -25 minimum)	0
DIST (2)	Axis dimensions in inches (x,y)	8,6.5
IGRID	Flag to specify plot paper: 0 for grid paper and 1 for blank paper	0
ISYM (150)	Graphical plotting symbol identification	-1
IUVST	Flag for calling plot of mean T value vs. enrichment: 0 for no plot and 1 gives plot	
ISTAT	Flag for calling statistical package: 0 no call and 1 calls statistics	0
ISUM	Suppresses statistical output into a summary: ≤ 0 gives all output without summary, 1 gives just summary, >1 gives all output plus summary	0
NCOMP	Number of comparison data sets for statistical package (50 maximum)	--
ICOMP (100)	Pairs of comparison or non-comparison data sets analyzed by the statistical package	--
ILINE (150)	Flag for which type of line is plotted: -1 plots just the symbol for each data point, 0 draws just the line between data points, +1 plots the symbol and the line connecting each data point	-1

TABLE 5. Case Input Parameters (con'd)

Name (Dimensions)	Description	Preset
IDFPT	Flag for obtaining a plot of the paired comparison percent differences versus: 1 the first Q value, 2 the second Q value, or 3 the cooling time	0
IDATA	Flag for obtaining a convenient listing of the data in the data bank (no isotopic variables or functions are formed)	0
IMA	Flag for designating the working units to be in atoms/initial metal atom (This flag is not fully functional because of necessary data lacked in the data bank.)	0
DEL (15)	Flag for making Q values relative to initial values: 1.0 is relative and 0 is direct	0
Q Constants:		
CN (15)	Coefficients of the numerator of the Q values	1
AN (11,15)	Numeric subtraction in the numerator of the Q value	0
EN (11,15)	Exponent of the numerator of the Q value	0
CO (15)	Analogous constants in the denominator of the Q values	1
AD (11,15)		0
EO (11,15)		0
T Constants:		
FN (25)	Coefficient of irradiated Q value in the numerator of the T value	1
GN (25)	Coefficient of initial Q value in the numerator of the T value	-1
HN (101, 25)	Numerical addition in the numerator of the T value	0
FO (25)	Analogous constants in the denominator of the T value	1
GD (25)		-1
HD (101, 25)		0

$$Q_{mi\ell} = \frac{CN_i \times \prod_{k=1}^{11} (D_{mk\ell} - AN_{ki})^{EN_{ki}}}{CD_i \times \prod_{k=1}^{11} (D_{mk\ell} - AD_{ki})^{ED_{ki}}}$$

where i (1-15) is the Q value or isotopic variable index; AN_{ki} and AD_{ki} are numerical shifts applied to the basic input data values in the numerator and denominator, respectively; EN_{ki} and ED_{ki} are real exponents applicable to the shifted data values in the numerator and denominator, respectively; and CN_i and CD_i are coefficients that can be multiplied to the numerator and denominator, respectively. These parameters are further summarized in Table 5, and the use of the parameters to form Q values is illustrated in Figure 3. Using the input parameter values shown in the middle of Figure 3, the isotopic variables listed at the bottom of Figure 3 are obtained. For example, the first value [$EN(3,1) = 1.$] yields the variable ^{236}U , and the eighth value [$EN(6,8) = 1.$, $AN(6,8) = 100.$, $ED(6,8) = -1.$] produces the $^{239}\text{Pu} \times (100 - ^{239}\text{Pu})$ variable.

Isotopic Functions and Plotting

The number of isotopic variables to be calculated is input through II. These variables can be paired (≤ 25 pairs) to form isotopic functions that can be graphically plotted if desired. MPLT gives the number of isotopic functions that may be plotted. Each graph is assigned a pair of Q values desired for the x and y axes using the Q value indices in combinations of two, specified through the MPLOT array. This plotting of one Q value versus another Q value forms a relationship or isotopic function between the two isotopic variables.

The actual plotting of the functions is an option that is described below, but it is always necessary to input MPLT and the MPLOT array for each case run in order to form the isotopic functions. Normally, these Q values are calculated and plotted directly. However, the irradiated values for each

can be replaced by values relative to the initial values. This option is accomplished by setting the DEL indices that correspond to the Q value indices to 1.0. The point to remember is that only the Q values, whether direct or delta relations (final-initial), are plotted.

The number of cases or data sets in a run to be plotted is indicated by IPLT1, with the option of having each data set plotted separately or all data sets plotted on one graph per isotopic function. IPLT1 is set positive for a separate plotting of each data set and function and is set negative for plotting multiple data sets on each functional graph. The negative setting should be used to limit the number of graphs, and to make it convenient to compare various data sets.

With the use of the ISYM array, each reactor in every plotted case is given a specific graphical plotting symbol for identification. A listing of the CALCOMP plotting symbols, numeric calling code (ISYM value), and the reactor(s) assigned to each symbol is provided in Table 6. The axis dimensions of the plot are specified (in inches) by the array DIST, and a request for grid plot paper is automatically made by the default value of the flag variable IGRID. The ILINE array can be used to specify the type of plot obtained. It is recommended that the default value of -1 be used all the time. This value will give a plot of just the symbols associated with each data set, and these plotted symbols will illustrate each data point. As an option, the user may input 0 or +1 for the array values. The 0 option draws a line between each successive data point with no symbols being plotted. The +1 option plots a symbol at each data point and draws a line between successive points. However, as stated before, the preset or default value is recommended because the lines would clutter the graphs and also because a least squares fitted line is available to be drawn through the data points. This graphical regression line will be explained later.

Isotopic Ratios

For each pair of Q variables specified by MPLOT, the following isotopic functional ratios or T values are calculated:

TABLE 6. Plotting Symbol Designations

CODE	SYMBOL	REACTOR	CODE	SYMBOL	REACTOR(S)
0		DRESDEN I	16		HB ROBINSON 2
1		GARIGLIANO	17		REFERENCE PWR
2		HUMBOLDT BAY	18		NPR
3		SENA	19		POINT BEACH
4		CHAPEL CROSS	20		DIABLO CANYON
5		TRINO	21		GENTILLY I
6		INDIAN POINT I	22		NINE MILE POINT OYSTER CREEK
7		CONNECTICUT YANKEE	23		NOVO VORONEZH I
8		SAN ONOFRE	24		JPDR I
9		YANKEE ROWE	25		KRB
10		DODEWAARD	26		FORT CALHOUN
11		NPD (CANDU)	27		SAXTON
12		CALDER HALL	28		BROWN'S FERRY
13		VAK	29		BIG ROCK POINT
14		DOUGLAS POINT	30		LA CROSSE
15		WINDSCALE	31		PICKERING I

$$T_{mp} = \frac{FN_p \times Y_{mp1} + GN_p \times Y_{mp2} + HN_{mp}}{FD_p \times X_{mp1} + GD_p \times X_{mp2} + HD_{mp}}$$

where p (1-25) is the plot or isotopic ratio index and m is again the batch or data point index; X_{mp1} and X_{mp2} are the irradiated and initial ordinate Q values, respectively; Y_{mp1} and Y_{mp2} are the irradiated and initial abscissa Q values, respectively; and FN_p , FD_p , GN_p , GD_p , HN_{mp} , and HD_{mp} are optional input constants (described in Table 5) that specify or adjust the particular ratios desired. The preset values of these constants will always yield a ratio that is equal to the slope of the line connecting the irradiated and initial Q values.

A plot of the mean T values or ratios versus the initial ^{235}U enrichment is available. The flag variable IUVEST specifies whether this plotting option is called or not.

Statistical Package

The statistical package can perform paired comparison statistics on duplicate sample measurements, regression analysis statistics using Deming's⁽²⁾ method for linear fitting with errors in both the x and y variables, outlier detection of anomalous data, and accuracy levels of each function. The statistical features are called using the flag variable ISTAT.

Additional input parameters needed for the statistical portion of the program include ISUM, NCOMP, and ICOMP. ISUM is used to suppress the majority of the statistical output and provide just the summary version of the information. NCOMP gives the number of data sets to be compared and/or have regression techniques applied to the data while the actual pairs of data sets are input through the ICOMP array. If two nonzero numbers are paired in ICOMP, both the difference and regression portions of the statistical package are utilized to provide information on the matched data points between the two specified data sets. These matched points that are found internally by the program must simply have the same IDENT number and the same initial enrichment to qualify as a paired comparison data point. If one of the paired numbers in the ICOMP array is zero, only the regression portion is applied to all the data points in the particular data set specified by the nonzero, paired number.

If the user makes an error in setting up the ICOMP array, two potential error messages could be generated by the program. One message states that no pairable data points could be found, while the other message indicates that only two or less paired data points were found. In either case, no paired comparison statistics will be performed.

A paired comparison difference statistics plotting option is also available. This plots the percent differences between Q values for duplicate sample measurements for each isotopic variable as a function of either data point (Q value) or cooling time. The flag variable for obtaining these plots is IDFPT. When IDFPT = 1, the percent differences are plotted against the first paired data set point; when IDFPT = 2, the percent differences are plotted against the second paired data set point; when IDFPT = 3, the plot is of the percent differences of each isotopic variable against the cooling time.

Other Options

Other available input options are IDATA and IMA. IDATA provides just the printout of the isotopic and total elemental data along with the quality index table for each of the data sets requested in that run. This feature can be used to obtain a convenient listing of the data in the data bank.

The IMA option at present is relatively useless. This option is designed to provide conversion to a second set of working units, namely atoms per initial metal atom (atoms/IMA). The working units used now are weight percent for the isotopes and grams for the total uranium and plutonium. To convert to the atoms/IMA units, either the initial metal atoms or an accurate exposure or burnup level must be provided. Because most data sets do not contain either of these values, the IMA conversion option will remain ineffective until these values are supplied for all data sets.

Table 5 provides a convenient listing of all of the above input parameters, a summary description, and any preset or default values.

Procedures for Using the Control Program

The system operating procedures for making a run on the Univac 1100/44 are illustrated in the top nine lines of Figure 3. Specifically, these procedures are as follows:

- access to the computing system
- assign or attach files MISTY and RANBASE
- use of tape 16 in substitution for RANBASE
- assign CALCOMP plotting package and associated storage tape (unit 18) for plotting runs
- execute the program file MISTY.

To input any or all of the previously described variables, the user must use another INPUT namelist read in by MISTY. This namelist must start with \$INPUT and end with a \$END. The input variables (described in the previous section) are placed between the dollar signs in any desired order with each entry followed by a comma. An example of this procedure has been illustrated in Figure 3.

The retrieval method used to call any number of data sets is also shown in Figure 3. After the \$END card, the next card indicates the number of cards that follow giving the various data set retrieval methods. The number on this card has an I3 format with the number being right justified (i.e., if a single-digit number is specified, the number must appear in column 3). The specified cards that follow provide the various methods by which the data sets can be retrieved through the three key words, namely data deck name (column 1 - 6), data measurement classification (column 8 - 11), and reactor type (column 13 - 15).

The retrieval system always detects the most stringent combination of these key words for obtaining the data set(s) from the random access data bank. This "most stringent" effect of key word combinations means that if all three key words were provided, only the single data deck would be retrieved; if the second and third key words are given, all data sets with the given data classification and reactor type would be retrieved; etc. Illustrative examples of this data retrieval system, excerpted from Figure 3, are provided in Table 7, along with an explanation of which data sets will be retrieved. The program also checks to make sure a data set is only retrieved and run once, therefore eliminating duplicate input of the same data set. It should be noted that using the second and/or third key words for retrieval is only a convenient way of requesting separate evaluations of each data set retrieved by these key words.

The remaining portion of Figure 3 illustrates the input of the titles of the isotopic variables to be created in this case run. These titles are listed directly after the data retrieval input as illustrated. The format associated with these variable titles is a 70-character Hollerith coding. The titles can begin anywhere in the 70-character field, excluding column 1. It is best to start the titles in Column 2 for left justification of the titles because the statistical routines shorten the titles to the first 30 characters to form a function title of one variable versus another (e.g., $^{235}\text{U} \times ^{242}\text{Pu}$ versus $^{240}\text{Pu} \times ^{241}\text{Pu}$).

The plotting routine is one of the most useful of the available options. The plots are done by attaching a CALCOMP plotting package, which transfers the appropriate information to magnetic tape (unit 18), which in turn can be visually displayed by a plotter-printer. A review of the graphic displays includes plots of one isotopic variable versus another, plots of the enrichment versus mean T values of each isotopic function, and plots of the percent differences between paired comparison isotopic variables versus either of the variables or the cooling time for each isotopic variable.

TABLE 7. Data Retrieval Examples

<u>Key Words</u>	<u>Data Retrieved</u>
YNR002	data set YNR002 - a remeasured data set for the Yankee Rowe Reactor
YNR001 MEAS PWR	data set YNR001 - a measured Yankee Rowe data set (last two key words ignored in this case)
TRI001 ISOC	data set TRI001 - measured data set for the Trino reactor (second key word ignored)
CALC BWR	all the calculated, boiling water reactor data sets
REMD	all the remeasured data sets
HWR	all the heavy water reactor data sets
BURN GMR	all the burnup, graphite moderator reactor data sets

The statistical package, developed by Kirk Stewart, is the other major available option. The statistics can be applied to compared sets of data (i.e., measured and remeasured samples from the same reprocessed batch) to determine the significance of the differences and therefore detect outliers in the data. These statistical procedures are performed for all the matched points of two compared data sets regardless of initial enrichment and then for the same points grouped by enrichment. The individual values (rather than a calculated average) from each of the two matched samples are used in a regression analysis of the paired comparison points grouped by enrichment to arrive at a more meaningful least squares fit of the comparison data. Or the regression analysis statistics may be applied directly to an individual data set to acquire a line fitting to each enrichment group of that particular data. More discussion and explanation of the statistics are supplied in the section describing the program's output.

The plotting sequence and the statistical subroutines are called by setting the plot and statistical variables (discussed previously) to their appropriate values, as indicated in Figure 3. Other options have been described which will be illustrated and discussed further in the next section.

Output

A listing of a sample output is given in Appendix B. The listing is for reference while following the general discussion of the printed output in the text. The sample, a compiled version of the data deck YNR002, is a remeasured data set from the Yankee Rowe Reactor. The data in this set was measured by the National Bureau of Standards (NBS). A measured data set, YNR001, measured by Nuclear Fuel Services (NFS), is also used to illustrate the statistical output of paired comparison data points, corresponding regression statistics, automatic outlier detection, and available plotting options.

The output is best described in this order:

1. A two-line case description is given, which provides the type of data set, reactor name, enrichment facts, number of points or batches, and the date and source from which the data set was recorded.

2. A table of Hollerith characters describes the identification of the various Q values or isotopic variables used.
3. Tables of the raw, input isotopic and chemical data for the irradiated and initial points are printed only when the input data need to be transformed to the program's working unit of weight percent or when some of the samples are ignored. Any samples ignored are marked with an asterisk after the identification number. (In the sample output illustrated the data units are already in weight percent and no samples are to be ignored; therefore, this portion of the output does not appear for this example.)
4. Tables of the basic data for the irradiated and initial samples, with the isotopic data expressed in weight percent and the total elemental data expressed in grams, are then given. (Enrichment groups are designated and separated by a space between each grouping throughout the output tables.)
5. Similar tables provide the composition in weight percent and grams of the irradiated and initial values of the overall superbatches (ID #999999).
6. A table of the isotopic plutonium composition, time-corrected for the β -decay of ^{241}Pu to the date immediately after reactor discharge, is printed only if the cooling time correction is actually made.
7. A table of the quality index and the associated property displayed for each data point is provided for each data set. This property index may provide some explanation the data points' measurement qualities.
8. Tables of Q values for irradiated and initial samples are calculated and printed for each isotopic variable illustrated in number 2 above. (These are the actual values that are plotted graphically.)
9. A table of T values, or isotopic ratios, is printed for each isotopic variable pairing. For each grouping (with two or more values) representing a given initial enrichment, a mean T value plus the standard deviation and the percent standard deviation are calculated for each isotopic function.

10. A table of initial ^{235}U enrichment and the corresponding mean isotopic ratios or T values, grouped by each data set, is printed as a summary after all of the above output is printed for each data set compiled. If there is more than one enrichment and T value for a particular data set the slope and intercept is calculated for that data grouping by the least squares method. (Graphical plot(s) of this table may also be obtained by setting IUVT = 1).
11. Much of the remainder of the output illustrates the statistical output that can be obtained by setting ISTAT = 1 and NCOMP and ICOMP equal to the designated values shown in Figure 3. The sample statistical output displays the paired comparison and regression statistics of the matched samples between the example remeasured data set (YNR002) and a corresponding measured data set (YNR001). Also illustrated is the regression statistics of the example data set (YNR002) as an individual data set.

The first three pages (B-10 through B-12) provide statistics of all paired comparisons from all enrichment groups for the two compared data sets listed in the heading (for this example, the two Yankee Rowe data sets). Each of the first two pages corresponds to the data of the isotopic variable listed in the heading, in this case, ^{236}U on the first page (B-10) and ^{235}U on the second page (B-11). The third page contains (B-12) similar statistics for the calculated ratio of the above two isotopic variables ($^{236}\text{U}/^{235}\text{U}$ in this example). Next the paired comparisons are grouped by enrichment, and the above statistical approach is redone and printed for each enrichment group. The line-fitting or regression analysis statistics of the matched comparison points of each enrichment group are printed following the paired comparison output for each enrichment group.

Two least squares, line-fitting methods utilizing Deming's approach are illustrated: one using the slope/intercept model, $y = \beta x + \delta$, and the other applying the initial point model, $y - y_0 = \beta(x - x_0)$. The summary tables of the paired comparison and the regression analyses follow the completion of all enrichment groups for each data set and each isotopic

function. These tables allow a quick glance summary of all the statistical output on a data set and isotopic function basis. By setting ISUM=1, these summary tables will be the only statistical output that is printed. To obtain only the detailed statistical output, set ISUM<0; to obtain both the detailed and summary output, set ISUM>2.

An example of the regression analysis and summary table as applied to a single data set (YNR002) is included to illustrate the statistical output obtainable from a single data set. This illustrates that the regression techniques are applicable to any single data set as well as to the individual values of any two compared data sets as shown earlier. These comparison or single data set points must be separated into enrichment groups in order to receive a good least squares fitting of these points. This grouping by initial enrichment is necessary for good linear fits because all isotopic functions are dependent on the starting enrichment quantity. Each of these enrichment groups must have more than two points to gain any meaningful regression statistics or, therefore to have the regression techniques performed on that group. In other words, if an enrichment grouping has two or less samples, no line-fitting methods are developed or performed on that group; and the program will generate an error message to the user for that enrichment group.

