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THESIS

A COMPARISON OF THE BASKET METHOD
AND DOLLAR UNIT SAMPLING FOR
CONTRACT CHANGE ORDER NEGOTIATIONS

by

James P. Tortorelli

December 1986

Thesis Advisor:

Shu S. Liao

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T233047

REPORT DOCUMENTATION PAGE

1a REPORT SECURITY CLASSIFICATION UNCLASSIFIED		1b. RESTRICTIVE MARKINGS	
2a SECURITY CLASSIFICATION AUTHORITY		3 DISTRIBUTION/AVAILABILITY OF REPORT Approved for public release; distribution is unlimited	
2b DECLASSIFICATION/DOWNGRADING SCHEDULE		4 PERFORMING ORGANIZATION REPORT NUMBER(S)	
4 PERFORMING ORGANIZATION REPORT NUMBER(S)		5 MONITORING ORGANIZATION REPORT NUMBER(S)	
6a NAME OF PERFORMING ORGANIZATION Naval Postgraduate School	6b OFFICE SYMBOL (if applicable) 54	7a. NAME OF MONITORING ORGANIZATION Naval Postgraduate School	
6c. ADDRESS (City, State, and ZIP Code) Monterey, California 93943-5000		7b. ADDRESS (City, State, and ZIP Code) Monterey, California 93943-5000	
8a NAME OF FUNDING/SPONSORING ORGANIZATION	8b OFFICE SYMBOL (if applicable)	9 PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER	
8c. ADDRESS (City, State, and ZIP Code)		10 SOURCE OF FUNDING NUMBERS	
		PROGRAM ELEMENT NO	PROJECT NO
		TASK NO	WORK UNIT ACCESSION NO
11 TITLE (Include Security Classification) A COMPARISON OF THE BASKET METHOD AND DOLLAR UNIT SAMPLING FOR CONTRACT CHANGE ORDER NEGOTIATIONS			
12 PERSONAL AUTHOR(S) Tortorelli, James P.			
13a TYPE OF REPORT Master's Thesis	13b TIME COVERED FROM TO	14 DATE OF REPORT (Year, Month, Day) 1986 December	15 PAGE COUNT 35
16 SUPPLEMENTARY NOTATION			
17 COSATI CODES		18 SUBJECT TERMS (Continue on reverse if necessary and identify by block number)	
FIELD	GROUP	SUB-GROUP	
		Basket Method, Dollar Unit Sampling, Auditing, Sampling, Change order negotiation, Simulation	
19 ABSTRACT (Continue on reverse if necessary and identify by block number) The Basket Method and Dollar Unit Sampling techniques are examined to determine which of them draws a sample which allows a more accurate estimate of a population to be made. The several populations used in the simulation have errors planted to represent both random "honest" mistakes and weighted "dishonest" mistakes. The author concludes that the Basket Method has a more desirable accuracy pattern than the Dollar Unit Sampling Technique.			
20 DISTRIBUTION/AVAILABILITY OF ABSTRACT <input checked="" type="checkbox"/> UNCLASSIFIED/UNLIMITED <input type="checkbox"/> SAME AS RPT <input type="checkbox"/> DTIC USERS		21 ABSTRACT SECURITY CLASSIFICATION UNCLASSIFIED	
22a NAME OF RESPONSIBLE INDIVIDUAL Shu S. Liao		22b TELEPHONE (Include Area Code) 408-646-2505	22c OFFICE SYMBOL 54LC

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A Comparison of The Basket Method
and Dollar Unit Sampling for
Contract Change Order Negotiations

by

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Submitted in partial fulfillment of the
requirements for the degree of

MASTER OF SCIENCE IN MANAGEMENT

from the

NAVAL POSTGRADUATE SCHOOL
December 1986

ABSTRACT

The Basket Method and Dollar Unit Sampling techniques are examined to determine which of them draws a sample which allows a more accurate estimate of a population to be made. The several populations used in the simulation have errors planted to represent both random "honest" mistakes and weighted "dishonest" mistakes. The author concludes that the Basket Method has a more desirable accuracy pattern than the Dollar Unit Sampling Technique.

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I. INTRODUCTION

A. NEED FOR THIS STUDY

In major weapon system acquisition, the Department of Defense typically issues a large number of change orders to modify an existing contract. In each case, the contractor prepares a proposal of contract price adjustment for the requested changes. A lead ship or aircraft production contract may generate over 10,000 such proposals.

Acquisition regulations require the government to analyze each proposal and negotiate with the contractor for a fair price adjustment. However, these requirements produce more work than the existing number of government auditors can undertake. Generally, as backlogs develop, thoroughness is reduced for expediency, and errors slip by. However, work in progress usually goes on, but contractors are not paid until after the proposal is processed. This delay in funding raises the capital cost to the contractor for performing work for the government.

It is in the best interests of both the government and the contractors to raise the accuracy and speed and reduce the cost of auditing such proposals of price adjustment. If it were allowed by the acquisition process, analyzing and negotiating a sample of proposals selected with an effective sampling technique could have these effects.

The reason for auditing the proposal population is to ensure the proposals are realistic and fair. During an audit, a proposal will be found to be understated, that is the Government feels that the proposed cost of a change to the contract is less than the actual cost the contractor will incur, or overstated, or correct. Any overstatement or understatement is considered an error in the proposal population. The ideal sampling technique would choose a sample from the population of proposals which, when audited, would always give an estimated value for the population as a whole which was exactly correct, no matter what the degree or distribution of errors in the proposal population. Such a technique does not exist.

Assuming, then, that there will be some degree of error in the prediction of the true value of the entire proposal population whenever a sampling technique is used; the behavior of the degree of error must be predictable and exhibit certain qualities in order for the sampling technique to be considered appropriate for the purpose described above.

Specifically, the degree of error should not be easily altered by the error arrangement, that is the distribution, size, frequency, or type (overstatement or understatement) of errors found in the population, as long as the total error is the same. A sampling procedure which shows little response to changes in the error arrangement will be said to show consistency. If certain patterns of errors caused the entire population to be evaluated as understated then the government would pay more than a fair price for the changes described by the population of proposals which contained those errors. This, in turn, would tend to encourage fraud, since a contractor could carefully seed his proposal population with deliberate errors of the appropriate size, type, and distribution and thereby be awarded a larger payment from the government.

Therefore, the desired method will not necessarily be the one which results in the most accurate, average estimate for various error arrangements in the proposal population. It will instead be the method which responds least to variations in the error arrangement.

B. METHODOLOGY

In this paper the Dollar Unit Sampling Method and the Basket Method will be used to draw samples from populations for evaluation. The populations were used earlier in a joint study of the American Institute of Certified Public Accountants and the American Statistical Association. Each population consists of two columns of values which represent the proposed, or book value of a contract change and the audited or true value of that change. The populations are rigged with either random or planned errors. Samples drawn by the two methods from each population will be evaluated and compared to determine which method gives a better estimate of the whole population according to the goals described above. Both the error rigging and evaluation steps are explained further in the description of the simulation.

The amount of work associated with auditing is more closely related to the number of items being audited than to the total dollar value of all the items being audited. Therefore, the sampling rules of the two methods will be adjusted so that they will draw samples with the same number of proposals from each population. The results of this study will then indicate which method yields the more desirable prediction, that is, the greater benefit, while holding the cost of the audit constant.

