# A RECOMMENDED APPROACH TO THE DEVELOPMENT OF AN ACTUARIAL

INFORMATION SYSTEM IN A LIFE INSURANCE COMPANY

An Abstract of a Thesis

Presented to

the Faculty of Graduate Studies

The University of Manitoba



In Partial Fulfillment

of the Requirements for the Degree

Master of Science

by

Harold A. C. Johnson

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#### ABSTRACT

The growth in number and diversity of insurance products involving actuarial elements, the increase in actuarial calculation requirements, and the growing need for computer system support were some of the reasons for the current investigations of methods, procedures, data files, and equipment usage associated with the actuarial functions and operations of the subject company.

The purposes of this investigation were, therefore:

- To determine the nature of the environment and other influencing factors which could affect the content, design, and use of a computer-supported actuarial information system;
- To develop and recommend an approach to the controlled and orderly development of such a system;
- 3. To justify the system, in terms of cost and benefit evaluations, to the extent possible; and
- 4. To provide the basis for corporate and divisional management decision-making as to the course of systems analysis and development to pursue.

The investigation procedures and methods included discussions with actuarial and data processing personnel, a review of computer programs involved in servicing the actuarial function, and an extensive exploration of pertinent reference material.

#### ABSTRACT (CONT'D)

The principal results of the investigation are as follows:

- An approach to the development of an actuarial information system in a life insurance company has been recommended.
- 2. The need for an integrated framework for actuarial information system developments, with extended usage of computer facilities, has been identified, and a proposed structure has been recommended.
- 3. The concept of a computer-oriented library of actuarial data and routines has been advanced, with due regard to the requirements and problems of storage, retrieval, and operational use.
- 4. A method for evaluating life insurance business in-force, new business, and transaction activity, in terms of the anticipated contribution of each policy to the corporate financial performance, has been developed and illustrated. The idea has been termed the prospective performance concept. Calculation examples are shown in Appendix C of the thesis.
- 5. Supporting information has been recorded, to demonstrate the range and scope of the recommendations, and, thereby, to assist the corporate decision-makers in reaching their conclusions as to the proposals and the course to follow.

6. A computer terminal display format for actuarial formulae

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#### ABSTRACT (CONT'D)

presentations has been developed for use in actuarial operations. Examples are contained in Appendix A. In it, the conventional actuarial symbols in their normal formats are effectively represented by standard characters and symbols of the IBM System/360 computer facilities.

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7. A method for using visual display terminals, in association with the computer and the proposed actuarial library, for actuarial processing of various forms, has been recommended, and demonstrated as shown in Appendix B.

The proposals, in summary, are intended to constitute an ambitious but practical and logical approach to the controlled evolution of an actuarial information system in the subject company for the purpose of further "unlocking the computer's profit potential" in the areas of operational control, management control, and strategic planning.

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#### PREFACE

This thesis recommends an approach to the development of a computer-supported actuarial information system for a life insurance company.

Much has been written about computer systems, in the areas of systems design, systems analysis, programming, and equipment technology and developments. There is little published material, however, which outlines the requirements of, or a planned approach to, actuarial information and calculation system developments. Two specific systems were investigated to determine their possible application to actuarial information requirements and processes of the subject company.

The first of these systems investigated was the IBM Advanced Life Information System (ALIS). The information source was a paper entitled "The IBM Advanced Life Information System" by Thomas P. Maher, Industry Marketing Manager - Life Insurance, International Business Machines Corporation, as published in the 1968 Proceedings of the Insurance Accounting and Statistical Association (pages 118-122).

The system has been developed by IBM, in close association with life insurance industry personnel, and is applicable to the individual life and health insurance lines of business. Its principal features, which demonstrate its design as an information system, include: (1) the storage of all policy information in direct access storage devices; (2) the provision of an inquiry capability to all stored files to display their contents and to generate reports and

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quotations; (3) the capability of maintaining and processing individual policy records, by means of the large base of program logic provided; and (4) the utilization of IBM System/360 hardware and the System/360 Operating System to provide flexibility for changes in the insurance operations and for the expansion of the system capabilities.

The Advanced Life Information System is essentially an administrative record-keeping and processing system, with information provision capabilities. It does not provide facilities for actuarial calculations, research investigations, and policy reserve determinations. Its main functions are very similar in scope to the record-keeping and processing system for individual insurance policies as operated by the subject company using the IBM 7070 computer.

The second system studied was the record-keeping and processing system of the Travelers Corporation. The source of information was a paper entitled "Travelers On-Line Real-Time System Cross + Country Link with the Data Center", by George P. Lukens, Assistant Secretary, Data Processing Department, The Travelers Corporation, as published in the 1968 Proceedings of the Insurance Accounting and Statistical Association (pages 141-142).

The Travelers Corporation system involves the maintenance of casualty and property insurance policy records in direct access drum storage devices associated with the company's UNIVAC computer equipment, and the direct access to these records by field offices through the facilities of terminal devices and communication lines. Extensions

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of the direct access concept are being planned by the company so as to incorporate the life insurance policy record maintenance and access operations, and to facilitate policy calculations of cash surrender values by means of terminal equipment use. The system does not include actuarial calculation and research capabilities, nor does it extend the uses of the data files to the area of actuarial information.

Neither of these system possibilities provided any information pertaining to the requirements of, or a planned approach to, computeroriented actuarial operations.

The emphasis in this thesis is on the broad aspects of an approach to actuarial information system developments, rather than on the detailed analysis and systems design of an actuarial information system.

The research task has been undertaken to provide a corporate long-range plan of actuarial information system development for the Great-West Life Assurance Company, and concurrently, to enable the preparation of this thesis, related to the Integrated Information Systems course of the Institute for Computer Studies, the University of Manitoba, for submission to the Faculty of Graduate Studies of that institution.

It is appropriate, therefore, that the author's appreciation be expressed to the Great-West Life Assurance Company, for the partial freedom from other duties and for the opportunity to conduct research in this area of two-fold purpose. In particular, the support, interest,

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and encouragement of Mr. H. E. Harland, Actuary, and Mr. J. O. Parsonage, Director, Computer Systems and Services, in connection with this project, are gratefully acknowledged.

The author is also indebted to three faculty members of the University of Manitoba, namely Professor B. A. Hodson, Director, Institute for Computer Studies; Dr. J. D. Mundie, Director, Business Administration and Finance, School of Commerce; and Mr. D. Costin, Institute for Computer Studies, for their helpful and constructive counselling of the candidate.

The final expression of grateful appreciation by the author is to Miss Florence Ball, for her exceptional work in typing the manuscript, and for her untiring and cheerful attitude to the revisions which were found necessary in the development of the final thesis submission.

Responsibility for the views expressed and conclusions drawn in the thesis, as well as for the accuracy of the contents, rests with the author alone, and not with the corporation or with individuals consulted during the investigation.

Throughout the thesis, the references to a "life insurance company" are to be construed as referring to The Great-West Life Assurance Company. Tabular data, unless specified to the contrary, are also applicable to the subject company.

The Bibliography, located immediately after the list of References, contains the details of books and other publications, not

referenced specifically in the thesis, but which may be of general or particular value subsequently in relation to actuarial information deliberations and possible system developments.

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#### CHAPTER I

#### INTRODUCTION

For the past fifteen years, computing equipment of a variety of forms and capacities has been used to perform actuarial calculations in the subject company. The extensiveness of the computational requirements, together with the rapid growth and diversity of corporate products involving actuarial elements, suggests that a current investigation of methods, procedures, data files, and equipment used in this area would be timely and constructive.

## 1. PURPOSE AND SCOPE OF THE INVESTIGATION

The purpose of this thesis is to present the results of research in depth of matters related to the concept, character, and approach to the development of an actuarial information system for a life insurance company.

The preparatory work involved discussions with actuarial personnel; a review of corporate records and procedures related to the actuarial function; an investigation of books and other published material pertinent to the general topic or to specific problem areas; the analysis of all data to identify the essential components of the problem; and the evolution of a recommended approach to provide a logical basis of system development in support of the actuarial operations. The results of these activities are contained in the subsequent chapters of the thesis and in Appendices A, B, and C. Sample forms used in record administration and containing actuarial data have been included in Appendix D, together with indications as to their use, so as to provide a general point-of-reference.

The character of the contents to follow is essentially broad in nature, so as to incorporate as many facets of actuarial operations as possible within a logical, long-range development plan. This approach is consistent with the initial objective and primary intent of the research task.

#### 2. MANAGEMENT INFORMATION SYSTEM CONSIDERATIONS

An actuarial information system is a component of the more fundamental system concept which has been given the identity of management information. In order to provide a proper perspective for the thesis topic, it is constructive at this point to outline some of the primary philosophies and elements of management information systems, and then to indicate the reason for restricting the present investigation scope to actuarial matters.

The term "management information" has probably been defined by most authors of books, reports, and other publications dealing with aspects of corporate information requirements and uses. The following have been selected for present purposes to demonstrate the scope of meanings implied by the term.

Martino (1) \* approached the definition problem by first defining the meaning of each word in the term. A system in his view is "a group, a set, or a collection of elements connected in some fashion and directed to some purpose." Information is "the result or a product of a process" (i.e., summarization, extraction, or compression). Management is "the process of setting the objectives of an enterprise and then judiciously allocating resources to achieve these objectives."

He then proceeded to define a management information system as one possessing the attributes of measuring the effects of decisions (before or after they are made); of measuring the environment (because of difficulties in controlling or forecasting the effects of changing external circumstances); and of reacting in an appropriate timeframe or period (i.e., learning of potential trouble area developments in time to take proper remedial action).

Jenkins (2) defined the concept of management information systems as envisioning "the organization of all data processing effort within an association to provide -- for all levels of management -- the facts necessary to make effective decisions in day-to-day operations."

Kronenberg (3) defined a management information system as "one in which the requirements at each level of management are carefully determined in advance of need and are then produced from an integrated

\* Numbers in brackets used in this way refer and correspond to the numbers in the list of References following the last chapter of the thesis.

system at predetermined times and in a form suitable for.....setting objectives, shaping and evaluating alternative strategies, making decisions, and measuring results."

Head (4), in exploring what a management information system really is, has noted the evolution from conventional or traditional data processing applications "to the use of the same information at the middle management level for control purposes and at the general management or executive level for planning purposes."

Rosove (5) clearly distinguishes between data and information. "A datum is a fact in isolation. Information is an aggregate of facts so organized or a datum so utilized as to be knowledge or intelligence. Information is meaningful data, whereas data, as such, have no intrinsic meaning or significance. Information is the concept relating data which are otherwise meaningless to some specified human purpose or objective."

Based on this difference of meanings, Rosove (6) proceeds to define an information system as "an integrated, multiple-purpose, geographically dispersed, computer-based configuration of people, procedures, and equipment designed to satisfy the informational needs of a user."

For the purpose of this investigation, the definition which has been adopted as providing the clearest statement of information system objectives is that of Kronenberg (3).

The essential objectives of management information systems, as defined by the foregoing, are to provide the information required to comprehend, plan, organize, operate, and control a business; to assist management <u>at all levels</u> to manage better; and to provide a basis whereby business results may be predicted and then used to measure and evaluate actual accomplishments. A further element in this last objective involves the taking of appropriate action, either to correct a problem situation or to capitalize on a favourable environment, as well as the adjustment of future goals in the light of present conditions.

The management information requirements of a life insurance company are extensive, and include to varying degrees the functional information elements of the marketing, administrative, actuarial, accounting, investment, underwriting, medical, legal, and personnel operations.

Figure 1.1 demonstates in chart form the nature and extent of information flow in a life insurance company management information system. The data were adapted from development work in this area by Parsonage (7).

Many of the boxes on the chart can be viewed as representing or involving separate functional systems, which are integral, complete entities for their respective purposes. Computer facilities may or may not be involved. The lines connecting the boxes indicate the data paths and communication linkages of the processes and areas shown.



FIG.1.1 INFORMATION FLOW - MANAGEMENT INFORMATION SYSTEM

The chart portrays a management information system in terms of data flow and functional elements. It demonstrates that a management information system is a system of systems, using the data files and processing logic of the individual functional systems as necessary, to produce integrated results for corporate measures of effectiveness, control, and action.

#### 3. STUDY LIMITATIONS TO ACTUARIAL INFORMATION

Considerations of the extensiveness of the research task involving an approach to the development of a management information system led to the conclusion that the scope should advantageously be limited to matters pertaining to the actuarial function. The investment, underwriting, medical, legal, and personnel operations are essentially excluded. Functional elements of marketing, administrative, and accounting operations are included where actuarial components are involved.

Figure 1.2 shows the principal relationships of these specific operations. The individual operations are shown in a series of boxes. The lines connecting the boxes indicate operational relationships, and thereby demonstrate the manner in which the operations fit together. The operations which are of concern in the thesis contents which follow are shown in the figure to the right of the heavy line with the arrow designations.

In present context, the term "actuarial information" includes



a broad range of topics which are directly or otherwise related to or involved in actuarial calculations, reports, and analyses. Chapter 7 contains a more detailed statement of the data and processes which are included, for the purpose of this thesis, in the term "actuarial information."

The actuarial functions and operations were selected as the subject-matter for this information system research task because of the very extensive involvement of actuarial elements in most of the areas of life insurance company activities. Company products are designed and marketed based on actuarial principles of premiums and benefits. In-force business is administered, again with the extensive involvement of actuarial factors, including premiums(\*), reserves, cash values, non-forfeiture values, dividends, and loans. Finally, on contract termination, by maturity, expiry, surrender, or death, the actuarial principles continue to play an important role in the determination of benefit amounts to be paid, and in the manner of payment (i.e., lump sum, instalment refunds, and life annuities, to mention but a few possibilities). Continuing actuarial responsibilities include the preparation of regular and special reports for government and corporate management use, for the purposes of demonstrating the state of affairs of the business and evaluating the actual results achieved, as related to anticipated standards.

\* A Glossary of Terms is provided in Appendix E.

On the basis of the above outline of actuarial elements, the actuarial operations may be regarded as the basic foundation of life insurance company operations, on which all other functional activities must be securely based.

## 4. ORGANIZATION OF THE THESIS CONTENTS

This section outlines the general plan of the material to follow.

Chapter 2 defines the areas of actuarial operations of a life insurance company which are of concern in the present research task. This is followed by a consideration of actuarial information requirements in Chapter 3. The characteristics of life insurance recordkeeping operations are reviewed in Chapter 4, with particular reference to the subject company.

Industry developments related to computer trends are discussed in Chapter 5, with emphasis on computer hardware, computer software and support, and the respective influences of hardware and software on system developments.

The needs of life insurance companies in the area of actuarial information systems are considered in Chapter 6. Chapter 7, as indicated previously, deals with the types and objectives of actuarial data and processes which are of concern in this investigation. Chapter 8 is a review of the pertinent functions of any data processing system. Chapter 9 is a broad appraisal of the actuarial information system design problem.

Chapter 10 outlines the recommended approach to the development of an actuarial information system. Chapter 11 is an evaluation of the proposed approach. Chapter 12 outlines some of the potential areas of further information system developments which, together with the recommended actuarial approach, enable considerations of their ultimate integration into a management information system.

Chapter 13 is a summary and recapitulation of the thesis contents, and is followed by References, a Bibliography, and Appendix material to conclude the presentation.

### CHAPTER II

## AREAS OF ACTUARIAL OPERATIONS

In introducing his consideration of the actuarial work phases which can be affected by electronic data processing, Goshay (8) has stated that the "influence (of actuaries) extends to every phase of insurance operations. Although the work of the actuary encompasses complex mathematical and dynamic-technical considerations, much of this work also involves statistical record-keeping and analysis by well-defined and somewhat routine procedures."

The contents of this chapter serve to outline and delimit the areas of actuarial operations which form the basis of this study. The material is organized under the headings of Head Office, Branch Offices, Policyholders, Sales and Service Representatives, and Legislative Bodies.

Figure 2.1 exhibits these areas as related to the Great-West Life Assurance Company, and shows the communication relationships by means of the connecting lines and arrows.

Figure 2.2 is an organization chart at the senior executive level of the Great-West Life Assurance Company. It indicates the relationship of the Actuary (represented by the first box in the bottom row of the chart) to the President and to the other senior executives.

The benefit-provision business operations include individual life insurance, health coverage, and annuity policies, and group



# FIG. 2.1 AREAS OF ACTUARIAL OPERATIONS -THE GREAT-WEST LIFE ASSURANCE COMPANY





life insurance, health coverage, and pension contracts, together with the supplementary contracts, related to these lines of business, which arise at the time of benefit maturity or surrender. The remaining portion of this chapter contains material which may be more applicable to one or some of these business types rather than to others.

## 1. HEAD OFFICE

Head Office actuarial operations include activities in which the actuarial role is direct, as in the calculation of premium rates and dividend scales, and those in which the participation is indirect, as in administrative area calculations of dividends on individual inforce contracts.

In support of the corporate marketing activities, the actuarial operations include the direct involvement in product research pertaining to benefits and premiums, and in the development of rate books, dividend scales, and other sales aid material containing actuarial data. The basic concerns in these actuarial operation areas are that the premium rates be adequate from the company viewpoint, vis-a-vis the benefits being provided, and that the benefit and rate structures and provisions be sound in actuarial principle.

Insurance premium rates are established initially on the basis of assumed rates of mortality, claim occurrence, interest, and expenses that apply to the future years of the policies. The actual rates experienced may coincide with or may differ from the assumptions inherent in the premium structure. For example, if the actual rates of mortality were double the assumed rates, the premiums would not be adequate to support the benefits provided in the policies and to provide a corporate profit margin. It is important to provide the means of corporate evaluation of actual experience as related to the assumed levels.

In order to control the adequacy of premiums, it is necessary to evaluate the results of previous assumptions as to the levels of mortality, health claim, interest, and expense rates, by the performance, on a periodic basis, of mortality, persistency, gross premium valuation, and health claims-versus-premiums studies. The study results are then utilized in establishing the current assumptions to be incorporated in the current rates. In the development of new products and in the preparation of premium rates for non-standard benefit provisions, special actuarial techniques, assumptions, and calculations may be necessary.

The organization of a life insurance company normally involves the separation of the direct actuarial operations from those which are related to business in-force record maintenance and data processing. Usually, the various work elements comprising this second category are performed in an administration division or department, while the direct actuarial operations are performed, as the name implies, in an actuarial division or department.

Actuarial operations are, nevertheless, an integral part of the corporate administrative work related to business record maintenance and data processing. The records for specific policies and contracts contain considerable amounts of actuarial data pertaining to benefit descriptions, rate bases, premium schedules, reserve and non-forfeiture benefit factors, and dividends. Effective actuarial controls are required to insure the correct assignment of factors to policies, as well as the proper maintenance of business record information for actuarial use. This record maintenance responsibility includes, indirectly, via the administrative area, the processing and controls related to the establishment of new business records in the corporate files of in-force cases; the processing of in-force business for regularly-scheduled activities such as premium billing, dividend calculations, and contractual benefit and premium changes; and the processing and controls of policy changes and terminations.

Uses of in-force business record data and of related transaction activity are required for the purpose of reporting to management on the corporate actuarial condition, including, primarily, the valuation of liabilities. This involves the classification and summarization of actuarial data, including official business amounts of insurance or annualized premiums, together with appropriate statement control groups (i.e., Canada-United States, state or province, and valuation basis). The results are meaningful and actionable information statements. A continuing requirement is the maintenance of the supporting
data detailed records, so as to enable more extensive management exploration into statement details, if and when deemed necessary. Again, in this situation, the statement classification and summarization work is usually performed in an administrative area, with the actuarial operations area participating indirectly by the establishment of statement content requirements and controls.

### 2. BRANCH OFFICES

The primary branch office operations include the servicing of in-force business, the maintenance of records and information to support the servicing function, certain activities pertaining to the sales of new policies and contracts, and, where applicable, special processing requirements associated with health coverage claims. In all of these areas, there are varying degrees of actuarial operation participation.

In-force business servicing and the related record-keeping work involve the use of actuarial data pertaining to benefit particulars, premium payment status, and monetary factors such as loan values, cash surrender and non-forfeiture values, and dividend accumulations. These data, and others as well, are required by the branches so that accurate, complete, and constructive replies may be given in response to policyholder requests. In the event that the data are not present in the branch files, reference to Head Office records may become necessary.

In the area of marketing support, the branch office serves as an effective intermediary between the sales representatives and Head Office, and performs such functions as the requesting of premium rates for non-standard plans, the maintenance of branch records on current marketing activity, and the receipt of material from Head Office for policyholder or representative use. The branch office also serves as a repository of information for sales representative use, in that more extensive rate book material than is supplied to each representative is normally provided to each branch.

In the area of health coverage claims processing, the extensiveness of the branch office activity depends upon the degree to which claim adjudication and payment routines are decentralized in the branches or centralized in Head Office.

The actuarial operation relationship to the foregoing branch office activities is indirect, in that the actuarial rules and procedures are established initially, and then executed by decentralized administrative areas. Apart from the geographical separation of the branches from Head Office, the indirect actuarial operation relationship is entirely analogous to that described previously in the consideration of the Head Office administration environment. The actuarial responsibility is to insure that the correct actuarial data are being communicated, and that the proper actuarial rules and procedures are being applied.

#### 3. POLICYHOLDERS

As noted in the preceding section, the branch offices and the sales representatives are extensively involved in an intermediary role between policyholders and Head Office. In addition, however, there are many situations in which the communication between policyholders and Head Office is direct (e.g., premium notices mailed directly to the policyholders; policyholder premium payments mailed directly to Head Office).

In all cases, regardless of the path of communication, there is a flow of information for action or for record maintenance purposes; moreover, much of the information may be actuarial in nature.

The actuarial operations involvement is generally of the indirect type, with the establishment of actuarial policies and the making of actuarial decisions in a functionally centralized area, and with the carrying out of the actuarial rules and procedures in a functionally centralized Head Office administrative area dealing with policyholder scruicing.

#### 4. SALES AND SERVICE REPRESENTATIVES

The actuarial requirements of the sales and service representatives include the accessibility of information pertaining to plans of insurance, benefit structures, and schedules of premiums, cash values, and non-forfeiture benefit particulars. In some marketing situations,

the need may arise for new products, special benefits, or unusual contractual provisions which necessitate special calculations by or on behalf of the actuarial area. This circumstance is especially applicable to the group line of business, in the three areas of life insurance, health coverages, and pension benefits.

The representatives are also very much aware of the monetary implications of good and bad persistency of in-force business. The term "persistency" refers to the degree to which business remains in-force and is not reduced by preventable terminations. Business once established as in-force is subject to decremental influences arising from death claims, maturities, contractual terminations, surrenders, lapses, elections of non-forfeiture benefit options, and policy changes. The reductions which are regarded as beyond the control or influence of the representatives are termed non-preventable, while those which are deemed to be within the control or influence of the representatives are classified as preventable. The representatives and the company have a joint monetary interest in the persistency of business, as the incomes of both are directly affected thereby.

Persistency studies are usually conducted in a Head Office administration area which maintains the in-force and transaction records. The various analyses, by plan of insurance, insured age groups, in-force durations, occupations, and sales representative groups are defined so as to fulfil the joint needs of the actuarial area in the preparation of persistency investigation reports, and of

the marketing area, in providing a means of performance evaluation, control, and remedial action basis related to the sales and service representatives.

The foregoing considerations of persistency indicate a very important area of actuarial operations which can affect or influence the representative group.

Another area of actuarial support or influence as related to sales operations involves the preparation of sales aid material, for individual prospects and specific plans of insurance, in which the financial elements of premiums, cash values, dividends, and net gains or losses are prepared for a number of years. The actuarial concern in this regard is that the sales aids, even though they may be prepared in an administrative area, do contain data which are consistent with the actuarial requirements.

Still another area of actuarial influence in the present context involves the use of in-force and related records to prepare lists and documents of policyholders grouped by income level, occupation, and plan of insurance, for use as sales and market leads. The actuarial influence in this situation is indirect, with proper controls being exercised over the administrative routines so as to insure the actuarial accuracy of the data provided.

In-force business records on each policy are indispensable to the representatives. A common current practice is to prepare, at the time of issue of each contract, a separate card record, containing pertinent financial and other data, for representative use. This is followed by the preparation of a new card record whenever a change of information takes place (e.g., address change, dividend declared). Again, the actuarial concern is that the data pertaining to cash values, premium particulars, and dividends are correct and therefore that they are properly controlled.

#### 5. LEGISLATIVE BODIES

Insurance companies are subject to extensive legislation by federal, state, and provincial governing bodies, for the purposes of controlling insurance company operations and of assuring the conformity of company operations and practices to the legal standards established. Corporate balance sheets and statements of operations are prepared annually and are submitted to the various governing authorities for their analysis and approval. In addition, the insurance company records and procedures are subjected to regular "on-premises" investigations conducted by government officials every three or four years. Extensive reports are prepared as a result of these examinations, for the purposes of reporting to the legislative bodies concerned and of communicating the results of the evaluations to the insurance companies.

A substantial proportion of the information required for these purposes is actuarial in nature, and deals with the official numbers of policies and amounts of insurance, together with the reserve valuation

of policy and benefit liabilities.

The actuarial operations are directly concerned with the preparation of the final submissions to the governments, and indirectly, by means of procedure and requirement controls, with the administrative record-keeping and processing from which the information is derived. In addition, the actuarial concern extends to the area of continued availability of detailed records for each examination period, which support the annual submissions. This enables the examiners to probe into statement details when and if deemed necessary, in any selected lines of business or groups of policies.

The actuarial calculation procedures are subject to examiner scrutiny to the same degree of detail as are the record-maintenance operations, so as to insure the accuracy of the manipulations and to demonstrate conformity to the legal standards.

#### CHAPTER III

#### ACTUARIAL INFORMATION REQUIREMENTS

The purpose of this chapter is to outline some of the general considerations associated with actuarial information requirements, in order to provide another perspective for the research task topic and its problem areas.

As noted in Chapter 2, an extensive amount of actuarial information is maintained and processed for operational purposes. In addition, the information is used in classified and summarized forms to provide appraisals of performance for the corporation as an entity and for the component functional divisions and lines of business. Still further, the actuarial information for current and previous business periods are utilized in the development of projections of possible business environments for future years.

In all of these situations, the actuarial information is used for decision-making purposes, regardless of the organization levels at which the various decisions may be made.

The concept of an actuarial information system implies the integration of the record-keeping and data processing functions of the various elements which constitute the actuarial function; and the integration of the system requirements of the operational control, management control, and strategic planning activities related thereto. According to Rosove (9), this involves a lateral integration of different functions which are at the same organizational level, and a vertical integration of different levels of the organizational hierarchy.

The terminology used to denote the three levels of actuarial information is derived from Anthony (10), who has defined each level as follows:

"Operational control is the process of assuring that specific tasks are carried out effectively and efficiently."

"Management control is the process by which managers assure that resources are obtained and used effectively and efficiently in the accomplishment of the organization's objectives."

"Strategic planning is the process of deciding on objectives of the organization, on changes in these objectives, on the resources used to attain these objectives, and on the policies that are to govern the acquisition, use, and disposition of these resources."

With these definitions of terms being applicable, Figure 3.1 depicts the structure of an actuarial information system, in which the decision-making requirements for operational control, management control, and strategic planning are supported by an integrated data base. The flow of data is indicated by input and output notations.

Figure 3.2 is a sectionalized view of the actuarial information structure, to illustrate the interdependencies of the data base and

the information requirement levels. Each of the three levels is supported directly or indirectly by the data base. In three-dimensional geometry, the stability and cohesiveness of a multiple-piece, triangular-shaped solid are dependent upon the "goodness-of-fit" of the component parts. In an analogous manner, the degree of effectiveness of an actuarial information system is dependent upon the degree of correlation between the information requirements and the supporting data base.

Head (11) has noted the problem, in information system development, of management's "information threshold," by which he means the levels to which executives may wish to proceed in the data base in order to have access to the information with the degree of detail they require. The systems design must be such as to provide the necessary levels of information, and to permit the changing of those levels easily and without a complete restructuring or reimplementing of the system.

This situation is directly applicable to the actuarial information system problem being considered. The data base must be capable of supporting the information requirements at all corporate levels, and must be adaptable to the changing requirements of those levels, if a cohesive, stable, and useful actuarial information system is to be the result.





FIG.3.2 ACTUARIAL INFORMATION SYSTEM STRUCTURE - SECTIONALIZED

#### CHAPTER IV

## CHARACTERISTICS OF THE RECORD-KEEPING OPERATIONS OF A LIFE INSURANCE COMPANY

The principal record-keeping operations of a life insurance company are related to the life insurance, health coverage, and annuity and pension contracts which are in-force, and to the associated transaction activity involving new issued business, changes to existing contracts, and terminations and maturities of contracts and benefits, in addition to in-force business administrative processes such as premium billing. This chapter presents some of the more significant characteristics in these areas of record-keeping.

#### 1. DIVERSITY OF DATA

The diversity of data maintained is due in part to the magnitude of the business in-force and associated transaction activity operations, and in part to the broad array of benefit provisions incorporated therein.

Table 4.1 contains statistics pertaining to gross life and annuity business in-force as at the end of 1957, 1962, and 1967. Tables 4.2 and 4.3 outline some of the principal transaction activity areas for the years 1957, 1962, and 1967 for, respectively, the life and annuity lines of business.

Table 4.4 contains statistics pertaining to accident and sickness insurance for the years 1957, 1962, and 1967.

TABLE 4.1	GROS AS	SS LIFE AND A AT THE END OF	NNU 19	JITY BUSINESS I 957, 1962, AND	N F 196	ORCE 7
		1957		1962		1967
INDIVIDUAL INSURANCE				and and and		
NO. OF POLICIES OFFICIAL AMOUNT	\$ 2	432,142 083,773,720	\$	424,227 2,607,740,016	\$	423,506 3,363,002,657
ROUP INSURANCE						
NO. OF POLICIES NO. OF CERTIFICATES OFFICIAL AMOUNT	\$ 1	1,858 513,503 038,299,732	ę.	3,801 1,268,078 2,188,445,434	\$	4,399 1,537,344 4,116,878,548
NDIVIDUAL ANNUITIES				•		
DEFERRED						
NO. OF POLICIES ANNUAL PAYMENT	\$	20,003 13,266,871	\$	15,945 10,044,386	\$	15,962 11,721,733
VESTED						
NO. DF POLICIES Annual payment	\$	4,351 2,367,475	\$	5,991 4,047,051	\$	7,029 5,716,367
ROUP ANNUITIES						
NO. OF CONTRACTS		380		759		1,512
DEFERRED						
NO. OF CERTIFICATES ANNUAL PAYMENT	\$	38,418 47,032,951	\$	58,301 84,554,188	\$	82,727 135,004,682
VESTED						
NO. OF CERTIFICATES ANNUAL PAYMENT	\$	2,389 1,114,087	\$	7,066 3,972,351	\$	8,241 5,947,131
ETTLEMENT ANNUITIES						
NUMBER ANNUAL PAYMENT	\$	2,456 1,544,565	\$	2,659 1,713,260	\$	3,021 2,079,623
ISABILITY ANNUITIES						
NUMBER ANNUAL PAYMENT	\$	266 119,560	\$	268 112,619	\$	186 63,960
SOURCE: ANNUAL ST FROM CANA EXHIBIT A EXHIBIT G	ATEMI DIAN - MO - MO	ENT AS RESPEC COMPANIES, D DVEMENT OF PO DVEMENT OF AN	TS EPI LIC NUI	LIFE INSURANCE . OF INSURANCE CIES (GROSS) ITIES (GROSS)	RE , C	QUIRED TTAWA:

4.2

. Kale t

1957       1962       196         INDIVIDUAL	
INDIVIDUAL NEW EFFECTED NO. OF POLICIES 25,764 21,503 OFFICIAL AMOUNT \$ 265,692,242 \$ 272,013,869 \$ 433,14 DEATHS	7
NEW EFFECTED NO. OF POLICIES 25,764 21,503 OFFICIAL AMOUNT \$ 265,692,242 \$ 272,013,869 \$ 433,14 DEATHS	- ,
NO. OF POLICIES 25,764 21,503 OFFICIAL AMOUNT \$ 265,692,242 \$ 272,013,869 \$ 433,1 DEATHS	
DEATHS	<b>27,1</b> 69 48,709
NO. OF POLICIES         3,118         3,419           OFFICIAL AMOUNT         \$ 11,252,644         \$ 12,978,744         \$ 17,61	<b>3,754</b> 86,172
MATURITIES	
NO. OF POLICIES 1,232 1,742 OFFICIAL AMOUNT \$ 2,915,972 \$ 4,452,749 \$ 5,7	1,856 37,479
LAPSES, EXPIRIES, AND SURRENDERS	
NO. OF POLICIES 17,878 18,927 2 OFFICIAL AMOUNT \$ 107,773,297 \$ 159,444,320 \$ 218,70	<b>21,</b> 480 00,774
GROUP	
NEW EFFECTED	
NO. DF POLICIES         340         595           NO. DF CERTIFICATES         146,504         113,249           OFFICIAL AMOUNT         \$ 142,974,534         \$ 245,966,604         \$ 414,45	608 52,821 56,337
DEATHS	
NO. DF CERTIFICATES 2,240 2,495 OFFICIAL AMOUNT \$ 5,283,116 \$ 10,833,046 \$ 16,09	2,660 93,751
LAPSES, EXPIRIES, AND SURRENDERS	
NO. OF POLICIES       132       290         NO. OF CERTIFICATES       9,430       18,178       2         OFFICIAL AMOUNT       \$ 21,931,167       \$ 49,973,058       \$ 134,34	602 27,331 46,421

SOURCE: ANNUAL STATEMENT AS RESPECTS LIFE INSURANCE REQUIRED FROM CANADIAN COMPANIES, DEPT. OF INSURANCE, OTTAWA:

EXHIBIT A - MOVEMENT OF POLICIES (GROSS)

4.3

TABLE 4.3	GROSS ANNUITY TRAN For the years 1957			
	1957	1962	1967	
INDIVIDUAL				
NEW EFFECTED				
NO. OF POLICIES ANNUAL PAYMENT	<b>2,3</b> 20 \$ 1,551,590	1,921 \$ 1,628,641	1,964 \$ 1,913,636	
	· · ·			
NO. OF POLICIES ANNUAL PAYMENT	283 \$ 211,388	210 \$ 216,876	298 \$255,257	
LAPSES, EXPIRIES, AND SURRENDERS				
NO. OF POLICIES ANNUAL PAYMENT	1,468 \$ 1,001,703	1,807 \$ 977,375	2,202 \$ 1,121,668	
GROUP				
NEW EFFECTED				
NO. OF POLICIES NO. OF CERTIFICATES ANNUAL PAYMENT	76 3,646 \$ 7,102,105	148 4,132 \$ 8,752,454	96 3,396 \$ 7,977,297	
DEATHS				
NO. OF CERTIFICATES ANNUAL PAYMENT	234 \$ 160,018	412 \$ 270,962	595 \$ 371,439	
SETTLEMENT AND DISABILITY ANNUITIES				
NEW EFFECTED				
NO. OF POLICIES ANNUAL PAYMENT	293 \$ 231,288	275 \$238,443	252 277,508	
DEATHS				
ND. OF POLICIES ANNUAL PAYMENT	20 \$ 8,120	28 \$ 13,643	42 \$ 16,571	
EXPIRIES AND SURREND	DERS			
NO. OF POLICIES ANNUAL PAYMENT	190 \$ 137,628	195 \$ 188,965	213 \$ 251,017	
SOURCE: ANNUAL ST FROM CANA EXHIBIT O	TATEMENT AS RESPECTS NDIAN COMPANIES, DEP G - MOVEMENT OF ANNU	LIFE INSURANCE R T. OF INSURANCE, ITTES (GROSS)	EQUIRED . OTTAWA:	

		TABLE 4.4	FC	IR THE YEARS 19				
				. 1957		<b>1</b> 962		1967
IND		DUAL						
	ND. FORC	OF POLICIES IN E DECEMBER 31		24,094(4)		34,480(4)		37,898(1)
	NET	EARNED PREMIUMS	\$	1,095,084(3)	\$	2,367,624(3)	\$	3,539,011(2)
	NET	INCURRED CLAIMS	\$	420,783(3)	\$	960,180(3)	\$	1,308,794(2)
GRO	UP							
	ND. Forc	OF POLICIES IN E DECEMBER 31		NOT AVAILABLE		NOT AVAILABLE		4,800(1)
	ND. IN F	OF CERTIFICATES ORCE DECEMBER 31		NOT AVAILABLE	• .	NOT AVAILABLE		592,278(1)

NET	EARNED PREMIUMS	\$ 21,791,855(3)	\$ 29,673,240(3)	\$ 57,664,411(2)
NET	INCURRED CLAIMS	\$ 18,393,797(3)	\$ 25,228,186(3)	\$ 46,038,372(2)

SOURCES:	ANNUAL STATEMENT REQUIRED FROM CANADIAN COMPANIES
	REGISTERED OR LICENSED TO TRANSACT THE BUSINESS OF
	INSURANCE OTHER THAN LIFE INSURANCE IN CANADA,
	DEPARTMENT OF INSURANCE, OTTAWA:

- (1) EXHIBITS 20 AND 21 ACCIDENT AND SICKNESS INSURANCE IN AND OUT OF CANADA
- (2) EXHIBITS 10 AND 24 PREMIUMS AND CLAIMS IN AND OUT OF CANADA
- (3) STATEMENT AND TAX DEPARTMENT RECORDS
- (4) HEALTH INSURANCE DEPARTMENT RECORDS

Not reflected in the activity statistics in the preceding tables are data pertaining to in-force administrative functions such as premium billing.

Table 4.5 is an analysis of individual insurance and annuity contracts and benefits, in which the numbers of different plan types by category are presented. Policy differences in durations of benefits and premium-paying periods, and in series or editions (i.e., the mortality table and interest rate assumptions used in premium and value calculations) are not reflected in the plan type statistics.

Group life insurance is primarily of the yearly renewable term plan, although there are a very few contracts with other plan types. Group pension contracts are generally custom-designed to each specific policyholder's needs, in terms of benefits and their relationships to annuitant salary schedules, and in terms of the premium proportions to be paid by the annuitants and by the employers.

Accident and sickness benefits, in both the individual and the group lines of business, consist of income indemnity related to losses of work time and expense indemnity related to hospital, medical, and surgical coverages.

The foregoing brief summary of business in-force, transaction activity, and contract and benefit provisions indicates some of the reasons for diversity in life insurance company record-keeping operations.

# ANALYSIS OF INDIVIDUAL INSURANCE AND TABLE 4.5 ANNUITY CONTRACT AND BENEFIT PLAN TYPES

CONTRACT OR NEFIT DESCRIPTION	NUMBER OF DIFFERENT PLAN OR BENEFIT TYPES (*		
BASIC POLICIES			
1166	2.2		
ENDOWMENT	11		
PENSION AND RETIREMENT INCOME	25		
TERM	38		
RETIREMENT ANNUITY	7		
INSURANCE AND ANNUITY RIDERS			
FAMILY PLAN INSURANCE	3		
FAMILY PROTECTION	10		
LEVEL TERM	4		
HOME SECURITY	2		
ADDITIONAL DEPOSIT PROVISION	2		
ADDITIONAL BENEFITS			
WAIVER AND INCOME DISABILITY	26		
ACCIDENTAL DEATH	9		
DEATH WAIVER	6		
GUARANTEED PURCHASE OPTION	6		
TOTAL	181		

SOURCE: INDIVIDUAL INSURANCE AND ANNUITY DATA PROCESSING SYSTEM, DATA DEFINITION MANUAL, PLAN CODES.

(\*) DIFFERENCES IN BENEFIT AND PREMIUM DURATIONS ARE NOT REFLECTED IN THESE STATISTICS.

#### 2. VOLUMES OF RECORDS AND DATA

Some measures of the volumes of records and data were presented in the preceding section in the considerations of numbers of policies and certificates.

Another indication of the large volumes of records and data which are maintained in a life insurance company's record-keeping activities is presented in Table 4.6. In it, the measurement units, the numbers of units, the numbers of characters per unit, and the file sizes are shown for the computer-based systems for individual insurance and annuity, group life and health insurance, and group pension contracts. Also shown is the file size for the American Dental Association policy (a special group contract providing life insurance coverage for Association members). In all cases, the file contents shown constitute the in-force records only, and make no provision for supplementary files containing transaction activity details or business summaries.

Still another demonstration of the volumes of records and data may be presented by reference to the operations of geographicallyseparate branch offices for sales, policyholder services, and health claims processing. In all of these situations, an adequate level of record-keeping has been found necessary so as to support effectively the needs of the area. To a lesser extent, some decentralized files of data in visual form are maintained in some Head Office departments,

# ANALYSIS OF COMPUTER-BASED SYSTEM MASTER FILE SIZESTABLE 4.6FOR BUSINESS IN-FORCE AS AT SEPTEMBER 30, 1968

SYSTEM	MEASUREMENT UNIT	NUMBER OF UNITS	CHARACTERS PER UNIT	FILE SIZE (NUMBER OF CHARACTERS)
Individual Insurance and Annuity	Policy	450,000	500	225,000,000
Group Life and Health Insurance	Policy	5,000	10,000	50,000,000
Group Pension	Policy	1,500	16,400	24,600,000
American Dental Association	Certificate	35,000	232	8,120,000

Source: Mr. H. S. Saunders, Manager, Programming and Computer Services, Personal Communication.

although the trend in this regard is to incorporate the required data into the computer files and to dispense with the separate visual records.

#### 3. RANGE AND SCOPE OF PROCESSING ACTIVITIES

Some indications were given pertaining to the range and scope of processing activities, by way of the transaction statistics in the initial section of this chapter, as contained in Tables 4.2 and 4.3.

A more detailed presentation of the major processing activity dimension is contained in Table 4.7. In it, the annual transaction volumes are shown for the individual insurance and annuity, group life and health insurance, group pension, and American Dental Association computer systems. The purpose of the table is to show that the annual processing volumes are very large, particularly in the individual insurance and annuity and group life and health systems. More extensive breakdowns of data, such as the numbers of characters per transaction and the distribution of transactions throughout a year, were considered for inclusion in the table; they were not incorporated, however, as they were not regarded as significantly contributory to the thesis topic and development. Such information is fundamental, however, in computer operations and administration, in identifying "bottlenecks" and peak periods, for use in scheduling and resource allocations.

