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SUMMARY OF MODEL HIGHWAY MANUALS

- PLANNING
- DESIGN
- SPECIFICATIONS
- CONSTRUCTION
- ACCOUNTING

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Project Number - Highway Manual AID/OTr C-1420

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INTRODUCTION

Practices for administration and management of highway agencies have evolved over a considerable period of years. Techniques and procedures have been developed for carrying out the various functions of highway agencies. And in order to assure consistency in operations, most well-established agencies have documented the most effective practices in manuals of procedures.

Developing countries throughout the world currently are going through the processes of establishing highway agencies to facilitate development and improvement of highway systems. In most instances, they have relied largely on external financing and outside consultant assistance for conceiving and carrying out highway improvement programs. But, there is a desire for and a need for developing local "in-house" capabilities for highway program administration and management.

One approach to developing these capabilities is to make certain that local officials have the opportunity to benefit from successful experience of established, operating agencies. It is toward this end that the United States Agency for International Development has developed a series of model specifications and manuals which reflect current practices. Five models have been developed to date.

- Highway Planning Manual;
- Highway Design Manual;
- Standard Specifications for Highways and Bridges;
- Highway Construction Manual; and
- Highway Accounting Manual.

These represent the principal functions in planning and development of highway systems. A sixth function, highway maintenance, is equally as important, but is not covered at this time.

Although these are described as model manuals, it must be recognized that no single model can be universally applicable for all highway agencies. Many agencies have unique characteristics of organizational responsibilities and other factors which must be considered individually. But the models provide a good starting point for guiding the development of manuals to fit specific individual needs.

Usually there will be need for personal training programs to supplement manuals of instruction -- but manuals are essential to document prescribed practices.

The model manuals are individually discussed on the following pages. The purpose of each is set forth, along with a brief summarization of the contents.

Further information on the model manuals may be obtained from:

Office of Engineering
United States Agency for International Development
Department of State
Washington, D. C. 20523, U. S. A.

HIGHWAY PLANNING MANUAL

PURPOSE

Transportation studies frequently have been conducted for developing countries, usually by consultants, for the purpose of defining long-range needs and priorities for highway development. They serve a useful purpose by establishing highway improvement programs in ways that will be most cost effective. But these are usually "one-time" studies -- and as such they are not readily adaptable to meet changing conditions in the future.

All modern highway agencies have a responsibility on a regular continuing basis to collect and analyze data on the highway system, traffic characteristics, and economic development as related to transportation services. Long-range goals are defined and short-range improvement programs are developed in ways consistent with priority scheduling and realistic financial capabilities.

It is the purpose of the Highway Planning Manual to establish a basic framework for highway planning processes -- and to describe techniques, procedures and organizational responsibilities that have proven effective.

SUMMARY OF CONTENTS

Following is a brief summary of the contents of the model Highway Planning Manual -- by individual chapters.

Chapter I -- Planning Concepts and Procedures

This chapter provides basic orientation on the concepts and procedures related to highway planning. It presents a general overview of the total planning process, and defines the sequence and relationships of the various elements of planning which are described in detail in subsequent chapters.

Chapter II - Objectives, Policies and Organization

This chapter is directed to the organization for planning within a highway agency. Emphasis is placed on the need for establishing formally-stated objectives -- overall goals and objectives for the government and for the highway agency, and specific goals for the planning unit in order to most effectively assure accomplishment of the overall objectives.

Policies and procedures are suggested to guide operating practices. And suggestions are made for organizational responsibilities and relationships to effectively carry out the individual elements of the planning process.

Chapter III - System Planning

This chapter deals principally with establishing long-range goals in terms of highway system development. There is discussion of the various factors to be considered when setting goals.

Information needs are identified -- the types of data needed to develop trends and projections in population, numbers and types of vehicles, traffic volumes, and economic developments.

Techniques and procedures are presented for conducting economic analyses to guide decision making for system planning.

Chapter III also contains detailed instructions for functional classification of segments of the highway system and for conducting inventory and evaluation of existing roads -- including systems for determining sufficiency ratings for individual sections.