II. DOLLAR UNIT SAMPLING

A. HISTORY

Dollar Unit Sampling is a technique which is strongly based on statistical theory. It determines the possible error in a sample based on a Poisson model of the population.

The roots of the Dollar Unit Sampling method can be traced to the 1960's when van Heerden developed the "guilder number" method [Ref. 1]. About the same time, K. W. Stringer developed a similar model which he called Cumulative Monetary Amounts (CMA) Sampling [Ref. 2]. Dr. Albert Teitlebaum then developed a model similar to Cumulative Monetary Amounts Sampling which he called Dollar Unit Sampling (DUS) [Refs. 3,4,5,6]. In December of 1973 he presented the first attempt at a comprehensive proof for Dollar Unit Sampling, which led to rising prominence of the Dollar Unit Sampling method [Refs. 3,7].

Dollar Unit Sampling is also known as Monetary Sampling (MS), Combined Attribute Variable Sampling (CAV), Monetary Unit Sampling Technique (MUST), Sampling Proportionate to size (SPS), and Probability Proportional to Size (PPS) [Ref. 8].

The CMA procedure is the most widely used version of DUS, but it has the disadvantage of overestimating the possible overstatement [Refs. 7,8,9]. While this is a conservative error, from the government's viewpoint, it is still an error, and contractors will be unlikely to bind themselves to a method which will routinely overcorrect against them.

B. DESCRIPTION OF DOLLAR UNIT SAMPLING

There are three steps to using the Dollar Unit Sampling method: calculating the sample size, choosing the sample, and calculating the error. These steps will be briefly discussed below.

1. Calculating Sample Size

There are four commonly used methods for the determination of the sample size. All require the total book value of the contract changes, the reliability factor for a given level of confidence, and the amount of error which can be tolerated for a given level of confidence. The better the estimated amount of error in the sample is known,

the more accurate the required sample size will be. In practice, tables are used which specify the sample size based certain arguments for book value, level of confidence, and estimated error rate.

In this study; however, the process of selecting a sample size is not required to be followed. This is because in actual applications where the true value of the population is not known the only way to be reasonably certain that one's results are valid is by complying with rules which will tie the audit to statistical theory. The sampling rules for Dollar Unit Sampling are intended to do just that, so that the auditor who follows the sampling procedures will be able to determine the extent of the audit required to achieve the desired certainty.

In this study the true values of the proposals are known, as are the size and distribution of the errors, and the Dollar Unit Sampling method is not being compared to its theoretical limits, but to a second method to determine which of the two gives a more desirable result in a certain case for the same amount of work. Therefore, the size of the sample must be based on a number of proposals rather than a number of dollars. This being the case, one tenth of the total number of proposals in the population was arbitrarily chosen as the size.

2. Drawing the Sample

The heart of Dollar Unit Sampling is the choosing of the sample. Rather than a random technique, which might select a certain number of *contracts* to audit, the sample size calculated in the previous step refers to a number of *single dollar units*. Single dollar units are merely dollars. Thus, a proposal which is estimated at one hundred dollars would contain one hundred single dollar units. Each of these dollars has the same probability of being selected as every other dollar in the entire proposal population. When a dollar unit is selected, the entire proposal in which it resides is audited. Since the single dollar units are each given the same chance of being selected, a proposal with a larger dollar value than another has a larger chance of being selected for the audit.

To select the dollars, and thereby the proposals, to be audited, the proposals are stacked and then added to form a series of partial sums. The proposals which lie between the partial sums which bracket the random numbers generated by the sizing calculations are selected for auditing. A simple algorithm for accomplishing this is to subtract the proposal book values from the random number until the difference is negative and audit the last proposal subtracted. The step by step process is as follows:

1. Arrange the proposals in a sequence and find the sum of their book values.

2. Calculate the Average Sample Interval (ASI) using the equation:

$$\text{ASI} = B / n$$

where

B = sum of book values and

n = number of dollars to be chosen as determined by the sample size calculation

3. Select a random start number RS such that $0 < RS < ASI$.
4. Subtract the proposal book values, in the sequence determined in step one, from RS until the difference is negative.
5. Audit the proposal which makes the running difference negative, add the ASI to the negative difference, and repeat from step 4.

If a proposal has a book value greater than the ASI it will be chosen. A proposal is only allowed to be chosen once, no matter how large it is, so the number of dollar units calculated when determining the sample size will be greater than number of proposals selected for audit if any proposals have a book value greater than the ASI. The development of digital computers has greatly eased the execution of this phase.

3. The Peach Problem

Before discussing the evaluation phase, it is useful to briefly illustrate and develop the Dollar Unit Sampling technique by examining the 'Peach Problem' [Ref. 8]. In the Peach Problem one must determine the portion of peaches in a lot of one million which is unusable. To determine the size of the portion one will draw a sample and use information on both the number of rotten peaches and the extent of rottenness found.

One hundred sample peaches are randomly drawn and examined. If there are no defective peaches, there is a 5% risk that the percentage of peaches defective exceeds 3%. These numbers are based on the Poisson distribution which is chosen because it is a good estimator of the binomial case being examined. The binomial is that a peach is either rotten to some detectable degree or it is not. Similarly, a proposal is either overstated or understated to some significant degree or it is accurate. It should also be noted that the terms mentioned in the sample size calculation now take on values. The total book value is one million. The α risk, or risk of accepting an unacceptable lot, is 5%, which means the confidence is 95%. The reliability factor for the 95% confidence level is 3%, meaning that at most, 30,000 peaches could be rotten to some degree and the population would still be acceptable.

If there had been one defective peach, there would have been a 5% α risk that the percentage of defective peaches exceeded 4.75%. Similarly, if two defective peaches

were found, there would have been a 5% α risk that the number of defective peaches will exceed 6.31%. These values also come from the Poisson distribution.

What is not considered yet is the fraction of the defective sample peaches which is rotten. This is important if one can use a partial peach or partial dollar.

To account for this in the case with two defective peaches in the sample, the two defective peaches are examined. Assume the two rotten peaches were 8% and 4% rotten. Then in 95% of the cases:

1. The number of totally rotten peaches will be less than 3%.
2. The number of 8% rotten peaches will not exceed an additional 1.75%. (4.75% - 3%)
3. The number of 4% rotten peaches will not exceed 1.56%. (6.31% - 4.75%)

Then the total portion of the population which is rotten will be less than:

3.00% x 100%	= 3.00%
1.75% x 8%	= 0.14%
1.56% x 4%	= 0.06%
	4.62%

This is a better estimate of the total amount of rotten peaches in the lot than 6.31% because it corrects for the usable part of the partially rotten or 'tainted' peaches. It should be noticed that the additional corrections are arranged in order of decreasing percent tainting. This gives the most conservative result since the smaller percent taintings are applied to the smaller percent defect increments.

The analogy applies directly to the proposals problem. The peaches are dollars, each one essentially the same size. The degree of rottenness is the degree of error in the entire proposal in which the sampled dollar is found. Thus, if a chosen dollar is in a proposal which, when audited, reveals an 8% overstatement error, each dollar in that proposal, and in particular, the dollar which was chosen to be sampled, is considered 8% wasted.