TABLE 4.7 SI	NUAL TRANSACTION VOLUMES BY YSTEM AS AT SEPTEMBER 30, 1968						
	ANNUAL	TRANSACTION	VOLUME BY	SYSTEM			
TRANSACTION DESCRIPTION	INDIVIDUAL INSURANCE AND ANNUIT SYSTEM	GROUP LIFE AND Y HEALTH SYSTEM	GROUP PENSION SYSTEM	AMERICAN DENTAL ASSOCIATION SYSTEM			
BUSINESS ADDED	50,000	150,000	20,800	3,500			
CHANGES	300,000	100,000	37,400	15,000			
FUNDS RECEIVED	675,000	75,000	18,200	60,000			
FUNDS WITHDRAWN	25,000	N. A.	16,100	N. A.			
SPECIAL PAYMENT PROCESSING	175,000	N. A.	N.A.	N. A.			
TERMINATIONS	35,000	110,000	19,200	400			
REQUESTS FOR INFORMATION	325,000	40,000	32,500	1,200			

N. A. NOT APPLICABLE TO THIS LINE OF BUSINESS.

SOURCE: MR. H. S. SAUNDERS, MANAGER, PROGRAMMING AND COMPUTER ----- SERVICES, PERSONAL COMMUNICATION.

4.11

In addition to the computer system records and processing requirements, there are numerous supplementary record-keeping operations throughout the Head Office departments and branch offices. In all situations, the files are maintained and used in order to supply data on specific policies for specific purposes, as required by other departments, branch offices, field representatives, policyholders, auditors, government examiners, and corporate management personnel. In effect, the nature of life insurance products and services results in the record-keeping and associated data processing activities as being the primary corporate data base. This contrasts to the manufacturing situation, in which the inventories of tangible goods, together with associated record-keeping and data processing, are the principal areas of concern.

#### 4. HISTORICAL RECORD REQUIREMENTS AND USES

Insurance record maintenance requirements involve an extensive element of historical data, in addition to current status information. There are several important reasons for this.

The long-term nature of insurance contracts necessitates the maintenance of adequate corporate historical records on individual policies, in order to provide reference sources for information requests by policyholders, beneficiaries, estate executors, field representatives, and government examination committees. The principal areas of historical data needs involve the benefit and other financial amounts, premium-

paying statuses, and beneficiary designations, for purposes of verifying the financial aspects of historical administrative processing. An additional area of primary concern to government examiners involves the classification of business in-force into groupings for liability valuation purposes, and the calculations of the reserves to be held for these groups. The reason for this requirement is to enable verification of the adequacy of corporate reserves, as related to the established governmental standards for insurance company liability valuations. Other forms of historical data, such as the records of all of the mailing addresses that policyholders may have had since the inceptions of their contracts, are much less significant.

The historical records, in addition to those pertaining to current status, must be people-independent; in other words, the records must be capable of providing the necessary data even though all the original participants in the contract may have changed. The information inquiries may originate from beneficiaries or estate executors rather than from the insureds, and may be processed by changing personnel in the insurance company. In effect, this means that the records must be complete within themselves, and not be dependent upon supplementary personal knowledge on the part of company staff members. The records must also be practically accessible.

In the administration of in-force business, situations are encountered in which policyholders request changes in the policy contractual terms pertaining to benefits and associated premiums, with the changes to be effective at some point-of-time in the past. This is particularly pertinent to the group life and health insurance line of business, in which changes of benefits may be back-dated, partly because of the time periods involved in negotiating the changes among the employer (the policyholder), the employees (the certificateholders), and the insurance company. Backdated policy changes may also be negotiated in individual insurance policies. Examples of this type are the changing of policy contractual benefits subsequent to the policy issue date, but with the changed status being effective from the issue date; a decision to alter or reverse a previous policy change as at the effective date of that change; and the reinstatement of a policy as at the date of termination.

In all retroactive changes, the final resulting statuses of the policies must be the same as if the changes had been made on, rather than subsequent to, the effective dates. This requires the reversal of premiums, dividends, and claims which may have been paid on the original policy basis during the period between the change effective date and the current time; the changing of the policy terms from the original to the revised basis; and the updating of the revised record to reflect premiums, dividends, and claims pertaining to the period between the change effective date and the present.

The records must contain sufficient data to enable the accurate processing of administrative activities pertaining to retroactive changes.

Historical records are also utilized extensively in corporate business analysis and evaluation. The establishment of premium rates to be charged for policy benefit provisions involves the making of assumptions as to anticipated mortality rates, expense levels, interest rates, and, for health coverages, the claims experience. Periodic studies of actual corporate experience, using historical records, are necessary in order to evaluate the original assumptions and, where indicated, to make changes in the assumptions so as to make them more realistic and representative. Mortality investigations, gross premium valuations, and persistency analyses are some of the specific studies which are conducted in the individual life insurance line of business. The yearly-renewable-term nature of group life and health insurance implies an annual analysis of each policy, in which premiums, claims, commissions, and expenses are correlated to determine the profit-orloss experience and to assist in the setting of revised rates, where indicated, for the next policy year.

A closely related use of historical records involves the analysis of data so as to develop meaningful bases for projections into the future. Trends in new business, business in-force, and transaction activity, as related to numbers of policies, amounts of insurance, and annualized premiums can be particularly useful.

An important historical and current record-keeping aspect involves the degree of detail to which the information is maintained. The summarization of data results in the destruction of some of the

detailed characteristics. In the event that the summarized data indicate areas or situations of considerable interest or concern, it must be possible to investigate the details supporting the summarized data, so as to determine the fundamental causes of the situations at the appropriate action-taking level. This point was made in a more general way in Chapter 3, in reference to information system developments and problems as analyzed by Head (11). Its importance must be stressed nevertheless by repetition in the present context, in that the historical records must be retained in sufficient detail, for adequately long periods of time, and in practically usable form, so as to support the information requirements at all corporate levels.

#### · 5. INCREASED COMPLEXITY OF PRODUCTS

The complexity of insurance company products has been increasing in recent years as the result of new coverage developments to meet the changing buyer needs. The custom-tailoring of benefits, premiums, and other contractual provisions for specific policies is a common feature of group life, health, and pension business. Moreover, the development of a new product to replace a previous one results in an increase in the complexity of business in-force administrative procedures, as there will be some policies issued on the former benefit basis that are still in-force and which must be dealt with as required, even though the benefit structures may no longer be available for new business policy issues.

Table 4.8 is a summary of the more significant increments to the complexity of individual insurance, annuity, and health business, for the period 1957-1968. Tables 4.9 and 4.10 are similar summaries dealing with, respectively, the group life and health and group pension lines of business. All three tables deal with the specific subject company.

It is thereby apparent that the insurance products, together with their administrative requirements, have become more complex during the period of review.

As one example, with reference to the individual insurance line of business, there have been changes in the dividend options available to policyholders, as noted in Table 4.8 as item 2 in 1957 and item 4 in 1963. The introductions of these new dividend options have complicated the dividend processing routines. New actuarial tables are required for the one-year term insurance rates. New processing logic is necessary to identify the extended range of options available and to perform the required calculations for each. Finally, additional policy information must be maintained, so as to enable the accurate processing of death claims and inquiries as they arise. The principal impact of the developments cited in this example is in the operational routines of administrative record-keeping and processing, rather than in the area of senior management decision-making. Nevertheless, there are associated management matters involved, such as the decisions as to the products to offer and the rates to be charged.

INCREMENTS TO THE COMPLEXITY OF INDIVIDUAL INSURANCE, ANNUITY, AND HEALTH BUSINESS TABLE 4.8 FOR THE PERIOD 1957-1968

1957

- 1. INTRODUCTION OF FAMILY PLAN LIFE INSURANCE (THERE CAN BE DEATH CLAIMS ON POLICIES THAT REMAIN IN FORCE).
- 2. INTRODUCTION OF DIVIDEND OPTION.(E); ONE-YEAR TERM INSURANCE OF AMOUNT UP TO THE CASH VALUE AT THE END OF THE POLICY YEAR.
- 3. INTRODUCTION OF THE REGISTERED RETIREMENT SAVINGS PLANS.

#### 1958

- INTRODUCTION OF THE "AUTOPAY" METHOD OF PAYING MONTHLY PREMIUMS (THE COMPANY OBTAINS AUTHORIZATIONS TO DRAW CHEQUES EACH MONTH AGAINST THE PAYORS' CHECKING ACCOUNTS; THE BANKS ARE AUTHORIZED TO HONOR THESE CHEQUES; THE CHEQUES SERVE AS PREMIUM RECEIPTS; NO PREMIUM NOTICES ARE REQUIRED).
- 2. INTRODUCTION OF NEW HEALTH INSURANCE PORTFOLIO, INCLUDING LEVEL PREMIUMS, GRADED COMMISSIONS, COMBINED LIFE AND HEALTH APPLICA-TIONS, AND NON-CANCELLABLE AND GUARANTEED RENEWABLE BENEFITS.
- 3. INTRODUCTION OF PROVINCIAL HOSPITAL SERVICES ACTS IN CANADA, WITH RESULTING CHANGES IN HOSPITAL EXPENSE POLICIES.
- 4. EXTENSION OF GROUP CONVERSION PLANS.

#### 1959

 ENACTMENT OF CANADA ESTATE TAX ACT AND SUBSEQUENT REGULATIONS THEREUNDER.

#### 1960

1. REVISION OF MEDICAL EXPENSE PLANS.

#### 1961

 INTRODUCTION OF THE PAYMENT OF DIVIDENDS BY A DIFFERENT SCALE TO POLICIES ISSUED UNDER U.S.A. PENSION TRUSTS AND IN VARIOUS TAX-SHELTERED CATEGORIES, EVEN AFTER POLICY WITHDRAWALS FROM THE PENSION TRUSTS.

#### 1962

- 1. INTRODUCTION OF USE OF SINGLE PREMIUM IMMEDIATE ANNUITY RATES AS AN ALTERNATIVE TO CONTRACTUAL SETTLEMENT OPTIONS.
- 2. INTRODUCTION OF OFFICE OVERHEAD EXPENSE PLAN FOR HEALTH INSURANCE.

INCREMENTS TO THE COMPLEXITY OF INDIVIDUAL INSURANCE, ANNUITY, AND HEALTH BUSINESS FOR THE PERIOD 1957-1968

#### TABLE 4.8 (CONT D)

1963

- 1. CHANGE IN THE BASIS OF CALCULATING NON-ANNUAL PREMIUM LOADINGS, FROM A STRAIGHT PERCENTAGE TO A PERCENTAGE PLUS A FLAT CHARGE.
- 2. INTRODUCTION OF RENEWAL COMMISSION PAYMENTS ON A BULK BASIS.
- 3. INTRODUCTION OF THE 1-4-7 WHOLE LIFE INSURANCE PLAN, WITH ATTEN-DANT COMMISSION AND VOLUME COMPLICATIONS IN THE FIRST, FOURTH, AND SEVENTH POLICY YEARS. THE INSURANCE AMOUNT REMAIN LEVEL FOR LIFE. THE PREMIUMS FOR THE FIRST TO THIRD AND FOURTH TO SIXTH POLICY YEARS ARE 50% AND 75% RESPECTIVELY OF THE PREMIUMS FOR THE SEVENTH AND SUBSEQUENT POLICY YEARS.
- 4. INTRODUCTION OF DIVIDEND OPTION (F); ONE-YEAR TERM INSURANCE OF AMOUNT UP TO \$300 PER THOUSAND OF INITIAL INSURANCE AMOUNT.
- 5. ADDITION OF TAXPAYER IDENTIFICATION NUMBERS AS PART OF INCOME TAX REPORTING PROCEDURES.
- 6. INTRODUCTION OF ALBERTA MEDICAL PLAN BY ALBERTA GOVERNMENT.

## 1964

1965

- ADDITION OF MORE COMPLICATED PROCEDURES FOR REPORTING ESTATE AND INHERITANCE TAX INFORMATION TO FEDERAL, PROVINCIAL, AND STATE AUTHORITIES.
  - 2. UNDERWRITING LIMITS AMENDED IN CONSIDERATION OF U.S.A. SOCIAL SECURITY BENEFITS.
  - 3. INTRODUCTION OF "INITIAL BENEFIT" RIDERS FOR INTEGRATING DISABILITY INCOME WITH U.S.A. SOCIAL SECURITY BENEFITS.
  - 4. REVISION OF U.S.A. HEALTH PREHIUM RATES AND NON-CANCELLABLE PLANS.

#### 1966

1. INTRODUCTION OF MEDICARE IN U.S.A., WITH COMPLICATING EFFECTS ON IN-FORCE HEALTH COVERAGE BUSINESS.

#### 1967

- 1. REVISION OF U.S.A. MEDICAL EXPENSE PLANS.
- 2. INTRODUCTION OF HOSPITAL INCOME POLICY.

INCREMENTS TO THE COMPLEXITY OF INDIVIDUAL INSURANCE, ANNUITY, AND HEALTH BUSINESS

#### TABLE 4.8 (CONT D)

## FOR THE PERIOD 1957-1968

#### 1968

 CURRENT CANADIAN FEDERAL BUDGET PROPOSALS FOR TAXING CANADIAN POLICYHOLDERS ON ''GAINS'' UNDER POLICIES.

#### CONTINUING

- INCREASING USE OF LOAN VALUES ON POLICIES WITH HIGH EARLY YEAR CASH VALUES (E.G., MAXIMUM SECURITY), WITH RESULTING COMPLICA-TIONS IN THE PREMIUM BILLING PROCESS.
- 2. INCOME TAX REPORTING FOR INTEREST ON DIVIDEND FUNDS, PREMIUM SUSPENSE ACCOUNT FUNDS, AND ADVANCE PREMIUM PAYMENTS, WITH ADDITIONS TO THE RECORD-KEEPING PROBLEMS (INCLUDING BRINGING THE TAXABLE AMOUNTS TOGETHER BY INDIVIDUAL).
- 3. TRANSFERS OF POLICIES FROM APPROVED PENSION PLANS TO REGISTERED RETIREMENT SAVINGS STATUS.
- 4. INTRODUCTION OF ''LOCKED IN'' BENEFITS UNDER ONTARIO AND QUEBEC PENSION PORTABILITY PROVISIONS, WITH RESULTING COMPLICATED CHANGES IN RESPECT OF COVERAGES ON INSUREDS WITH PENSION PLANS.
- 5. TRANSFERS OF REGISTERED RETIREMENT SAVINGS PLANS FROM ONE CARRIER TO ANOTHER.
- 6. EFFECTS OF TERM INSURANCE DIVIDEND OPTIONS ON POLICIES SUBJECT TO FLAT EXTRA OR AVIATION EXTRA PREMIUMS; AND ON POLICIES WITH STANDARD PREMIUM RATES, FOR WHICH THE INSURABILITY IS FOUND TO HAVE DETERIORATED WHEN REQUESTS TO CHANGE THE DIVIDEND OPTIONS TO A TERM INSURANCE FORM ARE MADE.
- 7. PENSION TRUSTS FUNDED BY ORD. LIFE PLUS AUXILIARY FUND DEPOSITS.
- 8. REGISTERED POLICIES ISSUED TO DEFER TAX ON PENSIONS PAYABLE TO FORMER CIVIL SERVANTS AND EX-MEMBERS OF THE ARMED FORCES.
- 9. ADJUSTMENT OF TERM POLICIES TO COMPLY WITH THE CANADIAN LEGIS-LATION CONCERNING THE DEDUCTIBILITY OF TERM PREMIUMS AS BUSINESS EXPENSES.
- 10. GENERAL DEVELOPMENT OF MORE COMPLICATED OWNERSHIP AND CONTROL SITUATIONS PERTAINING TO LIFE INSURANCE POLICIES.
- 11. INCREASE IN REQUESTS FOR INCOME TAX CALCULATIONS BY POLICY-HOLDERS, SO THAT THEY CAN DETERMINE THE BEST COURSE OF ACTION TO FOLLOW IN RELATION TO AVAILABLE POLICY BENEFITS.
- 12. INCREASE IN REQUESTS FOR ANNUITY SETTLEMENTS BASED ON INTEG-RATION WITH OLD AGE SECURITY BENEFITS.

SOURCE: MR. R. B. PENNYCOOK, DIRECTOR, INDIVIDUAL INSURANCE ADMINISTRATION, PERSONAL COMMUNICATION. INCREMENTS TO THE COMPLEXITY OF GROUP LIFE TABLE 4.9 AND HEALTH BUSINESS FOR THE PERIOD 1957-1968

4.21

1957

- 1. EXTENSION OF LIFE INSURANCE MAXIMUM AMOUNTS, RESULTING IN LARGE BENEFIT CLASS SCHEDULES AND EXCESS LIFE INSURANCE PROCESSING.
- 2. INTRODUCTION OF MAJOR MEDICAL COVERAGE.
- 3. INTRODUCTION OF COMPREHENSIVE HEALTH INSURANCE COVERAGE, WITH WIDE FLEXIBILITY IN PLAN TYPES AND COMPLICATIONS IN COMMISSION HANDLING.

#### 1958

- 1. INTRODUCTION OF GOVERNMENT HOSPITALIZATION.
- 2. USE OF RECIPROCAL INCURRED CLAIMS RESERVE AGREEMENTS.
- 3. ADDITION OF HEALTH INSURANCE CONVERSION PRIVILEGE.
- 4. IMPLEMENTATION OF REVISED "ACTIVITY INCREASE" COMMISSION RULES, RESULTING IN COMPLEXITIES IN COMMISSION ADMINISTRATION OF LARGE CASES.
- 5. INTRODUCTION OF RELATIVE VALUE SURGICAL, ANAESTHESIA, AND DIAG-NOSTIC SCHEDULES.

#### 1959

1. INTRODUCTION OF U.S. WELFARE DISCLOSURE LEGISLATION.

## 1960

- 1. PREDOMINANT INCREASE IN TRANSFER BUSINESS, REQUIRING DUPLICATION OF THE FORMER CARRIER'S CONTRACT.
- 2. INTRODUCTION OF MONTHLY INCOME INSURANCE AND OF EXCESS MONTHLY INCOME INSURANCE.
- 3. INTRODUCTION OF THE CLAIMS FLUCTUATION RESERVE CONCEPT TO LEVEL EXPERIENCE FLUCTUATIONS.
- 4. USE OF CONTRACT-REMISSABLE PREMIUM ARRANGEMENTS.
- 5. COMMENCEMENT OF ISSUE ON A GROUP BASIS OF GROUP WHOLE LIFE, 10-PAY LIFE, AND SINGLE PREMIUM LIFE INSURANCE. OFTEN THIS CALLS FOR INTEGRATION WITH PLANS INVOLVING EMPLOYEE PURCHASES OF PAID-UP UNITS.

4.22

	INCREMENTS TO THE COMPLEXITY OF GROUP LIFE TABLE 4.9 (CONT'D) AND HEALTH BUSINESS FOR THE PERIOD 1957-1968
1961	
1.	EXTENSION OF THE USE OF ABSOLUTE ASSIGNMENTS ON LIFE INSURANCE.
2.	INTRODUCTION OF SEPARATE COMMISSIONING PRACTICES ON MONTHLY INCOME INSURANCE.
1962	
1.	USE OF NON-MEDICAL UNDERWRITING TECHNIQUES FOR EXCESS LIFE INSU- RANCE AND EXCESS MONTHLY INCOME INSURANCE COVERAGES.
2.	INTRODUCTION OF PROVINCIAL FEE SCHEDULES AND KEY PLANS FOR HEALTH INSURANCE.
3.	INTRODUCTION OF ''HYBRID'' COMMISSION SCALES.
4.	INTRODUCTION OF INTEREST EARNING TAX REPORTS ON FUNDS ON DEPOSIT.
1963	
1964	
1.	RAPIDLY CHANGING STATE LEGISLATION AND EXTENSION INTO AREAS SUCH AS PARA-MEDICAL SERVICES.
2.	INTRODUCTION OF "DENTALCARE" COVERAGE, TOGETHER WITH SEPARATE COMMISSIONING PRACTICES.
3.	USE OF DEPOSIT ADMINISTRATION FUNDED TERMINAL PURCHASE PLANS FOR RETIRED BENEFITS.
4 .	INTRODUCTION OF LIFE INSURANCE WHICH IS INTEGRATED WITH PENSION BENEFIT PLANS, THE LIFE INSURANCE BEING A FUNCTION OF THE PROS- PECTIVE PENSION LESS THE ACCUMULATED DEATH BENEFIT UNDER THE PENSION PLAN.
1965	•
81.	ADDITION OF CO-DRDINATION OF BENEFITS PROVISIONS.

- 2. INTRODUCTION OF SURGICAL BREAKTHROUGH BENEFIT.
- 3. INTRODUCTION OF MOVING MAJOR MEDICAL BENEFIT.
- 4. INTRODUCTION OF POOLING AND STOP-LOSS TECHNIQUES TO LEVEL EXPERIENCE FLUCTUATIONS, PARTICULARLY ON REFUND CASES.
- 5. REFINEMENT OF RETENTION TECHNIQUES (E.G., INTEREST ALLOWANCE ON INCURRED CLAIMS RESERVES).
- 6. REVISION OF GROUP OVERRIDING (COMMISSION) BASIS TO ENABLE SEPA-RATION BY SALES OFFICE.

TABLE 4.9 (CONT®D)INCREMENTS TO THE COMPLEXITY OF GROUP LIFE<br/>AND HEALTH BUSINESS FOR THE PERIOD 1957-1968

4.23

#### 1966

- 1. INTRODUCTION OF U.S. MEDICARE FOR THE AGED.
- 2. INTEGRATION OF CO-ORDINATION OF BENEFITS WITH MEDICARE.
- 3. INTRODUCTION OF "'TOTALCARE'' COVERAGE.
- 4. INTEGRATION OF MONTHLY INCOME INSURANCE WITH THE U.S.A. SOCIAL SECURITY AND THE CANADA PENSION PLANS.
- 5. PARTICIPATION IN THE U.S.A. SERVICEMEN'S GROUP LIFE INSURANCE (SEGLI) PLAN, WITH ITS CONVERSION COMPLICATIONS.
- 6. INTRODUCTION OF VARIABLE BENEFITS WHICH ARE A DIRECT FUNCTION OF EARNINGS.
- 7. INTRODUCTION OF MONTHLY INCOME INSURANCE CONVERSION PRIVILEGE.

#### 1967

- 1. INTRODUCTION OF "'NO GAIN NO LOSS" PROVISIONS.
- 2. COMMENCEMENT OF INTRODUCTION OF MEDICARE IN CANADA.
- 3. COMMENCEMENT OF WIDOW'S AND CHILDREN'S LIFE INSURANCE PLANS.

#### 1968

- 1. REFINEMENT OF OVERDUE PREMIUM TECHNIQUES.
- 2. INTRODUCTION OF SPECIAL SERVICE ALLOWANCES AND EXPENSE ALLOW-ANCES FOR CERTAIN AGENTS AND BROKERS.
- 3. INTRODUCTION OF GROUP WHOLE LIFE INSURANCE (GROUP ORDINARY).

SOURCE: MR. A. E. DACK, DIRECTOR, GROUP INSURANCE ADMINIS-TRATION, PERSONAL COMMUNICATION.

### TABLE 4.10 PENSION BUSINESS FOR THE PERIOD 1957-1968 ----1957 -----1958 BEGINNING OF A TREND TO THE CONVERSION OF LARGE GROUP ANNUITY 1. CASES TO A DEPOSIT ADMINISTRATION BASIS. 1959 ----INTRODUCTION OF WELFARE DISCLOSURE ACT IN THE U.S.A. 1. 1960 ----1. DEVELOPMENT OF A NEW MONEY DEPOSIT ADMINISTRATION CONTRACT.

INCREMENTS TO THE COMPLEXITY OF GROUP

4.24

 INTRODUCTION OF THE NEW MONEY METHOD OF CREDITING INTEREST ON GROUP ANNUITY (AS OPPOSED TO DEPOSIT ADMINISTRATION) CONTRACTS.

#### 1961

1962

- 1. DEVELOPMENT OF THE TAX SHELTERED GROUP ANNUITY CONTRACT.
- 2. INTRODUCTION OF NEW BASIC GROUP ANNUITY RATES AND RELATED "DISCOUNT" TECHNIQUE BASED ON SIZE OF PREMIUM.
- 3. CHANGE IN RESERVE VALUATION BASIS.

#### 1963

- 1. DEVELOPMENT OF TERMINAL FUNDED GROUP ANNUITY PRODUCT.
- 2. INTRODUCTION OF SPECIAL AGENTS' COMPENSATION BASIS FOR TAX SHELTERED GROUP ANNUITY BUSINESS.

#### 1964

1. ESTABLISHMENT OF CANADIAN SEGREGATED EQUITY FUND.
INCREMENTS TO THE COMPLEXITY OF GROUPTABLE 4.10 (CONT®D)PENSION BUSINESS FOR THE PERIOD 1957-1968

1965 ·

- CHANGE IN METHOD OF ALLOCATING GROUP OVERRIDING (COMMISSION) TO ENABLE SPLIT BY SALES OFFICE.
- 2. ENACTMENT OF PENSION BENEFITS LEGISLATION IN ONTARIO.
- 3. CHANGE IN RESERVE VALUATION BASIS.

#### 1966

- 1. INTRODUCTION OF CANADA PENSION PLAN, AND RESULTING CHANGES IN BENEFIT FORMULAE IN GREAT-WEST LIFE POLICIES WHICH NECESSITATED CHANGES IN CONTRACTS AND ADMINISTRATION METHODS.
- 2. DEVELOPMENT OF GROUP PENSION COMPUTER SYSTEM.
- 3. DEVELOPMENT OF GROUP RETIREMENT ANNUITY CONTRACT.
- 4. DEVELOPMENT OF GUARANTEED PENSION FUND CONTRACT.
- 5. ENACTMENT OF PENSION BENEFITS LEGISLATION IN QUEBEC.
- 6. ESTABLISHMENT OF CANADIAN SEGREGATED PROPERTY FUND.
- 7. CHANGE IN RESERVE VALUATION BASIS.

#### 1967

- 1. ENACTMENT OF PENSION FUND LEGISLATION IN ALBERTA.
- 2. CHANGE IN RESERVE VALUATION BASIS.

#### 1968

- 1. DEVELOPMENT OF VARIABLE ANNUITY PRODUCT FOR USE IN THE TAX SHELTERED MARKET IN THE U.S.A.
- 2. DEVELOPMENT OF A SPECIAL PLAN FOR RETIRED SERVICEMEN.
- 3. ENACTMENT OF PENSION BENEFITS LEGISLATION IN SASKATCHEWAN.
- ENACTMENT OF FEDERAL PENSION BENEFITS LEGISLATION.

SOURCE: MR. W. J. HUDSON, DIRECTOR, GROUP PENSION ADMINIS-TRATION, PERSONAL COMMUNICATION. As a second example, with reference to the Group Life and Health insurance business, there has been an increasing degree of involvement of governments in health insurance. This is shown by the contents of Table 4.9, and in particular by item 1 in 1958, item 2 in 1962, item 1 in 1964, items 1 and 4 in 1966, and item 2 in 1967. The effects of these developments have been to necessitate company changes in existing products and the development of new products, so as to provide effective integration of benefit structures with those provided by governmental agencies, and to extend the potential range of business opportunities. The direct impact of these changes has extended throughout the corporate operations, and has affected not only the administrative systems but also management decisions as to the corporate direction to follow in the nature and content of product developments.

The trend in complexity increase for the 1957-1968 period, as illustrated by the contents of Tables 4.8, 4.9, and 4.10, suggests that a trend of at least similar proportions may well be experienced in the corresponding period now commencing.

6. INCREASING INVOLVEMENT OF GOVERNMENTAL BODIES

The increasing involvement of governmental bodies in the operations of a life insurance company, and the resulting effects upon their record-keeping operations, are due to two principal reasons.

The increasing complexity of insurance products and of associated administrative practices necessitates more work on the part of govern-

mental groups and the use of more extensive basic data in order to verify the corporate state-of-affairs vis-a-vis the legislative standards. The growth in business in-force and in the related actuarial reserves also contributes to the extensiveness of required governmental examinations of corporate actuarial records.

Table 4.11 is a summary of the number of reserve line entries and the net reserve liabilities as of the 1957, 1962, and 1967 yearends. The data are related to insurance, annuity, and pension business, and demonstrate the growth in total and in the participating and nonparticipating accounts as well. A similar table for health insurance reserve groupings cannot be prepared because of the different nature of the valuation methods. As an indication of growth in health insurance in the present context, however, the total health account liabilities in all countries, as at the end of 1957, 1962, and 1967 were shown in the Dominion Annual Statement Liability Exhibits as, respectively, \$9,520,085, \$21,812,055, and \$39,941,470.

A current product development which adds considerably to the business complexity involves the entry into the variable annuity market. As the name implies, the annuity benefits are not set at fixed dollar amounts in the contracts; rather, they are variable and are dependent in part upon the market values of the securities which are maintained to support the contractual obligations. A consequence of this business development is the necessity to conform to the conditions and regulations laid down by the Securities and

NUMBER TABLE 4.11 LIABIL	OF RESERVE LINE ITIES AS AT THE I	ENTRIES AND THE END OF 1957, 1962	NET RESERVE , AND 1967.
	1957	1962	1967
NUMBER OF RESERVE LINE ENTRIES			
PARTICIPATING ACCOUNT	72	89	108
NON-PARTICIPATING ACCOUNT	72	96	104
TOTAL	144	185	212
NET RESERVE LIABILITY			
PARTICIPATING ACCOUNT	\$ 366,177,106	\$ 475,232,816	\$ 609,591,699
NON-PARTICIPATING ACCOUNT	\$ 151,078,450	\$ 241,326,593	\$ 369,062,126

SOURCE: ANNUAL STATEMENT AS RESPECTS LIFE INSURANCE REQUIRED FROM CANADIAN COMPANIES, DEPT. OF INSURANCE, OTTAWA:

\$ 517,255,556

\$ 716,559,409

EXHIBIT 15 - VALUATION SUMMARY

TOTAL

4.28

\$ 978,653,825

Exchange Commission. Record-keeping activities required to support this statement area are materially affected.

In addition to the governmental information requirements pertaining to assets, liabilities, income, disbursements, and taxation, there is a further significant impact of governmental activities on insurance company operations. This is caused by direct competition in the industry, as the result of government-sponsored social security, pension, medical coverage, and federal employee life insurance benefits. The effects of this competitive activity on life insurance company operations are to remove some of the benefits from corporate markets and to require the development of new products which can be integrated with federal programs. The design of products which are to be so integrated with plans initiated elsewhere that are themselves subject to legislative changes, rather than the design of a totally-integrated and controlled benefit package, invariably leads to complications in benefit provisions and record-keeping activities of the insurance companies. Avoidance of coverage duplications and omissions is an important factor in this regard.

#### 7. INDUSTRY GROWTH

In section 1 of this chapter, the growth in corporate business in-force between 1957 and 1967 was demonstrated. The purpose of this section is to put the corporate growth into some perspective by outlining the growth which has taken place in the life insurance industry in Canada and United States during the same period.

Table 4.12 summarizes the insurance industry business in-force in Canada and United States as at the end of 1957, 1962, and 1967. Table 4.13 is a similar analysis of new insurance business purchased during 1957, 1962, and 1967.

#### 8. RISING OPERATIONAL COSTS

During the last ten years, there has been a continuous increase in operational costs. Some of the increase is due to the inflationary situations in both Canadian and American economies, with the attendant decreases in dollar purchasing power. Other contributory factors include the increasing complexity of products and services and the continually-increasing involvement of governmental bodies in insurance matters. Finally and undoubtedly most significant is the factor of business growth.

There are many different methods whereby rising operational costs may be demonstrated. Since it is not the purpose of this section to outline extensive evidence in support of the rising cost observations, a limited summary of selected components has been prepared. Table 4.14 outlines expenses and unit costs of operations by line of business for the years 1957, 1962, and 1967. Continued and significant growths are indicated in the unit costs as well as in the aggregate costs themselves.

		000,0	00 OMI1	TTED)					
		1	957		1	962			1967
URANCE - AMOUNT	s -		-						
CANADA									
INDIVIDUAL GROUP		\$22 9	• 324 • 164	\$	33 18	,317 ,049		\$4 3	7,666
INDUSTRIAL		1	,599			867			695
TOTAL		\$ 33	,087	\$	52	,233	:	\$8	4,805
UNITED STATES									
INDIVIDUAL GROUP INDUSTRIAL CREDIT		\$ 264 133 40 19	•678 •794 •139 •748	\$	389 209 39 38	,150 ,178 ,638	:	\$58 39 3 6	2,565 1,089 9,215 6,952
TOTAL	:	\$ 458	,359	\$	675	,977	\$	1,07	9,821
TOTAL UITY - ANNUAL PA	AYMENT	\$ 458	,359	\$	675	<b>,</b> 977	\$	1,07	9,821
TOTAL UITY - ANNUAL PA CANADA	AYMENT	\$ 458	,359	\$	675	,977	\$ 1	1,07	9,821
TOTAL UITY - ANNUAL PA CANADA INDIVIDUAL GROUP SUPPLEMENTARY	AYMENT  Y CONTRACTS	\$ 458 \$	\$359 57 447 15	\$	675 \$	, 977 65 783 18	\$ ]	\$	9,821 92 925 22
TOTAL UITY - ANNUAL PA CANADA INDIVIDUAL GROUP SUPPLEMENTARY TOTAL	AYMENT	\$ 458 \$ \$	,359 57 447 15 519	\$	675 \$	,977 65 783 18 866	\$ 1	\$ \$	9,821 925 22 1,039
TOTAL UITY - ANNUAL PA CANADA INDIVIDUAL GROUP SUPPLEMENTARY TOTAL UNITED STATES	AYMENT	\$ 458 \$ \$	,359 57 447 15 519	\$	675 \$	65 783 18 866	\$	\$ \$	9,821 925 22 1,039
TOTAL UITY - ANNUAL PA CANADA INDIVIDUAL GROUP SUPPLEMENTARY TOTAL UNITED STATES INDIVIDUAL GROUP SUPPLEMENTARY	AYMENT Y CONTRACTS Y CONTRACTS	\$ 458 \$ \$ \$1,	,359 57 447 15 519 592 ,478 183	<b>\$</b>	675 \$ \$ \$	65 783 18 866 569 169 252	\$	\$ \$ \$	9,821 925 22 1,039 844 3,211 311

UNITED STATES - LIFE INSURANCE FACT BOOK, PUBLISHED BY INFORMATION THE INSTITUTE OF LIFE INSURANCE, 1968.

	TABLE 4.13	INSURANCE PURCHASED	INDUSTRY DURING 19	NEW IN 357, 19	NSURANCE E	BUSINESS	
		(00	0,000 OMI1	TTED)			
			1957		1962	1967	
CANADA							
INDIVIDUA	\L	\$	3,861	\$	4,428	\$ <b>7,00</b> 5	
GROUP			1,005		1,583	3,376	
INDUSTRIA	L		73		16	10	
TOTAL		\$	4,939	\$	6,027	\$ 10,391	
UNITED STATE	S						
INDIVIDUA	L	\$	45,635	\$	56,998	\$ 94,699	
GROUP			14,325		15,533	38,761	
INDUSTRIA	L		6,766		7,046	7,152	
TOTAL		\$	66;726	ţ	79,577	\$ 140,612	

SOURCES:

#### CANADIAN DATA - CANADIAN LIFE INSURANCE FACTS, PUBLISHED BY THE CANADIAN LIFE INSURANCE ASSOCIATION, IN 1967 AND 1968.

UNITED STATES - LIFE INSURANCE FACT BOOK, PUBLISHED BY INFORMATION THE INSTITUTE OF LIFE INSURANCE, 1968.

EXPENSES AND UNIT COSTS OF OPERATIONS BY TABLE 4.14 LINE OF BUSINESS FOR 1957, 1962, AND 1967

	1957	1962	1967
INDIVIDUAL		1996 - 1997 - 1997 - 1998 -	
TOTAL GENERAL EXPENSES(1) IN FORCE (END OF YEAR):	\$ 2,361,493	\$ 3,450,590	\$ 4,552,096
NO. OF POLICIES (2) EXPENSE - PER POLICY	\$ 483,312 4.89	\$ 483,570 7.14	\$ 487,602 9.34
GROUP LIFE INSURANCE			
TOTAL EXPENSES IN FORCE (END OF YEAR):	\$ (3)	\$ 764,160	\$ 2,123,986
ND. OF POLICIES	1,858	3,801	4,399
EXPENSE - PER POLICY - PER CERTIFICATE	\$ (3)	\$ 201.04	\$ 482.83
GROUP HEALTH INSURANCE(5)			
TOTAL EXPENSES	\$ (3)	\$ 2,078,034	\$ 4,210,562
GROUP PENSIONS			
TOTAL EXPENSES IN FORCE (END OF YEAR):	\$ (3)	\$ 734,425	\$ 1,740,473
NO. OF POLICIES	380	759	1,512
EXPENSE - PER POLICY - PER CERTIFICATE	\$ 38,938 (3) (3)	\$ 60,285 967.61 12.18	\$ 86,686 1,151.11 20.08

- (1) EXCLUDING EXPENSES OF ACQUISITION, SELECTION, POLICY VALUA-TION, ADVERTISING, RATE DETERMINATION ETC., REINSURANCE, CON-SERVATION AND COMPANY CONTRIBUTIONS TO AGENTS' PENSION FUNDS.
- (2) INCLUDING INDIVIDUAL LIFE AND HEALTH INSURANCE AND INDIVIDUAL, SETTLEMENT, AND DISABILITY ANNUITIES (SEE TABLES 4.1 AND 4.4).
- (3) DATA FOR 1957 ARE NOT SHOWN WHERE INDICATED, AS THE BASIS OF EXPENSE ALLOCATION WAS MARKEDLY DIFFERENT FROM THE BASES FOR 1962 AND 1967. COMPARISONS WITH 1957 DATA WOULD THEREFORE NOT BE TOO MEANINGFUL.
- (4) NUMBER OF CERTIFICATES IF THE NUMBER UNDER SHARED GROUPS IS COUNTED ON A PRO RATA BASIS.
- (5) IN FORCE DATA NOT SHOWN, AS MOST GROUP POLICIES CONTAINING HEALTH COVERAGES ALSO CONTAIN LIFE INSURANCE BENEFITS.

TABLE 4.14 (CONT'D)EXPENSES AND UNIT COSTS OF OPERATIONS BY<br/>LINE OF BUSINESS FOR 1957, 1962, AND 1967

(6) NUMBER OF CERTIFICATES INCLUDES DEFERRED AND VESTED BENEFITS.

SOURCES: MR. J. N. CLAYTON, MANAGER, EXPENSE ACCOUNTING, PERSONAL ------ COMMUNICATION.

ANNUAL STATEMENT AS RESPECTS LIFE INSURANCE REQUIRED FROM CANADIAN COMPANIES, DEPT. OF INSURANCE, OTTAMA:

EXHIBIT A - MOVEMENT OF POLICIES (GROSS) EXHIBIT G - MOVEMENT OF ANNUITIES (GROSS) 양성감사람이 많은

#### 9. COMPUTER USAGE

4.35

The use of computers for various corporate data processing activities has continuously increased during the past decade.

One indication of this growth environment may be given by reference to computer acquisitions. Table 4.15 is a summary of the principal components and the related purchase costs of computer equipment acquired since 1958. The internal and direct access storage capacities are also shown, to provide a broad basis for processing power comparisons.

The IBM 650 computer was initially used on a regularly-scheduled basis to process a punched-card file of about 1,000,000 punched cards, representing individual insurance and annuity in-force business, for the valuation of reserves and calculations of dividend information. In addition, closely-related operations were similarly processed for transaction activity affecting the in-force file. Other functions for which the IEM 650 computer was used included premium billing, commision accounting, death claims, mortality investigations. policy loans, rate books, miscellaneous rate calculations for the individual insurance and annuity line of business; pension calculations and billing, annuity rate books, and commutation function calculations for the group function; mortgage accounting and interest table calculations for the investment operations; and premium billing and commission COMPUTER COMPONENT ACQUISITIONS AND TABLE 4.15 PURCHASE COSTS FOR THE PERIOD 1958-1968

INTERNAL AND DIRECT ACCESS STORAGE DATE PURCHASE **COMPUTER DESCRIPTION** PURCHASED PRICE TYPE CAPACITY(1) \_\_\_\_ IBM 650 - CARD-DRIENTED (2) SEPT., 1961 \$ 100,000 DRUM 20,000 P IBM 1401, WITH ONE CARD READ-JULY, 1962 \$ 365,000 CORE 4,000 P PUNCH, ONE PRINTER, AND FOUR TAPE DRIVES IBM 7070, WITH SIX TAPE DRIVES DEC., 1962 \$ 1,023,000 CORE 100,000 P IBM 360/50, WITH ONE CARD READ- MARCH, 1967 \$ 1,064,000 CORE 256,000 B PUNCH, ONE PRINTER, AND ONE TAPE DRIVE ONE DISK STORAGE UNIT (2314)

DNE DISK STORAGE UNIT (2314) MAY, 1967 \$ 374,000 DISK 200,000,000 B AND TWO TAPE DRIVES

ONE DATA CELL (2321) AND ONE JAN., 1968 \$ 253,000 2321 400,000,000 B PRINTER

(1) P DENOTES POSITIONS, EACH OF WHICH CONTAINING ONE NUMERICAL DIGIT OF INFORMATION. AN ALPHABETIC CHARACTER REQUIRES TWO CORE STORAGE POSITIONS.

B DENOTES BYTES. A BYTE CAN CONTAIN ONE ALPHABETIC CHARACTER OR TWO NUMERICAL DIGITS.

(2) THE 650 WAS RENTED FROM MARCH, 1958 TO SEPTEMBER, 1961. THE PURCHASE PRICE OF A NEW 650 WAS \$ 207,000.