Procedures also are described for identifying improvement needs for the total highway system, and for determining rough estimates of improvement costs. System planning concludes with a discussion of financial planning, the formulation of a priority plan, and documentation with a long-range planning report.

Chapter IV - Route and Project Planning

Whereas Chapter III was generally concerned with the total highway system, this chapter involves greater detail and refinement in planning segments of the system. The purpose of route planning is to study alternative locations in a general corridor connecting established control points, and to select that alternative with the best combination of construction costs and road user benefits. Criteria are presented for defining and evaluating alternatives.

Seldom can an entire new route be constructed as one project. And in the case of reconstruction, only portions of the route may need improvement. This means that judgments and decisions must be made for defining individual projects, the types of improvements and the timing and sequence of improvements. Guides are presented for making these decisions and for preparing project planning reports.

Chapter V - Programming and Scheduling

When individual improvement projects have been identified, there is need to develop and document a proposed highway improvement program and schedule which is realistically coordinated with an overall financial plan. The schedule must also consider the time period requirements for preliminary engineering activities needed in preparation for construction.

Techniques and procedures are presented for formulating short-range programs, for adjusting the program and for regular annual updating of the highway improvement program.

Chapter VI - Agency-Wide Program Planning

Previous chapters were concerned solely with planners of the highway improvement program. Although this is probably one of the most important functions, it cannot be undertaken independently without consideration of other obligations and responsibilities such as maintenance, equipment, repair shops, administration, etc.

Agency-wide program planning may not be a basic responsibility of the Planning Division, but planning officials most certainly should participate in agency-wide planning along with top management officials.

This chapter discusses budgeting concepts along with criteria for reviewing and analyzing objectives. Procedures are suggested for identifying various programs and defining funding levels. Only when such an overall work program budget has been identified -- even tentatively -- will there be a realistic basis to plan short-range programs of specific highway improvements.

Chapter VII - Supporting Functions for Planning

Previous chapters discussed the principal essential elements of the planning process. But for each of these operations, it is essential that there be available various types of reliable basic data. Much of the required data collection and analysis is of a periodic repetitive nature, and many agencies have established a unit within the planning division specifically for this purpose.

This chapter deals with techniques and procedures for performing these supporting functions, including:

- preparing for and conducting road and bridge inventories,
- conducting traffic counts and collecting data on vehicle characteristics,
- forecasting future traffic,
- conducting origin and destination studies, and
- developing and operating systems for data processing, storage and retrieval.

These operations, by themselves, are not planning -- but they are essential to the planning process.

HIGHWAY DESIGN MANUAL

PURPOSE

When specific improvement projects have been identified and the construction program and schedule developed, there is need to design the highway improvements and prepare detailed plans suitable for contract construction.

The purpose of the Highway Design Manual is to guide individual designers, uniformly and consistently, in the design of improvement projects and the preparation of contract plans. When consultants are retained by the agency for designing new highway projects, the Manual also serves to document established design standards and criteria, as well as the format to be followed in preparing contract plans.

SUMMARY OF CONTENTS

A general description of the contents of each chapter of the Highway Design Manual is presented below.

Chapter I - Design Standards

Appropriate geometric design standards for each of various classifications of highways are presented in this chapter. These include elements such as design speed, curvature, superelevation, sight distances, gradients and typical section dimensions and slopes.

Chapter II - Sources of Information

Many different kinds of information must be available to highway designers -- particularly various types of field survey information and recommendations. Various sources of information are described in this chapter, as well as how the information is to be used.

Chapter III - Horizontal Alignment

Detailed criteria and procedures for design of horizontal alignment are discussed in this chapter. Included are items related to computation of horizontal curves, superelevation, sight distances and survey equations.

Chapter IV - Vertical Alignment

This chapter presents guides and instructions for design of vertical alignment of highways. Criteria are set forth for gradients and vertical curves as related to sight distance. Procedures for computing vertical curves are described. And criteria are shown for good grade design practices.

Chapter V - Cross Sections

The preparation of cross section sheets is discussed in this chapter. Included are a description of field survey notes, how to use them for plotting original ground lines, how to template proposed roadway typical sections, and how to record earthwork and drainage design on cross section sheets.

