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American Institute of Certified Public Accountants. Statistical Sampling Subcommittee

EXPOSURE DRAFT

PROPOSED AUDIT GUIDE

AUDIT SAMPLING

MARCH 1, 1982

Prepared by the Statistical Sampling Subcommittee of
the American Institute of Certified Public Accountants

Comments should be received by August 15, 1982, and addressed to file 5000,
AICPA, 1211 Avenue of the Americas, New York, New York 10036

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AICPA

American Institute of Certified Public Accountants
1211 Avenue of the Americas, New York, New York 10036 (212) 575-6200

March 1, 1982

An exposure draft of a proposed Audit Guide entitled Audit Sampling accompanies this letter. The proposed guide provides guidance to the auditor for implementing Statement on Auditing Standards no. 39, Audit Sampling and, thus, is important to all CPA's who do audits. SAS no. 39 applies to both nonstatistical and statistical sampling. This proposed guide provides guidance to assist auditors using either approach in applying SAS no. 39.

Comments or suggestions on guidance provided in the exposure draft will be appreciated. The subcommittee is especially interested in comments or suggestions resulting from application of the proposed audit guide in audit engagements. Those comments or suggestions might identify:

- Any circumstances where you were unable to determine. whether SAS no. 39 or this proposed guide applies.
- Any difficulties you encountered in designing, selecting, and evaluating a nonstatistical sample in accordance with the guidance provided by this proposed guide.
- Any guidance that you found to be particularly difficult to understand.
- Any essential guidance that you believe is omitted from the proposed guide.
- Any special difficulties you found in applying the guidance to sampling applications in the audit of a small business.

The subcommittee's consideration of responses will be helped if comments refer to a specific page, explain the problem, and include supporting reasons for suggestions or comments.

Responses should be addressed to the AICPA Auditing Standards Division, File 5000, in time to be received by August 15, 1982. Written comments on the exposure draft will become part of the public record of the AICPA Auditing Standards Division, and will be available for public inspection at the office of the American Institute of Certified Public Accountants after August 15, 1982, for one year.

Sincerely,

James Kirtland, Chairman
Statistical Sampling Subcommittee

D.R. Carmichael, Vice President
Auditing

SUMMARY

This exposure draft is a proposed Audit Guide entitled Audit Sampling. The proposed guide is important to all CPAs who do audits. It provides guidance to the auditor for implementing Statement on Auditing Standards no. 39, Audit Sampling.

SAS no. 39 applies to all audit sampling – both statistical and nonstatistical. This proposed guide provides guidance to assist auditors using either approach in applying SAS no. 39. The guide is organized so that essentially all the guidance relating solely to statistical sampling is located beginning with Chapter 3, section 3. As a result, if an auditor is using this guide to assist him in applying nonstatistical sampling, the auditor would ordinarily follow the guidance in Chapters 1, 2, and 3 (sections 1 and 2).

The audit guide is organized as follows:

- The introduction to the guide describes the scope of the audit guide and provides guidance on the type of audit procedures covered by SAS no. 39 and this guide.

- Chapter 1 provides an overview of the relationship of audit sampling to the audit process.

- Chapter 2 provides guidance on the use of audit sampling for tests of compliance with prescribed internal accounting control procedures. This guidance applies to both nonstatistical and statistical sampling except where noted.

- Chapter 3 provides guidance on the use of audit sampling for substantive tests of details. Chapter 3 is divided into four sections. Section one provides general guidance that applies to both nonstatistical and statistical sampling. Section 2 provides guidance for nonstatistical sampling applications for substantive tests. Two types of statistical sampling approaches for substantive tests are described in sections 3 and 4. Sections 2, 3, and 4 each include a case study illustrating the application of the guidance in the respective section.

- The guide includes several appendices. Appendices A through E are primarily useful in applying certain statistical sampling approaches. Appendix F provides further guidance on the use of the risk model included in the appendix to SAS no. 39. Appendices G and H are a glossary and selected bibliography of further readings, respectively.

Neither SAS no. 39 nor this guide requires the auditor using nonstatistical sampling to compare the sample size for the nonstatistical sampling application to a corresponding sample size calculated using statistical theory. However, the guide provides several quantitative illustrations of sample sizes based on statistical theory that should be helpful to an auditor applying professional judgment and experience in considering the effect of various planning considerations on sample size.

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INTRODUCTION

Statement on Auditing Standards No. 39, Audit Sampling, provides guidance on the use of sampling in an audit of financial statements. The statement includes guidance for planning, performing, and evaluating the two general approaches to audit sampling: nonstatistical and statistical. SAS No. 39 recognizes that the auditor is often aware of items in an account balance or a class of transactions that might be more likely to contain errors.[1] The auditor considers this knowledge in planning his procedures, including audit sampling. The auditor usually will have no special knowledge about other items in an account balance or class of transactions that, in his judgment, will need to be tested to fulfill his audit objectives. The auditor might apply audit sampling to such a balance or class. This guide provides guidance to help auditors apply audit sampling in accordance with SAS No. 39. Alternatively, the auditor might apply procedures not involving audit sampling to such a balance or class. Neither this guide nor SAS No. 39 provide guidance on designing, performing, and evaluating audit procedures not involving audit sampling.

Procedures Not Involving Sampling

An audit consists of numerous interrelated procedures designed to obtain sufficient competent evidential matter to support an opinion on the financial statements being examined. Some procedures may involve audit sampling. According to SAS No. 39, Audit Sampling, audit sampling is "the application of an audit procedure to less than 100 percent of the items within an account balance or class of transactions for the purpose of evaluating some characteristic of the balance or class." Ordinarily an audit also includes procedures other than those involving audit sampling. Procedures not involving audit sampling are not the subject of SAS No. 39 or this guide. However, because distinguishing between sampling and procedures not involving sampling may be difficult, this section discusses the distinction between procedures that do and do not involve audit sampling.

In general, procedures that do not involve sampling may be grouped as follows.

Inquiry and observation. An auditor asks many questions during the course of his examination. The auditor also observes the operation of the client's business. Both inquiry and observation provide the auditor with evidential matter. Inquiry and observation include procedures such as:

- Interviewing management and employees

[1]For purposes of this guide, errors include both errors and irregularities as defined in SAS No. 16, The Independent Auditor's Responsibility for the Detection of Errors and Irregularities.

- Obtaining written representations from management
- Completing internal accounting control questionnaires
- Scanning accounting records for unusual items
- Examining one or a few transactions from an account balance or class of transactions to obtain an understanding of the entity's operations or to clarify an understanding of the entity's system of internal accounting control (a "walk through")
- Observing the behavior of personnel and the functioning of business operations
- Observing cash-handling procedures
- Inspecting land and buildings

Analytical review procedures. According to SAS No. 23, Analytical Review Procedures, analytical review procedures are "substantive tests of financial information made by a study and comparison of relationships among data." Analytical review procedures include procedures such as:

- Comparison of the financial information with information for comparable prior period(s).
- Comparison of the financial information with anticipated results (for example, budgets and forecasts).
- Study of the relationships of elements of financial information that would be expected to conform to a predictable pattern based on the entity's experience.
- Comparison of the financial information with similar information regarding the industry in which the entity operates.
- Study of relationships between the financial information and relevant nonfinancial information.

100 percent examination. In some circumstances an auditor may decide to examine every item comprising an account balance or a class of transactions. Because the auditor is examining the entire balance or class, rather than only a portion, to reach a conclusion about the balance or class taken as a whole, 100 percent examination is not a procedure involving audit sampling.

Untested balances. The auditor may decide that he need not apply any audit procedures to an account balance or class of transactions if he believes that any misstatement in the account or class would be immaterial. Untested balances are not the subject of sampling.

The determination of whether the application of a procedure to less than 100 percent of an account balance or class of transactions involves audit sampling generally depends on the audit objective to be achieved by the procedure. For example, an auditor may decide to supplement other audit procedures designed to test the valuation of inventory by testing the valuation of several large items included in the inventory balance. If the auditor's objective of that procedure is to evaluate the valuation of the entire inventory balance, the procedure involves audit sampling and is subject to the guidance in SAS No. 39. On the other hand, if the auditor's objective is only to search for misstatement in those few items without inferring anything about the valuation of the inventory as a whole, the procedure does not involve audit sampling.

An account balance or a class of transactions may be examined by a combination of several audit procedures. In some circumstances the auditor may decide to apply several audit procedures to the entire balance or class. For example, an auditor may wish to determine whether inventory quantities are complete by a combination of audit procedures such as:

- Observing the entity's personnel as they make a physical count of inventory

- Analytically reviewing the relationship of inventory balances to recent purchasing, production, and sales activities

- Selecting several quantities included in the physical inventory count to be agreed with the quantities on hand

If the auditor wishes to infer the results of his examination of the few selected inventory quantities to the entire population of inventory counts, that procedure would involve audit sampling. On the other hand, the auditor might have divided the physical inventory counts into two groups: those items that he considers to be individually significant and other items that are individually insignificant. The auditor might decide that he has obtained sufficient evidential matter relating to the individually insignificant items from the procedures not involving sampling and that he does not need to apply audit sampling to those items. The individually significant items might include, for example, items with large balances or unusual items that would be examined 100%. In that case his examination of the physical inventory would not include any procedure involving audit sampling and would not be the subject of SAS No. 39 or this guide.

Another illustration should help to clarify the distinction between procedures that do or do not involve audit sampling. An auditor might be examining fixed asset additions of $2 million for overstatement. Those additions might include five additions totaling $1,600,000 related to a plant expansion program and 400 other smaller additions comprising the remaining $400,000 book value. The auditor might decide that the five large additions are individually significant and need to be examined 100 percent. The auditor might then consider whether audit sampling should be applied to the remaining 400 items. This decision is based on the potential for material misstatement in the $400,000 of the remaining 400 items, not the percentage of the $2 million individually examined.

Alternatives are discussed in the following three situations:

Situation 1: The auditor has performed other procedures related to fixed asset additions, including

- A study and evaluation of related internal accounting controls, which supported substantial reliance on the controls

- A review of the entries to the fixed asset ledger, which revealed no unusual items

- An analytical review procedure which suggested that the $400,000 book value of the remaining 400 items is consistent with the trend from prior years

In this circumstance the auditor might decide that he has obtained sufficient evidential matter regarding fixed asset additions without applying audit sampling to the remaining individually insignificant items. Therefore, the guidance in SAS No. 39 and this guide would not apply.

Situation 2: The auditor has not performed any procedures related to the remaining 400 items, but he has decided that any misstatement in those items would be immaterial. The consideration of untested balances is not the subject of SAS No. 39 or this guide.

Situation 3: The auditor has performed some or all of the same procedures in situation one, but he concludes that he should obtain some additional evidential matter regarding the 400 individually insignificant additions through audit sampling. In this case, the guidance in SAS No. 39 and this guide should assist the auditor in designing, performing, and evaluating the audit sampling application.

The Development of Audit Sampling

Near the beginning of the twentieth century the rapid increase in the size of American companies created a need for audits based on selected tests of items comprising account balances or classes of transactions. Before then, many audits had included an examination of every transaction in the period covered by the financial statements.

In the early twentieth century, professional literature paid little attention to the subject of sampling. A program of audit procedures printed in 1917 in the Federal Reserve Bulletin included some early references to sampling, such as selecting "a few book items" of inventory. The program was prepared by a special committee of the AICPA's earliest predecessor, the American Association of Public Accountants.

For the first few decades of the century, auditors often applied sampling, but the extent of sampling was not related to the effectiveness of an entity's system of internal accounting control. Some auditing articles and textbooks in the 1910s and 1920s referred to reducing the extent of tests of detail based on reliance on the entity's "internal check," as internal accounting control was first called. However, there was little acceptance of this relationship in practice until the 1930s.

In 1955 the American Institute of Accountants (AIA - later to become the AICPA) published A Case Study of the Extent of Audit Samples that summarized audit programs prepared by several CPAs to indicate the extent of audit sampling each considered necessary for a case study audit. The study was significant because it was one of the first professional publications on sampling. Also, it ackowledged some relationship between the extent of tests of details and reliance on internal accounting control. The 1955 study concluded, "Although there was some degree of similarity among the views expressed as to the extent of sampling necessary with respect to most items in the financial statements, no clear-cut pattern resulted."

During the 1950s some interest developed in applying statistical principles to sampling in auditing. Some auditors succeeded in developing methods for applying statistical sampling; however, other auditors questioned whether those techniques should be applied in auditing.

The first pronouncement on the subject of statistical sampling was a special report, Statistical Sampling and the Independent Auditor, issued by the AICPA's Committee on Statistical Sampling in 1962. The report concluded that statistical sampling was permitted under generally accepted auditing standards. A second report, Relationship of Statistical Sampling to Generally Accepted Auditing Standards, issued by the committee in 1964, illustrated the relationship of precision and reliability in sampling to generally accepted auditing standards. The 1964 report was later included as Appendix A to Statement on Auditing Procedures (SAP) No. 54, The Auditor's Study and Evaluation of Internal Control (later codified as SAS No. 1, section 320). The statement elaborated on the guidance provided by the earlier report. An Auditing Procedures Committee report, Precision and Reliability for Statistical Sampling in Auditing, was issued in 1972 as Appendix B to SAP No. 54.

Two other statements on auditing procedure included references to sampling applications in auditing. SAP No. 33, issued in 1963, indicated that a practitioner might consider using statistical sampling in appropriate circumstances. SAP No. 36, issued in 1966, provided guidance on the auditor's responsibility when a client uses a sampling procedure, rather than a complete physical count, to determine inventory balances.

From 1967 to 1974 the AICPA published a series of volumes of guidance on statistical sampling prepared by the statistical sampling subcommittee. The series, entitled An Auditor's Approach to Statistical Sampling, was designed for use in continuing professional education. The AICPA also published a book, Statistical Auditing, by Donald M. Roberts (1978) explaining the theory underlying statistical sampling.

In 1981 the ACIPA's Auditing Standards Board issued SAS No. 39, Audit Sampling. That SAS provides general guidance on both nonstatistical and statistical sampling in auditing and supersedes both Appendices A and B to SAS No. 1, section 320. This guide expands on the guidance in SAS No. 39.

Purpose of This Guide

This audit guide is designed to assist the auditor in applying sampling in accordance with SAS No. 39. It provides detailed, practical guidance on the use of nonstatistical and statistical sampling in auditing. The terms used in this guide are consistent with those in SAS No. 39. Some auditors may be familiar with other terms often used in discussions of statistical sampling, including precision, confidence level, reliability, alpha risk and beta risk. SAS No. 39 does not use those terms because the statement applies to both statistical and nonstatistical sampling and therefore nontechnical terms are more appropriate. In addition, certain statistical terms, such as reliability and precision, each have been used with different meanings. Auditors may, of course, use whatever terms they prefer as long as they understand the relationship of those terms to the concepts in SAS No. 39 and this guide. In general, some of those relationships include:

- Reliability and confidence level: SAS No. 39 uses the concept of risk instead of reliability or confidence level. Risk is the complement of reliability or confidence level. For example, if an auditor wishes to specify his reliability or confidence level as 90 percent, he is willing to accept a 10 percent risk. The term risk is more consistent with the auditing framework described in the Statement on Auditing Standards.

- Alpha and beta risks (risks of Type I and Type II errors): SAS No. 39 uses the terms risk of overreliance on internal accounting control and risk of incorrect acceptance instead of beta risk. SAS No. 39 also uses the terms risk of underreliance on internal accounting control and risk of incorrect rejection instead of alpha risk. Both alpha risk and beta risk are statistical terms that have not been consistently applied among auditors.

- Precision: Precision may be used as a planning concept for audit sampling. SAS No. 39 uses the concept of tolerable error instead of this meaning of precision. Precision may also be used in audit sampling as an evaluation concept. SAS No. 39 uses the concept of an allowance for sampling risk instead of this meaning of precision.

This guide discusses several approaches to applying statistical sampling in auditing. It does not discuss the use of statistical sampling if the objective of the application is to develop an original estimate of quantities or amounts. To avoid a complex, highly technical presentation, the guide does not include guidance on every possible method of applying statistical sampling. This audit guide also does not discuss the mathematical formulas underlying statistical sampling. When auditors first started using statistical sampling, they had to become familiar with those complex formulas, some of which may be too complex for most auditors to apply without special technical knowledge. Now, well-designed tables and computer software are available to provide the information previously calculated by the auditor. Although it is generally not necessary for the auditor to be knowledgeable about the underlying formulas in performing a sampling application, those formulas can be obtained from reference sources included in the bibliography.[2] The guide generally assumes that the auditor will be using computer programs or tables to perform many of the calculations and selections necessary for statistical sampling. Appendix E describes available timesharing and batch programs and considerations in selecting appropriate programs.

This guide contains basic information on how to apply sampling in auditing. Chapter 1 discusses general concepts of sampling. Chapters 2 and 3 discuss sampling applications for compliance and substantive testing respectively. The guide also contains several appendices, including a glossary and an annotated bibliography of additional reading materials. The guide may be used both as a reference source for those who are knowledgeable in this area and as initial background for those who are new to this area. Auditors who are unfamiliar with technical sampling considerations may benefit from combining use of this guide with a continuing education course in audit sampling. Training is available from sources such as the AICPA, the various state societies, colleges and universities, and some CPA firms.

[2]Auditors interested in familiarizing themselves with these formulas should see Appendix 2 of Donald Roberts Statistical Auditing (New York: AICPA, 1978).

CHAPTER 1

THE AUDIT SAMPLING PROCESS

Purpose and Nature of Audit Sampling

Auditors frequently use sampling procedures to obtain audit evidence. Audit sampling is the application of an audit procedure to less than 100 percent of the items within an account balance or class of transactions for the purpose of evaluating some characteristic of the balance or class. The auditor may use either nonstatistical or statistical sampling.

The portion of the account balance or class of transactions to be examined is the sample. The items comprising the account balance or class of transactions of interest are the population.

The following questions apply to designing any audit samling procedure, whether nonstatistical or statistical.

1. What is the objective of the test? (What do you want to learn or be able to infer about the population?)

2. What is to be sampled? (How is the population defined?)

3. What is the auditor looking for in the sample? (How is an error defined?)

4. How is the population to be sampled? (What is the sampling plan, and what is the method of selection?)

5. How much is to be sampled? (What is the sample size?)

6. What do the results mean? (How are the sample results evaluated and interpreted?)

In some situations, sampling may not be appropriate. For example, the auditor may decide that it is more efficient to test an account balance or class of transactions by applying analytical review procedures. In some cases, legal requirements may necessitate 100% examination. In other situations, the auditor may decide that some items should be examined 100% because he does not believe acceptance of some risk is justified or he believes 100% examination is cost-effective in the circumstances. The auditor uses professional judgment to determine the circumstances where audit sampling is appropriate.

Risk

The justification for reasonable assurance rather than certainty as to reliability of financial information is based on the third standard of field work: "Sufficient competent evidential matter is to be obtained...to afford a reasonable basis for an opinion..." According to

SAS No. 39, the justification for accepting some uncertainty arises from the relationship between the time required to examine all of the data and the adverse consequences of possible erroneous decisions based on the conclusions resulting from examining only a sample of such data. The uncertainty inherent in performing auditing procedures is ultimate risk. Ultimate risk is a combination of two separate risks: that material errors will occur in the accounting process by which the financial statements are developed and that material errors will not be detected by the auditor.

Ultimate risk includes both uncertainties due to sampling and uncertainties due to other factors. These are sampling and nonsampling risk, respectively.

Nonsampling risk includes all the aspects of ultimate risk that are not due to sampling. An auditor may apply a procedure to all transactions or balances and still fail to detect a material misstatement or a material internal accounting control weakness. Nonsampling risk includes the possibility of selecting audit procedures that are not appropriate to achieve the specific objective. For example the auditor cannot rely on confirmation of recorded receivables to reveal unrecorded receivables. Nonsampling risk also arises because the auditor may fail to recognize errors included in documents that he examines, which would make that procedure ineffective even if he were to examine <u>all</u> items.

No sampling method will allow the auditor to measure the nonsampling risk. This risk can, however, be reduced to a negligible level by adequate planning and supervision of audit work (see SAS No. 22, <u>Planning and Supervision</u>) and proper conduct of an auditor's practice (see SAS No. 25, <u>The Relationship of Generally Accepted Auditing Standards to Quality Control Standards</u>). The subject of controlling nonsampling risk is outside the general scope of this guide. However, the section of this chapter, "General Implementation Considerations," may be helpful in controlling nonsampling risk.

Sampling risk arises from the possibility that, when a compliance or substantive test is restricted to a sample, the auditor's conclusions may be different from those he would have reached if the test were applied in the same way to all the items in the account balance or class of transactions. That is, a particular sample may contain proportionately more or less monetary errors or compliance deviations than exist in the account balance or class of transactions as a whole.

How Audit Sampling Differs From Other Sampling Procedures

Auditing is not the only discipline that uses the sampling method. For example, sampling is used in opinion surveys, market analysis, and scientific and medical research in which someone desires to reach a conclusion about a large body of data by examining only a portion of that data. There are major differences, though, between audit sampling and these other sampling applications.

First, accounting populations differ from most other populations because, before the auditor's testing begins, the data have been accumulated, compiled, and summarized. Rather than using the sample to estimate an unknown, the auditor's objective is generally to corroborate the accuracy of certain client data, such as account balances or classes of transactions, or to evaluate the internal accounting controls over the processing of the data. The audit process is generally an evaluation of whether a value is substantially correct rather than a determination of original values.

Second, the distribution of values in accounting populations generally differs from other populations. In typical nonaccounting populations the amounts tend to cluster around the average amount of the items in the population. In contrast, accounting populations tend to include a few very large amounts, a number of moderately large amounts, and a large number of small amounts. The auditor should consider this distribution of accounting amounts when designing audit samples for substantive tests.

Also, the evidence obtained from each audit test is just one element of the total evidence that the auditor obtains. The auditor generally does not rely on a single audit test, as might a market researcher or another sampler, but reaches an overall conclusion based on the results of numerous interrelated tests performed by him. Therefore, an auditor plans and evaluates audit samples with the knowledge that his overall conclusion about the population characteristic of interest will be based on more than the results of that audit sample.

Types of Audit Tests

SAS No. 39 describes three types of audit tests: compliance, substantive and dual purpose. Because the type of test to be performed is important to an understanding of audit sampling, these are discussed below.

Compliance testing. Compliance tests are intended to provide a basis for the auditor to conclude whether internal accounting control procedures are being applied as prescribed. Compliance testing is necessary if a prescribed procedure is to be relied on in determining the nature, timing and extent of substantive tests.

A specific internal accounting control procedure is expected to be applied in the same way to all transactions subject to that control, regardless of the magnitude of the transaction. Therefore, if the auditor is using audit sampling, it is generally not appropriate to select only high dollar amounts in testing compliance. All samples should be selected in such a way that the sample can be expected to be representative of the population.

Substantive testing. Substantive tests are audit procedures designed to obtain evidence about the validity and propriety of the accounting treatment of transactions and balances or to detect errors therein.

Substantive tests differ from compliance tests in that the auditor is interested primarily in a conclusion as to dollars. Substantive tests include (a) tests of details of transactions and balances and (b) analytical review procedures.

Dual purpose tests. In some circumstances the auditor may design a test that will be used for dual purposes: testing compliance with prescribed internal accounting control procedures and testing whether a recorded balance or amount of transactions is correct. Similarly, a dual purpose sample is a sample that is designed to achieve both a compliance and a substantive objective. Because the auditor will have begun his substantive procedures before he determines whether the compliance test supports his planned degree of reliance on internal accounting control, an auditor planning to use a dual purpose sample would have made a preliminary assessment that there is an acceptably low risk that the rate of compliance deviations in the population exceeds the maximum rate of deviations the auditor is willing to accept without altering his planned reliance. For example, an auditor designing a compliance test of a control procedure over entries in the voucher register may plan a related substantive test at a risk level that anticipates reliance on that internal accounting control procedure.

The size of a sample designed for dual purposes should be the larger of the samples that would otherwise have been designed for the two separate purposes. In evaluating such samples, the auditor should evaluate deviations from pertinent procedures and monetary errors separately, using the risk level applicable for the respective purposes. The guidance provided in chapters 2 and 3 for evaluating results of compliance and substantive tests, respectively, is applicable to the evaluation of dual purpose samples.

Nonstatistical and Statistical Sampling

Both nonstatistical and statistical sampling involve examining less than the whole body of data to express a conclusion about the total body of data. Both methods involve audit judgment in planning and performing a sampling procedure and evaluating the results of the sample. Also, the audit procedures involved in examining the selected items in a sample generally do not depend on the sampling approach used.

Once a decision has been made to use audit sampling, the auditor must choose between statistical and nonstatistical sampling. This choice is primarily a cost/benefit consideration. Statistical sampling helps the auditor (a) to design an efficient sample, (b) to measure the sufficiency of the evidential matter obtained, and (c) to evaluate the sample results. If audit sampling, either nonstatistical or statistical, is used, some sampling risk is always present. Statistical sampling uses the laws of probability to measure sampling risk. Any sampling procedure that does not measure the sampling risk is a nonstatistical sampling procedure. Even if the auditor rigorously selects a random sample but does not make a statistical evaluation of the sample results, the sampling procedure is not a statistical application.

A properly designed nonstatistical sampling application can provide results that are as effective as those from a properly designed statistical sampling application, but there is one difference: Statistical sampling measures the sampling risk associated with the sampling procedure.

Statistical sampling might involve additional costs (a) of training auditors, (b) of designing individual samples to meet the statistical requirements and (c) in selecting the items to be examined. For example, if the individual balances comprising an account balance to be tested are not maintained in an organized pattern, it might not be cost-effective for an auditor to select items in a way that would satisfy the requirements of a properly designed statistical sample. To illustrate: An auditor plans to use audit sampling to test a physical inventory count. Although the auditor can select a sample in such a way that the sample can be expected to be representative of the population, it might be difficult for him to satisfy certain requirements for a statistical sample (see Chapter 2, "Determining the Method of Selecting the Sample"). Because either nonstatistical or statistical sampling can provide sufficient evidential matter, the auditor chooses between them after considering their relative cost and effectiveness in the circumstances.

When an auditor plans any audit sampling application he first considers the specific account balance or class of transactions and the circumstances in which the procedure is to be applied. The auditor generally identifies items or groups of items that have significance with respect to the audit objective. For example, an auditor planning to use audit sampling as part of his tests of an inventory balance in conjunction with an observation of the physical inventory would generally identify those items that have significantly large balances or those items that might have other special characteristics (such as higher susceptibility to obsolescence or damage). In testing accounts receivable, an auditor might identify accounts with large balances, unusual balances, or unusual patterns of activity as individually significant items. The auditor considers all such special knowledge about the items comprising the balance or class before designing audit sampling procedures. For example, the auditor might identify three products included in the inventory that comprise 70 percent of the account balance. In addition, he might have identified several items comprising an additional ten percent of the balance that are especially susceptible to damage. The auditor may decide that those items should be examined 100 percent and therefore excluded from the inventory subject to audit sampling. These considerations would not be influenced by the auditor's intentions to use either nonstatistical or statistical sampling on remaining items. After the auditor has applied all his special knowledge about the account balance or class of transactions in designing an appropriate procedure, there is often a group of items about which the auditor has no special knowledge but that need to be evaluated to achieve the audit objective. The auditor might apply audit sampling - either nonstatistical or statistical - to such a population.