SOURCE: MR. J. D. PARSONAGE, DIRECTOR, COMPUTER SYSTEMS AND ----- SERVICES, PERSONAL COMMUNICATION, VIA DEPARTMENTAL WORK-PAPERS. accounting for individual health business (12).

The initial application processed on the IBM 7070 and IBM 1401 computers was a consolidated functions record-keeping system for individual insurance and annuity policies. This system became operational on January 1, 1964, and incorporated the dividend accounting, valuation, premium billing and accounting, policy loan, and commission accounting functions into a consolidated processing and file maintenance system, using an integrated file concept. One of the effects of this system was to reduce the amount of data processing being done on the IBM 650 computer, thereby relegating it to a secondary, support role.

Another system of significant dimension that was implemented using the IBM 7070 computer involved the processing of group pension business for valuation and statistical purposes. The files and processes were integrated with the group pension billing system which then utilized punched cards and the IBM 650 computer.

Major system changes in both the individual insurance and group pension systems on the IBM 7070 computer were made in 1967.

The IBM System/360 Model 50 computer was first used to maintain and process a system for the American Dental Association group policy. The system became operational in December, 1967, and involves billing, accounting, statistical, and file control functions.

A system to process a consolidated file of group life and health

insurance policy and certificate records became operational in March, 1968, using the IBM System/360 Model 50 computer. This constitutes the first step in the plan of a direct-access-storage-oriented system for the consolidated record-keeping and processing of group business policies and certificates.

New IBM System/360 Model 50 computer systems are currently being developed for variable annuities, for individual health valuation and statistical processing, and for life insurance programming (this last item, a marketing service aid).

#### 10. TECHNICAL NATURE OF ACTUARIAL DATA

Actuarial data are essentially technical in nature, because of the primary concern with the mathematical aspects of life insurance company operations. The fundamental elements pertaining to insurance and other benefits include rates of interest, mortality, persistency, and claim occurrence, as well as expense margins. The calculation processes used to develop schedules of premiums and benefits are based on assumptions pertaining to these elements. The maintenance of business in-force records necessitates further extensive involvement with technical actuarial matters, including valuations of liabilities, provisions of cash surrender, loan, and non-forfeiture benefit values, and allocations and calculations of dividends and experience refunds.

System considerations must include a proper and effective recognition of the technical aspects of the functional area under investigation.

#### CHAPTER V

#### INDUSTRY DEVELOPMENTS RELATED TO COMPUTER TRENDS

This chapter outlines some of the developments which have taken place or are occurring in the insurance industry, related to or caused by trends in the computer equipment and software support areas. The purpose is to give added perspective to the corporate environment of which the actuarial information system is an important component.

Consideration is first given to computer hardware developments and trends. This is followed by a review of computer software and support capabilities. Finally, the two areas, of computer hardware and software, are dealt with jointly in an analysis of their present and potential impacts on insurance system developments.

#### 1. COMPUTER HARDWARE DEVELOPMENTS

The computer hardware technology has been characterized from its inception by continuous improvements in data storage capacities, access speeds, and unit costs.

Table 5.1 summarizes the trends which have taken place in internal computer storage sizes and access speeds between 1949 and 1965.

The unit costs for core storage have been reduced between 1960 and 1965 by as much as 95% of the 1960 level.

Table 5.2 outlines some of the current general characteristics of core storage, in terms of capacity, cycle time, and cost per bit.

TRENDS IN INTERNAL COMPUTER STORAGE SIZESTABLE 5.1AND ACCESS SPEEDS BETWEEN 1949 AND 1965

DATE	STORAGE NAME	INTERNAL STORAGE (BITS)	ACCESS SPEED IN MICROSECONDS
10/0		17 (00	
1243	SEQUENTIAL AUTOMATIC COMPUTER)	11,408	1000
1949	CRT MEMORY (WILLIAMS)	NOT AVAILABLE	20
1952	CORE IN WHIRLWIND I	32,768	12
1964	CORE IN CDC 6600	7,860,000	0.3
1965	CORE IN IBM 360/67	2,097,152 TO 16,777,216	0.3

SOURCE:

\*\*THE CHALLENGE OF THE COMPUTER UTILITY, \*\* D.F. PARKHILL, ADDISON-WESLEY PUBLISHING COMPANY, 1966, PP. 28-29.

5.2

CURRENT GENE TABLE 5.2 ISTICS OF CO	RAL CHARACTER- RE STORAGE	
CRITERION	HIGH SPEED CORE STORAGE	MODERATE SPEED CORE STORAGE
CAPACITY PER UNIT IN BITS	UP TO 1,000,000	UP TO 10,000,000
CYCLE TIME IN MICROSECONDS	DOWN TO 0.5	4 TO 8
COST PER BIT	\$0.25 TO \$0.50	\$0.03 TO 0.05

SOURCE: "THE CHALLENGE OF THE COMPUTER UTILITY," D.F. PARKHILL, ADDISON-WESLEY PUBLISHING COMPANY, 1966, PAGE 29.

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The increase in capital costs of computer purchasing was demonstrated in part in Chapter 4, Table 4.15, in which the price of the IBM 650, of \$100,000 (or \$207,000 on a "new" basis) is contrasted with prices of \$1,388,000 for the IBM 7070-1401 complex, and \$1,691,000 for the presently-configured IBM System/360 Model 50 computer. The capital cost increase in the computer industry may be further stressed by noting that the purchase prices for an IBM System/360 Model 85 computer range from \$4.5 to \$10 million, with the price of a system with two million bytes of core storage being about \$7.5 million (13).

Notwithstanding the increasing capital costs of computer acquisitions, there have been significant reductions in the cost per unit of processing power. As stated by Parsonage (14), the performance factors, which measure the relative potential of three computer classifications, as published by the Life Office Management Association, are 1 for an IBM 650, 20 for an IBM tape-oriented 7070, and 72 for an IBM randomaccess-oriented System/360 Model 50. The typical purchase costs of, respectively, \$225,000, \$1,400,000, and \$1,800,000 produce relative performance-cost factors of 1, 3, and 9. Thus the effectiveness of the computer acquisition unit cost has increased 9-fold between the IBM 650 and the IBM System/360 Model 50.

Another demonstration of the increase in user computer power as related to costs is given by Parkhill (15), in a table in which processing and cost units are presented for several computers of different sizes. Table 5.3 outlines these data.

TABLE 5.3	PROCESSING AND COST UNITS OF SEVERAL REPRESENTATIVE COMPUTERS			
MACHINE TYPE	NUMBER OF INSTRUCTIONS PER SECOND	COST PER SECOND	COST TO COMPILE 100 FORTRAN STATEMENTS	
IBM 704	40,000	\$0.04	\$15.80	
IBM 7090	150,000	\$0.09	\$ 1.40	
CDC 3600	400,000	\$0.08	\$ 0.50	
CDC 6600	3,000,000	\$0.16	\$ 0.10	

SOURCE: 'THE CHALLENGE OF THE COMPUTER UTILITY,'' D.F. PARKHILL, ----- ADDISON-WESLEY PUBLISHING COMPANY, 1966, PAGE 137. The developments which have taken place in the range of peripheral devices that can be attached to central processing units are, perhaps, even more significant than the changes in the computers themselves.

Random access storage devices and uses have solved the serious problems of serial-file processing required for magnetic tape files, and have enabled the practical use of data files in an "on-line" inquiry and processing mode. The current cost-advantage of magnetic tape over random access devices necessitates a careful evaluation of the benefits of each method so as to insure the maximum return on the invested costs.

Table 5.4 outlines the trends which have taken place in random access mass memory size and average access speed during the period 1956-1965.

Card readers, card punches, and printers have been characterized by significant increases in processing speeds, with representative rates being 800 cards, 250 cards, and 1100 lines per minute. Of greater importance in the input-output peripheral device area, however, are the diversities of units which can now be considered for practical use.

Data for use as computer input may originate directly from people by way of typewriter keyboards, light pens, dial devices, voice, switches, pictorial representations, physiological factors, key-sets, and touchtone telephones. Machine-oriented data input sources include magnetic tape, magnetic cards, optical character readers, paper tape readers,

# TRENDS IN RANDOM ACCESS MASS MEMORY SIZE AND

	TABLE 5.4 AVE	RAGE ALLESS SPEED BET	WEEN 1956 AND 1	965.
YEAR	NAME	CONCEPT	CAPACITY *	AVERAGE ACCESS SPEED **
1956	BURROUGHS DATA FILE	MAGNETIC TAPE LOOPS	200,000,000 C	14 SECS.
1956	CLEVITE 'TAPE DRUM'	WIDE TAPE OF 128 TRACKS, MOVED OVER A 12-INCH DRUM	200,000,000 B	5.5 SECS.
1956	IBM RAMAC	ROTATING DISKS	5,000,000 C	0.5 SFCS.
1957	UNIVAC FILE COMPUTER	DRUMS (10)	1,800,000 C	17.6 MS.

- 1958 RANDEX DRUM DRUM 7,000,000 C 385 MS. (REMINGTON-RAND) 1964 IBM 2311 DISK DISK STORAGE 7,250,000 C 87.5 MS. STORAGE UNIT 1965 IBM 2314 DIRECT DISK STORAGE - EIGHT 233,408,000 C 87.5 MS. ACCESS STORAGE UNITS OF 29,176,000
- FACILITY CHARACTER CAPACITY 1965 IBM 2321 DATA CELL MAGNETIC STRIPS IN 400,000,000 C 0.5 SECS.

CELLS

- CHARACTERS \* С

B - BITS

MS - MILLISECONDS 农众

SOURCES: "THE CHALLENGE OF THE COMPUTER UTILITY, " D.F. PARKHILL, ADDISON-WESLEY PUBLISHING COMPANY, 1966, PP. 31-32.

> IBM SYSTEM/360 COMPONENT DESCRIPTIONS - 2314 DIRECT ACCESS STORAGE FACILITY ...., \*\* IBM SYSTEMS REFERENCE LIBRARY, FORM A26-3599-2, PAGE 4 AND PAGE 11.

\*\*IBH SYSTEM/360 COMPONENT DESCRIPTIONS - .... 2311 DISK STORAGE DRIVE, 2321 DATA CELL DRIVE, ...., \*\* IBM SYSTEMS REFERENCE LIBRARY, FORM A26-5988-3, PP. 35 AND 44.

magnetic disks, magnetic drums, computer memories, and analog-to-digital conversion units.

Computer output for direct use by people may be produced by printers, pictorial representations, typewriters, audio-response devices, plotters, and graphical and character displays. Computer output for machine use may be produced by card punches, magnetic tapes, magnetic cards, paper tape punches, magnetic disks, magnetic drums, computer memories, and digital-to-analog conversion units.

Table 5.5 contains monthly rental charges and speeds of representative input and output computer devices. Of necessity, the data are approximate. Rental charges are heavily dependent on the number of units and the required hardware control units. Speeds are dependent on the number of units, the degree of contention of the units for processing time, and the processing capabilities and speeds of the central processing units.

The developments of optical character readers, keyboard and video-screen input and output devices, and teleprocessing and on-line terminals warrant additional comments. The data were obtained in discussions with Mr. R. K. Pearce, International Business Machines Company Limited.

Optical character readers enable the direct transfer of personreadable characters and symbols from the containing documents to computer-processable storage, without the necessity of an intermediate

Unit	Monthly Rental Charge	Speed	
Input			
Light Pen, attached to an IBM 2760 Optical Image Unit	\$ 225	14.8 char./sec.	
IBM 1287 Optical Character Reader	2,800	33,000 char./min.	
IBM 1017 Paper Tape Reader	150-180	1,000 char./sec.	
IBM 2740 Typewriter Keyboard	250-300	Up to 66.7 char./sec.	
Input and Output			
IBM System/360 Model 50 Computer Memory ( t	4,263 for 128,000 posi- ions)	2 microsec. access	
IBM 2314 Magnetic Disk Storage ( b	6,557 for 233 million ytes)	87.5 ms. access	
IBM 2301 Magnetic Drum Storage	4,000	8.6 ms. access	
IBM 2401 Magnetic Tape Unit	700	Up to 180,000 bytes/sec.	
IBM 2260 Visual Display Unit	130-230	2,600 char./sec.	
IBM 2540 Card Read/Punch	785	1,000 cards/min. (read) 300 cards/min. (punch)	
Output			
IBM 7770 Audio-Response Unit	1,385	300 char./sec.	
IBM 1856 Analog Output Termin	nal 60-85	Not determinable	
IBM 2250 Display Unit (graphical plotter)	1,100	84,000 char./sec.	
IBM 1018 Paper Tape Punch	240	120 char./sec.	

### TABLE 5.5 MONTHLY RENTAL CHARGES AND SPEEDS OF REPRESENTATIVE INPUT AND OUTPUT COMPUTER DEVICES

#### TABLE 5.5 (CONT'D)

#### MONTHLY RENTAL CHARGES AND SPEEDS OF REPRESENTATIVE INPUT AND OUTPUT COMPUTER DEVICES

	Unit	Mc	onth C	ly Rental harge	Speed
Output (	Cont'd)				
IBM 1403	Printer	(high speed)	\$	1,040	1,100 lines/minute
IBM 1053 format)	Printer	(typewriter		105	14.8 char./sec.

<u>Sources</u>: (1) <u>Office Automation</u>, a series of papers on various aspects of the topic, Published by OA Business Publications, Inc., Elmhurst, Ill.

> (2) Mr. R. K. Pearce, International Business Machines Company Limited, personal communication.

key-punching operation. This capability can reduce input preparation costs and error frequencies.

The keyboard and video-screen input and output devices have the effect of making the computer capabilities a powerful extension of the user's own work capacities. The man-machine linkages, in which the human processes and decisions are interleaved with high-speed, complex computer processing under human controls and direction, enable problemsolving and calculation work to be done in a "real-time", rather than a batched or scheduled operational mode. For applications in which the time intervals between computer request (input) and computer response (output) are very important, the development of "real-time" hardware and software technology constitutes a major break-through.

Teleprocessing and on-line terminals are extensions of the online capabilities reviewed above in the consideration of video-screen devices. Here, however, the possibility involves the direct access, by means of communication lines, by geographically-remote locations to computer-stored information and processing logic. This means that information files may not have to be maintained in the remote offices, and that information may be requested and received from the computer system when and as needed. These capabilities, supported by random access file hardware that is able to respond quickly enough to information requests, represent the major areas of improvement in moving from a computer environment in which the principal data storage medium is magnetic tape to an environment in which the primary data storage media are direct access devices.

2. COMPUTER SOFTWARE AND SUPPORT DEVELOPMENTS

The three principal areas of computer software and support developments are the increased use and power of high-level programming languages (e.g., COBOL, PL/1, and FORTRAN); the creation of effective operating system programs to assist in the data storage and retrieval processes and in the control of computer components; and the design of microfilming equipment and procedures to enable the storage and retrieval of computer data, with effective speeds of operation and economies of file space.

The use of high-level programming languages reduces extensively the amount of time required to write the program steps, once the application specifications have been established. Moreover, the program steps are more easily read and understood by programmers during testing and maintenance work than are programs written in more basic, machineoriented languages. This is due to the nature of the high-level languages, which utilize statements and formats which in effect constitute a specialized English short-hand.

Operating system programs are special programs, usually prepared by the computer manufacturers, which contain the data storage and retrieval processes involving actual machine components, and all routines pertaining to read and write errors. The application

programmers in the user organizations do not have to be concerned with the intricacies of these programs, beyond a general awareness of their capabilities and limitations. Concentration on the application logic is thereby greatly facilitated, with a resulting acceleration of programming tasks.

Computer systems are capable of generating enormous amounts of output in the form of printed lists and documents. The results of this process, if uncontrolled or unchecked, can be storage problems arising from the sheer bulk of the paper, and reference problems arising from the unsuitability of the paper bulk and storage medium for reference purposes. Techniques have been developed whereby documents can be microfilmed either from computer print-outs or directly from computerstored data. The microfilm images are then stored in a controlled library-oriented medium, which is capable of effective use in response to inquiries. The economy of storage space of the microfilm records, coupled with the ready reference capability, makes these processes an important development in the area of computer software and support facilities. The RECORDAK MIRACODE system developed by the Eastman Kodak Company is one example of this facility.

## 3. IMPACTS OF COMPUTER HARDWARE AND SOFTWARE ON INSURANCE SYSTEM DEVELOPMENTS

This section deals with some of the impacts -- past, present, or future -- associated with insurance system developments, as a result

of computer hardware and software impacts.

One obvious impact of computer systems is the reduced space requirements related to the applications being processed by the computer. In some instances, the clerical staff required to process work done by the computer could number in the hundreds, with the related desk and aisle space being contrasted to the much smaller space requirements of even a large computer installation.

Punched-card files that formerly occupied many cabinets of space have been replaced by smaller and more convenient magnetic tape and data cell storage units. The economy of file size space may perhaps be more vividly suggested by reference to the data contained in Table 4.6. The total file size represented in Table 4.6, for the four principal insurance record files, of about 308 million characters, is somewhat more than one-half (say 60%) of the practical capacity of one data cell cylinder, with a diameter of about 12 inches and a height of approximately 13 inches. Program and support logic associated with the processing of these files, when they will have been converted to the IBM System/360 Model 50 computer and are stored in an IBM Model 2321 data cell, will require an extensive amount of disk storage space.

An important cost aspect associated with computer systems and installations is related to the required changes in space, air-conditioning and electrical facilities, which are a direct result of computer acquisitions. These alterations in building architecture and associated services constitute a significant element of increased cost.

The reduced costs per unit of data processing were dealt with in the first section of this chapter. Outlined at the same time were the substantial capital investments involved in the purchasing of computer equipment. Parkhill (16) has presented two rules-of-thumb related to programming costs, in which "the cost of programming at acquisition is approximately equal to the cost of the computer", and "the continuing cost of programming after installation is equal to the monthly computer rental."

Computer data files can be maintained and used in an "on-line" environment, using random access storage facilities, for use in responding immediately to requests for information. The amount of information transfer in the administrative processing related to the corporate business in-force and transaction activity (Tables 4.1, 4.2, 4.3, and 4.4) is such as to make the immediate provision characteristic a most important one.

Experience has shown that the adoption of the manufacturer's operating system programs and a high-level programming language results in the extensive use of core storage, to the extent that upward revisions in acquired capacity may be necessary for a particular application. In the computer operations at the Great-West Life Assurance Company, the IBM Operating System and the PL/1 programming language are used, notwithstanding the core storage utilization requirements. One important

result of the large core storage need is that currently the core capacity of the IBM System/360 Model 50 computer is being increased from 262,000 bytes to 393,000 bytes, with a further increase of 131,000 bytes being a definite possibility.

Johnson (17) demonstrated the extensive core requirements for the IBM Operating System logic in a table of actual IBM System/360 Model 50 computer core usages for the group life and health insurance data processing system; the table is reproduced herein as Table 5.6.

The Group Life and Health Insurance System is a record-keeping and processing system, in which a master file of group life and health policy and certificate records is maintained for transaction activity (additions, changes, premium payments, and terminations); and in which the master file is processed along with the transaction activity to produce results such as premium billings, policyholder records of insured lives, and administrative information.

The processes referred to as "Input" in Table 5.6 include the entry of transaction activity into the system from punched cards; the conversion of the information into appropriate formats for later use in processing with the master file; the performance of information checking routines so as to insure the accuracy of the data; and the sorting of the input into the appropriate sequence for master file processing.

The "File Maintenance" processes include the checking of transaction activity data against the master file data to make sure

	CORE USAGE (BYTES)			
	INPUT	FILE MAINTENANCE	OUTPUT	
OPERATING SYSTEM (0/S) NUCLEUS	37,000	40,000	37,000	
PROGRAM LINKAGES; INPUT AND OUTPUT RECORD ACCESS ROUTINES; FILE, RECORD, AND DATA FIELD DECLARATIONS, ETC.	55,100	<b>71,</b> 800	78,500	
MASTER FILE RECORD ACCESS ROUTINES (FILE MAINTENANCE ONLY)	-	41,000	-	
APPLICATION LOGIC	69,600	34,800	14,600	
OPERATING SYSTEM (O/S) INPUT AND OUTPUT ROUTINES	10,000	64,000	10,000	
FREE CORE	90,300	10,400	121,900	
TOTAL	262,000	262,000	262,000	

CORE STORAGE USAGES IN THE IBM 360/50 GROUP TABLE 5.6 LIFE AND HEALTH INSURANCE COMPUTER SYSTEM

## SOURCE:

"AN APPROACH TO CONSOLIDATED FUNCTIONS GROUP INSURANCE OPERATIONS," H.A.C. JOHNSON, PROCEEDINGS OF THE AUTO-MATION FORUM 1968 ("INFORMATION, PLEASE"), THE LIFE OFFICE MANAGEMENT ASSOCIATION, PAGE 214.

that processing can correctly take place (e.g., for a policy termination transaction, there must be a master file record available to enable the termination processes to be followed); the updating of the master file to reflect the transaction activity; the completion of other master file processing, such as premium billing, in which the initiation of activity arises from master file data such as next billing date rather than from transaction activity; and the production of messages to be used to produce results such as lists and documents.

The "output" processes of Table 5.6 include the sorting of messages produced by the input and file maintenance processes; the arranging or editing of the data so as to enable the preparation of reports and lists in readable form; and the preparation of the results and documents on a high-speed printer.

As the result of computer system developments, there has been an identification of essentially a new professional group in the insurance programming areas. The primary concerns of this group include standards, techniques, and overall effective computer resource management in terms of capacity use and processing throughput times.

Significant changes have taken place in the balances between computer costs and required system services, in terms of the content and speed of output produced. The previous environment, involving punched-card uses and resultant practical limitations on output, has been replaced by the present situation, in which the horizons of practical capability are much more distant and encompassing.

Increased computer processing speeds and storage capacities have enabled the development of the multiprogramming operational concept, by which is meant the simultaneous processing of two or more independent tasks. While it is true that, at any one instant of time, only one task is actually being performed by the computer, multiprogramming in effect interleaves the processing of several tasks, in contrast to operations of previous generation computers in which programs are run on a consecutive basis. The ability to use central processor time for one task while the records are being accessed or stored for another independent task enables the practical use of random access equipment for "on-line" file storage and retrieval. The lack of this capability would mean the dedication of the entire computer to inquiry and response operations, possibly during the entire range of normal office hours, even though the volume and distribution of inquiries did not require all of the processing time available.

Goshay (18) has dealt at length with the impact of Electronic Data Processing (EDP) on insurance operations with specific considerations pertaining to the actuarial function. The more significant views which he expressed have been summarized as follows:

> . EDP may impact actuarial operations directly, by facilitating the processes of data summarizations, statistical recordkeeping, and analysis of results; and indirectly, by

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materially altering the formats, contents, and means of updating the insurance files.

- The actuarial influence in EDP systems ranges from one extreme of no involvement to the other extreme of complete supervision, development, and control of all system development work.
- . The consolidation of functional files into an integrated record-keeping base is one of the most striking changes that have taken place. Work divisions are far less distinct after EDP has been introduced.
- . Substitutions of systems personnel for actuarial personnel have taken place.
- The development of EDP systems by non-actuarial-oriented personnel may result in extensive required justifications and undesirable delays in response, particularly with respect to non-routine requests.
- . Many of the actuarial processes cannot be readily subjected to the usual EDP evaluation criteria of costs and benefits.
- An inflexible EDP approach can relegate actuarial functions to the routine collection, processing, and transmission of data.

. EDP can provide effective actuarial services and support

facilities through the speeds and capabilities of the equipment; through the systems design and feasibility studies by EDP personnel; and through the provision of new and improved solution methods for actuarial problems.

The broad conclusions to be drawn from the preceding contents of this chapter are as follows:

- (a) Computer hardware developments over the last ten years have been significant, in terms of rate of development, processing power, improved performance in terms of performancecost factors, and component diversification. Direct access storage devices and a wide array of terminal units for access to stored information and processing logic are perhaps the most important elements in terms of potential of an actuarial information system and the approach to development thereto.
- (b) Progress has been similarly significant in the areas of improved, powerful, and easily-used programming languages; and effective and capable Operating System programs to aid in data storage and retrieval and computer component control. Techniques such as the microfilming of results are important developments as well. All are contributory to the potential of actuarial operations.
- (c) The combined effects of hardware and software developments, as related to actuarial processes, are to provide extensive

capabilities for improved ways of performing current and new tasks, and to introduce more complex evaluation problems as related to system design and practicability. As noted by Goshay (19), ".....EDP has served to pull aside..... some of the veils which have shrouded actuarial procedures."
#### CHAPTER VI

# NEEDS OF LIFE INSURANCE COMPANIES IN THE AREA OF ACTUARIAL INFORMATION SYSTEMS

The needs of life insurance companies in the area of actuarial information systems constitute important components of the systems analysis and fact-finding processes. This chapter is a presentation of some of the broader and more general aspects of these needs. Its purpose is to continue the industry perspective development process initiated in the preceding chapter. Subjects considered include the adequacy of basic records, the accessibility of data, the balancing of data availability and associated costs, the means of information production, the means of appraising data, the need for flexible response times, the use of research tools and techniques, the provision of the capacity for system growth as well as the growth of human resources, the provision for future needs, and finally, the avoidance of unnecessary or excessive paper form production and retention.

In the above list of subjects, the need for flexible response times means the need for flexibility in the time intervals between requests for information or action and the responses thereto, as determined by the degree of urgency and importance of the information or action normally and on an exception basis.

## 1. ADEQUACY OF BASIC RECORDS

It is axiomatic that the basic records must be adequate for present and future uses. By the term "records" is meant not only the

aggregation of data pertaining to each insurance, annuity, or health coverage policy, but also the wide range of corporate records related to calculating procedures, instruction manuals, processing rules, decision-making processes, and business results. The long-term nature of insurance contracts necessitates that proper attention be given to the record requirements of future years, and in particular to the potentially-changeable nature of those needs. In the terminology of Chapter 3 (Figure 3.1), present and future record-keeping processes must effectively serve the corporate needs in the areas of operational control (closely related to administrative practices), management control (the periodic assessments of corporate long-term goals, objectives, and operating philosophies).

## 2. ACCESSIBILITY OF DATA

Closely related to the adequacy of records is the required accessibility of their data contents in processable form. The formulation of corporate decisions at all levels involves the definition of the purposes or objectives of the decisions (i.e., to reduce costs, or to introduce new products to enhance marketing potentials); the basic data to be used; and the processing of the data, by extraction, summarization, and editing so as to produce information capable of being acted upon. The primary requirements of decision-making processes are that the basic data exist and that they are accessible in a form suitable for processing, as influenced by the urgency of the decisions

and by the degree of data reliability required.

## 3. DATA AVAILABILITY AND ASSOCIATED COSTS

An important consideration in life insurance company actuarial information systems involves the attainment of a proper balance between the percentage of data required for a specific purpose and the associated costs of producing the data. Closely related is the degree of detail required in the requested data. The costs of data production can vary extensively depending upon the need to review all or only part of the source records and upon the requirement of detailed or summarized information.

For example, in a magnetic tape file of individual insurance in-force policies, there is commonly a basic record for each policy, containing data related to the main contract. Each basic record is followed by a series of additional records, which contain data applicable to insurance rider and supplementary benefit provisions. The additional records are present only when applicable. A request for data pertaining to basic contracts (e.g., amounts of insurance) can be processed by reading all tape records in the computer and by directly retrieving the required amounts which are in known relative locations. If, however, the amounts of insurance riders and supplementary benefits are also required, it is necessary to carry out additional computer processing by expanding the variable-length records into a fixed format and then to extract the required amounts. The use of

variable-length records instead of fixed-length formats enables file size and consequent tape passing time economies to be realized.

As a second example, a data request may be made for the amount of insurance in-force in a particular branch office. If only one total figure is needed, it is entirely likely that a summary file will have been previously established to provide this information. This would enable a relatively fast and easy response to the inquiry. If, however, the request is for a list of policy numbers with associated amounts of insurance (as might be required for sales promotion or audit purposes), reference would have to be made to the master file of all policy records for the requested data. Additional processing time and greater costs would therefore be incurred. Finally, it is obvious in this case that one branch office total, even though much easier and less costly to obtain than detailed policy data, would not be acceptable to the user if the intended purpose was in fact for sales promotion or auditing, and required detailed records. In other words, the information purposes can dictate the nature of the data to be provided; in fact. the purposes must justify the incurred costs, just as the data provided must be suitable for the intended uses.

While the costs of preparation may sometimes be viewed as greatly exceeding the values or benefits of business statement submissions to government bodies, it must be noted that failure to comply with the established requirements could lead to suspension of the corporate business license and, thereby, to a loss of all

potential business benefits. In brief, some of the insurance company actuarial processes are necessary conditions for staying in business, and as such have the greatest potential values.

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There is no simple answer to the problems of data availability and related costs. The retention of all paper forms and documents indefinitely can rapidly violate the processable criterion. The retention of all data in computer-processable media such as magnetic tapes or disks will have adverse effects on the costs of retention, and also on the computer operation costs involved in processing the data. Up to the present, decisions as to data retention practices have been primarily based on legal requirements, related to government legislation of insurance operations and to contractual provisions. With the trend in computer emphasis away from traditional recordkeeping operations and in the direction of information systems for decision-making, a much more scientific approach to data retention and availability is required.

# 4. MEANS OF INFORMATION PRODUCTION

In addition to the maintenance of data in processable form, there must be a continuing means of producing information quickly, accurately, and completely. Moreover, the information must be meaningful and usable. The implications of these elements are, therefore, that information needs, data sources, and processing routines must be optimumly correlated. Some tasks may be ideally suited to computer processing, while others may be more easily completed by manual methods.

5. MEANS OF APPRAISING DATA

The information systems must provide the basis of appraising data, and of detecting exceptional situations, good and bad. These requirements apply to the evaluation of data at the time of input to the information system, and to the production of information system results based on the management by exception principle. They lead directly to quality control and to the need for establishing standards of measurement. They also require a data base that can respond to changing levels, in Head's terminology (11), of the "information threshold", as discussed in Chapter 3, on page 3.3.

# 6. FLEXIBILITY IN RESPONSE TIME

Response time represents the time interval between the initiation of an information request and the receipt of the reply. A characteristic of insurance company actuarial information needs is that of flexibility in the response times for specific requests. While there may be normal response times associated with regular requests, the system must be capable of more rapid responses when conditions warrant the increased speed. Moreover, the system must also be able to respond effectively to non-regular requests. In all response time considerations, there must be an optimum balance between the user needs (in terms of the value of the decisions to be made, based upon the information) and the costs of providing the information.

The capabilities and controls of a system, as related to flexibility in response times, are important aspects of the systems design problem. The required variations in response times must be defined prior to the systems design stage, as the variations can materially affect the computer hardware and software facilities required.

#### 7. USE OF RESEARCH TOOLS AND TECHNIQUES

An area of increasing importance involves the effective use of research tools and techniques to accelerate research tasks and to provide improved analyses of business conditions for decision-making use. The expanding activity in this area is evidenced by the extent of published material, conference agenda, and special seminars involving research-oriented topics and investigations. A partial list of subjects includes simulation, forecasting, linear programming, operations research, and game theory. The extensiveness of the computational processes in many of these areas is such as to require the use of large computer facilities. It is, in fact, in considerable measure due to the development of powerful computers with very fast processing speeds and large, effective storage capacities that some of the problems currently being investigated have become practical areas of research.

In the area of life insurance company research, one of the most active and recognized investigators is Dr. John D. Hogan, formerly

Manager of Markets Research for the Northwestern Mutual Life Insurance Company, and currently Vice President, Planning and Research, for the Nationwide Insurance Companies. His principal areas of research are related to marketing research and corporate long-range planning (20, 21, 22, and 23). Another prominent researcher is Mr. J. M. Bragg, Vice-President and Chief Actuary of the Life Insurance Company of Georgia; his areas of investigation are related to the pricing of insurance products, with due regard being given to the interests of the buyer, the agent, and the company, as well as to the nature of the sales encounters and the effects of competitive influences (24, 25).

In 1966, the International Business Machines Corporation organized a symposium to discuss the application of operations research techniques in the insurance industry. The published proceedings include papers by Zubay (26), dealing with operations research techniques and future potentials; Vincent (27), involving manpower and production projections; Jones (28), considering linear programming applications; Bartlett (29), simulating model agencies; Shellard (30), reviewing operations research applications in the Home Office; and Drandell (31), involving portfolio selection and security analysis. Also included is the paper by Hogan (22) referenced previously.

A similar operations research symposium was conducted in 1967, again with reference to the insurance industry. The published proceedings include papers by Zubay (32), surveying operations research techniques related to insurance operations; Bragg (33), dealing with

prices and profits of insurance contracts (this is a considerably condensed version of reference (25) previously cited); vanOosten (34), outlining organizational aspects and objectives of an operations research center; Burns (35), considering agency manpower and production models, and the application of operations research techniques thereto; Hogan (36), investigating aspects of corporate models for long-range planning; and Johns (37), presenting possible uses of the computer in investment research.

Additional examples of activities and interests in the use of research tools and techniques may be cited by reference to the triennial Automation Forums of the Life Office Management Association (whose membership consists of life insurance companies and fraternal benefit organizations).

In the Proceedings of the 1962 Automation Forum, Johnson (38) described some of major management science applications which might be of benefit to life insurance organizations. Grubinger (39) considered various aspects of the computer as a decision-making aid. Haskins (40) emphasized the greater importance of the use of computers as management decision-making tools rather than as data processors.

In the Proceedings of the 1965 Automation Forum, Plumley (41) outlined the ways in which a computer system can provide service to management, including more information on current conditions, exception reports, projections of future conditions, and evaluation of business

profitability.

In the Proceedings of the 1968 Automation Forum, Hogan (42) emphasized the need for communication channels between the technicians and the users of management science techniques. Scull (43) described some of the management research techniques which are or could be used to advantage. Shorr and Roy (44) outlined a specific management science application related to turnaround time for computer program testing.

A final general reference to activities related to research tools, techniques, developments, and uses is the series of semiannual conference agendas of the GUIDE organization ("Guidance for Users of Integrated Data Processing Equipment"). Membership in this organization is not restricted to life insurance companies; rather, it includes representatives of a wide variety of industries, banded together because of the common denominator of the use (actual or seriously planned) of large-scale computing equipment. The agendas for 1963 and later years include the research-oriented topics of simulation (and its relationships to on-line systems and queuing problems), operations research, linear programming, applications of Boolean algebra, optimization techniques, exponential smoothing, scientific techniques for management decision-making, mathematical and statistical methods, portfolio selection, and scientific programming.

The conclusions to be drawn from the preceding information and its relationship to the subject company are as follows:

- (a) There is currently available a wide range of management science techniques which can be applied to advantage to life insurance company operations.
- (b) Up to the present, the subject company generally, and its actuarial division in particular, have not made use of the full potential of management science capabilities.
- (c) There is an urgent need for the subject company to become more directly involved in aspects of management science, so as to become more aware of what is available, and to determine what aspects may be of corporate use.

8. CAPACITY FOR SYSTEM GROWTH

An actuarial information system is likely to make increasing use of computer facilities, because of the volume of data and the extensiveness of the processing requirements. As a result, it is necessary to provide an adequate capacity for growth of the computer system. This is required partly because of the increases in record sizes and complexities and partly because of the need for faster responses to information requests. It is also necessary to provide a corresponding capacity for growth of the human resources required to support the computer system. Improved speeds of systems analysis, documentation, programming, and implementation are essential, as are the more efficient operation and administration of the running systems.

#### 9. PROVISION FOR FUTURE NEEDS

The provision for future needs must take into account not only the obvious factors of growth, product diversification, and complexity but also the equally important element of competition. The adoption of changes in record-keeping and calculation routines so as to compete more effectively in the insurance market place is fundamental to adequate progress. An actuarial information system must be capable of effective and timely response to changing conditions, and, concurrently, be subject to reasonable and necessary expense controls. Provision for likely or possible requirements must be made within such a regulatory framework.

# 10. PAPER FORM PRODUCTION AND RETENTION

Actuarial information systems are no different from other data processing operations insofar as the capacity to produce great quantities of paper forms is concerned. This in turn leads to problems of retention, including space, ease of reference, and retention periods.

There are two common situations encountered with respect to paper form production and retention that warrant close scrutiny in the planning of an actuarial information system.

First, the present practice is to produce paper form output for all actuarial calculations. Up to the present at least there has been no suitable and practical computer system alternative to paper form

production.

Second, the ability to provide historical proof of actuarial calculations has been generally accepted as necessary without regard to document production, storage, and retrieval costs on the one hand, and to the possible incidence and magnitude of other costs that might be incurred if historical proof was not available. This viewpoint can lead to a philosophy of complete paper form retention, on the basis that someone may want some piece of information sometime for some reason.

The developments of random access storage devices and of online inquiry terminals associated with computer equipment, and of microfilming preparation and referencing systems, necessitate that a re-analysis of paper form production and retention, as related to actuarial information, be made, and that an improved basis of operation in this area be sought as the long-range goal.

#### CHAPTER VII

# TYPES AND OBJECTIVES OF ACTUARIAL INFORMATION AND PROCESSES

This chapter defines the types and objectives of actuarial data and processes for the purpose of this investigation and as applicable to the subject company.

## 1. TYPES OF ACTUARIAL INFORMATION

The term "actuarial information" in the present context includes the following:

- (a) Tabular data, by age, of the rates or probabilities of occurrence of events such as deaths, accidental deaths, retirements, and terminations.
- (b) Other tabular data of a mathematical nature, which may be required along with the actuarial data, and which are not readily or easily calculated from first principles when needed.
- (c) Actuarial factors, as applicable to the insurance policies of the company, and as required for administrative purposes related thereto.
- (d) The individual policy records, containing data as to premiums, amounts of insurance, cash values, reserves, dividends, plans of insurance (e.g., life, endowment, and term, together with variations thereof), and ages at issue.

(e) Actuarial reference material, including descriptions andexplanations of practices and procedures.

An insurance policy is a contract between the insurance company and the policyholder, in which the insurance company guarantees the payment of specified contractual benefits in return for the payments of premiums by the policyholder. A policy may insure only one or two lives, or may apply to a larger number of people such as the employees of a business. The terms "individual" and "group" apply to these respective categories.

The premium rates are based on assumptions as to the probabilities of event occurrence related to the contractual benefits. These probabilities affect the payments of insurance benefits and also of the premiums. As the rates of event occurrences do not follow mathematical formulas as is the case with compound interest tables, it is necessary to use the actual tables of event occurrence in the actuarial calculation processes. The tables of event occurrence are developed from population studies and by the combination of the actual experience data of many insurance companies.

Other tabular data required may be illustrated by reference to the probability densities and cumulative probabilities of a normal distribution. The data could be calculated as required, but would involve a considerable amount of work. The preferable approach, that extends to other tabular data which cannot be calculated by formula,

is to store the tables as pieces of actuarial data, and to refer to them as required.

In addition to the premium and benefit information, an insurance policy contains tables of benefits which specify, for each year of the policy, the benefits which are available to the insured if he wishes to discontinue the payments of premiums. The usual provisions include the right to surrender the policy: for which there is a cash value payable to the insured; to continue the policy in-force as before, but with a reduction in the amount of insurance and with no future premiums to be paid; and to continue the policy in-force for the original amount, but on a paid-up term insurance basis for as long a period as the available cash value can provide. Administrative record-keeping processes require the availability of these factors so as to provide policyholder services for policy inquiries and terminations. The calculation practices related to these factors are complex, and different methods have been used over the years of company operations. It is easier, therefore, to maintain records of the actuarial factors, and to refer to them as necessary, rather than to recalculate them from first principles each time.

In order for a company to determine the reliability of the assumptions inherent in the calculations of premium rates, it is necessary to make use of the actual corporate experience data, related to individual policies, which indicate the amounts and distributions of the benefit payments. In a mortality investigation, for example,

the actual death claim policies are studied by age at issue, age at death, plan of insurance (i.e., life, endowment, and term), duration from issue to death, and other breakdowns. The actual experience is related to the assumed experience incorporated in the premium rates. The results of the studies are used to evaluate underwriting practices and to make changes, as warranted, in the assumptions inherent in current premium rate calculations.

In support of actuarial operations generally, there is a need to maintain and have available for reference a large amount of information, in which explanations, descriptions, and other evidence of decisions and procedures are provided. For example, the calculation of a new dividend scale involves the making of assumptions as to the basis of the change; the testing and alteration of the assumptions until a satisfactory basis can be established; and an extensive amount of work in performing the calculations and preparing manuals of printed results. Actuarial records of this type of process are essential, so as to provide a basis for similar work when another dividend scale change may be under consideration.

2. TYPES OF ACTUARIAL PROCESSES

The types of actuarial processes with which this investigation is concerned include the following:

> (a) Maintenance of records on individual policies (policy particulars, statistical data, amounts of insurance, plans

of insurance, reserves, cash values, dividend information, insurance riders, supplementary benefits, and other descriptive data).

- (b) Calculations of actuarial factors for inclusion in premium rate books and dividend scale manuals, and the preparation of formatted pages for printing purposes.
- (c) Calculations of reserves, cash values, and dividends on existing business.
- (d) Experimental calculations on new or revised plans of insurance and on in-force business to determine the financial effects of considered changes (e.g., the cost of contemplated changes in dividend scales).
- (e) Asset share calculations.
- (f) Special actuarial calculations for non-standard plans and benefits.
- (g) Premium rate calculations for group business.
- (h) Provision for calculations and preparation of documents to be used as sales aids.
- (i) Provision of data for policyholder services (premium notices, annual reports of financial data, inquiries, etc.).

- (j) Mortality investigations.
- (k) Persistency investigations.
- Provision of information to government examiners on a request basis.
- (m) Provision of actuarial information to serve as indices of progress (growth, stability, and profitability).
- (n) Provision of actuarial information to be used in experimental work related to decision-making (e.g., simulation).
- (o) Provision of actuarial information to report progress and the state of condition to management and to government authorities.
- (p) Gross premium valuation calculations.
  - 3. OBJECTIVES OF ACTUARIAL INFORMATION AND PROCESSES

The objectives of the actuarial information and processes outlined above are as follows, and are applicable to the subject company specifically:

> (a) To provide an operational base of corporate activities as related to insurance policy contracts and their recordkeeping and administrative requirements, by means of controlled, available, and useful actuarial data.