Chapter VI - Earthwork Computations

Earthwork computations involve the basic steps of (1) computing cross section areas of cut and fills at each plotted cross section, (2) computing volumes of excavation and embankment, and (3) plotting mass diagrams and computing haul requirements. These techniques and procedures are discussed in this chapter.

Chapter VII - Drainage

The design of drainage structures is discussed in this chapter -- including procedures for estimating the amount of runoff, determining the proper size of culverts, the structural requirements of culverts and how they should be installed. Criteria are also set forth for the design of open drainage channels.

Chapter VIII - Highway Intersections

The design of highway intersections requires special considerations to assure safe and free flowing traffic operations. Guides and criteria are set forth in this chapter for geometric layout of various types of intersections -- from private driveway approaches to complex interchanges.

Chapter IX - Surfacing

Various types of surfacing materials are discussed in this chapter, along with criteria for typical section geometrics. Techniques and procedures also are presented for computing quantities of surfacing materials.

Chapter X - Right-of-Way

This chapter is written for the right-of-way designer and sets forth policies and procedures for his guidance in determining property ownership, designing right-of-way requirements, describing individual land parcels, and preparing right-of-way plans.

Chapter XI - Miscellaneous Design

Several design criteria are not directly related to major design elements discussed in other chapters. These miscellaneous criteria are presented in this chapter. Included are airway-highway clearances, guard rails, median barriers, guide posts, roadside development, detours and stage construction practices.

Chapter XII - Quantity Estimates

In order to assure uniformity in all contract plans, there is need to establish consistency in procedures for estimating quantities of work items. In this chapter, criteria are set forth for rounding of quantity estimates, degree of accuracy required for the various units as basis of payment and procedures for preparing detailed cost estimates.

Chapter XIII - Design Review

During the design phase of each project, one or more field inspections are usually needed to resolve special design problems and assure adequate and economical design. This chapter sets forth policies and procedures, and designates responsibilities for these design review checkpoints.

Chapter XIV - Contract Plans Assembly

Designers should ensure that contract plans contain the information required by contractors, material suppliers and construction inspection personnel. This chapter presents guidelines for preparing contract plans in a clear, concise and uniform manner. Included are examples of the format and contents of individual sheets, as well as the sequence for arranging the sheets.

Chapter XV - Pavement Structure Design

This chapter contains general design criteria for design of pavement structures. It sets forth suggestions for procedures on decisions related to surface types. And it provides guides to reference materials necessary for the designer to develop the most economical structural section, consistent with agency goals and policies.

STANDARD SPECIFICATIONS FOR HIGHWAYS AND BRIDGES

PURPOSE

The principal purpose of documented Standard Specifications is to make certain there is mutual understanding between the highway agency and contractors with regard to the quality and workmanship of construction operations and the materials used. Before the contractor bids on the work, he must know precisely what is expected of him -- and highway agency inspection personnel must be cognizant of requirements for workmanship and quality of materials before accepting completed work.

Standard specifications are used in all phases of highway development. Design personnel use them as technical guides. Laboratory technicians use them to determine the suitability of materials. And construction personnel use them as guides for inspection and as the basis for measurement and payment of completed work.

Because of continuing improvements in procedures, materials and equipment, bound volumes of Standard Specifications should be updated periodically -- at least every four years. During the interim periods, changes in the Standard Specifications can be documented with "Supplemental Specifications" which are bound with contract documents and which supercede the Standard Specifications.

SUMMARY OF CONTENT

This model Standard Specifications for Highways and Bridges is divided into seven sections which set forth relationships between the contractor and the agency, and which specify construction requirements for the major construction items.

Section 100 - General Provisions

This section defines specific relationships between contractors and the highway agency, including practices prior to award of contracts. Prospective bidders must understand the requirements and conditions established by the highway agency -- such as:

- types of contracts,
- prequalification and registration of bidders,
- invitations to bid,
- contents of proposals,
- delivery and opening of proposals,
- award and execution of contracts, and
- proposal guaranties.

Additionally, this section presents information on scope of work, control of work and materials, legal obligations and responsibilities, prosecution and progress of work, and measurement and payment for work.