A further attempt will be made to explain the meaning of parts of the statistical output. Many formulas, algorithms, and statistical usage definitions are provided in Reference 3. The paired comparison output provides statistics important to the differences between duplicate samples. In reference to the output, variable 1 lists values of the first or top data set listed in the title while variable 2 shows the second data set values. Differences between variable 1 and 2 are indicated in the difference column, with the differences divided by their standard deviation listed in the next column. A paired comparison residual is the difference minus the average difference for each duplicate sample. These residuals are normalized by dividing by the residual standard deviation. The normalized residual is the

quantity used to indicate outlier batch samples. These outliers are determined by forming a normalized residual t value and performing a simple t test⁽⁴⁾ with this value. If a sample is determined to be an outlier, its batch ident number is listed below the appropriate comparison printout. The remainder of the paired comparison printout provides the t values, the random, bias, and process variances and corresponding percent standard deviations for the entire set of illustrated data comparisons.

The regression statistics for each enrichment group provides an estimation of various line-fitting parameters for both the intercept model and the initial point model. For paired comparison data, all data points are listed for both sets with a repeat of the IDENT numbers - the first half corresponds to data in the first data set given in the title and the second half of the data corresponds to the second data set given in the title. In the case of a single data set regression analysis, all the data are from the single data set shown in the title.

The function (y versus x) and enrichment group are also illustrated in the title for each printout of a regression grouping. A list of the x and y values along with the predicted x and y values and the corresponding x and y residuals for each of the two regression models is provided. The predicted values are those values determined from the fit of each of the models, while the residuals are the differences between the actual and predicted x and y values. The averages and weighted averages (weighed according to total uranium content) are provided below the individual data values. The remainder of the regression output supplies estimates of common linear fitted parameters such as the slope, intercept, x and y variances, percent standard deviations, and correlation coefficient. As stated previously, most of these statistical terms are well documented in Reference 3.

The outlier decision criterion for the regression analysis is similar to that of the paired comparison in that it uses the residuals in the form of a t test. For a single data set the outliers are solely determined from the regression analysis. In the case of the regression

analysis of paired data, outliers in the regression portion are only identified if they have already been detected as an outlier from the paired comparison analysis. The outlier detection is performed in this manner for paired data because the paired comparison analysis is generally more reliable for detecting outliers, but the regression analysis is used for depicting exactly which paired data point is the outlier. In this way the paired comparison and the regression analysis work in support of each other in the detection of outliers. Another major reason for determining outliers in the manner described above is that only those data points that are definitely outliers will be detected. Once an outlier(s) is detected its batch ident number is printed, that point(s) is eliminated, and the regression analysis is rerun with that point(s) excluded. This procedure is followed until the program is satisfied that no more outliers exist.

12. The remainder of the output displays the graphical plots that are optionally available on request. A plot of each of the isotopic functions (one isotopic variable versus another), is illustrated by Figure B.1 in Appendix B, is obtained by setting IPLT1 equal (either negative or positive) to the number of data sets to be plotted. The data sets are plotted according to the sequence in which they were input to and run by the program. By setting IPLT1 equal to a negative number, all the data are superposed on one graph per function. If IPLT1 is positive, one graph for each data set and each function is obtained. It is recommended to use the negative setting to reduce the plotted output and because the superposing of data sets allows an easy comparison of various data sets on the same function. Using the negative setting for IPLT1, a least squares line fitting is drawn through the plotted points for each enrichment group with three or more points. This plotted regression line is obtained from the statistical package. These lines use the initial point model's slope if the exposure range is less than 4000 MWD/MT; the slope of the intercept model is used if the exposure exceeds the 4000 MWD/MT range. The intercept model's line provides a better fit to the actual exposure range, but the 4000 MWD/MT cut-off is used to establish a linear fit

for data points with a limited burnup, which essentially are all clustered at one point.

The second type of graphical output, shown in Figure B.2 in Appendix B, is the plot of the initial ^{235}U enrichment versus the mean T values or isotopic ratios. This plot illustrates the functional relationship that generally exists between the enrichment and the isotopic ratios of the input data sets. The plots are received by setting IUVEST = 1, and one plot will be drawn for each isotopic ratio determined.

The third and final type of plot, illustrated by Figures B.3 and B.4 in Appendix B, is the percent differences between paired comparison data points plotted against either of the paired isotopic variables or as a function of the cooling time. The usefulness of this plot is analogous to a shipper/receiver difference plot. Setting IDFPT = 1 supplies the percent differences plotted against the first data set's isotopic variable; IDFPT = 2 gives the percent differences plotted against the second data set's isotopic variable; and IDFPT = 3 plots the percent differences as a function of the cooling time from reactor discharge. With IDFPT equal to any of the above designated values, a difference plot will be received for each isotopic variable or Q value input to that specific program run, provided paired comparison statistics are performed during that run.

ADDITIONAL PROGRAM INFORMATION

In this section, additional information useful for program modification or conversion is given. After some brief general information, the individual subroutines and their functions are described. This is followed by a description of variables important to the program and subroutines that are contained in common.

General Information

MISTY is written in ASCII Fortran and utilizes a CALCOMP plotting package. All the plotting calls are made from the subroutines, SETUP and BOX; therefore if any CALCOMP package differences arise, the changes can be made in

SETUP or BOX. Subroutine LABEL contains two ENCODE statements, which are used to combine isotopic variable titles or labels into a specified format for printing.

Memory requirements as presently compiled and operated on a Univac 1100/44 are approximately 60,000 words. The following tape units are used within the program:

- 4 - Storing the enrichment and T mean values
- 5 - Read input
- 6 - Printed output
- 7 - Storing data for statistical package
- 10 - Stores paired comparison statistics for statistical summary
- 11 - Stores regression statistics for statistical summary
- 13 - Stores data for % differences plots
- 16 - Used to input data from the random access data base
- 18 - Stores data for CALCOMP plotter printer
- 28 - Storing isotopic variables for plotting
- 29 - Storing regression fittings for plotting.

Subroutines and Their Functions

The functions of all the subroutines are described below in the order in which they occur in the program.

- MISTY - Main program. Initializes some parameters. Redefines variables from random access file. Performs majority of the printout. Calls major subroutines. Stores values for statistical and plotting packages.
- BLOCK DATA - Initializes remaining parameters
- INPUT1 - Reads namelist INPUT. Reads data from desired data sets. Transfers data to MISTY for redefining. Called by MISTY.
- PSEUDO - Division routine that sets the resultant quotient equal to zero if division by zero occurs. Called from many points in the program.
- CONDAT - Unit conversion routine that converts raw data units to working units of weight percent for the isotopics and grams for the totals. Called from MISTY.

QCALC	- Calculates the isotopic variables or Q values. Called from MISTY.
SUMCAL	- Forms the product of all the numerical shifts and exponential calculations for the numerator and denominator of each isotopic variable. Called from QCALC.
TCALC	- Calculates the isotopic ratios or T values for each data point. Called from MISTY.
SETUP	- Plotting subroutine. Plots desired isotopic functions, enrichment versus T mean values, and percent differences versus isotopic variables or cooling time. Calls CALCOMP routines: PLOTS, SYMBOL, PLOT, AXIS, and LINE. Called from MISTY.
SHUTLE	- Scales axes for each set of plotted data. Called from SETUP.
UPP	- Dimensions isotopic variable title for printing axis label. Called from SETUP.
LABEL	- Combines two isotopic variable titles to form a function title or forms title of the y-axis of difference plot. Called from SETUP and STATO.
BOX	- Draws a box around the plots. Called from SETUP.
EXPNT	- Calculates optimum non-integer exponent of y isotopic variable using a least squares fit. Called from MISTY.
LSTSQ	- Provides a least squares fitting to the input arrays. Called from MISTY and EXPNT.
STATO	- Statistical routine. Reads statistical input from tape 7. Compares and finds paired data points. Calls paired comparison and regression analysis routines. Called from MISTY.
DIFF0	- Paired comparison statistical analysis routine. Called from STATO.
LINE0	- Statistical regression analysis or linear line-fitting by Deming's method for the intercept and initial point models. Also calculates line to be drawn through the plotted points. Called from STATO.

Contents of Common

Blank common is used to transfer variables not contained in other specific common blocks from INPUT1 to the main program MISTY. These arrays and data banks are:

DATIN	- An array with the contents of the first element of arrays and each individual variable value from the data bank.
DAT2IN	- An array containing contents of the remaining elements of array variables from the data bank.
TITLE	- An array containing the two-line title header for each data set being analyzed.
IMB	- An array storing the starting location of each random access data set.
SKIP	- A data bank array for ignoring specified data points.
IN	- A data bank array with the indices of batches starting a distinct enrichment group.
AUP	- An array containing the atomic weights of the four uranium and five plutonium isotopes.
HEAD	- An array for printing the appropriate units heading in the program.
UNITS	- A data array for storing the various data units from a data statement.
HED	- A two-dimensional labeling array for specifying a blank for irradiated data and the symbol (INIT) for initial data.
HC	- A two-dimensional labeling array for specifying either uranium (U) or plutonium (Pu).
DEL	- An input array for requesting the delta (final - initial) version of the Q values or isotopic variables.
SUM	- An array used to sum the isotopic and elemental content in weight percent and grams for all the data points in each requested data set. This array forms the superbatches.
AV	- An array that stores the average T value of the isotopic ratio determined for each enrichment grouping of T values.
SD	- An array containing the standard deviation of each enrichment grouping of T values.
PC	- An array containing the percent standard deviation of each T value enrichment group.
SUMT	- An array for calculating the total of each T value enrichment group that is used to determine the average or mean T value.

SSQT	- An array for calculating the variance of each T value enrichment group, which in turn provides the standard deviation of each T value group.
SNAM	- An array containing the labels mean, st dev (standard deviation), and pc sd (percent standard deviation) for labeling the above quantities for each T value enrichment group.
ENRICH	- An array storing the ^{235}U enrichment values for the table and plot of enrichment versus T mean values.
TMEAN	- An array storing the mean T values for the table and plot of enrichment versus mean T values.
SLOPE	- An array for calculating a least squares fitting of the enrichment versus each data set's mean T values.
CEPT	- An array for calculating the intercept corresponding to the above fitted slope for each data set's enrichment versus T mean grouping.
UINT	- An array for storing the initial ^{235}U enrichment of each data point from any requested data set.
ICOMP	- An input array for specifying which data sets are to have a statistical analysis performed on them.
EXPT	- An array for calculating a noninteger exponential fitting of the y variable of an isotopic function.
TVAL	- An array used to one dimensionalize the TMEAN array for calculation of a least squares fitting of the enrichment and T mean values.
IDATA	- An input flag variable used to obtain a convenient listing of the contents of specific or all data sets as specified by the user.
ISTAT	- An input flag variable used to call the statistics package when set equal to one.
IMA	- An input flag variable used to specify working data units of atoms per initial metal atom. (Not fully operable as yet because of lack of appropriate data.)
NCOMP	- An input variable used to specify the number of paired numbers in the ICOMP array.

Common block BLKCON contains the variable and arrays important in the calculation of the Q values or isotopic variables (see formula, p. 9) and the T values or isotopic ratios (see formula, p 16). These parameters are:

- CN - An input array for supplying a numerical coefficient to the numerator in the calculation of the Q values.
- CD - An input array for supplying a numerical coefficient to the denominator in the Q value calculation.
- AN - An input array for applying a numerical shift to any or each isotope in the numerator of a Q value calculation.
- AD - An input array for applying a numerical shift to any or each isotope in the denominator of a Q value calculation.
- EN - An input array for applying a real exponent to each shifted isotopic quantity in the numerator of a Q value calculation.
- ED - An input array applying a real exponent to each shifted isotopic quantity in the denominator of a Q value calculation.
- RELQ - An internal alphabetic array corresponding to the input DEL array for determining whether a Q value is to be formed solely from the irradiated data or to form a relative or delta Q value using the irradiated minus the initial data. This array actually stores the labels for indicating which Q value is formed - a blank for the irradiated Q values or the word "DELTA" for the relative Q values.
- RELATIV - A data variable storing the word "DELTA" for use when forming the relative or delta Q values.
- FN - An input array containing the coefficients of the irradiated Q value in the numerator of the T value.
- FD - An input array containing the coefficients of the irradiated Q value in the denominator of the T value.
- GN - An input array containing the coefficients of the initial Q value in the numerator of the T value.
- GD - An input array containing the coefficients of the initial Q value in the denominator of the T value.

- HN - An input array for specifying a numerical addition in the numerator of the T value.
- HD - An input array for specifying a numerical addition in the denominator of the T value.

The common block BLKPLT contains the variables and arrays used in the plotting of isotopic functions. These various parameters are:

- AR - A one dimensional array allowing the isotopic variables label to be printed on the plotting axes.
- TITL - An array containing the labels of all the isotopic variables as specified at input.
- DIST - An input array specifying the lengths of the x and y plotting axes in inches.
- IPLT1 - An input variable specifying the number of data sets desired to be plotted.
- MPLT - An input variable specifying the number of isotopic functions or pairs of isotopic variables to be formed and possibly plotted.
- MPLT - The input array specifying the pairs (x and y) of isotopic variables used to form the isotopic functions.

The next common block is UPLTT which is used to transfer variables used in the plotting of the initial ^{235}U enrichment versus the mean T values. These three parameters are:

- IUVST - The input variable for flagging if a plot of the enrichment versus the mean T values is to be made. This variable is set equal to 1 if a plot is desired.
- NCASE - The number of cases or data sets requested for each computer run.
- III - An array containing the number of enrichment groups and corresponding T mean values for each data set.

Common block STATUS contains variables used in the statistics calculations. These variables are:

- VARX - An estimate of the variance of the x isotopic variable.
- VARY - An estimate of the variance of the y isotopic variable.

VREST	- The variance estimate of each isotopic variable as calculated in subroutine DIFF0.
TT	- The 97.5% critical t value for N-1 degrees of freedom. ⁽⁴⁾
TL	- The 97.5% critical t value for N-2 degrees of freedom. ⁽⁴⁾
ISUM	- An input flag variable for obtaining a summary listing of the statistical output.
XMAX	- Maximum x coordinate for drawing a regression line through a set of plotted data points grouped by enrichment.
YMAX	- Maximum y coordinate for drawing a regression line through a set of plotted data points grouped by enrichment.
MARK	- An index array used in the detection and marking of outlier data points.
XINT	- The initial or minimum x coordinate for drawing a regression line through a set of plotted data points grouped by enrichment.
YINT	- The initial or minimum y coordinate for drawing a regression line through a set of plotted data points grouped by enrichment.
UT	- An array containing the irradiated total uranium values used to obtain a weighted average of variables in the statistical subroutine.

The next common block, BLKCAL, contains the important calculational and identification arrays. The parameters in BLKCAL are:

D	- The array storing the raw and converted data of the irradiated and initial values of the uranium and plutonium isotopics and elemental totals for each sample and the total or superbatches.
Q	- The array storing the calculated irradiated and initial isotopic variables (Q values) for each sample and the superbatches.
T	- The array storing the calculated isotopic ratios (T values) for each sample and the superbatches.
MB1	- The number of samples or data points in a data set plus one to encompass the superbatches or overall total.
II	- An input variable indicating the number of isotopic variables to be calculated.
IDENT	- A data bank array supplying the identification and burnup (if given) of each sample in a data set.

- SIGN - An internal alphabetic array corresponding to the numeric SKIP array used to mark samples to be ignored with an asterik.
- AST - A data variable containing asterik symbols (*).
- BLA - A data variable containing blank spaces.
- TIMPRO - A data bank array providing the cooling time for each sample, so the data can be decay corrected back to reactor discharge.
- IQUAL - A data bank array containing the quality or property index (see Table 3) displayed by each data point.

The last common block is SYMBL, which stores and transfers symbolic and other plotting variables. These SYMBL variables are:

- ISYM - An input array storing the plotting symbol indices specified for each reactor data set (see Table 6).
- ILINE - An input array specifying whether only data point symbols are to be plotted, only lines connecting consecutive points will be drawn, or both symbols and connecting lines will be plotted.
- IGRID - An input variable requesting the plots to be plotted on grid or blank paper.
- IPLLOT - An internal flag variable used to call the statistical sub-routines to obtain a linear fit of points in an enrichment group. This linear fit is then drawn over the previously plotted point symbols to illustrate a regression fitting of that group of points.
- NPC - An internal variable for recording the total number of paired comparison analyses so the correct number of difference plots can be made if desired.
- IDFPT - An input variable used to flag if the difference plots are to be made or not.

REFERENCES

1. M. F. Valerino and Z. R. Rosztoczy, Feasibility of Developing Simple Computational Procedures for Checking Heavy-Isotope Content in Operating Fuel Elements. CEND-541, Combustion Engineering Inc., October 31, 1965.
2. W. E. Deming, Statistical Adjustment of Data. Wiley, New York, 1943.
3. C. L. Timmerman and K. B. Stewart, "Isotopic Safeguards Statistics." presented at the Symposium on the Isotopic Correlation and Its Application to the Nuclear Fuel Cycle, Stresa, Italy, May 9-11, 1978.
4. J. L. Jaech, Statistical Methods in Nuclear Materials Control. TID-26298, USAEC, 1973.

APPENDIX A

SUMMARY LISTING OF DATA DECKS

This listing provides a summary of the data decks currently in ISTLIB or the isotopic safeguards data base. Included in the listing are the data deck name, reactor name, reactor type, reactor location by country, data classification (measured, calculated, etc.) and the data units (grams, weight percent, etc.) of each data set in the data bank.