- (b) To comply on a regular basis with the legally-established requirements pertaining to insurance operations, by the maintenance of an effective repository of actuarial data, with supporting details, descriptions, and explanations, related principally to the valuation of liabilities.
- (c) To support corporate and divisional management decisionmaking, by providing the means of assessing insurance business performance as related to the corporate standards.
- (d) To assist in preparing business projections into the future, in which business trends, together with implications of their continuation or change, are satisfactorily reflected.
- (e) To facilitate insurance research activities of an actuarial nature; to support the design and development of computer models of life insurance operations; and enable the use of these models in business projections.

In summary, the objectives of actuarial information and processes are to provide the means whereby the actuarial results of insurance operations can be controlled and evaluated, and to enable the preparation of information results for corporate and actuarial decisionmaking.

## CHAPTER VIII

## FUNCTIONS OF ANY DATA PROCESSING SYSTEM

The purpose of this chapter is to outline the essential functions of any data processing system. Notwithstanding the intent that the following sections of this chapter are to be applicable regardless of the extent of actual, planned, and potential usage of computer equipment, it is nevertheless a fact that the subject environment does use computer facilities extensively. Accordingly, the ideas expressed may logically be viewed in the context of extensive involvement of computers. Moreover, they should be considered in direct relationship to the subject of actuarial information.

The following sections of this chapter outline the functions of any data processing system in order of input, processing, output, control of input, control of record-keeping, control and distribution of output, measurements of costs and performances, storage capacities for data and processing logic, computer processing speeds, and batchcycle and on-line operations.

#### 1. INPUT

There is a wide range of devices and methods whereby input may be entered into a data processing system. Two broad classes of input facilities, after Parkhill (45), may be considered, containing, respectively, those components for which the immediate sources are people, and those for which the immediate sources are machines.

People input facilities include various forms of dial devices,

key-sets, light pens in association with visual displays, physiological devices, units with pictorial characteristics, switches, touch-tone telephones, typewriters, and voice-accepting devices.

Machine input facilities include analog-to-digital conversion units; computer memories, magnetic cards, disks, drums, and tape; and readers capable of accepting punched-cards, punched paper tape, and written or printed characters (i.e., optical character readers).

### 2. PROCESSING

Processing operations may be grouped into two main categories, according to the primary nature of the activities involved. One category has been termed data retrieval, and the other, data processing and problem solving.

The principal purpose of data retrieval operations is to provide information from stored data files or reservoirs, in response to requests by users. Some of the more important characteristics of data retrieval operations are:

- (a) the availability of a facility to enable the storage and retrieval of data;
- (b) the existence of a communication capability to link the users and the data files when and as necessary;

(c) the presence of input and output devices as required by

the nature of the data files and its functions, and of the environment of the communication system;

- (d) the capabilities of initial creation and subsequent maintenance of data banks;
- (e) the accessibility of stored data on a convenient, timely, and effective basis by users, with an appropriate diversity in response contents and formats in accordance with the specific intended data uses;
- (f) the likely incidence of high initial costs to create the data banks and the associated data storage and retrieval procedures;
- (g) the continuation of data maintenance costs; and
- (h) the need to establish appropriate data retrieval system charges to users, based upon the extent of system usage.

Possible applications of data retrieval types of operations in an actuarial information system include:

> (a) the retrieval, in response to user requests, of specific actuarial unit factors such as premiums, reserves, cash surrender values, non-forfeiture benefits, and dividends, from a file or bank of previously-calculated data established and maintained for reference purposes; and



(b) the retrieval, on request, of actuarial data pertaining to specific policies, from a file of policy records prepared and maintained principally as a data processing type of application.

The emphasis in the second category of processing operations is on data processing and problem-solving capabilities, rather than on data retrieval. It may be noted, nevertheless, that a considerable degree of the data retrieval type of operation may be incorporated within the data processing and problem-solving structure.

Some of the more important characteristics of data processing and problem-solving operations include those of data retrieval processes listed previously, and, in addition:

- (a) the availability of a facility to enable the data processing and problem-solving operations to be conducted;
- (b) the means of creating, maintaining, and using routines and processes which have been adequately tested, verified, and approved; and
- (c) the existence of effective communications between the users and the data processing and problem-solving facilities.

Possible applications of the data processing and problem-solving types of operations in an actuarial system include:

- (a) the calculation, on request, of specific actuarial unit factors such as premiums, reserves, cash surrender values, non-forfeiture benefits, and dividends, which have not previously been computed;
- (b) the incorporation of these factors, once calculated, in the library of data used for data retrieval operations (where it is deemed more advantageous so to do, rather than to recalculate the factors each time they are requested);
- (c) the retrieval, on request, of actuarial data pertaining to specific policies, where the requirements are not only to obtain the basic data from files of policy records but also to perform some data processing operations on them (e.g., the calculation of the current total value of a policy, taking into account the amount of the policy, the unit cash values, the policy duration as at the calculation date, the means of interpolating where the calculations are not being performed as at an anniversary date, the amount of policy loans outstanding, the interest rate applicable to the loan balance, the premium payment status as related to outstanding or paid in advance considerations, the dividend accumulations at interest, and the values of insurance riders, supplementary benefits, and paid-up insurance amounts purchased by the application of dividends); and

(d) the combination of calculation and specific policy processing routines, as outlined in (a) and (c) immediately preceding, into processes of experimentation under a variety of assumed conditions (i.e., simulation), in which the decisions as to new or revised sets of assumptions are based upon the results of the previous experiments (e.g., the determination of the effects on a selected group of policies, such as a model office, of a variety of changes in the assumptions of mortality, interest, and expense levels as used in determining dividend rates).

Finally, the data processing and problem-solving category may be further subdivided into two user operational environment types. One has been termed a dedicated environment, in which the user is provided with a pre-established array of standard responses to his requests. The other has been termed a non-dedicated environment, in which the user is involved in changing the nature of his processing or problem-solving requirements on the basis of responses to previous requests. Data retrieval operations do not require this facility.

Table 8.1 summarizes the classification of data processing operations as described in this section.

#### 3. OUTPUT

As was the case for data processing system input, there is an extensive variety of methods whereby output may be obtained from a

TABLE	8.1	CLASSIFICATION	OF	DATA	PROCESSING	OPERATIONS
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ТҮРЕ	PRINCIPAL FUNCTION
DATA RETRIEVAL	TO PROVIDE INFORMATION FROM STORED DATA FILES OR BANKS, IN RESPONSE TO REQUESTS BY USERS.
DATA PROCESSING AND PROBLEM SOLVING	TO PROCESS DATA AND SOLVE PROBLEMS.
	TO STORE, MAINTAIN, AND RETRIEVE INFORMATION AS A PART OF THE DATA PROCESSING AND PROBLEM SOLVING WORK (I.E., TO PROVIDE

THE DATA BANK TYPE OF USE).

8.7

(A) DATA PROCESSING

I. DEDICATED

II. NON-DEDICATED

(B) PROBLEM SOLVING

I. DEDICATED

II. NON-DEDICATED

SOURCE:

1.

2.

DERIVED FROM 'THE FUTURE OF THE COMPUTER UTILITY,'' C.C. BARNETT, JR. AND ASSOCIATES, AMERICAN MANAGEMENT ASSOCIATION, PP. 16-21. data processing system. Again, two broad classes of output, after Parkhill (45), may be considered, containing, respectively those components which are used by people, and those which are used by machines.

Devices providing output for use by people include audioresponse units, displays of various types (character, graphical, and projected), pictorial presentation units, plotters, printers, and typewriters.

Devices providing output for use by machines include card punches; computer memories; digital-to-analog conversion units; magnetic cards, disks, drums, and tape; and paper tape punches.

### 4. CONTROL OF INPUT

The control of any data processing system may be defined as the application of procedures, rules, and techniques, involving hardware, software, and people, whereby:

- (a) the system is installed and operated with confidence that its intended functions are being executed accurately and effectively; and
- (b) any deviations from the established standards of service quality are detected within an acceptable time span for individual attention, analysis, and remedy.

In essence, the foregoing criteria constitute the basis of effective management of a system, in terms of accuracy, service quality, expense level, timeliness of information production, and flexibility as related to the ease of making required procedural changes.

The purposes or objectives of control include continuous assurance of accuracy of record-keeping and information production activities, confirmation that operations and procedures comply with management policies, effective protection against carelessness, fraud, and inefficiency, and general protection of corporate operations against any contingencies.

The control of input to a data processing system includes confirmation of the validity, accuracy, consistency, and completeness of the input data; verification that all data have, in fact, been entered into the system; and decision-making as to input document storage and retention policies. The choice of control techniques is dependent on the nature of the data processing activities and system. Controlled authorization of source documents, independent checking, forms counts, prenumbered document use, punched-card verification, prebalancing to control totals, date-stamping to denote completion of processing stages, and data retention criteria as to period, location, and sequence, are some examples of input control methods.

#### 5. CONTROL OF RECORD-KEEPING

The control of record-keeping and associated data processing

operations is very closely related to the control of input as outlined in the preceding section. The nature or purpose of the input data. has an important bearing upon the control factors involved. An information request related to some maintained data file may not require any more careful control than a consideration of the possibly-confidential nature of the data. Input involving changes to a master file requires more extensive control, but once again the control standard may be variable according to the nature of the change (e.g., the change of a mailing address should not require the same level of control procedures as the alteration of financial factors in a record). Changes of tabular data used in the processing of many records must be carefully controlled, because of the possible aggregate effect of even nominallysmall errors (e.g., changes of premium, interest rate, or dividend factors). Finally, input data used for calculations and simulations must also be carefully controlled, because of the potential impact of decisions based on the calculation or simulation results (e.g., the establishment of the basis for a dividend scale change, in terms of altered mortality, interest, and expense assumptions, together with the aggregate effect on company operations in terms of increased or decreased financial disbursements).

Processing controls include:

(a) the verification, by inter-record checks of input and master file data, that the processing can take place;

- (b) the establishment of the proper date and file version selection criteria to insure the use of the appropriate files and the execution of the proper procedures;
- (c) the prior preparation and verification of current routinesto be followed in the processing activities;
- (d) the development and implementation of effective safeguard and emergency routines, including computer file back-up provisions, record retention, and documentation of procedures, and the establishment of a practical back-up means of operations (which may be clerically-oriented and involve "paper-work" rather than relying on computer availability), so as to insure the continuous effectiveness of the processing routines regardless of any eventuality;
- (e) the verification that all processing has been completed;
- (f) the preparation of adequate and clear records of processing operations, for use in auditing and quality administration;
- (g) the identification and control of processing output, asto type, volume, and retention period;
- (h) the verification of inter-file balances where applicable;
- (i) the provision of effective security for files and procedures, as related to the confidential nature of the contents; and

(j) the recording and analysis of incurred costs, so as to maintain a proper relationship of expenses to processing benefits.

On the subject of back-up considerations, it must be noted that the back-up system, whether it involves computer operations or manual procedures, is just as important as the original system.

6. CONTROL AND DISTRIBUTION OF OUTPUT

Output of any data processing system is also subject to control techniques and procedures, some of which being:

- (a) confirmation that the output has in fact been produced, and that it conforms to established quality standards;
- (b) efficient, controlled, and timely distribution of output to users; and
- (c) effective routines for the control and follow-up on situations requiring investigation and possibly some remedial action (independent controls may be warranted, so as to insure that error and warning situations, once detected, are not being ignored).

Perhaps the most important aspect of output control is the degree of correlation of the users' needs and the actual output produced. Excessive forms production, when only a few summary totals are required, is one common example of poor correlation. Another is the frequent preparation of detailed reports on a regularly-scheduled basis, without a clear idea as to actual uses, if any.

#### 7. MEASUREMENTS OF COSTS AND PERFORMANCES

Any data processing system involves the incurrence of costs, initially for design, development, and implementation, and subsequently for operation and maintenance. The justification of any specified level of costs for a given application is dependent upon the benefits derived from the operation of the system. Some of these benefits may be tangible items that can be measured in financial units (e.g., reduced annual salary expense and increased annual profitability). Other benefits may not lend themselves to this precise form of evaluation, and hence may be classified as intangible (e.g., improved service to customers, and better working facilities). It is therefore apparent that the evaluation of a data processing system, in terms of costs and performances, is a very subjective matter, in which opinions as to the relative merits of intangible benefits may be quite varied. Even in the areas of costs and tangible benefits, there may be divergent views as to the exact amounts represented.

Regardless of the difficulties inherent in attempting to measure system costs and performances, it is still necessary to make realistic and determined efforts in this area, so that the best possible data can be available for decision-making as to the optimum system approaches

to take.

8. STORAGE CAPACITIES FOR DATA AND PROCESSING LOGIC

Adequate provision must be made for the storage of data and processing logic of a system. This requirement is particularly applicable to computer systems, where the necessary capacities may be extremely large and may represent significant amounts of money in terms of component purchase or rental charges. Insufficient capacity can increase the computer processing times required for specific tasks, with the result that the computer facilities are not utilized to their maximum potential. The availability of excessive capacity can result in higher expense charges to the users of computer facilities than would be incurred if the capacity was more closely related to the actual system needs.

Adequate but not unrealistic provision of additional storage capacity for system growth, in terms of data and of processing logic, must also be made. It follows therefore that clear definitions of data and logic retentions must be established, so that the demanded capacity for growth does not continue on an uncontrolled or unjustified basis.

#### 9. PROCESSING SPEEDS

User satisfaction with a data processing system is greatly affected by the processing speeds and the resultant schedule of output distribution. This can apply to any form of data processing operation,

but is particularly pertinent in the context of computer processing. The potential value of output information can be materially altered by delayed availability to the user. Moreover, not only are certain types of output much more value-dependent on the timeliness factor than are others, but also the value of a specific output item may vary, depending upon the point of time in the month or year. Annual business statements of operations are much more critically related to a scheduling factor than are day-to-day regular processing activities.

Increases in processing speeds can be obtained by acquiring more staff or additional computer equipment and processing power. Both avenues of possibility, however, involve increases in attendant costs, and must be justified, as was noted in considerations of storage capacities in the previous section, in terms of the greater benefits, tangible and otherwise, to be realized from the faster speeds. The provision of inadequate processing speeds can create a major cause of system dissatisfaction in the user areas, because of work scheduling difficulties, delays in work completion, and client dissatisfaction with service, to mention but a few of the possible reasons. The provision of excessive processing speeds results in increased data processing unit costs. If the computer time made available by the excessive processing speeds cannot be utilized for other work, the costs to user areas for the work actually performed will be accordingly greater. One possible end result in this situation is a decision not to adopt or continue a specific data processing application, because the benefits

in aggregate do not offset the costs involved.

#### 10. BATCH CYCLE AND ON-LINE OPERATIONS

Data processing operations may be grouped into two main classes, as determined by the manner in which the work is done. One class contains those types of tasks in which constituent processing units are brought together in batches at predetermined points of time or work accumulation volumes. One example of this class of activity, which is common to the computer file maintenance systems of many industries, involves the preparation of transaction activity during each working day, and the processing of each day's work in a batch environment during the computer operations at night. This form of file updating is said to be on a cycle basis, and, for the general example cited, constitutes a day cycle file maintenance system. Another example of batch processing involves the accumulation of information requests until a previously-determined number or batch size is on hand, at which point the information required is obtained and the replies to the requests completed.

The other class of data processing operations related to the work execution environment may be termed "on-line" in character. This means that the processing is done completely at one point-of-time for each item involved, instead of being done in task-oriented batches for a number of similar items. One example of an "on-line" system involves the request of information from an index file, and the response to that
request in a suitable time interval, so as to give the impression of essentially-continuous processing to the user. Such an index file might be manual, of the type a telephone switchboard operator might maintain for local office numbers. The index file might also be computer-stored, and referenced by the data requester by means of terminal devices and communication links (e.g., an index file of policyowner names and contract numbers, stored in direct access storage devices attached to a computer, and accessed by means of visual or keydriven inquiry and response terminal devices).

In the so-called first and second generation of computers, the establishment of batch-cycle processes for large-scale computer data processing applications was the usual method. On-line access to specific records contained in serially-oriented magnetic tape files was not practical, and direct access storage equipment of adequate capacity and justifiable cost was not available. With the introduction of third-generation computers and concepts, however, adequate and justifiable direct access storage devices are available. The resulting trend is toward increased use of data files in an "online" mode of operation.

Initially the "on-line" mode of operation will likely be limited to file inquiry, although there is an increasing degree of interest in the use of terminals to collect data processing system input directly from the user areas (instead of continuing the present practices of coding, checking, key-punching, and verifying). The use of terminals

for the actual complete processing of transactions such as changes to insurance policies is perhaps some time away from the present, and will be contingent in part upon the establishment of adequate record-keeping controls and safeguards for such an environment. The use of terminals in an actuarial information system, and particularly in the calculation aspects involved, is a very strong immediate possibility. Subsequent chapters of this presentation elaborate on this potential application.

## CHAPTER IX

#### APPRAISAL OF THE ACTUARIAL INFORMATION SYSTEM DESIGN PROBLEM

The basic implications and significance of the preceding chapters, as related to the design of an actuarial information system, are as follows:

- The system must provide for the effective discharge of actuarial information requirements, by means of a carefully designed, developed, implemented, maintained, and controlled library of actuarial data and processing routines.
- 2. The nature and magnitude of the files and routines are such as to warrant the use of computer equipment for the direct access device storage of files and routines; the calculation processes using the files and routines; and the provision of inquiry and response services to remotelylocated users by means of terminal devices.
- 3. The system must be dynamic in character (i.e., must be readily responsive and adaptable to required additions, extensions, and changes of data and routines).
- 4. The system must be constructed logically in segments or phases, as it would be impractical and unsatisfactory to attempt to incorporate all requirements at one point-oftime. In spite of the need for a phased development, however, an overall blueprint of the complete system is

required at the outset, to demonstrate the magnitude of the entire recommended undertaking; to provide a clear indication of the component phase relationships; and to establish an administrative basis for project control, resource allocation, and progress evaluation. The contents and relative priorities of the project phases must take into account the logical relationships of different phases, as well as the costs and benefits of each phase by itself and in groupings of phases as may be warranted.

- 5. There must be an effective balance between the amount of data maintained in the actuarial computer library and the amount of computer time required to recompute the data from first-principles each time needed. Some of the decisionmaking criteria in this area are the relative amounts and costs of storage and calculation facilities, and, as well, the inherent difficulties in exactly recalculating some data by current computer methods that were previously calculated by different methods. The severity of slight computational differences because of such factors as rounding techniques must be evaluated in working towards the decision to store the data or to recalculate them each time required.
- 6. There must be an effective basis of task execution, involving the actuarial personnel and the computer facilities. The computer operations must be capable of timely response

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to requests. Moreover, the use of terminal devices must be so planned and implemented that a new operator can quickly learn the required procedures, and, concurrently, that an experienced operator can utilize shorter and more convenient forms of data and process requests.

- 7. The system should provide an index of all actuarial data and routines, and be available to users for terminal inquiry purposes. Those data and routines which have been incorporated into the computer system would be available for use, while those data and routines not yet implemented would provide index inquiry responses denoting how, where, and possibly by whom the required processing might be done.
- 8. There must be a basis of inventorying business in-force and transaction activity files, so that required data can be practically accessed for intended uses. Moreover, the inventory basis must be flexible, and capable of change and adaptation at short notice. Multiple selection criteria must be provided (e.g., all twenty-pay life policies issued between years X and Y to lives with ages M to N, with occupations A, B, and C).
- 9. Facilities must be provided for research-oriented investigations, including model-building, and simulation.

10. An actuarially-oriented communication language is required

to facilitate the two-way "dialogue" of users and the computer equipment. Design criteria include compatibility with actuarial literature standards, conformity to computer and terminal device character and symbol limitations, and ease of use.

- 11. Careful control of actuarial computer library contents is fundamental, to insure that proper and correct additions and changes are being made, and that data no longer needed are being deleted on a prompt basis.
- 12. The documentation of the system, including library and index contents and usage, should be established and maintained on the subject company's accepted computer system standard (i.e., SCOT). This requirement means that there must be an effective organizational administrative framework whereby conformity to performance standards is subject to continuous control.
- 13. There should be a consistent basis for the corporate determination of computer system costs and benefits, regardless of the organizational area in which the systems analysis and programming work may be done. Moreover, with respect to incurred personnel costs for analysis and programming, there is a need for agreement as to the corporate basis of estimating the cost of a work unit,

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such as a charged man-month, and for a corporate administrative system to record and control charged personnel time.

(Systems analysis and programming activities are currently conducted in at least two major areas of the subject company, namely the Actuarial Division and the Computer Systems and Services Department. Accurate and realistic personnel time and cost records are maintained in the latter area, as are records by specific task indicating the estimated personnel and computer charges for implementation and operation. The system documentation standard is SCOT. None of these characteristics apply to the Actuarial Division systems and programming work.)

- 14. Systems analysis and documentation work must be completed in accordance with the accepted standards, including user department approval as to content and accuracy, before programming is commenced. This means again that there must be an effective system for corporate control of this requirement, applicable to all personnel performing systems analysis tasks.
- 15. The production of hard-copy paper forms, documents, and listings should be related to actual requirements for such material, and should not automatically be undertaken in

all situations without any analysis as to need. The access of data, when needed, from computer files by means of terminal devices should be the encouraged mode of operations.

The nature of the problem under investigation involves the approach to be taken to the development of a system which will effectively provide for the actuarial information needs as noted in the preceding chapters. The primary components of the recommended approach, to be outlined in the next chapter, are the record-keeping operations of data and procedures, computer hardware considerations related thereto, data retrieval and processing considerations, and corporate functional applications.

In addition to the above factors, there are organizational considerations to be given to the optimal framework and use of personnel engaged in actuarial operations, as defined in this presentation. There are many factors, beyond the scope of the current investigation, to be taken into account in analyzing the organizational implications. It is important to observe however that, if the recommendations contained herein are approved in principle, it will be necessary to give early and diligent consideration to the organization within which and whereby the system is to be operated.

Finally, it will be necessary, if the recommended approach is adopted, to quantify the objectives of each subsequent phase, and to determine to the extent possible the likely costs of implementation

and operation to be incurred. This control framework, with associated task deadline dates, is essential if there is to be effective management control of a major series of tasks, in terms of effort and potential.

## CHAPTER X

# OUTLINE OF THE RECOMMENDED APPROACH TO THE DEVELOPMENT OF AN ACTUARIAL INFORMATION SYSTEM

This chapter provides an outline of the recommended approach to the development of an actuarial information system for the Great-West Life Assurance Company.

Notwithstanding the apparent extensiveness of the subjectmatter presented, it does not represent a proposed systems design for an actuarial information system. Nor is it intended to convey the impression that detailed analysis work has been done in depth in the possible component subject areas. Rather, it recommends some of the possibilities of system development which, in the author's opinion, can usefully serve the needs for actuarial information.

The contents of an actuarial information system are subject to change in the initial discussion stage, in the detailed developmental phases if the decision is made to proceed, with the passage of time, with changes in environmental factors, and with the discovery of new data. Some subject matter will undoubtedly be added; presently-proposed components may be changed in a minor or a major way; and some material may be deleted. In no way do these alteration possibilities detract from the most important objectives of the recommended approach, which are to stimulate actuarial division thinking as to the sorts of information and procedures required, and to suggest some of the possibilities which should be considered. The following sections outline various aspects of the recommended approach, in the order of record-keeping operations, computer hardware considerations, data retrieval and processing methods, and corporate and functional applications. The first of these topics, involving record-keeping operations, has been further subdivided into four parts, namely:

- 1. record-keeping of data;
- record-keeping of procedures using or operating on the data records;
- 3. processes of record maintenance; and
- 4. file controls of accuracy and security.

#### 1. RECORD-KEEPING OF DATA

Data records of or involved in the proposed actuarial information system approach include the following:

- (a) Tabular data, by age, of the probabilities of event occurrence, or of corresponding numbers of lives, depending on the nature of the source material. Event types would include death, accidental death, withdrawal or termination, disability, death while disabled, and recovery from disability.
- (b) Tabular mathematical and other data and factors which are not practically computable from first principles or obtainable from business record inventories each time

### required. Possible examples include:

- loading percentage and constant expense factors for use in calculating unit gross premiums and dividends;
- percentage distributions of group insurance certificateholders by state or province of residence;
- probability densities and cumulative probabilities, or normal areas and ordinates, for a normal distribution with zero mean and unit standard deviation, that is, for standard units;
- tables of random and/or random normal numbers;
- Chi-square, Student's t, and F distributions.
- (c) Actuarial library reference tables, including unit factors for premiums, reserves, cash surrender values, reduced paidup and extended term insurance non-forfeiture benefits, dividends, sums of dividends, accumulations of dividends, and term insurance amounts and permanent plan paid-up insurance amounts and related cash surrender values purchased by the application of dividends.
- (d) Business in-force and transaction activity records of individual policies and certificates, for use in statistical and liability valuation operations, business analyses, research investigations of mortality and persistency experience, and simulation procedures.

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(e) Information of the nature of the Mathematical Formulae book contents, in a format suitable for reference in a reading environment (just as one might read or browse through the present manual, except that the normal medium involved would be visual display computer terminal devices instead of paper).

## 2. RECORD-KEEPING OF PROCEDURES

Appendix A lists some of the procedures which are regarded as necessary to operate on the various forms of data records involved in the system. The basic classification framework is as follows:

A Interest and Annuities Certain Calculations Individual Life and Annuity Basic Calculations

Single Life Functions

- B The Mortality Table
- C Annuity Benefits
- D Insurance Benefits
- E Net Annual Promiums
- F Reserves
- G Dividends
- H Gross Premiums
- I Non-Forfeiture Benefits

J Multiple Life Functions

K Multiple Decrement Functions

L Individual Health Insurance Basic Calculations

M Group Insurance Basic Calculations

N Group Pension Basic Calculations

0 Actuarial Library Reference Tables

P Mathematical and Other Tables and Information

R Business Status and Activity Information - Individual

S Business Status and Activity Information - Group Insurance

T Business Status and Activity Information - Group Pensions

W Research - Individual

X Research - Group

The contents should not be regarded as all-inclusive, but rather as representing a general basis or foundation, to which additions, changes, and extensions may be applied to meet the required conditions. The Society of Actuaries' Textbook on Life Contingencies, by C.W. Jordan, Jr., the subject company's Mathematical Formulae book, and the documentation of various computer programs serving the actuarial function were all extensively consulted.

In presenting this outline of recommended procedures, it must be noted that the decision to include or exclude a particular formula or equation is not readily subject to precise definition or ground rules. The basis used involved a consideration of possible extensiveness of use of each routine, as a rough index of potential value if included. Differences of opinion are almost inevitable in this general area. However, the contents as recommended should be regarded as examples which are proposed for inclusion, with changes and additions to be capable of ready incorporation when needed and justified.

The Appendix A pages were printed on an IBM 1403 Model N1 printer, with a speed of 1100 lines per minute, attached to an IBM System/360 Model 50 computer. The character set used is the PL/1 60 Graphic Print Train. (The IBM terminology is Modified "QN".) The characters and symbols used are contained in Table 10.1. The purpose of the printing by machine is to portray the exact formats that would be produced by the computer facilities, rather than to present typewritten equivalents.

The contents of Appendix A have been prepared so that they can be displayed, if practical, on IBM Model 2260 visual display terminal units. It is not intended that the visual display approach be assumed to be the adopted or justified method for actuarial data displays, or that a detailed feasibility study of terminal device possibilities (e.g., the IBM 2740 Communication Terminal units) has been made as a part of this investigation. Rather, the visual display concept is intended as an illustration of a possible approach, and is related to a corporate decision to acquire IBM Model 2260 visual display units on an experimental basis.

Consideration by actuarial personnel is necessary to determine whether or not the visual display idea has reasonable merit in relation to actuarial operations. If the concept does appear to have value in actuarial applications, then a detailed evaluation will be necessary

CHARACTER SET AND SYMBOLS USED ON 1403 HODEL N1 TABLE 10.1 PRINTER FOR ACTUARIAL FORMULA REPRESENTATIONS. -----CHARACTER USE, IF ANY, IN ACTUARIAL FORMULAE \_\_\_\_\_ A - Z VARIABLE 0 - 9AS REQUIRED Э ANNUITY ANGLE, TO DENOTE DURATIONS DIERISIS ABOVE 2, TO DENOTE "DUE"; SUBSCRIPT SEPARATOR OTHERWISE. CONTINUOUS PAYMENTS (WITH @); IMME-DIATE PAYMENT OF CLAIMS (INSURANCE); MINUS SIGNS; FRACTION LINES. DEFERRED PERIOD (PREFIX SUBSCRIPT) 1 DIVISION SYMBOL. ( ) CLARIFICATION OF EQUATIONS; IN SUB-SCRIPT SUFFIXES, TO DENOTE SELECT AGES (NORMAL CONVENTION INVOLVES USE OF SQUARE BRACKETS); IN SUPERSCRIPT SUFFIXES, TO DENOTE NUMBER OF PAY-MENTS IN A PERIOD. EQUAL < LESS THAN > **GREATER THAN** PRIME SYMBOL, TO DISTINGUISH MORTA-LITY OR INTEREST RATES IN THE SAME EQUATION (USE MORE THAN ONE AS NECESSARY). PLUS SS SUMMATION SYMBOL (GREEK SIGMA) W USE WITH SS SUMMATION SYMBOL DENOTES LOWEST AGE IN A MORTALITY TABLE WHERE THE NUMBER LIVING IS O (OMEGA). OTHER SYMBOLS WITH NO SPECIFIC TECHNICAL USE 84 ŝ ¥ 3 : ? X

Source: H.A.C. Johnson (Developed For This Thesis)

to demonstrate the justification for using IBM Model 2260 units instead of other available terminal devices.

The number of formulae contained in Appendix A may exceed the justifiable or practical limit as to the number of displays and the supporting program logic required. In this area as well, therefore, it will be necessary, if the visual display idea has merit, to determine what the limits as to numbers of displays and support program logic capacity actually are. It is possible, for example, that displays for selected formulae only would be provided, and that the normal method of information preparation would be by means of high-speed printers.

Throughout the Appendix A pages, symbols are defined where used. Some conventions have been adopted where ambiguity was possible as a result of the use of capital letters only, instead of the more usual actuarial formats of capital, lower case, and script letters.

#### 3. PROCESSES OF RECORD MAINTENANCE

The data records of the system originate either from the initial entry of basic data via terminals or punched-cards or as the result of processing operations applied to the data files. Changes to records arise from similar sources. Deletions normally originate from sources external to the system (i.e., people decisions) but may also arise from computer program logic and pre-established deletion diary date rules.

The detailed processes of record maintenance depend upon the

contents of the records and procedures themselves, as well as on the sizes of the data and procedure files, and hence must be established in the detailed systems analysis work subsequent to the present broad system study. File sizes must be prevented from becoming prohibitively large, by careful consideration of all data and procedures to be included. Data and procedures used very infrequently should probably not be included. Data and procedures in the intermediate range of usefulness may be incorporated, but consideration should be given here to the less expensive and slower effective reference storage medium of magnetic tape. Data and procedures which are included in directly accessible storage facilities should be regularly reviewed, to determine whether they should be moved to magnetic tape storage or deleted entirely. Actuarial records maintained for historical purposes only, if required in computer-processable form, should be stored on magnetic tape. Microfilming of historical data is another possibility.

The means of adding, changing, and deleting data and procedures, by punched-card transactions or by visual display terminal input, are dependent upon the amount of data involved and upon the urgency of data entry and use.

## 4. FILE CONTROLS OF ACCURACY AND SECURITY

The subject of system and file controls of accuracy and security is a very extensive one, and considerably beyond the scope of the current investigation insofar as a detailed presentation is concerned. The record-keeping and data processing of in-force and transaction activity files include extensive logic to prove the integrity of the individual data fields, the interrelationships of data fields within and among files, and the accuracy of the programs and changes thereto. Provision is also made for the safeguarding of files and procedures from total or partial destruction, by means of backup files, normally on magnetic tape and stored away from the central computer room.

The calculation aspects of the proposed system also require effective controls of contents and logic accuracy, by means of control routines, testing procedures, and good documentation techniques. It is believed practical and most beneficial to assume the use of the subject company's "SCOT" documentation system, as outlined by Mathieson (46), in recording the details of the actuarial information system requirements.

Finally, in the area of terminal usage, it is important to provide control routines to safeguard the contents of confidential files, to prevent the destruction of computer-stored files and procedures as a result of terminal data entry, and to preclude the initiation of long-duration computer runs from terminals without the proper authorization (e.g., the request to calculate a new dividend scale for all company business requires appropriate approval, as the computer time involved is appreciable).

The design of effective controls of accuracy and security for

the actuarial information system developments is an integral part of the detailed system specification task. All possible eventualities must be considered, and appropriate safeguards designed and implemented, so that the system can become and remain securely and accurately operational. Some examples of possible control methods are the use of password controls to prevent unauthorized use of terminals and access to specified files; the use of magnetic tape to provide backup for data and procedure files in direct access storage; proper documentation of system details; the design and use of effective test data; and the recognition that controls must be continuously considered from the very start of detailed system specification work, and must be built into system developments in a practical and logical way if they are to be effective.

#### 5. COMPUTER HARDWARE CONSIDERATIONS

The subject company currently owns IBM computer equipment, consisting of one 7070 (a second-generation, tape-oriented system), one associated 1401 for input-output use primarily, and one System/360 Model 50 (a third-generation system with direct access disk and data cell storage facilities). Current plans include the acquisition of IBM Model 2260 visual display units, with associated keyboards and control devices.

Some of the more significant aspects of the actuarial information requirements, as related to computer hardware considerations, follow:

- (a) The computer files and processing capabilities must be available on demand to actuarial personnel, particularly during regular office hours. As a result, the computer should be operated in a multiprogrammed environment, so as to make optimum use of the available processing time intervals between actuarial information system requests.
- (b) The system must have an effective and adequate speed of response to data and processing requests. This implies the use of random access storage for files and procedures. It also indicates the desirability of use of on-line terminal units attached by communication lines to the computer, to enable the power of the computing facility to be used by actuarial personnel working in their own geographic area of the building. The application of IBM Model 2260 visual display terminals in this area, together with the provision of data print-outs when dictated by volume and other considerations, appears to be the most logical course to follow. It is also consistent with the planned program of extended usage of visual display units, and of the provision of printed output only when required.
- (c) The system must provide a logical extension of the capabilities of the individual users of the system, with computer power being used wherever warranted and justified, and, conversely, not applied where people processes should be

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used instead. Moreover, the system must take into account the degree of difference in the skill and experience levels of the various users, and provide the means whereby both experienced and new personnel can use it effectively. The use of visual display units in a conversational operating mode contributes materially to these objectives.

(d) Actuarial information processes can result in a wide range in the amount of output produced. For applications involving large volumes of output and, moreover, requiring printed documents, the use of the high-speed printer (1100 lines per minute) is necessary. Also, it would appear preferable to produce the print-outs by preparing a printing job queue of disk-stored data and then printing from the queue in a SPOOLing environment (i.e., Simultaneous Peripheral Operation On-Line). This avoids the dedication of a complete printer to the actuarial function for regular office hours, and also enables the use, where necessary, of pre-printed instead of blank paper stock.

The possible need for auxiliary printing facilities in the actuarial area may be met by use of IBM 1053 Printer or IBM 2740 Communication Terminal Units. Both types of devices are much slower printers than the 1100 line-perminute unit referenced earlier, as they print character-bycharacter for each line. At the present time, it is not

felt that the use of printers of this type would produce material benefits, by way of reduced response time for hard-copy results, of sufficient importance, when compared to the high-speed printer use concept, to warrant their acquisition.

(e) The system must be so designed as to be independent of the particular form of input and output devices employed. The use of a particular device should be determined on the basis of application requirements and device practicabilities.

For example, the 2260 visual display unit may be used for normal types of input requests and associated data. If the input, however, is a new mortality table, it may be preferable to have punched-cards prepared and then to read the punchedcards through the computer room card read-punch unit (i.e., an IBM 2540). At the same time, it should be possible to enter the mortality table by means of the IBM 2260 unit, even though it may not be the best way and may tie up the unit for excessively-long periods of time.

Output device selection should also be related to the application requirements and device practicabilities. For example, the user of an IBM 2260 terminal should be able to request the exception preparation of hard-copy replicas of the visual displays by the simple process of

terminal key depression, with the results being produced on the high-speed printer.

#### 6. DATA RETRIEVAL AND PROCESSING METHODS

Appendix B, printed on the IBM System/360 computer, outlines some examples of the possible uses of IBM 2260 visual display units in actuarial data retrieval and processing operations. Five examples are presented, involving the calculation of premium rates, reference to stored actuarial tables for selected cash values, reference to stored tables of normal distribution data for selected values, access to master file information for a particular policy, and the development of persistency rates for a business of a particular agent. Recognition has been given to the potentially wide range of knowledge and skills in actuarial matters on the part of the system users. Accordingly, a detailed, step-by-step approach has been outlined for new terminal operators, and a summarized short-cut method, for use by experienced personnel. The Appendix was printed on the 360 computer.

The basic operational structure of the Appendix B contents, in moving progressively from a major category of request to a minor or subordinate one, is analogous to the approach described by Hodson (47) in outlining a hospital information system using computer facilities.

It is not intended or implied that the IBM 2260 approach be the only recommended method for data retrieval and processing. Rather, it should be viewed as an alternative to computer room card readers and

high-speed printers, with the decision as to device selection being based on specific application parameters. The observations made in Section 5 of this chapter, immediately preceding, are particularly applicable in this context.

In support of the outlined approach, it will be necessary to provide effective file access controls, file content safeguards, process and data linkages, and appropriate system warning messages to the users in the event of erroneous request parameters. A fundamental requirement throughout involves the processing of data in such a manner as to produce the most meaningful and useful information for the system users. Flexibility in information specifications, and acceptable request-response time intervals, are important criteria in this regard.

## 7. CORPORATE AND FUNCTIONAL APPLICATIONS

As demonstrated by the range of topics outlined in Appendix A, the corporate and functional applications of the suggested actuarial information system framework are widespread. Included are management requirements, governmental submissions, and functional uses in the sales, policyholder services, administrative, and research areas.

For some time prior to the commencement of the present research task, the writer has been concerned with the significance of current business in-force as related to the corporate financial position. Deliberations in this area have been limited to individual life and annuity business; individual health insurance and all group business has been excluded because of the materially different nature of such business (e.g., the yearly renewable features of group life and health and of a significant proportion of individual health business).

Business in-force is commonly measured in terms of numbers of policies, amounts of insurance, and annualized premiums. Important as these indices are, they do not in themselves provide clear indications of the proportionate contribution of each policy to the company's financial position. What appears necessary is some additional criterion whereby the current position of each policy, and hence in aggregate the individual life and annuity line of business, is subject to continual evaluation in terms of its financial significance to the company. This section is an attempt to provide such a criterion.

The calculations of gross premium rates, particularly for nonparticipating business, involve assumptions as to mortality, interest, lapse, and expense rates, so as to provide the valuation net premiums required to support the contractual liabilities, and, in addition, the margins for corporate performance contributions and unforeseen contingencies. Publications of the Society of Actuaries and its predecessor organizations, the American Institute of Actuaries and the Actuarial Society of America, contain several papers on gross premium calculations including presentations by Cammack (48), Shepherd (49), Hoskins (50), Jenkins (51), Rosser (52), Anderson (53), and Stein (54).

An important component of the presentation by Hekimian (55)

on "Management Control in Life Insurance Branch Offices" is the outline of a method to measure the "expected contribution to profit" of each policy at the time of its sale. Jaffe (56) noted the similarity of approaches taken by Rosser (52) and Hekimian (55) in computing the expected contributions to performance.

Gold (57) has presented an account of some of the factors to be considered and methods to be employed in valuing a life insurance company. He goes into considerable detail in all valuation aspects, including assets, liabilities, earnings, personnel, agency organization, group insurance, participating and non-participating business, capital, and surplus. In another paper, Gold (58) set forth some of the mechanics of life insurance company projections.

Of the foregoing references, perhaps the most contributory to the current investigation are those of Rosser (52), Hekimian (55), and Jaffe (56) for their methods of calculation; and Anderson (53) and Gold (57 and 58) for their approaches to business in-force evaluation. It is significant to note, nevertheless, that none of these presentations provide a method whereby business in-force is subjected to continual scrutiny with regard to each policy's contribution to the corporate financial position. For this reason, the following recommended procedure was developed.

The recommended procedure involves the calculation of what is

herein termed the prospective performance of each policy. By this term is meant the value as at the current date of all of the future financial elements of the policy, (i.e., gross premiums, dividends, cash values, commissions, and expenses), based on current assumptions as to the mortality, lapse, and interest rates which are likely to be experienced.

The prospective performance for a policy consists of the prospective performance per unit factor times the number of policy units.

The prospective performance per unit consists of the sum of two parts, the basic margin factor and the margin adjustment factor.

The basic margin factors take into account those elements of potential financial contribution which are determinable from policy contractual data, the assumed tabular rate data, and, for participating business, the current dividend scale.

The margin adjustment factors take into account those elements of potential financial contribution which are oriented to individual policies (i.e., policy size, which affects the policy fee per unit and other expense factors; and commission rates, which vary by type of agent contract). Margin adjustment factors are, of course, also affected by the assumed tabular rate data.

The procedural steps involved in the recommended approach follow. Examples of the calculations are contained in Appendix C. It should be noted that all examples begin with duration 1, but that, for business no longer being issued, calculations would begin at the lowest duration required. The interest discount factors (column (3) in the examples) would always commence with one. The numerical data demonstrate the principles involved, but should not be regarded as representing or suggesting the degree of precision required in terms of number of significant digits used. The Appendix was printed on the 360 computer.

(a) Calculate the basic margin factors. For participating business, this can and should be done as a part of dividend scale calculation work, because of the need for common usage of many of the factors. Non-participating calculations should be done at the same time.

At the beginning of the calculation process, compute and store the persistency and discount factors (column (7) data) for all ages at issue and durations, with the durations beginning at one. Then, as each plan and age is to be calculated, access the appropriate set of persistency and discount factors, adjust the duration to the required starting point as outlined in Table 113 of Appendix C, and proceed with the calculations of the basic margin factors.