Section 200 - Earthwork

This section defines requirements pertaining to earthwork operations on a highway construction project, including:

- clearing of site,
- roadway excavation practices,
- construction of embankments,
- structure excavation,
- channel and ditch excavation, and
- borrow excavation.

In addition to describing methods of construction, this section also sets forth bases for measurement and payment of each item of earthwork.

Section 300 - Base Courses

This section defines the materials, mixes, equipment and construction methods to provide foundation base courses for highways. This is an important phase of construction operations. The quality of the material and workmanship must be carefully controlled.

Section 300 is very explicit in stipulating the requirements for all materials and work methods used in several types of base courses -- including aggregate base, bituminous base, lime-treated base and soil-cement treated base.

Methods of measurement and basis of payment for bid items also are defined in this section.

Section 400 - Bituminous Pavement

This section covers requirements that are applicable to all types of bituminous pavements, including gradation of aggregate, and the kind and amount of bituminous material to be used.

Detailed specifications are set forth for the following types of bituminous surfacing:

- Bituminous Concrete,
- Bituminous Prime and Tack Coat,
- Bituminous Surface Treatment,
- Penetration Aggregate Surface Course,
- Road Mix Bituminous Pavement, and
- Seal Coat.

In addition to describing pavement materials and work methods, this section sets forth equipment and expected results. Materials and workmanship are particularly important in all phases of bituminous pavement construction. Emphasis is placed on inspection control to assure proper quality.

Section 500 - Structures

This is the most comprehensive of all sections in the Standard Specifications. It covers all aspects of construction work associated with bridge and other structures.

Particular attention is directed to:

- foundation excavation,
- pile driving,
- mixing and placing concrete,
- masonry work,
- placement of reinforcing steel,
- erection of structural steel,
- construction of timber structures, and
- miscellaneous bridge details.

These activities involve many critical construction operations that must be carefully inspected and approved during several stages of construction.

The specifications describe the work, establish tolerances, stipulate specific materials and set forth bases for measurement and payment. The section also contains many formulae, reference tables and diagrams to assist the contractor and the inspector in performing the various tasks associated with the work.

Section 600 - Miscellaneous Construction

This is a general section that sets forth specifications for many miscellaneous operations not applicable to the other major sections. It describes the work involved in items such as:

- culverts and storm drains,
- manholes, inlets and catch basins,

- underdrains,
- guard rails,
- fences,
- sidewalks, and
- curb and gutter.

Criteria for materials and work methods are explained for each construction item, along with bases for measuring and paying for the work.

Specifications for Highway Materials

The final section of the Manual consists of a series of detailed specifications for materials commonly used for highway and bridge construction. These particular specifications have been developed and issued by the American Association of State Highway Officials. Similar specifications from other recognized sources may be adopted by a highway agency.

In addition to specifying properties of materials, other criteria are set forth for items such as manufacturing processes, tolerances, size and dimensions and bases for rejection. Procedures are also set forth to guide the inspectors in sampling and testing each item.

HIGHWAY CONSTRUCTION MANUAL

PURPOSE

The Construction Manual is directed primarily to highway agency personnel who are responsible for supervision and inspection of contract projects for highway and bridge construction. The principle objectives are:

- to provide basic orientation and understanding of contract construction practices and responsibilities,
- to document policies and procedures with regard to standardized inspection procedures and reports,
- to define criteria to guide judgments and decisions by construction personnel, and
- to describe the most effective techniques and procedures, and to present reporting systems, tables and other information valuable to the engineer and inspector on construction projects.

The Manual should not be considered a complete and comprehensive Construction Manual -- rather it is a first step toward orderly documentation of policies, procedures, and construction, and a guide toward better management.

SUMMARY OF CONTENTS

The following is a brief summary of each of the five chapters of the Manual.

Chapter I - Organization and Responsibilities

This chapter examines a "typical" organization structure for the construction function of a highway agency. It assumes that there are three basic levels of organizational responsibility:

- Headquarters Construction Staff,
- District Engineer, and
- Field organization responsible to the District Engineer.