Statistical sampling provides the auditor with a tool that assists him in applying experience and professional judgment to more explicitly control sampling risk. Because this risk, like the other factors affecting sample size, is present in both nonstatistical and statistical sampling plans, there is no reason to expect a nonstatistical sample size to be smaller than the size of a well designed statistical sample for the same sampling procedure. This general statement does not imply that a nonstatistical sample size will always be larger than any statistical sample size for the same sampling objective. For example, if the auditor were to design an inefficient statistical sampling application or did not take full advantage of his experience and professional judgment, the resulting sample size might in fact be larger than an appropriate nonstatistical sample. However, if the auditor is able to use the statistical tools available to him efficiently, there is no reason to expect that the auditor could design a more efficient nonstatistical sampling plan.

Types Of Statistical Sampling Plans

Attributes sampling

Attributes sampling is used to reach a conclusion about a population in terms of a rate of occurence. Its most common use in auditing is to test the rate of compliance with a prescribed internal accounting control procedure to determine whether planned reliance on that control is appropriate. In attributes sampling each occurence or deviation from a prescribed control procedure is given equal weight in the auditor's evaluation regardless of the dollar amount of the transaction on which the deviation occurred.

The following are some examples of tests in which attributes sampling is typically used:

- Tests of controls over voucher processing
- Tests of controls over billing systems
- Tests of recording of shipments
- Tests of controls over payroll and related personnel policy systems
- Tests of controls over inventory pricing
- Tests of controls over fixed asset additions
- Tests of controls over depreciation computations

If the audit objective is to obtain evidence about a monetary amount being examined, the auditor generally designs a variables sampling application.

Variables sampling

Variables sampling is used if someone desires to reach a conclusion about a population in terms of a dollar amount. Variables sampling is generally used to answer either the question, "How much?" (generally described as dollar value estimation), or the question, "Is the account materially correct?" (generally described as hypothesis testing).

The principal use of variables sampling in auditing is for substantive tests of details to determine the reasonableness of recorded amounts. However, if the auditor chooses to measure the dollar amount of transactions containing deviations from an internal accounting control procedure, the auditor also would use variables sampling. (See chapter 3, section 3, "Probability-proportionate-to-size Sampling" for a discussion of one variables sampling technique commonly used for testing compliance in dollar amounts.)

The following are some examples of tests for which variables sampling is typically used:

- Tests of the amount of receivables
- Tests of inventory quantities and values
- Tests of recorded payroll expense
- Tests of the amount of fixed asset additions
- Tests of the amount of transactions that are not supported by proper approval

As discussed above, attributes sampling is generally used to reach a conclusion about a population in terms of a rate of occurrence; variables sampling is generally used to reach conclusions about a population in terms of a dollar amount. However, one statistical sampling approach, probability-proportional-to-size sampling, uses attributes sampling theory to express a conclusion in dollar amounts.

General Implementation Considerations

The following considerations may be helpful to the auditor in implementing audit sampling procedures.

Continuing professional education

The auditor might better understand the concepts of audit sampling by combining live instruction with a textbook. Some firms develop their own educational programs; others use programs developed by the AICPA, a state society of CPAs, a college or university, or another CPA firm.

Continuing education programs should be directed to appropriate staff levels. For example, an auditor may decide to train all assistants to select random samples, to calculate a sample size, and to evaluate sample results for attributes sampling procedures. More experienced staff might be trained to design variables sampling applications.

Practice guidelines

Some auditors achieve consistent sampling applications throughout their practice by establishing guidelines to be used by assistants. For example, guidelines might include standards for establishing acceptable risk levels, minimum sample sizes, and appropriate levels of tolerable error.

Documentation

SAS No. 1, section 338, "Working Papers," provides guidance on documentation of audit procedures. While neither this guide nor SAS No. 39 requires specific documentation of audit sampling applications, some auditors find it practical to document those procedures. Examples of items that the auditor might consider including in documentation for compliance and substantive testing are included in chapters 2 and 3, respectively.

Use of specialists

Some auditors designate selected individuals as audit sampling specialists. These specialists may consult with the auditors on the design and execution of planned sampling procedures. In addition, some specialists teach continuing professional education courses on audit sampling.

Some auditors train all assistants in the essential concepts of designing and executing sampling procedures, thus minimizing the need for specialists.

Also, some auditors engage a statistician or professor to consult on statistical applications. The consultant may be used to solve difficult statistical problems, to review the firm's practice guidelines, to assist in designing continuing education programs, to review the coding of timesharing programs, and to teach courses for specialists. Typically, the auditor frequently confers with the consultant when he begins to use statistical sampling and confers less frequently as he gains experience.

Supervision and review

The first standard of field work requires that assistants be properly supervised. Quantified measurement of risk and tolerable error in auditing are primarily used to establish an overall audit strategy and to provide a structure for supervising the conduct of an examination. Use of quantifiable concepts, even though subjective, can be useful in communicating audit objectives to the auditor's assistants.

The auditor might review documentation of sampling procedures designed by assistants. Review in the planning stage helps to assure that the application has been well planned and can be successfully implemented. Review after performance helps to assure that the work has been done properly.

In reviewing audit sampling, the auditor might consider the following:

- Were the population and sampling unit defined appropriately for the test objectives?

- Were tests performed to provide reasonable assurance that the sample was selected from the correct population?

- Did the design of the sampling application provide for an appropriate risk level? For example, did the design reflect planned reliance on related internal accounting controls or additional related substantive tests?

- If additional audit tests were planned in designing the sampling procedure, did these tests support the book value of the account being tested?

- Were planned procedures applied to all sample items? If not, how were those unexamined items in the sample considered in the evaluation?

- Were all errors discovered in the test properly evaluated?

- If the test was a compliance test, did it support the planned reliance on the internal accounting control procedure? If not, were related substantive tests appropriately modified?

- Was the audit objective of the test met?

The general concepts discussed in this chapter are applied to compliance and substantive tests in Chapters 2 and 3, respectively.

CHAPTER 2

COMPLIANCE TESTS

This chapter provides guidance on the use of audit sampling for compliance tests of internal accounting control procedures.[3] Unless otherwise indicated, the guidance in this chapter applies equally to nonstatistical and statistical sampling.

Audit sampling for compliance tests generally involves the following considerations:

Determining the objectives of the test

Defining the deviation conditions

Defining the population

- Defining the period covered by the test
- Defining the sampling unit
- Considering the completeness of the population

Determining the method of selecting the sample

Determining the sample size

- Considering the acceptable risk of overreliance on internal accounting control
- Considering the tolerable rate
- Considering the expected population deviation rate
- Considering the effect of population size
- Determining whether to use a sequential or a fixed sample size approach

Performing the sampling plan

Evaluating the sample results

[3]If the auditor chooses to measure the dollar amount of transactions containing deviations from an internal accounting control procedure, the auditor would use variables sampling. See chapter 3, section 3, probability-proportional-to-size Sampling, for a discussion of one variables sampling technique commonly used for testing compliance in dollar amounts.

- Calculating the deviation rate
- Considering sampling risk
- Considering the qualitative aspects of the deviations
- Reaching an overall conclusion

Documenting the sampling procedure

Determining the Objectives of the Test

The objective of compliance tests is to provide a basis for the auditor to conclude whether internal accounting control procedures are being applied as prescribed. The auditor tests compliance with those controls he plans to rely on in determining the nature, timing and extent of substantive tests. Tests of compliance, therefore, are concerned primarily with these questions: Were the necessary procedures performed, how were they performed, and by whom were they performed? SAS No. 1, Section 320, "The Auditor's Study and Evaluation of Internal Control," and SAS No. 30, Reporting on Internal Accounting Control, provide guidance on identifying specific control objectives and related specific control procedures.

Audit sampling for compliance tests generally is used only if there is a trail of documentary evidence. Sampling for testing compliance with control procedures that do not leave such a trail might be appropriate, however, when the auditor is able to plan the sampling procedures early in the engagement. For example, the auditor might wish to observe compliance with prescribed control procedures for bridge toll collections. In that case, he might select a sample of days and locations for observation of actual procedures. The auditor needs to plan the sampling procedure to allow him to observe compliance with such procedures on days sampled from the days covered by the period under audit.

Defining the Deviation Conditions

On the basis of his knowledge of the internal accounting control system, the auditor should identify the characteristics of interest that indicate compliance with the internal accounting control procedure. The auditor then defines the possible deviation conditions on the basis of the action required by the internal accounting control procedure on which he plans to rely. For compliance testing, a deviation is a departure from the prescribed internal accounting control procedure. The procedure consists of all the steps the auditor believes are necessary to achieve the related specific internal accounting control objective.

For example, if the prescribed procedure includes stamping each paid invoice with a rubber stamp marked "Paid," but does not require stamping vouchers or receiving reports or purchase orders, the deviation may be defined as "a paid invoice that has not been stamped 'Paid.'"

Definitions such as "lack of effective cancellation of supporting documents" are not appropriate since these are not departures from the entity's prescribed internal accounting control procedure.

In some circumstances the entity's system may prescribe a control procedure that requires more action on the part of the entity's personnel than the auditor believes necessary to support his planned reliance on that control. For example, if a purchase order requires four approvals, but the auditor believes only one approval is necessary to support his planned reliance on the control procedure, the absence of the other three need not be defined as a deviation for the auditor's purposes.

Defining the Population

The population consists of the items comprising the account balance or class of transactions, or a portion of that balance or class. The auditor should determine that the population from which he draws the sample is appropriate for the specific audit objective. For example, if the auditor wishes to test compliance with a prescribed control procedure that is designed to ensure that all shipments are billed, the auditor would not detect deviations from the internal accounting control procedure by sampling billed items because some orders may have been shipped but not billed. An appropriate population for detecting such deviations is usually the population of all shipped items.

Multiple Locations. An entity with multiple locations may have different internal accounting control procedures for different locations, each adequately designed to achieve the same specific control objective. The auditor should decide whether to design one sample of transactions at all locations or a separate sample for transactions subject to each different control procedure. The appropriate decision depends on the overall objective of the auditor's test.

One sample of transactions from all locations may be appropriate when the auditor's objective is to reduce the extent of his substantive tests of consolidated balances or transactions for all locations. For example, an entity may have three subsidiaries, each with different specific control procedures designed to provide reasonable assurance that all shipped goods are billed. If the auditor wishes to rely on those procedures to reduce the extent of his substantive tests of sales in the consolidated financial statements, one sample of all shipped goods may be appropriate. If an auditor wishes to reach separate conclusions at the same risk level about compliance with the specific control procedures at each location, he would not rely solely on one sample of all transactions subject to those different control procedures. In that circumstance, a sample that includes transactions subject to different control procedures does not provide assurance that compliance with each individual specific control procedure is adequate to be relied on.

Changes in the System. An auditor should also consider similar factors when an entity changes a specific control procedure during the period under audit. If one control procedure is superseded by another control procedure designed to achieve the same specific control objective, the auditor needs to decide whether he should design one sample of all transactions executed throughout the period or separate samples of transactions subject to the different control procedures. The appropriate decision depends on the overall objective of the auditor's tests. For example, if the auditor wishes to rely on both the new and the superseded control procedures in reducing the extent of his substantive tests of sales transactions throughout the period under audit, one sample of all sales transactions may be appropriate; however, if the auditor wishes to rely on the control procedures in reducing the extent of substantive tests of accounts receivable primarily from sales in the latter part of the period, he may wish to place substantial reliance on the specific control procedure operating during that portion of the period and little or no reliance on the other, superseded control procedure. The auditor decides whether to design one sample of all transactions executed throughout the period or separate samples of transactions subject to different control procedures according to which approach he believes is effective and efficient in the circumstances. For example, it may be more efficient for the auditor to design one sample of all such transactions executed throughout the period than to design separate tests of the transactions subject to different control procedures.

Defining the period covered by the test

According to SAS No. 1, paragraph 320.61, "tests of compliance . . . ideally should be applied to transactions executed throughout the period under audit because of the general sampling concept that the items to be examined should be selected from the entire set of data to which the resulting conclusions are to be applied."

However, it is not always efficient to include all transactions executed throughout the period under audit in the population to be sampled. In some cases it may be more efficient to use alternative approaches, rather than audit sampling, to test transactions executed during a portion of the period under audit. For example, the auditor might define the population to include transactions for the period from the beginning of the year to an interim date. SAS No. 1, paragraph 320.61 provides guidance to be considered in this circumstance:

> Independent auditors often make such tests during interim work. When this has been done, application of such tests throughout the remaining period may not be necessary. Factors to be considered in this respect include (a) the results of the tests during the interim period, (b) responses to inquiries concerning the remaining period, (c) the length of the remaining period, (d) the nature and amount of the transactions or balances involved, (e) evidence of compliance within the remaining period that may be obtained from substantive tests performed by the independent auditor or from tests performed by internal auditors, and (f) other matters the auditor considers relevant in the circumstances.

When the auditor decides to define the period covered by the test as less than the period under audit, the auditor may reach a conclusion about compliance with the prescribed procedure for the period to the interim date by use of audit sampling and then obtain reasonable assurance regarding the post interim period by additional procedures such as those described above.

If the population is defined as transactions from the entire period under audit and initial testing is to be performed during an interim period, the auditor may estimate the number of transactions in the population for the remaining period under audit after interim. The auditor may define the population to include transactions executed before interim and those estimated to be executed during the balance of the period under audit. Any sampled transactions that have not been executed before the interim period would be examined during the completion of the audit. For example, if in the first ten months of the year the entity issued invoices numbered from 1 to 10,000, the auditor may estimate that based on the company's business cycle, 2,500 invoices will be issued in the last two months, and the auditor will thus use 1 to 12,500 as the numerical sequence for selecting the desired sample. Invoices that are selected with numbers less than 10,000 will be examined during the interim work, and the remaining sampling units will be examined during the completion of the audit.

In estimating the size of the population, the auditor may consider such factors as the actual usage in the similar period of the prior year, the trend of usage, and the nature of the business. As a practical consideration, the auditor might overestimate the remaining volume. If at year end some of the selected document numbers do not represent transactions (because fewer transactions were executed than estimated), they may be replaced by other transactions. To provide for this possibility the auditor may wish to select a slightly larger sample; the additional items would be examined only if they are used as replacement items.

If, on the other hand, the usage is underestimated, some transactions will not have a chance of being selected, and, therefore, the sample will not be representative of the population defined by the auditor. In this case, the auditor may redefine the population to exclude those items not subject to inclusion in the sample. The auditor may perform alternative tests to reach a conclusion about the items not included in the redefined population. Such tests might include testing the items as part of a separate sample (either nonstatistical or statistical), examining 100% of the items, or making inquiries concerning the remaining period. The auditor selects an appropriate approach based on his judgment as to which procedure would be most effective and efficient in the circumstances.

In some cases the auditor might not need to wait until the end of the period under audit to form a conclusion about whether compliance with a prescribed control is adequate to be relied on. During the interim testing of selected transactions the auditor may discover enough deviations to reach the conclusion that, even if no deviations are found in transactions to be executed after interim, the control procedure cannot be relied on in determining the nature, timing and extent of related substantive procedures. In that case, the auditor may decide not to examine the selected transactions to be executed after interim and to modify planned substantive tests immediately.

Defining the sampling unit

The sampling units are individual elements comprising the population. A sampling unit may be, for example, a document, an entry, or a line item. Each sampling unit constitutes one item in the population.

The auditor should define the sampling unit in light of the control procedure that he is testing. For example, if the objective of the test is to determine whether disbursements have been authorized and the prescribed control procedure requires an authorized signature on the voucher before processing, the sampling unit may be defined as the voucher. On the other hand, if one voucher pays several invoices and the prescribed control procedure requires each invoice to be authorized individually, the line item on the voucher representing the invoice may be defined as the sampling unit.

An overly broad definition of the sampling unit may not be efficient. For example, if the auditor is testing a control over pricing of invoices and each invoice contains up to ten items, the auditor could define the sampling unit as an individual invoice or as a line item. If the auditor defines the invoice as the sampling unit, it is necessary to test all the line items on the invoice. If the auditor defines the line items as the sampling units, only the selected line item need be tested. If either sampling unit definition is appropriate to achieve the test objective, it might be more efficient to define the sampling unit as a line.

An important consideration in selecting a sampling unit is the manner in which the documents are filed and cross-referenced. For example, if a test of purchases starts from the purchase order, in some systems it may not be possible to locate the voucher and cancelled check because the system has been designed to provide an audit trail from voucher to purchase order, but not vice versa.

Considering the completeness of the population

The auditor actually selects sampling units from a physical representation of the population. For example, if the auditor defines the population as all customer receivable balances as of a specific date, the physical representation may be the printout of the customer accounts receivable trial balance as of that date.

The auditor should consider whether the physical representation includes the entire population. Because the physical representation is what the auditor actually samples, any conclusions based on the sample relate only to that physical representation. If the physical representation and the population differ, the auditor might make erroneous conclusions about the population.

For example, if the auditor wishes to test compliance with a prescribed control over the vouchers issued in 19XX, such vouchers would be the population. If the auditor physically selects the vouchers from a filing cabinet, the vouchers in the filing cabinet are the physical representation. If the vouchers in the cabinet represent all the vouchers issued in 19XX, then the physical representation and the population are the same. If they are not the same because vouchers have been removed or vouchers issued in other years have been added, the conclusion applies only to the vouchers in the cabinet.

Selecting from a controlled source should minimize differences between the physical representation and the population. For example, an auditor sampling vouchers might select from a voucher register or a cash disbursements journal that has been reconciled with issued checks through a reconciliation of open vouchers or through a bank reconciliation. He might test the footing to obtain reasonable assurance that the source of selection contains the same transactions as the population.

If the auditor reconciles the selected physical representation and the population and determines that the physical representation has omitted items in the population that he wishes to include in his overall evaluation, the auditor should select a new physical representation or perform alternative procedures on the items excluded from the physical representation.

Determining The Method Of Selecting The Sample

Sample items should be selected in such a way that the sample can be expected to be representative of the population. An overview of selection methods follows.

Random number sampling

The auditor may select a random sample by matching random numbers generated by a computer or selected from a random number table with, for example, document numbers. With this method, every sampling unit has the same probability of being selected as every other sampling unit in the population, and every combination of sampling units has the same probability of being selected as every other combination of the same number of sampling units. This approach is appropriate for both nonstatistical and statistical sampling applications. Because statistical sampling applications require the auditor to select the sample in a manner that allows him to measure the probability of selecting the combination of sampling units in the sample, this approach is especially useful for statistical sampling.

Systematic sampling

For this method the auditor determines a uniform interval by dividing the number of physical units in the population by the sample size. A random number is selected as a starting point for the first interval, and one item is selected throughout the population at each of the uniform intervals from the starting point. For example, if the auditor wishes to select 100 items from a population of 20,000 items, the uniform interval is every 200th item. First the auditor selects a random starting point and then he selects every 200th item from the random start, including the random start item.

Because a random start is used, the systematic method provides a sample that allows every sampling unit in the population an equal chance of being selected. If the population is arranged randomly, systematic selection is essentially the same as random number selection. However, unlike random number sampling, this method does not give every possible combination of sampling units the same probability of being selected. For example, a population of employees on a payroll for a construction company might be organized by teams; each team consists of a crew leader and nine other workers. A selection of every tenth employee will either list every crew leader or no crew leaders, depending on the random start. No combination would include both crew leaders and other employees. In these circumstances the auditor may consider using a different sample selection method such as random selection or making a systematic selection using an interval that does not coincide with the pattern in the population.

This method is useful for both statistical and nonstatistical sampling.

<u>Other Sampling Methods</u>

Two other sampling techniques, block sampling and haphazard sampling, are sometimes used by auditors.

A block sample consists of contiguous transactions.[4] For example, a block sample from a population of all vouchers processed for the year 19XX might be all vouchers processed on February 3, May 17, and July 19, 19XX. This sample includes only three sampling units out of 250 business days because the sampling unit, in this case, is a period of time rather than an individual transaction. A sample with so few blocks is generally not adequate to reach a reasonable audit conclusion. Although a block sample might be designed with enough blocks to minimize this limitation, using such samples might be inefficient. If an auditor decides to use a block sample, he should exercise special care to control sampling risk in designing that sample.

A haphazard sample consists of sampling units selected by the auditor without any special reason for including selected items in, or omitting items from, the sample. For example, a haphazard sample of all vouchers processed for the year 19XX, where the physical representation of the population is a file cabinet drawer of vouchers, might include any of

[4] A variation of block sampling that can be designed to yield an adequate statistical sampling approach is called cluster sampling. The considerations for designing a cluster sample are beyond the scope of this guide. That guidance can be found in technical references on statistical sampling.

the vouchers that the auditor pulls from the drawer regardless of the voucher's size, shape, location, or other physical features.

A properly selected haphazard sample can be expected to be representative of the population. The auditor using haphazard selection should be cautious to avoid distorting his sample by selecting, for example, only unusual or physically small items or by omitting items such as the first or last items in the physical representation of the population. While haphazard sampling is valid for nonstatistical sampling, it is not used for statistical sampling because it does not allow the auditor to measure the probability of selecting the combination of sampling units in the sample.

Determining the Sample Size

This section discusses the factors that the auditor considers in determining an appropriate sample size. Appendix A includes additional guidance, along with several tables, which should help the auditor to apply the following discussion for statistical sampling applications.

Determining the acceptable risk of overreliance on internal accounting control

The auditor is concerned with two aspects of sampling risk in performing tests of internal accounting control. The risk of overreliance on internal accounting control is the risk that the sample supports the auditor's planned degree of reliance on the control when the true compliance rate for the population does not justify such reliance. The risk of underreliance on internal accounting control is the risk that the sample does not support the auditor's planned degree of reliance on the control when the true compliance rate supports such reliance.

The risk of underreliance on internal accounting control relates to the efficiency of the audit. For example, if the auditor's evaluation of a sample leads him to unnecessarily reduce his planned degree of reliance on internal accounting control, he would ordinarily increase the scope of substantive tests to compensate for the perceived inability to rely on internal accounting control to the extent originally planned. Although the audit may be less efficient in this circumstance, it is, nevertheless, effective. Therefore, the discussion of sampling risk in the following paragraphs relates primarily to the risk of overreliance on internal accounting control.

Samples taken for compliance tests are intended to provide a basis for the auditor to conclude whether internal accounting control procedures are being applied as prescribed. Regardless of how the control procedure has been designed to achieve the related internal accounting control objectives, the auditor should not rely on a control procedure that is not being applied as prescribed. Because the compliance test is the primary source of evidence of whether the control procedure is being applied as prescribed, the auditor generally wishes to obtain a high degree of assurance that his conclusions about the application of the control procedure, based on a sample of transactions subject to the control procedure, would not differ from the conclusion he would reach if he applied the test in the same way to all transactions. Therefore, the auditor should allow for a low level of risk of overreliance. Although consideration of risk is implicit in all sampling applications, an auditor must explicitly state an acceptable risk of overrreliance for a statistical sampling application.

The following table illustrates the relative effect on sample size of various levels of sampling risk. Computations use statistical theory and assume a tolerable rate of 5 percent, a large population size, and an expected population deviation rate of approximately one percent.

Risk of Overreliance	Sample Size
10%	77
5%	93
1%	165

Some auditors find it practical to select one level of risk for all compliance tests and to determine a tolerable rate for each test based on the planned degree of reliance on the internal accounting control.

<u>Considering the tolerable rate</u>

In designing substantive tests, the auditor considers the reliance that he plans to place on related internal accounting controls. The tolerable rate is the maximum rate of deviations from a prescribed control procedure that the auditor is willing to accept without altering his planned reliance on a control. The auditor considers the nature, timing, and extent of planned substantive tests in determining the tolerable rate. If, after performing the sampling application, the auditor finds that the rate of deviations from the prescribed control procedure is close to or exceeds the tolerable rate, the auditor might decide that there is an unacceptably high sampling risk that the deviation rate for the population exceeds the tolerable rate. In such cases, the auditor should consider modifying planned reliance on the internal accounting control.

An auditor using statistical sampling generally calculates an allowance for sampling risk. If the auditor finds that the rate of deviations from the prescribed control procedure plus the allowance for sampling risk exceed the tolerable rate, he should consider modifying planned reliance on the internal accounting control.

Sometimes the auditor specifies a high tolerable rate because he plans to place little reliance on the control procedure. A very high tolerable rate often indicates that the planned reliance on the control procedure does not significantly reduce the extent of related substantive tests. In that case, the particular compliance test might be unnecessary and may be omitted.

The following guide illustrates how some auditors determine the tolerable rate for a control procedure. Because the tolerable rates shown are intended only to be illustrative of the relative reliance an auditor might place on the internal accounting control procedure, overlapping, rather than discrete, ranges are presented.

Planned Degree of Reliance	Tolerable Rate
Substantial reliance on the internal accounting control	2% - 7%
Moderate reliance on the internal accounting control	6% - 12%
Limited reliance on the internal accounting control	11% - 20%
No reliance	omit test

In assessing the tolerable rate, the auditor should consider that, while deviations from pertinent control procedures increase the risk of material errors in the accounting records, such deviations do not necessarily result in errors. A recorded disbursement that does not show evidence of required approval may nevertheless be a transaction that is properly authorized and recorded. Therefore, a tolerable rate of 5 percent does not imply that 5 percent of the dollars are in error. Auditors usually select a tolerable rate for compliance tests greater than the tolerable rate of dollars in error. This conclusion is based on the fact that deviations would result in errors in the accounting records only if the deviations and the errors occurred on the same transactions. Consequently, deviations from pertinent control procedures of a given rate ordinarily would be expected to result in errors at a lower rate.

The following table illustrates the relative effect of tolerable rate on sample size. Computations use statistical theory and assume a risk of overreliance of 5 percent, a large population size, and an expected population deviation rate of zero percent.

Tolerable Rate	Sample Size
2%	149
4	74
6	49
8	36
10	29
20	14

When performing compliance tests, the auditor is generally concerned only that the actual rate of deviations in the population does not exceed the tolerable rate. That is, if the auditor is evaluating the sample results and finds the sample deviation rate to be less than the tolerable rate for the population, the auditor needs only to consider the risk that such a result might be obtained even if the actual deviation rate in the population exceeds the tolerable rate. The sample size illustrations in this chapter assume that the sample is designed to measure only the risk that the estimated deviation rate is understated. This is sometimes referred to as an upper-limit approach.[5]

Considering the expected population deviation rate

The auditor might control the risk of underreliance by adjusting the sample size for his assessment of the deviation rate he expects to find in the population. As the expected population deviation rate approaches the tolerable rate, the need arises for more precise information from the sample. Therefore, the auditor selects a larger sample size as the expected population deviation rate increases. The expected population deviation rate is sometimes referred to as the expected error rate or the rate of occurrence expected.

The expected population deviation rate should not equal or exceed the tolerable rate. If the auditor believes that the actual deviation rate is higher than the tolerable rate, he generally omits compliance testing of that control procedure and designs substantive tests without relying on that control procedure.

The auditor estimates the expected population deviation rate on the basis of his judgment, considering such factors as results of the prior year's tests and the overall control environment. Prior year results should be considered in light of changes in the entity's system of internal accounting control and changes in personnel.

The following table illustrates the relative effect on sample size of various expected population deviation rates. Computations use statistical theory and assume a tolerable rate of 5 percent, a large population size, and a risk of overreliance of 5 percent.[6]

Expected Population Deviation Rate (approximate)	Sample Size
0.0%	59
1.0	93
1.5	124
2.0	181
2.5	234
3.0	361

[5]For a discussion of interval estimates, see Roberts, Statistical Auditing, p. 53.