(b) Establish the basic margin factors as a part of the actuarial factor file, along with reserves, cash values, and dividend rates (i.e., by valuation basis code, interest rate, premium

sub-group, plan of insurance, age at issue, and duration).

- (c) Provide for the inclusion on the master file for individual life and annuity policies of three basic margin factors (previous, current, and next) wherever terminal reserve factors are used.
- (d) Assign basic margin factors to the master file records in the same manner and at the same time that reserve, cash value, and dividend factors are assigned.
- (e) Provide for the inclusion on the master file of individual life and annuity policies of three prospective performance fields (previous, current, and next) wherever terminal reserve factors are used.
- (f) For each policy, at the time of assignment of basic margin factors, or when changes are occurring which alter the margin adjustment factors, calculate the margin adjustment factors, combine the margin adjustment factors and basic margin factors to obtain the prospective performance factors, and multiply the prospective performance factors so obtained by the number of units to develop the prospective performance data for the fields specified in (e) above.

It is assumed that insurance riders (family protection, home security, and level term) would have their own basic

margin factors and prospective performances (total) separate from the corresponding data for the basic policies to which they are attached.

(g) Summarize master file and transaction activity data as required for statistical purposes, but show the prospective performance totals along with the other summations of numbers of policies and amounts of insurance. In this way, aggregate and average prospective performance data will be available wherever required or useful (e.g., analysis of new business and business in-force by branch, agent, plan type, age at issue, duration from issue).

Some of the implications and observations based on the preceding recommendation follow:

(a) Since prospective (i.e., looking forward) performance factors are required, the dividend scales must extend to maturity, if the results are to be all-inclusive. Cash value factors to maturity are also required for the same reason. Possibly some short-cut assumptions may be found necessary and practical in this regard (i.e., assumptions as to dividend and cash value factors which will apply more than a stipulated number of years, such as 20, from the prospective performance evaluation date).

(b) The calculations are considerably simpler if only one interest

rate is assumed. Interest rate variations by duration can be processed in the manner outlined if required, although some of the calculation processes would have to be changed.

- (c) Mortality and lapse rates on a select and ultimate basis can be accommodated as indicated in the examples.
- (d) Variations in mortality and/or lapse rates by plan can be accommodated (e.g., preferred risk and term plans). Preferably, such variations should be expressed as percentage or constant increments or decrements to the normal tables, rather than as completely new tables. Similarly, the margin adjustment factors can take into account the variations in underwriting practice associated with each policy (e.g., non-medical, substandard, and guaranteed issue business).
- (e) The approach does not take into account the refinements which might be required for fractional and outstanding premiums, supplementary benefits, and death benefits payable on an immediate claim payment basis. It does provide for contractual changes in amounts of insurance and gross premiums. Refinements where necessary or justified can be incorporated, with some possible incremental effect on data storage space and computer processing time.
- (f) The method as outlined suggests the addition of one set of prospective performance factors to each policy and each rider.

Assuming 500,000 policies and riders in-force, and 30 digits per record (six fields of 5 digits), the in-force master file would be increased by 15,000,000 digits.

It might be, however, that more than one set of prospective performance factors might be desirable, e.g., three sets, denoting respectively, the most favourable, least favourable, and most probable estimates in terms of mortality, lapse, interest, and expense rate assumptions. The effect of this approach on the size of the master file would be an increase of 45,000,000 digits.

- (g) The effect of the additional master file data fields on existing pre-printed forms could be significant, depending upon the number of forms involved, and the extent to which prospective performance data should be shown thereon.
- (h) The formula used in the calculation examples to calculate the probability of not dying and not lapsing (i.e., column (4) data) is the approximation used in the subject company's asset share calculations. No problem would arise from the introduction of the theoretically more accurate method. However, the method used is simpler, and provides a convenient control by summations of example columns (1), (2), and (4).
- (i) The method could be used in experimental work by selecting or creating sample blocks of business and by determining

the effects of different assumptions on their prospective performances. The examples in Appendix C demonstrate some of the effects of changes in interest, lapse, and mortality rates, taken individually and in combination. Changes in policy-oriented factors such as policy size, policy fee, and commission rates could also be tested as to their effects on prospective performances.

- (j) The initial approach of assigning prospective performance factors to individual policies, and of summarizing the data in groupings as required, can lead to the identification of those parameters which contribute significantly to prospective performance, those which do not, the quantifying of the degree of contribution of each, and the beginning of the build-up of a corporate model of individual in-force business.
- (k) The process and scheduling of the assignment of new prospective performance factors to the entire business in-force, in the event of changes in the assumptions of interest, lapse, and mortality rates to be experienced, warrant some consideration at this point.

When a dividend scale change is made, the new dividend rates are assigned to in-force business on their policy anniversary dates next following the effective date of the new scale.

This means that the current dividend information on the business in-force records, during the one-year period following the new scale effective date, is a mixture of new and old scale data, depending upon whether or not the policies have passed their anniversary dates. Summations of current dividend data for groups of in-force policies would also therefore consist of mixtures of old and new scale data.

With reference to changes in prospective performance factors (which will occur whenever the dividend scale is changed, as well as whenever the assumed interest, lapse, and mortality assumptions warrant revision), there are three possible methods which can be considered. The first is to update the master file factors at the same time that anniversary processing is being done. By this method, the work is spread over a one-year period, but it also means that summations of prospective performances contain mixtures of old and new factors. The second method involves the compression of the master file factor updating into a one-month period, with policies for all anniversary months being updated when their anniversary days of the month are reached in the processing cycles. By this method, the work is spread over one month, and further, the master file prospective performance data are all on the new basis after one month rather than one year as in the first method. The third method involves the further

compression of the master file factor updating into one processing cycle, with the peaking of all the work at one point-in-time, and the immediate updating of all factors to the new basis for more meaningful statistical results.

The degree of urgency for updated prospective performance data, the practical problems associated with increased compression of the updating schedule, in terms of available computer time, and the degree of completeness of the dividend factors for a new scale, are some of the more important areas of consideration in determining the approach to take.

(1) The incorporation of prospective performance data into business in-force records, at the time of addition of policies to the file and of changes to policies on the file, enables analyses to be made of new issued business, transaction activity, and terminations with regard to their prospective performance data.

Measures of new business prospective performances by agent, branch, plan of insurance, age, and occupation of insured, and comparisons of data for successive years of new business issues, could be most useful for corporate and marketing purposes.

Similar measures of transaction activity, and in particular of preventable terminations (i.e., lapses and surrenders,
in contrast to death claims, maturities, and term insurance expiries) could also be of value for corporate, marketing, and conservation purposes. Trends from year to year would, it is felt, be most useful to note and evaluate.

(m) The approach as outlined has been limited, as stipulated previously, to individual life and annuity policies. The subsequent incorporation of other lines of business (i.e., individual health insurance and all types of group business) would extend the usefulness of the concept by providing measures of all lines in terms of prospective performances.

The calculation methods for the other lines, now excluded, would be considerably different in detail. However, the broad framework, involving the valuation on a current basis of the future financial factors of each policy, using the most realistic assumptions available at the present time, seems to have universal application to all lines of business.

#### 8. SUMMARY

In summary, the preceding sections of this chapter, the actuarial calculation and data contents, as outlined in Appendix A, the possible alternative operational methods using terminals as shown in Appendix B, and the concepts of prospective performance and continuous business evaluation as illustrated in Appendix C, constitute the recommended approach to the development of an actuarial information system for the

10.28

subject company.

Specific elements of the recommended approach are as follows:

- (a) A basic framework has been outlined for the orderly and controlled development of an actuarial library of data and procedures.
- (b) A concept has been illustrated for the consolidation of basic actuarial calculation routines, which are currently decentralized in a number of computer programs as well as in manual procedure files.
- (c) The development of a computer-stored actuarial library of data and procedures has been proposed.

The library approach provides for the addition, change, and deletion of routines and data without necessitating a complete revision of the storage and retrieval concepts. It also provides more effective control of procedures and data files, and, in addition, an improved reference capability as to what specific routines, tables, and data are actually available within the system. A current problem involves the difficulty of knowing, on a common and uniform basis within the actuarial area, precisely what routines have been programmed, what data files are available, and what their individual capabilities and constraints actually are.

- (d) A basis of system documentation has been recommended as the operational standard. This is important in that improved controls are a direct consequence, and, moreover, that good documentation provides the basis for better system understanding and use.
- (e) A format for the printing and visual display of actuarial symbols and formulae, using standard IBM System/360 characters, has been developed, and has been illustrated by the contents of Appendix A.
- (f) A method has been developed for the evaluation of business in-force, new issued business, and transaction activity in terms of the potential contribution each policy is likely to make to the corporate financial position, and has been illustrated by the contents of Appendix C. This method, involving the concept of prospective performance factors assigned to each policy, can, it is believed, contribute in a significant and cost-justifiable way to the evaluation of corporate, divisional, and individual performances. The availability of such measures on a continuous basis will, it is felt, provide the corporation with a valuable control element, over and beyond other control elements which currently are in use.

(g) Possible uses of computer terminal devices for actuarial

inquiries and calculations have been suggested, and have been illustrated by the contents of Appendix B.

No attempt has been made to confirm the detailed feasibility of the component elements. Moreover, it is very likely that some at least may be changed materially in the detailed systems analysis and development work phases.

In effect, the recommended approach involves the creation and constructive use of a library of computer-stored actuarial data and processing routines. One of the 1961 Centennial Year lectures at the Massachusetts Institute of Technology had the title "A Library for 2000 A.D." Hopefully, the current recommended approach conveys the impression of a much shorter time span in its progressive development, and constitutes an incisive approach in which operational goals may be quickly achieved. However, it is useful to consider the above title in the present environment, as what is being recommended is a framework for actuarial information storage, retrieval, and effective use for the entire company. The program must be regarded as an ambitious one. For this reason, a number of distinct projects will emerge, with the initial emphasis on the basic data and procedural foundation elements illustrated in Figure 3.1. File structures and contents will be subject to extensive revision as the requirements for information to serve the operational control, management control, and strategic planning functions become increasingly well-defined. Considerable research work has been done by authorities in the highly complex and difficult area of file

structures.

While it is beyond the scope of this presentation to go into detail in the areas of computer-oriented libraries and uses, and of hierarchical file structures, it is nevertheless constructive to record selected references which may be of assistance in these areas in the more detailed system development phases it is hoped will follow. This has been done in the Bibliography.

#### CHAPTER XI

## EVALUATION OF THE PROPOSED APPROACH

The purpose of this chapter is to present an evaluation of the proposed approach, in terms of its potential benefits, costs, and overall justification considerations. The dimensions of the approach necessitate a very general treatment of these topics, particularly in the areas of dollar benefits and costs. It is important, nevertheless, to provide perspective for the suggested plan by outlining, to the extent possible, the pertinent evaluation elements.

#### 1. BENEFITS

The benefits to be realized, by adopting the guidelines provided by the recommended approach as the basis for actuarial system developments, include the following:

> (a) Actuarial calculation methods for gross premiums, reserves, cash and non-forfeiture values, and dividends; and for research activities including asset share computations, persistency investigations and mortality studies will be materially improved, in response time, effectiveness, and quality control. The concept of a computer-stored library of actuarial data and procedures is fundamental in this regard, in common with the need to organize, control, and thereby augment the effectiveness of technical libraries in other specialist subject areas. It is important to stress, however, that current objectives are not restricted to data

storage and retrieval, but include the facility for processing and calculation as may be required.

- (b) The documentation method for the actuarial system will be standardized and unified in one structure, which can support current needs and provide flexibility of contents or approach with respect to changing future needs.
- (c) Improved actuarial information, such as prospective performance measurements of business activities, will be available for management control and decision-making. Research-oriented investigations, involving the combined use of data files, computational procedures, and mathematical techniques will become increasingly valuable aids to management in support of corporate strategic planning deliberations.
- (d) The capabilities of actuarial personnel will be greatly extended by the creation of powerful computational aids and constructive reference facilities to assist them. The disciplinary environment of the actuarial library concept does not constitute a constraint or restriction to personnel involved. Rather, in common with library facilities of other disciplines, it provides for the orderly storage, efficient retrieval and use, and an improved degree of awareness of the data contents and processing routines.

These benefits provide some of the more important reasons which

support the recommended approach. It is recognized, nevertheless, that they do not indicate in quantified terms, the economic justification of the proposals. The quantification of benefits cannot, in fact, be determined at this stage, because of the almost limitless range of possible data elements and procedures which could be included. As the first step towards the determination of quantified benefits, this investigation has been conducted and the results documented so as to demonstrate some of the computer system possibilities as related to actuarial operations. Its most important purpose, perhaps, is to stimulate actuarial thinking in relation to what actuarial information is needed for current and future uses, and why it can be justified, where possible in economic terms. Following the determination of what is required and why, the means of producing the information in the best way in terms of costs, response times, and other factors of system quality, must be determined.

The prospective performance concept may be used as one example of the problem situation related to the quantifying of benefits. The qualitative justification may appear quite sound, but the quantified merit of the idea, in terms of actuarial decision-making is a very subjective matter. What, for example, would be the dollar value of a decision to discontinue a given product line because of unfavourable prospective performance indications? A corporate evaluation of the concept must be made in terms of what it may contribute to the business performance. Logically, the evaluation of benefits is the responsibility

of the corporate area or individual that is going to use the information for decision-making purposes. In the case of the prospective performance idea, this responsibility rests with the Actuary. The same responsibility relationship applies to the other actuarially-oriented proposals of this presentation.

## 2. COST CONSIDERATIONS

A detailed presentation of costs related to the proposed approach is not possible at this stage, for the same reason that quantified benefits could not be determined. The initial requirement is to define what is to be done (the Actuary's responsibility). This is followed by systems analysis work to determine the best way of doing it, with the criterion of "best" including cost considerations. At the same time, however, some general indications of costs can be provided.

The Great-West Life has adopted the practice of preparing annually a report entitled the Computer System Development Plan. In it, the computer tasks to be undertaken for the next five years are recommended, together with costs and benefits related thereto. The contents are developed by discussions involving systems analysts and user department personnel.

The November, 1968 version of the Computer System Development Plan made provision for specific tasks related to actuarial information 'system developments. Table 11.1 is an extract from the report, which

TABLE 11.1 COMPUTER ACTUARIAL TASKS PLANNED FOR 1969-1973	Completion Date	Computer and Ser Charges fo Develop Implemen and Main Manpower	Systems cvices or System oment, ntation ntenance <u>Machines</u>	Annual Recurring Operation Charges Machines
Completion of Actuarial Calculation System, Phase 1. Preliminary investigation of required elements, proposed uses, storage and retrieval techniques.	March, 1969	\$ 5,445	ş <b>-</b>	\$ <b>-</b>
Actuarial Calculation System, Phase 2. Storage of tables and rules to enable replacement of 650 simulated actuarial calculations; availability of actuarial factors and formulas for servicing of Computer Ledger Statement System, and Estate Security Program, Phase 2 System.	Dec., 1971	67,710	13,056	4,920
Actuarial Calculation System, Phase 3. Extension of stored data and accessing thereof to provide for servicing of all individual in-force business.	Dec., 1972	31,460	6,528	820
Full use of Financial Reporting System, Actuarial Calculation System, and Master files for Profit Centre analysis, simulation, projection, etc.	Continuing	24,480	4,896	5,740
Total		\$129,095	\$24,480	\$11,480
Source: "Computer System Development Plan", the Great-West Assurance Company, November, 1968, Appendix Pages	Life 15-17.			

outlines, for 1969-1973, the recommended computer actuarial tasks, completion dates, and estimated costs. The cost data represent charges to the actuarial division for services provided by the Computer Systems and Services Department. No provision is made for the charges to be incurred by the actuarial division with respect to the time spent by their personnel on the various development aspects of the system.

The investigation which is the basis of this thesis is represented by the first task outlined in summary in Table 11.1. The costs included relate to the 1969-1973 period, and do not include provision for charges in 1968.

By the point of time and stage of system development represented by the completion of these actuarially-oriented tasks, together with the completion of other planned tasks related to financial reporting requirements, considerable headway will have been made in the integration of annual statement actuarial liabilities and the accounting system, as discussed by Vogel (59).

Before any project in the Computer System Development Plan is started, a set of Project Control Forms is prepared, on the basis of discussions involving systems analysts and user department personnel. Project objectives, charged man-months, costs, and benefits are determined as accurately as possible and are used to evaluate progress. User department approvals of projects and associated expenses are a part of the system. Significant deviations of actual costs, benefits,

and project contents from the original estimates necessitate the preparation of revised project control forms and their approval by user department personnel.

The current investigation involved the preparation of Project Control Forms, as shown in Tables 11.2 and 11.3, and their approval by the actuarial and data processing areas.

Subsequent phases of actuarial information system developments will be controlled as to objectives, contents, costs, and benefits by means of the project control system. Estimates will be prepared and approved at the commencement of each task, and will be used to control actual progress. Estimate revisions will be prepared as necessary.

The preceding information is related to the costs of new projects. In addition, costs must be considered in relation to systems, involving actuarial components, which are currently operational, and to other cost topics. The subjects to be outlined in this context are computer hardware and operations, systems development and maintenance, staff training and development, and future cost projections.

(a) Computer Hardware and Operations

Computer equipment currently utilized by the subject company was outlined in Chapter IV. Changes and additions to the presently installed 360 equipment are planned for the period 1969-1973. In May, 1969, the core storage capacity is to be increased from 262,000 positions

# TABLE 11.2 PROJECT CONTROL FORM, PAGE 1, APPLICABLE TO THIS PRELIMINARY STUDY OF AN ACTUARIAL INFORMATION SYSTEM

## COMPUTER SYSTEMS AND SERVICES

	PROJECT CONTROL			PAGE 1 OF 2				
PROJECT NAME (30 CHARACTER LIMIT)			VERSION DEPT LEU	PROJECT IDENTI				
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DATE PREPARED PREPARED BY (PRINT	) TYPE OF PROJEC	ст <u>і і і і і і</u>	<u>, , , , , , , , , , , , , , , , , , , </u>					
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- OTHER								
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	241000							
NET QUANTIFIABLE BENEFITS	14-000		4800	3000				
COST OF NON-QUANTIFIABLE BENEFITS	24000		4800	2000				
INCIDENCE OF COSTS BY YEAR								
EXPENSE ITEM	19.6.8	19 . 9.9	19	19				
COMPUTER SYSTEMS & SERVICES COSTS	11000	7000						
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TOTAL COSTS	14500	9500						
APPROVAL	<u> </u>	1200		<u>/</u> l				
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PROJECT START DATE

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31-3-69

## TABLE 11.3PROJECT CONTROL FORM, PAGE 2, APPLICABLE TO THIS<br/>PRELIMINARY STUDY OF AN ACTUARIAL INFORMATION SYSTEM

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STALL OF DEAL	eer costs	S AND B	ENEFITS		PAGE 2 OF 2		
DETAILS OF PROJECT CUSTS AND BENETITS			PROJECT IDENTIFICATION				
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SYSTEM DESIGN						-	
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to 393,000; two magnetic tape drives are to be added; and another direct access disk storage facility is to be acquired. In 1970, the core storage capacity is to be increased again to 524,000 positions. The purchase cost of these modifications is \$738,000. Beginning in 1969, a program of acquiring and using computer terminals for Head Office purposes will be initiated. Sixteen IBM 2260 terminals are to be obtained during the 1969-1973 period, together with the necessary control and adapter units. Monthly rental charges when all terminals have been installed will be \$2,472. The above data were obtained from the November, 1968 Computer System Development Plan previously referenced.

The projected usage of the 360 computer for 1969-1973, with the expanded capacity and terminal additions as noted, does not currently indicate that another major computer would have to be acquired before 1974. The recommended approach will lead to increased use of the IBM System/360 Model 50 computer, in terms of computer time and file storage space. It is believed, however, that sufficient capacity is currently available for use in actuarial developments. Nevertheless, it is recognized that this condition can change, and is influenced not only by the contents and processes which may be agreed on as essential components of an actuarial information system, but also by all of the system developments and operations which use the computer facilities.

In addition to the costs for new actuarial projects, consideration must be given to the functional costs for actuarial operations which arise from systems which are currently operational. The cost data which follow

in this subsection were obtained from Parsonage (60).

He has indicated that, for 1968, the actual computer system functional costs for actuarial operations were \$13,000 for systems analysis and programming, \$25,000 for computer services, and \$8,000 for key punch and unit record work, for a total of \$46,000, or 3.2% of the total 1968 functional cost of \$1,447,000. The planned expenditures, as shown in Table 11.1, of \$104,615, \$19,584, and \$5,740 for respectively the non-recurring manpower charges, non-recurring computer usage charges, and annual recurring computer usage charges for the first three actuarial projects listed, indicate a marked growth in resource allocations to actuarial systems. As such, therefore, the provision for increased activity in this area appears prudent and justified, and demonstrates one index of potential impact of the recommended approach.

The 1968 functional costs of operation for the individual insurance and annuity systems were \$90,000 for systems analysis and programming, \$246,000 for computer services, and \$148,000 for key punch and unit record work, for a total of \$484,000, or 33.4% of the total functional cost (60). Within these systems and charges are elements, involving reserves, cash values, and dividends, which are indirectly related to actuarial operations. The recommended approach for prospective performance evaluations could have the effect, on the preceding data, of estimated increases in systems analysis and programming work in the year of implementation, of 25%, or \$22,500 and in computer services work, for the first full year of operation, of 5%, or \$12,300. Prospective

performance factor preparation costs have been estimated at \$50,000 initially (when many cash values will have to be accessed and key punched) and \$20,000 for each full revision thereafter. As noted in Chapter X, the degree of precision required in the prospective performance factors remains to be defined. This could materially affect the preceding cost estimates.

## (b) Systems Development and Maintenance

The manpower cost estimates for system development and maintenance of the actuarial system phases, as shown in Table 11.1, represent the allocation of an estimated nineteen charged man-months of analyst time and thirty-six charged man-months of programmer time during the 1969-1973 period. These data exclude actuarial division time. The nature of the recommended approach is such as to suggest that the actuarial division time required for system specification and verification could correspond closely to the combined analyst and programmer time estimate of fifty-five charged man-months.

The recommended actuarial information system development approach is believed to be adequately supported by the cost estimates and manpower resource allocations which have been stated. Improved estimates will be prepared when the actuarial data and procedures to be included have been determined.

Three members of the actuarial division are currently engaged in programming and actuarial systems work. In the event of approval of the

recommended approach, it is likely that a considerable part of the work time of these individuals will be required, along with the time of systems analysts, for systems design and feasibility determinations. The current operational systems, for dividend scale, rate book, and asset share calculations, will have to continue to be supported by adequate personnel resources.

## (c) Staff Training and Development

Much of the success of the recommended approach will be dependent upon the effectiveness of the program for staff training and development related thereto. This is particularly true for activities involving the use of computer terminals, and for administrative practices related to system documentation and control.

The time estimates and associated charges for systems analysts and programmers, as contained in previous sections of this chapter, do not include provision for staff training and development time. Rather, this is viewed as an overhead item in establishing computer system unit charges. The non-charged time for the Computer Systems and Services Department (excluding computer operations) amounts to 25% of the total time available, and includes provision for education, administration, and vacations.

The significance of the foregoing is that provision must be made in establishing project operational schedules for the fact that one available man-year of time will generate on the average about nine months of charged time.

Training costs for user department personnel have not been included in the cost data provided. However, the preceding indications that 75% of available time will be used directly on actuarial system tasks, and 25%, for non-charged activities of education, administration, and vacation, may be useful first approximations to the actual factors experienced.

The potential magnitude of the actuarial program is such as to warrant increased staff training resources in the computer systems and services area. The development and presentation of courses and seminars can prove a vital factor in the degree of success to be attained. The task of training, and the associated cost ingredients, must be viewed as increasingly-demanding components of progress. The derivative potential benefits from the training programs and efforts can, and should, increase at much more rapid rates than the incurred costs, and provide a more than satisfactory return on the investment of effort and money represented.

(d) Future Cost Projections

Future costs associated with the proposed actuarial system approach cannot be projected beyond the degree of detail and implied precision presented earlier in this chapter. The important considerations, however, are not associated with costs in themselves, but rather with the relationship of costs and benefits of system proposals. For this reason,

the cost estimates outlined in the preceding sections should be appraised in association with the contents of Chapter X, the outline of the recommended approach, and section 1 of this chapter, dealing with benefits.

Finally, as stated previously, but worthy of repetition in this present area of consideration is the fact that each component project of the overall strategy will be subject to content, cost, and justification controls, by means of the project control system, from start to finish. In this way, components can be added, altered, and deleted in accordance with possible changing requirements, and controls can be revised as necessary to fit the altered circumstances. The means are thereby provided for the joint control of all aspects of the proposed approach by the actuarial and computer systems and services divisions.

## 3. JUSTIFICATION OF APPROACH

Considerations of the general overall justification of the recommended approach are outlined in the sub-sections which follow, under the headings of benefits, corporate planning for the future, costs and performance evaluations, and clarification of objectives.

## (a) Benefits

The recommended approach in effect represents a consolidation of the wealth and diversity of actuarial data and procedures currently existing in a decentralized variety of forms and structures. Just as any collection of books, periodicals, and documents is greatly enhanced in value to the users by the application of library concepts and disciplines, so is it with the corresponding actuarial components of the subject company. The many requirements for computational capabilities, in addition to the conventional computer library facilities of data storage, retrieval, and reference, justify the computer-oriented approach. The adaptation of the computer concept, so as to serve the reference function as well as the calculation needs, enables the degree of data and procedure duplication in manual and computer files to be minimized.

Of equivalent importance to the library concept is the evolution of an accepted standard approach to actuarial information processing. Regardless of the many factors which may influence the final decision as to the organizational structure to be adopted, it is very important, if not essential, to establish an agreed-upon framework for system development, control, and documentation. No part of corporate operations or of the technically-oriented actuarial area should be dependent, for continued effective contribution to the corporate performance, on the presence of any one person. By means of standardized approaches to system analysis, programming, verification, control, and documentation, much can be done to insure optimum operations. At the same time, due and adequate provision must be made for some aspects of actuarial operations which involve great urgency of completion.

## (b) Corporate Planning for the Future

The primary intent of any information system is to provide information in a form, with the content, and on a time-interval basis, that enables improved and more timely decision-making, action-taking, and use. The information should be viewed as data with a purpose, and, as such, must be related to the present and the future.

A considerable part of the recommended approach involves the calculation of information for use in operational control of the insurance business. (See Figure 3.1.) Included in this category are the computations of premiums, reserves, cash values, dividends, and other actuarial factors. The potential dimensions of the data and procedural base necessitate a major degree of emphasis in this area.

The recommendations are not restricted to operational control elements, but extend into the areas of management control and strategic planning. The prospective performance concept can provide an effective means of realistically evaluating individual business in-force, new business, and transaction activity. It thereby represents a recommendation pertaining to increasingly effective management control. At the same time, it provides the facility for strategic planning considerations by providing the means of testing hypotheses of changes in assumed interest, lapse, mortality, and expense rates.

The structural framework proposed for the approach enables the

logical and controlled extension of actuarial activities into the three areas of strategic planning, management control, and operational control. The degree of development in each area is dependent upon the benefits to be realized and the costs to be incurred. The detailed program of activities to be adopted is subject, therefore, to control by the actuarial and computer services areas on a continuing basis.

The ever-increasing usage of computers for data processing and related operations, together with the significant costs associated with system development and operation, necessitates that corporate long-range plans take into account the potentials and constraints of computer systems. The growing dependence on computer systems must not become, or be allowed to become, a restriction in the aggressive pursuit of business opportunities. Rather, the capabilities which currently exist in computer technology must be organized as constructive extensions of personnel capabilities.

There is no evidence to suggest that a plateau of computer technological development has been reached, or in fact that it does or could ever actually exist. Similarly no proof exists that the pace of technological advance has in any way slackened.

As one example, a recent article (61) outlined the effects of using barium sodium niobate crystals in assocation with laser beams to add information to the beams. The technological potentials suggested for this approach include a dramatic increase in the number of communication lines available (estimated at ten thousand times the number of

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telephone lines currently in use by Bell Telephone); the adaptation of lasers into optical versions of computer memories; and the resulting replacement of electrical input on magnetic tape by optical input on film.

Another article (62) dealt with some of the problems associated with high computer speeds and inadequate printing speeds of standard output printing devices. One approach being developed involves the linkage of microfilm facilities with the computer. Computer data are converted to visual images on cathode ray tubes, and are photographed therefrom on microfilm. Speeds range from 7,000 to 30,000 lines per minute, in contrast to mechanical and electronic line printer speeds of 300 to 1,500 lines per minute. Compact microfilm libraries and associated film viewing equipment provide the necessary system storage and retrieval capabilities.

These examples illustrate some of the exciting technological advances that are being made. More important, perhaps, than the facilities themselves are the associated challenges and difficulties of evaluation, selection, and use.

## (c) Costs and Performance Evaluations

The recommended approach is based on a plan for the continuous evaluation of costs and benefits of all component tasks. Management control is thereby provided to an adequate degree. The quantitative determination of best possible estimates of costs and benefits brings

into proper perspective and focus the reasons why a task should be undertaken. The importance of intangible system development benefits, such as better service, improved public relations, and greater accuracy is generally not subject to question. However, the primary business elements of any system consideration are the cost, benefit, and net return criteria. The proposed approach enables the exercising of effective management and divisional controls throughout.

## (d) Clarification of Objectives

An integral aspect of planning for the future involves the clarification of corporate and divisional objectives. What is to be achieved over a period, in terms of growth, financial performance, and other useful progress indices must be established at the outset, to provide the basis for determining the means whereby the goals may be achieved.

The proposed plan incorporates a variety of means whereby computer assistance can be improved in the various actuarial activities. It also provides the basis of incorporating procedures and concepts which can measure the actual progress being made towards the overall objectives. Finally, it includes the potential capability of measuring variations of actual and expected results, in accordance with actuariallycontrolled criteria, and of bringing the significant variations to actuarial attention for decision-making.

The need to clarify corporate and divisional objectives so as

to provide the evaluation standards becomes increasingly apparent. An influencing factor in this regard is the awareness of computer system, equipment and technological capabilities, which can bring into the realm of possibility and practicability some of the goals, which may, heretofore, have been regarded as impossible.

## 4. SUMMARY

The preceding sections of this chapter have outlined the benefits, costs, and overall justification considerations related to the recommended approach to the development of an actuarial information system.

## CHAPTER XII

## POTENTIAL AREAS OF FURTHER INFORMATION SYSTEM DEVELOPMENTS

This chapter indicates some of the potential areas for further information system developments. Its purpose, therefore, is to demonstrate the wide range of possible computer-oriented applications which may be considered along with the actuarial system proposals.

## 1. ACCOUNTING AND AUDITING

As noted in Table 11.1, the ultimate combined use of actuarial procedures and data files and financial reporting system developments is planned, to serve the corporate needs for profit centre analyses and business simulations and projections.

The current systems in use for the accounting function are involved with the recording of historical financial data, and with the summarization of these data for statement purposes. Business projections are prepared on a very informal basis. Profit analyses by geographical area, agent, and detailed product lines are not produced.

It is because of this basic environment associated with the accounting function that a series of specific new tasks dealing with financial reporting system developments was included in the November, 1968 version of the Computer System Development Plan. Table 12.1 is an extract from the Report, which outlines, for 1969-1973, recommended financial reporting system computer tasks, completion dates, and estimated costs.

TABLE 12.1 FINANCIAL REPORTING SYSTEM COMPUTER TASKS   PLANNED FOR 1969-1973	Completion	Computer Systems and Services Charges for System Development, Implementation and Maintenance		Annual Recurring Operation Charges	
Objective	Date	Manpower	Machines	Machines	
Completion of Financial Reporting System, Phase 1. Preliminary investigation of and report on the structure of a system for storage and retrieval of summarized and detail accounting, reserve, policy exhibit, etc., information, required breakdowns, storage and retrieval techniques, etc.	June, 1969	\$ 10 <b>,</b> 890	\$ <b>-</b>	\$ <b>-</b>	
Financial Reporting System, Phase 2. Use of Financial Reporting System to record Health accounting activity flowing from new consolidated functions system, and other accounting activity flowing from present systems; production of accounting elements of presently defined internal and Government statements by computer.	Dec., 1970	29,640	6,528	24,600	
Financial Reporting System, Phase 3. Preliminary investigation of the information and system require- ments for meaningful Profit Centre analyses (departure from Government statement basis).	June, 1972	7,920	-	-	
Financial Reporting System, Phase 4. Incorporation of reserve and exhibit information into the Financial Reporting System; production of all presently defined internal and Government statements by computer.	Dec., 1973	64,220	13,056	5,740	
Total		\$112,670	\$19,584	\$30,340	
Source: "Computer System Development Plan", the Great-West Life Assurance Company, November, 1968, Appendix 1	t Pages 15 <b>-</b> 17.				

The annual savings which have been estimated for the second and fourth tasks listed in Table 12.1 are, respectively, \$34,500 and \$6,000.

The actuarial and accounting functions of this life insurance company are very closely linked, with information regularly flowing from one area to the other. It is apparently inevitable, therefore, that the information system developments for both areas be on converging courses. The functional and organizational responsibilities of the traditional actuarial and accounting areas are becoming increasingly interwoven in practice. This trend will likely continue into the future, with extended usage of operations research techniques such as simulations, projections, and other types of experimental investigation. The possibility, at some future point of time, of organization structure revisions to reflect the changing operational environment cannot be overlooked.

Auditing activities are closely related to actuarial and accounting records, data, and procedures. It is important, therefore, to make provision for adequate and effective auditing procedures as the actuarial and accounting systems are evolved and modified.

## 2. BUDGETING

Budgeting tasks are very closely associated with accounting matters. The current methods involved in budget preparation are essentially manual, and are dependent to too great a degree on the methods of allocating expenses. The primary concern in budget work is with

current experience, with a resulting adverse effect on longer-range budgetary planning. Scientific methods of budget projections and evaluations are not used. The informational requirements have not been effectively defined.

One possible area of system development involves the determination of informational requirements needed to prepare and maintain budgets; the use of computer facilities where warranted; and the means of relating actual data to estimates, and of identifying significant variations between the two for review and action-taking.

## 3. PERSONNEL AND ADMINISTRATION

The largest element of life insurance company general expenses consists of salaries and related items such as pension fund contributions. Budget preparation and maintenance would therefore be dealing with these types of expenses as well as with expenses related to plant and equipment. The salary and related expenses for personnel are, however, components of personnel resource acquisition, maintenance, and administration. It is in this context that informational system developments could be considered.

The current payroll operations are extensively decentralized, and involve different record-keeping and processing for different groups of employees (e.g., Head Office clerical staff, building staff, Branch Office staff, and agents). The record-keeping of personnel resource characteristics is similarly decentralized. No convenient,

rapid, and reliable means exist to determine the individuals on staff with a particular set of characteristics and qualifications, as might be required in order to fill a vacant position in the best way. Projected staff complements and characteristics for future requirements are not determinable to the degree of detail required. Personnel resource planning is therefore severely hampered.

Data on educational levels, professional training, experience, periodic evaluations, and other job-influencing factors could be established and maintained along with payroll and other financial elements. Computer facilities would expedite the processing involved. Derivative information could be produced as needed, for use in corporate policy-making relative to salary levels, hiring policy, and type of applicant, and for administrative decisions involving promotions, transfers, and associated qualifications and requirements.

## 4. MARKETING

The possibilities for computer-assisted marketing support are virtually unlimited, except as to the need for justifying the plans adopted. The prospective performance concept, applied to the analysis of new business and transaction activity, could provide considerable benefits to the marketing area. Sales by agent and branch office could be compared on the basis of projected contributions to the corporate results. Variations in contribution projections by prospect characteristics could be used in developing improved agent training information,

as to the characteristics to seek in their sales efforts. The prices of insurance products could be subjected to constructive scrutiny by marketing and actuarial personnel. This might produce a better degree of optimization in this area as influenced by competitive and corporate profitability objective factors. Product research could be materially aided by computer processing speeds and by projection concepts similar to the prospective performance idea.

Other possible marketing applications include:

- (a) the forecasting of new product sales, and the provision therefrom of the basis for decision-making relative to their development;
- (b) the establishment of production quotas by sales territory;
- (c) the analysis of present and proposed company products, to determine the most profitable or contributory mixture;
- (d) the determination of optimum branch locations;
- (e) the preparation of marketing forecasts, as influenced by economic changes, population shifts, and buying characteristics and customs;
- (f) the analysis of field force characteristics, productivity and prospective performance, for use in personnel acquisition and development;

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- (g) the integration of data and procedures into a forecasting system to assist the long-range planning of products and sales outlets; and
- (h) the analysis of probable effects of different methods of financing and compensating field representatives.

## 5. MEDICAL AND UNDERWRITING

Provision has been made within the suggested system framework for mortality investigations. Closely related are medical aspects of underwriting practices as well as the entire range of underwriting operations and regulations.

Potential information system developments in these areas include the underwriting, by means of computer programs and systems, of a considerable portion of individual business; and the investigation of actual medical history data, by means of computer-oriented research, so as to identify and evaluate trends that could be of value in premium rate-setting (particularly as related to substandard premiums) and in maintaining underwriting regulations on an up-to-date basis.

## 6. INVESTMENT

The flow of substantial amounts of money into life insurance companies in the form of premium payments necessitates that rapid action be taken to get the funds invested and working for the mutual benefit of policyholders and the company. Computer facilities applied to a cash flow system may enable the available funds to be put to work more promptly, with additional investment income being one result.

Another potential area involves the development of an information system in which different investment policy courses of action, in terms of projected net return, degree of risk, and extent of diversity can be evaluated.

### 7. COMPUTER FACILITY GROWTH AND APPLICATIONS

The examples of potential applications cited in the preceding sections are all associated with growth and increased capabilities of the computer facilities involved. New forms of application, particularly in the area of on-line systems and computations, can require new types of terminal facilities, as well as faster and more economical bulk data storage. Business pressures are evidenced by the great increase in number of terminal equipment manufacturers, the diversity of devices, and the continually decreasing unit cost of computer data storage. Development plans must therefore be flexible, in terms of devices to be used as well as the applications to be implemented. Costs throughout must be controlled, and, more importantly, justified by the anticipated revenues to be realized.

## 8. SUMMARY

The interrelationships of the various life insurance company functions were demonstrated in Figure 1.1. In aggregate, and regardless of how they are performed, by computer or by manual means, they constitute a management information system. This term may be defined for present purposes as a system of systems, using data bases and functional system logic as required, to produce integrated results for measuring the effectiveness and degree of control of business activities and for corporate decision-making. The potential of the management information system concept is directly related to the degree of attention given to the decision-making processes and to the associated information needs.

Garrison (63) in outlining his company's philosophy in this area, emphasized the need to define, develop and implement an "information management system." His sequence of priorities was first to "get the basic data and its structure in order and then develop the feedback and management reporting requirements." This approach is consistent with that taken by many companies in developing computer-supported aspects of management information systems. The extent to which information requirements can be anticipated will have an important effect upon the degree of required re-definition of the supporting data and procedures. Nevertheless, the information needs will change continuously, and the system structure, file organizations, and processing routines must be sufficiently flexible to meet these changing conditions.

The potential areas of further information system developments, as outlined in this chapter, and the wide range of possible applications in the actuarial operations, demonstrate the opportunities and challenges

ahead. A logical program of development is required, to insure that the individual tasks are undertaken in the correct priority sequence, and that over-commitment of resources is avoided.
#### CHAPTER XIII

#### SUMMARY AND CONCLUSIONS

#### 1. SUMMARY

This thesis has been concerned with aspects of actuarial information requirements and related procedures. Investigations have been made of areas of actuarial operations, insurance company record-keeping characteristics, industry trends, and other related topics. Arising from the investigations, from discussions with actuarial personnel, and from the study of pertinent published material are the details of the recommended approach to the development of an actuarial information system, which have been presented in Chapter X. Three Appendices to the thesis proper (A, B, and C) have been included to provide the necessary supporting details for, respectively, the system framework and contents, the use of computer terminals for actuarial work, and the prospective performance concept. Appendices D and E contain, respectively, sample forms used in policy administration and containing actuarial data, and a glossary of insurance and data processing terms. An evaluation of the proposed approach, in terms of benefits, cost considerations, and overall justification, has been presented. Potential areas for further developments have been outlined.

#### 2. CONCLUSIONS

The principal results of this investigation are as follows:

1. An approach to the development of an actuarial information

system in a life insurance company has been recommended.

- The need for an integrated framework for actuarial information system developments, with extended usage of computer facilities, has been identified, and a proposed structure has been recommended.
- 3. The concept of a computer-oriented library of actuarial data and routines has been advanced, with due regard to the requirements and problems of storage, retrieval, and operational use.
- 4. A method for evaluating life insurance business in-force, new business, and transaction activity, in terms of the anticipated contribution of each policy to the corporate financial performance, has been developed and illustrated. The idea has been termed the prospective performance concept.
- 5. Supporting information has been recorded, to demonstrate the range and scope of the recommendations, and, thereby, to assist the corporate decision-makers in reaching their conclusions as to the proposals and the course to follow.
- 6. A computer terminal display format for actuarial formulae presentations has been developed for use in actuarial operations. In it, the conventional actuarial symbols in their normal formats are effectively represented by

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7. A method for using visual display terminals, in association with the computer and the proposed actuarial library, has been recommended for actuarial processing of various forms.

Due recognition has been given to the importance of system benefits and costs which contribute to the justification equation. The proposed approach involves the evaluation of each considered task at the outset, and the continued reappraisal of its projected or estimated justification throughout actual development, implementation, and operation.

The need for adequate concern with benefit and cost elements is possibly best demonstrated by reference to a recent study of computer systems by McKinsey and Company, a well-known management consultant firm (64). The most important aspects of the McKinsey report have been summarized as follows:

- Computer system developments are currently characterized by increasing expenditures and less rapidly increasing economic returns, in spite of technological developments and staff growth.
- There is reason for greater concern related to lost opportunities for profit than to increasing expenditures.