An organization chart is provided to graphically illustrate these levels of responsibility. Furthermore, it indicates the relationship between the construction function and the other functional units in the district organization -- administration, maintenance and equipment.

Each level of organizational responsibility consists of many supporting functions. The Manual contains several sample functional statements which define the objectives and responsibilities of each of these organizational units.

These statements will serve as a guide for any highway agency desiring to develop its organization along these lines. The concept applies to the entire agency and not just to the construction function.

Chapter II - General Provisions

In this chapter, highway agency personnel are provided basic orientation in such subjects as:

- Specifications,
- Highway Plans,
- Bridge Plans,
- Construction Staking, and
- Highway Terms and Definitions.

The above items are "tools of the trade" for personnel engaged in highway construction activities. Everyone from construction inspectors on up to resident and district engineers must be knowledgeable in these areas.

The Manual provides instruction on how to use the plans. It explains how each part defines the various work items required to construct a highway or bridge.

Stakes provide the ground control for performing construction work. The use of uniform staking procedures within a highway agency is extremely important. The Manual describes simple and practical procedures that can be used on highway and bridge construction projects.

The final section in Chapter II is a glossary of highway terms. The General Provisions of the Standard Specifications contains a section devoted to defining highway terms. The glossary in the Manual is much broader than that contained in the Specifications. It defines the many types of highways, the elements of the roadway, traffic terms, right-of-way terms and the many terms used in designing the various elements of the roadway.

Chapter III - Roadway Construction

This chapter describes procedures for construction of major roadway items and identifies principle responsibilities for supervision and inspection of the work.

The chapter begins with an explanation of the pre-construction conference -- a meeting between the contractor and the engineer where the job plan, possible problem areas and other job related items are discussed.

It moves on to earthwork -- roadway excavation, embankment construction -- culvert placement and finally pavement construction.

The Roadway Construction chapter contains instructions, ideas and suggestions that can be used by a highway agency to develop an effective inspection program. It not only tells how certain procedures should be done, but also why they should be done that way.

The end of the chapter contains several examples for estimating material requirements. The contract plans usually identify the estimated quantities of surfacing materials required for a project. These quantities are based on estimated rates of application, and quite often there is need to alter these rates during construction. The Manual explains how these computations are made.

Chapter IV - Bridge Construction

Four major categories of bridge construction are included in this chapter. They are:

- reinforcing steel,
- welding,
- pile driving, and
- concrete.

These are not all the categories of bridge construction that engineers and inspectors are concerned about but they are the most significant.

A portion of this chapter is devoted to pile driving. It describes the different types of piling used in bridge construction and explains in great detail the different kinds of pile driving equipment. Jetting and pre-boring operations are also discussed.

The principles of concrete design are discussed in detail. This chapter contains an example of concrete mix design using the fineness modulus method. There are other instructions relating to mixing concrete. A check shows correct and incorrect methods of stockpiling aggregates to prevent segregation.

Like the other chapters, this one has many tables and charts that engineers and inspectors will find useful on construction projects.

Chapter V - Records and Reports

Every construction program must have a reporting system. Some of the requirements for a reporting system are:

- to report the progress of the work,
- to report the quantity of work performed for payment purposes,
- to report on the quality of the work,
- to document work performance, and
- to report changes in conditions affecting the contracts.

To fulfill the requirements of this system, the engineer is required to keep records and prepare numerous reports. The success of the reporting system depends upon the versatility and usefulness of the report forms.

The final chapter of the Manual contains examples of reports commonly required on a construction project. A highway agency may wish to change the format of the forms from that shown in this chapter, but the data required by the report will remain basically the same.

This chapter may be used by any highway agency to design a construction reporting system.

HIGHWAY ACCOUNTING MANUAL

PURPOSE

This Manual has been developed to guide Highways Departments in meeting essential accountability requirements for the receipt and expenditure of public funds. In addition to meeting fiduciary responsibilities, the Manual outlines record systems designed to facilitate management decisions with respect to utilization of financial resources.

In accomplishment of these objectives, an accounting system must:

1. appropriately document all receipts and expenditures so as to discharge the organization's responsibilities to Central Government and the public for the funds entrusted to it; and
2. provide Highways Department management with planning and control information so that it may cost-effectively direct its operations.