[6]Large sample sizes, such as 234 and 361, are included for illustrative purposes and not to suggest that it would be cost-beneficial to test compliance with internal accounting control using such large sample sizes.

Considering the effect of population size

The size of the population has little or no effect on the determination of an appropriate sample size. For example, it is generally appropriate to treat any population over 5,000 sampling units as if it were infinite. If the population size is under 5,000 sampling units, the estimate of population size may have a small effect on the calculation of an appropriate sample size.

The following table illustrates the limited effect of population size on sample size. Computations use statistical theory and assume a risk of overreliance of 5 percent, an expected population deviation rate of 1 percent and a tolerable rate of 5 percent.

Population Size	Sample Size
50	45
100	64
500	87
1,000	90
2,000	92
5,000	93
100,000	93

Because population size has little or no effect on sample size, all other illustrations of sample sizes for compliance tests assume a large population size.

Determining whether to use a sequential or a fixed sample size approach

Audit samples may be designed using either a fixed sampling plan or a sequential sampling plan. Under a fixed sampling plan, the auditor examines a single sample of a specified size. In sequential sampling (sometimes referred to as stop-or-go sampling), the sample is taken in several steps, with each step conditional on the results of the previous step. A sequential sampling plan might be more efficient than a fixed sampling plan when the population contains a low compliance deviation rate.

Guidance on sequential sampling plans is included in Appendix B.

Performing the Sampling Plan

After the sampling plan has been designed, the auditor selects the sample and examines the selected items to determine if they contain deviations from the prescribed control procedure.

When selecting the sampling units, it is often practical to select several additional sampling units as extras. If, in the following circumstances, the size of the remaining sample is inadequate to meet the auditor's objectives, the auditor may use the extra sampling units.

Voided, unused, or inapplicable documents. An auditor might select items to be included in a sample that he finds are void, unused, or inapplicable. For example, an auditor testing compliance with an internal accounting control procedure that is evidenced on the entity's vouchers might match random numbers with voucher numbers for the period included in the population definition. However, a random number might match with a voucher that has been voided. If the auditor obtains reasonable assurance that the voucher has been properly voided and does not represent a deviation from the prescribed internal accounting control procedure, he should replace the voided voucher by matching an extra number with the appropriate voucher. To provide for this possibility, the auditor might select a slightly larger sample. The additional items would only be used as replacement items.

The auditor's consideration of unused or inapplicable documents is similar to the consideration of voided documents. For example, a sequence of vouchers might include unused vouchers or an intentional omission of certain numbers. If the auditor selects such a document, he should obtain reasonable assurance that the voucher number actually represents an unused voucher and does not represent a deviation from the prescribed control procedure. He might then replace the unused voucher with an additional voucher. To provide for this possibility, the auditor might select a slightly larger sample, with the additional items used only as replacement items.

Sometimes a selected item is not applicable for a given definition of a deviation. For example, a telephone expense selected as part of a sample for which an error has been defined as "transaction not supported by receiving report" may not be expected to include a receiving report. If the auditor has obtained reasonable assurance that the transaction is not applicable and does not represent a deviation from the prescribed control procedure, he might replace the item with another transaction. To provide for this possibility the auditor might select a slightly larger sample. The additional items would only be used as replacement items. The occurrence of this problem may be minimized if the auditor can segregate transaction types into populations that have similar audit implications.

Errors in estimating population sequences. If the auditor is using random number sampling to select sampling units, the population size and numbering sequence might be estimated before the documents have been used. The most common example of this situation is where the auditor has defined the population to include the entire period under audit but plans to perform a portion of the sampling procedure before the end of the period. If the auditor overestimates the population size and numbering sequence, any numbers selected as part of the sample that exceed the actual numbering sequence used would be treated as unused documents and replaced by matching an extra random number with the appropriate document.

In planning and performing an audit sampling procedure, the auditor also should consider two special situations that may occur.

Stopping the test before completion. Occasionally, the auditor may find a large number of deviations in auditing the first part of a sample. As a result, he may believe that, even if no additional deviations are discovered in the remainder of the sample, the results of the sample will not support the planned reliance on the internal accounting control. Under these circumstances, the auditor can evaluate the sample under a best case assumption (that no additional deviations exist in the sample). If the sample results are unacceptable, the auditor need not continue examining items in the sample and should alter the nature, timing, or extent of related planned substantive tests. However, if the results under this best case assumption are acceptable, or may support a reduced level of reliance, he ordinarily continues to examine all selected sample items to reach an appropriate conclusion.

Inability to examine selected items. The auditor should apply auditing procedures that are appropriate to achieve the objective of the compliance tests to each sampling unit. In most circumstances compliance with the prescribed control procedure being tested is evidenced only on the document selected as part of the sample. If that document cannot be located or if for any other reason the auditor is unable to examine the selected item, he generally will be unable to use alternative procedures to test whether that control procedure was applied as prescribed. If the auditor is not able to apply the planned audit procedures or appropriate alternative procedures to selected items, he should ordinarily consider those selected items to be deviations from the control procedures for the purpose of evaluating the sample. In addition, the auditor should consider the reasons for this limitation and the effect that such limitations may have on his understanding of, and reliance on, the entity's system of internal accounting control.

Evaluating the Sample Results

After completing the examination of the sampling units and summarizing the deviations from prescribed control procedures, the auditor evaluates the results. The auditor uses judgment in evaluating the results and reaching an overall conclusion, whether the sample is statistical or nonstatistical.

Calculating the deviation rate

Calculating the deviation rate in the sample involves dividing the number of deviations by the sample size. The deviation rate in the sample is the auditor's best estimate of the deviation rate in the population from which it was selected.

Considering sampling risk

As discussed in chapter 1, sampling risk arises from the possibility that when compliance testing is restricted to a sample the auditor's conclusions may differ from those he would have reached if the test were applied in the same way to all items in the account balance or the class of transactions. When the auditor evaluates a sample for a compliance test, he considers sampling risk. If the estimate of the population deviation rate is less than the tolerable rate for the population, the auditor should consider the risk that such a result might be obtained even if the deviation rate for the population exceeds the tolerable rate for the population. SAS No. 39, Audit Sampling, provides the following general illustration of how an auditor might consider sampling risk for compliance tests:

> For example, if the tolerable rate for a population is 5 percent and no deviations are found in a sample of 60 items, the auditor may conclude that there is an acceptably low sampling risk that the true deviation rate in the population exceeds the tolerable rate of 5 per cent. On the other hand, if the sample includes, for example, two or more deviations, the auditor may conclude that there is an unacceptably high sampling risk that the rate of deviations in the population exceeds the tolerable rate of 5 percent.

If an auditor is performing a statistical sampling application, he often uses a table or timesharing program to assist him in measuring the allowance for sampling risk. For example, most timesharing programs used to evaluate sampling applications calculate an estimate of the upper limit of the possible deviation rate based on the sample size, the sample results, and the auditor's acceptable level of the risk of overreliance.

If the auditor is performing a nonstatistical sampling application, sampling risk cannot be measured directly. However, it is generally appropriate for the auditor to assume that the sample results do not support planned reliance if the rate of compliance deviations identified in the sample exceeds the expected population deviation rate used in designing the sample. In that case, there is likely to be an unacceptably high risk that the true deviation rate in the population exceeds the tolerable rate.

Appendix A includes statistical sampling tables that should help the auditor in using his professional judgment to evaluate the results of statistical samples for compliance tests. The tables might also be useful to auditors using nonstatistical sampling.

If the auditor concludes that there is an unacceptably high risk that the true population deviation rate exceeds the tolerable rate, it might not be practical to extend that sample for the compliance test. In such circumstances it is generally more efficient to modify planned reliance on the internal accounting control.

Considering the qualitative aspects of the deviations

In addition to evaluating the frequency of deviations from pertinent procedures, the auditor should consider the qualitative aspects of the deviations. These include (a) the nature and cause of the deviations, such as whether they are errors or irregularities or are due to misunderstanding of instructions or to carelessness , and (b) the possible relationship of the deviations to other phases of the audit. The discovery of an irregularity ordinarily requires a broader consideration of the possible implications than does the discovery of an error.

Reaching an overall conclusion

The auditor uses professional judgment to reach an overall conclusion about the effect of the evaluation of the compliance test on the nature, timing, and extent of planned substantive tests. If the sample results, along with other relevant evidential matter, support the planned reliance on internal accounting control, the auditor generally does not need to modify planned substantive tests. If the sample results do not support the planned reliance, the auditor would ordinarily either test compliance with other internal accounting controls on which he may rely or modify the related substantive tests to reflect reduced or eliminated reliance.

Documenting the Sampling Procedure

SAS No. 1, section 338, "Working Papers," provides guidance on documentation of audit procedures. While specific documentation of audit sampling applications is not required by either SAS No. 39 or this guide, some auditors find it practical to document those procedures. Documentation might include such items as

- A description of the prescribed control procedure being tested
- The objectives of the test, including the relationship to planned substantive testing
- The definition of the population and sampling unit, including how the auditor considered completeness of the population
- The definition of the deviation condition
- The rationale for the risk of overreliance, the tolerable deviation rate, and the expected population deviation rate used in the application
- The method of sample size determination
- The method of sample selection
- A description of the performance of the sampling procedure and a listing of compliance deviations identified in the sample
- The evaluation of the sample and a summary of the overall conclusion

The evaluation and summary might contain the number of deviations found in the sample, an explanation of how the auditor considered sampling risk, and a determination of whether the sample results support planned reliance on the control procedure. For sequential samples, each step of the sampling plan, including the preliminary evaluation made at the completion of each step, might be documented. Also, the workpapers might document the nature of the deviations, the auditor's consideration of the qualitative aspects of the deviations, and the impact of the evaluation on related planned substantive tests.

CHAPTER 3

SUBSTANTIVE TESTS OF DETAIL

INTRODUCTION

The purpose of substantive tests of details of transactions and balances is "to obtain evidence as to the validity and the propriety of accounting treatment of transactions and balances or, conversely of errors or irregularities therein" (SAS No. 1, paragraph 320.70). As discussed in SAS No. 39, Audit Sampling, an auditor relies on a combination of internal accounting controls, analytical review procedures, and substantive tests of details to obtain reasonable assurance that the financial statements being audited are not materially misstated. When testing the details of an account balance or class of transactions, the auditor can use audit sampling to obtain substantive evidence about the correctness of monetary amounts.

This chapter is divided into 5 sections. Section 1 introduces the general concepts of audit sampling applicable to both nonstatistical and statistical sampling for substantive tests. Sections 2, 3, and 4 discuss concepts related to nonstatiscal sampling, probability-proportional-to-size statistical sampling, and classical variables statistical sampling, respectively.

SECTION 1 - GENERAL CONSIDERATIONS

The use of audit sampling for substantive tests of details generally includes the following considerations:

Determining the objectives of the test

Defining the population

- Defining the sampling unit
- Considering the completeness of the population
- Identifying individually significant items

Selecting an audit sampling technique

Determining the sample size

- Considering variation within the population
- Considering the acceptable level of risk of incorrect acceptance.
- Considering the tolerable error
- Considering the expected amount of error
- Considering the population size

Determining the method of selecting the sample

Performing the sampling plan

Evaluating the sample results

- Estimating the error in the population and considering sampling risk
- Considering the qualitative aspects of errors
- Reaching an overall conclusion

Documenting the sampling procedure

Determining the Objective of the Test

A sampling plan for substantive tests of details may be designed (1) to test the reasonableness of an amount (for example, the balance in accounts receivable) or (2) to make an independent estimate of some amount (for example, the LIFO index for a LIFO inventory). The first approach, often referred to as hypothesis testing, is generally used by an auditor performing a substantive test as part of an examination of financial statements. In that case, the auditor desires to accept an amount if it is reasonably correct. The second approach, generally referred to as dollar value estimation, may be appropriate when a CPA has been engaged to assist management in developing independent estimates of quantities or amounts. For example, a CPA may assist management in estimating the value of LIFO inventory that was previously recorded on a FIFO basis. This guide does not provide guidance on the use of statistical sampling for dollar value estimation.

It is important that an auditor carefully identify the characteristic of interest for the sampling application that is consistent with the audit objective. For example, a characteristic of interest may be defined as certain differences between the recorded amount and the amount the auditor determines to be correct, in which case, the characteristic of interest may be called an error. Some differences may not involve the characteristic of interest. For example, differences in posting to the correct detail account may not result in misstatement of the aggregate account balance. The auditor may also decide to exclude errors the entity has detected and corrected in the proper period independent of the audit process.

Defining the Population

The population consists of the items comprising the account balance or class of transactions of interest. The auditor should determine that the population from which he draws the sample is appropriate for the specific audit objective because any conclusions that he reaches based on the sample will relate only to that population. For example, an auditor cannot detect understatements of an account that reults from omitted items by sampling the recorded items. An appropriate plan for detecting such understatements would involve selecting from a source in which the omitted items are included. To illustrate: The auditor might sample subsequent cash disbursements to test recorded accounts payable for understatement resulting from omitted purchases, or he might sample shipping documents for understatement of sales resulting from shipments that were made but not recorded as sales.

Because the nature of the transactions resulting in debit balances, credit balances, and zero balances are generally different, the audit considerations may also differ. Therefore the auditor should consider whether the population to be sampled should include all those items. For example, a retailer's accounts receivable balance may include both debit and credit balances. The debit balances generally result from customer sales on credit, while the credit balances may result from advance payments and, therefore, represent liabilities. The audit objective for testing those debit and credit balances may be different.

If the amount of credit balances is significant, the auditor may find it more effective and efficient to perform separate tests of the debit balances and the credit balances. In that case, the debit and credit balances would be defined as separate populations for the purpose of audit sampling.

Defining the Sampling Unit

The sampling units are the individual elements comprising the population. The auditor selects a definition of a sampling unit for the particular audit sampling application. A sampling unit might be, for example, a customer account balance, an individual transaction, or an individual entry in a transaction.

The definition of a sampling unit depends on the nature of the audit procedures to be applied. For example, if the objective of the sampling application is to test the accounts receivable balance, the auditor may select customer balances, customer invoices, or individual items comprising an invoice as his sampling unit. In making that judgment the auditor might consider which sampling unit leads to a more effective and efficient sampling application in the circumstances. For example, if the auditor's procedure is positive confirmation of receivable amounts with the entity's customers he selects a sampling unit that he believes the customers would be most likely to confirm. The auditor also considers the definition of the sampling unit on the basis of ease in applying planned or alternative procedures. In the above example, if the auditor defines his sampling unit as a customer balance he may need to test each individual transaction supporting that balance if the customer does not confirm the balance. Therefore, it may be more efficient to define the sampling units as the individual transactions comprising the accounts receivable balance.

Considering the Completeness of the Population

The auditor actually selects sampling units from a physical representation of the population. If the auditor defines the population as all customer receivable balances as of a specific date, the physical representation may be the printout of the customer accounts receivable trial balance as of that date.

The auditor should consider whether the physical representation includes the entire population. Because the physical representation is what the auditor actually samples, any conclusions based on the sample relate only to that physical representation. If the physical representation and the population diifer, the auditor might make erroneous audit conclusions.

If the auditor reconciles the selected physical representation and the population and determines that the physical representation has omitted items in the population that he wishes to include in his overall evaluation, he should select a new physical representation or perform alternative procedures on the items excluded from the physical representation.

Identifying Individually Significant Items

As discussed in SAS No.1, paragraph 150.04, the sufficiency of tests of details for a particular account balance or class of transactions relates to the individual importance of the items examined, as well as to the potential for material error. When planning a sample for a substantive test of details, the auditor uses his judgment to determine which items, if any, in an account balance or class of transaction should be individually tested and which items should be subject to sampling. For those items for which, in the auditor's judgment, acceptance of some sampling risk is not justified, the auditor should examine each item. These may include items for which potential errors *could individually equal or exceed the tolerable error. Any items that* the auditor has decided to test 100 percent are not part of the population subject to sampling. Other items, if any, which in the auditor's judgment need to be tested to fulfill the audit objective but need not be examined 100 percent, would be subject to sampling.

Selecting an Audit Sampling Technique

Either nonstatistical or statistical sampling is appropriate for substantive tests of details. Chapter 1 discusses the general considerations in choosing between a nonstatistical and a statistical sampling approach. Additional considerations in selecting among the alternative approaches for sampling applications for substantive tests are discussed in sections 2 - 4 of this chapter.

The most common statistical approaches are classical variables sampling and probability-proportional-to-size (PPS) sampling. Classical variables techniques use normal distribution theory to evaluate the sample results; the probability-proportional-to-size approach described in this guide uses attributes sampling theory.

Determining the Sample Size

Considering Variation Within the Population

The characteristics (such as values) of individual items in a population often vary significantly; accounting populations tend to include a few very large amounts, a number of moderately large amounts, and a large number of small amounts. The auditor considers the variation among those characteristics when he determines an appropriate sample size for a substantive test. Auditors generally measure the variation of the items' book values as a means of estimating the variation of the audit *values of the items in the population. A measure of this variation, or* scatter, is called the standard deviation.

The required sample size generally decreases as the variation becomes smaller. A population can be separated into relatively homogeneous groups, or stratified, to reduce the sample size by minimizing the effect of the variation of values for items in the population. Sample sizes for unstratified populations are generally very large. To be most efficient, stratification should be based on some characteristic of the items in the population that is expected to reduce variation. Common bases for stratification for substantive tests may be, for example, the book value of the items, the nature of internal accounting controls related to processing the items, and special considerations associated with certain items (for example, portions of the population that may be more likely to contain errors). Each group into which the population has been divided is called a stratum. Separate samples are selected from each stratum. The auditor combines the results for all strata in reaching an overall conclusion about the population.[7]

Auditors using a nonstatistical sampling approach subjectively consider this factor. The auditor using a classical variables sampling approach explicitly considers this variability in designing a sampling application. Auditors using PPS sampling do not directly consider this factor because a PPS sample indirectly considers it through assessment of expected error.

Auditors using a classical variable sampling approach often use a computer in estimating the standard deviation of a population's audited values by measuring the variation of recorded values. Another method of measuring the variation, or standard deviation, of the items' values is to select a pilot sample. A pilot sample is an initial sample of items in the population. If the auditor is stratifying the population, the pilot sample is selected by strata. The auditor performs planned audit procedures on sampling units of the pilot sample and evaluates the pilot sample to gain a better understanding of the variation of both book and audited values in the population. Although the appropriate size of a pilot sample differs according to the circumstances, it generally consists of thirty to fifty sampling units. The pilot sample can often be designed in a way that allows the auditor to use it as part of the main sample.

It is not always necessary to use a pilot sample to gain a better understanding of the standard deviation of a population. The results of prior years' tests and an adequate understanding of the entity's business and accounting records may provide the auditor with sufficient understanding of the variation of values without incurring the additional cost of using a pilot sample.

Considering the Acceptable Level of Risk

The auditor is concerned with two aspects of sampling risk in performing substantive tests of details. The risk of incorrect acceptance is the risk that the sample supports the conclusion that the recorded account

[7]While projected error results from each stratum are added, sampling risk related to each stratum are not added.

balance is not materially misstated when it is materially misstated. The risk of incorrect rejection is the risk that the sample supports the conclusion that the recorded account balance is materially misstated when it is not. The risk of incorrect acceptance and the risk of incorrect rejection are related to the statistical concepts of beta and alpha risk, respectively, as explained in many textbooks on sampling.

The Risk of Incorrect Acceptance. In determining an acceptable level of the risk of incorrect acceptance, the auditor considers (1) the level of ultimate risk that he is willing to accept, and (2) the extent of assurance for his opinion provided by reliance on internal accounting control and other audit procedures, including analytical review procedures.

Ultimate risk, with respect to a particular account balance or class of transactions, is the risk that there is monetary error equal to or greater than tolerable error in the balance or class, which the auditor fails to detect. The auditor uses his professional judgment in determining the acceptable ultimate risk for a particular test after he considers such factors as the risk of material misstatement in the financial statements, the cost to reduce the risk, and the effect of the potential misstatement on the use and understanding of the financial statements.

After assessing the acceptable ultimate risk, the auditor decides the extent of assurance to be provided by reliance on internal accounting control and other audit procedures. The second standard of field work recognizes that the extent of substantive tests required to obtain sufficient evidential matter under the third standard should vary inversely with the auditor's reliance on internal accounting control. These standards, taken together, imply that the combination of the auditor's reliance on internal accounting control and his reliance on his substantive tests should provide a reasonable basis for his opinion, although the portion of reliance derived from the respective sources may vary. The greater the reliance on internal accounting control or on other substantive tests directed toward the same specific audit objective, the greater the allowable risk of incorrect acceptance for the substantive test of details being planned and, thus, the smaller the required sample size for the substantive test of details. For example, if the auditor relies neither on internal accounting control nor on other substantive tests directed toward the same specific audit objective, he should specify a low risk of incorrect acceptance for the substantive test of details. Thus, the auditor would select a larger sample for the test of details than if he specified a higher risk of incorrect acceptance.

The appendix to SAS No. 39 provides a model expressing the general relationship of ultimate risk to the extent of reliance the auditor places on a substantive test of details, internal accounting control, and other substantive tests, such as analytical review procedures, directed toward the same specific audit objective. Appendix F of this guide discusses how the auditor might use that model in considering the acceptable level of risk of incorrect acceptance.

The Risk of Incorrect Rejection. The risk of incorrect rejection is related to the efficiency of the audit. For example, if the auditor's evaluation of a sample leads him to the initial erroneous conclusion that a balance is materially misstated when it is not, the consideration of other audit evidence and performance of additional audit procedures would ordinarily lead the auditor to the correct conclusion. When an auditor decides to accept a higher risk of incorrect rejection, he reduces the appropriate sample size for the substantive test; however he also increases the risk that he may incur cost for performing additional procedures to resolve differences between a correct recorded amount and an erroneous estimate resulting from inadequately controlled risk of incorrect rejection. Although the audit may be less efficient in this circumstance, it is, nevertherless, effective.

Although it is still an efficiency consideration, the auditor is generally more concerned with the risk of incorrect rejection when planning a sampling application for substantive testing than when he is planning a sampling application for compliance testing. If the sample results for a compliance test do not support the auditor's planned reliance on internal accounting control, the auditor considers relying on other internal accounting controls or modifies his planned substantive tests to compensate for the reduction, or elimination, of reliance on internal accounting control. Because an alternative audit approach is readily available, the inconvenience to the auditor and the entity resulting from underreliance on internal accounting control is generally relatively small. However, if the sample results for a substantive test support the conclusion that the recorded account balance or class of transactions is materially misstated when it may not be, the alternative approaches available to the auditor may be more costly. Ordinarily, the auditor will need to have further discussions with entity personnel and to perform subsequent additional audit procedures. The cost of this additional work may be substantial. Further consideration of the risk of incorrect rejection is discussed in sections 3 and 4 of this chapter.

Considering the tolerable error

When planning a sample for a substantive test of details, the auditor should consider how much monetary error in the related account balance or class of transactions may exist without causing the financial statements to be materially misstated. This maximum monetary error for the balance or class is called tolerable error for the sample. Tolerable error is related to the auditor's preliminary estimates of materiality levels in such a way that tolerable error, combined for the entire audit plan, does not exceed those estimates.

For a given account balance or class of transactions, the sample size required to achieve the auditor's objective at a given risk of incorrect acceptance increases as the auditor's assessment of tolerable error for that balance or class decreases.

Considering the expected amount of error

In determining the sample size, the auditor generally considers the rate and total amount of error he expects to find in the population. In general, as the expected amount of error approaches the tolerable error, there is a need for more precise information from the sample. Therefore, the auditor selects a larger sample size as the expected amount of error increases.

The auditor determines the expected amount of error on the basis of his professional judgment after considering such factors as his understanding of the entity's business, prior years' tests of the account balance or class of transactions, results of the pilot sample, any related substantive tests, and results of tests of related internal accounting controls.

Considering the population size

The effect of population size on the appropriate sample size varies according to the method used (see sections 2-4 of this chapter).

Determining the Method of Selecting the Sample

The auditor should select the sample in such a way that the sample can be expected to be representative of the population or the stratum from which it is selected. An overview of these methods is described in chapter 2. In addition, PPS selection is discussed in section 3 of this chapter.

Performing the Sampling Plan

The auditor should apply auditing procedures appropriate to the particular audit objective to each sample item. In some circumstances the auditor may not be able to apply the planned procedures to selected sampling units (for example, because supporting documentation is missing). The auditor's treatment of those unexamined items depends on their effect on his evaluation of the sample. If the auditor's evaluation of the sample results would not be altered by considering those unexamined items to be in error, it is not necessary to examine the items. However, if considering those unexamined items to be misstated would lead to a preliminary conclusion that the balance or class is materially in error, the auditor should consider alternative procedures that would provide him with sufficient evidence to form a conclusion. The auditor should also consider whether the reasons for his inability to examine the items have implications in relation to his planned reliance on internal accounting control or his degree of reliance on management representations.

Some of the selected sampling units may be unused or void items. The auditor should carefully consider how he has defined the population when he decides whether to include the item in his sample. For example, if the auditor is selecting a sample of customer balances to reach a conclusion about the value of the accounts receivable balance, a customer account with a zero balance would be a valid sampling unit. However, an account number that the auditor has determined is not assigned to any customer would not be a valid sampling unit and might be replaced by another sampling unit. In the first case, the selected item is one of the customer balances comprising the population; in the second case, the selected account number does not represent one of the customer balances comprising the population. To provide for this possibility, the auditor might wish to select a slightly larger sample. The additional items would be examined only if they are used as replacement items.

Special considerations for performing each of the sampling techniques for substantive tests are discussed in sections 2 - 4.

Evaluating the Sample Results

Estimating the error in the population and considering sampling risk

According to SAS No. 39, Audit Sampling, the auditor should project the error results of the sample to the population from which the sample was selected and should add that amount to the errors discovered in any items examined 100 percent. The entity may adjust the book value of the account because of the errors identified in the population. The total projected error after the book value has been adjusted by the entity should be compared with the tolerable error for the account balance or class of transactions, and the auditor should consider the risk that such result might be obtained even though the true monetary error for the population exceeds tolerable error.

Although the general factors to be considered in making the projection and considering the effect of sampling risk are the same for all sampling techniques, the consideration of those factors differs according to the sampling technique used. The evaluation process for each of the techniques discussed in this chapter is described in sections 2 - 4.

Considering the qualitative aspects of errors

In addition to his evaluation of the frequency and amounts of errors, the auditor should consider their qualitative aspects. These include (a) the nature and cause of misstatements, such as whether they are differences in principle or in application, are errors or irregularities, or are due to misunderstanding of instructions or to carelessnesss, and (b) the possible relationship of the misstatements to other phases of the audit. The discovery of an irregularity ordinarily requires a broader consideration of possible implications than does the discovery of an error.

If the sample results suggest that the auditor's planning assumptions were in error, he should take appropriate action. For example, if errors are discovered in a substantive test of details in amounts or frequency greater than that implied by the degree of reliance initially placed on internal accounting control, the auditor should consider whether the planned reliance is still appropriate. For example, a large number of errors discovered in the confirmation of receivables may indicate the need to reconsider the intital evaluation of the reliance to be placed on internal accounting control related to sales or cash receipts. The auditor should also consider whether to modify the audit tests of other accounts that were designed with reliance being placed on those internal accounting controls.