- 3. The gap between technical capabilities and practical achievements continues to widen, with attendant increases in lost opportunities for business improvement.
- 4. The corporate aspects of computer management problems are related more closely to future direction than to current effectiveness.
- 5. The issues of system feasibility, with particular emphasis on the technical, economic and operational elements, must be properly and responsibly confronted. Technical feasibility is concerned with the test of whether or not a particular application is possible, within the limits of technological and personnel resource capabilities. Economic feasibility directs attention to the determination of whether or not a specific undertaking will return more benefit dollars than it will cost to develop. Operational feasibility is concerned with the degree of acceptance and use of a system by its users, in terms of adaptation and resistance.

Technical feasibility is too frequently used as the major or sole evaluation criterion. Economic feasibility is often treated very casually, partly because of the difficulty of evaluating so-called intangible benefits. Operational feasibility must be assessed by the users of the system, since the term implies the degree to which the system is accepted and utilized.

- 6. Teamwork effort, linking top management leadership, operating manager knowledge of requirements, computer systems personnel capabilities, and the constructive interest of all three areas, are the keys to successful computer systems.
- 7. The requirement of high economic expectations from computer applications, a careful diversification of skills in the personnel groups assigned to computer projects, and the active participation of top management are the common denominators of successful computer practice.

The organizational framework of the subject company, and the responsibilities of the user area personnel and of the computer systems and services staff are clearly defined. All projects are subject to the Project Control System discipline, involving the specification of objectives, costs, and benefits. Computer System Development Plan reports provide a corporate program of planned activities for the next five-year period. Evaluation reports of progress, cost, and resource factors are prepared quarterly. Much has been achieved to date in the development and implementation of record-keeping and data processing systems, involving the extensive use of computer facilities. Much, however, remains to be done in determining the needs for corporate and divisional information, and of devising systems capable of producing the information on a timely, cost-justified, and well-controlled

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basis, for use in decision-making.

This thesis has outlined some of the possibilities of actuarial information system components which are regarded as technically feasible. It has indicated some of the economic factors that may apply, and has demonstrated some new concepts of actuarial operations (e.g., the use of visual display terminals, and the prospective performance approach).

Nevertheless, it must be emphasized that the thesis does not constitute a feasibility study and recommendation of an actuarial information system. Actuarial guidelines are required as to the sorts of data and processes which are necessary or desirable in an actuarial system, not only for current needs but also for possible future growth and diversity in the inherent processes. At that point, the feasibility and other aspects of a system to support these needs must and will be determined. Some of the ideas expressed herein may serve as positive catalysts in influencing the development of the required guidelines.

Sterling (65), in his keynote address to the 1968 Automation Forum of the Life Office Management Association, paraphrased the original sub-title of "Information, Please" as "Imagination, Please" and as "Innovation, Please," and used both alterations to challenge the audience as to the needs of management for information.

The recommended approach to actuarial information system developments contains, hopefully, some elements of imagination and

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innovation, and at the same time represents a practical, controlled and orderly course of action. The difficulties inherent in determining and projecting costs are recognized. Considerable work in this area must be done, so as to determine the feasibility of each system task which may be contemplated in relation to actuarial operations.

Of prime importance in actuarial system possibilities are the attitudes and frame of mind of the personnel concerned with plotting the course of action. The ideas contained in this thesis may serve to stimulate the individuals involved, and thereby to contribute to the basic solution of the problem of direction.

The proposals are intended to constitute the logical evolution of computer systems in support of actuarial requirements and responsibilities; and to assist in further "unlocking the computer's profit potential" in the subject company, in the three areas of operational control, management control, and strategic planning.

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(a)	J.	N.	Clayton	Manager, Expense Accounting
(b)	Α.	Ε.	Dack	Director, Group Insurance Administration
(c)	Η.	Ε.	Harland	Actuary
(d)	W.	J.	Hudson	Director, Group Pension Administration
(e)	J.	0.	Parsonage	Director, Computer Systems and Services
(f)	R.	Β.	Pennycook	Director, Individual Insurance Administration
(g)	Β.	Pop	peski	Associate Actuary
(h)	H.	S.	Saunders	Manager, Programming and Computer Services

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## APPENDIX A

# PROCEDURES RECOMMENDED FOR INCLUSION IN THE ACTUARIAL INFORMATION SYSTEM.

APPENDIX A. TABLE OF CONTENTS		A.2	
SUBJECT	SECTION	PAGE	
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A. INTEREST AND ANNUITIES CERTAIN CALCULATIONS

A.3

1. BASIC DATA

(A)	INTEREST F	RATE (SA)	/ 10	DECIMAL	PLACES)	I
(B)	NUMBER OF	PERIODS	(SAY IS A	4 DIGIT YFAR)	'S )	N

2. BASIC CALCULATIONS

(A)	2 3 N (1+I), (1+I), (1+I), (1+I)
(B)	2 3 N V, V, V, o o o o o o V V = 1/(1+1)
(C)	D = IV
(D)	$\frac{2}{1/F} = 1/I + 1/2 - I/12 + I/24$ F = FORCE OF INTEREST
(E)	I/F = 1 + I/2 - I / 12 + I / 24
(F)	1/1
(G)	$1/D = (1 \div I)/I$
(H)	F = I - I / 2 + I / 3 - I / 4

3. SUPPLEMENTARY BASIC CALCULATIONS AS REQUIRED

	м	=	NUMBER OF TIMES PAY	ABLE PER PERIOD	
(1)	(M) 1/I	=	1/F - (1/M)(1/2) *	$\binom{2}{(1/M}(1/12) - (1/M)(1/24)$	
(J)	(M) I/I	=	(M) (I)(1/I )	(M) = NUMBER OF TIMES	
(K)	(M) 1/D	=	(M) 1/I + 1/M	PATADLE PER TEAR	
(L)	(M) I/D	=	(M) (I)(1/D }		

4.	ANNUIT	Y CERTA	IN	PRESEN	T VALUE FORMULAE	A	4
		ρ	=	DEFER	RED PERIOD		
	(A)	a- N	=	(1 - )	N V ) / I	<pre>∂ = ANNUITY ¬ = ''ANGLE'''</pre>	
	(B)	: a- N	=	(1 - )	N V )/D	: = DIERESIS , TO DENOTE ""DUE""	
	(C)	(M) a- N	-	(1 - )	N (M) V )/I		
	(D)	:(M) @- N	-tagen Viligen	(1 - )	N (M) V)/D		
	(E)	a- P   N	=	(1 - )	N P V }{V }/I	P  = DEFERRED PERIOD	
	(F)	: a- P  N	=	(1 - )	N P √)(V)/D		
	(G)	(M) a- P   N	=	{1 - \	N P (M) /)(V)/I		
	(H)	:(M) @- ₽  N	=	(1 - \	N P (M) /)(V)/D		
	(1)	- อา N	=	(1 - \	N / )/F	- = CONTINUOUS SYMBC	
	(J)	a- PIN	z	(1 - \	N P /)(V)/F		

5.	ANNUIT	CERTAI	N	ACCUMULATION FORMULAE
	(A)	S-1	=	((1+I) - 1)/I
	(B)	: S- : N	=	((1+I) - 1)/D
	(C)	(M) S⊸ : N	=	N (M) ((1+I) - 1)/I
	(D)	:(M) S⊸ : N	=	N (M) ((1+I) - 1)/D
	(E)	- S- :	-	((1+I) - 1)/F

S = ACCUMULATION SYMBOL

A.5

### B. THE MORTALITY TABLE

### 1. BASIC DATA

(A)	AGE RANGE	x	
(B)	NUMBER LIVING AT EACH AGE	L X	
(C)	NUMBER DYING AT EACH AGE	MD X	= MORTALITY OR SMALL SCRIPT D
(D)	MORTALITY RATE AT EACH AGE	Q X	= PROBABILITY OF DEATH
(E)	COMMUTATION FUNCTION TABLE RADIX AND AGE		

ANY ONE OF (B), (C), OR (D) WILL BE STORED, WITH THE MOST COMMON BEING (D). A SPECIFIC RADIX VALUE FOR A SPECIFIC AGE MAY BE STORED ALONG WITH EACH TABLE IN (D) FORMAT. IF SUCH A RADIX VALUE IS NOT PRESENT, AN ASSUMED RADIX FOR THE LOWEST AGE IN THE TABLE WILL BE USED. THE RADIX IS THE L VALUE FOR THE LOWEST AGE IN THE RELATED MORTALITY RATES. X

PROVISION WILL BE MADE TO CALCULATE (B), (C), OR (D) VALUES AS REQUIRED AND AS DETERMINED BY THE FORMAT OF THE STORED TABLE.

#### 2. BASIC CALCULATIONS (DEPENDING UPON INPUT)

(A)	L - L = MD X X+1 X
(B)	$\begin{array}{ccc} MD & / L &= Q \\ X & X & X \end{array}$
(C)	(Q)(L) = MD X X X
(D)	$\begin{array}{cccc} \mathbf{L} & - & MD & = & L \\ X & & X & & X+1 \end{array}$
(E)	L + MD = L X+1 X X
(F)	
(G)	(L)(MP) = L X X X+1

MP = MORTALITY P , OR SURVIVAL PROBA-BILITY

(H) L = L /MPX X+1 X

#### 3. SUPPLEMENTARY CALCULATIONS AS REQUIRED \_\_\_\_\_

(A)	MP NX	æ	L /L X+N X	N =	NUMBER OF YEARS
(8)	Q N X	Ξ	1 – MP N X		
(C)	Q N I X	-	MD /L X+N X	N   =	DEFERRED PERIOD
(D)		=	(L – L )/L X+N X+N+M X	N] = M =	DEFERRED PERIOD NUMBER OF YEARS

A.7

A.8 4. SELECT MORTALITY TABLE CALCULATIONS (A) **BASIC DATA:** AGE RANGE Х SELECT PERIOD SP SELECT YEAR MINUS ONE SA (RANGE O TO SP - 1) NUMBER LIVING AT EACH AGE L. (X) + SA NUMBER DYING AT EACH AGE MD (X) + SA MORTALITY RATE AT EACH AGE ۵ (X) + SA COMMUTATION FUNCTION TABLE RADIX AND AGE NUMBER OF YEARS Ν SUBSCRIPTS INVOLVING (X) DENOTE DATA DURING THE SELECT PERIOD. WHEN THE SELECT PERIOD HAS BEEN COMPLETED, THE BRACKETS ARE NO LONGER USED, AND THE DATA ARE DEFINED AS APPLYING TO THE ULTIMATE PERIOD. IN ACTUARIAL LITERA-TURE , THE BRACKETS ARE SQUARE , NOT CURVED. (B) = 1 - Q MP (X)+SA (X)+SA (C) = (L )/ MP (X)+SA (X)+SA+1 (X)+SA

- (D) MD = L (X)+SA (X)+SA (X)+SA+1
- (E) MP = (L (FOR SELECT PERIOD) )/L N (X)+SA (X)+SA+N (X)+SA
- (F) MP = (L 1/L (FOR ULTIMATE PERIOD) N (X)+SA X&SA+N (X)+SA

C. ANNUITY BENEFITS

A.9

#### 1. BASIC DATA

(A) AGE RANGE Х (B) NUMBER LIVING AT EACH AGE L Х (0) NUMBER DYING AT EACH AGE MD = MORTALITY OR SMALL SCRIPT D Х (D) MORTALITY RATE AT EACH AGE = PROBABILITY OF DEATH Q Х COMMUTATION FUNCTION TABLE (E) RADIX AND AGE (F) INTEREST RATE ĩ

#### 2. BASIC CALCULATIONS

CALCULATE (B), (C), AND (D) AS NECESSARY (DEPENDING UPON INPUT) AS OUTLINED IN THE MORTALITY TABLE SECTION.

CALCULATE THE INTEREST TABLE BASIC CALCULATIONS AS OUTLINED IN THE INTEREST AND ANNUITIES CERTAIN SECTION. DURATIONS REQUIRED CORRESPOND TO THE AGES OF THE MORTALITY TABLE INVOLVED.

AVAILABLE ON COMPLETION OF THESE STEPS ARE :

L ; MD ۵ ŝ ŝ Х Х X (1 + I)D 1/F I/F : 1/I 1/D ê F : :

#### 3. SUPPLEMENTARY BASIC CALCULATIONS

₩-X-1

T = 1

SS (D

)

X+T

(A) 
$$D = \{V\} \{L\}$$

(B) N X

W = SMALLEST AGE WHERE L = ZERO. X

#### SS = SUMMATION SYMBOL

TABLES OF N VALUES ARE CALCULATED AND USED WHENEVER REQUIRED.  $_{\rm X}$  OTHER FUNCTIONS MAY ALSO BE CALCULATED IN TABULAR FORM IF NEEDED.

THE STORAGE AND MAINTENANCE OF COMMUTATION FUNCTION TABLES ARE NOT PLANNED.

D

X

A.10

(A)	D X	7	N – N X X+1
(B)	a X	=	N /D X+1 X
(C)	: a X	=	N /D X X
(D)	a - X:N	=	(N - N )/D X+1 X+N+1 X
(E)	: a - X:N	=	(N - N)/D X X+N X
(F)	a N X	H	N /D X+N+1 X
(G)	: a N   X	=	N /D X+N X
(H)	a NIM X	=	(N – N )/D X+N+1 X+N+M+1 X
(I)	: @ N M X	=	(N - N )/D X+N X+N+M X
(J)	S ¬ X:N	=	(N - N )/D X+1 X+N+1 X+N
(K)	: S ¬ X:N	=	(N - N)/D X X+N X+N
(L)	E N X	-	D ∕D X≁N X

4. SUPPLEMENTARY BASIC CALCULATIONS (AS NECESSARY)

A.11

5. SELECT MORTALITY TABLE BASIC CALCULATIONS AS REQUIRED

(A)	N X+T	1	W-X-1 SS (D) R=T+1 X*R	÷	D T X+T	>= SEL (SP	ECT PERIOD
(B)	N (X)+T	Ξ	W-X-1 SS (D) R=SP X+R	÷	SP-1 SS (D ) R=T+1 (X)+R	+ [	) (X)+T

0 <= T < SELECT PERIOD

THE ABOVE EQUATIONS, WHEN APPLIED TO A SET OF MORTALITY RATES INVOLVING A 3-YEAR SELECT PERIOD (AS IN JORDAN, "LIFE CON-TINGENCIES", CHAPTER 1, TABLE 3), PRODUCES A TABLE OF N VALUES AS FOLLOWS:

AGE (X)	N (X)	N (X)+1	N {X}+2	N X∻3	X+3
20					23
21					24
22					25
٥					٩
٥					•
3					•
•					•
۰					•

VALUES ARE REFERENCED BY AGE (X)+T FOR  $0 \le T < SP$  (THE SELECT PERIOD), AND BY X+T FOR T >= SP. OTHERWISE, THE BASIC CALCULATION FORMULAE GIVEN IN SECTION 4 IMMEDIATELY PRECEDING ARE APPLICABLE.

D (X)+T	=	N (X)+T		N (X)+T+1	0 <= T < SP-1
D (X)+T		N (X)+T		N X+T+1	T = SP-1
D X + T	=	N X÷T	-	N X+T+1	T >= SP

(C)

A.12

(A)	(M) @ X	÷	∂	
(8)	(m) a N   X	=	a + (M−1)(E)/2M N X NX	
(C)	(M) a X:N	=	a – a + (M−1)(1– E)/2M X N X N X	
(D)	:(M) a X	=	: @ - (M-1)/2M X	
(E)	:(M) @ N  X	=	a – (M-1)(E)/2M NIX NX	
(F)	:(M) @ ¬ X:N	=	: a - a - (M-1)(1-E)/2M X N X NX	
(G)	– a X	=	a + 1/2 X	
(H)	a NIX	=	a + (1/2)(E) NXX NX	
(I)	- a - X:N	=	a – a X NIX	
(J)	N X	. =	(1/2)(N + N ) X X+1	
(K)	D X	=	(1/2)(D + D ) X X+1	

#### ANNUITIES PAYABLE MORE FREQUENTLY THAN ONCE A YEAR (AS REQUIRED) A.13 6

7. ANNUITIES WITH PAYMENTS DEFERRED A FRACTION OF A YEAR (AS NECESSARY) A.14 \_\_\_\_\_

	FRACTION OF	A YEAR DEFERRED = 1/KY
(A)	: 3 = 1/KY  X	: a - 1/ky X
(B)	: @ - = 1/KY] X:N	: a - (1/KY)(1-E) X:N N X
(C)	:{M) @ = 1/KY  X	° ∂ - (M-1)(E)/2M - 1/KY 1/KY < 1/M X N X
(D)	:(M) a - = 1/KY  X:N	: a - a - (M-1)(1- E)/2M - (1- E)/KY X NIX NX NX

ASSUMING 1/KY < 1/M

8. VARYING ANNUITIES (AS NECESSARY)

\_\_\_\_\_

(A)	s =	W-X-1 SS (N) + N T=1 X+T X
(B)	(10) = X	S /D X+1 X
(C)	: (Ia) = X	S /D X X
(D)	(1a) - = X:N	(S - S - (N)(N ))/D X+1 X+N+1 X+N+1 X
(E)	: (Ia) - = X:N	(S - S - (N)(N ))/D X X+N X+N X
(F)	(I-a) =	(S - S )/D X+1 X+N+1 X
(G)	(I-a) = N X	(S - S )/D X X+N X

\_\_\_\_

### D. INSURANCE BENEFITS

### 1. BASIC DATA

(A) AGE RANGE Х (B) NUMBER LIVING AT EACH AGE L Х (C) NUMBER DYING AT EACH AGE MD = MORTALITY OR SMALL SCRIPT D Х MORTALITY RATE AT EACH AGE (D) = PROBABILITY OF DEATH Q Х (E) COMMUTATION FUNCTION TABLE RADIX AND AGE (F) INTEREST RATE ĩ

#### 2. BASIC CALCULATIONS

CALCULATE (B) , (C) , AND (D) AS NECESSARY (DEPENDING UPON INPUT) AS OUTLINED IN THE MORTALITY TABLE SECTION.

CALCULATE THE INTEREST TABLE BASIC CALCULATIONS AS OUTLINED IN THE INTEREST AND ANNUITIES CERTAIN SECTION. DURATIONS REQUIRED CORRESPOND TO THE AGES OF THE MORTALITY TABLE INVOLVED.

AVAILABLE ON COMPLETION OF THESE STEPS ARE :

L; MD; Q; X X X (1+I); V; D; 1/F; I/F; 1/I; 1/D; F

A.16

### 3. SUPPLEMENTARY BASIC CALCULATIONS (AS NECESSARY)

<b>(</b> A)	C = X	X+1 (V)(MD) X
(8)	M = X	W-X-1 SS (C ) + C T=1 X+T X
(C)	R = X	W−X−1 SS (M ) ↔ M T=1 X+T X
(D)	C = X	(V)(D) - D X X+1
(E)	M = X	(V)(N) - N X X+1
(F)	R = X	(V)(S) - S X X+1
(G)	C = X	M – M X X÷1
(H)	- C = X	(I/F)(C) X
(I)	- M = X	(I/F)(M) X
(J)	- R = X	(1/F)(R) X
(K)	к = т х	1 (A ¬) / E X:T T X
(L)	- K = T X	1 (I/F)(A ¬) / E X:T T X

A.17

4. INSURANCE BENEFIT CALCULATIONS (AS NECESSARY)

(A)	А Х		M /D X X
(B)	A X	=	1 - (D)(a) X
(C)	1 A - X:N	1	(M – M )/D X X+N X
(D)	1 A - X:N	=	: (V)(a ¬) - a ¬ X:N X:N
(E)	1 A -" X:N	=	D /D X+N X
(F)	1 A ~ X:N	-	E N X
(G)	A	=	1 1 A - + A - X:N X:N

(H)	A ¬ X:N	=	(M – X	M ≁ X+N	D ) X÷N	/ D X
				:		

(I) 
$$A = 1 - (D)(a)$$
  
X:N X:N X:N

$$\begin{array}{ccc} (J) & A & = & (I/F)(A) \\ X & & X \end{array}$$

$$\begin{array}{ccc} (K) & A & = 1 - (F)(\partial) \\ X & & X \end{array}$$

A.18
(0)	Α	=	1	-	(F)(a	-)
	X:N				X	: N
(P)	A	=	м	/D		

(N)

A ¬ X:N

5. VARYING INSURANCES (AS NECESSARY)

(A)	(IA) X	=	R/D X X
(B)	(IA) X	=	((V)(S) - S)/D x +1 x
(C)	( ] A )	-	= (D)(IA)

(D) (IA) 
$$\neg = (R - R - (N)(M))/D$$
  
X:N X X+N X+N X

$$\begin{array}{c} (E) \quad (I\neg A) \quad = \quad (R - R) / D \\ N \quad X \quad X \quad X + N \quad X \end{array}$$

$$(F) (IA) = (I/F)(IA) X X X$$

(G) 
$$(IA) = (I/F)(IA) = X:N$$

E. NET ANNUAL PREMIUMS

## 1. BASIC DATA

1

(A)	AGE AT ISSUE	х
(8)	MATURITY OR TERMINATION AGE	Y
(C)	PAID-UP AGE	7

2. CALCULATIONS

(A) T-PAYMENT LIFE (\$1000 LEVEL INSURANCE AMOUNT)

		:	:
Ρ	=	(1000)(A )/a	ə ~
ТΧ		X	X:T

(B) T-PAYMENT LIFE WITH IMMEDIATE PAYMENT OF CLAIMS (\$1000 AMOUNT)

P(A) = (I/F)(P)T X T X

\_

(C) WHOLE LIFE (\$1000 LEVEL INSURANCE AMOUNT)

P = (1000)(A)/a X X X

(D) WHOLE LIFE WITH IMMEDIATE PAYMENT OF CLAIMS (\$1000 LEVEL AMOUNT)

 $P(\overline{A}) = (I/F)(P)$ 

(E) T-PAYMENT N-YEAR TERM (1<=T<=N) (\$1000 LEVEL INSURANCE AMOUNT)

1		1 :
P	=	(1000)(A -)/a -
T X:N		X:N X:T

(F) T-PAYMENT N-YEAR TERM WITH IMMEDIATE PAYMENT OF CLAIMS

-1  $P(A \neg) = (I/F)(P \neg)$ T X:N T X:N A.20

\_\_\_\_\_

(G) T-PAYMENT N-YEAR ENDOWMENT (1<=T<=N) (\$1000 LEVEL AMOUNT) A.21

P = (1000)(A -)/a -T X:N X:N X:T

(H) T-PAYMENT N-YEAR ENDOWMENT WITH IMMEDIATE PAYMENT OF CLAIMS

-		1				1	•
P(A -)	=	(1000)((I/F)(A	-)	*	A	-)/2	a -
T X:N		X s	N		Х	: N	X:T

(I) 1-4-7 WHOLE LIFE WITH IMMEDIATE PAYMENT OF CLAIMS (\$1000 AMOUNT)

THIS PLAN OF INSURANCE INVOLVES WHOLE LIFE INSURANCE COVERAGE WITH PREMIUMS PAYABLE FOR LIFE. THE NET ANNUAL PREMIUMS FOR YEARS ONE TO THREE ARE 50% OF THE ULTIMATE NET ANNUAL PREMIUMS, WHILE THOSE FOR YEARS FOUR TO SIX ARE 75%.

(PI) = (1000)(A)/(a - (1/4)(a -) - (1/4)(a -))X X X X:3 X:6

> (PI) = ULTIMATE NET ANNUAL PREMIUM X

(J) RETIREMENT INCOME PLANS WITH IMMEDIATE PAYMENT OF CLAIMS

THESE PLANS OF INSURANCE PROVIDE INITIAL INSURANCE OF \$1000 PER UNIT, AND PAYMENT OF A LIFETIME MONTHLY INCOME OF \$10 PER \$1000 OF INITIAL INSURANCE AT THE RETIREMENT DATE. THE DEATH BENEFIT IS THE FACE AMOUNT OF THE POLICY OR ITS CASH VALUE, WHICHEVER IS GREATER. PREMIUMS ARE PAYABLE TO MATURITY (COTERMINOUS).

-1 N-A 1 (1000)(A -) + (MV)(V )(A -) (PI)= X X:A X:A \_\_\_\_\_ \_ \_ \_ \_ \_ 1 : : ∂ ¬ + (A ¬)(∂---) X:A X:A N-A

\*\*A\*\* IN THE SUBSCRIPTS ABOVE IS THE LAST DURATION WHERE THE NET LEVEL PREMIUM RESERVE IS LESS THAN \$1000.

SEE SECTION (K) FOLLOWING FOR ""A"" PERIOD CALCULATIONS. ""N"" IS THE IN-FORCE DURATION (I.E., MAT. AGE - ISSUE AGE). MV = MATURITY VALUE (K) RETIREMENT INCOME PLAN ""A"" PERIOD CALCULATIONS

BEGIN WITH AN ASSIGNED VALUE OF 2 TO (N-A).

CALCULATE THE FOLLOWING:

N -N X X+A	: (Ə)(1 + N-A	1 * ((I/D)-1)(A ¬)) X:A			
D X	(.001)(MV-1	.000)(@	: - @		

IF THE RESULT IS NOT NEGATIVE, INCREASE (N-A) BY ONE AND REPEAT.

IF THE RESULT IS NEGATIVE, STORE THE ""A"" PERIOD, WHICH HAS NOW BEEN DETERMINED, AS

(MATURITY AGE) - (ISSUE AGE) - (N-A) .

(L) ESTATE BUILDER WITH IMMEDIATE CLAIM PAYT (FROM SEPT. 30, 1963)

THIS PLAN PROVIDES \$1000 INSURANCE TO AGE 21, \$5000 TERM INSURANCE FROM AGE 21 TO AGE 65, AND A PURE ENDOWMENT AT 65 OF AN AMOUNT DENOTED BELOW BY CSV . CURRENTLY THESE 65

AMOUNTS ARE \$3985 IN CANADA AND \$4070 IN UNITED STATES.

THE NET ANNUAL PREMIUM BEFORE AGE 21 IS GREATER THAN THAT AFTER 21, BY AN AMOUNT SHOWN AS K IN THE FOLLOWING EQUATION (CURRENTLY \$7.00 IN CANADA AND \$5.00 IN UNITED STATES).



(M) ESTATE BUILDER (1947 TO JUNE 30, 1958)

THIS PLAN PROVIDES \$1000 INITIAL INSURANCE, INCREASING TO \$5000 ENDOWMENT AT AGE 85 AT THE EXCHANGE DATE, WHICH IS DEFINED AS:

1. ATTAINED AGE 21 FOR ISSUE AGES 00-11.

2. 10TH POLICY ANNIVERSARY FOR ISSUE AGES 12-15.

PREMIUMS REDUCE BY \$K PER UNIT AT THE EXCHANGE DATE:

AM(5)3% AGES O TO 7, K = \$9.63,9.81,9.93,10.06,10.17,10.29, 10.42,10.52, AND 10.67 AGES 8 ON.

CSO 2.50% AGES 0-3, K= \$6.70,6.64,6.85, 6.96, &7.00 AGES 4 ON.

1. AGES 00-11



2. AGES 12-15

(PI) = ULTIMATE NET ANNUAL PREMIUM PER UNIT

K DENOTES THE AMOUNT BY WHICH THE INITIAL NET ANNUAL PREMIUM PER UNIT EXCEEDS THE ULTIMATE NET ANNUAL PREMIUM PER UNIT. PREMIUMS ARE PAYABLE FOR THE ENTIRE IN FORCE PERIOD.

(N) ESTATE BUILDER (JULY 1, 1958 TO SEPTEMBER 30, 1963)

THIS PLAN WAS INTRODUCED JULY 1, 1958. IT BEARS THE SAME NAME AS THE PLAN ISSUED PRIOR TO THAT DATE, BUT IT PROVIDES FOR DIFFERENT BENEFITS.

THE BENEFITS ARE \$1000 INSURANCE TO THE POLICY ANNIVERSARY NEAREST AGE 21, INCREASING AT THAT TIME TO \$5000 TERM INSU-RANCE TO AGE 65 AND \$4060 PURE ENDOWMENT AT AGE 65.

PREMIUMS ARE PAYABLE TO AGE 65.

1 1 (PI) (5000)(A -----) - (4000)(A -----) = X X:65-X X:21-X 1 \$ (4060)(A ----) - (K)(a ----)X:65-X X:21-X \_\_\_\_ • a -----X:65-X

(PI) = ULTIMATE NET ANNUAL PREMIUM PER UNIT X

THE NET ANNUAL PREMIUM BEFORE THE EXCHANGE DATE IS GREATER THAN THAT AFTER THE EXCHANGE DATE BY AN AMOUNT SHOWN AS K IN THE PRECEDING EQUATION.

K = \$3.50

(O) SECURITY BUILDER

THE BENEFITS ARE \$1000 INSURANCE, INCREASING TO \$3000 ENDOWMENT AT AGE 65 AT ATTAINED AGE 21.

PREMIUMS REDUCE BY \$K PER UNIT AT AGE 21 (FOR CSO 2.50%, K = \$2.75).

(PI) = ULTIMATE NET ANNUAL PREMIUM PER UNIT

#### (P) SECURITY SAVINGS

THIS PLAN PROVIDES FOR AN ENDOWMENT AT AGE 65 OF THE SUM OF THE REGULAR ANNUAL GROSS PREMIUMS, AND A DEATH BENEFIT PRIOR TO MATURITY OF \$1000 OR THE SUM OF THE REGULAR ANNUAL GROSS PREMIUMS, IF THIS IS GREATER THAN \$1000. IF ''GP'' DENOTES THE GROSS PREMIUM, AND = ((PI) + C) / (1-K), THEN THE FOLLOWING APPLY: GΡ ¥ 1. ISSUE AGES 31 TO 45 (GP) = Х 1 : (1000)(A -) + (C)(a ----) X:A X:65-X \_\_\_\_\_ \_\_\_\_\_ (1-K)(a ----) + (1/D)(SS(T)(C)) - (65-X)(A -----)1 X:65-X X:65-X X T=A+1 X+T+1 2. ISSUE AGES 15 TO 30 : 1 (1000)(A -----) + (C)(a ------) X:65-X X:65-X (GP) = х \_\_\_\_ 1 : THE NUMBER OF YEARS, FOR AGES 31 TO 45, FOR WHICH THE Δ = SUM OF GROSS PREMIUMS IS LESS THAN \$1000. (PI) = ((GP))(1-K) - CХ Х

VALUES OF C AND K FOR EACH AGE X ARE AS FOLLOWS:



25

## (P) SECURITY SAVINGS (CONT'D)

-----

Х	С	K	Х	С	к	Х	С	к
15	2.75	.1290	25	2.50	.1310	35	2.25	.1350
16	2.75	.1290	26	2.45	.1310	36	2.20	.1355
17	2.75	.1290	27	2.40	.1320	37	2.15	.1360
18	2.75	.1300	28	2.35	.1320	38	2.10	.1365
19	2.75	.1300	29	2.30	°1330	39	2.05	.1370
20	2.75	.1300	30	2.25	.1330	40	2.00	.1375
21	2.70	.1300	31	2.25	.1330	41	1.95	.1380
22	2.65	.1300	32	2.25	.1340	42	1.90	.1385
23	2.60	.1310	33	2.25	.1340	43	1.85	.1390
24	2.55	.1310	34	2.25	.1350	44	1.80	.1395
						45	1.75	.1400



## (Q) MORTGAGE REPAYMENT

т

\_\_\_\_\_

THIS IS A DECREASING TERM POLICY, DESIGNED TO BE USED AS A SOURCE OF FUNDS FOR MORTGAGE REDEMPTION PURPOSES. PREMIUMS ARE PAYABLE DURING 60% OF THE BENEFIT PERIOD. M : (PI) ¬ = (1/D)(SS(R)(C)) / a ¬ N X:M X T=1 T X+T-1 X:N WHERE R IS THE AMOUNT AT RISK AT THE BEGINNING OF THE T "T"TH POLICY YEAR. R Ξ 1000 AND R 0 =

М

1 M+1R = (1000)(a-----) / a- AT 5 %.

M+1-T

#### (R) DOUBLE INSURANCE WITH IMMEDIATE PAYMENT OF CLAIMS

THESE PLANS PROVIDE WHOLE LIFE INSURANCE OF \$1000 PER UNIT AND TERM INSURANCE OF \$1000 PER UNIT FOR THE DURATION OF THE DOUBLE INSURANCE PERIOD. PREMIUMS DO NOT REDUCE AT THE END OF THE DOUBLE INSURANCE PERIOD.

-1 (PI) ((1000)(A) + (1000)(A -)) / @ = X X X:M X

M IS THE DOUBLE INSURANCE PERIOD.

### (S) FAMILY INCOME BENEFIT

-----

THE FAMILY INCOME BENEFIT, AN ADDITIONAL BENEFIT ADDED TO A POLICY BY MEANS OF A RIDER, IS DECREASING TERM INSURANCE WHICH RUNS FOR A PERIOD, CALLED THE FAMILY INCOME PERIOD, FROM DATE OF PURCHASE. THE BENEFIT PROVIDES THAT, IF THE INSURED DIES DURING THE FAMILY INCOME PERIOD, A MONTHLY INCOME WILL BE PAID TO HIS BENEFICIARY UNTIL THE END OF THE PERIOD. THE BENEFIT AMOUNT IS INDEPENDENT OF THE AMOUNT OF THE BASIC POLICY, THE PROCEEDS OF WHICH BECOME PAYABLE IMMEDIATELY AND MAY BE PAID OUT IN ANY MANNER DESIRED. PREMIUMS ARE PAYABLE FOR THE ENTIRE FAMILY INCOME PERIOD.

(PI) --X:N N (12) 1/24 1 1 1/24 ((I)(V°)) 1 (Va)(Iaa)(D)(Va) 1 ) -- ( A \* \* وجور الثان الاي الجود الذي عنه الله الله الله الله الذي الذي الذي الله الله الذي التي الزار ......... (120)(-----(A ¬) -11 ( (12) (12) X:N) (12) X:N ((F)(D) (F)(D<sup>1</sup>)(D<sup>1</sup>) ) ) 2 9 X:N WHERE U.S.A. CANADA \_\_\_\_ -----I IS THE CALCULATION RATE OF INTEREST 3 % 4 %

 $I^{00} = (I - I^{0}) / (1 + I^{0})$ .243309% .726392%

2.75%

3.25%

I' IS THE COMMUTATION RATE OF INTEREST

## (T) FAMILY PROTECTION RIDER

A. RIDER INTEREST AND VALUATION MORTALITY INTEREST ARE THE SAME.

 $\begin{array}{cccc} (12) & (12) : \\ (PI) & \neg & = (120)(\partial_{\neg} & - \partial_{\neg} & )/\partial_{\neg} \\ N & X:M & M & X:M & X:N \end{array}$ 

B. RIDER INTEREST AND VALUATION MORTALITY INTEREST ARE DIFFERENT.

Μ 2 (1/D)(SS(D)(C))/a -(PI) ¬ = N X:M X T=1 T X+T-1X:N WHERE (12)(12) D (12)(S-)(@---) + (6)(a----)(1+(I/2)) Т 1 M-T 1/2 (12)(12), a--- , AND a--- ARE CALCULATED AT RATE J S¬ 1 M-T 1/2 J = RIDER INTEREST RATE I = SPECIAL ACCUMULATION RATE (12) <u>a---</u> PRESENT VALUE OF SIX MONTHLY PAYMENTS OF 1/6 EACH, = DUE AT THE END OF EACH MONTH FOR THE NEXT SIX 1/2 MONTHS.

(U) HOME SECURITY RIDER

THIS IS A DECREASING TERM POLICY, DESIGNED TO PROVIDE THE INSURANCE REQUIRED TO LIQUIDATE THE BALANCE DUE UNDER A MORTGAGE LOAN AT 6% INTEREST.

М (1/D)(SS(K)(C))/a -(PI) ¬ = N X:M X T=1 T X+T-1 X:N WHERE AMOUNT AT RISK AT THE BEGINNING OF THE ""T" TH YEAR K = Т 1000 К AND Κ 0 = = 1 N+1 2 • (1000)(a----)/ a-Κ = т N+1-T N

A.29

#### (V) FAMILY PROTECTION POLICY

THE FAMILY PROTECTION POLICY PROVIDES DECREASING TERM INSU-RANCE FOR A PERIOD, CALLED THE FAMILY PROTECTION PERIOD. IN THE EVENT OF THE INSURED'S DEATH DURING THE FAMILY PROTEC-TION PERIOD, THE SPECIFIED MONTHLY INCOME IS PAID, COMMEN-CING AT THE NEXT MONTHLY POLICY ANNIVERSARY AFTER DEATH AND CONTINUING UNTIL THE EXPIRY OF THE SPECIFIED PERIOD. IF THE INSURED SURVIVES THE FAMILY PROTECTION PERIOD, THE POLICY TERMINATES WITHOUT VALUE. THE PREMIUM PAYING PERIOD IS LESS THAN THE PROTECTION PERIOD IN CANADA, BUT IS EQUAL TO THE PROTECTION PERIOD IN UNITED STATES.

(PI) ρ X:N

( 1/24	N	(12)	1/24	)
(1)(V <sup>1</sup> ) 1	(V°)(I°	•)(D)	( V "	
(120)((A -)) ( (12) X:N	(1)	2) (1	.2)	X:N)
((F)(D <sup>0</sup> )	(F)(D'	)(D°°	)	)
	e e			
	9 - P			

THE RESULT IS THE NET ANNUAL PREMIUM PER \$10 MONTHLY INCOME.

							U.S.A.	CANADA
I	IS	THE	CALCULATION	RATE	OF	INTEREST	3 %	 4 %
I o	IS	тне	COMMUTATION	RATE	OF	INTEREST	2.75%	3.25%
I .	. =	(1-	[°)/(l+I°)				.243309%	.726392%

THE PREMIUM PAYING PERIODS IN CANADA ARE AS FOLLOWS:

BENEFIT PERIOD		PREMIUM	IS PAYABLE (P)
15 YEARS		FOR 1	2 YEARS
20 YEARS		FOR 1	6 YEARS
25 YEARS		FOR 2	0 YEARS
TO AGE 65:			
(1) AGES AT I	ISSUE UP TO	40 TO AG	E 60
(2) AGES AT 1	SSUE 41 TO	45 TO AG	E 61
(3) AGES AT I	ISSUE 46 TO	50 TO AG	E 62

## (W) FAMILY PLAN INSURANCE BENEFIT

THE FAMILY PLAN INSURANCE BENEFIT (FPIB) IS A RIDER FOR ADDITION TO A BASIC POLICY ON A HUSBAND'S LIFE AND PROVIDES CONVERTIBLE TERM INSURANCE FOR A REDUCING AMOUNT ON HIS WIFE, AND CONVERTIBLE TERM INSURANCE FOR A LEVEL AMOUNT ON EACH OF HIS ELIGIBLE CHILDREN.

THE WIFE'S INSURANCE BECOMES FULLY PAID-UP TERM INSURANCE IF THE HUSBAND DIES. EACH CHILD'S INSURANCE BECOMES FULLY PAID-UP TERM INSURANCE AT THE DEATH OF EITHER THE HUSBAND OR THE WIFE.

PREMIUMS ARE PAYABLE FOR THE ENTIRE PERIOD OF THE FPIB OR UNTIL THE EARLIER DEATH OF EITHER THE HUSBAND OR THE WIFE.

THE AMOUNT OF WIFE'S INSURANCE PER FPIB UNIT IS \$2500 AT AGES 18 THROUGH 35, REDUCING \$100 PER YEAR AT AGE 36 TO \$1000 AT AGE 50, WHERE IT REMAINS UNTIL EXPIRY.

EXPIRY OF THE WIFE'S INSURANCE OCCURS AT HER AGE 60 OR WHEN PREMIUM PAYMENTS ON THE HUSBAND'S INSURANCE CEASE, WHICHEVER COMES FIRST.

IF THE HUSBAND DIES BEFORE EXPIRY OF THE FPIB, THE FULL AMOUNT OF TERM INSURANCE ON HIS WIFE, DETERMINED EACH YEAR THEREAFTER ACCORDING TO THE FOREGOING SCHEDULE, CONTINUES IN EFFECT UNTIL THE DATE IT WOULD NORMALLY TERMINATE. AT THE HUSBAND'S DEATH, HER COVERAGE BECOMES FULLY PAID-UP TERM INSURANCE.

THE AMOUNT OF EACH CHILD'S INSURANCE PER FPIB UNIT IS \$1000 (EXCEPT THAT THE AMOUNT PAYABLE IF DEATH OCCURS BEFORE ACTUAL AGE 6 MONTHS IS RESTRICTED TO \$250). THE INSURANCE CEASES AT THE CHILD'S AGE 25 OR AT THE EXPIRY OF THE MOTHER'S COVERAGE, WHICHEVER COMES FIRST.

IF EITHER THE FATHER OR MOTHER OF THE CHILD DIES PRIOR TO THE EXPIRY OF THE FPIB, THE FULL AMOUNT OF TERM INSURANCE ON THE CHILD CONTINUES IN EFFECT UNTIL THE DATE IT WOULD NORMALLY TERMINATE. IN THIS EVENT IT BECOMES FULLY PAID-UP TERM INSURANCE. (W) FAMILY PLAN INSURANCE BENEFIT (CONT D)

A. WIFE'S INSURANCE (AGES LESS THAN 36 AT ISSUE)

 $\begin{array}{c} 1 \\ (PI) \\ x:60-x \\ x:60-x \end{array} = \begin{array}{c} -1 \\ (1000) (A \\ x:60-x \\ x:60-x \\ x:35-x \\ (1500) ((DA) \\ 35:15 \\ 35 \\ x \\ x:60-x \end{array}$ 

\_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_ \_

X IS THE WIFE'S AGE AT ISSUE.