While the basic objectives of an accounting system are relatively simple, carrying out the objectives leads to somewhat complex and very detailed records. For this reason, the Accounting Manual is developed in a form which is intended to provide first a discussion of the overall structure of the system, and then more specifics of the numerous subsystems which may be required.

The Manual points out the need to design the system for a particular Highways Department within the framework presented.

SUMMARY OF CONTENTS

Following is a brief summary of the model Highway Accounting Manual -- by individual chapters.

Chapter I -- Introduction

In addition to stating the purpose of a Highways Accounting Manual, this chapter briefly provides two items of discussion and illustration that become the basis of subsequent Manual presentations.

First, there is outlined a general model of a Highways Accounting System. Figure 1, from the Manual, is included here to illustrate this. Then, there is presented an example of a Highway Department organization structure which will be used for illustrative purposes in subsequent portions of the Manual.

Chapter II -- Account Structures

This chapter presents a framework of accounts through which the accounting system is carried out. It is important to recognize the hierarchy of these accounts which is illustrated simply by Figure 3 from the Manual, which is here presented.

The Manual provides detailed descriptions and examples. It points out the mandatory nature of General Ledger and Program accounts and encourages discrimination in selection and implementation of other sets of accounts.

Chapter III -- Budget Processes

This chapter describes the way in which the budget becomes the financial statement of the Highways Department work programs and objectives.

It outlines the processes and decision making through which the budget is formulated. It provides guidance to the forecasting of revenues and expenditures. It includes examples and illustrative forms which carry the process to the final definition of resource allocations to specific work programs and operating management units.