Reaching an overall conclusion

The auditor should relate the evaluation of the sample to other relevant audit evidence when forming a conclusion about the related account balance or class of transactions.

Documenting the Sampling Procedure

SAS No. 1, section 338, "Working Papers," provides guidance on documentation of audit procedures. While specific documentation of audit sampling applications is not required by either SAS No. 39 or this guide, some auditors find it practical to document those procedures. Documentation may include such items as

- The objectives of the test and a description of other audit procedures related to those objectives
- The definition of the population and the sampling unit, including how the auditor considered completeness of the population
- The definition of an error
- The rationale for the risk of incorrect acceptance, the risk of incorrect rejection, the tolerable error, and the expected population deviation rate used in the application
- The audit sampling technique used
- The method of sample selection
- A description of the performance of the sampling procedures and a listing of errors identified in the sample
- The evaluation of the sample and a summary of the overall conclusion

The evaluation and summary might contain a projection of the errors found in the sample to the population, an explanation of how the auditor considered sampling risk, and an overall conclusion about the population. The workpapers also might document the auditor's consideration of the qualitative aspects of the errors.

SECTION 2 - NONSTATISTICAL SAMPLING

This section provides further guidance on designing, performing, and evaluating a nonstatistical sample for substantive tests. Chapter one discusses the differences between nonstatistical and statistical sampling. As discussed in that chapter, an auditor chooses between nonstatistical and statistical sampling after considering their relative cost and effectiveness in the circumstances.

Section one of this chapter provides general guidance applicable to all sampling applications for substantive tests, either nonstatistical or statistical. This section discusses some aspects of the factors to be considered by an auditor using nonstatistical sampling. In general, these factors relate to:

Identifying individually significant items

Determining the sample size

- Variation within the population
- Risk of incorrect acceptance
- Tolerable error and error expectation
- Population size
- Relating the factors to determine the sample size

Selecting the sample

Evaluating the sample results

- Projecting the error
- Considering sampling risk
- Considering qualitative characteristics

Identifying Individually Significant Items

When planning a nonstatistical sample for a substantive test of details, the auditor uses his judgment to determine which items, if any, in an account balance or class of transactions should be tested individually and which items should be subject to sampling. The auditor should test each item for which, in his judgment, acceptance of some sampling risk is not justified. These might include items, for example, for which potential errors could individually equal or exceed the tolerable error. The auditor might also identify unusual balances and transactions as individually significant items. Any items that the auditor has decided to test 100 percent are not part of the items subject to sampling. Other items, if any, that, in the auditor's judgment, need to be tested to fulfill the audit objective but need not be examined 100 percent would be subject to sampling.

Determining the Sample Size

As discussed in SAS No. 39, the sample size necessary to provide sufficient evidential matter depends on both the objectives and the efficiency of the sample. For a given objective, the efficiency of the sample relates to its design; one sample is more efficient than another if it can achieve the same objectives with a smaller sample size. In general, careful design can produce more efficient samples.

If the auditor plans too small a sample, the sample results will not meet his planned objective. In that case, the auditor ordinarily needs to perform additional procedures to gather sufficient evidential matter to reach a conclusion. If the auditor plans too large a sample, he examines more items than necessary to achieve the planned objective. In both cases the examination would be effective even though the auditor did not use sampling efficiently.

In determining an appropriate sample size for a substantive test of details, the auditor using nonstatistical sampling considers the factors discussed in section one of this chapter even though he might not be able to quantify his consideration explicitly. The following paragraphs discuss the relative effect of changes in his planning considerations on the determination of the appropriate sample size.

Variation within the population

The characteristics (such as their values) of individual items in a population often vary significantly. The auditor considers this variation when determining an appropriate sample size for a substantive test. The appropriate sample size generally decreases as the variation becomes smaller.

The auditor can separate a population into relatively homogeneous groups (called strata) to reduce the sample size by minimizing the effect of the variation of values for items in the population. Common bases for stratification for substantive tests may be, for example, the book value of the items, the nature of internal accounting controls related to processing the items, and special considerations associated with certain items (for example portions of the population that may be more likely to contain errors). The auditor selects separate samples from each stratum and combines the results for all strata in reaching an overall conclusion about the population.

Risk of Incorrect Acceptance

As discussed in SAS No. 39, Audit Sampling, an auditor relies on the internal accounting controls, analytical review procedures, and substantive tests of details in whatever combination he believes adequately controls utlimate risk. If the auditor places greater reliance on internal accounting controls, he can accept a greater risk of incorrect acceptance for the planned substantive test. As the acceptable level of risk of incorrect acceptance increases, the required sample size for the substantive test decreases. Conversely, if the auditor places less reliance on the internal accounting controls, the acceptable level of risk of incorrect acceptance decreases and the appropriate sample size increases. The same relationship is true for the auditor's reliance on other substantive tests, including analytical review procedures, related to the same audit objectives. As the auditor's reliance on the other related substantive tests increases, the acceptable level of risk of incorrect acceptance increases, and the appropriate sample size decreases. Conversely, as the auditor's reliance on the other related substantive tests decreases, the acceptable level of risk of incorrect acceptance decreases, and the appropriate sample size increases.

Tolerable error and error expectation

The auditor also considers tolerable error in determining the appropriate sample size for a substantive test. For a given account balance or class of transactions, the sample size required to achieve the auditor's objectives at a given risk of incorrect acceptance increases as the tolerable error for that balance or class decreases. The auditor also considers the amount and possibly the frequency of errors that he expects to exist in the account balance or class of transactions when he determines the appropriate sample size for a substantive test of details. As the size or frequency of expected errors decreases, the appropriate sample size also decreases. Conversely, as the size or frequency of expected errors increases, the appropriate sample size increases.

Population size

The number of items in the population should have little effect on the determination of an appropriate nonstatistical sample size for substantive tests. As a result it is generally not efficient to determine a sample size as a fixed percent of the population.

Relating the Factors to Determine the Sample Size

An understanding of the relative effect of various planning considerations on sample size is useful in designing an efficient sampling application. The auditor uses professional judgment and experience in considering those factors to determine a sample size.

Neither SAS No. 39 nor this guide requires the auditor to compare the sample size for a nonstatistical sampling application with a corresponding sample size calculated using statistical theory. At times, however, an auditor may find familiarity with sample sizes based on statistical theory helpful when he applies professional judgment and experience in considering the effect of various planning considerations on sample size. This section includes an illustrative sample size table and an illustrative model for determining sample sizes solely for that purpose. Those tools are provided solely to illustrate the relative effect of different planning considerations on sample size; they are not intended as substitutes for professional judgment in the circumstances.

Table 1 illustrates various sample sizes for a statistical sampling approach.[8] The auditor using this table to assist him in gaining an understanding of the relative size for samples for substantive tests of details will need to apply professional judgment in

- quantifying risk level,

- quantifying error expectation,

- determining the appropriate sample size that would reflect any difference in efficiency between his nonstatiscal approach and the statistical sampling approach underlying the table. For example, the auditor should consider the extent of stratification used in the nonstatistical sampling plan. Table 1 is based on a very efficient, highly stratified sampling approach.

Table 1 might also help an auditor to understand the risk levels implied by a given sample size. For example, the auditor might be designing a nonstatistical sampling application to test a population of 2,000 accounts receivable balances with a total book value of one million dollars. The auditor may have:

- considered selecting a sample of 140,

- assessed tolerable error as $30,000, and

- expected the population might contain about $9,000 of errors.

Table 1 would indicate that the sample of 140 would imply at least 10 percent[9] risk of incorrect acceptance.

The auditor might also compare other sample sizes in the table to the sample size of 140 to gain a better understanding of how sample size affects the risk levels in the circumstances. The auditor using Table 1 for this purpose will also need to apply professional judgment in assessing the two factors described in the preceding paragraph.

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[8]Table 1 is based on the statistical theory underlying probability-proportional-to-size sampling which is discussed in section three of this chapter.

[9]Based on the information provided, tolerable error as a percent of population book value would be equal to 3% ($30,000 ÷ $1,000,000) and expected error as a percent of tolerable error would be equal to 30 percent ($9,000 ÷ $30,000).

TABLE 1

ILLUSTRATIVE SAMPLE SIZE TABLE

TOLERABLE ERROR AS PERCENT OF POPULATION

RISK*	EXPECTED ERROR AS % OF TOLERABLE ERROR	50	30	10	8	6	5	4	3	2	1	.5
						SAMPLE SIZES						
5%	0%	6	10	30	38	50	60	75	100	150	300	600
	10%	8	12	37	46	61	73	91	121	182	364	727
	20%	10	16	46	58	77	92	115	154	230	460	920
	30%	12	20	60	75	100	120	150	200	300	600	1200
	40%	16	27	81	101	135	162	202	269	404	807	1614
	50%	23	39	116	144	192	231	288	384	576	1152	2304
10%	0%	5	8	23	29	39	46	58	77	115	230	460
	20%	7	12	34	43	57	68	85	113	169	338	675
	30%	9	15	44	54	72	87	108	144	216	431	862
	40%	12	19	57	72	95	114	143	190	285	570	1140
	50%	16	27	80	100	133	160	200	266	399	798	1596
30%	0%	3	4	12	15	20	24	30	40	60	120	240
	20%	4	6	16	20	27	32	40	54	80	160	319
	40%	5	8	24	30	40	48	60	80	119	238	476
	60%	9	14	43	53	71	85	106	142	212	424	848
50%	0%	2	3	7	9	12	14	18	23	35	69	138
	20%	2	3	9	11	15	18	22	29	44	87	173
	40%	3	4	12	15	20	23	29	39	58	115	230
	60%	4	6	18	22	29	35	43	58	86	173	345

* Risk of Incorrect Acceptance

The following model also illustrates various sample sizes for a statistical sampling approach.[10] The auditor using this model to assist him in gaining an understanding of the relative size for samples for substantive tests of details will need to apply professional judgment in both:

- classifying the degree of audit assurance desired and the auditor's anticipation of the extent of error likely to exist in the population, and

- determining the appropriate sample size that would reflect any difference in efficiency between his nonstatistical approach and the statistical sampling approach underlying the model. For example, the auditor should consider the extent of stratification used in the nonstatistical sampling plan. This model is based on a very efficient, highly stratified sampling approach.

1. Classify the degree of audit assurance desired for the sample as follows:

   a. Substantial - a relatively high level of assurance generally indicating that little or no reliance is placed on internal accounting control or other related substantive procedures.

   b. Moderate - an average degree of assurance generally indicating that some reliance is placed on internal accounting control or other related substantive procedures.

   c. Little - the minimal assurance, generally indicating that considerable reliance is placed on internal accounting controls or other related substantive procedures.

2. Choose an appropriate assurance factor.

	ASSURANCE FACTORS	
Degree of Audit Assurance	Little Error Is Anticipated	Some Error Is Anticipated
Substantial	3	6
Moderate	2.3	4
Little	1.5	3

3. Estimate the population book value after deducting any items to be examined 100 percent.

[10]This simplistic model is based on the statistical theory underlying probability-proportional-to-size sampling which is described in section three of this chapter.

4. Estimate the sample size:

$$\frac{\text{Population book value}}{\text{Tolerable error}} \times \text{Assurance factor} = \text{Sample Size}$$

5. Adjust the sample size estimate to reflect any differences in efficiency between the nonstatistical approach and the statistical approach underlying this model.

For example, if the auditor is designing a sample of accounts receivable with a book value of $150,000 and he desires moderate audit assurance, he can use this model to estimate an appropriate sample size. First, he identifies those items he wishes to examine 100 percent - in this case, twelve items with a total book value of $70,000. The remaining items, with a total book value of $80,000, would be subject to sampling. If the auditor assesses the tolerable error as $4,000, and if he anticipated some error, the auditor can estimate the sample size as:

$$\frac{\text{Population book value}}{\text{Tolerable error}} \times \text{Assurance factor} = \text{Sample Size}$$

$$\frac{80{,}000}{4{,}000} \times 4 = 80 \text{ sampling units}$$

The calculation of eighty sampling units is based on a highly stratified sampling approach. Because the auditor plans to design the nonstatistical sample with only minimal stratification, he may decide to select, for example, a sample of 110 items. In that case, he examines a total of 122 items - twelve individually significant items with a book value of $70,000 and 110 sampling units.

Selecting the Sample

In selecting the sample, the auditor generally identifies individually significant items, stratifies the items subject to sampling, and allocates the sample size to the specific strata.

When the auditor plans the sample, he uses his judgment to determine which items, if any, in the account balance or class of transactions should be individually tested and which items should be subject to sampling. In selecting the sample the auditor separates those individually significant items from the remaining population. For example, in testing an entity's accounts receivable balance, the auditor might have identified 10 customer balances which individually equalled, or exceeded, tolerable error and 2 other large customer balances that he believed were individually significant because no recent payments had been made on the outstanding balance.

For efficiency, the auditor generally stratifies the remaining population - that is, the items subject to sampling. For example, the accounts receivable balance may include some large dollar balances and many smaller dollar balances. In that case, the auditor might design his sample to include two strata: one of large dollar balances and one of smaller dollar balances. The table shows two such strata:

Stratum	Population Items	Book Value
Book value from $100 to $1000	100	$47,000
Book value up to $100	1,000	$33,000

The auditor should allocate a portion of the sample to each stratum. In general, the sample results can provide the auditor with greater assurance if that allocation results in a proportionalely larger sample size for the large dollar stratum than for the smaller dollar stratum. For example, after considering the factors in this section. the auditor might determine the appropriate sample size to be eighty customer balances. If the large dollar stratum and the smaller dollar stratum include book values of $47,000 and $33,000 respectively, the auditor might select fifty sampling units from the large dollar stratum and the remaining thirty sampling units from the smaller dollar stratum.

Evaluating the Sample Results

Projecting the error

SAS No. 39, Audit Sampling, states, "The auditor should project the error results of the sample to the items from which the sample was selected..." The auditor can project the amount of error found in a nonstatistical sample to estimate the amount of error in the population by any one of several methods. This section describes two acceptable methods.

One method of projecting the amount of error found in a nonstatistical sample is to divide the amount of error in the sample by the fraction of total dollars from the population included in the sample. For example, an auditor may have selected a sample that could be expected to be representative of trade receivable balances that includes 10 percent of the book values of the account balance. If the auditor has found $1,000 of error in the sample, his best estimate of error in the population would be calculated to be $10,000 ($1,000 ÷ 1/10). This method does not require an estimate of the number of sampling units in the population.

Under another method the auditor projects the average difference between the audited and the book values of each item included in the sample to all items comprising the population. For example, the auditor may have selected a nonstatistical sample of 100 items. If the auditor found $200 of error in the sample, the average difference between audited and book values for items in the sample is $2 ($200 ÷ 100). The auditor can then estimate the amount of error in the population by multiplying the total number of items in the population (in this case, 25,000 items) by the average difference for each sample item of $2. The auditor's estimate of error in the population is $50,000 (25,000 X $2). This approach is the equivalent of the SAS No. 39 illustration of projecting errors from a sample ($200/(100/25,000) = $50,000).

The two methods described above will give identical results if the sample includes the same proportion of items in the population as the proportion of the population's book value included in the sample. If the proportions are different, the average value of a sample item is generally different from the average value of an item in the population. If the difference is significant, the auditor chooses between the approaches on the basis of his understanding of the magnitude and distribution of errors in the population. For example, if the auditor expects that the amount of error relates closely to the size of an item, he ordinarily uses the former approach. On the other hand, if the auditor expects the errors to be relatively constant for all items in the population, he ordinarily uses the latter approach.

If the auditor designed the sample by separating the items subject to sampling into strata, he should separately project the error results of each stratum and then calculate his estimate of error in the population by summing the individually projected amounts of error. The auditor should also add to the projected amount of error, any error found in the items examined 100 percent.

Considering sampling risk

According to SAS No. 39, Audit Sampling, the total projected error for a sample "should be compared with the tolerable error for the account balance or class of transactions, and appropriate consideration should be given to sampling risk." If the total projected error is less than tolerable error for the account balance or class of transactions, the auditor should consider the risk that such a result might be obtained even though the true monetary error for the population exceeds tolerable error. For example, if the tolerable error in an account balance of $1 million is $50,000 and the total projected error based on an appropriate sample is $10,000, he may be reasonably assured that there is an acceptably low sampling risk that the true monetary error for the population exceeds tolerable error. On the other hand, if the total projected error is close to or exceeds the tolerable error, the auditor may conclude that there is an unacceptably high risk that the actual errors in the population exceed the tolerable error.[11]

The auditor using nonstatistical sampling uses his experience to assist him in applying professional judgment in making such an evaluation. However, when the projected error is neither very close to tolerable error nor very far from tolerable error, it may require especially careful consideration to determine whether there is an unacceptably high risk that the true error exceeds the tolerable error. If the number and size of errors identified in the sample do not exceed the auditor's expectation of errors used in determining an appropriate sample size, the auditor can generally conclude that there is an acceptably low risk that the actual error exceeds tolerable error. On the other hand, if the number or size of errors identified in the sample exceeds the

[11]If the auditor has stratified the nonstatistical sample, the consideration of sampling risk is more complex. In general, any allowance for sampling risk related to the overall sampling application is no smaller than the sampling risk associated with any one stratum and no larger than the sum of sampling risk for all strata.

auditor's expectation of errors used in determining an appropriate sample size, the auditor would generally conclude that there is an unacceptably high risk that the actual error exceeds tolerable error.

Occasionally, the sample results may not support acceptance of the book values because the sample is not representative of the population. When the auditor believes that the sample might not be representative of the population, he might select additional sampling units to try to obtain a sufficiently representative sample or perform alternative procedures to assist him in determining whether the book value of the population is misstated.

If the sample results do not support the book value of the population and the auditor believes the book value might be misstated, the auditor considers the error along with other audit evidence in evaluating whether the financial statements are materially misstated. The auditor ordinarily suggests that the entity investigate the errors and, if appropriate, adjust the book value.

Considering qualitative characteristics

In addition to evaluating the frequency and amounts of monetary misstatements, the auditor should consider the qualitative aspects of the errors. These include (a) the nature and cause of misstatements, such as whether they are differences in principle or in application, are errors or irregularities, or are due to misunderstanding of instructions or to carelessness, and (b) the possible relationship of misstatements to other phases of the audit. The discovery of an irregularity ordinarily requires a broader consideration of possible implications than does the discovery of an error.

Nonstatistical Sampling Case Study

Jones of Jones & Co., CPAs, designed a nonstatistical sample to test the December 31, 19X0 accounts receivable of Short Circuit, Inc. Short Circuit, Inc., an electrical supply company, is a new client of Jones & Co. For the year ended December 31, 19X0, Short Circuit had sales of approximately $25 million. At December 31 there were 1,100 accounts receivable, with debit balances aggregating $4.25 million. These balances ranged from $10 to $140,000. There were also forty credit balances aggregating $5,000.

Jones decided that

- The results of his study and evaluation of internal accounting control supported a moderate level of reliance on internal accounting control in determining the extent of substantive testing.
- A misstatement of $130,000 in the accounts receivable balance might result in material misstatements of the financial statements.
- The credit balances in accounts receivable would be tested separately as accounts payable.
- The balance for each selected customer would be confirmed.

Some additional information related to the case study includes:

- The population contains five balances over $50,000, which total $500,000. Jones decided to examine those five balances 100 percent and exclude them from the population to be sampled. The population also contains 250 balances equal to or greater than $3,000, which total $2,500,000.
- Through analytical review procedures and an inventory shortage test, Jones obtained reasonable assurance that all shipments were billed and that no material understatements existed.
- Jones is also performing some analytical review procedures on the account receivable balance.

Determining the sample size

Jones considered the four general factors influencing the appropriate size of a sample:

- Variation in the population. Jones decided to separate the population into two strata, based on the book values of the items comprising the population. The first group consisted of the 250 balances equal to or greater than $3,000 (total book value of $2.5 million), and the second group consisted of the remaining balances with book values less than $3,000.

- Risk of incorrect acceptance. Jones wanted the sample size to be sufficient to provide him with only a moderate risk that the sample results would support the account balance if it is materially misstated. His decision to accept a moderate risk of incorrect acceptance was based on his moderate reliance on internal accounting control and analytical review procedures related to the same account balance.

- Tolerable error. Because Jones had decided that a misstatement of $130,000 in the accounts receivable balance might result in material misstatement of the financial statements, the tolerable error for the balance was $130,000.

- Expectation of error. Because Short Circuit, Inc. has only moderately effective internal accounting controls over the processing of accounts receivable transactions, Jones believed that some errors may have existed in the accounts receivable balance.

Jones considered these factors and, using his experience and professional judgment, decided to use a sample size of 110 customer balances.[12] He also decided to divide the sample between the two strata in a way approximately proportional to the book values of the accounts in the strata. Accordingly, he selected 73 of the 110 customer balances from the first stratum (balances with book values equal to or greater than $3,000) and the remaining 37 customer balances from the second stratum (balances with book values under $3,000).

[12]Jones found the characteristics of this account balance to be different from those he generally encounters on most of his engagements. Generally Jones' clients do not have accounts receivable balances with such large balances comprised of so many small accounts of which Jones has no special knowledge. Because the characteristics of this population are different from those Jones ordinarily tests, Jones decided to use a table illustrating sample sizes based on statistical theory (such as the table in this section) to assist him in gaining an understanding of the risk implied by a sample size of 110. (This procedure is not required by SAS No. 39 or this guide.) Jones calculated the tolerable error as a percentage of the total book value of the population subject to sampling to be 3.5% ($130,000 ÷ $3,750,000) and he assessed the error expectation to be $34,000 or approximately 25% of the tolerable error. The table suggested that a sample of 110 implied a risk level of at least 10%. Jones believed that, although a higher level of risk would be acceptable to him in the circumstances, the sample size of 110 appropriately reflected the difference between the design of his sampling plan and the sample design underlying the sample sizes presented in the table. For example, he recognized that his sample was divided into only two strata but the sample sizes in the table were based on a highly stratified sampling approach.

Evaluating the sample results

Jones mailed confirmations to each of the 110 customers whose balance had been selected and to each of five customers selected in the 100 percent examination group. Ninety of the 115 confirmations were returned to him. Jones was able to obtain reasonable assurance through alternative procedures that the twenty-five customer balances that were not confirmed were bona fide receivables and were not misstated. Of the ninety responses only three indicated that the balance was overstated. Jones determined that the misstatements resulted from ordinary errors in the accounting process. The sample was summarized as follows.

Stratum	Book Value of Stratum	Book Value of Sample	Audit Value of Sample	Amount of Over-statement
100% examination	$ 500,000	$ 500,000	$ 499,000	$ 1,000
Over $3,000	$2,500,000	$ 739,000	$ 727,500	$ 11,500
Under $3000	$1,250,000	$ 62,500	$ 61,000	$ 1,500

Jones observed that the sample included 29.56 percent of the dollar value of the over $3,000 stratum but it only included 29.2 percent of the items included in that stratum. He also observed that the sample included 5 percent of the dollar value of the under $3,000 stratum but it only included 4.38 percent of the items included in that stratum. On the basis of the above computations, Jones believed that the two methods of projecting sample results described in this section might yield different results. Jones considered the errors found and concluded that the amount of error in the population was more likely to correlate to total dollar value of items in the population than to the number of items in the population. Therefore, Jones separately projected the amount of error found in each stratum of the sample by dividing the amount of error in the stratum by the fraction of total dollars from the population stratum that was included in the sample stratum. For the "over $3,000" stratum, Jones calculated that the sample included 29.56 percent ($739,000 ÷ $2,5000,000) of the stratum book value. He projected the sample results for that stratum to the population by dividing the amount of error in the sample by 29.56 percent. He calculated the projected error to be $38,903.92 ($11,500 ÷ .2956). Similarly, Jones calculated that the sample for the "under $3,000" stratum included 5 percent ($62,500 ÷ $1,250,000) of the stratum book value and that the projected error was $30,000 ($1,500 ÷ .05). Because the items examined 100 percent were not subject to sampling, the amount of overstatement identified in those five account balances is also the projected error for those items. The total projected error was $69,903.92 ($1,000 + $38,903.92 + $30,000).

Jones compared the total projected error of $69,903.92 with the $130,000 tolerable error and decided that there was an acceptably small risk that he would have obtained the sample results if the true value of the accounts receivable balance was misstated by more than the tolerable error of $130,000. In other words, even the addition of a reasonable allowance for sampling risk to projected error would not be likely to result in a total exceeding tolerable error.

Jones concluded that the sample results supported the book value of the accounts receivable balance. He did, however, include the projected error from the sample results along with other relevant audit evidence when he evaluated whether the financial statements taken as a whole were materially misstated.

SECTION 3
PROBABILITY-PROPORTIONAL-TO-SIZE SAMPLING

This section discusses a statistical sampling approach called probability-proportional-to-size (PPS) sampling. Variations of PPS sampling are known as dollar unit sampling (DUS), cumulative monetary amount (CMA) sampling, and combined attribute variables (CAV) sampling.

As discussed in chapter 1, attributes sampling is generally used to reach a conclusion about a population in terms of a rate of occurrence. Variables sampling is generally used to reach conclusions about a population in terms of a dollar amount. PPS sampling is a hybrid method that uses attributes sampling theory to express a conclusion in dollar amounts rather than as a rate of occurrence.[13]

Selecting a Statistical Approach

Both statistical approaches to sampling for substantive testing -- classical variables sampling and probability-proportional-to-size sampling -- can provide sufficient evidential matter to achieve the auditor's objective. However, there are some circumstances in which PPS sampling may be more practical to use than classical variables sampling. Some of the advantages of PPS sampling include

- PPS sampling is generally easier to use than classical variables sampling. Since PPS sampling is based on attributes sampling theory, the auditor can calculate sample sizes and evaluate sample results by hand or with the assistance of tables. Sample selection can be performed with the assistance of either a computer program or an adding machine.

- The size of a PPS sample is not based on any measure of the estimated variation of audited values. As discussed in section 4 of this chapter, the sample size of a classical variables sample is based on the variation, or standard deviation, of the characteristic of interest of the items in the population. PPS sampling does not require direct consideration of the standard deviation to determine the appropriate sample size.

- PPS sampling automatically results in a stratified sample because items are selected in proportion to their dollar values. The auditor

[13]A PPS sample may be evaluated using the classical sampling approach discussed in section 4 of this chapter. That evaluation is not frequently used by auditors and is beyond the scope of this guide. For further information see Donald Roberts, Statistical Auditing, pp. 116-19.

using classical variables sampling must provide for special design considerations to stratify the population in order to reduce the sample size.

- The PPS systematic sample selection described in this guide automatically identifies any item that is individually significant if its value exceeds an upper monetary cutoff.

- If the auditor expects no errors, a PPS sampling approach will usually result in a smaller sample size than a classical variables sampling approach.

- A PPS sample can be designed more easily and sample selection can begin before the complete population is available.

Some of the circumstances where PPS sampling may be especially useful include

- Accounts receivable when unapplied credits are not significant.

- Loans receivable (for example, real estate mortgage, commercial loans, and installment loans).

- Investment securities.

- Inventory price tests where the auditor anticipates relatively few differences.

- Fixed asset additions.

There are also several disadvantages of PPS sampling.

- The general approach to PPS sampling includes an assumption that the audited value of a sampling unit should not be less than zero or greater than the book value. If the auditor anticipates overstatements where the audited value will be less than zero, a PPS sampling approach may require special design considerations.