4. Calculation of the Result

If there are no errors in the sample, no calculation is required and the amount of error for the planned level of confidence is the planned, tolerable amount of error.

Similarly, if the sample size was determined using the β Risk Only tables, and the sum of the taintings in the sample is less than that planned when the sample size was determined, then the resulting tolerable amount of error is less than that planned and no calculation is required.

If the sample size was determined using the α and β risk tables, and the sum of the taintings is less than the K-factor,¹ then the actual error is less than the planned, tolerable error limit; three percent in the previous example.

If some other result is reached then some calculation will be necessary. Each erroneous proposal is listed in order of decreasing tainting. The taintings are then multiplied by the incremental percent defect. The sum of the taintings and tainting products are then used to compute the *net upper error limits*.

If any errors are found materiality must be redefined since the sample size anticipates that the sample will contain no errors. If the errors found are few or small, the new materiality might be close enough to the original goal to allow acceptance of the population.

¹The K-factor is one of the two values read from the tables used to determine the sample size, the other being the sample size. The K-factor is significant because it is compared to the sum of the tainting in the sample to determine if the population can be accepted without exceeding the β risk (\sum taintings \leq K-factor) or rejected without exceeding the α risk. (\sum taintings $>$ K-factor)

III. THE BASKET METHOD

A. HISTORY

The Basket Method was developed by Dr. K. T. Wallenius under the sponsorship of the Office of Naval Research and the Naval Material Command. It is a recently created technique which was formed in direct response to the problems of auditing and negotiating numerous contract proposals with sole source contractors [Ref. 10].

B. DESCRIPTION

The Basket Method derives its name from its process of sorting a population into a number of baskets, one of which will be randomly selected for sampling. The aim of the basket assignment process is to make each basket resemble the population in any traits of interest. In general, the spread and proportion of proposal values will be nearly identical to the population. Sophisticated software can quickly balance baskets for work center assignments, material usage, skill requirements, etc. In short, whatever trait is deemed pertinent to the value of an audit will be balanced by the Basket Method *where possible*. Obviously, in a population of proposals where one is ten times larger than any others it would be more practical to remove that proposal from the population before assigning the baskets.

1. Basket Assignment

Assignment of a population to baskets follows a simple set of rules:

1. All the proposals in the population are arranged in descending order by book value.
2. The largest unassigned proposal is assigned to the first basket, the second largest to the second basket, and so on for the first proposals.
3. The baskets are sorted in *ascending* order by total assigned proposal book value. (The first time this step is performed it will simply reverse the order of the baskets.)
4. The assignment and sort steps are repeated until all the proposals are assigned to a basket.

The effect of this procedure is to add the largest of the next *n* unassigned proposals to the basket with the smallest total book proposal value. The end result is that each basket will have nearly identical total book values and proposal size mixes. The software previously noted will make adjustments to correct for any deviations in totals and balance the mix for traits other than cost as well.

2. Evaluation of Baskets

One basket is chosen randomly and all its proposals are audited. The resulting audit value of the basket is divided by the proposal value to produce a correction factor. The proposal value of the population is then multiplied by the correction factor to determine the population audit result. This will be the *estimated true value* of the population.

IV. DESCRIPTION OF SIMULATION

A. DERIVING COMPARABLE RESULTS

Direct comparison of the Basket Method and the Dollar Unit Sampling method will not be meaningful since the former yields a best estimate of the error rate of a population and the latter returns an upper error limit for a stated assurance level. Since it is the consistency of the drawn sample which is of interest in this investigation, the sample selection process of both the Basket Method and the Dollar Unit Sampling Technique will be used to draw samples from the same populations. The samples will then be evaluated according to the Basket Method, which will give an estimate of the true value of the population, to see how well the sample produced by each method reflects the value of the population. This is appropriate since the negotiated price of a contract should be a best estimate, not an upper limit.

The rules of the Basket Method will create the identical set of baskets from a given population every time they are applied. Therefore, the baskets of the Basket Method can easily be evaluated by complete enumeration. The rules of the Dollar Unit Sampling technique also provide a finite number of samples, but that number is much larger than the number of different baskets. Therefore, the Dollar Unit Sampling technique will be evaluated using a Monte Carlo process in which a random start number is generated for each run and the ASI and order of proposals are kept constant.

To evaluate the sample drawn with the Dollar Unit Sampling rules using the Basket Method evaluation technique the sample is treated as if it was a basket. All its resident proposals are audited and their true value is divided by their proposal value. The resulting factor is multiplied against the population proposal total to determine the best estimate of the true total value of the proposal population.

B. PREPARATION OF THE TEST POPULATIONS

The populations used are described in Table 1.

The original populations were randomly seeded with errors at a 5% and 10% rate of occurrence. The 5% population was then skewed to form two additional test populations. One had its errors skewed strongly to its higher valued proposals, the other to its lower valued proposals. The total dollar amount of error and number of

TABLE 1
POPULATION DESCRIPTION

NAME	A	B	C	D	E
Population	8,300	8,300	8,300	8,300	8,300
Erroneous Proposals	5%	5%	5%	10%	10%
$\sum \$ \text{ Errors} / \sum \$ \text{ Proposals}$	9%	9%	9%	0.1%	10%
Types of Errors	+	+	+	+	+
Skew (none, high, or low)	N	H	L	N	N

NAME	AA	BB	CC	DD	EE
Population	8,300	8,300	8,300	8,300	8,300
Erroneous Proposals	5%	5%	5%	10%	10%
$\sum \$ \text{ Errors} / \sum \$ \text{ Proposals}$	9%	9%	9%	0.1%	10%
Types of Errors	+/-	+/-	+/-	+/-	+/-
Skew (none, high, or low)	N	H	L	N	N

overstated proposals remained constant during the skewing process. All populations were created in both a "dishonest" version which had overstatements only and are named by single letters, and in an "honest" version with both overstatements and understatements named by double letters. Except for the sign on each error, the single letter named populations are identical to their double letter named counterparts. The populations with 10% errors differ in that E and EE, while containing the same number of errors in the same distribution and sign as D and DD respectively, have errors of much larger magnitude, so that the sum of the dollar value of the errors make up 10% of the population in E and EE but only 0.1% of the population in D and DD.

C. SIMULATION EXECUTION

Simulations were run on all populations using both a Basket Method evaluating program and a Dollar Unit Sampling monte carlo simulation program. First, ten baskets were chosen for the Basket Method to remain consistent with the earlier arbitrary decision to audit one tenth of the proposals. This resulted in 830 proposals per basket. Next, an ASI was then selected to produce an average of 830 proposals in the Dollar Unit Sampling simulation, and ten trials were run using the Dollar Unit Sampling selection method. The programs, written for this study in Waterloo Basic, are listed in Appendix A.

The ten audit results for each method were then divided by their respective proposal sums to derive the correction factors. These correction factors were multiplied by the sum of all proposals to give the predicted true total for the population. The difference between the predicted and the actual total was then divided by the sum of all proposals to give a percent error for each basket and trial. The means of the percent errors for each method and each population are listed in Table 2.