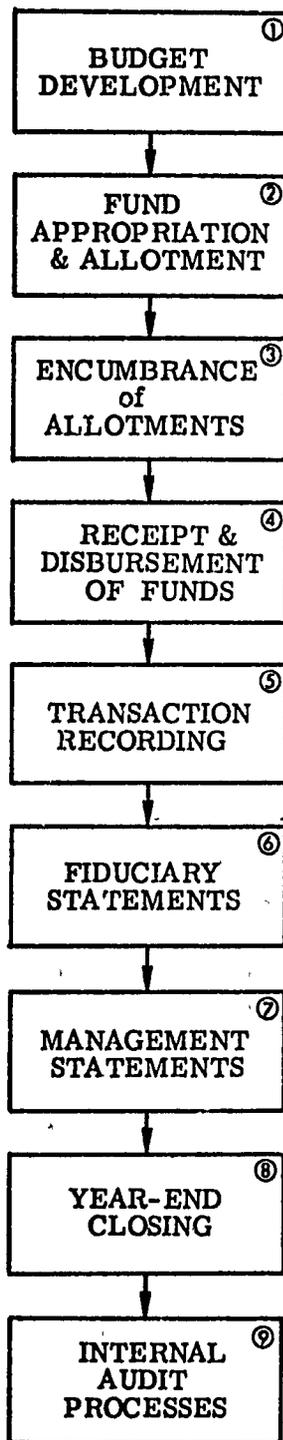


FIGURE 1
GENERAL MODEL OF HIGHWAYS ACCOUNTING SYSTEM

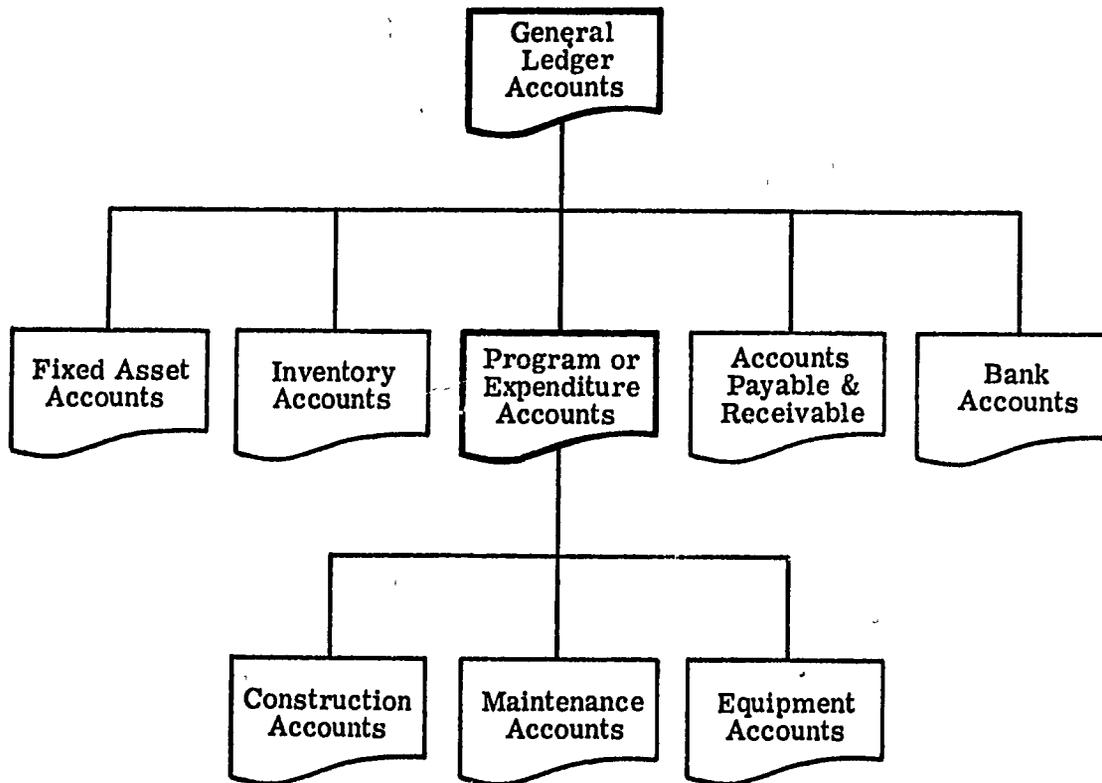


FIGURE 3
ACCOUNT HIERARCHY

Chapter IV -- Appropriation, Allotment and Apportionment

This chapter describes the appropriation action by which the legislative body of government acts upon the budget statements of the Highways Department. The appropriation action becomes an authorization to expend for specified budget statement items.

Allotments represent the release of specific amounts of annual appropriations. In some instances allotments may be limited by Central Government budgetary controls. The Manual describes and illustrates how allotments are made to managerial units within the Department. It also briefly indicates the way in which apportionment of funds between management units is associated with the allotment process.

Chapter V -- Encumbrance Processes

This chapter presents the processes by which appropriated and allotted funds are obligated in the accomplishment of specific Departmental objectives.

Obligations are basically either external to the Department through contracts and purchases, or internal through payroll, equipment rentals and administrative charges. Accounting responsibilities are defined in terms of:

1. confirming availability of allotted funds; and
2. recording requested expenditure as encumbrance.

Chapter VI -- Receipts and Disbursements

This chapter describes the processes of cash receipt and disbursements and provides a step by step diagram of the actions involved. Examples of record forms are included.

Chapter VII -- Transaction Recording Processes

This chapter outlines and illustrates the documentation of transactions in the journals and books of accounts. Figure 24 from the Manual is included here to illustrate the several steps involved in the processes.

The Manual presents examples both of forms and of example entries.

Chapter VIII -- Branch Accounting

This chapter outlines the manner in which decentralization of the accounting functions can be accomplished.

Chapter IX -- Fiduciary Statements

This chapter describes the several types of statements by which accounting systems reflect the financial position of the Highways Department. These include

- Trial Balances;
- Balance Sheets;
- Annual Reports;
- Bank Reconciliations; and
- Document Registers.

The purposes of the different statements are indicated, and illustrative examples are presented.

Chapter X -- Management Statements

This chapter discusses the concept of management statements as a tool of managers in the planning and controlling the operations for which they are responsible. It provides guides to the development of reports that will optimize their effectiveness.