- If an auditor identifies understatements in a PPS sample, evaluation of the sample may require special considerations.

- Selection of zero balances or balances of a different sign also requires special design considerations. For example, if the population to be sampled is accounts receivable, the auditor may need to segregate credit balances into a separate population. If examination of zero balances is important to the auditor's objectives, he would need to test them separately since zero balances are not subject to PPS selection.

- PPS evaluation may overstate the allowance for sampling risk when errors are found. As a result, the auditor may be more likely to reject an acceptable book value for the population.

- The auditor needs to add through the population for certain PPS selection procedures. However, adding through the population may not require significant additional audit effort if the related accounting records are on computer files that can be used by the auditor or if the auditor is adding through the population as a part of another audit procedure.

- As the expected number of errors increases, the appropriate PPS sample size increases. In those circumstances the PPS sample size can become larger than the corresponding sample size for classical variables sampling.

Some of the circumstances in which PPS sampling might not be the most cost-effective approach include

- Accounts receivable where a large number of unapplied credits exist

- Inventory test counts and price tests where the auditor anticipates a significant number of audit differences or where errors can be both understatements and overstatements

- Conversion of inventory from FIFO to LIFO

- Any application where the primary objective is to independently estimate the value of a class of transactions or balances

USING PPS SAMPLING

Section 1 of this chapter provides the general considerations in using sampling for substantive tests. This section describes additional factors the auditor should consider when using PPS sampling.[14] The discussion of those factors includes:

Defining the sampling unit.

Selecting the sample.

Determining the sample size.

- no errors anticipated.
- errors anticipated.

Evaluating the sample results.

[14]A PPS sampling approach can also be used to obtain evidence of compliance with internal accounting control procedures. A PPS sampling approach would provide evidence in terms of dollar amounts of transactions containing deviations rather than rates of deviations. In that case, the feature of interest is compliance deviations rather than substantive errors.

- Sample evaluation with 100% errors.
- Sample evaluation with less than 100% errors.
- Quantitative considerations.
- Qualitative considerations.

Defining the Sampling Unit

PPS sampling applies attributes sampling theory to reach dollar value conclusions by selecting sampling units proportional to their size. A sampling approach that meets this criterion is to give each individual dollar in the population an equal chance of selection. As a practical matter, however, the auditor does not examine an individual dollar within the population. For illustative purposes some auditors think of each dollar as acting like a hook that snags the entire balance or transaction that contains it. The auditor examines the balance or transaction that includes the selected dollar. The balance or transaction that will be audited is called a logical unit.

PPS sampling helps the auditor to direct the audit effort toward larger balances or transactions. Because every dollar has an equal chance of being selected, logical units having more dollars (that is, larger book values) have more chance of being selected. The name for this sampling approach, probability proportional to size sampling, is derived from this concept - that each balance or transaction in the population has a probability of selection proportional to its size.

Selecting the Sample

This guide discusses only one method of selection: systematic selection.[15] That approach is easy to apply when selecting a sample from either manually maintained or computerized records. Systematic selection divides the population into equal groups of dollars and selects a logical unit from each group. Each group of dollars is a sampling interval.

To use the systematic selection method, the auditor selects a random number between one and the sampling interval, inclusive. He then begins adding the book values of the logical units through the population. The first logical unit selected is the one that contains the dollar corresponding to the random start. The auditor then selects each logical unit containing every nth dollar thereafter. N dollars represents the sampling interval.

For example, if an auditor specifies a sampling interval of $5,000, he selects a random number between $1 and $5,000, inclusive - for example, the 2,000th dollar. Then the 7,000th dollar (2,000 + 5,000), then the 12,000th dollar (2,000 + 5,000 + 5,000), and every succeeding nth dollar is selected until the entire population has been subjected to sampling.

[15]For a discussion of other PPS selection methods, see Roberts, Statistical Auditing, pp. 21-23.

The auditor therefore examines the logical units that contain the 2,000th, 7,000th, and 12,000th, dollars and so on.

Because every dollar has an equal chance of being selected, logical units having more dollars (that is, a larger book value) have a greater chance of being selected. Conversely, smaller logical units have a smaller chance of being selected. All logical units with dollar values equal to or greater than the sampling interval are certain to be selected under the systematic selection method. A logical unit that is one-half the size of the sampling interval has a 50 percent probability of selection.

If the book value of a logical unit exceeds the sampling interval, the logical unit may be selected more than once. If that happens, the auditor ignores the repeat selection and considers the logical unit only once when evaluating the sample results. Because logical units with book values greater than the sampling interval may be selected more than once, the actual number of logical units examined may be less than the computed sample size.

Items in the population with credit balances require special consideration. One way of accomplishing this is to exclude them from the selection process and test them separately.

If the selection is to be done manually, the auditor can use an adding machine as follows.

1. He clears the adding machine.

2. He subtracts the random start.

3. He begins adding the book values of logical units in the population, obtaining a subtotal after the addition of each succeeding logical unit. Items with credit balances should be excluded. The first logical unit that makes the subtotal zero or positive is selected as part of the sample. The auditor lists or segregates selected logical units from the remaining population.

4. After each selection, he subtracts the sampling interval as many times as necessary to make the subtotal negative again.

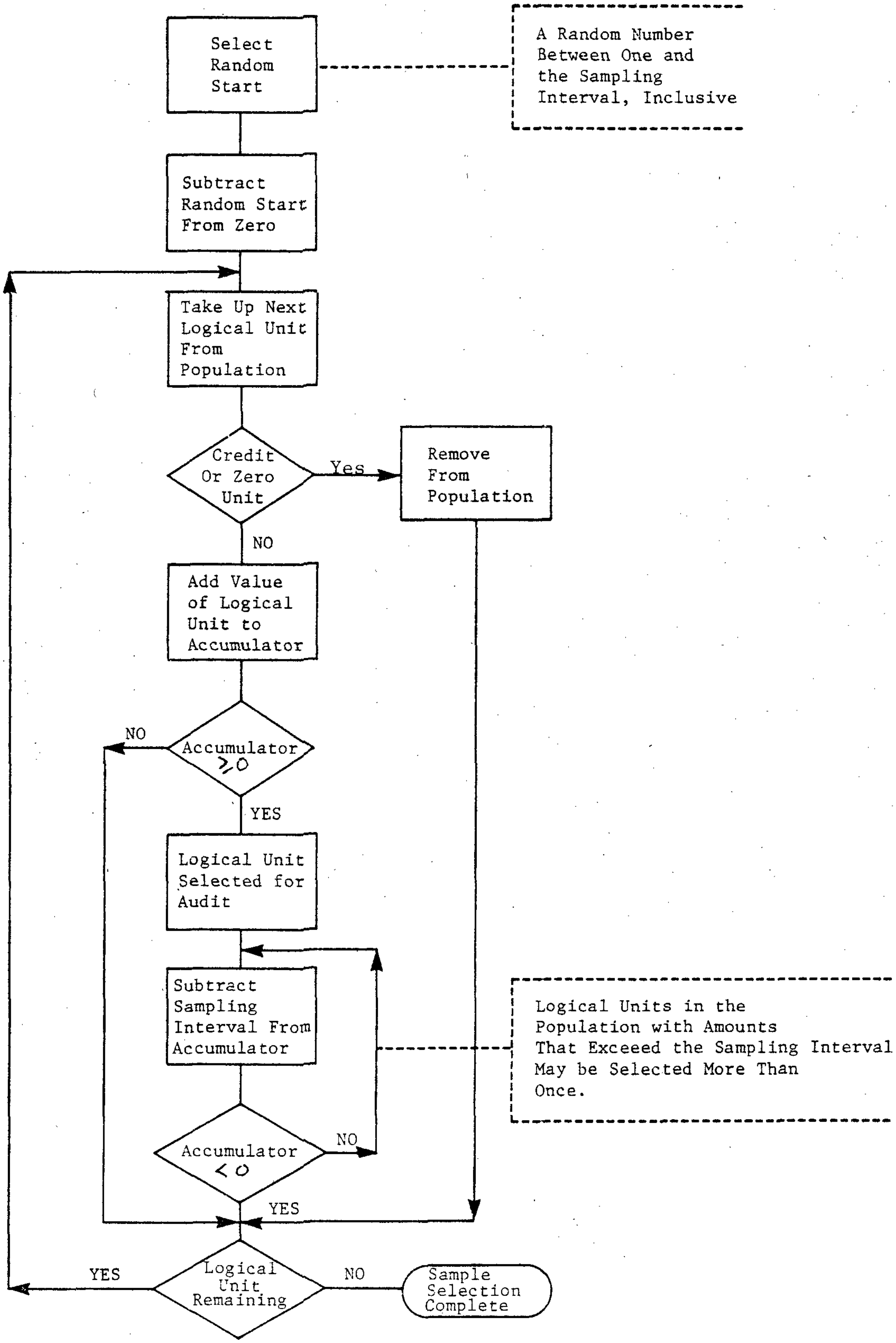
5. He continues adding the logical units as before, selecting all items that cause the subtotal to equal zero or become positive.

A summary of the sample selection process is flowcharted in Figure 1.

Figure 1

PROBABILITY PROPORTIONAL TO SIZE

SAMPLE SELECTION FLOWCHART



The auditor should reconcile the total book value of logical units accumulated on the adding machine to a control total of the book value of the population. Generally, he adds (1) the balance shown on the adding machine, (2) the random start, and (3) the sampling interval times the number of times the sampling interval was subtracted on the adding machine. The total should be the control total.

Determining the Sample Size

As discussed above, the auditor selecting a PPS sample divides the population into uniform groups of dollars called sampling intervals and selects a logical unit from each sampling interval. Therefore, the number of selections is equivalent to the book value of the population divided by the sampling interval.[16]

$$\text{Sample size} = \frac{\text{Book value of the population}}{\text{Sampling interval}}$$

Because the book value of a given population is constant, the determination of an appropriate PPS sample size is a function of the sampling interval specified by the auditor.

Sample Size Determination - no error anticipated. The size of a sampling interval is related to the auditor's consideration of the risk of incorrect acceptance and the auditor's assessment of tolerable error. Some auditors calculate the sampling interval by dividing tolerable error by a factor that corresponds to the risk of incorrect acceptance. The factor is known as the reliability factor.

Approximate Risk of Incorrect Acceptance	Reliability Factor
37%	1
14%	2
5%	3

If the auditor assesses the tolerable error as $15,000 and the risk of incorrect acceptance as 5 percent, the sampling interval is calculated to be $5,000 ($15,000 ÷ 3).

Table 1 of Appendix D provides reliability factors for some of the more commonly used risks of incorrect acceptance. The appropriate row to use with the guidance in this section, "Sample size determination - no errors anticipated," is the row with zero number of overstatement errors.

[16] Because logical units with values greater than the sampling interval may be selected more than once, the actual number of logical units examined may be less than the calculated sample size. This consideration is included in the evaluation method described in this section of the guide.

Sample size determination - errors anticipated. When planning a PPS sample, the auditor controls the risk of incorrect rejection by making an allowance for expected errors in the sample. The auditor specifies a desired allowance for sampling risk such that his estimate of projected error plus the allowance for sampling risk will be less than or equal to tolerable error.

If the auditor anticipates errors, the use of the reliability factor is modified. When errors are anticipated, the auditor can

- Subtract the effect of anticipated error from tolerable error and calculate the sampling interval using the method described for sample size determination where no errors are anticipated,[17]

- Convert the tolerable error and the expected amount of error into percentages of the population book value and use a sample size for the equivalent rates shown in the sample size table based on attributes sampling theory.

For example, an auditor using PPS sampling may have assessed tolerable error as $15,000 and the risk of incorrect acceptance as 5 percent. In addition, the auditor may anticipate approximately $3,000 of error in the population to be sampled. The auditor using the first approach subtracts the anticipated effect of the errors from the $15,000 tolerable error. The effect is calculated by multiplying the expected error, in this case $3,000, by an appropriate expansion factor. Table 2 of Appendix D provides approximate expansion factors for some of the more commonly used risks of incorrect acceptance. The appropriate expansion factor for a risk of incorrect acceptance of 5 percent in table 2 is 1.6; therefore, the effect is $4,800 ($3,000 X 1.6). The auditor subtracts the $4,8000 effect from the $15,000 tolerable error, and the resulting $10,200 ($15,000 - $4,800) is divided by the appropriate reliability factor for applications in which no errors are anticipated, in this case three. The sampling interval in this example is $3,400 ($10,200 ÷ 3).

Since PPS sampling is based on attributes theory, a second option is to refer directly to the statistical sample size tables for compliance testing in Appendix A. This approach results in a more exact calculation of the sample size than does use of the appropriate expansion factors in Appendix D. The auditor converts the tolerable error and the expected amount of error into percentages of the population book value and uses a sample size for the equivalent rates shown in the table. For example, if the auditor is designing a PPS sampling application for a population with a book value of $500,000, he may have assessed tolerable error as $15,000 and anticipated $2,500 of error in the population. The auditor would calculate tolerable error to be 3 percent ($15,000 ÷ $500,000) of the book value and the anticipated error to be .5 percent ($2,500 ÷ $500,000) of the book value. The sample size for a 5 percent risk of overreliance (table 1 of

[17]As the anticipated error approaches tolerable error, this approach tends to overstate sample size.

Appendix A), where the tolerable error is 3 percent and the anticipated error rate is .5 percent, is 157. In this example, the sampling interval is $3,184 ($500,000 ÷ 157). If the auditor were to calculate a percentage of anticipated error that is not shown on the table, he would generally select the sample size for the next highest percent shown. In the example, if the anticipated error were $3,000 (.6 percent of the book value), the appropriate sample size for the next highest percentage in table 1 is 208. The sampling interval is $2,404 ($500,000 ÷ 208). Conversely, if he were to calculate a percent for tolerable error that is not shown on the table, the auditor would select the sample size for the next lowest percentage shown. The auditor then calculates the sampling interval by dividing the book value by the sample size.

Evaluating the Sample Results

The auditor using PPS sampling projects the error results of the sample to the population from which the sample was selected and calculates an allowance for sampling risk. If no errors are found in the sample, the error projection would be zero dollars and the allowance for sampling risk would be less than or equal to the tolerable error used in designing the sample. As a result, if no errors are found in the sample, the auditor can generally conclude without making additional calculations that the book value of the population is not overstated by more than the tolerable error at the specified risk of incorrect acceptance.

If errors are found in the sample, the auditor needs to calculate a projected error and an allowance for sampling risk. This guide illustrates one means of calculating projected error and an allowance for sampling risk that is appropriate for PPS samples selected using the method described in this section. The discussion of that method is limited to overstatements because the PPS approach is primarily designed for overstatements. If understatements are a significant consideration, the auditor should decide whether a separate test designed to detect understatements is appropriate. The consideration of understatement errors discovered in a PPS sample is a subject of current research and is beyond the scope of this guide.[18] An auditor interested in obtaining information on that subject should refer to some of the materials included in Appendix H, "Selected Bibliography."

The auditor's approach to calculating the projected error and an allowance for sampling risk depends on whether the errors are equal to the book value of the logical unit or less than the book value.

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[18]There are several methods for evaluating understatements. For a discussion of one approach to evaluating sample results with a few understatements, see Roberts, Statistical Auditing, p. 124.

Sample evaluation with 100 percent errors.

Projected error. Since each selected dollar represents a group of dollars, the percentage of error in the logical unit represents the percentage of error (tainting) in a sampling interval. For example, if the sampling interval is $5,000 and a selected account receivable of $100 has an audit value of zero dollars, then the projected error of that sampling interval is $5,000 (100 percent X $5,000). The auditor adds the projected errors for all sampling intervals to calculate the total projected error for the population.

If a logical unit equals or exceeds the sampling interval, the projected error is the actual amount in error for the logical unit.

Upper Limit on Error. When evaluating a PPS sample, the auditor calculates an upper limit on error equal to the projection of error found in the sample plus an allowance for sampling risk. The auditor uses either a computer program or a table of reliability factors to assist in calculating the upper limit of error. The following reliability factors are from table 1 of Appendix D.

5% Risk of Incorrect Acceptance

Number of Overstatement Errors	Reliability Factor	Incremental Changes in Factor
0	3	-
1	4.74	1.74
2	6.30	1.56
3	7.75	1.45
4	9.15	1.40
5	10.51	1.36

The first two columns come directly from table 1 in Appendix D. The third column is the difference between the reliability factor and the preceding reliability factor.

If no errors are found in the sample at completion of the test, the upper limit on errors equals the reliability factor for no errors at a given risk of incorrect acceptance times the sampling interval. This upper limit, also referred to as basic precision, represents the minimum sampling risk inherent in the sample. For example, if the auditor specified a 5 percent risk of incorrect acceptance, used a $5,000 sampling interval, and no errors are found, the upper limit on errors equals the reliability factor times the sampling interval (3 X $5,000 = $15,000).

Because no errors were found, the projection of errors is zero, and the allowance for sampling risk equals the upper limit on errors.

However, if the auditor found two errors in the sample (for example, receivable balances of $10.00 and $20.00 were each found to have a value of zero), the auditor would calculate the upper limit on errors by multiplying the reliability factor for the actual number of errors found at the given risk of incorrect acceptance times the sampling interval.

Upper limit on errors = Reliability factor X Sampling interval

= 6.30 X $5,000

= $31,500

The $31,500 represents a projected error of $10,000 (2 X 100 percent X $5,000) and an allowance for sampling risk of $21,500 ($31,500 - $10,000).

If the logical units in which the 100 percent errors occurred were equal to or larger than the sampling interval, for example, $15,000 and $20,000 instead of the $10 and $20 errors in the previous example, the upper limit on error equals (a) the known errors in the logical units equal to or greater than the sampling interval plus (b) the allowance for sampling risk calculated above. In this example, the upper limit equals $35,000 ($15,000 + $20,000) plus $15,000 (3 X $5,000), or a total of $50,000. The auditor should add this result to the errors discovered in any other items examined 100 percent.

Sample evaluation with less than 100 percent errors

In many sampling applications, the auditor identifies errors where the logical unit is neither completely correct nor completely incorrect. The ratio of the error to the size of the logical unit containing the error is called a tainting.

Projected error when taintings occur. To project errors when taintings occur, the auditor determines the percentage of error in the logical unit and multiplies that percentage by the sampling interval. For example, if a receivable balance with a book value of $100 has an audit value of $50, the auditor would calculate a 50 percent tainting ($50 ÷ $100 = 50%). A tainting percentage is calculated for all logical units except those that have book values equal to or greater than the sampling interval. The auditor multiplies the tainting percentage by the sampling interval to calculate a projected error. He then adds the sum of all projected errors to the actual error found in the logical units equal to or greater than the sampling interval to calculate the total projected error. For example, the auditor may have identified six errors in the sample. He would calculate the projected errors as follows:

A Book Value	B Audit Value	C Tainting A - B ÷ A	D Sampling Interval	E Projected Error C X D
$ 100	$ 25	75%	$ 5,000	$ 3,750
1,000	950	5%	5,000	250
500	250	50%	5,000	2,500
50	0	100%	5,000	5,000
10	9	10%	5,000	500
10,000	9,000	NA*	NA*	1,000
Total projected Error				$13,000

Upper limit on errors when taintings occur. The allowance for sampling risk when taintings occur includes both the basic percision and an incremental allowance resulting from the occurrence of errors. To calculate that incremental allowance the auditor divides the errors into two groups: those occurring in logical units less than the sampling interval and those occurring in logical units equal to or greater than the sampling interval. In the preceding example, the first five errors are of the first type, and the last error is of the latter type.

Errors occurring in logical units equal to or greater than the sampling interval have no allowance for sampling risk associated with them since all logical units of this size have been examined. (Sampling risk only exists where sampling takes place.)

Ordinarily the auditor ranks the errors by percentage tainting and calculates the incremental allowance for sampling risk for each error by (a) multiplying the projected error for each error occurring in a logical unit less than the sampling interval by the incremental change in the reliability factor, and (b) subtracting the related projected error.

Projected Error	Incremental Changes in Reliability Factor	Projected Error Plus Incremental Allowance for Sampling Risk
$ 5,000	1.74	$ 8,700
3,750	1.56	5,850
2,500	1.45	3,625
500	1.40	700
250	1.36	340
$12,000		$19,215

The $19,215 represents $12,000 in projected error and $7,215 in additional allowance for sampling risk.

* Logical unit is greater than sampling interval; therefore, projected error equals actual error.

To calculate the upper limit of error, the auditor adds the $19,215 to two components: the basic precision and the error, if any, occurring in logical units equal to or greater than the sampling interval.

In the example, the basic precision was calculated to be $15,000 (3.00 X $5,000) and the error occurring in logical units equal to or greater than the sampling interval is $1,000. The upper limit on errors is $35,215 ($19,215 + $15,000 + $1,000).

The sample results can be summarized as follows:

a. The sample contains actual error of $1,426.

b. The total projected error is $13,000.

c. The total allowance for sampling risk is $22,215.

d. There is a 5 percent risk that the book value is overstated by $35,215 or more.

Quantitative considerations

In general, if the upper limit on error is less than tolerable error, the sample results would support the conclusion that the population is not misstated by more than tolerable error at the specified risk of incorrect acceptance. If the upper limit on error exceeds tolerable error, the sample results may have been obtained because the sample results do not reflect the auditor's expectation of error. In designing a PPS sampling application, the auditor makes an assumption about the amount of error in the population. If the sample results do not support the auditor's expectation of errors because more error exists in the population than were anticipated, the allowance for sampling risk will not be adequately limited. If the sample results do not support the conclusion that the population is not misstated by more than tolerable error because the allowance for sampling risk has not been adequately limited, the auditor can either:

- Examine an additional representative sample from the population. Because of the mechanics of a PPS sampling application, some auditors use an additional number of sampling units equal to the original sample size.[19]

[19] In order to select a sample in this circumstance, the auditor divides the original sampling interval in half and begins selecting the expanded sample using the same random start. If that random start exceeds the new sampling interval, the auditor subtracts the new sampling interval from the original random start. This results in a sample consisting of the original sample plus additional sampling units. The complexities of alternative methods of expanding the sample are beyond the scope of this guide.

- Perform additional substantive tests, such as analytical review, directed toward the same audit objective. The additional reliance on other tests would allow the auditor to accept a greater risk of incorrect acceptance for the sampling application. Recalculating the allowance for sampling risk with the greater risk of incorrect acceptance will not change the point estimate of the population but it will move both ends of the range closer to that estimate.

The sample results also might not support acceptance of the book value because the sample is not representative of the population. Although the auditor selects a sample in such a way that the sample can be expected to be representative of the population, occasionally the sample may not be representative of the population. For example, if all the related evidential matter contradicts the sample evidence, the auditor may suspect, among other possibilities, that the sample is not representative of the population. When the auditor believes that the sample may not be representative of the population, he examines additional sampling units or performs alternative procedures to assist him in determining whether the book value of the population is misstated.

If the sample results do not support the book value of the population and the auditor believes the book value is misstated, the auditor would consider the error along with other audit evidence when evaluating whether the financial statements are materially misstated. The auditor ordinarily suggests that the entity investigate the errors and, if appropriate, adjust the book value. If the upper limit on error after adjustment is less than tolerable error, the sample results would support the conclusion that the population, as adjusted, is not misstated by more than tolerable error as the specified risk of incorrect acceptance.

Qualitative considerations

In addition to evaluating the frequency and amounts of monetary misstatements, the auditor should consider the qualitative aspects of errors. These considerations are discussed in section one of this chapter.

Probability-Proportional-to-Size Sampling Case Study

Andrews of Andrews, Baxter & Co. is the auditor of the EZ Credit Bank. Andrews designed a sampling application to test EZ Credit's commercial loans receivable balance as of September 30, 19X1.

As of September 30, 19X1, the balance of commercial loans receivable was $5,000,000. Andrews expected little, if any, error to exist in the commercial loans receivable balance because of the bank's strong internal accounting controls over loan transactions. If any error did exist, Andrews believed that the errors would be overstatements. As a result, Andrews decided that probability-proportional-to-size sampling would be an appropriate sampling approach to use.

Andrews decided to confirm all selected commercial loans receivable with the bank's customers. He decided that a $55,000 misstatement in the commerical loans receivable might result in the financial statements being materially misstated. As a result, tolerable error for the sampling application was $55,000. Also, because Andrews decided to place only minimal reliance on related internal accounting control and the sampling application was the primary test of the commercial loans receivable, Andrews decided that a 10 percent risk of incorrect acceptance was appropriate.

Becuase Andrews had only a very limited period of time to complete his examination, he decided to anticipate that some misstatement might exist in the account balance when he determined the appropriate sample size. Although this would result in a somewhat larger sample size, anticipating some misstatement when determining the sample size would reduce the possibility that he would have to extend the sampling application.

Selecting the sample.

Andrews calculated the appropriate sampling interval as follows.

Tolerable error		$55,000
Anticipated error	$10,000	
(times) Appropriate expansion factor for 10% risk of incorrect acceptance (Appendix D)	1.5	
(less) Anticipated effect of errors		$15,000
Tolerable error adjusted for anticipated errors		$40,000
(divided by) Reliability factor for no anticipated errors for 10% risk of incorrect acceptance (Appendix D)		2.3
Sampling interval		$17,391

Andrews then calculated the appropriate sample size by dividing the commercial loans receivable book value by the sampling interval. The calculated sample size was 287 ($5,000,000 ÷ $17,391). Andrews did not need to identify the commercial loans that individually exceeded the tolerable error of $55,000 because the systematic selection method used by Andrews to select the logical units to be examined would be certain to select all logical units with book values greater than or equal to the $17,391 sampling interval. Andrews manually selected his sample on an adding machine as follows:

1. He cleared the adding machine.

2. He subtracted a random start between 1 and 17,391, inclusive.

3. He began adding the book values of logical units in the population, obtaining a subtotal after the addition of each succeeding logical unit. The first logical unit that made the subtotal zero or positive was selected as part of the sample.

4. After each selection, he subtracted the sampling interval of $17,391 as many times as necessary to make the subtotal negative again.

5. He continued adding the logical units as before, selecting all items that caused the subtotal to become positive.

The selected sample included 281 customer balances rather than the 287 originally calculated because three large accounts were selected more than once.

Evaluating the sample results

Andrews mailed confirmations to each of the 281 customers whose commercial loan balances had been selected. Two hundred of the 281 confirmations were returned to him. Andrews was able to obtain reasonable assurance through alternative procedures that the remaining eighty-one balances were bona fide receivables and were not misstated. Of the 200 responses, only two indicated that the balances were overstated.

Andrews calculated the projected error for the sample as follows.

Error Number	A Book Value	B Audit Value	C Tainting (A-B÷A)	D Sampling Interval	Projected Error (C X D)
1	$9,000	$8,100	10%	$17,391	$1,739
2	500	480	4%	17,391	696
				Total projected error	$2,435

Andrews then calculated an allowance for sampling risk. That allowance consisted of two parts: the basic precision and the incremental allowance.

Sampling interval	$17,391
Reliability factor for 10% risk of incorrect acceptance	2.3
Basic precision	$39,999

Error Number	Projected Error	Incremental Factor	Projected Error plus Incremental Factor
1	$1,739	1.59	$2,765
2	$ 696	1.43	995
			3,760
	(less) Projected error		2,435
	Incremental allowance		$1,325

Andrews compared the total projected error plus an allowance for sampling risk, $43,759 ($2,435 + $39,999 + $1,325), with the tolerable error of $55,000. Because the total projected error plus the allowance for sampling risk was less than tolerable error, Andrews concluded that the sample results supported the commercial loans receivable balance. Andrews also determined that the overstatements were due to ordinary errors in the accounting process and that they did not require him to modify his reliance on related internal accounting controls or other planned substantive procedures.