TABLE 2
SIMULATION RESULTS (MEAN % ERROR)

NAME	A	B	C	D	E
Basket Method	0.77	1.03	0.66	0.14	0.35
DUS	2.40	-2.06	2.75	0.25	4.75
NAME	AA	BB	CC	DD	EE
Basket Method	0.99	0.99	1.16	0.15	1.21
DUS	0.13	0.14	-0.01	-0.08	-0.28

Detailed results are shown in Appendix B. A positive percent error represents an overestimate and a negative number represents an underestimate error. Using the Basket Method to draw a sample was always more accurate against the overstatements only padding technique. Using the Dollar Unit Sampling technique to draw the sample was more accurate when the proposals contained errors in both directions.

D. RESISTANCE TO PROPOSAL RIGGING

In order to benefit from the potential time and labor savings a sampling system offers, the sampling technique must be resistant to padding schemes. If not, a contractor has much to gain by manipulating the errors in his proposals. Therefore, as mentioned previously, the central issue is not necessarily to determine which of these two methods is the most accurate, but to discover which one benefits padding schemes least. When comparing a method's performance between the single and double letter versions of a population it can be seen that the Basket Method is essentially as strict or stricter, from the governments view, when estimating the value of the overstatement only population as it is when estimating the value of the honest population. For example, the A population, which was rigged with overstatements only, was evaluated by the Basket Method at a value exceeding its actual value by 0.77%. The AA

population, with randomly decided over and understatement, was evaluated at a value exceeding its true value by 0.99%. If these two populations had been submitted, the contractor who made overstatements only would have received 0.22% less in payment from the government. In other words, padding one's proposed contract changes with overstatements in random, low, or high skewed distributions prior to submitting them to the Basket Method for evaluation is not likely to raise the resulting estimate for the population but is instead likely to lower the estimated value. On the other hand, the sample drawn with Dollar Unit Sampling allowed the overstatement padded populations a significantly larger estimate than it did the honest populations.

E. EVALUATION

Assuming honest contractors are as likely to understate as overstate their costs and dishonest contractors are not, honest contractors will be more successful than dishonest contractors against the Basket Method, and dishonest contractors will be more successful than honest contractors against the Dollar Unit Sampling sample method. To choose the Dollar Unit Sampling method to determine a contract value would, in effect, encourage overbidding, since it would be more profitable than remaining honest. Under the Basket Method honesty is as profitable as dishonesty.

F. AREAS FOR FURTHER RESEARCH

This study may be expanded in several ways. It may be repeated with fewer or more baskets. A data set with a much smaller variance in proposal size may be used. The Basket Method can be compared to additional sampling methods. Additional strategies for error arrangements which will reduce the accuracy of the Basket Method can be developed and tested. Particularly, will an understatement only strategy with the same magnitude and distribution of proposal errors result in a total population error in equal magnitude and opposite sign as an overstatement strategy.

APPENDIX A

SIMULATION PROGRAM LISTINGS

Basket Method Enumeration Program Listing

```

00100 REM THIS IS A PROGRAM TO PROCESS DATA USING THE BASKET METHOD
00120 REM DATA IS INPUT FROM A FILE, SEPARATED BY COMMAS, AND LISTED
00140 REM AS PAIRS OF VALUES FOR A BID, THE BOOK FIRST AND THE
00160 REM AUDITED VALUE SECOND. THE PROGRAM EXPECTS 'DATPOP' PAIRS
00180 REM OF VALUES. DATA MUST BE IN DESCENDING ORDER BY BOOK VALUE.
00200 REM
00220 REM ** DIMENSION VARIABLES **
00240 REM
00260 DIM ASUM(50), BSUM(50), ANEXT(50), BNEXT(50)
00280 DIM ERRORP(50), FACTOR(50), ERRORA(50)
00300 REM
00320 REM ** SET CONSTANTS **
00340 REM
00360 B = 10 ! NUMBER OF BASKETS
00380 DATPOP = 8300 ! NUMBER OF DATA PAIRS
00400 BPOP=INT(DATPOP/B) ! INITIATE RUNNING TALLY OF DATA PAIRS READ
00420 OPEN #3, 'TEST (RECFM F LRECL 80)', INPUT
00440 ATOT = 0
00460 BTOT = 0
00480 BPOP1 = 1
00500 FOR J = 1 TO 10
00520 ASUM(J) = 0
00540 BSUM(J) = 0
00560 NEXT J
00580 EES = 0 ! SUM OF ERROR SQUARES
00600 EED = 0 ! SUM OF BASKET DOLLAR SQUARES
01000 REM
01020 REM ** ROUTINE TO READ IN DATA **
01040 REM
01060 IF BPOP1 > BPOP
01080 GOTO 4000 ! IF NO MORE DATA, THEN PROCESS
01100 ENDIF
01120 FOR I = 1 TO B
01140 INPUT #3, ANEXT(I), BNEXT(I)
01160 NEXT I
01180 BPOP1 = BPOP1 + 1
02000 REM
02020 REM ** ROUTINE TO SORT PARTIAL SUMS IN **
02040 REM ** BASKETS IN ASCENDING ORDER **
02060 REM
02080 I = 1
02100 WHILE I < B
02120 IF BSUM(I) > BSUM(I+1)
02140 C1 = BSUM(I)
02160 C2 = ASUM(I)
02180 BSUM(I) = BSUM(I+1)
02200 ASUM(I) = ASUM(I+1)
02220 BSUM(I+1) = C1
02240 ASUM(I+1) = C2
02260 IF I > 1
02280 I = I-1
02300 ENDIF
02320 GOTO 2120
02340 ENDIF
02360 I = I+1
02380 ENDLOOP
03000 REM
03020 REM ** ADD NEXT ROUND TO BASKETS **
03040 REM

```

```

03060 FOR I = 1 TO B
03080   BSUM(I) = BSUM(I) + BNEXT(I)
03100   ASUM(I) = ASUM(I) + ANEXT(I)
03120   NEXT I
03140 GOTO 1060
04000 REM
04020 REM ** ADDING ROUTINE **
04040 REM
04060 FOR I = 1 TO B
04080   BTOT = BTOT + BSUM(I)
04100   ATOT = ATOT + ASUM(I)
04120   NEXT I
04140 FOR I = 1 TO B
04160   FACTOR(I) = ASUM(I)/BSUM(I)
04180   ERRORA(I) = BTOT * FACTOR(I) - ATOT
04185   EES = EES + ERRORA(I) * ERRORA(I)
04190   EED = EED + BSUM(I) * BSUM(I)
04200   ERRORP(I) = 100 * ERRORA(I)/BTOT
04220   MAE = MAE + ABS(ERRORA(I))
04240   MPE = MPE + ABS(ERRORP(I))
04260   NEXT I
04280 MAE = MAE / B
04300 MPE = MPE / B
05000 REM
05020 REM ** PRINT RESULTS **
05040 REM
05060 PRINT 'BASKET BOOK VALUE AUDIT VALUE FACTOR %ERROR ERR OF PR'
05080 FORMO$='TOTAL #####.## #####.## #.#### #.#### #####.##'
05100 FORM1$=' ## #####.## #####.## #.#### #.#### #####.##'
05120 FORM2$=' MEAN #####.##'
05140 PRINT USING FORMO$, BTOT, ATOT, ATOT/BTOT, 100*(BTOT-ATOT)/BTOT,&
05160 & BTOT - ATOT
05180 FOR I = 1 TO B
05200 & PRINT USING FORM1$, I, BSUM(I), ASUM(I), FACTOR(I), ERRORP(I),&
05220 & ERRORA(I)
05240 NEXT I
05260 PRINT USING FORM2$, MPE, MAE
05280 FORM3$=' DOLLARS #####.## #####.##'
05300 FORM4$=' CONTRACTS #####.## #####.##'
06000 PRINT ' MEAN AUDITED S. D.'
06020 PRINT USING FORM3$, BTOT/B, SQR(((B*EED)-(BTOT*BTOT))/(B*(B-1)))
06040 PRINT USING FORM4$, DATPOP/B, 0
06060 REM
06080 REM ** CLEANUP **
06100 REM
06120 CLOSE #3
07000 END