B. WIFE'S INSURANCE (AGES OVER 35 AT ISSUE)

1		-1	- 1
(PI)	=	(1000)(A) +	(6000-(100)(X))((DA) =)
X:60-X		X:60-X	X:50-X
		8 6	
		a	
		X:60-X	

A.32

(X) MULTIPLE OPTION

THIS PLAN MAY TAKE ONE OF TWO FORMS:

- A. THE "LIFE 20" FORM, IN WHICH THE OPTIONS ARE ORDINARY LIFE PAID-UP AFTER 20 YEARS, OR A DOUBLE ENDOWMENT AT AGE "R"" WHICH DEPENDS ON AGE AT ISSUE.
- B. THE SAVINGS PLAN FORM, IN WHICH THE OPTIONS ARE A SINGLE ENDOWMENT AT AGE ""X+A"", OR A DOUBLE ENDOWMENT AT AGE ""R"", OR A PENSION AT AGE ""R"".

A. THE LIFE 20 FORM

CALCULATE THE PREMIUM FOR AN ORDINARY 20-PAY LIFE PLAN.

P = (1000)(A) / 2 ---20 x x x:20

CALCULATE THE °°A°° PERIOD FOR WHICH V <= 1000 AND V > 1000 FROM THE RELATION A A+1

CALCULATE THE MATURITY AGE ""R"" FOR WHICH V < 2000 and V > 2000 FROM THE RELATION  $R\!-\!X$  R-X+1

CALCULATE THE NET ANNUAL PREMIUM FROM THE RELATION

(PI) = P + 2000 - V X = 20 X - R R - X - A : : : (1 + I) (S - + 2 - - - - -) X : A - R - X - A

IN THE ABOVE EQUATION, THE NET ANNUAL PREMIUM FOR A 20-PAY LIFE PLAN IS INCREASED BY AN EXPRESSION AS SHOWN SO THAT THE VALUE OF THE RESERVE AT AGE ""R"" WILL BE 2000.

### B. THE SAVINGS PLAN FORM

ESTIMATE THE VALUE FOR THE ""A"" PERIOD FOR WHICH V <= 1000 AND V > 1000. A+1

CALCULATE THE NET ANNUAL PREMIUM FROM THE RELATION

(PI) = (2000)(V) + K  $X = \frac{1}{(S + 2)} + K$   $K = \frac{1}{(S + 2)} + K$ 

TEST THE VALUE OF V TO SEE IF IT FULFILLS THE CONDITION A THAT V <= 1000 AND V > 1000. IF THE ESTIMATED "A" A VALUE IS NOT CORRECT, REVISE THE ESTIMATE AND REPEAT THE CALCULATIONS UNTIL THE REQUIRED CONDITIONS ARE MET.

(Y) ENHANCED EQUITY "185" (LIFE PAID-UP AT AGE 85)

(Z) ESTATEMASTER SELECT (LIFE PAID-UP AT AGE 95)

P(A) = (1000)(A) / a -----95-X X X X:95-X

## (AA) GUARANTEED INSURABILITY RIDER

-----

THIS RIDER GIVES THE RIGHT TO PURCHASE ADDITIONAL INSURANCE WITHOUT EVIDENCE OF INSURABILITY ON THE LIFE OF THE INSURED ON CERTAIN SPECIFIC FUTURE DATES.

THE NET ANNUAL PREMIUMS ARE CALCULATED TO PROVIDE PURE ENDOWMENTS AT OPTION AGES SUBSEQUENT TO ISSUE AS FOLLOWS:

OPTION AGE	PURE ENDOWMENT AMOUNT
Party Anna Malar Malar anan anan mark many anya Jaga Jaga	
25	\$2.80
28	2.90
31	3.00
34	3.10
37	3.25
40	3.55



SUCCESSIVE TERMS OF THE ABOVE EQUATION DROP OUT AS THE AGE AT ISSUE ADVANCES.

### (BB) GUARANTEED PURCHASE OPTION BENEFIT

\_\_\_\_\_

THIS BENEFIT GIVES THE RIGHT TO PURCHASE ADDITIONAL INSU-RANCE WITHOUT EVIDENCE OF INSURABILITY ON THE LIFE OF THE INSURED ON CERTAIN SPECIFIC FUTURE DATES OR ALTERNATIVELY, UPON THE INSURED'S MARRIAGE OR THE ADDITION OF A CHILD TO HIS FAMILY EITHER BY BIRTH OR ADOPTION.

THE NET PREMIUMS ARE THE SAME AS THOSE CALCULATED FOR THE GUARANTEED INSURABILITY RIDER (SECTION (AA) IMMEDIATELY PRECEDING).

## (CC) EXECUTIVE SPECIAL

DOUBLE INSURANCE TO AGE 70, WITH PREMIUMS REDUCING TO WHOLE LIFE PREMIUMS AT 70.

T<70-X

T>=70-X

(PI) = (1000)(P) X X

-----

F. RESERVES

=

=

- X

Z – X

1.	BASIC	DATA		
	(A)	AGE AT ISSUE		x
	(8)	MATURITY OR TERMINATION	AGE	Y
	(C)	PAID-UP AGE		Z
	(D)	RESERVE DURATION		T
	(E)	IN-FORCE PERIOD		N
	(F)	PREMIUM-PAYING PERIOD		M
	(G)	CLAIM PAYMENT BASIS		СРВ
		(IMMEDIATE (IPC): (END OF POLICY YEAR:	CPB = I/F) CPB = ONE)	
2.	CALCUL	ATIONS		
	(A) M-	PAYMENT LIFE (\$1000 LEVEL	INSURANCE AMOU	NT)
	T< 	M 		

 $M = \{CPB\}\{\{1000\}\{A\}\} - \{P\}\{\partial_{D} - \neg_{n}\}\}$   $T \times X + T = M \times X + T: M - T$   $M \times X + T: M - T$   $M = \{CPB\}\{1000\}\{A\}\}$   $T \times X + T$ 

(B) WHOLE LIFE (\$1000 LEVEL INSURANCE AMOUNT)

V = (CPB)((1000)(A) - (P)(a))T X X+T X X+T

\_ \_ \_ \_ \_ \_ \_

(C) M-PAYMENT N-YEAR TERM (\$1000 LEVEL INSURANCE AMOUNT) A.38 T<M \_\_\_ M 1 V ¬ = (CPB)((1000)(A ----) - (P)(@ ----)) T X:N X+T:N-T M X:N X+T:M-T T>=M -----M 1 1 T X:N X+T:N-T (D) M-PAYMENT N-YEAR ENDOWMENT (\$1000 LEVEL INSURANCE AMOUNT) T<M -----X+T:N-T X+T:N-T T X:N : X+T:M-T M X:N M X:N (E) 1-4-7 WHOLE LIFE WITH IMMEDIATE PAYMENT OF CLAIMS T<=3 V ---- T X = a ----)) 4<=T<=6 \_ \_ \_ \_ \_ \_ \_ V ТХ T>=7 ----= (1000)(A) - (PI) (a) X+T X X+T V ΤХ

A.39 (F) ESTATE BUILDER AND SECURITY BUILDER PRIOR TO EXCHANGE DATE \_\_\_\_\_ V = ((PI) - K)(S -) - (1000)(CPB)(K) X ТΧ X:T ТΧ K IS THE DIFFERENCE BETWEEN INITIAL AND ULTIMATE NET ANNUAL PREMIUMS. (PI) IS THE SYMBOL FOR THE ULTIMATE NET ANNUAL X PREMIUMS FOR THESE PLANS. VALUES FOR K ARE CONTAINED IN THE SECTION DEALING WITH NET ANNUAL PREMIUMS. AFTER EXCHANGE DATE 1 v X+T:N-T ТΧ X+T:N-T . ((PI))(a ----) X X+T:N-T WHERE = AFTER EXCHANGE DATE AMOUNT OF TERM INSURANCE AET PE AMOUNT OF PURE ENDOWMENT (G) SECURITY SAVINGS \_\_\_\_\_ AGES 15 TO 30 : ٧ = (PI) (S  $\neg$ ) - (1000) (K) ТΧ X X:T тх AGES 31 TO 45, THE FIRST "'A"" DURATIONS : = (PI) (S  $\neg$ ) - (1000)(K) V ТΧ X X:T ТΧ AGES 31 TO 45, THE REMAINING DURATIONS V ΤХ X X+T:65-X-T X X+T:65-X-T . ((PI))(a ------) X X+T:65-X-T

THIS PLAN WAS NOT ISSUED ON AN IMMEDIATE CLAIM PAYMENT BASIS.

#### (H) MORTGAGE REPAYMENT

RESERVES ARE CALCULATED USING FACKLER'S ACCUMULATION FORMULA.

V = (V + (PI))(S - ) - (D)(K)T+1 X T X X+T:1 T X+T

WHERE

D IS THE AMOUNT AT RISK DURING THE ""T" TH POLICY YEAR. T VARIOUS FORMULAS HAVE BEEN USED TO DETERMINE D VALUES FOR DIFFERENT ISSUES.

(I) DOUBLE INSURANCE

T<M

M IS THE DOUBLE INSURANCE BENEFIT PERIOD.

DOUBLE INSURANCE PLANS INVOLVE THE PAYMENT OF PREMIUMS FOR LIFE. AS NO LIMITED PAY SITUATIONS ARE INVOLVED, THE USE OF THE SYMBOL ""M"" FOR THE DOUBLE INSURANCE PERIOD DOES NOT INTRODUCE ANY AMBIGUITY.

(J) FAMILY INCOME BENEFIT

-----

RESERVES ARE CALCULATED USING FACKLER'S ACCUMULATION FORMULA.

V = (V + (PI))(S - ) - (D)(K)T+1 X T X X+T:1 T X+T

WHERE

D IS THE AMOUNT AT RISK DURING THE ""T" TH POLICY YEAR. T VARIOUS FORMULAS HAVE BEEN USED TO DETERMINE D VALUES FOR DIFFERENT ISSUES.

## (K) FAMILY PROTECTION RIDER

RESERVES ARE CALCULATED USING FACKLER'S ACCUMULATION FORMULA.

V = (V + (PI))(S - ) - (D)(K)T+1 X T X X X+T:1 T X+T

WHERE

D IS THE AMOUNT AT RISK DURING THE "'T" TH POLICY YEAR. T VARIOUS FORMULAS HAVE BEEN USED TO DETERMINE D VALUES FOR DIFFERENT ISSUES.

## (L) FAMILY PROTECTION POLICY

RESERVES ARE CALCULATED USING FACKLER'S ACCUMULATION FORMULA.

 $V = (V \div (PI))(S \neg) - (D)(K)$ T $\div 1 X T X X \div T:1 T X \div T$ 

•

WHERE

D IS THE AMOUNT AT RISK DURING THE ""T" TH POLICY YEAR. T VARIOUS FORMULAS HAVE BEEN USED TO DETERMINE D VALUES FOR DIFFERENT ISSUES.

(M) FAMILY PLAN INSURANCE BENEFIT

A. WIFE'S INSURANCE

B. CHILDREN'S INSURANCE



# (N) MULTIPLE OPTION

A. THE LIFE 20 FORM T<=A ----: v = ((PI))(S  $\neg$ ) - (1000)(K) ТΧ X X:T тх T>A ------R-X-T : = (2000)(V) - ((PI))(a----)۷ ΤX X R-X-T B. THE SAVINGS PLAN FORM T<=A : ٧ = ((PI))(S  $\neg$ ) - (1000)(K) ΤХ X X:T ТΧ T>A -----R-X-T • V = (2000)(V) - ((PI))(2----)ΤX X R-X-T

(O) ENHANCED EQUITY "'85"" (LIFE PAID-UP AT AGE 85)

85-X		_			-	:	
V	=	(1000)(A	)	 (	P (A	))(@	
тх		X÷	Т	85->	( )	K X	+T:85-X-T

\_\_\_\_\_

(P) ESTATEMASTER SELECT (LIFE PAID-UP AT AGE 95)

95-X		-			-	÷	
v	=	(1000)(A	)	 1	PIA	))(@	
ТХ		X÷	٠T	95	-x >	(	X+T:95-X-T

A.42

## (Q) GUARANTEED INSURABILITY RIDER

\_\_\_\_\_

SEPARATE RESERVES ARE HELD FOR PAST AND FUTURE CONVERSIONS.

A. RESERVES FOR PAST CONVERSIONS

\_ \_ \_ \_ \_ \_ \_ \_ \_ \_

THE INITIAL RESERVES USED AT RESPECTIVE OPTION AGES ARE \$10, \$12, \$14, \$16, \$18, AND \$20. THESE INITIAL RESERVES ARE DECREASED IN EQUAL STEPS OVER A PERIOD OF 10 YEARS.

B. RESERVES FOR FUTURE CONVERSIONS

THESE RESERVES ARE DIVIDED INTO TWO CATEGORIES FOR:

- (I) RIDERS ATTACHED TO BASIC PLANS WITH PREMIUMS PAYABLE BEYOND AGE 40.
- (II) RIDERS ATTACHED TO BASIC PLANS WITH PREMIUMS PAYABLE FOR 20 YEARS OR LESS.

THE RESERVES ARE CALCULATED BY ACCUMULATING THE VALUATION PREMIUMS AND DEDUCTING (140 - X)% OF THE INCURRED PURE ENDOWMENT CHARGES ALSO ACCUMULATED, WHERE:

X IS THE AGE AT ISSUE;

THE VALUATION PREMIUM FOR AGES OO TO 24 IS THE GROSS PREMIUM; AND FOR AGES 25 AND UP IS (140 - X)% OF THE NET PREMIUM.

THE EFFECT FOR AGES 25 AND UP IS TO HOLD (140 - X)% OF THE RESERVE ON THE PREMIUM-PAYING BASIS.

FOR AGES UNDER 25, THE GROSS PREMIUM IS ALWAYS IN EXCESS OF THE NET PREMIUM (A 2-CENT EXCEPTION AT AGE 24). THE RESERVE WILL THEREFORE ALWAYS BE MORE THAN (140 - X)% OF THE NET PREMIUM RESERVE.

(R) GUARANTEED PURCHASE OPTION BENEFIT

THE RESERVES ARE CALCULATED IN THE SAME MANNER AS FOR THE GUARANTEED INSURABILITY RIDER (WHICH THIS PLAN REPLACES).

#### A.43

## (S) EXECUTIVE SPECIAL

DOUBLE INSURANCE TO AGE 70, WITH PREMIUMS REDUCING TO WHOLE LIFE PREMIUMS AT 70.

T<70-X

T>=70-X

ν	=	(1000)(A	) -	(P)(a	) }
ΤX		X÷	۲۲	x	X+T

THIS PLAN WAS NOT ISSUED ON AN IMMEDIATE CLAIM PAYMENT BASIS. FOR THIS REASON, THE "CPB" TERM DOES NOT APPEAR IN THE ABOVE EQUATIONS. IF IT WAS INCLUDED FOR GENERALI-ZATION PURPOSES, IT WOULD HAVE A VALUE OF ONE.

# G. DIVIDENDS

# 1. DEFINITION OF SYMBOLS

D T	DIVIDEND IN THE ""T" TH POLICY YEAR.	
G	MALE GROSS ANNUAL PREMIUM PER UNIT (INCLUDING FEMALE RETIREMENT PLANS AND SPECIAL FEMALE OPTION ON ESTATE BUILDER). DOES NOT INCLUDE ANY POLICY FEE.	
P T	PERCENTAGE EXPENSE CHARGE DURING ""T""TH POLICY YEAR.	
к	CONSTANT EXPENSE CHARGE PER M	:
ΡI	VALUATION NET PREMIUM	
ΡΙ	NET PREMIUM BASED ON THE VALUATION INTEREST RATE AND THE GWº58 MORTALITY TABLE.	
bIaa	NET PREMIUM BASED ON THE VALUATION INTEREST RATE AND THE GW°55 MORTALITY TABLE. (SEE A LATER EXPLANATION OF THE EQUALIZATION OF MORTALITY PROFIT USING THE PI°° FOR PRIOR TO APRIL 1956 ISSUES).	
r T	TERMINAL RESERVE IN THE ""T""TH POLICY YEAR.	
I	VALUATION INTEREST RATE.	
ž c	DIVIDEND INTEREST RATE FOR CURRENT SCALE.	
1 8 9	INTEREST RATE OF 3.35% TO BE USED ONLY ON U.S. 3.50% ISSUES.	
Q	MORTALITY RATE BASED ON VALUATION TABLE. (*)	
Q٥	MORTALITY RATE BASED ON CURRENT EXPERIENCE TABLE, I.E., GW®63. (*)	
Q * *	MORTALITY RATE BASED ON THE GWº58 TABLE. (*)	
Q * * *	MORTALITY RATE BASED ON THE GW'55 TABLE. (*)	
s _	SUM ASSURED IN A PARTICULAR POLICY YEAR.	
1000A - X:N	OR 1000A - = VALUATION NET SINGLE PREMIUM. X:N	
CV T	SPECIAL CASH SURRENDER VALUE IN DOLLARS AND CENTS, WHICH IS USED ONLY FOR THE PURPOSE OF CALCULATING DIVIDENDS.	

\* MOST TABLES OF DIFFERENCES IN MORTALITY RATES IN THE ACTUARIAL GENERAL DEPARTMENT ARE EXPRESSED IN TERMS OF 1000 Q . X

2. ""V"" SCALE DIVIDENDS EFFECTIVE JANUARY 1, 1967 FOR CURRENT A.46 INSURANCE POLICY ISSUES - OCTOBER 1, 1963 AND ON. (A) PREMIUM-PAYING D  $(G(100.00-P)-K-PI) + (V+PI)(I^{\circ}-I) + (Q -Q^{\circ})(S-V)$ T T T-1 X+T−1 X+T−1 T +(1/2)(Q )(S) X+T-1 (B) PAID-UP AND SINGLE PREMIUM (\*) PLANS \_\_\_\_ ---------(I°-I)\*(Q -Q° )(S-1000A D 1000A Т X+T-1:N-(T-1) X÷T−1 X+T−1 X+T:N-T -K(S) + (I/2)(Q )(S) + ADJ (\*) X+T-1 THE EXPRESSION (1/2)(Q ) DENOTES A SPECIAL ADJUSTMENT TO BE X+T-1 APPLIED TO ALL 1958 C.S.O. ISSUES. IT APPLIES ONLY DURING "A" PERIODS ON RETIREMENT INCOME PLANS, AND APPLIES FOR THE FULL AMOUNT ON ESTATE BUILDER PLANS AFTER AGE 21. FOR DERIVATION, SEE "DIVIDEND RULES BOOK"".

\* ON JUVENILE SINGLE PREMIUM PLANS WHERE THE AGE 10 PREMIUM HAS BEEN CHARGED (I.E., ENDOWMENTS OF 30 YEARS OR LESS) THE EXCESS SINGLE PREMIUM IS RETURNED IN EQUAL PARTS OVER 20 YEARS, OR OVER THE PREMIUM PAYING PERIOD, IF LESS. USE THE ADJUSTMENT OF

> $ADJ = (1000)(A \to) - (1000)(A \to)$ 10:N X:N 20 OR P.P. IF LESS

NO RESTRICTION ON AGE O DEATH BENEFIT, I.E., \$1000 THROUGHOUT.

NOTE RE AGE AT ISSUE O

THE PROFIT Q HAS BEEN ADJUSTED SO THAT THE FACE AMOUNT CAN BE X TAKEN AS THE AMOUNT AT RISK DURING THE FIRST POLICY YEAR.

PENSION TRUST DIVIDENDS

FOR U.S. ISSUES ONLY. FOLLOW REGULAR METHODS OF CALCULATION BUT REFLECT ADDITIONAL INTEREST PROFIT. (SEE CALCULATION INTEREST RATE IN THE "DEFINITION OF SYMBOLS" SECTION).

## GUARANTEED ISSUE DIVIDENDS

FOR CANADIAN ISSUES USE REGULAR INTEREST RATE.

FOR U.S. ISSUES USE PENSION TRUST INTEREST RATE (SEE DEFINITION OF SYMBOLS). REPLACE Q' (GW'63) IN THE FORMULA BY X+T-1 (1+K)(Q'

) WHERE K IS CONSTANT DURING THE FIRST 6 POLICY X+T-1 YEARS AND IS GRADED UNIFORMLY TO O AT DURATION 11 AND ON.

K = (.765 - .009X) where X is age at issue.

THE INITIAL VALUES OF K ARE:

AGE	к	AGE	к	AGE	к
20	<u>- 585</u>	35	<b>。</b> 450	50	.315
25	<b>₀</b> 540	40	.405	55	. 270
30	.495	45	• 360	60	•225
				65	-180

INTERPOLATE FOR INTERVENING AGES AT ISSUE.

DIVIDEND OPTIONS (E) AND (F) 

PROVIDE THAT THE DIVIDEND PAYABLE BE APPLIED TO PURCHASE ONE YEAR NON-PARTICIPATING TERM INSURANCE FOR THE FOLLOWING POLICY YEAR.

OPTION (E) - EQUAL TO THE CASH SURRENDER VALUE AT THE END OF SUCH POLICY YEAR OR WHATEVER LESSER AMOUNT THE DIVIDEND APPLIED WOULD PURCHASE. TERM INSURANCE CHARGES PER \$1000 WILL BE THE FOLLOWING PERCENTAGES OF THE CHARGES SHOWN IN THE NEXT SECTION.

STANDARD OR CLASS AAA	100%
CLASS AA	137.5%
CLASS A	150%
CLASS B	170%
CLASS C	200%
HIGHER RATINGS	NOT AVAILABLE

OPTION (F) - EQUAL TO THE FOLLOWING AMOUNTS PER \$1000 OF INITIAL INSURANCE, OR WHATEVER LESSER AMOUNT THE DIVIDEND APPLIED WOULD PURCHASE.

STANDARD OR CLASS	AAA \$300
CLASS AA	225
CLASS A	200
CLASS B	175
CLASS C	150
HIGHER RATINGS	NOT AVATIABLE

CHARGES AS FOR OPTION (E) ABOVE.

ANY BALANCE OF DIVIDEND NOT REQUIRED TO PURCHASE THE TERM INSURANCE MAY BE APPLIED UNDER ANY ONE OF THE OTHER REGULAR DIVIDEND OPTIONS.

## TERM INSURANCE CHARGE PER M

1.075 OF GW\*63 (M) Q PLUS \$0.95 TO AGE 30, GRADING TO \$1.15 AT X+T AGE 40 AND ON (SEE TERM INSURANCE CHARGES BELOW). NO ADJUSTMENT FOR IMMEDIATE PAYMENT OF CLAIMS.

## DIVIDEND OPTIONS (E) AND (F)

CHARGE FOR TERM INSURANCE - PER M

AGE	CHARGE	AGE	CHARGE	AGE	CHARGE
			which while option make state to be		
16	1.85	41	2 4 2		
17	1.90	42	3.03	61	20.60
18	1.94	42	2.73	62	22.52
19	1,97	43	4.29	63	24.64
20	2.00	~~~~ / ~	4.0/	64	26.95
	2000	40	5.08	65	29.51
21	2.01	46	5 51		
22	2.03	47	5.00	66	32.25
23	2.04	4 P	2098	67	35.16
24	2.04	40	0.49	68	38.38
25	2-05	49	1.05	69	41.96
		50	1.66	70	45.84
26	2.05	51	8 40	-	_
27	2.06	52	0.40	/1	50.13
28	2.06	52	2017	72	54.59
29	2.07	54	10.04	73	59.16
30	2.09	55	10.90	74	63.99
			11.98	75	69.25
31	2.13	56	13.09	71	75
32	2.17	57	14.33	10	15.09
33	2.24	58	15.68	11	81.67
34	2.32	50	17 19	78	89.13
35	2.44	60	10 00	79	97.39
		00	10.02	80	106.36
36	2.58				
37	2.75				
38	2.93				
39	3.13				
40	3.38				

THE ABOVE CHARGES APPLY TO THE DIVIDEND SCALE EFFECTIVE JANUARY 1, 1967 BUT MAY VARY IN FUTURE ACCORDING TO COMPANY EXPERIENCE.

MODIFIED LIFE (1-4-7)

NO DIVIDENDS PAYABLE UNTIL THE END OF THE 3RD POLICY YEAR. CALCULATE AS REGULAR, BUT REDISTRIBUTE THE SUM OF THE FIRST TWO DIVIDENDS OVER YEARS 3 TO 6 ON THE BASIS OF 40:20:20:20. A.48

CONSTANT EXPENSE CHARGES

A.49

REGULAR PLANS (PER M INITIAL INSURANCE)

		CANAD	A – AGI	ES		ι	J.S.A.	- AGE	S	
P.P.P.	0	1	5	10	15 UP	0	1	5	10	15 UP
	-	-				-		-		
10 PAY	\$1.80	\$1.60	\$1.45	\$1.40	\$1.30	\$1.70	\$1.50	\$1.35	\$1.30	\$1.20
15 PAY	1.55	1.40	1.25	1.20	1.10	1.45	1.30	1.15	1.10	1.00
20+ PAY	1.30	1.20	1.05	1.00	。90	1.20	1.10	。95	.90	.80

INTERPOLATE FOR INTERVENING PERIODS AND AGES AT ISSUE. (GRADE BETWEEN AGES 1 AND 5 BY 3-4-4-4).

SPECIAL PLANS:

\_\_\_\_\_

PREFERRED WHOLE LIFE

CANADA ISSUES OF 1.10.63 AND ON, U.S.A. ISSUES OF 1.10.63 TO 30.6.65 - SAME AS ABOVE FOR 20\* PAY. U.S.A. ISSUES 1.7.65 AND ON - AGE 15 AND UP \$1.20 FIRST YEAR REDUCING \$.02 PER ANNUM TO \$.80 IN THE 21ST YEAR AND THEREAFTER. SAME INCREASE IN CONSTANTS FOR AGES BELOW 15 AS FOR REGULAR PLANS.

LIFE @ 95 - \$.80 PER M.

LIFE a 85

\_ \_\_ \_\_ \_\_ \_\_ \_\_ \_\_ \_\_ \_\_ \_\_ \_\_ \_\_

CANADA - \$1.70 FIRST YEAR REDUCING \$.04 PER YEAR TO \$.90 IN THE 21ST YEAR AND THEREAFTER. U.S.A. - \$1.85 FIRST YEAR REDUCING \$.05 PER YEAR TO \$.90 IN THE 20TH YEAR AND THEREAFTER. SAME INCREASE AS REGULAR FOR PREMIUM PAYING PERIODS BELOW 20 YEARS.

10-PAY ENDOWMENTS @ 60 AND @ 65

SAME AS 10 PAY DURING PREMIUM PAYING PERIOD AND SAME AS PAID-UP THEREAFTER, FOR CANADA OR U.S.A. AS APPROPRIATE.

20-PAY ENDOWMENTS @ 60 AND @ 65

SAME AS 20+ PAY DURING PREMIUM PAYING PERIOD AND SAME AS PAID-UP THEREAFTER, FOR CANADA OR U.S.A. AS APPROPRIATE.

MODIFIED LIFE (1-4-7) - SAME AS 20\* PAY, CANADA AND U.S.A. RESPECTIVELY.

## MAXIMUM SECURITY

ISSUED IN U.S.A. ONLY (1.10.63 - 30.6.65). \$2.40 IN FIRST YEAR REDUCING \$.15 ANNUALLY TO \$.90 FROM DURATION 11 ON. INCREASE BY \$.40 FOR 10 PAY, AND \$.20 FOR 15 PAY AT ALL DURATIONS. INTERPOLATE FOR INTERVENING PERIODS.

ESTATE BUILDER - PER M INITIAL INSURANCE

	CANADA	U.S.A.		
AGES AT ISSUE	TO AGE 21	TO AGE 21		
	and a shift was able to a solution of a solution of the soluti			
0	1.30	1.20		
1	1.20	1.10		
5	1.05	°95		
10	1.00	•90		
14	。92	82		

INTERPOLATE FOR INTERVENING AGES AT ISSUE. (GRADE BETWEEN AGES 1 AND 5 BY 3-4-4-4).

AFTER ATTAINED AGE 21: PER M ULTIMATE INSURANCE	1.50	1.40
FEMALE OPTION: PER M OPTION AMOUNT	1.90	1.80

JOINT LIFE PLANS - PER M INITIAL INSURANCE:

	PREMIUM-PAYING	PAID-UP	
CANADA	REG. 4 1.35	2.70	
U.S.A.	REG. + 1.35	2.70	

SINGLE PREMIUM AND PAID-UP POLICIES - PER M DEATH BENEFIT:

CANADA	2.20
U.S.A.	2.20

## PERCENT EXPENSE CHARGES

THE FOLLOWING PERCENTAGE EXPENSE CHARGES APPLY TO BOTH CANADA AND UNITED STATES. ALWAYS INTERPOLATE FOR INTERVENING PREMIUM PAYING PERIODS AND AGES AT ISSUE. GRADING TO X% IN THE 21ST YEAR APPLIES REGARDLESS OF THE LENGTH OF THE PREMIUM PAYING PERIOD (I.E., PERIODS OF LESS THAN 20 YEARS).

PREMIUM PAYING PERIOD		AGE AT	AGE AT ISSUE			
LIFE	TO 55	60	65	70		
5	18.75%	19.00%	 19.25%	19.25	8	
10	14.75	15.00	15.25	15.50		
15	14.75	15.00	15.50	16.00		
20	14.75	15.25	15.75	16.25		
25	15.50	16.00	16.50	17.00		
30*	15.50	16.00	16.50	17.00		
ENDOWMENTS						
10	12.50	12.75	13.00	13.75		
15	13.00	13.25	13.75	14.75		
20	14.00	14.50	15.00	16.00		
25	14.75	15,25	16.00	10000		
30	15.50	16.00	20000			
35	15,50	10000				
40÷	15.50					
RETIREMENT INCOMES						
10	12.25	12.50	12.75			
15	12.50	12.75				
20	12.75					
25	13.50					
30	14.00					
35	14.75					
40*	15.50					
CDECTAL DLANC					GRADE	ACTUAL
SPECIAL PLANS					10	21 & UN
PREFERRED RISK ORDI- NARY LIFF. LIFF AT						
85, LIFE AT 95 U.S.A.	10.00	10.50	11.00	11.50	6.00%	8.00%
MAXIMUM SECURITY	12.00	12.50	13.00	13.50	6.50	8.00
MODIFIED LIFE (1-4-7)	17.00	-		-	7.00	8.00
ESTATE BUILDER	15.50		-	-	7.00	8.00
LIFE AT 95 CANADA	9.00	9.25	9.75	10.25	INITIAL	8.00

# SPECIAL PLANS (CONTO)

10 PAY ENDOWMENTS AT 60 AND 65 - GRADE TO 7% IN 21ST YEAR. ACTUAL CHARGE FOR DURATION 21 AND ON IS 8%.

# AGE AT ISSUE TO 35 40 45 50 55 14.50% 14.00% 13.50% 13.00% 12.50%

20 PAY ENDOWMENT AT 60 - GRADE TO 7% IN 21ST YEAR. ACTUAL CHARGE FOR DURATION 21 AND ON IS 8%.

#### AGE AT ISSUE

20 PAY ENDOWMENT AT 65 - GRADE TO 7% IN 21ST YEAR. ACTUAL CHARGE FOR DURATION 21 AND ON IS 8%.

JOINT PLANS - PERCENTAGE CHARGES WILL BE 1% GREATER THAN FOR SINGLE LIVES ON CORRESPONDING PLANS AT ALL DURATIONS. (N.B. GRADE TO 8% IN 21ST YEAR). ACTUAL CHARGE FOR DURATION 21 AND ON IS 9%.

A.52

. . . .

3. "V" SCALE DIVIDENDS EFFECTIVE JANUARY 1, 1967 FOR INSURANCE A.53 POLICIES ISSUED FROM JULY 1, 1958 TO SEPTEMBER 30, 1963 INCLUSIVE.

4. "VV" SCALE DIVIDENDS EFFECTIVE JANUARY 1, 1967 FOR INSURANCE POLICIES ISSUED FROM APRIL 1, 1956 TO JUNE 30, 1958 INCLUSIVE.

5. "V" SCALE DIVIDENDS EFFECTIVE JANUARY 1, 1967 FOR INSURANCE POLICIES ISSUED PRIOR TO APRIL 1, 1956

6. "V"" SCALE DIVIDENDS EFFECTIVE JANUARY 1, 1967 FOR WESTERN EMPIRE (A REINSURED COMPANY) INSURANCE AND ANNUITY POLICIES

7. \*\*V\*\* SCALE DIVIDENDS EFFECTIVE JANUARY 1, 1967 FOR RETIREMENT ANNUITY POLICIES

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H. GROSS PREMIUMS

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## 1. INSURANCE - UNITED STATES PARTICIPATING

GP = (NET + C)/K

WHERE

GPIS THE GROSS PREMIUMNETIS THE NET PREMIUMCIS THE LOADING CONSTANTKIS 100% MINUS THE LOADING PERCENT

C AND/OR K MAY BE CONSTANT, OR MAY VARY BY AGE AT ISSUE, BY AGE AT ISSUE AND PREMIUM-PAYING DURATION, OR BY THE IN FORCE PERIOD, DEPENDING UPON THE PLAN OF INSURANCE.

VALUES ARE NORMALLY ESTABLISHED FOR 5 OR 10 YEAR GROUPINGS, AND INTERMEDIATE VALUES AS REQUIRED ARE CALCULATED BY INTERPOLATION.

(A) ESTATEMASTER PREFERRED

		AGE	AT ISSU	JE
	0	5	15	25 AND UP
с	1.80	1.55	1.45	1.25
v	97 47		AT TCCI	15

K .87 AT ALL AGES AT ISSUE.

(B) ENHANCED EQUITY "85"

AGE AT ISSUE								
15 25 35 45 55 65								
С	1.80	1.70	1.60	1.50	1.40	1.30	1.25	
к	.865 A	T ALL AG	ES AT IS	SUE.				

(C) ESTATEMASTER SELECT - LIFE AT 95

		AGE	AT ISSU	IE -		
	15	25	35	45 	55	65-70
с	1.00 AT	ALL AGE	S AT ISS	UE.		
к	.87	.88	.89	•90	.91	<b>.</b> 92

A.54
(D) 1-4-7 WHOLE LIFE

С

\_\_\_\_

2.20 ON ULTIMATE NET FOR ALL AGES AT ISSUE.

K .845 FOR ALL AGES AT ISSUE.

GROSS PREMIUM FOR YEARS 1-3 = .5 (ULTIMATE GROSS) GROSS PREMIUM FOR YEARS 4-6 = .75 (ULTIMATE GROSS)

(E) STANDARD LIFE PLANS

K .845 FOR ALL AGES AT ISSUE AND PREMIUM PAYING PERIODS.

C VARIES BY AGE AT ISSUE AND PREMIUM PAYING PERIOD AS FOLLOWS:

# AGE AT ISSUE

P.P.P.	0	5	10	25 AND UP
	_	-		
10 PAY	2.30	2.05	1.95	1.80
15 PAY	2.15	1.90	1.80	1.65
20* PAV	2.00	1.75	1.65	1.50

#### (F) COTERMINOUS ENDOWMENT PLANS

K VARIES AS FOLLOWS:

#### AGE AT ISSUE

P.P.P.	TO 50	55	60	65	70				
10 PAY	.8725	.8700	.8650	.8600	.8550				
15 PAY	.8675	<b>.</b> 8650	<b>.8600</b>	.8550	.8500				
20 PAY	<u>。8650</u>	<b>.</b> 8600	<b>.</b> 8550	<b>.8500</b>	<b>.</b> 8450				
25 PAY	.8600	<b>.</b> 8550	.8500	<b>.845</b> 0					
30 PAY	°8520	<b>.8500</b>	•8450						
35 PAY	.8500	.8450							
40+ PAY	.8450								

C VARIES AS FOLLOWS:

	AG	E AT ISS	UE		
		یہ حسورہ جے حدد خط مانہ ہے			
P.P.P.	0	5	10	15	25 AND UP
	_				
10 - 30 PAY				1.60	1.50
30+ PAY	2.00	1.75	1.65	1.60	1.50

FOR COTERMINOUS ENDOWMENTS OF 10 TO 30 YEARS ISSUED AT AGES 0-14 THE MALE AND FEMALE PREMIUMS ARE EQUAL TO THE AGE 15 MALE PREMIUM FOR THE SAME PLAN. WHERE AN ENDOWMENT IS ISSUED TO A FEMALE WITHOUT THE WAIVER OF PREMIUM DISABILITY BENEFIT, THE FEMALE PREMIUM SHOULD NOT BE GREATER THAN THE FEMALE PREMIUM AT AGE 15. . .

#### (G) LIMITED PAYMENT ENDOWMENTS

K	VARI	ES	AS	FOLLOWS:
YE	ARS	TO		
MA	TURI	TΥ		K
				-
30	) 4			.8500
25	5			.8575
20	)			<b>.865</b> 0

C VARIES AS FOLLOWS:

	AGE AT ISSUE						
	0 -	5	10	15	25 AND UP		
С	2.00	1.75	1.65	1.60	1.50		

# (H) RETIREMENT INCOME PLANS

K VARIES AS FOLLOWS:

AGE AT ISSUE						
P.P.P.	то	50		55	60	65
10 PAV	. 87	775	. 87	75	.8725	.8625
15 PAY	. 87	750	.87	25	.8675	
20 PAV	. 87	725	。86	75		
25 PAY	. 87	700				
30 PAY	. 86	675				
35 PAV	. 86	625				
40 PAY	. 85	550				
45 PAY	. 85	525				
50 PAY	. 85	500				
55* PA	γ <u>84</u>	475				

C VARIES AS FOLLOWS:

С



#### (I) ESTATE BUILDER

к

.8450 FOR ALL AGES AT ISSUE.

	AGE	AT	ISSUE
0		14	÷
			-

С

(J) JOINT LIFE PLANS

C VARIES BY PLAN:

ORDINARY I	LIFE	AND	LIFE	20	С	=	2.25
ENDOWMENT	20				c	=	2.50

K VARIES AS FOLLOWS:

\_\_\_\_

	J01	NT AGE A	T ISSUE	
	TO 50	55	60	65
ORDINARY LIFE				
AND LIFE 20	<b>.</b> 8450	<u>。8450</u>	<b>.</b> 8450	<b>.</b> 8450
ENDOWMENT 20	.8650	.8575	.8500	<b>.</b> 8450

(K) SINGLE PREMIUM PLANS

PLAN		С	К
		-	-
LIFE		10.00	.90
ENDOWMENT	20+ YEARS	10.00	.90
ENDOWMENT	15 YEARS	10.00	.91
ENDOWMENT	10 YEARS	10.00	。92

FOR ENDOWMENTS OF 10-30 YEARS ISSUED TO MALES AT AGES 0-9, THE MALE RATE AT AGE 10 IS USED. THE PREMIUM FOR FEMALE AGES 0-14 FOR ENDOWMENTS OF 10-30 YEARS IS THE LESSER OF THE FEMALE RATE AT AGE 15, OR THE MALE RATE FOR THE SAME ISSUE AGE.

A.57

## 2. INSURANCE - UNITED STATES NON-PARTICIPATING

3. INSURANCE - CANADA PARTICIPATING

#### 4. INSURANCE - CANADA NON-PARTICIPATING

5. SUPPLEMENTARY BENEFITS

A.58

### 6. ANNUITIES - UNITED STATES

A 2.50% REDUCTION IN THE GROSS PREMIUM IS ALLOWED FOR ALL SINGLE PREMIUM NON-PAR ANNUITIES, EXCEPT ANNUITIES CERTAIN, WHERE THE PROCEEDS ARISE FROM PENSION TRUST FUNDS.

THE TAX RATE DEPENDS ON THE STATE OF RESIDENCE OF THE OWNER OF THE CONTRACT AT THE DATE OF ISSUE.

			ADJUSTMENT
	STATE TAX	FACTOR	FACTORS (#)
	REGULAR	QUALIFIED	QUALIFIED
STATE OF OWNER	ANNUITIES	ANNUITIES	LIFE ANNUITIES
CALIFORNIA	1.0233	1.01	.985
COLORADO	1.0225	1.0225	.997
DISTRICT OF COLUMBIA	1.02	1.02	. 994
FLORIDA	1.01	1.01	•985
ILLINOIS	1.02	1.02	<b>。</b> 994
IOWA	1.02	1.00	<b>•97</b> 5
KANSAS	1.02	1.02	<b>°</b> 994
KENTUCKY	1.02	1.02	.994
MISSOURI	1.02	1.00	<b>.97</b> 5
NORTH DAKOTA	1.025	1.025	.999
SOUTH DAKOTA	1.0125	1.00	.975
WASHINGTON	1.02	1.0075	<b>°</b> 985
ALL OTHER STATES	1.00	1.00	<b>°</b> 9 <b>7</b> 5
IN WHICH THE COMPANY			
IS LICENSED			

# DOES NOT APPLY TO ANNUITY CERTAIN CONTRACTS.

SPECIAL TAX ADJUSTMENTS FOR REFUND RATES AGES 71 AND OVER.

(A) SINGLE PREMIUM IMMEDIATE ANNUITIES - NON-PARTICIPATING

PREMIUMS ARE BASED ON 1967 STERNHELL MODIFICATION OF 1959 ANNUITY TABLE - 5.25% INTEREST FOR THE FIRST 15 YEARS AND 3.50% THEREAFTER -- MALE AND FEMALE TABLES.

LOADING 4.50% OF GROSS FOR MALES AND FEMALES.

CONSTANTS PER \$10 MONTHLY INCOME ARE AS FOLLOWS:

A.59

	MALES				FEMALES	A.60
LIFE	LIFE 10	LIFE 20	AGE	LIFE	LIFE 10	LIFE 20
75	75	75	25	75	75	75
70	70	70	30	70	70	70
65	65	65	35	65	65	65
55	55	55	40	55	55	55
45	45	45	45	45	45	45
35	35	40	50	35	35	40
20	20	35	55	25	20	35
10	10	28	60	15	10	28
0	3	21	65	3	3	21
0	3	21	70	0	3	21
0	3	21	75	0	3	21
3	3	-	80	3	3	-
8	3	-	85	8	3	-
8	2	-	87	Q	2	

THE GROSS PREMIUM FOR AN INSTALMENT REFUND TYPE ANNUITY IS OBTAINED BY INTERPOLATING BETWEEN THE GROSS PREMIUMS IN DOLLARS AND CENTS (TO WHICH HAVE BEEN ADDED THE \$9.00 QUANTITY DISCOUNT FACTOR PER \$10 MONTHLY INCOME) FOR ANNUITIES WITH 'N' AND 'N+1' YEAR GUARANTEES. THE RESULTING INSTALMENT REFUND ANNUITY IS EQUIVALENT TO A GUARANTEED PERIOD OF 'N+F' YEARS, WHERE 0<F<1. FROM THIS GROSS INSTALMENT REFUND PREMIUM IS DEDUCTED THE \$9.00 QUANTITY DISCOUNT FACTOR TO PRODUCE A BASIC SINGLE PREMIUM PER \$10 MONTHLY INCOME.