SECTION 4 - CLASSICAL VARIABLES SAMPLING

Classical variables sampling techniques use normal distribution theory to evaluate selected characteristics of a population on the basis of a sample of the items comprising the population. This section will describe several classical variables techniques and some of the special factors to be considered by an auditor applying these techniques.

The design of a classical variables sampling approach involves mathematical calculations that are complex and difficult to apply manually. Because auditors generally use computer programs to assist them in determining sample sizes and evaluating sample results for classical variables sampling applications, it is not essential for auditors to know mathematical formulas in order to use these methods. As a result, those formulas are not provided in this guide.[20]

Selecting a Statistical Approach

Both statistical approaches to sampling for substantive testing classical variables sampling and probability-proportional-to-size sampling can provide sufficient evidential matter to achieve the auditor's objective. However, there are some circumstances in which classical variables sampling may be more practical to use than probability-proportional-to-size sampling. Some of the advantages of classical variables sampling include:

- If there are a large number of differences between book and audited values, classical variables sampling may meet the auditor's objectives with a smaller sample size.

- Classical variables samples may be easier to expand if that becomes necessary.

- Selection of zero balances generally does not require special sample design considerations. If examining zero balances is important to the auditor's objectives, the auditor using probability-proportional-to-size sampling would need to design a separate test of zero balances because the usual PPS method of sample selection does not allow for selection of zero balances.

- Inclusion of credit balances in the evaluation of a classical variables sample generally does not require special considerations.[21] A probability-proportional-to-size sample might need to be designed with special considerations to be able to include credit balances in the sample evaluation.

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[20]Formulas related to the use of classical variables sampling may be found in Roberts, Statistical Auditing, Appendix 2.
[21]For further information concerning ratio estimations, see Roberts, Statistical Auditing, p. 79.

There are also several disadvantages of a classical variables sampling approach.

- Classical variables sampling is more complex than probability-proportional-to-size sampling; generally, an auditor needs the assistance of computer programs to design an efficient sample and to evaluate sample results.

- To determine a sample size for a classical variables sample, the auditor must have an estimate of the standard deviation of the characteristic of interest in the population. Because the auditor generally does not know this information when designing a sample, the auditor determines the appropriate sample size on the basis of an estimate of that standard deviation. That estimate may be difficult or time consuming to make. In some applications, if the population is maintained on a computer file and the auditor is able to analyze the file using computer-assisted audit techniques, he may be able to measure the standard deviation of the book values as a reasonable estimate of the standard deviation of the audited values. That estimate may also be based on the standard deviation of a pilot sample or the auditor's prior knowledge of the population.

The auditor considers the advantages and disadvantages of classical variables sampling in deciding which approach to use. Some circumstances in which a classical variables approach may be especially useful include

- Accounts receivable when a large number of unapplied credits exist.

- Inventory test counts and price tests where the auditor anticipates a significant number of audit differences.

- Conversion of inventory from FIFO to LIFO.

- Applications for which the objective is to estimate independently the value of a class of transactions or account balance.

Types of Classical Variables Sampling Techniques

There are three classical variables sampling methods discussed in this section: mean-per-unit, difference, and ratio.[22]

Mean-per-unit approach. When using this approach, the auditor estimates a total population value by calculating an average audited value for all items in the sample and multiplying that average value by the number of

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[22]Another approach, the regression approach, is similar to the difference and ratio approaches. This approach has the effect of using both the average ratio and the average difference in calculating an estimate of the total value for the population. Although the regression approach may be more efficient than the other approaches discussed in this section, the approach is very complex and is not discussed in detail in this section.

items comprising the population. For example, an auditor has selected 200 items from a population of 1,000 inventory items. After determining the correct purchase price and recalculating price-quantity extensions, the auditor determines the average audited value for items in the sample to be $980 by adding the audited values of the 200 sampling units and dividing by 200. The estimated inventory balance is then calculated as $980,000 ($980 X 1,000). The auditor also uses normal distribution theory to calculate an allowance for sampling risk based on the variability of the audited values in the sample.

Difference approach. When using this approach, the auditor calculates the average difference between audited values and book values of the sample items and projects that average difference to the population. For example, an auditor has examined 200 items from a population of 1,000 inventory items. The total book value for the population is $1,040,000. The auditor compares the audited value with the book value for each of the 200 sampling units and accumulates the difference between the book values ($208,000) and the audited values ($196,000) - in this case, $12,000. He divides the difference of $12,000 by the number of sample items (200) to yield an average difference of $60. He then multiplies the average difference by the number of items in the population to calculate a total difference between book and audited values of $60,000 ($60 X 1,000). Because the total book value of the sampling units is greater than the total audited value, the difference is subtracted from the total book value to obtain an estimate of the inventory balance of $980,000. The auditor also calculates an allowance for sampling risk using normal distribution theory based on the variability of the differences between book and audited values of the sampling units.

Ratio Approach. When using this approach, the auditor calculates the ratio between the sum of the audited values and the sum of the book values of the sample items and projects that ratio to the population. The auditor estimates the total population value by multiplying the total book value for the population by the aforementioned ratio. If the auditor had used the ratio approach in the previous example, the ratio of the sum of the sample's audited values to the sum of the sample's book values is .94 ($196,000/$208,000). The auditor would multiply the total book value for the population by this ratio to obtain an estimate of the inventory balance of $978,000 ($1,040,000 X .94). The auditor also would calculate an allowance for sampling risk using normal distribution theory based on the extent and magnitude of the differences.[23]

Special Considerations

Section 1 of this chapter provides the general considerations in using audit sampling for substantive tests. This section will describe additional factors the auditor should consider when using classical variables sampling for a substantive test. In general, these factors relate to the following considerations discussed in section 1:

[23]For further information, see Roberts, Statistical Auditing, p. 81.

Selecting a classical variables approach

Determining the sample size

- Considering variation within the population
- Calculating the sample size

Evaluating the sample results

Selecting a Classical Variables Approach

The auditor should consider the constraints of each of the classical variables approaches when selecting a classical variables sampling approach for a substantive test. They include

- The ability to design a stratified sample. As discussed in section one of this chapter, the auditor can reduce sample size by effectively stratifying a population. The mean-per-unit approach requires sample sizes for an unstratified population that may be too large to be cost-effective for ordinary audit applications. There are circumstances, however, when the auditor might not efficiently use a stratified sampling approach. Stratification might not significantly reduce sample size for the ratio or difference approach.

- The expected number of differences between audited and book values. Both the ratio and the difference approaches require that differences between audited and book values exist in the sample. If no differences exist between the audited and book values of the sample items, the mechanics of the formula underlying these methods would lead to the erroneous conclusion that the allowance for sampling risk is zero - that is, there is no sampling risk. That conclusion is naturally erroneous because sampling risk always exists unless the auditor examines all items comprising the population. There is some disagreement about how many differences are necessary to estimate the allowance for sampling risk for a sample using the ratio and difference approaches. The required minimum number of differences has been described as from twenty to fifty.[24] If the auditor expects to find only a few differences, he should consider alternative approaches, such as mean-per-unit or probability-proportional-to-size sampling.

- The available information. In addition to sample size, all the classical variables approaches require different information for the population or for each stratum if stratified sampling is used. To use the mean-per-unit approach, the auditor needs to know the total number of items in each stratum and an audited value for each sampling unit. Both the ratio and the difference approaches require an audited value and book value for each sampling unit. The book value may be developed from the entity's normal recordkeeping system (for example,

[24]For further information on this consideration, see Roberts, Statistical Auditing, pp. 84-85.

the inventory shown by the perpetual records), or it may be any value developed by the entity for each item in the population (for example, the entity's priced inventory). In both approaches the auditor needs to know the book value for the total population and the total number of items in the population.

In both the ratio and the difference methods, the auditor needs to obtain reasonable assurance that the entity has properly accumulated the book values of the items in the population. In the mean-per-unit method an estimation of the total population value will correct for accumulation errors, but not in the other two methods. This generally requires the auditor to perform a test independent of the sampling application. For example, the auditor can use a computer-assisted audit test to foot the book values of the items in the population. However, accumulation is a concept broader than footing; tests of accumulation also should include tests for duplication of sampling units, omission of sampling units, and other errors that may cause the actual total of all the sampling units to be different from the entity's total.

In some circumstances all of these constraints may be satisfied by any of the classical variables approaches. In such cases, many auditors prefer to use either a difference or a ratio approach because they are generally more efficient than the mean-per-unit approach. That is, the difference and ratio approaches generally require a smaller sample size to achieve the same results at the risk of incorrect acceptance and tolerable error specified by the auditor. The increased efficiency is a result of the auditor's ability to utilize more information about the population and the sampling units in making his evaluation.

Determining the Sample Size

The mathematical calculations necessary to design a classical variables sampling approach, including the calculation of an appropriate sample size, tend to be complex and difficult to apply manually. Because auditors usually use computer programs to assist them in determining appropriate sample sizes for classical variables sampling applications, auditors generally do not need to know mathematical formulas in order to use these methods.

Considering variation within the population.

Section one of this chapter discusses the effect of variation in the population on sample size. The sample size required for a classical variables sampling application increases as the variation becomes greater. In general, any change in the variation in the population *affects the sample size by the square of the relative change.* For example, the sample size (unstratified) for a given risk of incorrect acceptance, population size, tolerable error, and amount of variation in the population has been determined to be 100. If the amount of variation was twice the original amount, the sample size necessary to meet the auditor's objectives would increase by a multiple of four (in this case, a sample size of 400).

The auditor can reduce the effect of this variation by stratifying the population. For example, if an auditor designs an unstratified mean-per-unit sampling application, the appropriate sample size may be too large to be cost-effective for an ordinary audit application. Stratification can reduce the appropriate sample size.

The optimal number of strata depends on the circumstances. After a certain point, division of the population into additional strata has a diminishing effect on the variation within strata. The auditor should consider the additional costs of dividing the population into additional strata against the resulting reduction of the overall sample size.

Stratification can be performed on computerized records with the assistance of programs designed for such audit applications. Stratification can be more time consuming where the auditor must select his sample from manual records. In those circumstances, the auditor subjectively determines strata boundaries.

Some auditors believe it is generally not cost-effective to manually stratify a population into more than two or three strata. The auditor then estimates the variation for each stratum and, using the tolerable error and risk of incorrect acceptance for the population, calculates the sample size and allocates sampling units to each stratum.

Calculating the sample size

The auditor considers tolerable error and the risk of incorrect acceptance when determining sample size. Some auditors also find it practical to consider explicitly the risk of incorrect rejection. Some computer programs for classical variables sampling applications allow the auditor to specify those factors directly in calculating a sample size. Other computer programs do not allow the auditor to directly specify the tolerable error, the risk of incorrect acceptance, and the risk of incorrect rejection. Instead they ask the auditor to specify a confidence level and a desired precision (also referred to as desired allowance for sampling risk).

For the latter computer programs, the confidence level is the complement of the risk of incorrect rejection. For example, if the auditor wishes to specify a 20 percent risk of incorrect rejection, he enters an 80 percent confidence level into the computer program input.[25]

The auditor determines a desired allowance for sampling risk by relating the tolerable error and the risk of incorrect acceptance for a given level of the risk of incorrect rejection. The table in Appendix C illustrates the relationship of these factors in order to determine the appropriate desired allowance for sampling risk.

[25]The risk of incorrect rejection is usually measured for a particular hypothesis - for example, that the audited value is equal to the book value. Further discussion of this concept can be found in Roberts, Statistical Auditing, pp. 41-43.

For example, in planning a classical variables sampling application, the auditor may wish to specify a tolerable error of $10,000, a risk of incorrect acceptance of 5 percent, and a risk of incorrect rejection of 10 percent. If the computer program he is using asks him to specify a confidence level and a desired allowance for sampling risk, the auditor would specify a confidence level of 90 percent (the complement of the 10 percent risk of incorrect rejection), and he would determine the appropriate desired allowance for sampling risk using the table in Appendix C. The ratio of the desired allowance for sampling risk to tolerable error for a 5 percent risk of incorrect acceptance and a 10 percent risk of incorrect rejection is .500. The auditor calculates the desired allowance for sampling risk by multiplying that ratio by the tolerable error. In this case, the desired allowance for sampling risk is $5,000 ($10,000 X .500).

The size of the sample required to achieve the auditor's objective will be affected by changes in the auditor's desired allowance for sampling risk. The sample size required to achieve the auditor's objective at a given risk of incorrect rejection for a given population increases as the auditor specifies a smaller desired allowance for sampling risk. In general, any change in the desired allowance for sampling risk affects the sample size by the square of the relative change. For example, the sample size for a given desired allowance for sampling risk may be 100. If the desired allowance for sampling risk is reduced by one-half, the sample size would increase by a multiple of four to 400.

Evaluating the Sample Results

Each of the classical variables approaches to sampling provides the auditor with an estimated value of the account balance or class of transactions being examined. The difference between this estimated value and the entity's book value is the projected error. Each approach also provides the auditor with an allowance for sampling risk, often referred to as achieved precision.[26] Because of the complexities involved, many auditors use computer programs to calculate the estimated value of the population and the allowance for sampling risk when evaluating a classical variables sample.

According to SAS No. 39, the auditor should compare total projected error with tolerable error for the population and should give appropriate consideration to sampling risk. The comparison of projected error with tolerable error and the consideration of an appropriate allowance for sampling risk are generally considered in one decision rule when the auditor evaluates the results of a classical variables sample.

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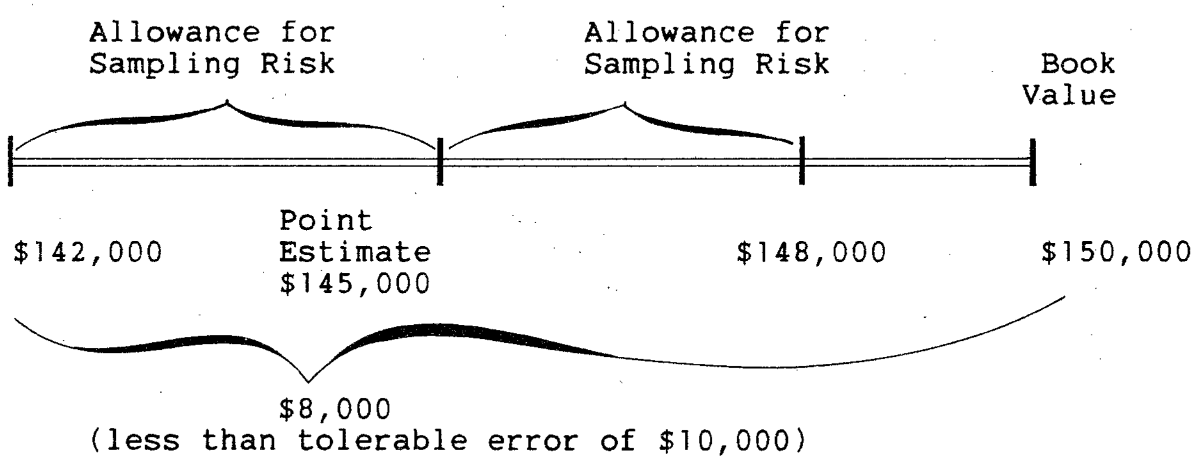
[26]Some computer programs for evaluating classical variables sampling applications provide the auditor with such measures of sampling risk as "sampling error" and "precision." See Roberts, Statistical Auditing, pp. 70 and 103, for a discussion of how these measures relate to an allowance for sampling risk.

That decision rule is to accept the book value of a population if the book value is within the range of the audit estimate of the population plus or minus an allowance for sampling risk no greater than the allowance specified in planning the sample. However, in some circumstances the book value may be outside that range but the auditor may still find the sample results to be acceptable. In general, if the difference between the book value and the far end of the range is less than tolerable error, the sample results would support the book value of the population.

For example, the sample results may have yielded an allowance for sampling risk smaller than the desired allowance for sampling risk specified by the auditor when he calculated the sample size. To illustrate: an auditor has calculated a sample size based on a 5 percent risk of incorrect acceptance and a 10 percent risk of incorrect rejection. The auditor has assessed tolerable error to be $10,000 for a population with a book value of $150,000 and has specified a desired allowance for sampling risk of $5,000. In evaluating the sample results, the auditor might determine that the audit estimate of the population on the basis of a classical variables sample, is $145,000, with an achieved allowance for sampling risk of $3,000. (That is, the audit estimate is $145,000 plus or minus $3,000.) Although the book value of $150,000 is outside the range of the audit estimate, the auditor may still find that the sample results support the book value because the difference between the $150,000 book value and the far end of the range, $142,000, is less than the tolerable error of $10,000.



Alternatively, the auditor might compare the sum of the projected error plus an allowance for sampling risk with tolerable error. In the example, the sum of projected error ($5,000) and an allowance for sampling risk ($3,000) is $8,000, which is less than the tolerable error of $10,000.

When deciding whether the sample results support the book value, the auditor needs to control the achieved risk of incorrect acceptance to an acceptable level. This may require recomputation of the initially computed allowance for sampling risk.[27]

Of course, the fact that the sample results support the assertion that the book value is not misstated by an amount greater than tolerable error does not preclude the auditor from proposing that the entity adjust the financial records for any errors identified by the audit sampling procedure.

If the difference between the book value and the far end of the range is greater than tolerable error, the sample results might have been obtained because

- The sample results yield an allowance for sampling risk larger than specified by the auditor because the sample size was too small
- The sample is not representative of the population
- The book value is misstated by an amount greater than tolerable error

In designing a classical variables sampling application, the auditor determined a sample size that he believed would be sufficient to allow him to expect that, when evaluating the sample results, the allowance for sampling risk when combined with expected error would be adequately limited. However, the sample results may not adequately limit the allowance for sampling risk if the variation of the characteristic of interest exceeds the estimate of the variation used by the auditor when he determined the sample size. The auditor using a computer program to perform a classical variables application generally can determine if this has occurred by comparing the standard deviation used to determine sample size with the standard deviation calculated as part of the evaluation of the sample results. If the standard deviation calculated when evaluating the sample results is greater than the standard deviation used to determine sample size, the allowance for sampling risk may not be adequately controlled. In the example, the audit estimate of the population, based on a classical variables sample, may be $145,000, with an allowance for sampling risk of $10,000 (that is, $145,000 plus or minus $10,000). Because the difference between the book value ($150,000) and the far end of the range ($135,000) is greater than tolerable error of $10,000, the sample results do not support acceptance of the book value.

If the allowance for sampling risk has not been adequately limited, the auditor can either:

- Examine additional randomly selected sampling units using a revised estimate of the variation in the population. The auditor should calculate the additional sample size so that the total number of sampling units in the additional sample combined with the original

[27]For further discussion, see Donald Roberts, <u>Statistical Auditing</u>, pages 43-44.

sample can be expected to adequately limit the allowance for sampling risk.

- Perform additional substantive tests, such as analytical review, directed toward the same audit objective. The additional reliance on other tests would allow the auditor to accept a greater risk of incorrect acceptance for the sampling application. Recalculating the allowance for sampling risk with the greater risk of incorrect acceptance will not change the point estimate of the population but it will move the ends of the range closer to that estimate.

The sample results also may not support acceptance of the book values because the sample is not representative of the population. Although the auditor selects a sample in such a way that the sample can be expected to be representative of the population, occasionally the sample might not be representative of the population. In some circumstances, the auditor may have reason to believe that the sample is not representative of the population. For example, (1) if the results of a mean-per-unit sample do not support the book value of the population even though no errors were found in the sample, or (2) if all the other related evidential matter contradicts the sample evidence, the auditor may suspect, among other possibilities, that the sample consists of items with unrepresentatively small or large values. In such situations, the auditor may examine additional sampling units or perform alternative procedures to assist him in determining whether the book value of the population is misstated.

If the sample results do not support the book value of the population and the auditor believes that the book value may be misstated, the auditor considers the error along with other audit evidence when evaluating whether the financial statements are materially misstated. The auditor ordinarily suggests that the entity investigate the errors and, if appropriate, adjust the book value. If the difference between the adjusted book value and the far end of the range is less than tolerable error, the sample results support the conclusion that the population, as adjusted, is not misstated by more than tolerable error.

In addition to evaluating the frequency and amounts of monetary misstatements, the auditor should consider the qualitative aspects of errors. These considerations are discussed in section one of this chapter.

<u>Classical Variables Sampling Case Study</u>

ABC Co., a distributor of household products, is audited by Smith, Stein, & Co., CPAs. Stein of Smith, Stein & Co. decided to design a classical variables statistical sample to test the pricing of ABC Co.'s inventory as part of the examination of ABC Co.'s June 30, 19X1 financial statements.

For the year ended June 30, 19X1, ABC Co.'s inventory had a book value of $3,257,892.50 and consisted of approximately 2,700 different items.

Stein decided that the results of her study and evaluation of ABC Co.'s internal accounting control procedures supported a moderate degree of reliance on the control procedures in determining the scope of substantive tests of the inventory balance. She also decided that a misstatement of $45,000 in the inventory balance would result in the financial statements being materially misstated.

Stein also decided to use a classical variables sampling approach because:

- on the basis of the prior year's audit, she expects that the account may contain both overstatements and understatements.
- the accounting records have been maintained on computer file, and she has computer software available for analyzing the accounting records and assisting her in designing and evaluating the sample.

Stein obtained reasonable assurance that inventory quantities were recorded properly through observation of ABC Co.'s physical inventory as of June 30, 19X1 and application of cutoff procedures. Stein also planned to perform some analytical review procedures on the inventory account to obtain further assurance that both the quantities and pricing were reasonable.

Although Stein expected to find some errors, she did not expect to find enough errors to use either a ratio or difference sampling approach. Stein decided to design a mean-per-unit statistical sample.

The approximately 2,700 items comprising ABC Co.'s inventory balance had a wide range of book values, from approximately $20 to $7,500. Stein decided to stratify the items comprising the balance in order to reduce the impact of the variation in book values on the determination of an appropriate sample size. Stein first identified nine items whose book values each exceeded $4,500. Those items were to be examined 100 percent and would not be included in the items subject to sampling.

Because Stein had decided that a misstatement of $45,000 in the inventory balance might result in the financial statements being materially misstated, tolerable error for the balance was $45,000.

Stein decided that a 30 percent risk of incorrect acceptance was appropriate for this test because of the moderately effective internal accounting controls related to inventory transactions and the moderate reliance she intended to place on other planned substantive tests related to the inventory account. In calculating the sample size, Stein also decided to specify a five percent risk of incorrect rejection to provide a sample size that would be large enough to tolerate some error.

Because ABC Co.'s inventory records were maintained on a computer file, Stein was able to use a computer program to assist her in stratifying the June 30, 19X1 inventory and in selecting an appropriate sample. The computer program, MPUSTRAT, divided the items subject to sampling into ten strata and calculated an appropriate sample size for each stratum (see figure 1). The overall sample size calculated by the program, based on the risk levels and tolerable error specified by Stein, was 209 (see figure 1). The total sample size of 209 was comprised of 200 items selected from the population subject to sampling and the 9 items examined 100 percent.

Stein tested the pricing of the 209 inventory items and identified six errors: five errors in the sample of 200 and one overstatement error in the items examined 100 percent.

Stein used another computer program to assist her in calculating a projected error and an allowance for sampling risk for the sample. That program, MPUEVAL, calculated a projected error for each stratum and then calculated a total projected error and allowance for sampling risk for the entire sample at the 30 percent risk of incorrect acceptance specified by Stein. (See figure 2.) The total projected error was $16,394.48 ($3,207,892.50 - $3,191,498.02).

Because the total projected error in the inventory balance of $16,394.48 ($14,394.48 projected from the population subject to sampling plus $2,000 of error identified in the items examined 100 percent) plus a $21,222.11 allowance for sampling risk (see figure 2) was less than the $45,000 tolerable error for the inventory balance, Stein concluded that the sample results supported ABC Co.'s inventory book value. However, Stein included the projected error from this sample results along with other relevant audit evidence when she evaluated whether the financial statements taken as a whole were materially misstated.

FIGURE 1

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ABC, CO. INVENTORIES JUNE 30, 19X1

SAMPLE SIZE REPORT

****

STRATUM NUMBER	STRATUM LOW RANGE	STRATUM HIGH RANGE	TOTAL ITEMS IN STRATUM	STANDARD DEVIATION	SAMPLE SIZE
1	0	236	409	65.06	21
2	237	450	420	62.38	21
3	451	663	390	62.23	19
4	664	911	356	68.65	19
5	912	1260	308	101.21	24
6	1261	1698	187	123.70	18
7	1699	2441	127	212.92	21
8	2442	3116	144	181.52	21
9	3117	3555	205	113.52	19
10	3556	4500	148	145.71	17
100%	4500	-	9	-	9

BOOK VALUE OF POPULATION	3207892.50
TOTAL SAMPLING UNITS IN POPULATION	2695
TOTAL SAMPLE SIZE	209

THE SAMPLE WAS CALCULATED BASED ON THE FOLLOWING SPECIFICATIONS:

TOLERABLE ERROR	45,000
RISK OF INCORRECT ACCEPTANCE	.30
RISK OF INCORRECT REJECTION	.05
LOWER 100% CUTOFF	0
UPPER 100% CUTOFF	4,500

FIGURE 2

****

ABC, CO.   INVENTORIES   JUNE 30, 19X1

SAMPLE EVALUATION REPORT

****

ERRORS LOCATED IN AUDIT

	BOOK VALUE	AUDIT VALUE
1	1250.00	850.00
2	200.00	360.00
3	600.00	240.00
4	510.00	650.00
5	320.00	319.00
6	7550.00	5550.00
TOTAL	10430.00	7469.00

VARIABLES TEST EVALUATION

BOOK VALUE OF 3207892.50 CAN BE ACCEPTED AS CORRECT, GIVEN THE TOLERABLE ERROR ORIGINALLY SPECIFIED, IF THE RISK OF INCORRECT ACCEPTANCE OF .30 FOR THIS TEST REMAINS APPROPRIATE AFTER CONSIDERING THE RESULTS OF OTHER AUDITING PROCEDURES.

ESTIMATED TOTAL VALUE	3191498.02
ALLOWANCE FOR SAMPLING RISK	21222.11
SAMPLING UNITS IN POPULATION	2695
SAMPLE SIZE	209
TOLERABLE ERROR	45000.00
RISK OF INCORRECT ACCEPTANCE	.30
RISK OF INCORRECT REJECTION	.05

****

APPENDIX A

STATISTICAL SAMPLING TABLES FOR COMPLIANCE TESTS

This appendix includes four tables to assist the auditor in planning and evaluating a statistical sample of a fixed size for a compliance test.[28] They are:

Table 1 - Calculation of sample size with 5 percent risk of overreliance

Table 2 - Calculation of sample size with 10 percent risk of overreliance

Table 3 - Sample evaluation for 5 percent risk of overreliance

Table 4 - Sample evaluation for 10 percent risk of overreliance

Using the Tables

Chapter 2 discusses the factors that the auditor needs to consider when planning an audit sampling application for a compliance test. For statistical sampling, the auditor needs to explicitly specify an acceptable level of the risk of overreliance on internal accounting control, the tolerable rate, and the expected population deviation rate. This appendix only includes tables for 5 percent and 10 percent acceptable levels of risk of overreliance. If the auditor wishes to accept another level of risk of overreliance, he will need to use either a table in another reference on statistical sampling or a computer program.