```

Dollar Unit Sampling Monte Carlo Program Listing

```

00010 REM ***** DUS USING ASI ON TESTSET *****
00100 REM THIS IS A PROGRAM TO PROCESS DATA USING DOLLAR UNIT SAMPLING.
00120 REM DATA IS INPUT FROM A FILE, SEPARATED BY COMMAS, AND LISTED
00140 REM AS PAIRS OF VALUES FOR A BID, THE BOOK FIRST AND THE
00160 REM AUDITED VALUE SECOND. THE PROGRAM EXPECTS 'DATPOP' PAIRS
00180 REM OF VALUES. DATA MAY BE IN ANY ORDER
00200 REM
00220 REM ** SET CONSTANTS **
00240 REM
00260 RANDOMIZE ! RANDOMIZE THE START OF THE RANDOM NUMBER GEN
01000 REM
01020 REM **** SET THESE VALUES FOR EACH NEW FILE ****
01040 REM
01060 L = 0 ! LAP COUNTER
01080 L1 = 1 ! TOTAL LAPS TO BE RUN
01100 EEA = 0 ! SUM OF ACTUAL ERROR
01120 EEP = 0 ! SUM OF PERCENTAGE ERROR
01140 EES = 0 ! SUM OF ERROR SQUARES
01160 EEL = 0 ! SUM OF PREDICTIONS
01180 EEV = 0 ! SUM OF AUDIT SIZE IN DOLLARS
01200 EC = 0 ! NUMBER OF CONTRACTS AUDITED
01220 EC2 = 0 ! EC-SQUARED
01240 ED = 0 ! TOTAL BID DOLLARS IN CONTRACTS AUDITED
01260 ED2 = 0 ! ED-SQUARED
01280 B = 21 ! NUMBER OF BASKETS USED IN ALT METHOD
01300 DATPOP = 8300 ! NUMBER OF DATA PAIRS
01310 ASI = DATPOP / B
01320 OPEN #3, 'TEST (RECFM F LRECL 80)', INPUT
01340 POP = 0
01360 AUDITSUM = 0
01380 RESULTS = 0
01400 BIDTOTAL = 0
01420 TRUETOTAL = 0
01440 ECC = 0
01460 K = RND * ASI
01480 RTALLY = -K
02000 REM
02020 REM ** ROUTINE TO READ IN DATA **
02040 REM
02060 POP = POP + 1
02080 IF POP > DATPOP ! IF NO MORE DATA, THEN PROCESS
02100 GOTO 4000
02120 ENDIF
02140 INPUT #3, NEXTAUD, NEXTBID
02160 BIDTOTAL = BIDTOTAL + NEXTBID
02180 TRUETOTAL = TRUETOTAL + NEXTAUD
02200 RTALLY = RTALLY + NEXTBID
03000 REM
03020 REM ** ROUTINE TO DETERMINE IF **
03040 REM ** THIS BID WILL BE AUDITED **
03060 REM
03080 IF RTALLY < 0
03100 GOTO 2060
03120 ENDIF
03140 R = CEIL(RTALLY/ASI)
03160 RTALLY = RTALLY - (R * ASI)
03280 AUDITSUM = AUDITSUM + NEXTBID
03300 RESULTS = RESULTS + NEXTAUD
03320 ECC = ECC + 1
03340 GOTO 2060
04000 REM ** FINAL CALCULATIONS **
04020 REM
04040 F = TRUETOTAL/BIDTOTAL
04060 AE = BIDTOTAL - TRUETOTAL
04080 FF = RESULTS / AUDITSUM
04100 EA = (BIDTOTAL * FF) - TRUETOTAL
04120 EP = EA * 100 / BIDTOTAL

```

```

04140 EEA = EEA + EA
04160 EEP = EEP + EP
04180 EES = EES + EA * EA
04200 EEL = EEL + BIDTOTAL * FF
04220 EEV = EEV + AUDITSUM
04240 EC = EC + ECC
04260 EC2 = EC2 + (ECC * ECC)
04280 ED = ED + AUDITSUM
04300 ED2 = ED2 + (AUDITSUM * AUDITSUM)
05000 REM
05020 REM ** PRINT RESULTS **
05040 REM
05060 FORM0$='TOTAL #####.## #####.## #.#### ###.### #####.##'
05080 FORM1$='AUDIT #####.## #####.## #.#### ###.### #####.##'
05100 FORM2$='#####.## #####.## #####.## #####.##'
05101 FORM3$=' DOLLARS #####.## #####.##'
05102 FORM4$='CONTRACTS #####.## #####.##'
05120 IF L = 0
05140 PRINT 'BASKET BOOK VALUE AUDIT VALUE FACTOR %ERROR ABS ERROR'
05160 PRINT USING FORM0$, BIDTOTAL, TRUETOTAL, F,&
05180 & 100*(AE)/BIDTOTAL,&
05200 & AE
05220 ENDIF
05240 PRINT USING FORM1$, AUDITSUM, RESULTS, FF,&
05260 & 100 * ((BIDTOTAL * FF) - TRUETOTAL)/BIDTOTAL,&
05280 & (BIDTOTAL * FF) - TRUETOTAL
06000 REM
06020 REM ** CLEANUP **
06040 REM
06060 CLOSE #3
06080 L = L + 1
06100 IF L < L1
06120 GOTO 1320
06140 ENDIF
06160 PRINT ' MEAN PRED S. D. MEAN % ERR MEAN ERROR'
06180 PRINT USING FORM2$, EEL/L1, SQR(EES/(L1-1)), EEP/L1, EEA/L1
06190 PRINT
06200 PRINT ' MEAN AUDITED S. D.'
06220 PRINT USING FORM3$, ED/L1, SQR(((L1*ED2)-(ED*ED))/(L1*(L1-1)))
06240 PRINT USING FORM4$, EC/L1, SQR(((L1*EC2)-(EC*EC))/(L1*(L1-1)))
06260 PRINT
06280 PRINT 'HOW MANY MORE';
06300 INPUT L2
06320 L1 = L1 + L2
06340 IF L2 > 0
06360 GOTO 1320
06380 ENDIF
07000 END