Data Tape Deck Name	Reactor (type)	Location	Date Type	Raw Isotopic Data Units
BRP001	Big Rock Point (BWR)	United States	CALCULATED	Grams
BRP002	Big Rock Point (BWR)	United States	CALCULATED	Grams
BRP003	Big Rock Point (BWR)	United States	*ISOCHECK	Grams
BRP004	Big Rock Point (BWR)	United States	MEASURED	Wt%
BRP005	Big Rock Point (BWR)	United States	CALCULATED	Wt%
BRF101	Browns Ferry 1 (BWR)	United States	CALCULATED	Grams
BRF102	Browns Ferry 1 (BWR)	United States	CALCULATED	Atoms/b-cm
DOD001	Dodewaard (BWR)	Netherland	**BURNUP	Atoms/IMA
DOD002	Dodewaard (BWR)	Netherland	BURNUP	Wt%
DOD003	Dodewaard (BWR)	Netherland	MEASURED	Wt%
DOD004	Dodewaard (BWR)	Netherland	REMEASURED	Wt%
DRE101	Dresden 1 (BWR)	United States	MEASURED	Wt%
DRE102	Dresden 1 (BWR)	United States	REMEASURED	Wt%
DRE103	Dresden 1 (BWR)	United States	CALCULATED	Grams
DRE104	Dresden 1 (BWR)	United States	CALCULATED	Grams
DRE105	Dresden 1 (BWR)	United States	ISOCHECK	Grams
DRE106	Dresden 1 (BWR)	United States	ISOCHECK	Grams
DUM001	(Dummy Data - used to scale plots)			
GAR001	Garigliano (BWR)	Italy	MEASURED	Wt%
GAR002	Garigliano (BWR)	Italy	BURNUP	Atoms/IMA
HMB001	Humboldt Bay (BWR)	United States	MEASURED	Wt%
HMB002	Humboldt Bay (BWR)	United States	REMEASURED	Wt%
HMB003	Humboldt Bay (BWR)	United States	CALCULATED	Grams
***HMB004	Humboldt Bay (BWR)	United States	CALCULATED	Grams
HMB005	Humboldt Bay (BWR)	United States	ISOCHECK	Grams
JPD101	JPDR 1 (BWR)	Japan	BURNUP	Wt%
KRB001	KRB (BWR)	West Germany	CALCULATED	Grams
KRB002	KRB (BWR)	West Germany	MEASURED	Wt%
KRB003	KRB (BWR)	West Germany	REMEASURED	Wt%
KRB004	KRB (BWR)	West Germany	REMEASURED	Grams
LAC001	LaCrosse (BWR)	United States	ISOCHECK	Grams
NMP001	Nine Mile Point (BWR)	United States	ISOCHECK	Grams
OYC001	Oyster Creek (BWR)	United States	ISOCHECK	Grams

*ISOCHECK is also calculated data by a combustion engineering code.

**BURNUP means burnup data taken from a small post irradiation sample.

***These data sets cannot be released at the utility's request.

Data Tape Deck Name	Reactor (type)	Location	Data Type	Raw Isotopic Data Units
VAK001	VAK (BWR)	West Germany	MEASURED	Grams
VAK002	VAK (BWR)	West Germany	REMEASURED	Grams
VAK003	VAK (BWR)	West Germany	CALCULATED	Wt%
VAK004	VAK (BWR)	West Germany	BURNUP	Wt%
CNY001	Connecticut Yankee (PWR)	United States	ISOCHECK	Grams
DBC001	Diablo Canyon (PWR)	United States	CALCULATED	Grams
FTC001	Fort Calhoun (PWR)	United States	CALCULATED	Grams
HBR201	H B Robinson 2 (PWR)	United States	BURNUP	Wt%
INP001	Indian Point 1 (PWR)	United States	MEASURED	Wt%
INP002	Indian Point 1 (PWR)	United States	REMEASURED	Wt%
INP003	Indian Point 1 (PWR)	United States	ISOCHECK	Grams
PTB001	Point Beach (PWR)	United States	CALCULATED	Grams
PWR001	Reference PWR		CALCULATED	Grams
PWR002	Reference PWR		CALCULATED	Grams
PWR003	Reference PWR		CALCULATED	Grams
PWR004	Reference PWR		CALCULATED	Grams
SN0001	San Onofre 1 (PWR)	United States	ISOCHECK	Grams
SN0002	San Onofre 1 (PWR)	United States	CALCULATED	Grams
SN0003	San Onofre 1 (PWR)	United States	CALCULATED	Grams
SN0004	San Onofre 1 (PWR)	United States	BURNUP	Wt%
SAX001	Saxton (PWR)	United States	BURNUP	Atoms/b-cm
SAX002	Saxton (PWR)	United States	BURNUP	Wt%
SAX003	Saxton (PWR)	United States	BURNUP	Wt%
SAX004	Saxton (PWR)	United States	BURNUP	Wt%
SAX005	Saxton (PWR)	United States	ISOCHECK	Grams
SEN001	SENA (PWR)	France	MEASURED	Grams
SEN002	SENA (PWR)	France	REMEASURED	Grams
SEN003	SENA (PWR)	France	MEASURED	Wt%
SEN004	SENA (PWR)	France	REMEASURED	Wt%
TRI001	Trino (PWR)	Italy	MEASURED	Grams
TRI002	Trino (PWR)	Italy	REMEASURED	Grams
TRI003	Trino (PWR)	Italy	CALCULATED	Grams
TRI004	Trino (PWR)	Italy	BURNUP	Wt%
TRI005	Trino (PWR)	Italy	MEASURED	Wt%
TRI006	Trino (PWR)	Italy	CALCULATED	Grams
TRI007	Trino (PWR)	Italy	REMEASURED	Wt%
VVR101	Novo Voronezhi 1 (PWR)	Soviet Union	BURNUP	Wt%

Data Tape Deck Name	Reactor (type)	Location	Data Type	Raw Isotopic Data Units
YNR001	Yankee Rowe (PWR)	United States	MEASURED	Wt%
YNR002	Yankee Rowe (PWR)	United States	REMEASURED	Wt%
YNR003	Yankee Rowe (PWR)	United States	REMEASURED	Wt%
YNR004	Yankee Rowe (PWR)	United States	BURNUP	Wt%
YNR005	Yankee Rowe (PWR)	United States	BURNUP	Atoms/b-cm
YNR006	Yankee Rowe (PWR)	United States	ISOCHECK	Grams
YNR007	Yankee Rowe (PWR)	United States	CALCULATED	Grams
YNR008	Yankee Rowe (PWR)	United States	CALCULATED	Grams
YNR009	Yankee Rowe (PWR)	United States	CALCULATED	Grams
CLH001	Calder Hall (GMR)	United Kingdom	CALCULATED	Wt%
NPR001	Hanford NPR (GMR)	United States	MEASURED	Wt%
NPR002	Hanford NPR (GMR)	United States	CALCULATED	Wt%
CHC001	Chapelcross (GMR)	United Kingdom	BURNUP	Wt%
WIN001	Windscale (GMR)	United Kingdom	MEASURED	Wt%
WIN002	Windscale (GMR)	United Kingdom	CALCULATED	Wt%
NPD001	NPD (HWR)	Canada	MEASURED	Grams
NPD002	NPD (HWR)	Canada	REMEASURED	Wt%
NPD003	NPD (HWR)	Canada	CALCULATED	Grams
NPD004	NPD (HWR)	Canada	BURNUP	Wt%
DPT001	Douglas Point (HWR)	Canada	MEASURED	Grams
DPT002	Douglas Point (HWR)	Canada	REMEASURED	Grams
DPT003	Douglas Point (HWR)	Canada	CALCULATED	Grams
GEN101	Gentilly 1 (HWR)	Canada	CALCULATED	Grams
PIC101	Pickering 1 (HWR)	Canada	CALCULATED	Grams
PIC102	Pickering 1 (HWR)	Canada	BURNUP	Wt%

APPENDIX B

EXAMPLE OUTPUT OBTAINED FROM A SAMPLE COMPUTER RUN

A listing of a sample output is provided for reference to follow the general discussion of the computer output given by the Output section in the text. The sample, a compiled version of the data deck YNR002, is a remeasured data set from the Yankee Rowe Reactor. The data in this set was measured by the National Bureau of Standards (NBS). A data set (YNR001), measured by Nuclear Fuel Services (NFS), is also used to illustrate the statistical output of paired comparison data points, corresponding regression statistics, automatic outlier detection, and available plotting options. The output follows in the order transmitted by the program, with the available plots supplied in Figures B.1-B.4.

REMEASURED SET YANKEE ROWE (PWR 185MW) NBS CORES 5,6 015 US P
 32 POINTS ENRICHMENT 2.902,4,101,4.935 SS-CLAD 11/28/73

CASE 1

INPUT

DESCRIPTION OF QUANTITIES Q(I)

Q(1) IS U-236
 Q(2) IS U-235
 Q(3) IS PU/U
 Q(4) IS DELTA 0-235
 Q(5) IS (PU-239)**2.2
 Q(6) IS (100-PU-239)
 Q(7) IS DELTA DEL(U-235*PU-239**2)
 Q(8) IS PU-239*(100-PU-239)
 Q(9) IS PU-240*PU-241
 Q(10) IS U-235*PU-242

CHEMICAL PLANT MEASUREMENT DATA

CASE 1

IDENT	U-234 WT %	U-235 WT %	U-236 WT %	U-238 WT %	PU-238 WT %	PU-239 WT %	PU-240 WT %	PU-241 WT %	PU-242 WT %	TOTAL U GMS	TOTAL PU GMS
12302	1.9900-002	1.8735+000	2.1970-001	9.7887+001	3.1500-001	7.7410+001	1.4661+001	8.4+89+000	9.4500-001	4.6780+005	2.7870+003
12302	2.0000-002	1.8735+000	2.1990-001	9.7887+001	3.1500-001	7.7410+001	1.4661+001	8.4+89+000	9.4500-001	4.6780+005	2.7870+003
25616	1.6500-002	2.0405+000	4.4560-001	9.7497+001	1.2370+000	6.9458+001	1.6366+001	1.0666+001	2.2760+000	1.0534+006	1.1712+004
21418	1.7500-002	2.2608+000	4.0130-001	9.7320+001	9.1900-001	7.2848+001	1.5460+001	9.0210+000	1.7510+000	1.0457+006	1.0242+004
19722	1.7700-002	2.4643+000	3.5830-001	9.7160+001	8.7800-001	7.5280+001	1.4543+001	8.1560+000	1.3430+000	5.3147+005	4.7100+003
19012	1.8200-002	2.4733+000	3.6010-001	9.7149+001	6.7800-001	7.5333+001	1.4537+001	8.1100+000	1.3430+000	1.0590+006	4.2610+003
19004	1.8400-002	2.5068+000	3.5850-001	9.7116+001	6.6200-001	7.5870+001	1.4278+001	7.9320+000	1.2580+000	1.0817+006	4.3380+003
19004	1.8200-002	2.5059+000	3.5820-001	9.7118+001	6.6200-001	7.5870+001	1.4278+001	7.9320+000	1.2580+000	1.0817+006	4.3380+003
17008	1.8800-002	2.6373+000	3.3280-001	9.7011+001	5.4400-001	7.7716+001	1.3480+001	7.2370+000	1.0220+000	1.0549+006	8.4200+003
17008	1.8600-002	2.6343+000	3.3210-001	9.7015+001	5.4400-001	7.7716+001	1.3480+001	7.2370+000	1.0220+000	1.0549+006	8.4200+003
15810	1.8800-002	2.6363+000	3.2830-001	9.7017+001	5.3900-001	7.7702+001	1.3478+001	7.2390+000	1.0410+000	1.0653+006	8.4480+003
17014	1.8800-002	2.6511+000	3.3090-001	9.6999+001	5.3900-001	7.7879+001	1.3433+001	7.1510+000	9.9900-001	1.0651+006	8.4460+003
15806	1.8600-002	2.6639+000	3.2430-001	9.6993+001	5.2300-001	7.8216+001	1.3257+001	7.0370+000	9.6700-001	1.0564+006	8.1990+003
15806	1.8800-002	2.6669+000	3.2530-001	9.6989+001	5.2300-001	7.8216+001	1.3257+001	7.0370+000	9.6700-001	1.0564+006	8.1990+003
13920	1.9300-002	2.7944+000	2.9990-001	9.6887+001	4.4000-001	7.9830+001	1.2576+001	6.3610+000	7.9300-001	1.0475+006	7.4410+003
9701	2.0600-002	3.1777+000	2.2130-001	9.6480+001	2.0900-001	8.5324+001	1.0279+001	3.8640+000	3.2400-001	5.3337+005	2.6500+003
9701	2.0600-002	3.1797+000	2.2200-001	9.6578+001	2.0900-001	8.5324+001	1.0279+001	3.8640+000	3.2400-001	5.3337+005	2.6500+003
25713	1.2300-002	2.7895+000	5.0520-001	9.6693+001	1.0690+000	7.2710+001	1.4626+001	9.7270+000	1.6680+000	7.8975+005	8.6720+003
26521	1.2200-002	2.8310+000	4.9580-001	9.6661+001	1.0420+000	7.3016+001	1.4761+001	9.5570+000	1.6240+000	7.9954+005	8.4190+003
25315	1.2800-002	2.8270+000	4.9600-001	9.6664+001	1.0240+000	7.3109+001	1.4706+001	9.5540+000	1.6040+000	7.9744+005	8.3410+003
25105	1.2600-002	2.8290+000	4.9680-001	9.6662+001	1.0330+000	7.3066+001	1.4733+001	9.5600+000	1.6090+000	7.8735+005	8.2200+003
25105	1.2500-002	2.8290+000	4.9680-001	9.6662+001	1.0330+000	7.3066+001	1.4733+001	9.5600+000	1.6090+000	7.8735+005	8.2200+003
23111	1.3200-002	2.9555+000	4.6110-001	9.6570+001	8.6700-001	7.5027+001	1.3944+001	8.8320+000	1.3300+000	7.8811+005	7.7520+003
23107	1.3000-002	2.9762+000	4.6690-001	9.6544+001	8.7700-001	7.4847+001	1.4050+001	8.8780+000	1.3480+000	7.8988+005	7.7620+003
23107	1.2900-002	2.9762+000	4.6640-001	9.6545+001	8.7700-001	7.4847+001	1.4050+001	8.8780+000	1.3480+000	7.8988+005	7.7620+003
21719	1.2600-002	2.9920+000	4.6230-001	9.6533+001	8.5000-001	7.5236+001	1.3887+001	8.7490+000	1.2980+000	7.9631+005	7.7670+003
22009	1.2600-002	3.0059+000	4.6090-001	9.6521+001	8.5300-001	7.5225+001	1.3871+001	8.7490+000	1.3020+000	7.9361+005	7.6970+003
22317	1.3200-002	3.0088+000	4.6090-001	9.6517+001	8.5400-001	7.5221+001	1.3881+001	8.7450+000	1.2990+000	7.9247+005	7.6720+003
20124	1.2900-002	3.0879+000	4.4360-001	9.6456+001	7.8900-001	7.6123+001	1.3560+001	8.3450+000	1.1820+000	5.3606+005	4.8750+003
18603	1.3600-002	3.1709+000	4.2500-001	9.6391+001	7.1700-001	7.7085+001	1.3196+001	7.9410+000	1.0600+000	7.9634+005	6.8420+003
18603	1.3500-002	3.1719+000	4.5230-001	9.6382+001	7.1700-001	7.7085+001	1.3196+001	7.9410+000	1.0600+000	7.9634+005	6.8420+003
11226	1.3100-002	3.0632+000	4.4450-001	9.6479+001	7.9000-001	7.6038+001	1.3621+001	8.3600+000	1.1910+000	5.3606+005	4.8750+003

B-3

IDENT	U-234 WT %	U-235 WT %	U-236 WT %	U-238 WT %	PU-238 WT %	PU-239 WT %	PU-240 WT %	PU-241 WT %	PU-242 WT %	TOTAL U GMS	TOTAL PU GMS
12302	1.9000-002	2.9020+000	1.3000-002	9.7066+001	.0000	1.0000+002	.0000	.0000	.0000	1.0000+000	.0000
12302	1.9000-002	2.9020+000	1.3000-002	9.7066+001	.0000	1.0000+002	.0000	.0000	.0000	1.0000+000	.0000
25016	2.0000-002	4.1010+000	3.2000-002	9.5847+001	.0000	1.0000+002	.0000	.0000	.0000	1.0000+000	.0000
21118	2.0000-002	4.1010+000	3.2000-002	9.5847+001	.0000	1.0000+002	.0000	.0000	.0000	1.0000+000	.0000
19722	2.0000-002	4.1010+000	3.2000-002	9.5847+001	.0000	1.0000+002	.0000	.0000	.0000	1.0000+000	.0000
19012	2.0000-002	4.1010+000	3.2000-002	9.5847+001	.0000	1.0000+002	.0000	.0000	.0000	1.0000+000	.0000
19004	2.0000-002	4.1010+000	3.2000-002	9.5847+001	.0000	1.0000+002	.0000	.0000	.0000	1.0000+000	.0000
19004	2.0000-002	4.1010+000	3.2000-002	9.5847+001	.0000	1.0000+002	.0000	.0000	.0000	1.0000+000	.0000
17008	2.0000-002	4.1010+000	3.2000-002	9.5847+001	.0000	1.0000+002	.0000	.0000	.0000	1.0000+000	.0000
17008	2.0000-002	4.1010+000	3.2000-002	9.5847+001	.0000	1.0000+002	.0000	.0000	.0000	1.0000+000	.0000
15810	2.0000-002	4.1010+000	3.2000-002	9.5847+001	.0000	1.0000+002	.0000	.0000	.0000	1.0000+000	.0000
17014	2.0000-002	4.1010+000	3.2000-002	9.5847+001	.0000	1.0000+002	.0000	.0000	.0000	1.0000+000	.0000
15806	2.0000-002	4.1010+000	3.2000-002	9.5847+001	.0000	1.0000+002	.0000	.0000	.0000	1.0000+000	.0000
15806	2.0000-002	4.1010+000	3.2000-002	9.5847+001	.0000	1.0000+002	.0000	.0000	.0000	1.0000+000	.0000
13202	2.0000-002	4.1010+000	3.2000-002	9.5847+001	.0000	1.0000+002	.0000	.0000	.0000	1.0000+000	.0000
9701	2.0000-002	4.1010+000	3.2000-002	9.5847+001	.0000	1.0000+002	.0000	.0000	.0000	1.0000+000	.0000
9701	2.0000-002	4.1010+000	3.2000-002	9.5847+001	.0000	1.0000+002	.0000	.0000	.0000	1.0000+000	.0000
25713	1.6000-002	4.9350+000	5.6000-002	9.4993+001	.0000	1.0000+002	.0000	.0000	.0000	1.0000+000	.0000
25521	1.6000-002	4.9350+000	5.6000-002	9.4993+001	.0000	1.0000+002	.0000	.0000	.0000	1.0000+000	.0000
25315	1.6000-002	4.9350+000	5.6000-002	9.4993+001	.0000	1.0000+002	.0000	.0000	.0000	1.0000+000	.0000
25105	1.6000-002	4.9350+000	5.6000-002	9.4993+001	.0000	1.0000+002	.0000	.0000	.0000	1.0000+000	.0000
25105	1.6000-002	4.9350+000	5.6000-002	9.4993+001	.0000	1.0000+002	.0000	.0000	.0000	1.0000+000	.0000
23111	1.6000-002	4.9350+000	5.6000-002	9.4993+001	.0000	1.0000+002	.0000	.0000	.0000	1.0000+000	.0000
23107	1.6000-002	4.9350+000	5.6000-002	9.4993+001	.0000	1.0000+002	.0000	.0000	.0000	1.0000+000	.0000
23107	1.6000-002	4.9350+000	5.6000-002	9.4993+001	.0000	1.0000+002	.0000	.0000	.0000	1.0000+000	.0000
21719	1.6000-002	4.9350+000	5.6000-002	9.4993+001	.0000	1.0000+002	.0000	.0000	.0000	1.0000+000	.0000

