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Auditor's Approach to Statistical Sampling, Volume 2. Sampling for Attributes

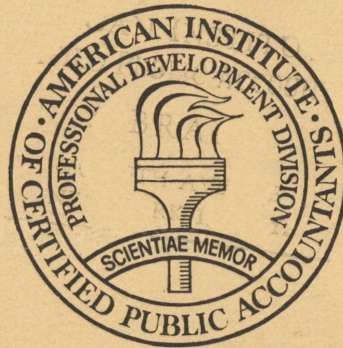
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SAMPLING FOR ATTRIBUTES



Individual Study Program
Professional Development Division
American Institute of Certified Public Accountants

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NOTICE TO READERS

This programmed learning text is a publication of the staff of the American Institute of Certified Public Accountants and is not to be regarded as an official pronouncement of the Institute. It was prepared by Teaching Systems Corporation, programming consultants; Saul Beldock, CPA, and Morton J. Rossman, CPA, consultants; and Brendan T. Mahon, CPA, Research Assistant. The members of the Committee on Statistical Sampling assisted in an advisory capacity.

c/1967.

AN AUDITOR'S APPROACH TO STATISTICAL SAMPLING

Volume 2

**SAMPLING
FOR
ATTRIBUTES**

**Programed for the
American Institute of Certified Public Accountants
by
Teaching Systems
A Service of The New York Times**

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PREFACE

This is the second volume in the series of programed texts on statistical sampling techniques in auditing being developed by the Committee on Statistical Sampling of the American Institute of Certified Public Accountants.

This volume deals with the subject of sampling for particular characteristics, such as the frequency of occurrence of a certain event, and is known as "sampling for attributes." The Committee believes that this type of sampling is presently widely used in transaction testing, evaluation of a system of internal control, etc., and that the statistical techniques outlined in this volume will provide the means for more effective sample selection and evaluation of results.

To obtain the maximum benefits from this volume, the Committee believes that the reader should have completed Volume 1 of this series, entitled *An Introduction to Statistical Concepts and Estimation of Dollar Values*, which is the basic introductory volume around which this and future volumes have been planned. No attempt has been made to explain the mathematics and theory underlying the tables used in this volume nor have criteria been suggested or established for statistical precision and reliability. Precision and reliability are subjective determinations and should be based upon the judgment of the auditor. Examples of statistical sampling applications have been constructed for teaching purposes only and no implication should be drawn that the techniques discussed in this volume provide the sole means of making estimates in similar situations.

The tables in this volume have been developed from tables of the Cumulative Binomial Probability Distribution in Volume XXXV of *The Annals of the Computation Laboratory of Harvard University*. If more refined sample intervals are required, they may be obtained from these Harvard University Annals.

The determination as to whether sampling for attributes is appropriate in the circumstances must be made in each instance by the auditor based on his knowledge and judgment. In those cases where such sampling is appropriate, the methods and techniques presented in this volume should enable the auditor to:

1. Determine the size of the sample.
2. Select the sample. (See also Volume 1 of this series)
3. Evaluate the results of the sample.

While this volume is the result of a joint effort on the part of the entire (1966-1967) Committee on Statistical Sampling, with the assistance of Brendan T. Mahon, CPA, Research Assistant, special acknowledgement is made of the contribution of two of its members, Saul Beldock, CPA, and Morton J. Rossman, CPA, to the content and for coordination with the chief programing consultant, John C. Gill, Jr., Teaching Systems, a service of The New York Times.

This booklet is being made available to the Institute membership as part of the continuing education program of the Professional Development Division.

RICHARD A. NEST, CPA
Director of Technical Services

September, 1967

INTRODUCTION

Sampling For Attributes is a “programed instruction” text. The essential feature of this relatively new method is a step-by-step approach that requires the reader to absorb each point thoroughly before going on to the next. You will notice that the pages are divided into three “frames.” Most frames require you to answer a question, or work out a problem, in addition to reading the material. Complete instructions are given below.

Although this method may seem slow at first, it virtually guarantees that the reader who conscientiously works through each frame will, upon completing the book, be able to solve problems, answer questions, and perform tasks that involve all the knowledge required for applying the concepts taught to actual auditing situations. The reader who has invested the time required in the prescribed manner will be able to work out field problems of this nature without further instruction.

The text has been designed to follow Volume I of this series, *An Introduction to Statistical Concepts and Estimation of Dollar Values*. It is assumed that the reader has an understanding of the concepts taught in that volume. As in Volume I, certain frames have been designated to be skipped by the reader who has evidenced mastery of the topic under discussion. However, except for these clearly specified cases, maximum value will be obtained from this book only by going through each frame according to the sequence “programed” by the authors. If the early chapters seem relatively easy, it is only in order that the reader will be fully prepared for the more difficult later chapters.

INSTRUCTIONS FOR USE

A. Programed Text

Each frame contains either a *blank* to fill in, a *choice* to circle, a *direction* to do an exercise or read an Exhibit in the Supplementary Section, or the phrase “No answer required.” In the latter case, simply read the material and go on to the next frame. The “no answer” frames are, however, as important in the teaching sequence as the others, and usually are followed up with a question in a later frame.

If an answer is required, write it directly in the space provided. When a choice is given, it is recommended that you circle the correct one rather than crossing out the wrong one or answering mentally. All questions are designed to be answered easily, based on the material immediately preceding or on your own judgment. The correct answer appears on the following page in the space adjacent to the next frame. If your response is incorrect, you are advised to cross it out and substitute the correct one.