```

**APPENDIX B
DETAILED RESULTS**

POPULATION A

BASKET	BOOK VALUE	AUDIT VALUE	FACTOR	%ERROR	Numeric Error
TOTAL	409605.73	372255.73	0.9088		37350.00
1	40960.47	36910.47	0.9011	-00.77	-3150.10
2	40960.51	38170.51	0.9319	002.31	9449.96
3	40960.57	37450.57	0.9143	000.55	2250.00
4	40960.57	37540.57	0.9165	000.77	3150.00
5	40960.55	37270.55	0.9099	000.11	449.98
6	40960.56	36370.56	0.8879	-02.09	-8550.01
7	40960.57	37090.57	0.9055	-00.33	-1350.00
8	40960.66	37270.66	0.9099	000.11	450.08
9	40960.64	37090.64	0.9055	-00.33	-1349.94
10	40960.63	37090.63	0.9055	-00.33	-1349.95
MEAN				000.77	3150.00
	MEAN AUDITED		S. D.		
DOLLARS	40960.57		0.06		
CONTRACTS	830.00		0.00		

DUS	BOOK VALUE	AUDIT VALUE	FACTOR	%ERROR	Numeric Error
TOTAL	409605.73	372255.73	0.9088		37350.00
AUDIT	158976.31	148626.31	0.9349	2.608	10683.01
AUDIT	158949.19	148599.19	0.9349	2.607	10678.46
AUDIT	158824.04	147574.04	0.9292	2.035	8336.35
AUDIT	158604.10	148614.10	0.9370	2.820	11550.15
AUDIT	158856.17	147966.17	0.9314	2.263	9270.47
AUDIT	158996.13	149096.13	0.9377	2.892	11845.63
AUDIT	158693.67	147443.67	0.9291	2.029	8312.52
AUDIT	158827.85	147757.85	0.9303	2.149	8801.26
AUDIT	158825.64	147755.64	0.9303	2.149	8800.86
AUDIT	159021.75	148401.75	0.9332	2.440	9995.17
MEAN PRED		S. D.	MEAN	% ERR	MEAN ERROR
382083.12	10441.56		2.399		9827.389
	MEAN AUDITED		S. D.		
DOLLARS	158857.48		134.49		
CONTRACTS	829.80		0.42		

POPULATION B

BASKET	BOOK VALUE	AUDIT VALUE	FACTOR	%ERROR	Numeric Error
TOTAL	409605.73	372255.73	0.9088		37350.00
1	40960.52	37270.52	0.9099	000.11	449.95
2	40960.53	36820.53	0.8989	-00.99	-4050.04
3	40960.56	37630.56	0.9187	000.99	4049.99
4	40960.55	37000.55	0.9033	-00.55	-2250.02
5	40960.57	36550.57	0.8923	-01.65	-6750.00
6	40960.61	36910.61	0.9011	-00.77	-3149.96
7	40960.62	37450.62	0.9143	000.55	2250.04
8	40960.60	38080.60	0.9297	002.09	8550.02
9	40960.61	36730.61	0.8967	-01.21	-4949.96
10	40960.56	37810.56	0.9231	001.43	5849.99
MEAN				001.03	4230.00

	MEAN AUDITED	S. D.
DOLLARS	40960.57	0.04
CONTRACTS	830.00	0.00

DUS

	BOOK VALUE	AUDIT VALUE	FACTOR	%ERROR	Numeric Error
TOTAL	409605.73	372255.73	0.9088		37350.00
AUDIT	171892.21	152812.21	0.8890	-1.981	-8116.15
AUDIT	171815.30	152735.30	0.8890	-1.986	-8136.50
AUDIT	172017.42	151497.42	0.8807	-2.810	-11511.97
AUDIT	171892.21	152812.21	0.8890	-1.981	-8116.15
AUDIT	172155.89	153435.89	0.8913	-1.755	-7189.98
AUDIT	172040.59	152150.59	0.8844	-2.443	-10005.44
AUDIT	171784.85	153334.85	0.8926	-1.622	-6642.39
AUDIT	172091.02	152651.02	0.8870	-2.178	-8920.49
AUDIT	172171.50	153361.50	0.8907	-1.807	-7400.05
AUDIT	171894.96	152814.96	0.8890	-1.981	-8115.42
MEAN PRED		S. D.	MEAN % ERR	MEAN ERROR	
	363840.28	8985.13		-2.055	-8415.455

	MEAN AUDITED	S. D.
DOLLARS	171975.59	138.51
CONTRACTS	830.00	0.00

POPULATION C

BASKET	BOOK VALUE	AUDIT VALUE	FACTOR	%ERROR	Numeric Error
TOTAL	409605.73	372255.73	0.9088		37350.00
1	40960.48	37090.48	0.9055	-00.33	-1350.09
2	40960.53	37540.53	0.9165	000.77	3149.96
3	40960.57	37000.57	0.9033	-00.55	-2250.00
4	40960.54	36910.54	0.9011	-00.77	-3150.03
5	40960.57	36910.57	0.9011	-00.77	-3150.00
6	40960.58	36910.58	0.9011	-00.77	-3149.99
7	40960.59	37720.59	0.9209	001.21	4950.01
8	40960.64	37180.64	0.9077	-00.11	-449.94
9	40960.64	37630.64	0.9187	000.99	4050.05
10	40960.59	37360.59	0.9121	000.33	1350.01
MEAN				000.66	2700.01
	MEAN AUDITED		S. D.		
DOLLARS	40960.57		0.05		
CONTRACTS	830.00		0.00		

DUS	BOOK VALUE	AUDIT VALUE	FACTOR	%ERROR	Numeric Error
TOTAL	409605.73	372255.73	0.9088		37350.00
AUDIT	157773.16	147783.16	0.9367	2.787	11414.28
AUDIT	157713.97	148353.97	0.9407	3.184	13040.74
AUDIT	157738.10	148198.10	0.9395	3.071	12577.05
AUDIT	158027.14	148217.14	0.9379	2.911	11922.52
AUDIT	157816.30	147646.30	0.9356	2.674	10954.18
AUDIT	157838.59	147398.59	0.9339	2.504	10257.24
AUDIT	158054.38	147794.38	0.9351	2.627	10760.70
AUDIT	157816.61	147556.61	0.9350	2.617	10720.64
AUDIT	157782.93	147702.93	0.9361	2.730	11182.24
AUDIT	157840.97	147310.97	0.9333	2.447	10024.09
MEAN PRED		S. D.	MEAN % ERR	MEAN ERROR	
383541.10	11935.61		2.755	11285.367	
	MEAN AUDITED		S. D.		
DOLLARS	157840.21		113.57		
CONTRACTS	831.00		0.00		

POPULATION D

BASKET	BOOK VALUE	AUDIT VALUE	FACTOR	%ERROR	Numeric Error
TOTAL	375545.95	372255.73	0.9912		3290.22
1	37503.29	37274.23	0.9939	0.2653	996.49
2	37507.89	37282.36	0.9940	0.2748	1032.11
3	37520.51	37172.52	0.9907	-0.0513	-192.84
4	37530.36	37232.51	0.9921	0.0825	309.80
5	37540.11	37167.81	0.9901	-0.1156	-434.22
6	37571.67	37233.59	0.9910	-0.0237	-89.04
7	37580.30	37271.16	0.9918	0.0535	200.93
8	37589.90	37164.13	0.9887	-0.2566	-963.48
9	37591.16	37249.01	0.9909	-0.0341	-127.95
10	37610.76	37208.41	0.9893	-0.1937	-727.27
MEAN				0.1351	507.41
DOLLARS	MEAN AUDITED		S. D.		
CONTRACTS	37554.59		38.68		
	830.00		0.00		