TOTAL ISOTOPIC CONTENT OF ALL SAMPLES

IDENT	U-234 WT %	U-235 WT %	U-236 WT %	U-238 WT %	PU-238 WT %	PU-239 WT %	PU-240 WT %	PU-241 WT %	PU-242 WT %	TOTAL U GMS	TOTAL PU GMS
999999	1.6151-002	2.7210-000	3.9162-001	9.6871-001	7.6601-001	7.5602-001	1.4058-001	8.2725-000	1.3008-000	2.6632-007	2.3477-005
IDENT	U-234 GMS	U-235 GMS	U-236 GMS	U-238 GMS	PU-238 GMS	PU-239 GMS	PU-240 GMS	PU-241 GMS	PU-242 GMS	TOTAL U GMS	TOTAL PU GMS
999999	4.3013-003	7.2468-005	1.0430-005	2.5799-007	1.7983-003	1.7749-005	3.3004-004	1.9421-004	3.0538-003	2.6632-007	2.3477-005

(INIT) TOTAL ISOTOPIC CONTENT OF ALL SAMPLES

IDENT	U-234 WT %	U-235 WT %	U-236 WT %	U-238 WT %	PU-238 WT %	PU-239 WT %	PU-240 WT %	PU-241 WT %	PU-242 WT %	TOTAL U GMS	TOTAL PU GMS
999999	1.8062-002	4.4170-000	4.2062-002	9.5523-001	.0000	1.0000-002	.0000	.0000	.0000	3.2006-001	.0000
IDENT	U-234 GMS	U-235 GMS	U-236 GMS	U-238 GMS	PU-238 GMS	PU-239 GMS	PU-240 GMS	PU-241 GMS	PU-242 GMS	TOTAL U GMS	TOTAL PU GMS
999999	5.7800-003	1.4134-000	1.3460-002	3.0567-001	.0000	.0000	.0000	.0000	.0000	3.2006-001	.0000

DECAY CORRECTED PU COMPOSITIONS (WT%)

IDENT	TIME (YR)	PU-238	PU-239	PU-240	PU-241	PU-242
12302	3.2410-000	3.1162-001	7.6580-001	1.4702-001	7.4719-000	9.3487-001
12302	3.2410-000	3.1162-001	7.6580-001	1.4702-001	7.4719-000	9.3487-001
25616	1.7750-000	1.2215-000	6.8808-001	1.6213-001	1.1502-001	2.2547-000
21418	3.2410-000	9.0531-001	7.1763-001	1.5230-001	1.0376-001	1.7249-000
19722	3.2410-000	6.6886-001	7.4265-001	1.4347-001	9.3944-000	1.3249-000
19012	3.2410-000	6.6891-001	7.4323-001	1.4342-001	9.3421-000	1.3250-000
19004	3.2410-000	6.5332-001	7.4875-001	1.4091-001	9.1397-000	1.2415-000
19004	3.2410-000	6.5332-001	7.4875-001	1.4091-001	9.1397-000	1.2415-000
17008	3.2410-000	5.3748-001	7.6785-001	1.3318-001	8.3485-000	1.0098-000
17008	3.2410-000	5.3748-001	7.6785-001	1.3318-001	8.3485-000	1.0098-000
15810	3.2410-000	5.3254-001	7.6771-001	1.3316-001	8.3508-000	1.0265-000
17014	3.2410-000	5.3262-001	7.6957-001	1.3274-001	8.2505-000	9.8717-001
15806	3.2410-000	5.1690-001	7.7304-001	1.3102-001	8.1205-000	9.5573-001
15806	3.2410-000	5.1690-001	7.7304-001	1.3102-001	8.1205-000	9.5573-001
13920	3.2410-000	4.3536-001	7.8968-001	1.2443-001	7.3486-000	7.8464-001
9701	4.3640-000	2.0714-001	8.4566-001	1.0188-001	4.7180-000	3.2112-001
9701	4.3640-000	2.0714-001	8.4566-001	1.0188-001	4.7180-000	3.2112-001
25713	1.7750-000	1.0599-000	7.2089-001	1.4699-001	1.0498-001	1.6536-000
26521	1.7750-000	1.0533-000	7.2403-001	1.4637-001	1.0318-001	1.6104-000
25315	1.7750-000	1.0194-000	7.2496-001	1.4583-001	1.0313-001	1.5905-000
25165	1.7750-000	1.0243-000	7.2453-001	1.4609-001	1.0319-001	1.5955-000
25165	1.7750-000	1.0243-000	7.2453-001	1.4609-001	1.0319-001	1.5955-000
23111	1.7750-000	8.6027-001	7.4445-001	1.3836-001	9.5395-000	1.3197-000
23107	1.7750-000	8.7016-001	7.4263-001	1.3940-001	9.5888-000	1.3375-000
23107	1.7750-000	8.7016-001	7.4263-001	1.3940-001	9.5888-000	1.3375-000
21719	1.7750-000	8.4347-001	7.4658-001	1.3760-001	9.4505-000	1.2880-000
22009	1.7750-000	8.4644-001	7.4647-001	1.3764-001	9.4505-000	1.2920-000
22317	1.7750-000	8.4744-001	7.4643-001	1.3774-001	9.4443-000	1.2890-000
20124	1.7750-000	7.8321-001	7.5565-001	1.3461-001	9.0174-000	1.1733-000
18603	1.7750-000	7.1199-001	7.6547-001	1.3104-001	8.5838-000	1.0526-000
18603	1.7750-000	7.1199-001	7.6547-001	1.3104-001	8.5838-000	1.0526-000
11226	1.7750-000	7.8419-001	7.5479-001	1.3521-001	9.0334-000	1.1822-000

IDENT	QUALITY FACTOR	PROPERTY INDICATED
12302	6	CLADDING DIFFERENCES
12302	6	CLADDING DIFFERENCES
25616	0	NORMAL DATA POINT
21418	0	NORMAL DATA POINT
19722	0	NORMAL DATA POINT
19012	0	NORMAL DATA POINT
19004	0	NORMAL DATA POINT
19004	0	NORMAL DATA POINT
17008	0	NORMAL DATA POINT
17008	0	NORMAL DATA POINT
15610	0	NORMAL DATA POINT
17014	0	NORMAL DATA POINT
15806	0	NORMAL DATA POINT
15806	0	NORMAL DATA POINT
13720	0	NORMAL DATA POINT
9701	0	NORMAL DATA POINT
9701	0	NORMAL DATA POINT
25713	0	NORMAL DATA POINT
26521	0	NORMAL DATA POINT
25315	0	NORMAL DATA POINT
25105	0	NORMAL DATA POINT
25105	0	NORMAL DATA POINT
23111	0	NORMAL DATA POINT
23107	0	NORMAL DATA POINT
23107	0	NORMAL DATA POINT
21719	0	NORMAL DATA POINT
22009	0	NORMAL DATA POINT
22317	0	NORMAL DATA POINT
20124	0	NORMAL DATA POINT
18603	0	NORMAL DATA POINT
18603	0	NORMAL DATA POINT
11226	0	NORMAL DATA POINT

Q VALUES OR ISOTOPIC VARIABLES (AVAILABLE FOR PLOTS)

CASE 1

IDENT	Q(1)	Q(2)	Q(3)	Q(4)	Q(5)	Q(6)	Q(7)	Q(8)	Q(9)	Q(10)
12302	2.1970-001	1.8735+000	1.6785+002	-1.0285+000	1.3965+004	2.3420+001	-1.8033+004	1.7935+003	1.0985+002	1.7515+000
12302	2.1990-001	1.8735+000	1.6785+002	-1.0285+000	1.3965+004	2.3420+001	-1.8033+004	1.7935+003	1.0985+002	1.7515+000
25616	4.4560-001	2.0405+000	8.9940+001	-2.0605+000	1.1036+004	3.1192+001	-3.1349+004	2.1463+003	1.8648+002	4.6007+000
21418	4.0130-001	2.2608+000	1.0211+002	-1.8402+000	1.2106+004	2.8237+001	-2.9367+004	2.0264+003	1.5802+002	3.8997+000
19722	3.5830-001	2.4643+000	1.1283+002	-1.6367+000	1.3053+004	2.5735+001	-2.7419+004	1.9112+003	1.3478+002	3.2649+000
19012	3.6010-001	2.4733+000	1.1445+002	-1.6277+000	1.3076+004	2.5677+001	-2.7348+004	1.9084+003	1.3398+002	3.2771+000
19004	3.5850-001	2.5068+000	1.1580+002	-1.5942+000	1.3290+004	2.5125+001	-2.6956+004	1.8812+003	1.2879+002	3.1122+000
19004	3.5820-001	2.5059+000	1.1580+002	-1.5951+000	1.3290+004	2.5125+001	-2.6961+004	1.8812+003	1.2879+002	3.1111+000
17008	3.3280-001	2.6373+000	1.2528+002	-1.4637+000	1.4048+004	2.3215+001	-2.5461+004	1.7826+003	1.1119+002	2.6630+000
17008	3.3210-001	2.6343+000	1.2528+002	-1.4667+000	1.4048+004	2.3215+001	-2.5478+004	1.7826+003	1.1119+002	2.6600+000
15810	3.2830-001	2.6363+000	1.2610+002	-1.4647+000	1.4042+004	2.3229+001	-2.5472+004	1.7833+003	1.1120+002	2.7115+000
17014	3.3090-001	2.6511+000	1.2611+002	-1.4499+000	1.4117+004	2.3043+001	-2.5309+004	1.7733+003	1.0952+002	2.6171+000
15806	3.2430-001	2.6639+000	1.2884+002	-1.4371+000	1.4258+004	2.2696+001	-2.5091+004	1.7545+003	1.0640+002	2.5460+000
15806	3.2530-001	2.6669+000	1.2884+002	-1.4341+000	1.4258+004	2.2696+001	-2.5073+004	1.7545+003	1.0640+002	2.5488+000
13920	2.9990-001	2.7944+000	1.4077+002	-1.3066+000	1.4950+004	2.1012+001	-2.3575+004	1.6597+003	9.1442+001	2.1926+000
9701	2.2130-001	3.1777+000	2.0127+002	-9.2330+001	1.7371+004	1.5434+001	-1.8285+004	1.3052+003	4.8066+001	1.0204+000
9701	2.2200-001	3.1797+000	2.0127+002	-9.2130+001	1.7371+004	1.5434+001	-1.8271+004	1.3052+003	4.8066+001	1.0211+000
25713	5.0520-001	2.7895+000	9.1069+001	-2.1455+000	1.2227+004	2.7411+001	-3.4853+004	2.0121+003	1.5431+002	4.6131+000
26521	4.9580-001	2.8310+000	9.4969+001	-2.1040+000	1.2344+004	2.7597+001	-3.4509+004	1.9981+003	1.5100+002	4.5590+000
25315	4.9600-001	2.8270+000	9.5611+001	-2.1080+000	1.2379+004	2.7504+001	-3.4492+004	1.9939+003	1.5039+002	4.4965+000
25105	4.9680-001	2.8290+000	9.5785+001	-2.1060+000	1.2363+004	2.7547+001	-3.4499+004	1.9959+003	1.5076+002	4.5136+000
25105	4.9680-001	2.8290+000	9.5785+001	-2.1060+000	1.2363+004	2.7547+001	-3.4499+004	1.9959+003	1.5076+002	4.5136+000
23111	4.6110-001	2.9555+000	1.0167+002	-1.9795+000	1.3123+004	2.5555+001	-3.2971+004	1.9025+003	1.3199+002	3.9003+000
23107	4.6690-001	2.9762+000	1.0176+002	-1.9588+000	1.3053+004	2.5737+001	-3.2936+004	1.9113+003	1.3367+002	3.9806+000
23107	4.6640-001	2.9762+000	1.0176+002	-1.9588+000	1.3053+004	2.5737+001	-3.2936+004	1.9113+003	1.3367+002	3.9806+000
21719	4.6230-001	2.9920+000	1.0252+002	-1.9430+000	1.3206+004	2.5342+001	-3.2673+004	1.8920+003	1.3004+002	3.8538+000
22009	4.6090-001	3.0059+000	1.0311+002	-1.9291+000	1.3201+004	2.5353+001	-3.2601+004	1.8925+003	1.3008+002	3.8836+000
22317	4.6090-001	3.0088+000	1.0329+002	-1.9262+000	1.3200+004	2.5357+001	-3.2586+004	1.8927+003	1.3012+002	3.8784+000
20124	4.4360-001	3.0879+000	1.0998+002	-1.8471+000	1.3561+004	2.4435+001	-3.1718+004	1.8465+003	1.2138+002	3.6231+000
18603	4.2500-001	3.1709+000	1.1639+002	-1.7641+000	1.3952+004	2.3453+001	-3.0770+004	1.7953+003	1.1248+002	3.3377+000
18603	4.5230-001	3.1719+000	1.1639+002	-1.7631+000	1.3952+004	2.3453+001	-3.0765+004	1.7953+003	1.1248+002	3.3387+000
11226	4.4450-001	3.0632+000	1.0996+002	-1.8718+000	1.3528+004	2.4521+001	-3.1899+004	1.8508+003	1.2214+002	3.6215+000
999999	3.9162-001	2.7210+000	1.1344+002	-1.6960+000	1.3576+004	2.4398+001	-2.8617+004	1.8445+003	1.1630+002	3.5395+000

(INIT) Q VALUES OR ISOTOPIC VARIABLES (AVAILABLE FOR PLOTS)

CASE 1

IDENT	Q(1)	Q(2)	Q(3)	Q(4)	Q(5)	Q(6)	Q(7)	Q(8)	Q(9)	Q(10)
12302	1.3000-002	2.9020+000	.0000	.0000	2.5119+004	.0000	.0000	.0000	.0000	.0000
12302	1.3000-002	2.9020+000	.0000	.0000	2.5119+004	.0000	.0000	.0000	.0000	.0000
25016	3.2000-002	4.1010+000	.0000	.0000	2.5119+004	.0000	.0000	.0000	.0000	.0000
21419	3.2000-002	4.1010+000	.0000	.0000	2.5119+004	.0000	.0000	.0000	.0000	.0000
19722	3.2000-002	4.1010+000	.0000	.0000	2.5119+004	.0000	.0000	.0000	.0000	.0000
19012	3.2000-002	4.1010+000	.0000	.0000	2.5119+004	.0000	.0000	.0000	.0000	.0000
19004	3.2000-002	4.1010+000	.0000	.0000	2.5119+004	.0000	.0000	.0000	.0000	.0000
19004	3.2000-002	4.1010+000	.0000	.0000	2.5119+004	.0000	.0000	.0000	.0000	.0000
17008	3.2000-002	4.1010+000	.0000	.0000	2.5119+004	.0000	.0000	.0000	.0000	.0000
17008	3.2000-002	4.1010+000	.0000	.0000	2.5119+004	.0000	.0000	.0000	.0000	.0000
15810	3.2000-002	4.1010+000	.0000	.0000	2.5119+004	.0000	.0000	.0000	.0000	.0000
17014	3.2000-002	4.1010+000	.0000	.0000	2.5119+004	.0000	.0000	.0000	.0000	.0000
15806	3.2000-002	4.1010+000	.0000	.0000	2.5119+004	.0000	.0000	.0000	.0000	.0000
15806	3.2000-002	4.1010+000	.0000	.0000	2.5119+004	.0000	.0000	.0000	.0000	.0000
13920	3.2000-002	4.1010+000	.0000	.0000	2.5119+004	.0000	.0000	.0000	.0000	.0000
9701	3.2000-002	4.1010+000	.0000	.0000	2.5119+004	.0000	.0000	.0000	.0000	.0000
9701	3.2000-002	4.1010+000	.0000	.0000	2.5119+004	.0000	.0000	.0000	.0000	.0000
25713	5.6000-002	4.9350+000	.0000	.0000	2.5119+004	.0000	.0000	.0000	.0000	.0000
26521	5.6000-002	4.9350+000	.0000	.0000	2.5119+004	.0000	.0000	.0000	.0000	.0000
25315	5.6000-002	4.9350+000	.0000	.0000	2.5119+004	.0000	.0000	.0000	.0000	.0000
25105	5.6000-002	4.9350+000	.0000	.0000	2.5119+004	.0000	.0000	.0000	.0000	.0000
25105	5.6000-002	4.9350+000	.0000	.0000	2.5119+004	.0000	.0000	.0000	.0000	.0000
23111	5.6000-002	4.9350+000	.0000	.0000	2.5119+004	.0000	.0000	.0000	.0000	.0000
23107	5.6000-002	4.9350+000	.0000	.0000	2.5119+004	.0000	.0000	.0000	.0000	.0000
23107	5.6000-002	4.9350+000	.0000	.0000	2.5119+004	.0000	.0000	.0000	.0000	.0000
21719	5.6000-002	4.9350+000	.0000	.0000	2.5119+004	.0000	.0000	.0000	.0000	.0000
22009	5.6000-002	4.9350+000	.0000	.0000	2.5119+004	.0000	.0000	.0000	.0000	.0000
22317	5.6000-002	4.9350+000	.0000	.0000	2.5119+004	.0000	.0000	.0000	.0000	.0000
20124	5.6000-002	4.9350+000	.0000	.0000	2.5119+004	.0000	.0000	.0000	.0000	.0000
18603	5.6000-002	4.9350+000	.0000	.0000	2.5119+004	.0000	.0000	.0000	.0000	.0000
18603	5.6000-002	4.9350+000	.0000	.0000	2.5119+004	.0000	.0000	.0000	.0000	.0000
11226	5.6000-002	4.9350+000	.0000	.0000	2.5119+004	.0000	.0000	.0000	.0000	.0000
999799	4.2062-002	4.4170+000	.0000	.0000	2.5119+004	.0000	.0000	.0000	.0000	.0000