The auditor selects the table for his acceptable level of risk of overreliance. He then reads down the expected population deviation rate column to find the appropriate rate. Next, the auditor locates the column corresponding to the tolerable rate. The appropriate sample size is shown in the box where the two factors meet.

In some circumstances, tables 1 and 2 can be used to evaluate the sample results. The parenthetical number shown in each sample size box is the expected number of deviations to be found in the sample. The expected number of deviations is the expected population deviation rate multiplied by the sample size. If the auditor finds exactly that number of errors, or fewer, in the sample, he can conclude that, at the desired risk of overreliance, the projected deviation rate for the population

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[28]Auditors using a sequential sampling plan should not use these tables for designing or evaluating the sampling application. See the discussion of sequential sampling in Appendix B.

plus an allowance for sampling risk, is not more than the tolerable rate. In those circumstances, the auditor need not use table 3 or 4 to evaluate his sample results.

If more than the expected number of deviations are found in the sample, the auditor cannot conclude that the population deviation rate is less than the tolerable rate. Accordingly, the test would not support his planned reliance on internal accounting control.

If the number of deviations found in the sample is not the expected number of deviations shown in parentheses in tables 1 or 2 and the auditor wishes to calculate the maximum deviation rate in the population, he can evaluate the sample results using either table 3 for a 5 percent acceptable risk of overreliance or table 4 for a 10 percent acceptable risk of overreliance. Space limitations do not allow tables 3 and 4 to include evaluations for all possible sample sizes and number of deviations. If the auditor is evaluating sample results for a sample size or number of deviations not shown in these tables, he can use either a table in another reference on statistical sampling or a computer program. Alternatively, the auditor may interpolate between sample sizes shown in these tables. Any error due to interpolation should not be significant to the auditor's evaluation. If the auditor wishes to be conservative, he can evaluate the number of deviations found in the sample using the next lower sample size shown in the table.

The auditor selects the table for his acceptable level of risk of overreliance. He then reads down the sample size column to find the appropriate sample size. Next the auditor locates the column corresponding to the number of deviations found in the sample. The projection of the sample results to the population plus an allowance for sampling risk (that is, the maximum population deviation rate) is shown in the box where the two factors meet. If this maximum population deviation rate is less than the tolerable rate, the test supports the planned reliance on internal accounting control.

How the Tables Might be Useful in Applying Nonstatistical Sampling

The auditor using nonstatistical sampling for compliance testing uses his professional judgment to consider the factors described in chapter 2 of this guide in considering sample sizes. The relative effect of each factor on the appropriate nonstatistical sample size is illustrated in chapter 2 and is summarized below.

Factor	General effect on sample size
Tolerable rate increase (decrease)	Smaller (larger)
Risk of overreliance on internal Accounting controls increase (decrease)	Smaller (larger)
Expected population deviation rate increase (decrease)	Larger (smaller)
Population size	Virtually no affect

Neither SAS No. 39 nor this guide requires the auditor to compare the sample size for a nonstatistical sampling application with a corresponding sample size calculated using statistical theory. However, in applying professional judgment to determine an appropriate nonstatistical sample size for a compliance test, an auditor might find it helpful to be familiar with the tables in this appendix. The auditor using these tables to assist him in gaining an understanding of the relative size for sample sizes for compliance tests will need to apply professional judgment in reviewing the risk levels and expected population deviation rates in relation to sample sizes.

For example, an auditor is designing a nonstatistical sampling application to test compliance with a prescribed control procedure. The auditor has assessed the tolerable rate as 8 percent. If the auditor were to consider selecting a sample size of sixty, these tables would imply that at approximately a 5 percent risk level the auditor expected no more than approximately 1.5 percent of the items in the population to be deviations from the prescribed control procedure. These tables also would imply that at approximately a 10 percent risk level the auditor expected no more than approximately 3 percent of the items in the population to be deviations.

TABLE 1

STATISTICAL SAMPLE SIZES FOR COMPLIANCE TESTING
5% RISK OF OVERRELIANCE
(with number of expected errors in parenthesis)

Expected Population Deviation Rate	at Tolerable Rate 2%	3%	4%	5%	6%	7%	8%	9%	10%	15%	20%
0.00%	149(0)	99(0)	74(0)	59(0)	49(0)	42(0)	36(0)	32(0)	29(0)	19(0)	14(0)
.25	236(1)	157(1)	117(1)	93(1)	78(1)	66(1)	58(1)	51(1)	46(1)	30(1)	22(1)
.5	*	157(1)	117(1)	93(1)	78(1)	66(1)	58(1)	51(1)	46(1)	30(1)	22(1)
.75	*	208(2)	117(1)	93(1)	78(1)	66(1)	58(1)	51(1)	46(1)	30(1)	22(1)
1.00	*	*	156(2)	93(1)	78(1)	66(1)	58(1)	51(1)	46(1)	30(1)	22(1)
1.25	*	*	156(2)	124(2)	78(1)	66(1)	58(1)	51(1)	46(1)	30(1)	22(1)
1.50	*	*	192(3)	124(2)	103(2)	66(1)	58(1)	51(1)	46(1)	30(1)	22(1)
1.75	*	*	227(4)	153(3)	103(2)	88(2)	77(2)	51(1)	46(1)	30(1)	22(1)
2.00	*	*	*	181(4)	127(3)	88(2)	77(2)	68(2)	46(1)	30(1)	22(1)
2.25	*	*	*	208(5)	127(3)	88(2)	77(2)	68(2)	61(2)	30(1)	22(1)
2.50	*	*	*	*	150(4)	109(3)	77(2)	68(2)	61(2)	30(1)	22(1)
2.75	*	*	*	*	173(5)	109(3)	95(3)	68(2)	61(2)	30(1)	22(1)
3.00	*	*	*	*	195(6)	129(4)	95(3)	84(3)	61(2)	30(1)	22(1)
3.25	*	*	*	*	*	148(5)	112(4)	84(3)	61(2)	30(1)	22(1)
3.50	*	*	*	*	*	167(6)	112(4)	84(3)	76(3)	40(2)	22(1)
3.75	*	*	*	*	*	185(7)	129(5)	100(4)	76(3)	40(2)	22(1)
4.00	*	*	*	*	*	*	146(6)	100(4)	89(4)	40(2)	22(1)
5.00	*	*	*	*	*	*	*	158(8)	116(6)	40(2)	30(2)
6.00	*	*	*	*	*	*	*	*	179(11)	50(3)	30(2)
7.00	*	*	*	*	*	*	*	*	*	68(5)	37(3)

*Sample size is too large to be cost/effective for most audit applications.

NOTE: This table assumes a large population. For a discussion of the effect of population size on sample size, see Chapter 2.

TABLE 2

STATISTICAL SAMPLE SIZES FOR COMPLIANCE TESTING
10% RISK OF OVERRELIANCE
(with number of expected errors in parenthesis)

Expected Population Deviation Rate	at Tolerable Rate 2%	3%	4%	5%	6%	7%	8%	9%	10%	15%	20%
0.00%	114(0)	76(0)	57(0)	45(0)	38(0)	32(0)	28(0)	25(0)	22(0)	15(0)	11(0)
.25	194(1)	129(1)	96(1)	77(1)	64(1)	55(1)	48(1)	42(1)	38(1)	25(1)	18(1)
.5	194(1)	129(1)	96(1)	77(1)	64(1)	55(1)	48(1)	42(1)	38(1)	25(1)	18(1)
.75	265(2)	129(1)	96(1)	77(1)	64(1)	55(1)	48(1)	42(1)	38(1)	25(1)	18(1)
1.0	*	176(2)	96(1)	77(1)	64(1)	55(1)	48(1)	42(1)	38(1)	25(1)	18(1)
1.25	*	221(3)	132(2)	77(1)	64(1)	55(1)	48(1)	42(1)	38(1)	25(1)	18(1)
1.50	*	*	132(2)	105(2)	64(1)	55(1)	48(1)	42(1)	38(1)	25(1)	18(1)
1.75	*	*	166(3)	105(2)	88(2)	55(1)	48(1)	42(1)	38(1)	25(1)	18(1)
2.00	*	*	198(4)	132(3)	88(2)	75(2)	48(1)	42(1)	38(1)	25(1)	18(1)
2.25	*	*	*	132(3)	88(2)	75(2)	65(2)	42(1)	38(1)	25(1)	18(1)
2.50	*	*	*	158(4)	110(3)	75(2)	65(2)	58(2)	38(1)	25(1)	18(1)
2.75	*	*	*	209(6)	132(4)	94(3)	65(2)	58(2)	52(2)	25(1)	18(1)
3.00	*	*	*	*	132(4)	94(3)	65(2)	58(2)	52(2)	25(1)	18(1)
3.25	*	*	*	*	153(5)	113(4)	82(3)	58(2)	52(2)	25(1)	18(1)
3.50	*	*	*	*	194(7)	113(4)	82(3)	73(3)	52(2)	25(1)	18(1)
3.75	*	*	*	*	*	131(5)	98(4)	73(3)	52(2)	25(1)	18(1)
4.00	*	*	*	*	*	149(6)	98(4)	73(3)	65(3)	25(1)	18(1)
4.50	*	*	*	*	*	218(10)	130(6)	87(4)	65(3)	34(2)	18(1)
5.00	*	*	*	*	*	*	160(8)	115(6)	78(4)	34(2)	18(1)
5.50	*	*	*	*	*	*	*	142(8)	103(6)	34(2)	18(1)
6.00	*	*	*	*	*	*	*	182(11)	116(7)	45(3)	25(2)
7.00	*	*	*	*	*	*	*	*	199(14)	52(4)	25(2)
7.50	*	*	*	*	*	*	*	*	*	52(4)	25(2)
8.00	*	*	*	*	*	*	*	*	*	60(5)	25(2)
8.50	*	*	*	*	*	*	*	*	*	68(6)	32(3)

*Sample size is too large to be cost/effective for most audit applications.

NOTE: This table assumes a large population. For a discussion of the effect of population on sample size, see Chapter 2.

TABLE 3

STATISTICAL SAMPLE RESULTS EVALUATION TABLE FOR COMPLIANCE TESTS 5% RISK OF OVERRELIANCE

Sample Size	Actual Number Of Deviations Found										
	0	1	2	3	4	5	6	7	8	9	10
25	11.3	17.6	*	*	*	*	*	*	*	*	*
30	9.5	14.9	19.5	*	*	*	*	*	*	*	*
35	8.2	12.9	16.9	*	*	*	*	*	*	*	*
40	7.2	11.3	14.9	18.3	*	*	*	*	*	*	*
45	6.4	10.1	13.3	16.3	19.2	*	*	*	*	*	*
50	5.8	9.1	12.1	14.8	17.4	19.9	*	*	*	*	*
55	5.3	8.3	11.0	13.5	15.9	18.1	*	*	*	*	*
60	4.9	7.7	10.1	12.4	14.6	16.7	18.8	*	*	*	*
65	4.5	7.1	9.4	11.5	13.5	15.5	17.4	19.3	*	*	*
70	4.2	6.6	8.7	10.7	12.6	14.4	16.2	18.0	19.7	*	*
75	3.9	6.2	8.2	10.0	11.8	13.5	15.2	16.9	18.4	20.0	*
80	3.7	5.8	7.7	9.4	11.1	12.7	14.3	15.8	17.3	18.8	*
90	3.3	5.2	6.8	8.4	9.9	11.3	12.7	14.1	15.5	16.8	18.1
100	3.0	4.7	6.2	7.6	8.9	10.2	11.5	12.7	14.0	15.2	16.4
125	2.4	3.7	4.9	6.1	7.2	8.2	9.3	10.3	11.3	12.2	13.2
150	2.0	3.1	4.1	5.1	6.0	6.9	7.7	8.6	9.4	10.2	11.0
200	1.5	2.3	3.1	3.8	4.5	5.2	5.8	6.5	7.1	7.7	8.3

*Over 20%

NOTE: This table presents upper limits as percentages. The table assumes a large population.

TABLE 4

STATISTICAL SAMPLING RESULTS EVALUATION
TABLE FOR COMPLIANCE TESTS
10% RISK OF OVERRELIANCE

Sample Size	Actual Number Of Deviations Found: 0	1	2	3	4	5	6	7	8	9	10
20	10.9	18.1	*	*	*	*	*	*	*	*	*
25	8.8	14.7	19.9	*	*	*	*	*	*	*	*
30	7.4	12.4	16.8	*	*	*	*	*	*	*	*
35	6.4	10.7	14.5	18.1	*	*	*	*	*	*	*
40	5.6	9.4	12.8	15.9	19.0	*	*	*	*	*	*
45	5.0	8.4	11.4	14.2	17.0	19.6	*	*	*	*	*
50	4.5	7.6	10.3	12.9	15.4	17.8	*	*	*	*	*
55	4.1	6.9	9.4	11.7	14.0	16.2	18.4	*	*	*	*
60	3.8	6.3	8.6	10.8	12.9	14.9	16.9	18.8	*	*	*
70	3.2	5.4	7.4	9.3	11.1	12.8	14.6	16.2	17.9	19.5	*
80	2.8	4.8	6.5	8.3	9.7	11.3	12.8	14.3	15.7	17.2	18.6
90	2.5	4.3	5.8	7.3	8.7	10.1	11.4	12.7	14.0	15.3	16.6
100	2.3	3.8	5.2	6.6	7.8	9.1	10.3	11.5	12.7	13.8	15.0
120	1.9	3.2	4.4	5.5	6.6	7.6	8.6	9.6	10.6	11.6	12.5
160	1.4	2.4	3.3	4.1	4.9	5.7	6.5	7.2	8.0	8.7	9.5
200	1.1	1.9	2.6	3.3	4.0	4.6	5.2	5.8	6.4	7.0	7.6

* Over 20%.

NOTE: This table presents upper error limits as percentages. The table assumes a large population.

APPENDIX B

SEQUENTIAL SAMPLING FOR COMPLIANCE TESTS[29]

The auditor designs samples for compliance tests using either a fixed sampling plan or a sequential sampling plan. Under a fixed sampling plan, the auditor examines a single sample of a specified size; under a sequential sampling plan, the sample is selected in several steps, with each step conditional on the results of the previous steps. The auditor decides whether to use a fixed or a sequential sampling plan depending on which plan he believes will be most efficient in the circumstances.

If, based on his understanding of the entity's operations and prior year's test, the auditor expects a low or a zero deviation rate from the prescribed internal accounting control procedure, he may find it efficient to use a fixed sampling plan. Under the fixed sampling plan, the auditor determines a single sample size for the compliance test by specifying that low or zero expected population deviation rate. If the actual population deviation rate is low and the auditor specifies a low or zero expected population deviation rate, the required sample size will be the minimum appropriate sample size for a given tolerable rate and risk of overreliance on internal accounting control.

In planning a fixed sampling application, the auditor should consider, however, that, if the number of errors in the minimal sample exceeds the specified expected population deviation rate, the sample results would suggest that the estimated populaton deviation rate, plus an allowance for sampling risk, exceeds the tolerable rate. In that case, the sample results would not support the auditor's planned reliance on the internal accounting control. These results may be obtained even though the actual population deviation rate would support the auditor's planned reliance because the minimal sample size is too small to adequately limit the allowance for sampling risk.

The auditor can use a sequential sampling plan to help overcome this limitation of a fixed sampling plan. A sequential sample generally consists of two to four groups of sampling units. The auditor determines the sizes of the individual groups of sampling units on the basis of his specified risk of overreliance on internal accounting control, the tolerable rate, and the expected population deviation rate. The auditor generally uses a computer program or tables for sequential sampling plans to assist him in determining the appropriate size for each group of sampling units. The auditor examines the first group of sampling units and, on the basis of the results, decides whether (a) to rely on the internal accounting control as planned without examining additional sampling units, (b) to reduce the planned reliance on the internal accounting control without examining additional sampling units, or (c) to examine additional sampling units because he has not obtained

[29]A more thorough discussion of designing a sequential sample can be found on pp. 57-60 of Donald Roberts, Statistical Auditing.

sufficient information to determine whether planned reliance is warranted.

Example of a Four-step Sequential Sampling Plan

The following table illustrates the number of sampling units for each group of a four-step sequential sampling plan based on a tolerable rate of 5 percent, a risk of overreliance on internal accounting control of 10 percent, and an expected population deviation rate of .5 percent.

			Accumulated Errors		
Group	No. of Sampling Units	Accumulated Sample Size	Accept Planned Reliance	Sample More	Reduce Planned Reliance
1	50	50	0	1-3	4
2	51	101	1	2-3	4
3	51	152	2	3	4
4	51	203	3	N/A	4

In this example if the auditor finds four deviations, the examination of sampling units stops, and planned reliance on the internal accounting control is reduced. If no deviations are found in the first group of fifty sampling units, the auditor evaluates the sample as supporting the planned reliance without examining more sampling units. If one, two or three deviations exist in the first group of sampling units, the auditor examines additional sampling units in the next group(s). The auditor continues to examine sampling units in succeeding groups until the sample results either support or do not support the planned reliance. For example, if three deviations exist in the first group, the next three groups of sampling units must be examined without finding additional deviations in order to support the planned reliance on the internal accounting control.

Comparison of Sequential Sample Sizes With Fixed-Plan Sizes

Sample sizes under fixed sampling plans are larger, on the average, than those under sequential sampling plans if the auditor overstates the expected population deviation rate. For example, if the population deviation rate is .5 percent the four-stage sequential sampling plan just illustrated generally would require the auditor to examine fewer sampling units to support his planned reliance than a fixed sampling plan would require. Under a fixed sampling plan, a sample size of 77 is sufficient to support the planned reliance when the population deviation rate is .5 percent (see table 2 in Appendix A). Under the sequential sampling plan, the auditor examines 50, 101, 152, or 203 items. However, the auditor considers the long-run average sample size when deciding whether to use a fixed or a sequential sampling approach. If the true population deviation rate is .5 percent, the auditor may need to examine an average of 65 sampling units under the four-stage sequential sampling plan as compared with 77 sampling units under the fixed sampling plan.

As discussed earlier, a sequential sampling plan provides the auditor with an opportunity to design a sample with a minimum size in anticipation of a low population deviation rate. However, an auditor may find that the audit effort of examining the total number of sampling units for all four steps of a sequential sampling plan would exceed the reduction of substantive testing that could be achieved by reliance on internal accounting control. Therefore, some auditors decide to stop a four-step sequential sampling plan before completing all four steps. For example, an auditor using the four-stage plan illustrated above may decide to stop examining sampling units, if he finds two or three deviations in the second group. In that case, he may have decided that the resulting reduction in substantive testing may not justify the additional audit effort of examining up to 102 additional sampling units.

If the auditor believes that he would not find it practical to examine the total number of sampling units for all stages of a four-stage sequential sampling plan, he could design a sequential sampling plan with fewer than four stages. For example, some auditors find it practical to design two-stage sequential sampling plans.

Sequential sampling plans are generally designed for statistical sampling applications. However, by using the same tables or computer program to determine the sample size, it may be possible to design a nonstatistical sequential sampling plan.

APPENDIX C

RATIO OF DESIRED ALLOWANCE FOR SAMPLING RISK TO TOLERABLE ERROR

Risk of Incorrect Acceptance	Risk of Incorrect Rejection .20	.10	.05	.01
.01	.355	.413	.457	.525
.025	.395	.456	.500	.568
.05	.437	.500	.543	.609
.075	.471	.532	.576	.641
.10	.500	.561	.605	.668
.15	.511	.612	.653	.712
.20	.603	.661	.700	.753
.25	.653	.708	.742	.791
.30	.707	.756	.787	.829
.35	.766	.808	.834	.868
.40	.831	.863	.883	.908
.45	.907	.926	.937	.952
.50	1.000	1.000	1.000	1.000

This table is derived from Donald Roberts, Statistical Auditing (New York: AICPA, 1978), and is used in connection with the classical variables sampling guidance in chapter 3, section 4, "Calculating the Sample Size." For further information on the hypotheses underlying this measure of the risk of incorrect rejection, see Roberts pages 41 to 43.

APPENDIX D

PROBABILITY-PROPORTIONAL-TO-SIZE SAMPLING TABLES

TABLE 1 - RELIABILITY FACTORS FOR ERRORS OF OVERSTATEMENT

Number of Over-statement Errors	Risk of Incorrect Acceptance								
	1%	5%	10%	15%	20%	25%	30%	37%	50%
0	4.61	3.00	2.30	1.90	1.61	1.39	1.20	1.00	.69
1	6.64	4.74	3.89	3.37	2.99	2.69	2.44	2.15	1.69
2	8.41	6.30	5.32	4.72	4.28	3.92	3.62	3.27	2.69
3	10.05	7.75	6.68	6.01	5.52	5.11	4.76	4.37	3.69
4	11.60	9.15	7.99	7.27	6.72	6.27	5.89	5.46	4.69
5	13.11	10.51	9.27	8.49	7.91	7.42	7.01	6.54	5.69
6	14.57	11.84	10.53	9.70	9.08	8.56	8.11	7.61	6.69
7	16.00	13.15	11.77	10.90	10.23	9.68	9.21	8.68	7.69
8	17.40	14.43	12.99	12.08	11.38	10.80	10.30	9.74	8.69
9	18.78	15.71	14.21	13.25	12.52	11.91	11.39	10.80	9.69
10	20.14	16.96	15.41	14.41	13.65	13.02	12.47	11.86	10.69
11	21.49	18.21	16.60	15.57	14.78	14.12	13.55	12.91	11.69
12	22.82	19.44	17.78	16.71	15.90	15.22	14.62	13.96	12.69
13	24.14	20.67	18.96	17.86	17.01	16.31	15.70	15.01	13.69
14	25.45	21.89	20.13	19.00	18.13	17.40	16.77	16.06	14.69
15	26.74	23.10	21.29	20.13	19.23	18.49	17.83	17.11	15.69
16	28.03	24.30	22.45	21.26	20.34	19.57	18.90	18.16	16.69
17	29.31	25.50	23.61	22.38	21.44	20.65	19.96	19.21	17.69
18	30.58	26.69	24.76	23.50	22.54	21.73	21.02	20.26	18.69
19	31.85	27.88	25.90	24.62	23.63	22.81	22.08	21.31	19.69
20	33.10	29.06	27.05	25.74	24.73	23.88	23.14	22.35	20.69

TABLE 2 - EXPANSION FACTORS FOR EXPECTED ERRORS

	Risk of Incorrect Acceptance								
	1%	5%	10%	15%	20%	25%	30%	37%	50%
Factor	1.9	1.6	1.5	1.4	1.3	1.25	1.2	1.15	1.0

APPENDIX E

COMPUTERIZED METHODS FOR STATISTICAL SAMPLING

Many tools have been developed to assist the auditor in performing sampling applications without the use of complex formulas. For example, tables to determine sample sizes and to evaluate sample results are available in many books on auditing applications of statistical sampling. While tables may be convenient reference tools, they have several limitations. In general, tables are difficult to use for certain variables sampling applications. For example, classical variables sampling by strata requires the calculation of a standard deviation by strata. Also, tables generally are limited to a small number of factors, such as risk levels and sample sizes.

Computer programs have been developed to assist the auditor in planning and evaluating sampling procedures. These programs overcome the limitations of tables and perform calculations, such as a standard deviation computation, that are difficult and time consuming to perform manually.

Computer programs are flexible. For example, they can calculate sample sizes for different sampling techniques. They can help the auditor select a random sample. They can evaluate samples covering single or multiple locations and can offer many more options for the auditor's planning considerations. These programs generally have built-in controls over human errors. For example, programs can be designed to include controls to identify unreasonable input.

The printed output is generally written in nontechnical language that can be easily understood by an auditor. The printout can be included in the auditor's workpapers as documentation of the sampling procedure.

Timesharing Programs

Individual timesharing applications for a statistical sampling procedure are relatively inexpensive. An auditor who decides to use computer timesharing in performing statistical sampling may need to pay a small minimum monthly fee to receive a confidential user code and password to access a vendor's library of statistical sampling programs.

Timesharing programs are available from a variety of sources, including vendors who make their programs available to all auditors. In selecting a timesharing program, the auditor should obtain reasonable assurance that the program is suitable for his needs. The following considerations may assist the auditor in making that determination.

Consideration: Are the assumptions used in developing the program appropriate and has it been properly tested under a variety of circumstances?

Comment: Programs offered by timesharing vendors generally are developed by the vendors, by third parties for the vendor, or by CPA firms. In most circumstances, more than one statistical theory may be acceptable for use in developing programs. The auditor should inquire which theory was used in order to determine whether that theory is appropriate for his specific purpose.

The extent of a vendor's testing of its programs varies significantly. It is important for the auditor to determine the extent of such tests before using the programs. For example, the auditor should inquire whether the programs were tested with data that an auditor may encounter both in usual and in rare, but possible, circumstances.

The auditor should also consider making inquiries about the business reputation of the vendor and the qualifications of the program developer. Vendors have significant differences in philosophies about their responsibility to the user of their programs. The extent to which the vendor is willing to assume responsibility for his programs may indicate the degree to which he believes the programs are suitable for an auditor's purpose.

Consideration: What controls are included in the program?

Comment: Statistical sampling software should contain basic control features that, for example, reject negative numbers where inapplicable or alert the auditor to inappropriately high risk levels or tolerable rates. The auditor should also inquire whether documentation of the controls is available for his review. The software also should contain prompts to lead an auditor who is new to statistical sampling through the various input requirements and alternatives.

Consideration: What services does the vendor provide?

Comment: A clear and comprehensive user manual should accompany each program. The auditor also should consider if the availability of programs will meet his needs based on his work hours and the location of his offices. For example, some vendors make their programs available twenty-four hours a day. The auditor should consider the amount of technical support available from the vendor when programs are used.

Consideration: Can the programs be understood easily by auditors?

Comment: Many timesharing vendors provide simple operating instructions designed to meet the needs of the auditor. The program instructions should indicate the program's capabilities. The amount of required input should be minimal and free of complex, special codes. The printout reports should be concise and readily understandable to the auditor.

Batch Programs

Batch programs are especially useful where the company's records are in computer-readable form and the auditor wishes to perform other procedures along with the statistical procedures. For example, the auditor may wish to print confirmation requests at the same time he selects a sample of items to be confirmed using a random selection technique. Many batch processing computer-assisted auditing packages contain routines for statistical sampling to allow for this flexibility.

Batch programs can be purchased, leased, or internally developed and are usually stored on computer cards or magnetic tape. Instruction manuals which describe the program, its use, and the output to be produced generally accompany purchased or leased programs.

Auditors often find it practical to use batch programs on the company's computer system. In circumstances in which the auditor does not believe this is practical, he may decide to use his own computer or a service bureau computer system to process the batch programs.

The use of batch programs generally requires the preparation of a description of the input data file and parameter cards. The file description is needed to instruct the program where data are located. The parameter cards are used to relay instructions to the program and instruct the program how to process data or what statistical routine to execute.

In order to execute the program, the user needs only to combine the file description and parameters with the program and to process with the appropriate data file.

Many of the criteria used in selection of a timesharing program described above apply to selection of a batch program.