DUS	BOOK VALUE	AUDIT VALUE	FACTOR	%ERROR	Numeric Error
TOTAL	375545.95	372255.73	0.9912	0.876	3290.22
AUDIT	154991.06	154005.19	0.9936	0.240	901.44
AUDIT	155019.49	154034.41	0.9936	0.241	903.79
AUDIT	154681.74	153707.70	0.9937	0.246	925.39
AUDIT	154986.95	154047.14	0.9939	0.270	1012.98
AUDIT	155019.33	154032.08	0.9936	0.239	898.53
AUDIT	154677.71	153762.34	0.9941	0.284	1067.77
AUDIT	154698.02	153716.51	0.9937	0.242	907.50
AUDIT	155015.48	154063.07	0.9939	0.262	982.88
AUDIT	154917.86	153974.62	0.9939	0.267	1003.65
AUDIT	154721.97	153729.01	0.9936	0.234	880.08
MEAN PRED		S. D.	MEAN % ERR		MEAN ERROR
373204.13		1001.71	0.253		948.401
DOLLARS	MEAN AUDITED		S. D.		
CONTRACTS	154872.96		156.44		
	838.10		0.32		

POPULATION E

BASKET	BOOK VALUE	AUDIT VALUE	FACTOR	%ERROR	Numeric Error
TOTAL	413614.33	372255.73	0.9000		41358.60
1	41361.43	37265.53	0.9010	000.10	399.60
2	41361.45	36965.85	0.8937	-00.63	-2597.38
3	41361.39	37215.54	0.8998	-00.02	-199.94
4	41361.39	36765.99	0.8889	-01.11	-4595.45
5	41361.39	37265.49	0.9010	000.10	399.56
6	41361.37	37465.27	0.9058	000.58	2397.54
7	41361.40	37365.40	0.9034	000.34	1398.57
8	41361.50	37365.50	0.9034	000.34	1398.66
9	41361.50	37315.55	0.9022	000.22	899.17
10	41361.51	37265.61	0.9010	000.10	399.68
MEAN				000.35	1458.55
	MEAN	AUDITED	S. D.		
DOLLARS	41361.43		0.05		
CONTRACTS	830.00		0.00		

DUS	BOOK VALUE	AUDIT VALUE	FACTOR	%ERROR	Numeric Error
TOTAL	413614.33	372255.73	0.9000		41358.60
AUDIT	155856.65	147964.55	0.9494	4.936	20414.45
AUDIT	155788.89	147746.94	0.9484	4.837	20007.49
AUDIT	155686.91	146995.61	0.9442	4.417	18268.37
AUDIT	156020.28	147578.73	0.9459	4.589	18979.80
AUDIT	155820.19	147678.34	0.9477	4.774	19746.60
AUDIT	155941.85	148299.50	0.9510	5.099	21088.32
AUDIT	155747.96	147306.41	0.9458	4.579	18940.68
AUDIT	155728.97	146937.77	0.9435	4.354	18009.28
AUDIT	155957.70	148265.40	0.9507	5.067	20957.90
AUDIT	155987.63	147995.63	0.9488	4.876	20167.14
MEAN PRED		S. D.	MEAN % ERR	MEAN ERROR	
391913.73		20749.01	4.753	19658.002	
	MEAN	AUDITED	S. D.		
DOLLARS	155853.70		117.46		
CONTRACTS	830.50		0.53		

POPULATION AA

BASKET	BOOK VALUE	AUDIT VALUE	FACTOR	%ERROR	Numeric Error
TOTAL	409605.73	408975.73	0.9985		630.00
1	40960.47	41050.47	1.0022	0.3735	1530.00
2	40960.51	40330.51	0.9846	-1.3843	-5670.01
3	40960.57	40690.57	0.9934	-.5054	-2070.00
4	40960.57	39880.57	0.9736	-2.4829	-10170.00
5	40960.55	41410.55	1.0110	1.2524	5130.00
6	40960.56	41410.56	1.0110	1.2524	5130.00
7	40960.57	40870.57	0.9978	-.0659	-270.00
8	40960.66	41590.66	1.0154	1.6919	6929.99
9	40960.64	41050.64	1.0022	0.3735	1530.00
10	40960.63	40690.63	0.9934	-.5054	-2070.00
MEAN				0.9888	4050.00
	MEAN AUDITED		S. D.		
DOLLARS	40960.57		0.06		
CONTRACTS	830.00		0.00		

DUS	BOOK VALUE	AUDIT VALUE	FACTOR	%ERROR	Numeric Error
TOTAL	409605.73	408975.73	0.9985		630.00
AUDIT	158582.04	158582.04	1.0000	0.154	630.00
AUDIT	158560.98	159100.98	1.0034	0.494	2024.97
AUDIT	158265.77	157905.77	0.9977	-.074	-301.71
AUDIT	158495.01	158855.01	1.0023	0.381	1560.36
AUDIT	158599.40	159049.40	1.0028	0.438	1792.19
AUDIT	158595.41	159315.41	1.0045	0.608	2489.55
AUDIT	158446.91	158176.91	0.9983	-.017	-67.98
AUDIT	158327.61	157697.61	0.9960	-.244	-999.86
AUDIT	158426.34	157256.34	0.9926	-.585	-2394.99
AUDIT	158583.44	158493.44	0.9994	0.097	397.54
MEAN PRED		S. D.	MEAN % ERR		MEAN ERROR
409488.74	1610.08		0.125		513.006
	MEAN AUDITED		S. D.		
DOLLARS	158488.29		119.20		
CONTRACTS	825.90		0.32		

POPULATION BB

BASKET	BOOK VALUE	AUDIT VALUE	FACTOR	%ERROR	Numeric Error
TOTAL	409605.73	410235.73	1.0015		-630.00
1	40960.52	41230.52	1.0066	0.5054	2070.00
2	40960.53	40960.53	1.0000	-.1538	-630.00
3	40960.56	41590.56	1.0154	1.3843	5670.00
4	40960.55	40600.55	0.9912	-1.0327	-4230.00
5	40960.57	40690.57	0.9934	-.8130	-3330.00
6	40960.61	40510.61	0.9890	-1.2524	-5130.00
7	40960.62	40330.62	0.9846	-1.6919	-6929.99
8	40960.60	41860.60	1.0220	2.0434	8369.99
9	40960.61	41410.61	1.0110	0.9448	3870.00
10	40960.56	41050.56	1.0022	0.0659	270.00
MEAN				0.9888	4050.00
	MEAN AUDITED		S. D.		
DOLLARS	40960.57		0.04		
CONTRACTS	830.00		0.00		