T VALUES (ISOTOPIC RATIOS) FOR EACH POINT

IDENT	PLOT(1) Q 1 VS Q 2	PLOT(2) Q 3 VS Q 4	PLOT(3) Q 5 VS Q 6	PLOT(4) Q 7 VS Q 8	PLOT(5) Q 9 VS Q 10	PLOT(6) Q 11 VS Q 12
12302-2.0097-001-1.6320+002	1.0844+004	7.1669+000-9.9458-002	6.2719+001			
12302-2.0117-001-1.6320+002	1.0844+004	7.1669+000-9.9458-002	6.2719+001			
MEAN-2.0107-001-1.6320+002	1.0844+004	7.1669+000-9.9458-002	6.2719+001			
ST DEV 1.3648-004	.0000	.0000	.0000	.0000	.0000	
PC SD-6.7876-002	.0000	.0000	.0000	.0000	.0000	
EXPNT 3.5714-002	.0000	.0000	.0000	.0000	.0000	
25616-2.0073-001-4.3650+001	6.8347+003	2.8834+000-6.8463-002	4.0532+001			
21418-2.0068-001-5.5487+001	7.0717+003	3.6161+000-6.9001-002	4.0521+001			
19722-1.9936-001-6.8938+001	7.3718+003	4.3843+000-6.9705-002	4.1281+001			
19012-2.0157-001-7.0312+001	7.3988+003	4.4572+000-6.9783-002	4.0885+001			
19004-2.0480-001-7.2635+001	7.4197+003	4.6087+000-6.9789-002	4.1381+001			
19004-2.0450-001-7.2594+001	7.4155+003	4.6087+000-6.9776-002	4.1396+001			
17008-2.0551-001-8.5594+001	7.5638+003	5.3966+000-7.0013-002	4.1753+001			
17008-2.0461-001-8.5419+001	7.5483+003	5.3966+000-6.9964-002	4.1801+001			
15810-2.0229-001-8.6093+001	7.5625+003	5.4285+000-7.0010-002	4.1012+001			
17014-2.0615-001-8.6978+001	7.5880+003	5.4727+000-7.0066-002	4.1847+001			
15806-2.0340-001-8.9655+001	7.5577+003	5.6770+000-6.9925-002	4.1791+001			
15806-2.0452-001-8.9843+001	7.5735+003	5.6770+000-6.9975-002	4.1744+001			
13920-2.0504-001-1.0774+002	7.7829+003	6.6944+000-7.0399-002	4.1705+001			
9701-2.0503-001-2.1799+002	8.3912+003	1.3041+001-7.1381-002	4.7104+001			
9701-2.0623-001-2.1846+002	8.4094+003	1.3041+001-7.1436-002	4.7074+001			
MEAN-2.0363-001-9.6759+001	7.5660+003	6.0259+000-6.9979-002	4.2122+001			
ST DEV 2.1685-003	5.1654+001	4.0789+002	2.9931+000	7.4281+004	2.0653+000	
PC SD-1.0649+000-5.3384+001	5.3911+000	4.9671+001-1.0615+000	4.9032+000			
EXPNT-5.8487-001-1.0020+000	9.5353-001-8.8265-001	1.0745+000	1.1198+000			
25713-2.0937-001-4.2446+001	6.0089+003	3.2628+000-5.7730-002	3.3451+001			
26521-2.0903-001-4.5137+001	6.0715+003	3.4413+000-5.7900-002	3.3121+001			
25315-2.0873-001-4.5356+001	6.0436+003	3.4762+000-5.7808-002	3.3446+001			
25105-2.0931-001-4.5482+001	6.0570+003	3.4771+000-5.7852-002	3.3400+001			
25105-2.0931-001-4.5482+001	6.0570+003	3.4771+000-5.7852-002	3.3400+001			
23111-2.0465-001-5.1359+001	6.0600+003	3.9783+000-5.7702-002	3.3840+001			
23107-2.0977-001-5.1951+001	6.1600+003	3.9539+000-5.8030-002	3.3581+001			
23107-2.0952-001-5.1951+001	6.1600+003	3.9539+000-5.8030-002	3.3581+001			
21719-2.0911-001-5.2766+001	6.1313+003	4.0456+000-5.7907-002	3.3745+001			
22009-2.0989-001-5.3448+001	6.1777+003	4.0668+000-5.8052-002	3.3495+001			
22317-2.1021-001-5.3626+001	6.1877+003	4.0736+000-5.8084-002	3.3544+001			
20124-2.0984-001-5.9532+001	6.2572+003	4.5001+000-5.8215-002	3.3501+001			
18603-2.0917-001-6.5977+001	6.3300+003	4.9626+000-5.8344-002	3.3700+001			
18603-2.2477-001-6.6014+001	6.3336+003	4.9626+000-5.8355-002	3.3690+001			
11226-2.0755-001-5.8746+001	6.1928+003	4.4844+000-5.8022-002	3.3727+001			
MEAN-2.1002-001-5.2618+001	6.1485+003	4.0078+000-5.7992-002	3.3548+001			
ST DEV 4.2986+003	7.3750+000	1.0175+002	5.3655+001	2.0094+004	1.7988+001	
PC SD-2.0468+000-1.4016+001	1.6549+000	1.3388+001-3.4649+001	5.3618+001			
EXPNT-7.9046-001-8.5780+001	9.3553-001-7.8069+001	1.0757+000	1.0348+000			
999999-2.0611-001-6.6490+001	6.8060+003	4.6497+000-6.4455-002	3.2857+001			

ENRICHMENT		MEAN T VALUES (ISOTOPIC RATIOS)						
	Q 1 VS Q 2	Q 3 VS Q 4	Q 5 VS Q 2	Q 3 VS Q 6	Q 8 VS Q 7	Q 9 VS Q 10	Q	
2.9020+000	-2.0107-001	-1.6320+002	1.0644+004	7.1669+000	-9.9458-002	6.2719+001	Q	
4.1010+000	-2.0363-001	-9.6759+001	7.5660+003	6.0259+000	-6.9979-002	4.2122+001		
4.9350+000	-2.1002-001	-5.2618+001	6.1485+003	4.0078+000	-5.7992-002	3.3548+001		
SLOPE	-4.2419-003	5.4464+001	-2.3395+003	-1.5119+000	2.0669-002	-1.4546+001		
INTERCEPT	-1.8802-001	-3.2092+002	1.7496+004	1.1750+001	-1.5814-001	1.0401+002		
2.9020+000	-1.9777-001	-1.6249+002	1.0870+004	7.1098+000	-9.9568-002	5.4156+001		
3.4040+000	-2.0221-001	-3.3150+002	1.0376+004	1.5607+001	-8.6928-002	5.1041+001		
3.4060+000	-1.9557-001	-1.6913+002	9.4939+003	8.6495+000	-8.4906-002	5.1130+001		
3.4700+000	-2.2481-001	-1.3057+002	9.8109+003	6.3127+000	-8.5394-002	4.8570+001		
3.5270+000	-1.9725-001	-1.1570+002	8.6944+003	6.3142+000	-8.1201-002	5.1710+001		
3.9050+000	-2.0094-001	-8.2424+001	7.8938+003	4.9234+000	-7.3574-002	4.1033+001		
4.1010+000	-2.0326-001	-8.9647+001	7.5354+003	5.5799+000	-6.9973-002	4.1109+001		
4.1010+000	-2.0314-001	-9.2131+001	7.6242+003	5.7797+000	-7.0140-002	4.1309+001		
4.9350+000	-2.0913-001	-5.1576+001	6.1359+003	3.9321+000	-5.7966-002	3.3069+001		
4.9351+000	-2.0685-001	-4.3970+001	6.0006+003	3.3785+000	-5.7701-002	3.3207+001		
4.9406+000	-2.0900-001	-4.8467+001	6.1140+003	3.6834+000	-5.7940-002	3.1781+001		
SLOPE	-3.4673-003	8.0934+001	-2.3909+003	-2.9944+000	1.9226-002	-1.1432+001		
INTERCEPT	-1.9079-001	-4.4077+002	1.7714+004	1.8355+001	-1.5128-001	6.8804+001		
2.7190+000	-1.8785-001	-1.5302+002	1.1124+004	6.4647+000	-1.0509-001	6.6790+001		
2.9250+000	-1.8857-001	-1.3952+002	1.0241+004	6.4251+000	-9.7295-002	6.2948+001		
3.1120+000	-1.9294-001	-1.8750+002	1.0935+004	8.1957+000	-9.5076-002	5.1827+001		
3.1300+000	-2.0955-001	-1.5205+002	9.9934+003	7.2366+000	-9.2044-002	5.6699+001		
3.3080+000	-1.9584-001	-1.9499+002	1.0496+004	8.9489+000	-8.9876-002	4.7580+001		
SLOPE	-2.1950-002	-7.5833+001	-9.2695+002	4.3231+000	2.5467-002	-3.3519+001		
INTERCEPT	-1.2825-001	6.5026+001	1.3356+004	-5.6826+000	-1.7333-001	1.5903+002		

U-236

REMEASURED SET YANKEE ROWE (PWR 185MW) NBS CORES 5,6 015 US P
 MEASURED SET YANKEE ROWE (PWR 185MW) NFS CORES 1-8 015 US P
 ALL PAIRED BATCHES

I	IDENT	VARIABLE 1	VARIABLE 2	DIFFERENCE	DIFF/SIGD	RESIDUAL	NORMALIZED RESIDUAL
1	12302	2.19700-001	2.18800-001	8.99998-004	.177	-3.22592-005	-.006
2	12302	2.19900-001	2.18800-001	1.10000-003	.216	1.67742-004	.034
3	25616	4.45600-001	4.45400-001	2.00000-004	.039	-7.32258-004	-.146
4	21418	4.01300-001	3.99300-001	2.00000-003	.393	1.06774-003	.213
5	19722	3.58300-001	3.58900-001	-5.99999-004	-.118	-1.53226-003	-.306
6	19012	3.60100-001	3.60100-001	.00000	.000	-9.32258-004	-.186
7	19004	3.58500-001	3.54000-001	-5.00001-004	-.098	-1.43226-003	-.286
8	19004	3.58200-001	3.59000-001	-8.00002-004	-.157	-1.73226-003	-.346
9	17008	3.32800-001	3.31300-001	1.50000-003	.295	5.67742-004	.113
10	17008	3.32100-001	3.31300-001	7.99999-004	.157	-1.32259-004	-.026
11	15810	3.28300-001	3.28200-001	9.99980-005	.020	-8.32260-004	-.186
12	17014	3.30900-001	3.29600-001	1.30000-003	.255	3.67742-004	.073
13	15806	3.24300-001	3.25300-001	-1.00000-003	-.197	-1.93226-003	-.386
14	15806	3.25300-001	3.25300-001	.00000	.000	-9.32258-004	-.186
15	13920	2.99900-001	2.99900-001	.00000	.000	-9.32258-004	-.186
16	9701	2.21300-001	2.20900-001	4.00001-004	.079	-5.32256-004	-.106
17	9701	2.22000-001	2.20900-001	1.10000-003	.216	1.67742-004	.034
18	25713	5.05200-001	5.04300-001	9.00000-004	.177	-3.22573-005	-.006
19	26521	4.95800-001	4.94600-001	1.20000-003	.236	2.67740-004	.053
20	25315	4.96000-001	4.96800-001	-8.00002-004	-.157	-1.73226-003	-.346
21	25105	4.96800-001	4.99000-001	-2.20000-003	-.432	-3.13226-003	-.626
22	25105	4.96800-001	4.99000-001	-2.20000-003	-.432	-3.13226-003	-.626
23	23111	4.61100-001	4.65200-001	-4.10000-003	-.806	-5.03226-003	-1.005
24	23107	4.66900-001	4.68200-001	-1.30000-003	-.255	-2.23226-003	-.446
25	23107	4.66400-001	4.68200-001	-1.80000-003	-.354	-2.73225-003	-.546
26	21719	4.62300-001	4.59600-001	2.70000-003	.531	1.76774-003	.353
27	22009	4.60900-001	4.59900-001	1.00000-003	.197	6.77444-005	.014
28	22317	4.60400-001	4.59800-001	1.10000-003	.216	1.67742-004	.034
29	20124	4.43600-001	4.43000-001	5.99999-004	.118	-3.32259-004	-.066
30	18603	4.25000-001	4.25000-001	.00000	.000	-9.32258-004	-.186
31	18603	4.52300-001	4.25000-001	2.73000-002	5.365	2.63677-002	5.267

AVERAGES 3.88016-001 3.87084-001 9.32258-004

STUDENTS	CRITICAL	RANDOM	% RANDOM	BIAS	% BIAS	PROCESS	% PROCESS
T VALUE	T VALUE	VARIANCE	STD DEV	VARIANCE	STD DEV	VARIANCE	STD DEV
1.020	2.042	1.295-005	.928	1.692-008	.034	8.331-003	23.551

BATCH IDENT NO. 18603 IS AN OUTLIER

U-235

REMEASURED SET YANKEE HOWE (PWR 185MW) NBS CURES 5,6 015 US P
 MEASURED SET YANKEE ROWE (PWR 185MW) NFS CURES 1-8 015 US P
 ALL PAIRED BATCHES

	IDENT	VARIABLE 1	VARIABLE 2	DIFFERENCE	DIFF/SIGD	RESIDUAL	NORMALIZED RESIDUAL
1	12302	1.87350+000	1.86900+000	4.50000-003	.718	6.35161-003	1.030
2	12302	1.87350+000	1.86900+000	4.50000-003	.718	6.35161-003	1.030
3	25616	2.04050+000	2.04670+000	-6.20002-003	-.989	-4.34840-003	-.705
4	21418	2.26080+000	2.25450+000	6.30000-003	1.005	8.15161-003	1.322
5	19722	2.46430+000	2.47090+000	-6.59999-003	-1.053	-4.74838-003	-.770
6	19012	2.47330+000	2.47540+000	-2.09999-003	-.335	-2.48379-004	-.040
7	19004	2.50680+000	2.51360+000	-6.80000-003	-1.085	-4.94838-003	-.802
8	19004	2.50590+000	2.51360+000	-7.70000-003	-1.228	-5.84838-003	-.948
9	17008	2.63730+000	2.63880+000	-1.49998-003	-.239	3.51631-004	.057
10	17008	2.63430+000	2.63880+000	-4.50000-003	-.718	-2.64839-003	-.429
11	15810	2.63630+000	2.63590+000	4.00007-004	.064	2.25162-003	.365
12	17014	2.65110+000	2.65230+000	-1.19999-003	-.191	6.51621-004	.106
13	15806	2.66390+000	2.67480+000	-1.09000-002	-1.739	-9.04841-003	-1.467
14	15806	2.66690+000	2.67480+000	-7.90000-003	-1.260	-6.04839-003	-.981
15	13920	2.79440+000	2.79580+000	-1.39999-003	-.223	4.51618-004	.073
16	9701	3.17770+000	3.17550+000	2.20001-003	.351	4.05162-003	.657
17	9701	3.17470+000	3.17550+000	4.19998-003	.670	6.05159-003	.941
18	25713	2.78950+000	2.78690+000	6.00010-004	.096	2.45162-003	.397
19	26521	2.83100+000	2.82030+000	1.07000-002	1.707	1.25516-002	2.035
20	25315	2.82700+000	2.83240+000	-5.40000-003	-.861	-3.54839-003	-.575
21	25105	2.82900+000	2.83730+000	-8.30001-003	-1.324	-6.44839-003	-1.045
22	25105	2.82900+000	2.83730+000	-8.30001-003	-1.324	-6.44839-003	-1.045
23	23111	2.95550+000	2.97340+000	-1.79000-002	-2.855	-1.60484-002	-2.602
24	23107	2.97620+000	2.97820+000	-1.99997-003	-.319	-1.48363-004	-.024
25	23107	2.97620+000	2.97820+000	-1.99997-003	-.319	-1.48363-004	-.024
26	21719	2.99200+000	2.99070+000	1.30001-003	.207	3.15162-003	.511
27	22009	3.00590+000	2.99430+000	1.16000-002	1.850	1.34516-002	2.181
28	22317	3.00880+000	3.00570+000	3.10001-003	.494	4.95162-003	.803
29	20124	3.08790+000	3.08680+000	1.10000-003	.175	2.95162-003	.479
30	18603	3.17090+000	3.17500+000	-4.10002-003	-.654	-2.24841-003	-.365
31	18603	3.17190+000	3.17500+000	-3.10001-003	-.494	-1.24840-003	-.202
AVERAGES		2.72552+000	2.72737+000	-1.85161-003			

STUDENTS T VALUE	CRITICAL T VALUE	RANDOM VARIANCE	% RANDOM STD DEV	BIAS VARIANCE	% BIAS STD DEV	PROCESS VARIANCE	% PROCESS STD DEV
-1.644	2.042	1.965-005	.163	1.080-006	.038	1.267-001	13.058

BATCH IDENT NO. 26521 IS AN OUTLIER
 BATCH IDENT NO. 23111 IS AN OUTLIER
 BATCH IDENT NO. 22009 IS AN OUTLIER

U-236 REMEASURED SET YANKEE ROWE (PWR 185MW) NFS CORES 5,6 015 US P
 MEASURED SET YANKEE ROWE (PWR 185MW) NFS CORES 1-8 015 US P
 VS U-235 ALL PAIRED BATCHES