A special format used occasionally in later chapters is the “branching” frame. This consists of a multiple-choice question together with an instruction to turn to a specified frame depending on the answer you give. Except for these clearly indicated cases, however,

all answers appear on the page immediately following the question and should be checked before you proceed to the next frame.

The frames are not to be read *down* the page, but rather go in numerical order *across* the book. Thus, every frame in the top row will be read before going on to the middle row.

B. Supplementary Section

The smaller booklet serves as both a workbook and review book, and is also designed to be a reference manual for on-the-job use. The programed text directs you to the relevant pages in this book at the proper time, and it may also be referred to whenever necessary. The individual summaries should be read immediately before and immediately after each chapter. The recommended procedure is to do one chapter at one uninterrupted sitting.

A NOTE ON CONTENT

This book is not designed to be a statistics course. Rather, it examines in detail one particular statistical technique – unrestricted random sampling with replacement – solely for the purpose of aiding in an auditing situation. Mathematical proofs and derivations have been omitted. Even the “basic statistical concepts” have been screened so that only those with practical relevance are covered. Certain basic statistical concepts such as probability theory and small-sample applications are not discussed.

Due to this approach, questions may arise due to curiosity or philosophical considerations while you are going through this book. In addition, questions will almost certainly occur to you having to do with types of situations not included under the topic of unrestricted sampling. The fact that these questions cannot be answered in this book has nothing to do with the method of programed instruction, but rather results from the decision to make this instruction as effective as possible for practical applications with a minimum investment of the reader’s time. Questions of this nature, therefore, will either be answered in future volumes in this series, or will remain unanswered without detracting from the book’s practical effectiveness.

HOW TO USE THIS MANUAL

This book has been organized in a new method known as “programed instruction.” Each page is divided into three paragraphs or “frames.” Each one of these frames is numbered. #2 is not below #1. Instead, it is on the following page. #3 is on the page following #2, and so on.

Almost every frame contains a question for you to answer. The most common type of question consists of a blank line for you to fill in. Look at Example 1.

EXAMPLE 1. The name of this book is “Sampling for _____”

You have already seen that the name of this book is “Sampling for Attributes,” so naturally you would fill in the word “Attributes” in the blank space.

Sometimes part of the word will already be filled in as an extra clue. Two blanks means that two words are called for.

Another type of question consists of a choice for you to circle. Look at Example 2.

EXAMPLE 2. This book (IS/IS NOT) an ordinary book.

You have already read that this book is not an ordinary book, so you would circle the choice as follows: (IS/IS NOT)

Of course, most of the questions in this book will not be at this level of simplicity. However, there are always a few hints given. If you read carefully you will get the correct answer almost every time.

After you have read the frame and made your response, *turn the page immediately.* You will find the correct answer on the next page. Then you will simply go on to the next frame. Notice that you do *not* read down the page as you would in an ordinary book. After you have finished the top row of frames in each section, you will be directed to go on to the second row.

If an answer of yours proves to be incorrect, cross it out lightly and substitute the correct answer. Please do not erase any of your wrong answers.

Sometimes there will be no answer required from you. In that case, read the paragraph carefully and then, as always, turn the page and go on to the next.

Now begin with Chapter 1 on the next page.

Chapter 1. DEFINITION OF SAMPLING PROBLEM

1-1. In Volume I, An Introduction to Statistical Concepts and Estimation of Dollar Values, we discussed the technique of estimating the total dollar value of a body of data by examination of the individual values of a statistically valid sample drawn from the body of data. The procedures taught in Volume I are referred to as sampling for variables. In this volume, we will be concerned with sampling for _____.

WRITE IN YOUR ANSWER AND THEN TURN THE PAGE.

attributes

(The correct answer always appears in this space.)

Now go on to the frame at the right.

1-2. A variable is a characteristic which may be represented numerically and may vary within a range of values. The total dollar value of a firm's accounts payable would be an example of a _____.

WRITE IN YOUR ANSWER AND THEN TURN THE PAGE.

variable

REMINDER

As you go through this book, remember that you will completely ignore the material in the rows above and below the one you are reading.

If you make a mistake, go back and cross out your answer and substitute the correct answer.

TURN THE PAGE AND GO ON TO FRAME 1-3.

2-9. To find the required sample size, the auditor first locates the column corresponding to his specified upper precision limit and proceeds down the column until he arrives at the value of his estimated sample occurrence rate. He then locates the sample size for the line in which the estimated sample occurrence rate lies.

(No answer required)

3-10. Since the sampling problem required that the auditor be 95% confident that the occurrence rate of the population does not exceed 3%, the auditor selects the table for a _____ confidence level.

No answer required

1-3. While variables are defined as quantitative characteristics of a body of data (or population, to employ the more common statistical term), attributes are usually associated with the rate of occurrence of qualitative characteristics of a population. The percentage of vendors' invoices containing errors would be an example of a(n) _____. The total dollar value of the invoices would be a(n) _____.

No answer required

2-10. The required sample size is determined by:

1. Selecting the table corresponding to the specified _____.
2. Locating the column corresponding to the specified _____.
3. In that column, locating the percentage corresponding to the estimated _____.
4. The line in which the estimated occurrence rate occurs is the required _____.

95%

3-11. The tables for evaluation of results, at each confidence level, indicate the number of occurrences found in the sample corresponding to the various sample sizes and upper precision limits. To evaluate our result, we proceed in the opposite direction from that we followed in selecting the sample size. In that case we began at the top of the column headed by our specified _____, proceeded down the column until we reached our estimated _____, and noted the sample size of the line in which this occurred.

attribute
variable

1-4. In sampling for variables, we estimate the mean dollar value of the items in a population, from which we can estimate the total dollar value by multiplying the mean value by the number of items in the population. In sampling for attributes, we estimate the frequency with which a certain characteristic occurs in a population. Which of the following statements might result from an attribute sampling program?