APPENDIX F

A MODEL FOR RELATING THE RISK COMPONENTS OF AN AUDIT

The appendix to SAS No. 39, Audit Sampling, provides a model expressing the general relationship of ultimate risk to the extent of reliance the auditor places on a substantive test of details, internal accounting control, and other substantive tests, such as analytical review procedures, directed toward the same specific audit objective. The model is not intended to be a mathematical formula including all factors that may influence the determination of individual risk components. However, some auditors find such a model to be useful.

That model is UR = IC X AR X TD. The model can be restated to assist the auditor in determining an acceptable level of risk of incorrect acceptance (TD) when he has determined the level of ultimate risk he is willing to accept (UR) and has decided on the extent of reliance he can place on internal accounting control (IC) and other substantive tests directed toward the same specific audit objective (AR). The revised model is TD = UR/(IC + AR). To use this model, the auditor selects an acceptable ultimate risk (UR) and subjectively quantifies the judgment risks IC and AR.

UR is the allowable ultimate risk that monetary errors greater than tolerable error might remain undetected in the account balance or class of transactions after the auditor has completed all audit procedures deemed necessary.

For purposes of this model, the nonsampling risk aspect of ultimate risk is assumed to be negligible. This is usually a reasonable assumption in light of the typical level of supervision on an audit and the quality control policies and procedures applicable to audit practice.

IC is the auditor's assessment of the risk that, given that errors greater than tolerable error have occurred, the system of internal accounting control would fail to detect them. By evaluating the system and testing compliance with the control procedures, the auditor would assign this risk for control procedures on which he intends to rely in establishing the scope of the substantive test of details.

The quantification of internal accounting control effectiveness necessarily requires professional judgment. That same judgment is used when the auditor implicitly evaluates the effectiveness of internal accounting control on which he plans to rely in reducing the extent of a substantive test, whether sampling is used or not. Some auditors find a guide, such as the one that follows, to be useful in making an explicit judgment for the purpose of this model about the effectiveness of internal accounting controls related to a specific account balance or class of transactions.

Subjective Evaluation	Risk of Undetected Error Due to Internal Accounting Control Failure (IC)
Substantial reliance is warranted	10% - 30%
Moderate reliance is warranted	20% - 70%
Limited or no reliance is warranted	60% - 100%

The quantification of the effectiveness of internal accounting control for purposes of this model should not be confused with any levels of risk of overreliance on internal accounting control that the auditor accepted for compliance testing. That acceptable level of risk was an indication of how sure the auditor could feel that an individual sample provided him with correct information about the population. However, the quantification for this model relates to the auditor's evaluation of the overall effectiveness of one or more related internal accounting controls. For example, an auditor may have accepted a 10 percent risk of overreliance on internal accounting control in performing sampling applications for each compliance test of three internal accounting controls related to a particular account balance. The overall evaluation of the three samples may lead the auditor to conclude that he can place moderate reliance on internal accounting control in performing substantive tests of that account balance. He may therefore subjectively decide to quantify the risk of undetected error due to internal accounting control failure as 40 percent.

AR is the auditor's assessment of the risk that analytical review procedures and other relevant auditing procedures would fail to detect errors greater than tolerable error, given that such errors have occurred and were not detected by the system of internal accounting control. Some auditors find a guide, such as the one that follows, to be useful in making an explicit judgment for the purpose of this model about the effectiveness of analytical review procedures and other substantive tests of details directed toward the same account balance or class of transactions.

Subjective Evaluation	Risk of Undetected Error Due to Analytical Review Procedures Failure (AR)
Very effective	10% - 40%
Moderately effective	30% - 60%
Marginally effective or ineffective	50% - 100%

<u>Illustration of use of the model</u>: Although the model is not intended to be used as a mathematical formula, the auditor may find it helpful when

he relates his subjective evaluations of the factors in the model. For example, if the auditor is planning a sampling application to test an entity's accounts receivable balance, he may subjectively quantify the risk of undetected error due to internal accounting control failure as 30 percent and the risk of undetected error due to analytical review failure as 80 percent. The auditor may also have decided that he will accept a 5 percent level of ultimate risk. He might then use the model to gain some understanding of what level of risk of incorrect acceptance may be appropriate for the sampling application being designed.

TD = UR/(IC X AR)

TD = .05/(.30 X .80)

TD = .21

The auditor using this model must be cautioned that the resulting quantification of the risk of incorrect acceptance is only a general indication of appropriate acceptable level relative to other alternative planning considerations. For example, the auditor may compare the above results with an alternative approach that would include an additional analytical review procedure. He may decide that the combination of analytical review procedures and other related substantive tests in this case should result in a 60 percent risk of undetected error due to analytical review failure. Use of the model would suggest that the acceptable level of risk of incorrect acceptance under the alternative planning considerations would be approxiately 27 percent. The auditor would then decide if the additional analytical review procedure is warranted by the resulting reduction in sample size for the planned substantive test.

The following table illustrates some allowable risks of incorrect acceptance (TD) for various assessments of IC and AR when UR = .05.

Allowable Risk of Incorrect Acceptance (TD) for Various Assessments of IC and AR for UR = .05

Auditor's subjective assessment of risk that internal accounting control might fail to detect aggregate errors greater than tolerable error	Auditor's subjective assessment of risk that analytical review procedures and other relevant substantive tests might fail to detect aggregate errors greater than tolerable error.			
	AR			
IC	10%	30%	50%	100%
	TD			
10%	•	•	•	50%
30%	•	55%	33%	16%
50%	•	33%	20%	10%
100%	50%	16%	10%	5%

- The allowable level of UR of 5 percent equals or exceeds the product of IC and AR, and, thus, the planned substantive test of details may not be necessary.

Note: Table entries for TD are computed from the illustrative model; TD equals UR/ (IC X AR). For example, for IC = .50 and AR = .30, TD = .05/ (.50 X .30) or .33 (equals 33%).

APPENDIX G

GLOSSARY

This glossary summarizes definitions of the terms related to audit sampling used in this guide. It does not contain definitions of common audit terms nor of statistical terms not necessary for an understanding of the guide. Related terms are shown in parentheses.

Allowance for sampling risk (precision, sampling error): A measure of the closeness of a sample estimate to the corresponding population characteristic at a specified sampling risk.

Alpha risk: See risk of incorrect rejection and risk of underreliance on internal accounting control.

Attribute: Any characteristic that is either present or absent. In compliance testing, the presence or absence of evidence of the application of a specified internal accounting control procedure is sometimes referred to as an attribute.

Attributes sampling: A statistical procedure based on estimating whether the rate of occurrence of a particular attribute in a population exceeds a tolerable rate.

Audit sampling: The application of an audit procedure to less than 100 percent of the items within an account balance or class of transactions for the purpose of evaluating some characteristic of the balance or class.

Block sample (cluster sample): A sample consisting of contiguous transactions.

Beta risk: See risk of incorrect acceptance and risk of overreliance on internal accounting control.

Classical variables sampling: A sampling approach that measure sampling risk using the variation of the underlying characteristic of interest. This approach includes methods such as mean-per-unit, ratio estimation and difference estimation.

CMA sampling: See probability-proportional-to-size sampling.

Confidence level (reliability level): The complement of the applicable sampling risk (see risk of incorrect acceptance, risk of overreliance on internal accounting control, risk of incorrect rejection, risk of underreliance on internal accounting control).

Difference estimation: A classical variables sampling technique that uses the total difference between audited values and individual book values to estimate the total audited value of a population and an allowance for sampling risk.

Dollar-unit sampling: See probability-proportional-to-size sampling.

Dollar value estimation: A decision model to estimate the value of the population.

Expansion factor: A factor used to adjust the calculation of sample size in a probability-proportional-to-size sampling application if errors are expected.

Expected population deviation rate: An anticipation of the deviation rate in the entire population. It is used in determining an appropriate sample size for an attributes sample.

Field: See population.

Haphazard sample: A sample consisting of sampling units selected by the auditor without any special reason for including or omitting particular items.

Hypothesis testing: A decision model to test the reasonableness of an amount.

Logical unit: The balance or transaction that includes the selected dollar in a probability proportional to size sample.

Mean-per-unit method: A classical variables sampling technique that projects the sample average to the total population by multiplying the sample average by the total number of items in the population.

Nonsampling risk: All aspects of ultimate risk not due to sampling.

Nonstatistical sampling: A sampling technique for which the auditor considers sampling risk in evaluating an audit sample without using statistical theory to measure that risk.

Population (field, universe): The items comprising the account balance or class of transactions, or a portion of that balance or class, of interest. The population excludes individually significant items that the auditor has decided to examine 100 percent or other items that will be tested separately.

Precision: See allowance for sampling risk.

Probability-proportional-to-size (PPS) sampling (Dollar-unit sampling, CMA sampling): A variables sampling procedure that uses attributes theory to express a conclusion in dollar amounts.

Random sample: A sample drawn so that every combination of the same number of items in the population has an equal probability of selection.

Ratio estimation: A classical variables sampling technique that uses the ratio of audited values to book values in the sample to estimate the total dollar value of the population and an allowance for sampling risk.

Reliability level: See confidence level.

Risk of incorrect acceptance (beta risk, type II error): The risk that the sample supports the conclusion that the recorded account balance is not materially misstated when it is materially misstated.

Risk of incorrect rejection (alpha risk, type I error): The risk that the sample supports the conclusion that the recorded account balance is materially misstated when it is not.

Risk of overreliance on internal accounting control (beta risk, type II error): The risk that the sample supports the auditor's planned degree of reliance on the control when the true compliance rate does not justify such reliance.

Risk of underreliance on internal accounting control (alpha risk, type I error): The risk that the sample does not support the auditor's planned degree of reliance on the control when the true compliance rate supports the reliance.

Sample: Items selected from a population to reach a conclusion about the population.

Sampling error: See allowance for sampling risk.

Sampling risk: The risk that the auditor's conclusion based on a sample may be different from the conclusion he would reach if the test were applied in the same way to the entire population. For compliance testing, sampling risk is the risk of overreliance on internal accounting control or the risk of underreliance on internal accounting control. For substantive testing, sampling risk is the risk of incorrect acceptance or the risk of incorrect rejection.

Sampling unit: Any of the individual elements, as defined by the auditor, that comprise the population.

Sequential sampling: A sampling plan for which the sample is selected in several steps, with each step conditional on the results of the previous steps.

Standard deviation: A measure of the dispersion among the respective values of a particular characteristic as measured for all items in the population for which a sample estimate is developed.

Statistical sampling: Audit sampling that uses the laws of probability for selecting and evaluating a sample from a population for the purpose of reaching a conclusion about the population.

Stratification: Division of the population into relatively homogeneous groups.

Systematic sampling: A method of drawing a sample in which every nth item is drawn from one or more random starts.

Tainting: In a PPS sample, the proportion of error present in a logical unit. It is usually expressed as the ratio of the amount of error in the item to its book value.

Tolerable error: An estimate of the maximum monetary error that may exist in an account balance or class of transactions without causing the financial statements to be materially misstated.

Tolerable rate: The maximum population rate of deviations from a prescribed control procedure that the auditor will tolerate without modifying the nature, timing or extent of substantive testing.

Type I error: See risk of incorrect rejection and risk of underreliance on internal accounting control.

Type II error: See risk of incorrect acceptance and risk of overreliance on internal accounting control.

Universe: See population.

Variables sampling: Statistical sampling that reaches a conclusion on the monetary amounts of a population.

APPENDIX H

SELECTED BIBLIOGRAPHY

The following bibliography includes articles and books on the use of audit sampling. The articles and books in this bibliography are both generally available to auditors and should help an auditor obtain background information or solve sampling problems.

The listing for each article or book is supplemented with a brief description of the subject of the article. Each listing also includes a general designation of the area of the subject matter and the degree of expertise that an auditor should have in order to adequately understand the article.

Articles Requiring Basic Expertise

These articles require little or no knowledge of statistical sampling. The reader is not expected to have performed more than a few statistical sampling applications. However, the articles assume a basic knowledge of auditing procedures and standards.

Akresh, Abraham D. "Some Common Problems in Statistical Sampling Applications." The Internal Auditor, v. 36 (December 1979) 45-49. Summarizes some problems encountered during the author's experiences with planning, executing and evaluation of statistical sampling applications. Useful for attribute sampling and variables sampling.

Akresh, Abraham D. "Statistical Sampling in Public Accounting." CPA Journal, v. 50 (July 1980): 20-26. Summarizes an AICPA Statistical Sampling Subcommittee survey of the use of statistical sampling in public accounting practice. Useful for attribute sampling and variable sampling.

Akresh, Abraham D., and George R. Zuber "Exploring Statistical Sampling." Journal of Accountancy, v. 151 (February 1981): 50-56. Discusses some basic considerations for use of statistical sampling and some sources of assistance available to the auditor.

Anderson, Rodney J., and A.D. Teitlebaum "Dollar Unit Sampling: A Solution to the Audit Sampling Dilemma." C.A. Magazine, v. 102 (April 1973): 30-38. Discusses PPS sampling and presents the arguments in favor of widespread use of the technique. The article avoids technical details.

Baggett, Walter "Using Time-Sharing Facilities for Statistical Sampling." CPA Journal, v. 47 (October 1977): 85-6. An introduction to the performance of statistical computations on a timesharing terminal. It is an elementary summary for anyone unfamiliar with the subject. Useful for statistical sampling.

Baker, Revenor C. "Determining Sample Size." The Internal Auditor, v. 34. (August 1977): 36-42. Summarizes sample size estimation formulas applicable to the most common mean-per-unit sampling situations. It includes several case studies to illustrate how the formulas are applied. Useful for classical variables sampling.

Carmichael, D.R. "Tests of Transactions - Statistical and Otherwise." Journal of Accountancy, v. 125 (February 1968): 36. Presents a comprehensive discussion of the nature of audit sampling objectives and the choice among sampling techniques to best achieve audit objectives. Useful for both statistical and nonstatistical sampling.

Davis, Maurice "Using Statistical Sampling for Inventory Observation." CPA Journal, v. 67 (February 1978): 73-75. Describes a practical case in which the use of variable sampling increased audit efficiency and benefited a client by reducing down time at the inventory observation. Useful for classical variables sampling.

Elliott, Robert K. "Basic Concepts of Statistics and Hypothesis Testing for Auditing." Handbook of Modern Accounting (New York: McGraw-Hill, 1977). Presents an approach to the use of statistical sampling in auditing, dealing primarily with the concept of hypothesis testing. Useful for classical variables sampling.

Elliott, Robert K., and John R. Rogers, "Relating Statistical Sampling to Audit Objectives." Journal of Accountancy, v. 134 (July 1972): 46-55. Presents a sampling plan that specifically controls both types of risk accepted by an auditor when he makes a decision based on a sample. The article illustrates the implications of not controlling both types of risks. Useful for classical variables statistical sampling.

Area: Statistical Sampling

Gibbs, Thomas E., and Clyde T. Stambaugh. "Problems in Determining Audit Sample Size." Internal Auditor, v. 34 (December 1977): 52-57. The Internal Auditor, December 1977. Describes several considerations of which an auditor should be aware when he uses population estimators to determine sample size and when he is choosing between statistical techniques. Useful for classical variables sampling.

Goodfellow, James L., and James K. Loebbecke and John Neter. "Some Perspectives on CAV Sampling Plans." C.A. Magazine, v. 105 (October and

November 1974 issues): (Part I: 22-30, Part II: 46-53). Part I discusses the basic concepts of PPS sampling plans; part II identifies the strengths and weaknesses of PPS plans and calls for additional research into their application. Problems of understatement and partial errors are illustrated. Useful for PPS sampling.

Guy, Dan M., William C. Dent and Frederick A. Hancock. Some practical Guidelines for Using Attribute Sampling." Practical Accountant v. 12 (April/May 1979): 35-40. Discusses the the authors' experiences using attribute sampling. The article includes an attribute sampling review checklist. It discusses nine attribute sampling areas, including block sampling, systematic sampling, random number tables, sequential sampling, representative samples, selection of reliability levels, selection of tolerable rates, sample evaluation, and error analysis.

Hall, William D. "Inventory Determinations by Means of Statistical Sampling Where Clients Have Perpetual Records." Journal of Accountancy, v. 123 (March 1967): 65. Presents basic concepts in determining inventories by means of statistical sampling. Useful for classical variables sampling.

Ijiri, Yuji, and Robert S. Kaplan. "The Four Objectives of Sampling in Auditing: Representative, Corrective, Protective and Preventive." Management Accounting v. 52 (December 1970): 42-44. Presents considerations in the design of sampling plans, both statistical and nonstatistical.

Kaplan, Robert S. "Statistical Sampling Methods for Auditing and Accounting." Handbook of Modern Accounting (New York: McGraw-Hill, 1977). An introduction to statistical methods in auditing and accounting, including estimation techniques and hypothesis testing. Useful for statistical sampling.

Kinney, William R., and Wilfred C. Uecker. "Judgmental Error in Evaluating Sample Results." CPA Journal, v. 47 (March 1977): 61-62. Research study of the effectiveness of judgmental evaluations of attribute sampling results. The study demonstrates the unreliability of judgmental estimates of population error rates based on random samples. Useful for nonstatistical sampling and attribute sampling.

Kline, William H. "Statistical Sampling for Small Audits." Delaware CPA, v. 3 (November 1976): 9-12, 35. Makes a case for the use of statistical sampling in smaller engagements. It goes through the steps required to use attribute sampling in an audit situation. Useful for attribute sampling.

Myers, Carol A. "Determining Nonstatistical (judgmental) Sample Sizes." CPA Journal, v. 49 (October 1978): 72-79. Describes the factors that influence the determination of sample sizes for both compliance and substantive tests. The article concludes by stating that if these factors are carefully evaluated sample sizes determined judgmentally should be substantially the same as sample sizes obtained using statistical sampling methods. Useful for nonstatistical sampling.

Naus, James H. "Effective Uses of Statistical Sampling in the Audit of a Small Company." Practical Accountant, v. 11 (March/April 1978): 33-45. Discusses the use of attribute and difference estimation sampling in a small company audit. Practical workpaper techniques and sample selection criteria are included in the article. Useful for attribute sampling and classical variable sampling.

Reneau, James. "Guidelines for Selecting Sampling Procedures." Internal Auditor, v. 37 (June 1980): 77-82. A brief introduction to sampling estimation methods used in auditing. It also contains a flowchart to assist in selecting an appropriate estimation method; this flowchart may be helpful to auditors having some understanding of statistical concepts. Useful for statistical sampling.

Roberts, Donald M. "Sample Size Determination for Attributes." Journal of Accountancy, v. 139 (June 1975): 46-7. Answers an inquiry concerning determination of sample size for an attribute sample using the table in an AICPA CPE individual study program, Sampling for Attributes: Estimation and Discovery. Useful for attribute sampling.

Sawyer, Lawrence B. "Simple Sampling: How to Stop Worrying and Learn to Love Statistical Tables." Internal Auditor, v. 25 (July/August 1968): 9-26. Discusses basic concepts of statistical sampling without technical terms and sets forth ten principles for the auditor. Useful for attribute sampling and classical variable sampling.

Stringer, Kenneth W. "Statistical Sampling in Auditing: The State of the Art." Annual Accounting Review (1979): 113-127. Describes the development and current use of statistical sampling in auditing.

Taylor, Robert G. "Error Analysis in Audit Tests." Journal of Accountancy, v. 137 (May 1974): 78, 80-2. Discusses the importance of classifying errors by type and nature as part of the evaluation of sample results. The cause of the error may be more important than its quantative evaluation. Useful for both statistical and nonstatistical sampling.

Van Matre, Joseph, and Loudell Ellis. "The Ratio Estimate - Conceptual Review and a Case Illustration." Woman CPA, v. 40 (April 1978): 12-15. Explains ratio estimation and provides a case study.

Warren, Carl S. "Interpreting and Evaluating Attribute Sampling." Internal Auditor, v. 32 (July/August 1975): 45-46. Gives the auditor insight into proper statistical inferences and interpretations of attribute sampling, including a discussion of the risk of overreliance and the risk of underreliance.

Articles Requiring Intermediate Expertise

These articles require a familiarity with basic statistical sampling concepts and experience in the performance of statistical sampling applications. The reader need not have received any formal education in statistics. The articles assumes a basic knowledge of auditing procedures and standards.

Akresh, Abraham D., and D.R. Finley. "Two-Step Attributes Sampling in Auditing." CPA Journal, v. 49 (December 1979): 19-24. Explains a two-step method of statistical attribute sampling in compliance testing. The method is designed to minimize sample sizes for populations with very low expected population deviation rates.

Boatsman, James R., and G. Michael Crooch. "An example of Controlling the Risk of a Type II Error for Substantive Tests in Auditing." Accounting Review, v. 50 (July 1975): 10-15. Discusses the risks of incorrect rejection and acceptance and demonstrates the importance of considering the risk of incorrect acceptance and properly controlling that risk. Useful for classical variable sampling.

Deming, W. Edwards, and T. Nelson Grice, Jr. "An Efficient Procedure for Audit of Accounts Receivable." Management Accounting, v. 51 (March 1970): 17-27. Studies the practical application of statistical theory to the audit of a trucking company's freight bills receivable. Useful for classical variable sampling.

Hatherly, David. "Segmentation and the Audit Process." Accounting and Business Research, v. 9 (Spring 1979): 152-6. This article in an English journal discusses the segmentation of populations based on auditor risk assessments to increase the efficiency of PPS sampling.

Loebbecke, James K. and John Neter. "Statistical Sampling in Confirming Receivables." Journal of Accountancy, v. 135 (June 1973): 44-50. Presents an approach to evaluating statistical samples using both positive and negative confirmation requests,. The article discusses the role of alternative procedures. Useful for classical variable sampling.

Loebbecke, James K., and John Neter. "Considerations in Choosing Statistical Sampling Procedures in Auditing." Journal of Accounting Research, v. 13 (1975 Supplement): 38-52. Discusses considerations in

the auditor's choice of statistical estimators in the auditing process. Useful for classical variable sampling.

Articles Requiring Advanced Expertise

These articles require extensive experience with statistical sampling applications. The reader should also have extensive knowledge of statistics and other quantitative techniques. The articles assume a basic knowledge of auditing procedures and standards.

Baker, R.L. and R.M. Copeland. "Evaluation of the Stratified Regression Estimator for Auditing Accounting Populations." Journal of Accounting Research (Autumn 1979): 606-17. Investigates some statistical properties of the regression estimator by using simulation and comparison with previously examined estimators. The article finds its performance to be similar to that of difference and ratio estimators. Useful for classical variable sampling.

Garstka, Stanley J. "Models for Computing Upper Error Limits in Dollar-Unit Sampling." Journal of Accounting Research, v. 15 (Autumn 1977): 179-92. Suggests seven alternative methods of computing upper error limits. The author uses the compound Poisson process to model the error rate and the distribution of error sizes. The seven methods are tested by simulation with a challenge to test them in real auditing situations. Useful for PPS sampling.

Garstka, Stanley J., and P.A. Ohlson. "Ratio Estimation in Accounting Populations With Probabilities of Sample Selection Proportional to Size of Book Values." Journal of Accounting Research, v. 17 (Spring 1979): 23-59. Presents an improvement on conventional variable estimation for dollar unit sampling that replaces the t-statistic of Student's distribution with a new statistic, C, based on the binomial distribution. Strengths and weaknesses of the new procedure are presented and discussed. Useful for classical variable sampling and PPS sampling.

Kaplan, Robert S. "Sample Size Computations for Dollar-Unit Sampling." Journal of Accounting Research: Studies on Statistical Methodology in Auditing, v. 13 (1975 Supplement): 126-133. Presents a procedure to compute sample sizes in PPS applications that will control the risks of incorrect acceptance and incorrect rejection.

Kaplan, Robert S. "Statistical Sampling in Auditing With Auxiliary Information Estimators." Journal of Accounting Research, v. 2 (March 1973): 238-58. Discusses problems in variable sampling because of a general low error rate in accounting populations. The article discusses the advantages and usefulness of various estimators for use in variable estimation techniques. Useful for classical variable sampling.

Neter, John, Robert A. Leitch and Stephen E. Feinberg. "Dollar Unit Sampling: Multinomial Bounds for Total Overstatement and Understatement Errors." <u>Accounting Review</u>, v. 53 (January 1978): 77-93. Presents an evaluation approach to PPS based on the multinomial distribution. The author claims that "the auditor is assured of the specified confidence level..." The approach hinges on the definition of the underevaluation set (S-set). Useful for PPS sampling.

Teitlebaum, A.D., and C.F. Robinson. "The Real Risks in Audit Sampling." <u>Journal of Accounting Research</u>, v. 13 (1975 Supplement): 70-97. Discusses rules in audit sampling, developing situations in which actual sampling risks may be larger than nominal sampling risks. It offers PPS as a technique to overcome this potential problem. Useful for PPS sampling and classical variable sampling.

Books Requiring Basic Expertise

These books require little or no knowledge of statistical sampling. The reader is not expected to have performed more than a few statistical sampling applications. However, the books assume a basic knowledge of auditing procedures and standards.

Anderson, Rodney J., Donald A. Leslie, and Albert D. Teitlebaum. Dollar Unit Sampling. Chicago : Commerce Clearing House, 1979. Discusses general audit theory and PPS sampling.

Arens, Alvin, and James K. Loebbecke. Applications of Statistical Sampling to Auditing. Englewood Cliffs, N.J.: Prentice-Hall, 1981. A basic introduction to the comprehensive use of contemporary statistical sampling methods.

Arkin, Herbert. Handbook of Sampling for Auditing and Accounting. New York: McGraw-Hill, 1974. A reference text for the auditor or accountant who wishes to use statistics in his work. The book contains numerous tables, an explanation of statistical formulas, and many statistical sampling plans and methods. Useful for sttribute sampling and classical variable sampling.

Cyert, Richard M., and H. Juston Davidson, Statistical Sampling for Accounting Information. Englewood Cliffs, N.J.: Prentice-Hall, 1962. A general reference and learning text for statistical sampling methods commonly used in accounting and auditing. Problems and solutions are included. Useful for attribute sampling and classical variable sampling.

Guy, Dan M. An Introduction to Statistical Sampling in Auditing. New York: John Wiley & Sons, 1981. A basic introduction to the comprehenisve use of contemporary statiscal sampling.

Books Requiring Intermediate Expertise

These books require a familiarity with basic statistical sampling concepts and experience in the performance of statistical sampling applications. The reader need not have received any formal education in statistics. The books assume a basic knowledge of auditing procedures and standards.

Newman, Maurice. Financial Accounting by Computer Estimates Through Statistical Sampling. New York: John Wiley & Sons, 1976. Explains the nature and limits of estimation sampling and demonstrates estimates of varying degrees of sophistication in an application-oriented framework.

A detailed case study explores the use of stratified regression estimate to evaluate physical inventory. Useful for classical variable sampling.

Roberts, Donald H. Statistical Auditing. New York: AICPA, 1978. A reference textbook discussing statistical sampling in auditing.

Books Requiring Advanced Expertise

These books require extensive experience with statistical sampling applications. The reader also should have extensive knowledge of statistics and other quantitative techniques. The articles assume a basic knowledge of auditing procedures and standards.

Cochran, William. Sampling Techniques. 3d ed. New York: John Wiley& Sons, 1977. A standard reference on statistical theory and formulas used in auditing. Useful for attribute sampling and classical variable sampling.

Neter, John and James K. Loebbecke. Behavior of Major Statistical Estimators in Sampling Accounting Applications. New York: AICPA, 1975. Presents an empirical investigation of a variety of important complex problems in the use of major statistical estimators in accounting populations. Useful for classical variable sampling and PPS sampling.