	IDENT	VARIABLE 1	VARIABLE 2	DIFFERENCE	DIFF/SIGD	RESIDUAL	NORMALIZED RESIDUAL
1	12302	1.17267-001	1.17068-001	1.99195-004	.126	-2.19034-004	-.141
2	12302	1.17374-001	1.17068-001	3.05948-004	.194	-1.12281-004	-.072
3	25616	2.18378-001	2.17619-001	7.59244-004	.481	3.41015-004	.220
4	21418	1.77504-001	1.77112-001	3.91096-004	.248	-2.71331-005	-.017
5	19722	1.45396-001	1.45251-001	1.45540-004	.092	-2.72689-004	-.176
6	19012	1.45595-001	1.45471-001	1.23514-004	.078	-2.94715-004	-.140
7	19004	1.43011-001	1.42823-001	1.87967-004	.119	-2.30262-004	-.148
8	19004	1.42943-001	1.42823-001	1.19612-004	.076	-2.98617-004	-.192
9	17008	1.26190-001	1.25549-001	6.40171-004	.406	2.21942-004	.143
10	17008	1.26068-001	1.25549-001	5.18154-004	.328	9.99254-005	.064
11	15810	1.24531-001	1.24512-001	1.90390-005	.012	-3.99190-004	-.257
12	17014	1.24816-001	1.24270-001	5.46611-004	.346	1.28382-004	.043
13	15806	1.21739-001	1.21617-001	1.22235-004	.077	-2.95994-004	-.141
14	15806	1.21977-001	1.21617-001	3.60258-004	.228	-5.79710-005	-.037
15	13920	1.07322-001	1.07268-001	5.37420-005	.034	-3.64487-004	-.235
16	9701	6.96416-002	6.95638-002	7.77170-005	.049	-3.40512-004	-.219
17	9701	6.98179-002	6.95638-002	2.54660-004	.161	-1.64169-004	-.106
18	25713	1.81108-001	1.80824-001	2.83744-004	.180	-1.34485-004	-.087
19	26521	1.75132-001	1.75371-001	-2.38953-004	-.151	-6.57182-004	-.423
20	25315	1.75451-001	1.75399-001	5.20516-005	.033	-3.66177-004	-.246
21	25105	1.75610-001	1.75871-001	-2.61670-004	-.166	-6.79899-004	-.438
22	25105	1.75610-001	1.75871-001	-2.61670-004	-.166	-6.79899-004	-.438
23	23111	1.56014-001	1.56454-001	-4.39681-004	-.279	-8.57910-004	-.552
24	23107	1.56878-001	1.57209-001	-3.31156-004	-.210	-7.49385-004	-.483
25	23107	1.56710-001	1.57209-001	-4.99155-004	-.316	-9.17384-004	-.591
26	21719	1.54512-001	1.53676-001	8.35633-004	.529	4.17404-004	.269
27	22009	1.53332-001	1.53592-001	-2.60042-004	-.165	-6.78271-004	-.437
28	22317	1.53184-001	1.52976-001	2.07981-004	.132	-2.10248-004	-.135
29	20124	1.43657-001	1.43514-001	1.43182-004	.091	-2.75047-004	-.177
30	18603	1.34031-001	1.33858-001	1.73081-004	.110	-2.45148-004	-.158
31	18603	1.42596-001	1.33858-001	8.73765-003	5.535	8.31942-003	5.357
AVERAGES		1.43013-001	1.42594-001	4.18229-004			

STUDENTS	CRITICAL		RANDOM	% RANDOM	BIAS	% BIAS	PROCESS	% PROCESS
T VALUE	T VALUE		VARIANCE	STD DEV	VARIANCE	STD DEV	VARIANCE	STD DEV
1.475	2.042		1.246-006	.782	4.727-008	.152	9.667-004	21.773

BATCH IDENT NO. 18603 IS AN OUTLIER

U-236 REMEASURED SET YANKEE ROWE (PWR 185MW) NBS CORES 5,6 015 US P
 MEASURED SET YANKEE ROWE (PWR 185MW) NFS CORES 1-8 015 US P
 ENRICHMENT= 4.10100

	I	IDENT	VARIABLE 1	VARIABLE 2	DIFFERENCE	DIFF/SIGD	RESIDUAL	NORMALIZED RESIDUAL
	3	25616	4.45600-001	4.45400-001	2.00000-004	.227	-9.99996-005	-.117
	4	21418	4.01300-001	3.99300-001	2.00000-003	2.267	1.70000-003	1.934
	5	19722	3.58300-001	3.58900-001	-5.99999-004	-.680	-8.99998-004	-1.056
	6	14012	3.60100-001	3.60100-001	.00000	.000	-2.99999-004	-.352
	7	19004	3.58500-001	3.59000-001	-5.00001-004	-.567	-8.00000-004	-.938
	8	19004	3.58200-001	3.59000-001	-8.00002-004	-.907	-1.10000-003	-1.240
	9	17008	3.32800-001	3.31300-001	1.50000-003	1.700	1.20000-003	1.408
	10	17008	3.32100-001	3.31300-001	7.99999-004	.907	4.99999-004	.547
	11	15810	3.28300-001	3.28200-001	9.99980-005	.113	-2.00001-004	-.275
	12	17014	3.30400-001	3.29600-001	1.30000-003	1.473	1.00000-003	1.173
	13	15806	3.24300-001	3.25300-001	-1.00000-003	-1.133	-1.30000-003	-1.525
	14	15806	3.25300-001	3.25300-001	.00000	.000	-2.99999-004	-.352
	15	13920	2.99900-001	2.99900-001	.00000	.000	-2.99999-004	-.352
	16	9701	2.21300-001	2.20900-001	4.00001-004	.453	1.00002-004	.117
	17	9701	2.22000-001	2.20900-001	1.10000-003	1.247	8.00001-004	.938
		AVERAGES	3.33260-001	3.32960-001	2.99999-004			

STUDENTS	CRITICAL		RANDOM	% RANDOM	BIAS	% BIAS	PROCESS	% PROCESS
T VALUE	T VALUE		VARIANCE	STD DEV	VARIANCE	STD DEV	VARIANCE	STD DEV
1.317	2.145		3.893-007	.187	1.905-008	.041	3.293-003	17.228

BATCH IDENT NO. 21418 IS AN OUTLIER

U-235

REMEASURED SET YANKEE ROWE (PWR 185MW) NBS CORES 5,6 015 US P
 MEASURED SET YANKEE ROWE (PWR 185MW) NFS CORES 1-8 015 US P
 ENRICHMENT= 4.10100

	IDENT	VARIABLE 1	VARIABLE 2	DIFFERENCE	DIFF/SIGD	RESIDUAL	NORMALIZED RESIDUAL
1	25616	2.04050+000	2.04670+000	-6.20002-003	-1.269	-3.28668-003	-.696
3	21418	2.26080+000	2.25450+000	6.30000-003	1.290	9.21333-003	1.952
4	19722	2.46430+000	2.47090+000	-6.59999-003	-1.351	-3.68666-003	-.781
5	19012	2.47330+000	2.47540+000	-2.09999-003	-.430	8.13341-004	.172
6	19004	2.50680+000	2.51360+000	-6.80000-003	-1.392	-3.88666-003	-.824
7	19004	2.50590+000	2.51360+000	-7.70000-003	-1.576	-4.78666-003	-1.014
8	17008	2.63730+000	2.63880+000	-1.49998-003	-.307	1.41335-003	.299
9	17008	2.63430+000	2.63880+000	-4.50000-003	-.921	-1.58667-003	-.336
10	15810	2.63630+000	2.63590+000	4.00007-004	.082	3.31334-003	.702
11	17014	2.65110+000	2.65230+000	-1.19999-003	-.246	1.71334-003	.353
12	15806	2.66390+000	2.67480+000	-1.09000-002	-2.231	-7.98669-003	-1.692
13	15806	2.66690+000	2.67480+000	-7.90000-003	-1.617	-4.98667-003	-1.057
14	13920	2.79440+000	2.79580+000	-1.39999-003	-.287	1.51334-003	.321
15	9701	3.17770+000	3.17550+000	2.20001-003	.450	5.11334-003	1.043
16	9701	3.17970+000	3.17550+000	4.19998-003	.860	7.11331-003	1.507
17							
	AVERAGES	2.61955+000	2.62246+000	-2.91333-003			

STUDENTS	CRITICAL		RANDOM	% RANDOM	BIAS	% BIAS	PROCESS	% PROCESS
T VALUE	T VALUE		VARIANCE	STD DEV	VARIANCE	STD DEV	VARIANCE	STD DEV
-2.310	2.145		1.193-005	.132	3.448-006	.071	8.502-002	11.125

BATCH IDENT NO. 21418 IS AN OUTLIER

U-236

REMEASURED SET		YANKEE ROWE (PWR 185MW)		NBS	CORES 5-6	015 US P	
MEASURED SET		YANKEE ROWE (PWR 185MW)		NFS	CORES 1-8	015 US P	
		VS U-235		ENRICHMENT# 4.10100			
	IDENT	VARIABLE 1	VARIABLE 2	DIFFERENCE	DIFF/SIGD	RESIDUAL	NORMALIZED RESIDUAL
1	25616	2.18378-001	2.17619-001	7.59244-004	3.243	4.71313-004	2.084
3	21418	1.77504-001	1.77112-001	3.91096-004	1.670	1.03165-004	.456
4	19722	1.45396-001	1.45251-001	1.45540-004	.622	-1.42391-004	-.629
5	19012	1.45595-001	1.45471-001	1.23514-004	.527	-1.64417-004	-.727
6	19004	1.43011-001	1.42823-001	1.87967-004	.803	-9.99636-005	-.442
7	19004	1.42943-001	1.42823-001	1.19612-004	.511	-1.68319-004	-.744
8	17008	1.26190-001	1.25549-001	6.40171-004	2.734	3.52240-004	1.567
9	17008	1.26068-001	1.25549-001	5.18154-004	2.213	2.30224-004	1.018
10	15810	1.24531-001	1.24512-001	1.90390-005	.081	-2.68892-004	-1.149
11	17014	1.24816-001	1.24270-001	5.46611-004	2.334	2.58680-004	1.144
12	15806	1.21739-001	1.21617-001	1.22235-004	.522	-1.65695-004	-.732
13	15806	1.21477-001	1.21617-001	3.60258-004	1.539	7.23273-005	.320
14	13920	1.07322-001	1.07268-001	5.37420-005	.230	-2.34189-004	-1.035
15	9701	6.96416-002	6.95638-002	7.77170-005	.332	-2.10214-004	-.929
16	9701	6.98179-002	6.95638-002	2.54060-004	1.085	-3.38705-005	-.150
17							
AVERAGES		1.30995-001	1.30707-001	2.87931-004			

STUDENTS	CRITICAL	RANDOM	% RANDOM	BIAS	% BIAS	PROCESS	% PROCESS
T VALUE	T VALUE	VARIANCE	STD DEV	VARIANCE	STD DEV	VARIANCE	STD DEV
4.763	2.145	2.741-008	.127	3.962-008	.152	1.344-003	28.013

BATCH IDENT NO. 25616 IS AN OUTLIER
 BATCH IDENT NO. 21418 IS AN OUTLIER

REMEASURED SET YANKEE ROWE (PWR (R5MW)) NBS CORES 5-6 015 US P
 MEASURED SET YANKEE ROWE (PWR (R5MW)) NFS CORES 1-8 015 US P
 U-23b VS U-235 ENRICHMENT= 4.10100

I	IDENT	X VALUE	Y VALUE	PRED X	Y = B*X + A	PRED Y	Y RESIDUAL	PRED X	Y = Y0 + B*(X-X0)	PRED Y	Y RESIDUAL
1	25616	2.040+000	4.456+001	2.045+000	-4.892-003	4.464+001	-8.109-004	2.055+000	-1.415-002	4.479+001	-2.272-003
2	21418	2.261+000	4.013+001	2.268+000	-7.476-003	4.025+001	-1.239-003	2.274+000	-1.286-002	4.034+001	-2.064-003
3	19722	2.464+000	3.583+001	2.480+000	-1.560-002	3.609+001	-2.585-003	2.482+000	-1.737-002	3.611+001	-2.789-003
4	19012	2.473+000	3.601+001	2.479+000	-5.745-003	3.611+001	-9.523-004	2.481+000	-7.398-003	3.613+001	-1.188-003
5	19004	2.507+000	3.585+001	2.499+000	8.028-003	3.572+001	1.331-003	2.500+000	6.919-003	3.574+001	1.111-003
6	19004	2.506+000	3.582+001	2.499+000	6.712-003	3.571+001	1.113-003	2.500+000	5.591-003	3.573+001	8.977-004
7	17008	2.637+000	3.328+001	2.629+000	7.992-003	3.315+001	1.325-003	2.628+000	9.176-003	3.313+001	1.473-003
8	17008	2.634+000	3.321+001	2.630+000	4.433-003	3.314+001	7.348-004	2.629+000	5.576-003	3.312+001	8.951-004
9	15810	2.636+000	3.283+001	2.641+000	-4.982-003	3.291+001	-8.224-004	2.640+000	-3.753-003	3.289+001	-6.026-004
10	17014	2.651+000	3.309+001	2.641+000	1.024+002	3.292+001	1.698-003	2.639+000	1.166-002	3.290+001	1.872-003
11	15806	2.664+000	3.243+001	2.665+000	-1.010-003	3.245+001	-1.675-004	2.663+000	6.699-004	3.242+001	1.076-004
12	15806	2.667+000	3.253+001	2.664+000	3.376-003	3.247+001	5.596-004	2.662+000	5.095-003	3.245+001	8.180-004
13	13920	2.794+000	2.999+001	2.792+000	2.539-003	2.995+001	4.209-004	2.788+000	6.501-003	2.989+001	1.044-003
14	9701	3.178+000	2.213+001	3.184+000	-6.156-003	2.223+001	-1.020-003	3.173+000	4.567-003	2.206+001	7.332-004
15	9701	3.180+000	2.220+001	3.183+000	-3.140-003	2.225+001	-5.204-004	3.172+000	7.608-003	2.204+001	1.222-003
16	25616	2.047+000	4.454+001	2.049+000	-2.078-003	4.457+001	-3.444-004	2.058+000	-1.124-002	4.472+001	-1.804-003
17	21418	2.255+000	3.993+001	2.271+000	-1.641-002	4.020+001	-2.720-003	2.276+000	-2.167-002	4.028+001	-3.512-003
18	19722	2.471+000	3.589+001	2.481+000	-1.036-002	3.606+001	-1.717-003	2.483+000	-1.204-002	3.608+001	-1.933-003
19	19012	2.475+000	3.601+001	2.480+000	-4.605-003	3.609+001	-7.634-004	2.482+000	-6.225-003	3.611+001	-9.994-004
20	19004	2.514+000	3.590+001	2.501+000	1.310+002	3.568+001	2.171+003	2.502+000	1.209+002	3.571+001	1.941+003
21	19004	2.514+000	3.590+001	2.501+000	1.310+002	3.568+001	2.171+003	2.502+000	1.209+002	3.571+001	1.941+003
22	17008	2.639+000	3.313+001	2.634+000	4.649+003	3.305+001	7.740+004	2.633+000	5.890+003	3.304+001	9.457+004
23	17008	2.639+000	3.313+001	2.634+000	4.649+003	3.305+001	7.740+004	2.633+000	5.890+003	3.304+001	9.457+004
24	15810	2.636+000	3.282+001	2.641+000	-5.454-003	3.291+001	-9.041-004	2.640+000	-4.252-003	3.289+001	-6.826-004
25	17014	2.652+000	3.296+001	2.645+000	7.309+003	3.284+001	1.212+003	2.644+000	8.759+003	3.282+001	1.406+003
26	15806	2.675+000	3.251+001	2.667+000	7.665+003	3.240+001	1.270+003	2.665+000	9.508+003	3.238+001	1.527+003
27	15806	2.675+000	3.253+001	2.667+000	7.665+003	3.240+001	1.270+003	2.665+000	9.508+003	3.238+001	1.527+003
28	13920	2.796+000	2.999+001	2.793+000	3.299+003	2.994+001	5.469+004	2.789+000	7.283+003	2.987+001	1.169+003
29	9701	3.176+000	2.209+001	3.184+000	-8.453-003	2.223+001	-1.401+003	3.173+000	2.238+003	2.205+001	3.593+004
30	9701	3.176+000	2.209+001	3.184+000	-8.453-003	2.223+001	-1.401+003	3.173+000	2.238+003	2.205+001	3.593+004

AVERAGES 2.621+000 3.331+001

WEIGHTED
AVERAGES 2.586+000 3.404+001

	Y = B*X + A	Y - Y0 = B*(X - X0)
SLOPE ESTIMATE	-1.966-001	-2.032-001
% STD DEV OF SLOPE	.980	.209
INTERCEPT ESTIMATE	8.490+001	
VARIANCE OF X	1.193+005	
X VARIANCE ESTIMATE	4.142+006	9.320+005
% STD DEV OF X	.078	.368
VARIANCE OF Y	3.893+007	
Y VARIANCE ESTIMATE	1.351+007	2.402+006
% STD DEV OF Y	.010	.465
CORRELATION COEFFICIENT	-.9987	-.9999

U-236

REMEASURED SET YANKEE ROWE (PWR 185MW) NBS CORES 5,6 015 US P
 MEASURED SET YANKEE ROWE (PWR 185MW) NFS CORES 1-8 015 US P
 ENRICHMENT= 4.93500

I	IDENT	VARIABLE 1	VARIABLE 2	DIFFERENCE	DIFF/SIGD	RESIDUAL	NORMALIZED RESIDUAL
18	25713	5.05200-001	5.04300-001	9.00000-004	.118	-7.00000-004	-.095
19	26521	4.95800-001	4.94600-001	1.20000-003	.158	-4.00002-004	-.055
20	25315	4.96000-001	4.96800-001	-8.00002-004	-.105	-2.40000-003	-.327
21	25105	4.96800-001	4.99000-001	-2.20000-003	-.289	-3.80000-003	-.518
22	25105	4.96800-001	4.99000-001	-2.20000-003	-.289	-3.80000-003	-.518
23	23111	4.61100-001	4.65200-001	-4.10000-003	-.538	-5.70000-003	-.777
24	23107	4.66900-001	4.68200-001	-1.30000-003	-.171	-2.90000-003	-.345
25	23107	4.66400-001	4.68200-001	-1.80000-003	-.236	-3.40000-003	-.463
26	21719	4.62300-001	4.59600-001	2.70000-003	.355	1.10000-003	.150
27	22009	4.60900-001	4.59900-001	1.00000-003	.131	-5.99998-004	-.042
28	22317	4.60900-001	4.59800-001	1.10000-003	.144	-5.00000-004	-.068
29	20124	4.43600-001	4.43000-001	5.99999-004	.079	-1.00000-003	-.136
30	18603	4.25000-001	4.25000-001	.00000	.000	-1.60000-003	-.218
31	18603	4.52300-001	4.25000-001	2.73000-002	3.586	2.57000-002	3.503
AVERAGES		4.70714-001	4.69114-001	1.60000-003			