- a. "We estimate, with 90% confidence, that the percentage of accounts receivable with balances more than 90 days overdue is between 8% and 12%."
- b. "We estimate, with 90% confidence, that the total value of all accounts more than 90 days overdue is between \$73,000 and \$79,000."

- 1. Reliability
(Confidence Level)
- 2. Precision Limit
- 3. Occurrence Rate
- 4. Sample Size

2-11. An auditor wishes to select a sample from a group of records to determine their accuracy. He estimates that the records contain 5% errors and he wishes to determine with 99% reliability that the occurrence rate of population errors does not exceed 8%. Does he have sufficient information to use the tables in Exhibit 1 for selection of an appropriate sample size? (YES/NO)

upper precision limit
occurrence rate

3-12. To evaluate our sample result, we begin at the line corresponding to our actual sample size and proceed along the row until we reach the number of occurrences (not the percentage of occurrences) we discovered in our sample. On Exhibit 2, Table 2-B (Page S-21), we would begin at the line for a sample size of _____ and proceed along that row until we reach the actual number of occurrences we found in our sample, which was _____.

a. "We estimate, with 90% confidence, that the percentage of accounts receivable with balances more than 90 days overdue is between 8% and 12%."

1-5. Definition of an attribute sampling problem requires a precise definition of the characteristic whose frequency of occurrence we are attempting to measure. For every item in the population, we must be able to state unequivocally that the characteristic does exist or does not exist. No other alternatives are possible.

NO ANSWER REQUIRED. TURN THE PAGE.

YES

2-12. In the previous problem, which of the following three factors determines the table he will use in Exhibit 1 to determine his required sample size?

- a. Precision limit
- b. Estimated occurrence rate
- c. Reliability (Confidence Level)

340

2

3-13. The column in which we find our actual number of occurrences is the upper precision limit of the occurrence rate in our population at the confidence (reliability) level specified. For the sample size of 340 and the two occurrences discovered in the sample of Worksheet 2, what is the estimated upper limit of our population occurrence rate? Enter your answer on Line 6 of Worksheet 2.

No answer required

1-6. When examining the items in his sample, the auditor can make only one of two judgments about the item; either the characteristic for which he is looking does exist or it _____ exist.

Prior to drawing his sample, he must define the characteristic in such a manner that no "gray" areas may arise.

c. Reliability
(Confidence Level)

2-13. For a reliability (confidence level) of 99%, which table in Exhibit 1 must be used for determining the sample size?

6. 2%

(If this is your answer, proceed to Frame 3-17. If not, continue with Frame 3-14.)

3-14. Unlike the tables for determination of sample size, which show estimated sample occurrence rates (in %) for various values of upper limit and sample size, the tables for evaluation of results show the _____ of sample occurrences for values of sample size and upper limit.

does not

1-7. As in the foregoing example, the auditor, in sampling for attributes, is looking for the rate of occurrence of a certain characteristic in a body of data. His result, therefore, is usually expressed as a percentage of the total population. If 50 invoices out of a sample of 1000 were found to be in error, the rate of occurrence of errors in the invoices sampled would be expressed as _____.

Table 1-A (Sheet 1)

2-14. Table 1-A (Sheet 1 in Exhibit 1) has been reproduced as Worksheet 1, Sheet 1. Locate this worksheet (Page S-25) so that you may use it in the next few frames. In our problem, the auditor seeks to determine with 99% reliability that the rate of occurrence of errors in the records does not exceed 8%. His first step in selecting the required sample size is to locate the column corresponding to his upper precision limit of _____%.

number

3-15. Turn to Worksheet 3 (Page S-28). This is a reproduction of the 95% confidence level table for evaluation of results. Reading down the extreme left column (the column headed Sample Size), you will note a circle drawn around _____, size of the sample used in the ABC Loan Company problem. Follow the arrows along the row and you will see the next circle drawn around 2, the _____ of occurrences found in the sample.

5% ($50 \div 1000 = .05$ or 5%)

1-8. The occurrence rate, in percent, could easily be extended to calculate the number of items in a population which possess the characteristic under examination. If a population of 10,000 inventory records is known to have an error rate of 1%, we could calculate that 100 invoices are in error. However, it is more common to express the rate of occurrence as a _____ of the population.

8%

2-15. A circle, marked A, has been drawn on Worksheet 1, Sheet 1, to identify the proper column. The auditor then proceeds down the column until he arrives at the value of his estimated occurrence rate of 5%. Draw a circle around this value and label it B.

340
number

3-16. From that circle, the arrows now go up the column to the heading, Upper Limit. Draw a circle around the value appearing at the top of that column. That value is the upper limit of the population occurrence rate. Enter the value on Line 6 of Worksheet 2.

percentage

1-9. Which of the following sampling programs are examples of sampling for attributes?

___ determining the percentage of vendors' invoices received for amounts less than \$5.00

___ determining the total dollar value of unpaid vendors' invoices at the close of the accounting period

___ determining the percentage of vendors' invoices which contain errors

Your circle should appear on Worksheet 1, Sheet 2.

2-16. The line in which the estimated occurrence rate is found determines the required sample size. On Worksheet 1, Sheet 1, this line corresponds to a sample size of _____.