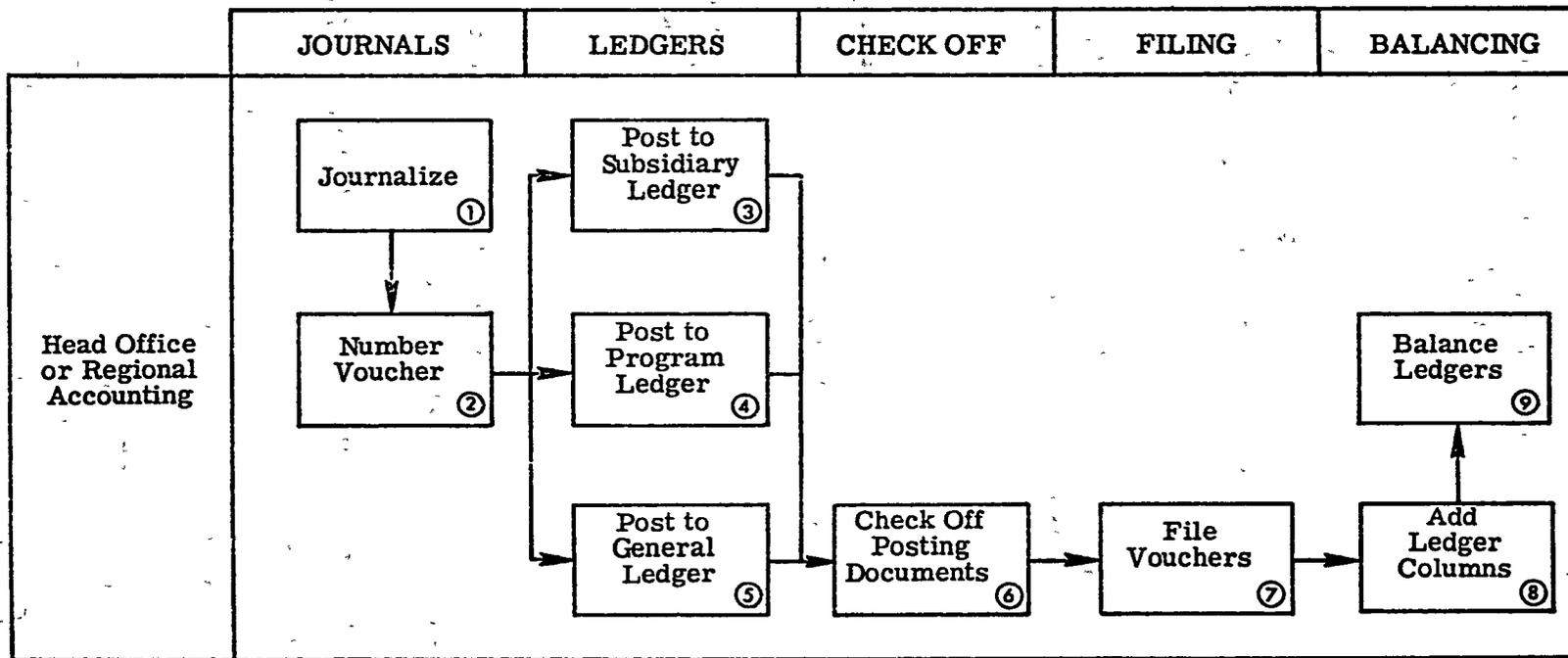


FIGURE 24

TRANSACTION RECORDING SUBSYSTEM

The chapter includes a number of illustrations and distinguishes between the needs of managers at different levels of responsibility.

Chapter XI -- Year-End Closing Processes

This chapter describes the processes involved in year-end closing of accounts. These deal particularly with service accounts such as inventories, warehousing, and equipment.

There are four major functions identified for attention: inventory adjustments, service center closing, account closing and account re-opening.

Chapter XII -- Internal Audit

This chapter defines the purpose of the internal audit and provides a general framework for the development and conduct of the function.

The chapter suggests organizational placement of the audit function, describes the scope of the activity and provides staffing recommendations.

Chapter XIII -- Computerization

This chapter discusses the potential for computerizing the accounting processes. The problems involved in computerization are defined.

To facilitate the implementation of computer-based systems, a suggested phasing is presented in a tabular form.