STUDENTS T VALUE	CRITICAL T VALUE	RANDOM VARIANCE	% RANDOM STD DEV	BIAS VARIANCE	% BIAS STD DEV	PROCESS VARIANCE	% PROCESS STD DEV
.786	2.160	2.899-005	1.146	.000	.000	5.975-004	5.202

BATCH IDENT NO. 18603 IS AN OUTLIER

U-235

REMEASURED SET YANKEE ROWE (PWR 185MW) NBS CORES 5-8 015 US P
 MEASURED SET YANKEE ROWE (PWR 185MW) NFS CORES 1-8 015 US P
 ENRICHMENT= 4.93500

	I	IDENT	VARIABLE 1	VARIABLE 2	DIFFERENCE	DIFF/SIGD	RESIDUAL	NORMALIZED RESIDUAL
18	25713	2.78950+000	2.78890+000	6.00010-004	.079	2.22144-003	.304	
19	26521	2.83100+000	2.82030+000	1.07000-002	1.412	1.23214-002	1.687	
20	25315	2.82700+000	2.83240+000	-5.40000-003	-.712	-3.77857-003	-.517	
21	25105	2.82900+000	2.83730+000	-8.70001-003	-1.095	-6.67858-003	-.914	
22	25105	2.82900+000	2.83730+000	-8.30001-003	-1.095	-6.67858-003	-.914	
23	23111	2.95550+000	2.97340+000	-1.79000-002	-2.362	-1.62786-002	-2.229	
24	23107	2.97620+000	2.97820+000	-1.99997-003	-.264	-3.78547-004	-.052	
25	23107	2.97620+000	2.97820+000	-1.99997-003	-.264	-3.78547-004	-.052	
26	21719	2.99200+000	2.99070+000	1.30001-003	.172	2.92143-003	.400	
27	22009	3.00590+000	2.99430+000	1.16000-002	1.530	1.32214-002	1.810	
28	22317	3.00880+000	3.00570+000	3.10001-003	.409	4.72144-003	.646	
29	20124	3.06790+000	3.06680+000	1.10000-003	.145	2.72143-003	.373	
30	18603	3.17090+000	3.17500+000	-4.10002-003	-.541	-2.47860-003	-.339	
31	18603	3.17190+000	3.17500+000	-3.10001-003	-.409	-1.47856-003	-.202	

AVERAGES 2.96077+000 2.96239+000 -1.62143-003

STUDENTS	CRITICAL		RANDOM	% RANDOM	BIAS	% BIAS	PROCESS	% PROCESS
T VALUE	T VALUE		VARIANCE	STD DEV	VARIANCE	STD DEV	VARIANCE	STD DEV
-.800	2.160		2.873-005	.181	.000	.000	1.604-002	4.277

BATCH IDENT NO. 23111 IS AN OUTLIER
 BATCH IDENT NO. 18603 IS AN OUTLIER

U-236

REMEASURED SET YANKEE ROWE (PWR 185MW) NBS CORES 5,6 015 US P
 MEASURED SET YANKEE ROWE (PWR 185MW) NFS CORES 1-8 015 US P
 VS U-235 ENRICHMENT= 4.93500

	IDENT	VARIABLE 1	VARIABLE 2	DIFFERENCE	DIFF/SIGD	RESIDUAL	NORMALIZED RESIDUAL
1							
18	25713	1.81108-001	1.80824-001	2.83744-004	.119	-2.97756-004	-.130
19	26521	1.75132-001	1.75371-001	-2.38953-004	-.101	-8.20453-004	-.359
20	25315	1.75451-001	1.75399-001	5.20516-005	.022	-5.29448-004	-.231
21	25105	1.75610-001	1.75871-001	-2.61670-004	-.110	-8.43170-004	-.368
22	25105	1.75610-001	1.75871-001	-2.61670-004	-.110	-8.43170-004	-.368
23	23111	1.56014-001	1.56454-001	-4.39681-004	-.185	-1.02118-003	-.446
24	23107	1.56878-001	1.57209-001	-3.31156-004	-.139	-9.12656-004	-.399
25	23107	1.56710-001	1.57209-001	-4.99155-004	-.210	-1.08066-003	-.472
26	21719	1.54512-001	1.53676-001	8.35633-004	.352	2.54133-004	.111
27	22009	1.53332-001	1.53592-001	-2.60042-004	-.110	-8.41542-004	-.368
28	22317	1.53184-001	1.52976-001	2.07981-004	.088	-3.73519-004	-.163
29	20124	1.43657-001	1.43514-001	1.43182-004	.060	-4.38318-004	-.192
30	18603	1.34031-001	1.33858-001	1.73081-004	.073	-4.08419-004	-.178
31	18603	1.42596-001	1.33858-001	8.73765-003	3.660	8.15615-003	3.564
AVERAGES		1.59559-001	1.58977-001	5.81500-004			

STUDENTS T VALUE	CRITICAL T VALUE	RANDOM VARIANCE	% RANDOM STD DEV	BIAS VARIANCE	% BIAS STD DEV	PROCESS VARIANCE	% PROCESS STD DEV
.916	2.160	2.819-006	1.054	.000	.000	2.263-004	9.445

BATCH IDENT NO. 23111 IS AN OUTLIER
 BATCH IDENT NO. 18603 IS AN OUTLIER

U-236

NEMEASURED SET YANKEE ROWE (PWR 185MW) NBS CONES 5-6 015 US P
 MEASURED SET YANKEE ROWE (PWR 185MW) NFS CORES 1-8 015 US P
 VS U-235 ENRICHMENT= 4.93500

I	IDENT	X VALUE	Y VALUE	PRED X	Y = B*X + A X RESIDUAL	PRED Y	Y RESIDUAL	PRED X	Y = Y0 + H*(X - X0) X RESIDUAL	PRED Y	Y RESIDUAL
1	25713	2.789+000	5.052-001	2.789+000	3.165-004	5.036-001	1.636-003	2.790+000	-1.372-004	5.059-001	-6.600-004
2	26521	2.831+000	4.956-001	2.831+000	7.421-005	4.954-001	3.838-004	2.831+000	-2.761-004	4.971-001	-1.329-003
3	25315	2.827+000	4.960-001	2.827+000	-3.400-005	4.962-001	-1.758-004	2.827+000	-4.033-004	4.979-001	-1.941-003
4	25105	2.829+000	4.968-001	2.829+000	1.878-004	4.958-001	9.712-004	2.829+000	-1.605-004	4.976-001	-7.724-004
5	25105	2.829+000	4.966-001	2.829+000	1.878-004	4.958-001	9.712-004	2.829+000	-1.605-004	4.976-001	-7.724-004
6	23111	2.956+000	4.611-001	2.957+000	-1.864-003	4.707-001	-9.637-003	2.957+000	-1.987-003	4.707-001	-9.564-003
7	23107	2.976+000	4.669-001	2.976+000	-3.001-005	4.671-001	-1.552-004	2.976+000	3.189-005	4.667-001	1.535-004
8	23107	2.976+000	4.664-001	2.976+000	-1.232-004	4.670-001	-6.370-004	2.976+000	-6.768-005	4.667-001	-3.256-004
9	21719	2.992+000	4.623-001	2.992+000	-3.126-004	4.639-001	-1.610-003	2.992+000	-2.244-004	4.634-001	-1.080-003
10	22009	3.006+000	4.609-001	3.006+000	-6.786-005	4.613-001	-3.508-004	3.006+000	7.725-005	4.605-001	3.718-004
11	22317	3.004+000	4.609-001	3.009+000	3.764-005	4.607-001	1.946-004	3.004+000	1.983-004	4.599-001	9.545-004
12	20124	3.088+000	4.436-001	3.088+000	-3.092-004	4.452-001	-1.599-003	3.088+000	5.625-005	4.431-001	2.707-004
13	18603	3.171+000	4.250-001	3.172+000	-7.565-004	4.289-001	-3.911-003	3.171+000	-1.819-004	4.259-001	-8.751-004
14	18603	3.172+000	4.523-001	3.168+000	4.369-003	4.297-001	2.256-002	3.167+000	5.246-003	4.268-001	2.549-002
15	25713	2.789+000	5.043-001	2.789+000	1.269-004	5.036-001	6.562-004	2.789+000	-3.415-004	5.059-001	-1.643-003
16	26521	2.820+000	4.968-001	2.821+000	-5.387-004	4.974-001	-2.785-003	2.821+000	-4.619-004	4.992-001	-4.629-003
17	25315	2.832+000	4.968-001	2.832+000	3.116-004	4.952-001	1.611-003	2.832+000	-1.657-005	4.969-001	-8.923-005
18	25105	2.837+000	4.990-001	2.836+000	8.999-004	4.943-001	4.652-003	2.837+000	6.242-004	4.960-001	3.003-003
19	25105	2.837+000	4.990-001	2.836+000	8.999-004	4.943-001	4.652-003	2.837+000	6.242-004	4.960-001	3.003-003
20	23111	2.973+000	4.652-001	2.974+000	-4.488-004	4.675-001	-2.320-003	2.974+000	-4.236-004	4.672-001	-2.038-003
21	23107	2.978+000	4.682-001	2.978+000	2.851-004	4.667-001	1.474-003	2.978+000	3.743-004	4.664-001	1.801-003
22	23107	2.978+000	4.682-001	2.978+000	2.851-004	4.667-001	1.474-003	2.978+000	3.743-004	4.664-001	1.801-003
23	21719	2.991+000	4.596-001	2.992+000	-8.632-004	4.641-001	-4.462-003	2.992+000	-8.163-004	4.635-001	-3.928-003
24	22009	2.994+000	4.599-001	2.995+000	-6.763-004	4.634-001	-3.446-003	2.995+000	-6.083-004	4.628-001	-2.917-003
25	22317	3.006+000	4.598-001	3.006+000	-2.802-004	4.612-001	-1.448-003	3.006+000	-1.501-004	4.605-001	-7.224-004
26	20124	3.087+000	4.430-001	3.087+000	-4.511-004	4.454-001	-2.384-003	3.087+000	-1.092-004	4.435-001	-5.252-004
27	18603	3.175+000	4.250-001	3.176+000	-6.074-004	4.281-001	-3.140-003	3.175+000	-1.065-005	4.251-001	-5.126-005
28	18603	3.175+000	4.250-001	3.176+000	-6.074-004	4.281-001	-3.140-003	3.175+000	-1.065-005	4.251-001	-5.126-005

AVERAGES 2.962+000 4.699-001

WEIGHTED
AVERAGES 2.954+000 4.705-001

$$Y = B * X + A \quad Y - Y0 = H * (X - X0)$$

SLOPE ESTIMATE	-1.952-001	-2.097-001
% STD DEV OF SLOPE	-4.422	-4.264
INTERCEPT ESTIMATE	1.848+000	
VARIANCE OF X	2.873-005	
X VARIANCE ESTIMATE	1.061-006	1.326-006
% STD DEV OF X	.035	.039
VARIANCE OF Y	2.899-005	
Y VARIANCE ESTIMATE	1.072-006	3.070-005
% STD DEV OF Y	.220	1.179
CORRELATION COEFFICIENT	-.9754	-.9999

BATCH IDENT NO. 18603 IS AN OUTLIER

I	IDENT	X VALUE	Y VALUE	Y = B*X + A				Y - YU = B*(X - X0)			
				PRED X	X RESIDUAL	PRED Y	Y RESIDUAL	PRED X	X RESIDUAL	PRED Y	Y RESIDUAL
1	25713	2.789+000	5.052-001	2.789+000	7.173-005	5.049-001	3.471-004	2.789+000	5.168-005	5.050-001	2.493-004
2	26521	2.831+000	4.958-001	2.831+000	-7.552-005	4.962-001	-3.653-004	2.831+000	-4.069-005	4.962-001	-4.372-004
3	25315	2.827+000	4.960-001	2.827+000	-2.013-004	4.970-001	-4.735-004	2.827+000	-2.173-004	4.970-001	-1.048-003
4	25105	2.829+000	4.968-001	2.829+000	3.996-005	4.966-001	1.934-004	2.829+000	2.488-005	4.967-001	1.202-004
5	25105	2.829+000	4.968-001	2.829+000	3.996-005	4.966-001	1.934-004	2.829+000	2.488-005	4.967-001	1.202-004
6	23111	2.956+000	4.611-001	2.957+000	-1.806-003	4.698-001	-6.734-003	2.957+000	-1.810-003	4.698-001	-8.726-003
7	23107	2.976+000	4.669-001	2.976+000	1.997-004	4.659-001	9.660-004	2.976+000	2.040-004	4.659-001	9.839-004
8	23107	2.976+000	4.669-001	2.976+000	1.006-004	4.659-001	4.866-004	2.976+000	1.046-004	4.659-001	5.047-004
9	21719	2.992+000	4.623-001	2.992+000	-5.874-005	4.626-001	-2.843-004	2.992+000	-5.315-005	4.626-001	-2.562-004
10	22009	3.006+000	4.609-001	3.006+000	2.384-004	4.597-001	1.153-003	3.006+000	2.467-004	4.597-001	1.190-003
11	22317	3.009+000	4.609-001	3.008+000	3.583-004	4.592-001	1.733-003	3.008+000	3.673-004	4.591-001	1.771-003
12	20124	3.088+000	4.436-001	3.088+000	1.994-004	4.426-001	9.665-004	3.088+000	2.185-004	4.425-001	1.054-003
13	18603	3.171+000	4.250-001	3.171+000	-5.507-005	4.253-001	-2.665-004	3.171+000	-2.645-005	4.251-001	-1.275-004
15	25713	2.789+000	5.043-001	2.789+000	-1.314-004	5.049-001	-6.357-004	2.789+000	-1.522-004	5.050-001	-7.336-004
16	26521	2.820+000	4.946-001	2.821+000	-7.557-004	4.943-001	-3.659-003	2.821+000	-7.742-004	4.943-001	-3.733-003
17	25315	2.832+000	4.968-001	2.832+000	1.605-004	4.959-001	8.733-004	2.832+000	1.663-004	4.960-001	8.020-004
18	25105	2.837+000	4.990-001	2.836+000	8.191-004	4.950-001	3.962-003	2.836+000	8.073-004	4.951-001	3.893-003
19	25105	2.837+000	4.990-001	2.836+000	8.191-004	4.950-001	3.962-003	2.836+000	8.073-004	4.951-001	3.893-003
20	23111	2.973+000	4.652-001	2.974+000	-2.530-004	4.684-001	-1.224-003	2.974+000	-2.503-004	4.684-001	-1.207-003
21	23107	2.978+000	4.682-001	2.978+000	5.400-004	4.656-001	2.612-003	2.978+000	5.455-004	4.656-001	2.631-003
22	23107	2.978+000	4.682-001	2.978+000	5.400-004	4.656-001	2.612-003	2.978+000	5.455-004	4.656-001	2.631-003
23	21719	2.991+000	4.596-001	2.991+000	-6.476-004	4.627-001	-3.133-003	2.991+000	-6.438-004	4.627-001	-3.105-003
24	22009	2.994+000	4.594-001	2.995+000	-4.393-004	4.620-001	-2.125-003	2.995+000	-4.345-004	4.620-001	-2.095-003
25	22317	3.006+000	4.598-001	3.006+000	1.213-005	4.597-001	5.877-005	3.006+000	1.973-005	4.597-001	9.523-005
26	20124	3.087+000	4.430-001	3.087+000	3.541-005	4.428-001	1.714-004	3.087+000	5.351-005	4.427-001	2.581-004
27	18603	3.175+000	4.250-001	3.175+000	1.144-004	4.244-001	5.534-004	3.175+000	1.441-004	4.243-001	6.948-004
28	18603	3.175+000	4.250-001	3.175+000	1.144-004	4.244-001	5.534-004	3.175+000	1.441-004	4.243-001	6.948-004

AVERAGES 2.954+000 4.706-001

WEIGHTED
AVERAGES 2.951+000 4.712-001

$$Y = B * X + A$$

$$Y - YU = B * (X - X0)$$

SLOPE ESTIMATE	-2.086-001	-2.092-001
% STD DEV OF SLOPE	-2.034	-1.118
INTERCEPT ESTIMATE	1.087+000	
VARIANCE OF X	2.873-005	
X VARIANCE ESTIMATE	2.453-007	2.651-007
% STD DEV OF X	.017	.017
VARIANCE OF Y	2.899-005	
Y VARIANCE ESTIMATE	2.476-007	6.165-006
% STD DEV OF Y	.106	.528
CORRELATION COEFFICIENT	-.9947	-1.0000