6. 2%

3-17. Our auditor at the ABC Loan Company can now state that he is 95% confident that not more than 2% of the outstanding balances are in error. Does this statement satisfy his sampling objective? (YES/NO)

X determining the percentage of vendors' invoices received for amounts less than \$5.00

X determining the percentage of vendors' invoices which contain errors

1-10. As in the previous frame, the key to the definition of attribute sampling is the existence of a twofold choice. In each item of the population, either the characteristic does exist or it does not exist. A vendor's invoice may be less than \$5.00 or it may _____ be less than \$5.00. Similarly, the vendor's invoice is in error or it is _____ in error.

460

(If you had any other answer, examine Worksheet 1, Sheet 2, and review the last three frames.)

2-17. The steps for selection of the required sample size can be summarized as follows:

1. Locate table for specified reliability.
2. On that table, locate column for specified precision limit.
3. In that column, locate estimated occurrence rate.
4. Identify sample size corresponding to the line in which estimated occurrence rate appears.

(No answer required)

YES

3-18. On the table for 90% confidence, what would be the upper precision limit if a sample of 160 items revealed 6 occurrences?

not
not

1-11. An auditor, in reviewing a client's merchandise inventory records, is concerned about the possible existence of a significant percentage of items in the inventory which have shown relatively slow sales activity. The inventory contains a total of 2000 items. The auditor wishes to determine the percentage of items where sales in 1966 are less than 50% of the units on hand at December 31, 1966. In this sample, which of the following items exhibit the characteristic the auditor is measuring?

	<u>Item</u>	<u>On Hand (units)</u>	<u>1966 Sales (units)</u>
___	1. AJ05698	375	525
___	2. KR04398	260	800
___	3. LM06298	267	63

No answer required

2-18. From Exhibit 1 (Pages S-15 through S-19), determine the required sample size for each of the following conditions:

	<u>A</u>	<u>B</u>	<u>C</u>
Reliability	99%	90%	95%
Upper precision limit	12%	9%	14%
Estimated occurrence rate	5%	5%	10%
Sample size	___	___	___

7%

3-19. For each confidence level, sample size, and number of sample errors below, determine, from the tables, the upper precision limit.

	<u>A</u>	<u>B</u>	<u>C</u>
Confidence level	90%	95%	99%
Sample size	80	120	160
Number of errors	4	8	9
Upper limit	___	___	___

X 3.

1-12. An auditor examines a random sample drawn from a population of 10,000 records. He determines that the rate of occurrence of errors in his sample is 2.00%. At this point, he would estimate that the rate at which errors occur in the population is:

- a. Exactly 2.00% (If this is your answer, turn to Frame 1-13.)
- b. Within some range around 2.00% (If this is your answer, turn to Frame 1-14.)
- c. Likely to be contained within some range around 2.00% (If this is your answer, turn to Frame 1-15.)

<u>A</u>	<u>B</u>	<u>C</u>
120	120	240

2-19. In some cases, the estimated occurrence rate may not appear in the column corresponding to the upper precision limit. For a reliability of 90%, upper precision limit of 10%, is there a sample size corresponding to an estimated occurrence rate of 6%? (YES/NO)

<u>A</u>	<u>B</u>	<u>C</u>
10%	12%	12%

3-20. As you examined the tables for evaluation of results in Exhibit 2, you may have noticed that not every possible number of sample occurrences corresponding to a given sample size appears on the table. For example, for a reliability of 99% and a sample size of 160, can you determine directly the upper precision limit corresponding to 10 or 11 occurrences in the sample? (YES/NO)

1-13. YOUR ANSWER: a. Exactly 2.00%

Statistical sampling techniques are, by definition, methods for estimating population characteristics. The probability that the population would exhibit precisely the same occurrence rate as the sample is too small to warrant consideration.

Turn back to Frame 1-12 and select another answer.

NO

2-20. You may have concluded that there are many reasonable combinations of upper precision limit and estimated occurrence rate where the tables will not work. The numbers displayed on the tables for estimated occurrence rate such as 2.9%, 3.1%, or 5.9% are not the estimates an auditor would usually make. His estimate would probably be in round numbers. Instead of 2.9%, 3.1%, or 5.9%, he would probably estimate _____%, _____%, or _____%.

NO

3-21. Where the exact number of occurrences found in the sample does not appear in the line for the sample size, continue along the line until you reach the value corresponding to the next higher number. For a reliability of 99%, sample size of 160, 10 occurrences in the sample, this would be _____, corresponding to an upper precision limit of _____%.

1-14. YOUR ANSWER: b. Within some range
around 2.00%

Statistical sampling techniques do not permit us to state unequivocally that the population occurrence rate does fall within some range around the estimate based upon our sample findings. It does, however, permit us to say with some measurable degree of confidence that our population occurrence rate falls within some range of our sample estimate.

Turn back to Frame 1-12 and select another answer.

3
3
6

2-21. Turn again to the sample size determination for a 90% confidence level (Exhibit 1, Sheet 3, Page S-17). Select a sample size for a 6% upper limit and 3% estimated error rate. As you come down the 6% upper limit column you (WILL/WILL NOT) find a 3.0% estimated error rate. You will also notice that the estimated error rate (INCREASES/DECREASES) as you proceed down the column.

12
14

3-22. In each of the following cases, indicate the upper precision limit.

	<u>A</u>	<u>B</u>	<u>C</u>
Reliability	99%	95%	90%
Sample size	120	120	50
Sample occurrences	5	7	6
Upper precision limit	—	—	—

1-15. YOUR ANSWER: c. Likely to be contained within some range around 2.00%

Correct. The most appropriate statement of our auditor's findings would be that the rate of occurrence of errors in our population is "likely to be contained within some range around 2.00%." Further, with statistical sampling, we can quantitatively answer the questions, "How likely?", and "Within what range?"