DUS	BOOK VALUE	AUDIT VALUE	FACTOR	%ERROR	Numeric Error
TOTAL	409605.73	410235.73	1.0015		-630.00
AUDIT	172018.41	171208.41	0.9953	-.625	-2558.75
AUDIT	171894.73	172524.73	1.0037	0.213	871.22
AUDIT	171856.38	172126.38	1.0016	0.003	13.52
AUDIT	172016.66	171386.66	0.9963	-.520	-2130.15
AUDIT	172023.91	171753.91	0.9984	-.311	-1272.90
AUDIT	172135.86	174835.86	1.0157	1.415	5794.78
AUDIT	171870.32	172410.32	1.0031	0.160	656.94
AUDIT	171851.51	172391.51	1.0031	0.160	657.08
AUDIT	172035.15	171855.15	0.9990	-.258	-1058.57
AUDIT	172155.25	174495.25	1.0136	1.205	4937.52
MEAN PRED		S. D.	MEAN % ERR	MEAN ERROR	
410826.80		2855.92	0.144	591.070	
	MEAN AUDITED		S. D.		
DOLLARS	171985.82		112.32		
CONTRACTS	830.00		0.00		

POPULATION CC

BASKET	BOOK VALUE	AUDIT VALUE	FACTOR	%ERROR	Numeric Error
TOTAL	409605.73	410595.73	1.0024		-990.00
1	40960.48	40510.48	0.9890	-1.3403	-5490.01
2	40960.53	41140.53	1.0044	0.1978	810.00
3	40960.57	40600.57	0.9912	-1.1206	-4590.00
4	40960.54	41770.54	1.0198	1.7358	7110.01
5	40960.57	41590.57	1.0154	1.2964	5310.00
6	40960.58	41590.58	1.0154	1.2964	5310.00
7	40960.59	40240.59	0.9824	-1.9995	-8190.00
8	40960.64	40600.64	0.9912	-1.1206	-4589.99
9	40960.64	41590.64	1.0154	1.2964	5309.99
10	40960.59	40960.59	1.0000	-.2417	-990.00
MEAN				1.1645	4770.00
	MEAN AUDITED		S. D.		
DOLLARS	40960.57		0.05		
CONTRACTS	830.00		0.00		

DUS	BOOK VALUE	AUDIT VALUE	FACTOR	%ERROR	Numeric Error
TOTAL	409605.73	410595.73	1.0024		-990.00
AUDIT	157900.17	158170.17	1.0017	-.071	-289.60
AUDIT	158128.98	158218.98	1.0006	-.185	-756.87
AUDIT	158031.95	159291.95	1.0080	0.556	2275.82
AUDIT	157685.03	157595.03	0.9994	-.299	-1223.79
AUDIT	158113.10	158563.10	1.0028	0.043	175.76
AUDIT	157829.67	157559.67	0.9983	-.413	-1690.71
AUDIT	157795.92	158155.92	1.0023	-.014	-55.51
AUDIT	157782.24	158232.24	1.0029	0.044	178.21
AUDIT	157933.50	158833.50	1.0057	0.328	1344.18
AUDIT	158021.11	158291.11	1.0017	-.071	-290.13
MEAN PRED		S. D.	MEAN % ERR		MEAN ERROR
410562.47		1161.85	-.008		-33.265
	MEAN AUDITED		S. D.		
DOLLARS	157922.17		149.81		
CONTRACTS	830.90		0.32		

POPULATION DD

BASKET	BOOK VALUE	AUDIT VALUE	FACTOR	%ERROR	Numeric Error
TOTAL	372255.73	372687.17	1.0012		-431.44
1	37225.51	37252.65	1.0007	-00.04	-160.04
2	37225.53	37351.67	1.0034	000.22	829.96
3	37225.56	37265.96	1.0011	-00.01	-27.44
4	37225.56	37097.64	0.9966	-00.46	-1710.64
5	37225.57	37253.81	1.0008	-00.04	-149.04
6	37225.61	37245.16	1.0005	-00.06	-235.94
7	37225.61	37347.20	1.0033	000.21	784.46
8	37225.61	37272.67	1.0013	000.01	39.16
9	37225.61	37382.72	1.0042	000.31	1139.66
10	37225.56	37217.69	0.9998	-00.14	-510.14
MEAN				000.15	558.65
	MEAN AUDITED		S. D.		
DOLLARS	37225.57		0.04		
CONTRACTS	830.00		0.00		

DUS	BOOK VALUE	AUDIT VALUE	FACTOR	%ERROR	Numeric Error
TOTAL	372255.73	372687.17	1.0012		-431.44
AUDIT	153449.50	153530.55	1.0005	-.063	-234.82
AUDIT	153678.01	153708.72	1.0002	-.096	-357.05
AUDIT	153419.97	153541.36	1.0008	-.037	-136.90
AUDIT	153377.53	153443.02	1.0004	-.073	-272.49
AUDIT	153713.33	153672.20	0.9997	-.143	-531.05
AUDIT	153722.20	153766.66	1.0003	-.087	-323.78
AUDIT	153719.79	153736.26	1.0001	-.105	-391.56
AUDIT	153579.34	153665.42	1.0006	-.060	-222.79
AUDIT	153489.44	153547.29	1.0004	-.078	-291.14
AUDIT	153472.87	153584.51	1.0007	-.043	-160.65
MEAN PRED		S. D.	MEAN % ERR	MEAN ERROR	
372394.95		329.31	-.079	-292.222	
	MEAN AUDITED		S. D.		
DOLLARS	153562.20		136.34		
CONTRACTS	831.30		0.48		

POPULATION EE

BASKET	BOOK VALUE	AUDIT VALUE	FACTOR	%ERROR	Numeric Error
TOTAL	413614.33	416811.13	1.0077		-3196.80
1	41361.43	41061.73	0.9928	-1.4975	-6193.80
2	41361.45	40861.95	0.9879	-1.9805	-8191.80
3	41361.39	41910.84	1.0133	0.5555	2297.71
4	41361.39	42160.59	1.0193	1.1593	4795.21
5	41361.39	41361.39	1.0000	-.7729	-3196.80
6	41361.37	41661.07	1.0072	-.0483	-199.80
7	41361.40	41960.80	1.0145	0.6763	2797.20
8	41361.50	40961.90	0.9903	-1.7390	-7192.79
9	41361.50	41910.95	1.0133	0.5555	2297.69
10	41361.51	42959.91	1.0386	3.0916	12787.17
MEAN				1.2076	4995.00
	MEAN AUDITED		S. D.		
DOLLARS	41361.43		0.05		
CONTRACTS	830.00		0.00		

DUS	BOOK VALUE	AUDIT VALUE	FACTOR	%ERROR	Numeric Error
TOTAL	413614.33	416811.13	1.0077		-3196.80
AUDIT	155935.54	156584.89	1.0042	-.356	-1474.42
AUDIT	155671.11	156320.46	1.0042	-.356	-1471.49
AUDIT	155685.54	156234.99	1.0035	-.420	-1737.06
AUDIT	155821.71	156321.21	1.0032	-.452	-1870.92
AUDIT	155915.56	156864.61	1.0061	-.164	-679.15
AUDIT	155840.41	156339.91	1.0032	-.452	-1871.08
AUDIT	155740.43	157089.08	1.0087	0.093	384.94
AUDIT	155955.47	156005.42	1.0003	-.741	-3064.33
AUDIT	155894.34	156943.29	1.0067	-.100	-413.76
AUDIT	155769.62	157168.22	1.0090	0.125	516.90
MEAN PRED		S. D.	MEAN % ERR		MEAN ERROR
415643.09		1659.85		-.282	-1168.038
	MEAN AUDITED		S. D.		
DOLLARS	155822.97		103.18		
CONTRACTS	830.40		0.52		

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