BATCH IDENT NO. 23111 IS AN OUTLIER

		Y = B*X + A										Y - Y0 = B*(X - X0)									
I	IDENT	X VALUE	Y VALUE	PRED X	X RESIDUAL	PRED Y	Y RESIDUAL	PRED X	X RESIDUAL	PRED Y	Y RESIDUAL	PRED X	X RESIDUAL	PRED Y	Y RESIDUAL	PRED X	X RESIDUAL	PRED Y	Y RESIDUAL	PRED X	X RESIDUAL
1	25713	2.789+000	5.052-001	2.789+000	5.186-006	5.052-001	2.518-005	2.790+000	-2.331-005	5.053-001	-1.122-004	2.790+000	-2.331-005	5.053-001	-1.122-004	2.790+000	-2.331-005	5.053-001	-1.122-004	2.790+000	-2.331-005
2	26521	2.831+000	4.958-001	2.831+000	-1.427-004	4.965-001	-6.908-004	2.831+000	-1.643-004	4.966-001	-7.916-004	2.831+000	-1.643-004	4.966-001	-7.916-004	2.831+000	-1.643-004	4.966-001	-7.916-004	2.831+000	-1.643-004
3	25315	2.827+000	4.960-001	2.827+000	-2.683-004	4.973-001	-1.299-003	2.827+000	-2.911-004	4.974-001	-1.403-003	2.827+000	-2.911-004	4.974-001	-1.403-003	2.827+000	-2.911-004	4.974-001	-1.403-003	2.827+000	-2.911-004
4	25105	2.829+000	4.968-001	2.829+000	-2.724-005	4.969-001	-1.319-004	2.829+000	-4.870-005	4.970-001	-2.346-004	2.829+000	-4.870-005	4.970-001	-2.346-004	2.829+000	-4.870-005	4.970-001	-2.346-004	2.829+000	-4.870-005
5	25105	2.829+000	4.968-001	2.829+000	-2.724-005	4.969-001	-1.319-004	2.829+000	-4.870-005	4.970-001	-2.346-004	2.829+000	-4.870-005	4.970-001	-2.346-004	2.829+000	-4.870-005	4.970-001	-2.346-004	2.829+000	-4.870-005
7	23107	2.976+000	4.669-001	2.976+000	1.298-004	4.663-001	6.281-004	2.976+000	1.357-004	4.662-001	6.538-004	2.976+000	1.357-004	4.662-001	6.538-004	2.976+000	1.357-004	4.662-001	6.538-004	2.976+000	1.357-004
8	23107	2.976+000	4.664-001	2.976+000	3.073-005	4.663-001	1.488-004	2.976+000	3.624-005	4.662-001	1.746-004	2.976+000	3.624-005	4.662-001	1.746-004	2.976+000	3.624-005	4.662-001	1.746-004	2.976+000	3.624-005
9	21719	2.992+000	4.623-001	2.992+000	-1.288-004	4.629-001	-6.235-004	2.992+000	-1.211-004	4.629-001	-5.835-004	2.992+000	-1.211-004	4.629-001	-5.835-004	2.992+000	-1.211-004	4.629-001	-5.835-004	2.992+000	-1.211-004
10	22009	3.006+000	4.609-001	3.006+000	1.680-004	4.601-001	8.129-004	3.006+000	1.794-004	4.600-001	8.645-004	3.006+000	1.794-004	4.600-001	8.645-004	3.006+000	1.794-004	4.600-001	8.645-004	3.006+000	1.794-004
11	22317	3.009+000	4.609-001	3.009+000	2.878-004	4.595-001	1.393-003	3.008+000	3.002-004	4.595-001	1.447-003	3.008+000	3.002-004	4.595-001	1.447-003	3.008+000	3.002-004	4.595-001	1.447-003	3.008+000	3.002-004
12	20124	3.088+000	4.436-001	3.088+000	1.279-004	4.430-001	6.191-004	3.088+000	1.541-004	4.429-001	7.425-004	3.088+000	1.541-004	4.429-001	7.425-004	3.088+000	1.541-004	4.429-001	7.425-004	3.088+000	1.541-004
13	18603	3.171+000	4.250-001	3.171+000	-1.283-004	4.256-001	-6.211-004	3.171+000	-8.813-005	4.254-001	-4.247-004	3.171+000	-8.813-005	4.254-001	-4.247-004	3.171+000	-8.813-005	4.254-001	-4.247-004	3.171+000	-8.813-005
15	25713	2.789+000	5.043-001	2.789+000	-1.979-004	5.053-001	-9.576-004	2.789+000	-2.273-004	5.054-001	-1.095-003	2.789+000	-2.273-004	5.054-001	-1.095-003	2.789+000	-2.273-004	5.054-001	-1.095-003	2.789+000	-2.273-004
16	26521	2.820+000	4.946-001	2.821+000	-8.225-004	4.986-001	-3.980-003	2.821+000	-8.487-004	4.987-001	-4.084-003	2.821+000	-8.487-004	4.987-001	-4.084-003	2.821+000	-8.487-004	4.987-001	-4.084-003	2.821+000	-8.487-004
17	25315	2.832+000	4.968-001	2.832+000	1.112-004	4.963-001	5.478-004	2.832+000	9.292-005	4.964-001	4.477-004	2.832+000	9.292-005	4.964-001	4.477-004	2.832+000	9.292-005	4.964-001	4.477-004	2.832+000	9.292-005
18	25105	2.837+000	4.990-001	2.837+000	7.514-004	4.954-001	3.636-003	2.837+000	7.346-004	4.955-001	3.540-003	2.837+000	7.346-004	4.955-001	3.540-003	2.837+000	7.346-004	4.955-001	3.540-003	2.837+000	7.346-004
19	25105	2.837+000	4.990-001	2.837+000	7.514-004	4.954-001	3.636-003	2.837+000	7.346-004	4.955-001	3.540-003	2.837+000	7.346-004	4.955-001	3.540-003	2.837+000	7.346-004	4.955-001	3.540-003	2.837+000	7.346-004
20	23111	2.973+000	4.652-001	2.974+000	-3.276-004	4.668-001	-1.561-003	2.974+000	-3.191-004	4.667-001	-1.537-003	2.974+000	-3.191-004	4.667-001	-1.537-003	2.974+000	-3.191-004	4.667-001	-1.537-003	2.974+000	-3.191-004
21	23107	2.978+000	4.682-001	2.978+000	4.700-004	4.659-001	2.274-003	2.978+000	4.776-004	4.659-001	2.301-003	2.978+000	4.776-004	4.659-001	2.301-003	2.978+000	4.776-004	4.659-001	2.301-003	2.978+000	4.776-004
22	23107	2.978+000	4.682-001	2.978+000	4.700-004	4.659-001	2.274-003	2.978+000	4.776-004	4.659-001	2.301-003	2.978+000	4.776-004	4.659-001	2.301-003	2.978+000	4.776-004	4.659-001	2.301-003	2.978+000	4.776-004
23	21719	2.991+000	4.596-001	2.991+000	-7.174-004	4.631-001	-3.472-003	2.991+000	-7.123-004	4.630-001	-3.432-003	2.991+000	-7.123-004	4.630-001	-3.432-003	2.991+000	-7.123-004	4.630-001	-3.432-003	2.991+000	-7.123-004
24	22009	2.994+000	4.599-001	2.995+000	-5.093-004	4.624-001	-2.465-003	2.995+000	-5.027-004	4.623-001	-2.422-003	2.995+000	-5.027-004	4.623-001	-2.422-003	2.995+000	-5.027-004	4.623-001	-2.422-003	2.995+000	-5.027-004
25	22317	3.006+000	4.598-001	3.006+000	-5.817-005	4.601-001	-2.816-004	3.006+000	-4.770-005	4.600-001	-2.298-004	3.006+000	-4.770-005	4.600-001	-2.298-004	3.006+000	-4.770-005	4.600-001	-2.298-004	3.006+000	-4.770-005
26	20124	3.087+000	4.430-001	3.087+000	-3.636-005	4.432-001	-1.760-004	3.087+000	-1.106-005	4.431-001	-5.327-005	3.087+000	-1.106-005	4.431-001	-5.327-005	3.087+000	-1.106-005	4.431-001	-5.327-005	3.087+000	-1.106-005
27	18603	3.175+000	4.250-001	3.175+000	4.101-005	4.248-001	1.985-004	3.175+000	8.266-005	4.246-001	3.982-004	3.175+000	8.266-005	4.246-001	3.982-004	3.175+000	8.266-005	4.246-001	3.982-004	3.175+000	8.266-005
28	18603	3.175+000	4.250-001	3.175+000	4.101-005	4.248-001	1.985-004	3.175+000	8.266-005	4.246-001	3.982-004	3.175+000	8.266-005	4.246-001	3.982-004	3.175+000	8.266-005	4.246-001	3.982-004	3.175+000	8.266-005
AVERAGES		2.954+000	4.709-001																		
WEIGHTED AVERAGES		2.950+000	4.716-001																		

	Y = B*X + A	Y - Y0 = B*(X - X0)
SLOPE ESTIMATE	-2.085-001	-2.094-001
% STD DEV OF SLOPE	-1.447	-.085
INTERCEPT ESTIMATE	1.081+000	
VARIANCE OF X	2.873-005	
X VARIANCE ESTIMATE	1.342-007	1.400-007
% STD DEV OF X	.012	.013
VARIANCE OF Y	2.899-005	
Y VARIANCE ESTIMATE	1.354-007	3.249-006
% STD DEV OF Y	.078	.383
CORRELATION COEFFICIENT	-.9973	-1.0000

PAIRED COMPARISON STATISTICS

	REMEASURED SET MEASURED SET	YANKEE ROWE (PWR 185MW) YANKEE ROWE (PWR 185MW)	NBS NFS	CORES 5,6 CORES 1-8	015 US P 015 US P					
CORRELATION VARIABLE	U-235 ENRICHMENT	NO. OF SAMPLES	VARIABLE VAR 1	AVERAGES VAR 2	AVERAGE DIFFERENCE	STUDENTS T VALUE	CRITICAL VALUE	% RANDOM STD DEV	% BIAS STD DEV	% PROCESS STD DEV
U-236	99.999	31	3.8802-001	3.8708-001	9.3226-004	1.020	2.042	.928	.034	23.551
U-235	99.999	31	2.7255+000	2.7274+000	-1.8516-003	-1.644	2.042	.163	.038	13.058
RATIO	99.999	31	1.4301-001	1.4259-001	4.1823-004	1.475	2.042	.782	.152	21.773
U-236	4.101	15	3.3326-001	3.3296-001	3.0000-004	1.317	2.145	.187	.041	17.228
U-235	4.101	15	2.6195+000	2.6225+000	-2.9133-003	-2.310	2.145	.132	.071	11.125
RATIO	4.101	15	1.3100-001	1.3071-001	2.8793-004	4.763	2.145	.127	.152	28.013
U-236	4.935	14	4.7071-001	4.6911-001	1.6000-003	.786	2.160	1.146	.000	5.202
U-235	4.935	14	2.9608+000	2.9624+000	-1.6214-003	-.800	2.160	.181	.000	4.277
RATIO	4.935	14	1.5956-001	1.5898-001	5.8150-004	.916	2.160	1.054	.000	9.445

REGRESSION STATISTICS

REMEASURED SET	YANKEE ROWE (PWR 1RSMW)	NBS	CONES 5-6	015 US P
MEASURED SET	YANKEE ROWE (PWR 1RSMW)	NFS	CORES 1-8	015 US P
U-236		VS	U-235	

DEMINGS APPROACH TO ERRORS IN BOTH VARIABLES

U-235	NO. OF		Y = B*X + A		* STANDARD DEV. CORRELATION			Y-YO = B*(X-XO)				
ENRICHMENT	SAMPLES	SLOPE	% STO DEV	INTERCEPT	OF X	OF Y	COEFFICIENT	SLOPE	OF SLOPE	OF X	OF Y	CORR.
			OF SLOPE									COEFF.
4.101	30	-1.968-001	-.980	8.490-001	.078	.110	-.9987	-2.032-001	-.209	.364	.465	-.9999
4.935	28	-2.085-001	-1.447	1.087-000	.012	.078	-.9973	-2.094-001	-.085	.013	.343	-1.0000

U-235 REMEASURED SET YANKEE PUNE (PWR 145MW) NRS CORES 5,6 015 US P
VS U-235 ENRICHMENT= 4.93500

				$Y = B_0 + B_1 X$				$Y - Y_0 = B_1(X - X_0)$			
1	IDENT	X VALUE	Y VALUE	PRED X	X RESIDUAL	PRED Y	Y RESIDUAL	PRED X	X RESIDUAL	PRED Y	Y RESIDUAL
1	25713	2.789+000	5.052-001	2.784+000	5.045-001	5.044-001	7.630-004	2.793+000	-3.121-003	5.054-001	-3.714-004
2	25521	2.831+000	4.958-001	2.829+000	1.542-003	4.956-001	2.010-004	2.836+000	-5.223-003	4.964-001	-6.216-004
3	25315	2.827+000	4.960-001	2.827+000	-2.240-004	4.960-001	-2.850-005	2.834+000	-7.167-003	4.969+001	-6.530-004
4	25105	2.829+000	4.968-001	2.828+000	3.454-003	4.964+001	4.440-004	2.832+000	-3.454-003	4.977-001	-4.116-004
5	25105	2.829+000	4.968-001	2.826+000	3.454-003	4.964+001	4.440-004	2.832+000	-3.454-003	4.977-001	-4.116-004
6	23111	2.956+000	4.611-001	2.947+000	-3.164-002	4.632-001	-4.044-003	2.987+000	-3.130-002	4.644+001	-3.724-003
7	23107	2.976+000	4.669+001	2.977+000	-1.264-003	4.671-001	-1.043-004	2.977+000	-4.447-004	4.670+001	-5.351-005
8	23107	2.976+000	4.669+001	2.979+000	-2.814-003	4.668+001	-3.652-004	2.978+000	-1.970-003	4.664+001	-2.344-004
9	21719	2.992+000	4.623+001	2.994+000	-0.040-003	4.631-001	-7.649+004	2.994+000	-4.355+003	4.624+001	-5.183+004
10	22009	3.006+000	4.609+001	3.008+000	-2.120-003	4.612+001	-2.746+004	3.006+000	2.572+004	4.607+001	3.061+005
11	22317	3.009+000	4.609+001	3.009+000	-3.845+004	4.609+001	-4.444+005	3.007+000	2.108+003	4.604+001	2.506+004
12	20124	3.024+000	4.430+001	3.025+000	-6.750+003	4.445+001	-0.744+004	3.028+000	-2.424+005	4.434+001	-2.443+006
13	10603	3.171+000	4.250+001	3.136+000	-1.442+002	4.209+001	-1.919+003	3.175+000	-3.621+003	4.254+001	-4.309+004
14	10603	3.172+000	4.523+001	3.161+000	7.044+002	4.632+001	9.130+003	3.092+000	8.003+002	4.424+001	9.524+003
15	11220	3.083+000	4.445+001	3.072+000	-1.674+002	4.469+001	-2.420+003	3.076+000	-1.305+002	4.461+001	-1.553+003

AVERAGES 2.965+000 4.690+001

WEIGHTED
AVERAGES 2.963+000 4.701+001

$$Y = B_0 + B_1 X \quad Y - Y_0 = B_1(X - X_0)$$

SLOPE ESTIMATE	-1.428-001	-2.098-001
* STD DEV OF SLOPE	8.104	4.482
INTERCEPT ESTIMATE	1.041+000	
VARIANCE OF X	1.000+000	
X VARIANCE ESTIMATE	5.742-005	5.506+004
* STD DEV OF X	.255	.741
VARIANCE OF Y	1.000+000	
Y VARIANCE ESTIMATE	1.434+000	7.797+006
* STD DEV OF Y	.255	.595
CORRELATION COEFFICIENT	-.9570	-.9798

HATCH IDENT NO. 10603 IS AN OUTLIER

		Y = H*X + A						Y - Y0 = H*(X - X0)			
I	IDENT	X VALUE	Y VALUE	PRED X	X RESIDUAL	PRED Y	Y RESIDUAL	PRED X	X RESIDUAL	PRED Y	Y RESIDUAL
1	25713	2.789+000	5.052-001	2.788+000	1.843-003	5.050-001	2.218-004	2.787+000	2.620-003	5.049-001	3.179-004
2	26521	2.831+000	4.958-001	2.831+000	-1.529-004	4.958-001	-1.841-005	2.831+000	4.161-004	4.957-001	5.049-005
3	25315	2.827+000	4.960-001	2.829+000	-2.094-003	4.963-001	-2.520-004	2.829+000	-1.509-003	4.962-001	-1.831-004
4	25105	2.829+000	4.968-001	2.827+000	1.596-003	4.966-001	1.921-004	2.827+000	2.179-003	4.965-001	2.643-004
5	25105	2.829+000	4.968-001	2.827+000	1.596-003	4.966-001	1.921-004	2.827+000	2.179-003	4.965-001	2.643-004
6	23111	2.956+000	4.611-001	2.981+000	-2.578-002	4.642-001	-3.103-003	2.981+000	-2.588-002	4.642-001	-3.139-003
7	23107	2.976+000	4.669-001	2.971+000	4.916-003	4.663-001	5.918-004	2.971+000	4.781-003	4.663-001	5.800-004
8	23107	2.976+000	4.664-001	2.973+000	3.406-003	4.660-001	4.099-004	2.973+000	3.268-003	4.660-001	3.984-004
9	21719	2.992+000	4.623-001	2.991+000	1.071-003	4.622-001	1.289-004	2.991+000	8.502-004	4.622-001	1.031-004
10	22009	3.006+000	4.609-001	3.000+000	5.645-003	4.602-001	8.844-004	3.000+000	5.400-003	4.602-001	6.558-004
11	22317	3.009+000	4.609-001	3.001+000	7.531-003	4.600-001	9.065-004	3.002+000	7.241-003	4.600-001	8.784-004
12	20124	3.088+000	4.430-001	3.082+000	5.590-003	4.429-001	6.728-004	3.083+000	4.907-003	4.430-001	5.952-004
13	18603	3.171+000	4.250-001	3.169+000	2.203-003	4.247-001	2.651-004	3.170+000	1.104-003	4.249-001	1.339-004
15	11226	3.063+000	4.445-001	3.071+000	-7.407-003	4.454-001	-8.916-004	3.071+000	-7.996-003	4.455-001	-9.700-004

AVE-AGES 2.953+000 4.702-001

WEIGHTED
AVE-AGES 2.947+000 4.714-001

	Y = H*X + A	Y - Y0 = H*(X - X0)
SLOPE ESTIMATE	-2.106-001	-2.090-001
* STD DEV OF SLOPE	-3.120	-.170
INTERCEPT ESTIMATE	1.092+000	
VARIANCE OF X	1.000+000	
X VARIANCE ESTIMATE	8.367-006	6.874-005
* STD DEV OF X	.098	.281
VARIANCE OF Y	1.000+000	
Y VARIANCE ESTIMATE	2.121-007	1.011-006
* STD DEV OF Y	.098	.214
CORRELATION COEFFICIENT	-.9937	-1.0000

REGRESSION STATISTICS

REMEASURED SET YANKEE ROWE (PWH 1P5MW) NBS CORES 5+6 015 US P
U-236 VS U-235

DEMINGS APPROACH TO ERRORS IN BOTH VARIABLES

U-235 ENRICHMENT	NO. OF SAMPLES	SLOPE	Y = B*X + A % STD DEV OF SLOPE INTERCEPT		% STANDARD DEV. OF X OF Y		CORRELATION COEFFICIENT	SLOPE	Y-YO = B*(X-XO) % STANDARD DEVIATION OF SLOPE OF X OF Y			CORR. COEFF.
4.101	15	-1.962-001	-1.271	8.473-001	.115	.115	-.9989	-2.031-001	-.285	.456	.286	-.9999
4.935	15	-2.106-001	-3.120	1.092-000	.098	.098	-.9937	-2.090-001	-.170	.281	.214	-1.0000

FIGURE B.1. Plot of ^{236}U vs. ^{235}U for the Indicated Data Sets

FIGURE B.2. Plot of the Enrichment Against the Mean Isotopic Ratios of ^{236}U vs. ^{235}U for the Indicated Data Sets

FIGURE B.3. Plot of Cooling Time Against the Paired Comparison Percent Differences of ^{236}U .

FIGURE B.4. Plot of Cooling Time Against the Paired Comparison Percent Differences of ^{235}U .

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