WILL NOT
INCREASES

2-22. Our estimated error rate, 3%, falls between 2.5% and 3.1% which appear on the table. The sample sizes corresponding to those values are _____ and _____, respectively.

<u>A</u>	<u>B</u>	<u>C</u>
12%	12%	25%

3-23. In evaluating sample results, the relationships between sample size, upper precision limit, reliability, and sample occurrences are identical to those in determining sample size. However, in evaluating results we use the actual _____ of occurrences in the sample while, in determining sample size, we used the estimated _____ of occurrences in the sample.

1-16. Application of statistical theory permits us to assign numerical values to the range of values within which our population occurrence rate is likely to be contained as well as the degree of confidence that our population error rate is, in fact, contained within that range. The degree of confidence is referred to as the reliability of the estimate and the range of values is referred to as the precision of the estimate. Thus, with a statistical sample, we can estimate our population occurrence rate and state the _____ and _____ of our estimate.

120
160

2-23. Of the two choices, 120 and 160, which do you suspect would furnish the more conservative results? _____

number
percentage

3-24. Complete the following table for evaluation of sample results.

	<u>A</u>	<u>B</u>	<u>C</u>
Reliability	95%	95%	95%
Sample Size	160	160	160
Sample occurrences	2	3	4
Upper precision limit	_____	_____	_____

reliability

precision

1-17. In sampling for variables, an auditor determines that there is a 90% probability that the total value of a certain population is \$175,000 \pm \$10,000. Which of these quantities refers to the precision of his estimate? _____ Which refers to the reliability? _____

160

(The reason for this will be explored in greater detail later.)

2-24. We can now say that the procedure for selecting the sample size is as follows:

On the table for sample size determination corresponding to the specified confidence level (reliability), locate the column for the specified upper limit and proceed down that column to the estimated occurrence rate or next higher value.

(No answer required)

A

4%

B

5%

C

6%

3-25. As the number of sample occurrences increases while reliability and sample size remain constant, the upper precision limit _____.

\$10,000

90%

1-18. The expression, confidence level, is synonymous with reliability. Thus, the conclusion, "... a reliability of 90%" could also be stated "... a _____ of 90%."

No answer required

2-25. Select the sample size required for each of the following cases.

	<u>A</u>	<u>B</u>	<u>C</u>
Confidence level	90%	95%	99%
Upper limit	8%	10%	12%
Estimated error rate	3%	4%	8%
Sample size	_____	_____	_____

increases

3-26. Complete the following table for evaluation of sample results.

	<u>A</u>	<u>B</u>	<u>C</u>
Reliability	99%	95%	90%
Sample size	160	160	160
Sample occurrences	9	9	9
Upper precision limit	_____	_____	_____

confidence level

1-19. Instead of referring to the estimate and its precision as \$175,000 \pm \$10,000, the auditor can state the precision by expressing the upper and lower precision limits.

He could state that there is a 90% probability that the total value of the population falls between \$165,000 and \$185,000. The lower precision limit would be \$165,000 and the upper precision limit would be _____.

<u>A</u>	<u>B</u>	<u>C</u>
90	90	460

2-26. In some cases, you will note that there is no estimated error rate corresponding to a given upper limit and sample size. This presents no problem, however, since the tables are used by entering the column for a given upper limit and proceeding down to the estimated error rate (or next higher value). The blank spaces are simply ignored.

(No answer required)

<u>A</u>	<u>B</u>	<u>C</u>
12%	10%	9%

3-27. As the specified reliability decreases, the upper precision limit (INCREASES/DECREASES) although the sample size and number of sample occurrences remain the same.

\$185,000

1-20. If an auditor estimated that there is an 80% probability that a certain value is \$300,000 \pm \$30,000, what would be the upper and lower precision limits of his estimate?

Upper: \$ _____

Lower: \$ _____

No answer required

2-27. Three factors affect the required sample size as follows:

1. Reliability
2. Estimated occurrence rate
3. Upper precision limit

To examine the effect of each, in the next few frames you will be asked to select sample sizes from Exhibit 1, holding two factors constant while varying the third. We would probably expect an increase in reliability to (INCREASE/DECREASE) sample size.

DECREASES

3-28. In discussing the procedure for determination of the required sample size, we mentioned the possibility that an auditor may not be in a position to estimate a sample occurrence rate for a given set of records and therefore unable to use the tables in Exhibit 1. An auditor seeks to determine with 95% reliability that an inventory, unfamiliar to him, contains less than 6% items which have no sales activity in the preceding 12 months. His upper precision limit is _____, his specified reliability is _____, and his estimated sample occurrence rate is _____.

Upper: \$330,000

Lower: \$270,000

1-21. In sampling for attributes, the auditor's estimate is generally a percentage.

Similarly, the precision limits of his estimate are expressed as a percentage. An evaluation of the results of a sample of invoices might indicate an occurrence rate of $3.0\% \pm 1.5\%$. This means that the true occurrence rate of the entire population is likely to be in the interval between ____% and ____%.

INCREASE

2-28. Determine the required sample size for each of the following three cases:

	<u>A</u>	<u>B</u>	<u>C</u>
Reliability	90%	95%	99%
Estimated occurrence rate	5%	5%	5%
Upper precision limit	10%	10%	10%
Required sample size	—	—	—

6%

95%

unknown

3-29. Since he must have an estimated occurrence rate to determine the sample size, he could take the following steps:

1. Select a random sample of 50 records.
2. Count the number of occurrences in his sample.
3. Evaluate the results of his sample.
4. Expand the sample if required.

(No answer required)

1.5%

4.5%

1-22. From a statistical sample, an auditor estimates that, in a certain population, there is a 90% probability that the occurrence rate is between 4% and 6%. He is saying, in effect, that there are _____ chances out of ten that the true population occurrence rate is between 4% and 6%.

<u>A</u>	<u>B</u>	<u>C</u>
80	120	240

2-29. As the specified reliability increased in the preceding frame, the required sample size _____.

No answer required

3-30. If his sample of 50 inventory records indicated no occurrences, he could determine from Exhibit 2 that his upper precision limit is _____, and his sampling objective (IS/IS NOT) satisfied.

1-23. Generally, sampling for attributes involves the determination of the occurrence rate of some characteristic(s) in tests of transactions or other populations, or in tests for overdue accounts, slow-moving items in inventory, etc. The auditor seeks a stated degree of assurance that the occurrence rate does not exceed a stated figure. The (UPPER/LOWER) limit of error rate is therefore more important to the auditor's decision.

increased

2-30. Determine the required sample size for each of the following three cases.

	<u>A</u>	<u>B</u>	<u>C</u>
Reliability	90%	90%	90%
Estimated occurrence rate	6%	6%	6%
Upper precision limit	8%	10%	12%
Required sample size	—	—	—

6%

IS

3-31. If, however, he found 1 occurrence in the 50 items, his upper precision limit, based on the sample of 50, would be 10% and his objective would not be satisfied. However, he can now estimate his sample occurrence rate which is _____.

UPPER

1-24. From an evaluation of a sample of 160 items from a population of 5,000 items the auditor finds 16 errors. He is able to state from an evaluation table that he is 90% confident that the occurrence rate of such errors in the population does not exceed 14%. His maximum specified error rate is 18%, and his sampling program required a reliability of 90% that the population occurrence rate did not exceed the specified level. Based on the results of his sample, does the population meet the specifications of his sampling plan? (YES/NO)

<u>A</u>	<u>B</u>	<u>C</u>
460	160	80

2-31. As the upper precision limit increases while the remaining two factors are held constant, the required sample size _____.

2% ($1 \div 50 = .02$)

3-32. With this estimate of a 2% sample occurrence rate, he can refer to Exhibit 1 and determine, for an upper precision limit of 6% and reliability of 95%, that the required sample size is _____.

YES

1-25. In the preceding example, the auditor may also have been able, with a reliability of 90%, to say that the lower precision limit is 6%. However, his sampling objective is to determine, with 90% reliability, that the occurrence rate in the population did not exceed the specified level. Does knowledge of the lower precision limit generally provide information pertinent to his sampling objective? (YES/NO)

decreases

2-32. Determine the required sample size for each of the following cases:

	<u>A</u>	<u>B</u>	<u>C</u>
Reliability	90%	90%	90%
Estimated occurrence rate	6%	8%	10%
Upper precision limit	14%	14%	14%
Required sample size	—	—	—

160

3-33. The auditor should then draw an additional sample of 110 items and re-evaluate his results. If, in the total sample, he discovers 3 occurrences, would his sampling objective be satisfied? (YES/NO)

NO

1-26. The objectives of most attribute sampling plans are satisfied by the knowledge that the auditor can state, with a given degree of confidence, that the population error rate does not exceed a certain level. Which of the following statements of results conforms more closely to this criterion?

- a. I am 95% confident that the error rate does not exceed 5%.
- b. I am 95% confident that the error rate is $5\% \pm 2\%$.

<u>A</u>	<u>B</u>	<u>C</u>
50	120	160

2-33. As the estimated occurrence rate increases while the upper precision limit and reliability are held constant, the required sample size _____.

YES (The upper precision limit would be 5%.)

3-34. Refer to Worksheet 4, Major Eastern Utility (Page S-29). Complete all the lines for which the information is given in the statement of the auditing problem.

a. I am 95% confident that the error rate does not exceed 5%.

1-27. As the precision range widens, the degree of confidence with which the auditor can state his findings naturally increases. If an auditor finds 10 errors in a sample of 80 records, he can state, with 90% reliability, that the occurrence rate of errors in the population does not exceed 20%. He can say with (GREATER/LESSER) confidence that it does not exceed 25%.

increases

2-34. In each of the following cases, assume the factor is increased while the remaining two are held constant. Indicate with an I those factors which, when increased, will increase the required sample size and, with a D, those factors which will decrease the required sample size.

- A. Upper precision limit
- B. Estimated occurrence rate
- C. Reliability

- 1. 2%
- 2. 5%
- 3. 90%

3-35. Determine the required sample size and enter your answer on Line 4.

GREATER

1-28. When an auditor states that 10 errors in a sample of 80 records establish a 90% confidence level that the population occurrence rate does not exceed 20%, he is inferring that 100 random samples, of 80 records each, drawn from that population will, in approximately 90 instances, show an occurrence rate of less than 20%. If he increases his upper precision limit to 25%, obviously those 90 samples with occurrence rates of 20% or less (WILL/WILL NOT) fall below the new upper limit.

D A.

I B.

I C.

2-35. Turn to Worksheet 2, ABC LOAN COMPANY (Page S-27). For the problem specified, enter the appropriate values in Lines 1, 2, and 3.

4. 160

3-36. The auditor draws his sample and discovers 3 vouchers which have not been signed by an authorized individual. Complete Lines 5 and 6.

WILL

1-29. Since 90 of his 100 samples will have an occurrence rate of 20% or less, he can reasonably expect some portion of the remaining 10 samples to show occurrence rates between 20 and 25%. If 9 of these 10 samples show occurrence rates between 20 and 25%, then _____ of his 100 samples have occurrence rates of less than 25%, and he can state that he is approximately _____% confident that the population occurrence rate does not exceed 25%.

1. 1%
2. 3%
3. 95%

2-36. Using the tables in Exhibit 1, determine the required sample size for the problem of the ABC Loan Company. Enter your answer on Line 4 of Worksheet 2.

5. 3
6. 5%

3-37. Have the criteria of the auditor's sampling plan been satisfied? (YES/NO)

99

99

1-30. If you are interested in further discussion of the relationship between precision and reliability expressed in the last few frames, refer to Volume I, An Introduction to Statistical Concepts and Estimation of Dollar Values. A more rigorous treatment of this concept can be found in Frames 1-22 through 1-49 of that volume.

(No answer required)

4. 340

2-37. If the auditor of the ABC Loan Company required a higher reliability, would his sample size increase or decrease? _____

YES

3-38. As a review, let us go over the several stages of an attribute sampling plan.

1. Definition of sampling plan
 - a. Define the population
 - b. Define the occurrence
 - c. Specify confidence (reliability) level required
 - d. Specify allowable upper precision limit

Which item is missing from the following sampling plan: An auditor wishes to determine what percentage of the accounts receivable of ABC Corporation are more than 90 days overdue. His allowable upper limit is a 10% occurrence rate.

Missing item: _____

No answer required

1-31. As a review, indicate with a V which of the following sampling objectives are examples of sampling for variables and indicate with an A those which are examples of sampling for attributes.

- ___ 1. determination of total dollar amount of inventory
- ___ 2. determination of the frequency of billing errors
- ___ 3. determination of the percentage of accounts with balances more than 90 days overdue

increase

2-38. What three quantities must be defined in the sampling problem to select the required sample size?

- 1. _____
- 2. _____
- 3. _____

confidence level

3-39. The second step is to determine the required sample size.

- 1. Required information
 - a. Specified upper precision limit
 - b. Estimated occurrence rate of sample
 - c. Required reliability (confidence) level
- 2. Select sample size from tables for required confidence level.

If the upper precision limit were 10% and the confidence level required were 90%, what would be the required sample size for a population with an estimated occurrence rate of 7%?

V 1.

A 2.

A 3.

1-32. In sampling for variables, each element of the population can have any one of a wide range of values, whereas in attribute sampling each element can have one of _____ values.

/ANY ORDER/

estimated occurrence rate

upper precision limit

reliability
(confidence level)

2-39. Must the size of the population be known to determine the required sample size using the tables in this book? (YES/NO)

240

3-40. The third step is selection of a random sample from the population equal to the sample size already determined. The results are then evaluated.

1. Count occurrences in sample
 - a. Select table for evaluation of results at the required confidence level.
 - b. For sample size used, and number of occurrences found, determine upper limit of population occurrence rate.

If our sample of 240 items revealed 16 occurrences, the upper limit for a 90% confidence level would be _____.

two

1-33. Which of the following statements describes the result of a sampling plan for attributes?

- a. I am 90% confident that no more than 2% of the accounts receivable contain balances more than 120 days overdue.
- b. I am 90% confident that the total value of accounts receivable with amounts more than 120 days overdue is $\$180,000 \pm \$10,000$.

NO

END OF CHAPTER II

10%

3-41. Which of the following items must be known to determine the correct sample size?

- 1. confidence level required
- 2. size of population
- 3. specified upper precision limit
- 4. actual population occurrence rate
- 5. estimated occurrence rate

a. I am 90% confident that no more than 2% of the accounts receivable contain balances more than 120 days overdue.

END OF CHAPTER I

CHAPTER 3. EVALUATION OF SAMPLE RESULTS

3-1. After the auditor has determined his required sample size, he must draw the sample and evaluate his results. The tables used in this volume have been constructed for random sampling with replacement. Therefore, his sample must be random. If sampling is without replacement, the tables (WILL/WILL NOT) be applicable.

X 1.

X 3.

X 5.

3-42. After the sample has been selected, what three values must be known to evaluate the sample result from the tables?

1. _____

2. _____

3. _____

CHAPTER 2. DETERMINATION OF SAMPLE SIZE

2-1. When the auditor has defined his sampling objectives, his next step is to determine the appropriate sample size. This is done with the tables in Exhibit 1 (Pages S-15 to S-19). These tables are based on the cumulative binomial distribution and assume that a random sample will be drawn with replacement.

Note: In sampling with replacement, each sample item after being drawn and included in the sample is, in effect, replaced in the population so that it is subject to being drawn again. (No answer required)

WILL

(Results will be more conservative, however.)

3-2. In selecting his sample and evaluating the results thereof, the auditor must use a random selection method such as the procedure shown in Volume I, An Introduction to Statistical Concepts and Estimation of Dollar Values. Chapter 2 of that volume provides a thorough description of the use of random number tables in sample selection.

An alternate method of drawing a random sample which is often useful is presented in Appendix I of this volume. This begins on Page S-1.

(No answer required)

/ANY ORDER/

number of occurrences
in the sample

sample size

confidence level

3-43. For 99% confidence that a population with an estimated error rate of 5% has a true occurrence rate less than 10%, a sample of _____ items would be required. If the specified confidence level were reduced to 90% the sample size required would be _____ items.

No answer required

2-2. In some situations, it may not be desirable to draw the sample with replacement. However, these tables will still be applicable since the differences are not great and, to the extent that such differences do exist, results obtained with the tables will be on the conservative side. Therefore, these tables can be used when sampling with or _____ replacement.

No answer required

3-3. In sampling for attributes, we must examine each element of our sample to determine only whether or not the characteristic under investigation occurs or does not occur. In determining the accuracy of invoices, an auditor discovers that an extension of \$109.88 is shown as \$190.88. He would note for the purpose of attribute sampling, that:

- a. the invoice is in error
- b. the invoice is in error by \$81.00

240

80

3-44. For 95% confidence that the true occurrence rate of a population with an estimated occurrence rate of 5% does not exceed 14%, a sample of 60 items would be required. If the estimated occurrence rate were increased to 10%, the required sample size would be (INCREASED/DECREASED) to _____ items.

without

2-3. Examine Exhibit 1, Sheets 1 through 5. You will notice that each sheet is headed as follows:

Determination of Sample Size
Percentage of Occurrences in Sample
Reliability (Confidence Level): XX%

If your sampling plan specified a 95% reliability, to which sheet would you refer?

a. the invoice is in error

3-4. As part of his sampling plan, the auditor must precisely define his population and specify the characteristic that constitutes an occurrence in that population.

(No answer required)

INCREASED

240

3-45. Indicate which of the following statements are true or false. (Assume that all other factors are held equal in each case.)

- ___ 1. As our sample size increases, the difference between the sample occurrence rate and upper limit decreases.
- ___ 2. As the confidence level increases, required sample size increases.
- ___ 3. As the estimated occurrence rate increases, the required sample size increases.

2-4. Use of the tables requires a precise definition of the sampling problem. The following three factors must be known.

- ___ 1. Estimate of sample occurrence rate
- ___ 2. Upper precision limit
- ___ 3. Required confidence level

An auditor seeks to determine with 95% reliability that a group of vouchers does not contain more than 5% errors. He estimates, from experience, that the occurrence rate is probably about 2%. Beside 1, 2, and 3 above, enter the corresponding values for this problem.

No answer required

3-5. An auditor seeks to determine the percentage of vendor's invoices containing errors. In a sample of 100 invoices, he discovers 8 invoices containing 1 error each and 2 invoices with 2 errors each. What is the number of occurrences in his sample?

- a. 12 (Turn to Frame 3-6.)
- b. 10 (Turn to Frame 3-7.)

All are true.

3-46. In each of the following examples, assume a 95% reliability and an actual sample occurrence rate of 10%. Enter the number of sample occurrences and upper precision limit for each case.

	<u>A</u>	<u>B</u>	<u>C</u>
Sample Size	50	240	1000
Number of Occurrences	5	___	___
Upper Precision Limit	___	___	___

- 2% 1.
- 5% 2.
- 95% 3.

2-5. There will be occasions where an auditor will be called upon to examine records with which he has no previous experience and, therefore, is in no position to estimate his sample occurrence rate. Later we will illustrate a procedure to follow in this situation. Generally, however, three quantities must be included in definition of the sampling problem as follows:

- 1. _____
- 2. _____
- 3. _____

3-6. YOUR ANSWER: a. 12

Wrong. According to the definition in his sampling plan, an occurrence is the existence of an invoice containing an error, not the existence of the error. Therefore, the correct answer is:

8 (invoices containing 1 error each)
+2 (invoices containing 2 errors each)
10

Go on to Frame 3-8.

<u>A</u>	<u>B</u>	<u>C</u>
	24	100
20%	14%	12%

3-47. As the sample size increases while the sample occurrence rate and reliability are held constant, the upper precision limit _____.

/ANY ORDER/

estimate of sample
occurrence rate

upper precision limit

required confidence
level

2-6. When these three quantities are known, the auditor is in a position to determine the required sample size. The first step is to select the appropriate table in Exhibit 1. This selection is determined by:

- a. Estimated occurrence rate
- b. Upper precision limit
- c. Reliability (Confidence Level)

3-7. YOUR ANSWER: b. 10

Correct. Since the auditor has defined his population as vendor's invoices and defined the characteristic he is investigating as the number of invoices containing errors, the correct answer is 10 invoices.

decreases

THE END

c. Reliability
(Confidence Level)

2-7. Indicate the appropriate sheet in Exhibit 1 for each of the following specified confidence levels.

<u>Reliability</u>	<u>Sheet</u>
99%	_____
90%	_____
95%	_____

3-8. Refer to Worksheet 2 (Page S-27), the problem of the ABC Loan Company. Upon selecting his sample of 340 loan balances, the auditor determines that 338 are correct. Enter, on Line 5 of Worksheet 2, the number of occurrences discovered in the sample.

1
3
2

2-8. Examine Sheet 1 (Reliability: 99%) of Exhibit 1. You will note that this table, like the others, consists of columns headed by the upper precision limit and lines captioned by sample size. Each of the numbers in the table is a value of estimated sample occurrence rate and corresponds to some value of the upper precision limit and sample size. Of the three quantities, which two are known to the auditor from his sampling plan?

1. _____
2. _____

2

3-9. The auditor must now evaluate this result to determine whether or not he can state, with 95% confidence (reliability), that the population does not contain more than 3% errors. To do this, he uses the tables in Exhibit 2 (Page S-20 through Page S-24) for evaluation of results. Like the tables for determination of sample size, Exhibit 2 consists of several individual tables, each of which corresponds to a different _____.

/EITHER ORDER/

upper precision limit

estimated sample
occurrence rate

NOW TURN BACK TO PAGE 3 AND BEGIN THE
SECOND ROW.

confidence level
(reliability)

NOW TURN BACK TO PAGE 3 AND BEGIN THE
THIRD ROW.