FOR EXAMPLE, (ASSUMING MONTHLY PAYMENTS), IF A GROSS PREMIUM OF ""A"" CORRESPONDS TO A GUARANTEED RETURN OF \$120N AND A GROSS PREMIUM OF ""C"" CORRESPONDS TO A GUARANTEED RETURN OF \$120(N+1), THE DESIRED GROSS PREMIUM EQUALS

GP = A + 9 + (A + 9 - 120N)(C-A)  $\frac{120(N+1) - 120N - (C-A)}{120(N+1) - 120N - (C-A)}$ 

HENCE THE BASIC SINGLE PREMIUM IS (\$GP - \$9.00).

EXAMPLE: A = \$757.20 C = \$817.17 N = 6

GP = 757.20 + 9.00 + (757.20 + 9.00 - 720.00)(817.17 - 757.20)840.00 - 720.00 - (817.17 - 757.20)

= 812.35

HENCE THE BASIC SINGLE PREMIUM IS \$803.35.

## SINGLE PREMIUM IMMEDIATE ANNUITY - FORMULAE

# I. SINGLE LIFE

PRIMED FIGURES ARE AT THE SECOND RATE OF INTEREST. ""N"" IS THE GUARANTEED PERIOD.

LIFE ONLY

GP = (120)(a + (D /D)(a) - a)) + C X + 15 + K K

N<= 15 YEARS

GP =

N>15 YEARS

GP =

(12) 19	5 (12)					(12)	
(120)(a +(V	) { @ "" } + {	D /	'D )(D	۰ /D	)(a'	))+ C	
15	N-15	X*15	Х	X+N	X+15	X+N	
ويرحقون ويورد بينين ويورد ويرين منتخر بولان منتجر متحاد وترين متكر ويرين منتجر ويتري ويترين							
		К					

II. JOINT LIFE AND LAST SURVIVOR

SEE SECTION J ON MULTIPLE LIFE FUNCTIONS, AND IN PARTICULAR ITEM 6 OF THAT SECTION.

(B) SINGLE PREMIUM DEFERRED ANNUITIES - NON-PARTICIPATING -A.62 NO DEATH BENEFIT

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(C) SINGLE PREMIUM IMMEDIATE AND DEFERRED ANNUITIES CERTAIN -NON-PARTICIPATING 

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(D) SINGLE PREMIUM TEMPORARY LIFE ANNUITIES - NON-PARTICIPATING 

(E) 10 PAY IMMEDIATE AND DEFERRED ANNUITIES - NON-PARTICIPATING 

(F) ANNUAL PREMIUM DEFERRED ANNUITIES - NON-PARTICIPATING

(G) ANNUAL PREMIUM REVERSIONARY ANNUITIES - NON-PARTICIPATING

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### 7. ANNUITIES - CANADA

# (A) SINGLE PREMIUM IMMEDIATE ANNUITIES - NON-PARTICIPATING

#### (B) SINGLE PREMIUM DEFERRED ANNUITIES - NON-PARTICIPATING

(C) SINGLE PREMIUM IMMEDIATE AND DEFERRED ANNUITIES CERTAIN -NON-PARTICIPATING

(D) SINGLE PREMIUM TEMPORARY LIFE ANNUITIES - NON-PARTICIPATING

(E) 10 PAY IMMEDIATE AND DEFERRED ANNUITIES - NON-PARTICIPATING

(F) ANNUAL PREMIUM DEFERRED ANNUITIES - NON-PARTICIPATING 

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(G) ANNUAL PREMIUM REVERSIONARY ANNUITIES - NON-PARTICIPATING

(H) SINGLE PREMIUM REVERSIONARY ANNUITIES - NON-PARTICIPATING

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# I. NON-FORFEITURE BENEFITS

### 1. INSURANCE

ALL CASH SURRENDER VALUES ARE BASED ON THE 1958 COMMISSIONERS STANDARD ORDINARY MORTALITY TABLE. THE METHOD OF CALCULATION AND THE RATE OF INTEREST USED ARE EXPLAINED UNDER THE APPROP-RIATE SECTION (U.S. PAR, ETC.). FIRST AND SECOND YEAR CASH VALUES ARE ALLOWED ONLY IF PRODUCED BY FORMULA; THE MINIMUM CASH VALUE THEREAFTER IS \$1 PER \$1000 (PER UNIT FOR DOUBLE INS-URANCE) FOR PERMANENT PLANS ONLY. ALL CASH VALUES ARE ROUNDED TO THE HIGHER DOLLAR.

CASH VALUES ARE CONVERTED TO REDUCED PAID-UP INSURANCE USING A NET SINGLE PREMIUM BASED ON THE 1958 CSO TABLE AND THE CASH VALUE INTEREST RATE.

EXTENDED TERM PERIODS AND PURE ENDOWMENT AMOUNTS ARE CALCULATED USING THE 1958 CET TABLE AND THE CASH VALUE INTEREST RATE. AT CERTAIN AGES AND DURATIONS, HOWEVER, THESE WERE INCREASED FOR U.S. NON-PAR ENDOWMENTS; THE INCREASED VALUES ARE BASED ON MINIMUM CASH VALUES (CALCULATED BY THE STANDARD NON-FORFEITURE LAW METHOD) WHICH WERE CONVERTED ON A CURTATE BASIS.

IF NON-FORFEITURE BENEFITS ARE BEING CALCULATED FOR A PLAN WHICH DOES NOT APPEAR IN THE RATE BOOK, THEY SHOULD BE COMPARED AGAINST THE LEGAL MINIMUM VALUES AND INCREASED, IF NECESSARY.

SINGLE PREMIUMS FOR CONVERTING TO EXTENDED TERM AND REDUCED PAID-UP ARE BASED ON CURTATE FUNCTIONS FOR CANADA NON-PAR PLANS; FOR OTHER SECTIONS, IMMEDIATE PAYMENT OF CLAIMS IS ASSUMED.

IN THE DESCRIPTIONS WHICH FOLLOW, A GENERAL FORMULA IS GIVEN FOR EACH SECTION AND VARIATIONS BY PLAN ARE NOTED BELOW. THE PREMIUM PAYING PERIOD IS DENOTED BY ""N"".

IN THE CASE OF JUVENILE SINGLE PREMIUM PLANS, THE NON-FORFEITURE VALUES ARE BASED ON THE ACTUAL AGE AT ISSUE EVEN THOUGH THE GROSS PREMIUM MAY HAVE BEEN DETERMINED AT ANOTHER AGE. 2. UNITED STATES PARTICIPATING INSURANCE CASH VALUES A.65 NET PREMIUMS ARE BASED ON IMMEDIATE PAYMENT OF CLAIMS AND AN INTEREST RATE OF 2.50% , EXCEPT AS NOTED BELOW: : C۷ (P.V. BENEFITS AT DURATION T) - ((PI) )(@ T X X+T:N-T \$ - (PI) )(@ ----) 1 P X X+T:20-T X WHERE A (PI) + (C/a ---) P Х X:20 X AND C VARIES AS FOLLOWS: \$ 0 < PI <= \$ 25 C = \$21.50 + (.4)((PI))Х X \$ 25 < PI <= \$ 40 C = \$31.50Х \$ 40 < PI <= \$100 C = \$27.50 + (.1)((PI))Х Х \$100 < PI C = \$37.50Х

IF N < 20, SUBSTITUTE ""N"" FOR ""20"" IN THE ABOVE FORMULA.

### (A) ESTATEMASTER PREFERRED

THE \*\*T\*\*TH CASH VALUE IS FOUND BY THE ABOVE FORMULA WHERE:

.

A = (PI) + (C/a - - -) X = 14.00 + (.2)((PI)) X

#### (B) ENHANCED EQUITY "85"

NET PREMIUMS ARE BASED ON IMMEDIATE PAYMENT OF CLAIMS AND AN INTEREST RATE OF 2.25%.

THE ""T" TH CASH VALUE IS FOUND BY THE ABOVE FORMULA WHERE

A = (PI) + (C/a - -) X X X:10

AND "C" VARIES AS FOLLOWS:

AGE AT ISSUE	C
بلينه فلنت معد مهند بينه غلبة وإنه نبيه منه منه م	-
15	5.00
25	6.00
35	7.00
45	8.50
55	10.00
65	11.50
70	12.50

(C) ESTATEMASTER SELECT

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NET PREMIUMS ARE BASED ON IMMEDIATE PAYMENT OF CLAIMS AND AN INTEREST RATE OF 3%. THE °°T°°TH YEAR CASH VALUE IS FOUND BY THE ABOVE FORMULA WHERE:

(D) 1-4-7 WHOLE LIFE

THE ""T" TH YEAR CASH VALUE IS EQUAL TO THE ""T" TH YEAR LESS THE FOLLOWING:

WHERE (PI) IS THE ULTIMATE NET ANNUAL PREMIUM.

FOR CASH VALUE PURPOSES, THE ULTIMATE NET IN THE ABOVE FORMULA IS LIMITED TO \$35.39. THUS THE MAXIMUM EXPENSE ALLOWANCE AT ISSUE IS \$31.50.

## (E) ENDOWMENTS ISSUED AT AGE O

FOR ENDOWMENT 20, 25 AND 30, AND 20 PAY ENDOWMENT AT 60 AND 65, REDUCE THE PRECEDING VALUES OF "C" BY \$1.00. BECAUSE OF THE SMALLER DEATH BENEFIT AT AGE 0 AND THE EXCLUSION OF AN EQUI-VALENT UNIFORM AMOUNT FROM THE CASH SURRENDER VALUE FORMULA, IT IS NECESSARY TO REDUCE THE EXPENSE ALLOWANCE ON THESE PLANS.

3. UNITED STATES NON-PARTICIPATING INSURANCE CASH VALUES

NET PREMIUMS ARE BASED ON IMMEDIATE PAYMENT OF CLAIMS AND AN INTEREST RATE OF 3.25%. (P.V. BENEFITS AT DURATION T) C∀ - ( P )(@ T X+T:N-T X WHERE (PI) (20 + (.4)((PI)) + (.1)(X)) / aΑ P X:N Х HERE, THE (PI) IN (.4)((PI) ) IS NOT TO EXCEED \$40.00. X (A) ESTATEMASTER SPECIAL SAME AS ABOVE BUT BASED ON IMMEDIATE PAYMENT OF CLAIMS AND AN INTEREST RATE OF 3.50%. (B) DOUBLE INSURANCE PLANS = (PI) + ((20)(ELA) + (.1)(ELA)(X) + (.4)((PI) )) / a p X X X X WHERE AND ""M"" IS THE DOUBLE INSURANCE PERIOD. ELA =X:M (PI) IN (.4)((PI) ) IS NOT TO EXCEED 40 ELA. X X (C) TERM PLANS P (PI) + (20 + (.65)((PI) ) / a X X X X:N (PI) IN (.65)((PI) ) IS NOT TO EXCEED \$40.00. Х CASH VALUES ON TERM PLANS ARE ALLOWED ONLY WHERE THE TERM PERIOD IS 15 YEARS OR LONGER OR WHERE THE PLAN EXPIRES AT

AGE 66 OR LATER. CASH VALUES ARE GRANTED ONLY WHERE THEY

ARISE BY FORMULA.

### 4. CANADA PARTICIPATING INSURANCE CASH VALUES

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5. CANADA NON-PARTICIPATING INSURANCE CASH VALUES

الملاحق مرد بران که جله بران بید چند بران که مله که من جله الله است الله عنه الله ا

### 6. UNITED STATES ANNUITY CASH VALUES

### 7. CANADA ANNUITY CASH VALUES

# 8. REDUCED PAID-UP INSURANCE

(A) N-PAYMENT LIFE

$$\begin{array}{c} \mathsf{N} \\ \mathsf{(RPU)} \\ \mathsf{T} \\ \mathsf{X} \\ \mathsf{T} \\ \mathsf{X} \\ \mathsf{T} \\ \mathsf{X} \\ \mathsf{T} \\ \mathsf{X} \\ \mathsf{X} + \mathsf{T} \\ \mathsf{X} \\ \mathsf{X} \\ \mathsf{X} + \mathsf{T} \\ \mathsf{X} \\ \mathsf{X}$$

(B) WHOLE LIFE

$$(RPU) = (CV) / A$$
  
T X T X X+T

(C) N-PAYMENT ENDOWMENT

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(RPU) - = (CV) - / A ---T X:N T X:N X+T:N-T

(D) N-YEAR TERM

 $\hat{\tau} = \tau_{i}$ 

	1			1		1	
(RI	PU) -	=	(C	V) -	1	A	
Т	X:N		Т	X:N		X+I:	N-T

### T = DURATION

A.70

9. EXTENDED TERM INSURANCE (LIFE AND ENDOWMENT PLANS)

(A) FIND THE DURATION IN INTEGRAL YEARS, ""N"", SUCH THAT

(B) IF ""N" IS LESS THAN THE REMAINING IN FORCE DURATION, THE CASH VALUE IS USED TO PURCHASE TERM INSURANCE FOR AS LONG A PERIOD AS POSSIBLE. PROCEED TO STEP (C) ONLY.

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A.71

IF ""N"" IS NOT LESS THAN THE REMAINING IN FORCE PERIOD, THE CASH VALUE IS USED TO PURCHASE TERM INSURANCE FOR THE REMAINING IN FORCE PERIOD, AND THE BALANCE OF THE CASH VALUE IS USED TO PURCHASE AS MUCH PURE ENDOWMENT INSURANCE AS POSSIBLE. PROCEED TO STEP (D) ONLY.

(C) INTERPOLATE THE NUMBER OF DAYS OF EXTENDED TERM INSURANCE COVERAGE, ""ND"", FROM THE RELATIONSHIP

(D) IN THIS STEP, ""N"" IS THE REMAINING IN FORCE DURATION.

EXTENDED TERM INSURANCE IS PURCHASED FOR THIS PERIOD. THE AMOUNT OF PURE ENDOWMENT IS THEN CALCULATED AS FOLLOWS:

# J. MULTIPLE LIFE FUNCTIONS

# 1. JOINT-LIFE FUNCTION BASIC DATA

(A)	AGE RANGE	XX
(B)	NUMBER LIVING AT EACH AGE	L XX
(C)	NUMBER DYING AT EACH AGE	MD = MORTALITY OR SMALL XX SCRIPT D
(D)	MORTALITY RATE AT EACH AGE	Q = PROBABILITY OF DEATH XX
(E)	COMMUTATION FUNCTION TABLE RADIX AND AGE	

ANY ONE OF (B), (C), OR (D) WILL BE STORED, WITH THE MOST COMMON BEING (D). A SPECIFIC RADIX VALUE FOR A SPECIFIC AGE MAY BE STORED ALONG WITH EACH TABLE IN (D) FORMAT. IF SUCH A RACIX VALUE IS NOT PRESENT, AN ASSUMED RADIX FOR THE LOWEST AGE IN THE TABLE WILL BE USED. THE RADIX IS THE L VALUE FOR THE LOWEST AGE IN THE RELATED MORTALITY RATES. XX

PROVISION WILL BE MADE TO CALCULATE (B), (C), OR (D) VALUES AS REQUIRED AND AS DETERMINED BY THE FORMAT OF THE STORED TABLE.

THE APPROACH OUTLINED HEREIN IS APPLICABLE TO JOINT-LIFE FUNCTIONS INVOLVING ANY NUMBER OF LIVES, FOR WHICH THE MORTA-LITY OR EQUIVALENT DATA ARE PRESENT.

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## 2. JOINT-LIFE FUNCTION BASIC CALCULATIONS

(A) THE SINGLE LIFE FUNCTIONS AND FORMULAE OUTLINED IN PRECEDING SECTIONS ARE GENERALLY APPLICABLE TO CORRESPONDING JOINT LIFE FUNCTIONS, IF THE MORTALITY TABLE INVOLVED WAS CONSTRUCTED ON A MAKEHAM BASIS, THEREBY ENABLING THE REPLACEMENT OF M LIVES OF UNEQUAL AGES WITH M LIVES OF EQUIVALENT EQUAL AGE.

THE 1941 CSO TABLE FOLLOWS MAKEHAM'S LAW FOR AGES 15 TO 95.

AS NOTED IN ""LIFE CONTINGENCIES" BY C.W. JORDAN (SECOND EDITION, PAGE 201),

\*\*ALTHOUGH THE 1958 CSO TABLE IS NOT A MAKEHAM TABLE, EXTENSIVE TEST CALCULATIONS HAVE SHOWN THAT A TABLE OF UNIFORM SENIORITY WITH LOG C = .04 CAN BE USED 10 TO PRODUCE INTERPOLATED VALUES FOR ANNUITIES, NET ANNUAL PREMIUMS, AND RESERVES WHICH ARE REASONABLY CLOSE TO THE TRUE VALUES. . . THE DEGREE OF ACCU-RACY IN THE RESULTING JOINT-LIFE VALUES DEPENDS UPON THE AGES INVOLVED AND THE PARTICULAR FUNCTION BEING

COMPUTED. THIS METHOD SHOULD NOT BE USED WITH OTHER TABLES WITHOUT ADEQUATE TESTING, AND IF A HIGH DEGREE OF PRECISION IS NECESSARY, THE METHOD CANNOT BE USED."

(B) FOR CALCULATIONS OF JOINT-LIFE FUNCTIONS INVOLVING TWO LIVES, DETERMINE THE EQUIVALENT EQUAL AGE AS FOLLOWS:

CALCULATE THE DIFFERENCE IN AGES.

USING THIS DIFFERENCE, ENTER THE TABLE OF UNIFORM SENIORITY FOR THE MORTALITY TABLE INVOLVED, AND OBTAIN THE ADDITION TO BE MADE TO THE YOUNGER AGE TO COMPUTE THE EQUIVALENT EQUAL AGE.

(C) PROCEED WITH THE REQUIRED TWO-LIFE CALCULATIONS, USING THE EQUIVALENT EQUAL AGE AND THE APPROPRIATE MORTALITY TABLE AND INTEREST RATE. THE SINGLE-LIFE FORMULAE ARE GENERALLY APPLICABLE ON THIS BASIS.

> THE TABLE OF UNIFORM SENIORITY FOR THE 1958 CSO MORTALITY TABLE IS SHOWN ON THE NEXT PAGE. SELECTED VALUES ARE ROUNDED TO THE NEAREST INTEGRAL AGE.

TABLE OF UNIFORM SENIORITY (1958 CSO TABLE)

	ADDITION		ADDITION		ADDITION
DIFFE-	TO	DIFFE-	TO I	I. DIFFE- I	TU
RENCE	YOUNGER	RENCE	YOUNGER	RENCE	YOUNGER
IN AGE	AGE	IN AGE	AGE	IN AGE	AGE
				[]	
_					1.2 572
1	.512	26	1 19.422		40.010
2	1.046	27	20.342	1 52 1	44.704
3	1.603	28	21.268	55	40.000
4	2.183	29	22.201	54	46.549
5	2.785	30	23.139	1 55 1	41.543
6	1 3 4 0 9 1	   31	1 24.082 1	1 56 1	48,537
7		1 32	25.030	1 57 1	49,531
0	1 4 7 21	1 22	1 25 982 1	1 58 1	50.526
0		1 32	220702	1 50 1	51,522
9		1 25	20.700		52 517
10	0.113	30			120111
11	6.837	36	28.862	61	53.514
12	7.580	37	29.828	62	54.510
13	8.340	38	30.797	63	55.507
14	9,116	1 39	31.769	64	56.504
15	9,907	40	32.744	65	57.502
		1	1	1	
16	10.714	41	33.720	66	58.499
17	11.534	42	34.699	67	59.497
18	12.368	43	35.679	68	60.495
19	1 13.214	44	36.661	69	61.493
20	1 14.072	45	37.645	1 70	62.491
	1	1	1 1	1 1	
21	1 14.940	46	38.630	71	63.490
22	15.819	47	39.617	1 72 1	64.489
23	16.707	48	40.604	1 73	65.487
24	17,604	49	41.593	74	66.486
25	18.509	50	42.582 1	75	67.485
			1	1	

BASED ON LOG C = .04. PRODUCES APPROXIMATE VALUES FOR JOINT 10 TWO-LIFE FUNCTIONS.

SOURCE: ººLIFE CONTINGENCIES,ºº C.W. JORDAN, JR., SECOND ----- EDITION, SOCIETY OF ACTUARIES, 1967, PAGE 345.

## 3. JOINT-LIFE COMMUTATION FUNCTION ANALYSIS

AS NOTED IN THE PRECEDING SECTIONS, JOINT-LIFE CALCULATIONS FOR TWO LIVES CAN OFTEN BE MADE USING EQUIVALENT EQUAL AGES INSTEAD OF THE TWO UNEQUAL AGES. THIS REDUCES THE CALCULATION COMPLEXITY BY REPLACING ALL POSSIBLE AGE COMBINATIONS WITH A SINGLE SERIES OF AGES.

THIS APPROACH DOES NOT APPLY IN THE CASE OF JOINT-LIFE AND LAST SURVIVOR FUNCTION CALCULATIONS. THUS IT IS NECESSARY TO BE ABLE TO CALCULATE COMMUTATION FUNCTIONS FOR ALL COMBINATIONS OF AGES, AND TO USE THEM TO CALCULATE JOINT-LIFE AND LAST SURVIVOR BENEFITS.

SUBSEQUENT SECTIONS ON JOINT-LIFE AND LAST SURVIVOR FUNCTION BASIC DATA AND CALCULATIONS USE THE CALCULATION FACILITIES OF THIS SECTION.

THE MOST USUAL CALCULATIONS REQUIRED INVOLVE ONE MALE AND ONE FEMALE LIFE, WITH DIFFERENT MORTALITY TABLES APPLICABLE TO EACH. ALSO, DIFFERENT INTEREST RATES MAY APPLY TO DIFFERENT DURATION GROUPS (E.G., 5.25% FOR THE FIRST 15 YEARS AND 3.50% THEREAFTER).

IN "LIFE CONTINGENCIES" BY C.W. JORDAN, JR. (PAGE 194), THE CON-VENTION AS TO THE POWER OF THE INTEREST FACTOR V INVOLVES THE USE OF THE ARITHMETIC MEAN OF THE AGES. FOR TWO LIVES WITH AN ODD SUM OF AGES, THE POWER OF V IS FRACTIONAL; COMMUTATION FUNCTIONS ARE ACCORDINGLY MORE COMPLICATED TO CALCULATE.

FOR JOINT-LIFE AND LAST SURVIVOR CALCULATIONS, RATIOS OF D VALUES ARE REQUIRED. THE CONVENTION USED IN THEIR XY CALCULATION IS

 $D = (V)(L)(L^{\circ}) OR (D)(L^{\circ})$  XY X Y X Y X Y

NO INTEREST CALCULATION ERROR IS INTRODUCED AS THE AGES ADVANCE SYMMETRICALLY, WITH AN INCREASE OF ONE YEAR IN AGE PRODUCING AN INCREASE OF ONE IN THE V EXPONENT. THE HALF-POWERS OF V ARE AVOIDED. FINALLY, THE REQUIRED VALUES ARE READILY DERIVABLE FROM THE SINGLE LIFE TABLES INVOLVED.

A SIMILAR APPROACH IS TAKEN IN CALCULATING VALUES OF C , NAMELY:

X + 1 С 1 V )(MD 3 MD = MORTALITY OR SMALL XY XY XΥ SCRIPT D X+1 ) (L - L ) XY X + 1: Y + 1 X X + 1  $(V)(V)(L)(L^{\circ}) - (V)(L)(L^{\circ})$ } X Y X+1 Y + 1 (V)(D) D XY XY+1

XY

### 3. JOINT-LIFE COMMUTATION FUNCTION ANALYSIS (CONT'D)

THIS APPROACH IS CONSISTENT WITH THE METHOD ADOPTED FOR THE D CALCULATIONS; THE RESULTING EQUATION, MOREOVER, IS AS MIGHT XY HAVE BEEN EXPECTED FROM A REFERENCE TO THE SINGLE LIFE COUNTERPART.

## 4. JOINT-LIFE COMMUTATION FUNCTION CALCULATIONS

X {V}{L}(L°) X Y

$$(B) \qquad D^{u} = (V^{u}) (L) (L^{u})$$

=

$$(C) N = SS (D) + D$$
  

$$XY T = 1 XY + T XY$$
  

$$W - A - 1$$

(D) 
$$N^{\circ} = SS (D^{\circ}) + D^{\circ}$$
  
XY  $T=1 XY + T XY$ 

$$(E) C = (V)(MD)$$

$$XY XY$$

$$X + 1$$

(G) 
$$M = SS (C) + C$$
  
XY  $T=1 XY + T XY$ 

(H) 
$$M^{\circ} = SS XY + T XY$$
  
XY T=1

$$\begin{array}{ccc} (I) & C & = & (V)(D) & - & D \\ & & XY & & XY & & XY+1 \end{array}$$

$$\begin{array}{ccc} (J) & C^{\circ} & = & (V^{\circ})(D^{\circ}) & - & D^{\circ} \\ & XY & & XY & & XY + 1 \end{array}$$

$$\begin{array}{cccc} (K) & M & = & (V)(N) & - & N \\ & XY & & XY & & XY \\ \end{array}$$

$$\begin{array}{cccc} (L) & M^{\circ} & = & (V^{\circ})(N^{\circ}) & - & N^{\circ} \\ & & XY & & XY & & XY + 1 \end{array}$$

# 5. JOINT-LIFE ANNUITY VALUE CALCULATIONS

THE FOLLOWING EQUATIONS ARE EQUALLY APPLICABLE TO UNPRIMED AND PRIMED INTEREST RATES, ONCE THE PARTICULAR TABLE HAS BEEN SELECTED. ONLY ONE SET OF EQUATIONS IS PRESENTED.

(A)	a X Y	Ħ	N /D XY+1 XY
(B)	: а ХҮ	=	N /D XY XY
(C)	(M) a XY	=	a + (M−1)/2M XY
(D)	:(M) @ XY	=	: @ - (M-1)/2M XY

6. JOINT-LIFE AND LAST SURVIVOR FUNCTIONS - UNITED STATES

(A) SINGLE PREMIUM IMMEDIATE ANNUITY FORMULAE

LOADING 4.50% OF GROSS.

CONSTANT WOULD BE THE HIGHER OF MALE AND FEMALE SINGLE LIFE CONSTANTS.

A.79

X AND Y ARE AGES AT ISSUE OF THE TWO LIVES INVOLVED.

LIFE ONLY A.80 (12) (12)(@ + (D /D)(@° - @ )) X X+15 X X+15 X+15 GP =К N<= 15 YEARS (12) GP = (120)(a- + C + N K N> 15 YEARS (12) 15 (12) (120)(a-- + (V)(a)---)) + C + 15 N-15GP =(120)(D /D)(D° /D° )(a° ) + X+15 X X+N X+15 X+N (12) (120)(D /D)(D<sup>1</sup> /D<sup>1</sup>)(2<sup>1</sup>) -V+15 Y Y+N Y+15 Y+N (12)(120){D /D)(L /L)(D' /D' )(@' ) X+15 X Y+N Y X+N X+15 XY+N

к

3 34

### (B) SINGLE PREMIUM DEFERRED ANNUITY FORMULAE

# 7. JOINT-LIFE AND LAST SURVIVOR FUNCTIONS - CANADA

(A) SINGLE PREMIUM IMMEDIATE ANNUITY FORMULAE

\_\_\_\_\_

### (B) SINGLE PREMIUM DEFERRED ANNUITY FORMULAE

# K. MULTIPLE DECREMENT FUNCTIONS

1. BASIC CONSIDERATIONS

THE MULTIPLE DECREMENT CONCEPT IS APPLICABLE TO THE STUDY OF THE EFFECTS OF THE SIMULTANEOUS OPERATION OF SEVERAL CAUSES OF DECREMENT ON A BODY OF LIVES. SOME EXAMPLES OF POTENTIALLY-APPLICABLE AREAS ARE:

(A) THE CALCULATIONS OF PREMIUMS, ETC. FOR INSURANCE BENEFITS WHERE DEATH AND DISABILITY EVENTS CONSTITUTE INTER-ACTING CAUSES FOR CLAIM PAYMENT;

- (B) THE CALCULATIONS OF PREMIUMS, ETC. FOR ACCIDENTAL DEATH BENE-FIT PROVISIONS ATTACHED TO BASIC INSURANCE POLICIES; AND
- (C) THE VALUATION OF GROUP PENSION PLANS, IN WHICH THE LIVES INVOLVED ARE SUBJECT TO THE DECREMENTS OF DISABILITY, MORTA-LITY, RETIREMENT, AND WITHDRAWAL.

IN PRACTICE, HOWEVER, SOME SIMPLIFICATIONS IN COMPUTATIONAL APPROACH HAVE BEEN ADOPTED.

IN THE CASE OF DISABILITY AND ACCIDENT PREMIUM AND OTHER CALCULATIONS, THE METHOD USED INVOLVES THE COMBINATION OF THE PROBABILITY OF EVENT OCCURRENCE (I.E., DISABILITY OR ACCIDENTAL DEATH) AND THE FUNCTIONS FROM A STANDARD MORTALITY TABLE. THE EFFECT IS TO AVOID THE NEED TO CONSTRUCT A DOUBLE- DECREMENT TABLE.

FOR GROUP PENSION CALCULATIONS, REFERENCE SHOULD BE MADE TO SECTION N FOR ALL DETAILS, INCLUDING MULTIPLE DECREMENT CONSIDERATIONS.



2. ACCII	DENTAL DEATH	BENEFIT CALCULATIONS		A.83
(A)	BASIC DATA	A -		
	AGE RANGE		x	
	STANDARD M Commutatio	ORTALITY TABLE In Function	N X	
EQUAT	PROBABILIT	Y OF ACCIDENTAL DEATH	AD Q X	
(B)	AD C = X	AD {V}(Q)(D) X X		
(C)	A D M = X	W-X-1 AD AD SS (C ) + C T=1 X+T X		
(D)	- A C M = X	AD (I/F)(M) X		
(E)	A C A = X	AD (M)/(D) X X		
(F)	- A D A = X	AD (I/F)(A) X		
(G)	1 AD A - = X:N	AD AD (M – M )/(D) X X+N X		
(H)	-1 AD A - = X:N	1 AD (I/F)(A ¬) X:N		
(1)	1 AD = P ~ X:N	AD AD {M '− M }/(N − N X X+N X )	) (+N	.202
(J)	1 AD P - = M X:N	AD AD {M - M }/(N - N X X+N X )	) 《十四	

.

NOTE THAT SELECT AND ULTIMATE MORTALITY TABLES MAY BE USED IF DESIRABLE, BY PROVIDING THE APPROPRIATE COMMUTATION VALUES FOR N'S, AND BY ADJUSTING THE PRECEDING EQUATIONS.

### 3. DISABILITY BENEFIT CALCULATIONS

\*

## SEE SECTION L ON INDIVIDUAL HEALTH INSURANCE

L. INDIVIDUAL HEALTH INSURANCE BASIC CALCULATIONS

#### 1. BASIC DATA

(A) AGE RANGE

\_\_\_\_\_

 (B)
 AVERAGE ANNUAL CLAIM COST FOR A
 S
 NC

 PARTICULAR BENEFIT WITH RESPECT
 X
 CC

 TO CLAIMS INCURRED BETWEEN AGES
 SA

 X AND X+1, PER UNIT OF BENEFIT
 FC

 EXPOSED DURING THE YEAR OF AGE
 TC

 X TO X+1.
 N

S NOT TO BE X CONFUSED WITH THE SAME SYMBOL USED FOR LIFE FUNCTIONS TO DENOTE SUMS OF N VALUES. X N X

Х

A.85

(C) STANDARD MORTALITY TABLE COMMUTATION FUNCTION

# 2. BASIC CALCULATIONS

THE VALUES OF N AS NOTED IN 1(C) ABOVE WILL BE COMPUTED AS REQUIRED X FOR A PARTICULAR MORTALITY TABLE AND INTEREST RATE USING THE EQUA-TIONS GIVEN IN SECTION C ON ANNUITY BENEFITS.

WHEN THE BENEFIT PROVIDED VARIES BY AGE AND LEVEL PREMIUMS ARE TO BE CALCULATED, COMMUTATION FUNCTIONS MAY BE CALCULATED AND USED TO ADVANTAGE.

(A)	$H = (S)(D)$ $X \qquad X \qquad X$	H IS ANALOGOUS TO THE
		LIFE FUNCTION C .
(B)	K = SS (H) + H $X T = 1 X + T X$	K IS ANALOGOUS TO THE
		LIFE FUNCTION M . X
(C)	$\begin{array}{cccc} K & & - & K & - & K \\ X: Y - X & X & Y \end{array}$	THE ANALOGOUS LIFE FUNCTION EXPRESSION M IS NOT USED. X:Y-X

NOTE THAT SELECT AND ULTIMATE MORTALITY TABLES CAN BE USED IN THE ABOVE CALCULATIONS AND IN THOSE OF SECTION 3 WHICH FOLLOWS, BY ADJUSTING THE EQUATIONS AND PROVIDING FOR THE STORAGE OF THE APPROP-RIATE TABLES.

### 3. SUPPLEMENTARY CALCULATIONS (AS NECESSARY)

THE LIFE FUNCTION SYMBOL CONVENTIONS INCLUDE THE USE OF A ""1" ABOVE ONE ELEMENT OF THE SUFFIXED SUBSCRIPT TO INDICATE THAT THE EVENT IS DETERMINED UPON THE PRIOR FAILURE OF THAT ELEMENT. THE ABSENCE OF THE ""1" INDICATES THAT THE EVENT IS DETERMINED UPON THE FAILURE OF EITHER ELEMENT. EXAMPLES ARE THE NET SINGLE PREMIUM SYMBOLS FOR TERM AND ENDOWMENT INSURANCES.

ND SIMILAR DISTINCTION IS NEEDED FOR HEALTH INSURANCE NET SINGLE PREMIUMS, AS BENEFITS ARE PAYABLE ON THE OCCURRENCE OF SOME EVENT (E.G., DISABILITY OR ACCIDENTAL DEATH) BUT NOT ON THE EXPIRY OF A SPECIFIED NUMBER OF YEARS.

- (B) A = --- = (K K)/DX:Y-X X Y X
- (C) P = K /N X X X

(D) 
$$P = --- = (K - K)/(N - N)$$
  
 $X = Y - X - X - Y - X - Y$ 

(E) P - - - = (K - K)/(N - N) Z < OR = YZ - X X Y - X X Y X Z

(F) 
$$V = A - (P)(a)$$
  
T X X+T X X+T

(G) V = A = A = (P = --, (P = --, (Q = --, (Q = --, (Q = -, (Q = -,

### 4. GROSS ANNUAL PREMIUMS

5. TERMINAL AND MEDIAL RESERVES

# M. GROUP INSURANCE BASIC CALCULATIONS

#### 1. STOP-LOSS PREMIUMS FOR LIFE INSURANCE

- (1) THE CENSUS DATA MUST FIRST BE GROUPED INTO LIFE AMOUNT CLASSES. IF THE SCHEDULE RELATES LIFE INSURANCE TO SALARY OR SOMETHING SIMILAR, THEN THERE WILL BE TOO MANY CLASSES, AND THE DATA SHOULD BE GROUPED INTO AMOUNT RANGES DF, SAY, \$2000 - \$4000, \$4000 - \$6000, ETC.
- (2) FOR EACH AMOUNT CLASS "TT", CALCULATE THE AVERAGE NUMBER OF DEATHS PER 1000 (Q), USING TABLE 24 (MALES) FOR CANADIAN T GROUPS AND TABLE 23C (MALES) FOR U.S. GROUPS. FROM THIS, FIND THE EXPECTED CLAIMS FOR THE CLASS, EQUAL TO (@)(Q)(N), T T T WHERE @ IS THE AVERAGE LIFE AMOUNT IN 1,000°S, AND N IS THE T NUMBER OF LIVES IN CLASS "TT". THE EXPECTED CLAIM TOTAL FOR THE ENTIRE GROUP IS THEN THE SUM OF THE EXPECTED CLAIMS FOR EACH CLASS. AT THIS POINT, A CHECK SHOULD BE MADE TO INSURE THAT THE

AT THIS POINT, A CHECK SHOULD BE MADE TO INSURE THAT THE AVERAGE Q INCREASES AS THE LIFE AMOUNT CLASS INCREASES. IF T THERE IS NOT A REASONABLE INCREASING RELATIONSHIP, THEN THE METHOD IS INVALID.

- 2 (3) CALCULATE (1000)(SS((N)(@)(Q))) WHERE SS IS A SUMMATION T T T SYMBOL (CAPITAL SIGMA), N IS THE NUMBER OF LIVES IN AMOUNT CLASS "TT", @ IS THE AVERAGE LIFE AMOUNT FOR THAT CLASS IN T 1000'S, AND Q IS THE AVERAGE Q FOR THAT CLASS.
- (4) THE AVERAGE Q FOR THE ENTIRE GROUP IS FOUND BY DIVIDING THE TOTAL EXPECTED CLAIMS BY THE TOTAL VOLUME IN 1000'S. Q IS EXPRESSED AS, SAY, 3.16 DEATHS PER 1000. THE PROBABILITY OF DEATH IS THEN .00316, AND THE PROBABILITY OF SURVIVAL, P, IS 1 - .00316, OR .99684.
- (5) TAKE THE SQUARE ROOT OF STEP (3) TIMES STEP (4). THIS IS THE STANDARD DEVIATION OF CLAIM AMOUNT.
- (6) A STOP LOSS IS USUALLY EXPRESSED AS X% OF BILLED PREMIUMS, OR, SAY, \$S.L. IF THE EXPECTED CLAIMS FOR THE ENTIRE GROUP ARE WRITTEN AS E.C., STEP (5) AS S.D., AND THE LEVEL AT WHICH LOSSES ARE TO BE STOPPED AS S.L., THEN FIND Z WHERE

 $Z = (S_{\circ}L_{\circ} - E_{\circ}C_{\circ}) / S_{\circ}D_{\circ}$ 

(7) USING THE TABLE OF NORMAL AREAS AND ORDINATES, INTERPOLATE IN THE ""P(Z)"" COLUMN TO OBTAIN A VALUE CORRESPONDING TO Z.

1. STOP-LOSS PREMIUMS FOR LIFE INSURANCE (CONT'D)

(8) USING THE SAME TABLE, INTERPOLATE IN THE ""F(Z)" COLUMN TO OBTAIN A VALUE CORRESPONDING TO Z.

#### (9) CALCULATE THE NET STOP-LOSS PREMIUM, WHICH IS EQUAL TO

(S.D.)((STEP 7) - (Z)(.50000 - (STEP 8)))

(10) MULTIPLY THE NET STOP-LOSS PREMIUM FROM STEP 9 BY A FACTOR SELECTED FROM THE FOLLOWING TABLE.

STOP-LOSS LEVEL AS	
% OF EXPECTED CLAIMS	FACTOR
110%	1.11
120%	1.14
130%	1.19
140%	1.23
150%	1.30
160%	1.38
170%	1.46

# N. GROUP PENSION BASIC CALCULATIONS

THE PRINCIPAL CURRENT MEANS OF PERFORMING BASIC ACTUARIAL CALCULATIONS FOR GROUP PENSION BUSINESS INVOLVES THE USE OF THE COMPUTER PENSION VALUATION SYSTEM AND THE IBM SYSTEM/360 COMPUTER. THIS CALCULATION SYSTEM, ALSO CALLED "PENVAL", WAS PURCHASED BY THE SUBJECT COMPANY FROM COMPASS, INC. OF NASHVILLE, TENNESSEE (A FIRM OF COMPUTER CONSUL-TANTS INVOLVED IN THE DEVELOPMENT AND MARKETING OF ACTUARIAL, SCIENTI-FIC, AND BUSINESS COMPUTATION SYSTEMS).

THE SYSTEM PROVIDES FOR PROCESSING, AS REQUIRED, OF PROBABILITIES OF DEATH, WITHDRAWAL, AND RETIREMENT; SALARY SCALES; COMMUTATION FUNC-TIONS, INCLUDING MULTIPLE DECREMENTS; AND VARIABLE BENEFIT AND OUTPUT SPECIFICATIONS. IT CONTAINS AN EXTENSIVE LIBRARY OF TABULAR DATA AND PROCEDURAL ROUTINES, WRITTEN IN FORTRAN IV G. INPUT AND OUTPUT SPECI-FICATIONS ARE ENTERED BY PUNCHED CARDS.

THE SYSTEM IS ADEQUATE FOR PRESENT AND ANTICIPATED FUTURE NEEDS. IT IS CONVENIENT TO USE, AND THE NORMAL AVAILABILITY OF RESULTS ON AN OVERNIGHT BASIS IS SATISFACTORY. SPECIAL REQUESTS FOR MORE RAPID SERVICE CAN USUALLY BE ACCOMMODATED, AND SHOULD BE EVEN MORE READILY COMPLETED WHEN THE COMPUTER CORE CAPACITY HAS BEEN INCREASED AND THE MULTI-PROGRAMMING CAPABILITY EXTENDED. AN ADEQUATE DEGREE OF FLEXI-BILITY IN TERMS OF OUTPUT FORMAT CHOICES HAS BEEN PROVIDED. THE DOCU-MENTATION IS GENERALLY ADEQUATE, ALTHOUGH OCCASIONAL PROBLEMS ARE ENCOUNTERED IF UNUSUAL PROCESSING IS ATTEMPTED.

THE AVERAGE DAILY COMPUTER TIME REQUIREMENT IS 30 MINUTES, PLUS OR MINUS POSSIBLY 10 MINUTES.

NO PRESSING NEED WAS IDENTIFIED FOR THE USE OF 2260 VISUAL DISPLAY UNITS FOR THIS SYSTEM. IMPROVED SYSTEM OPERATIONAL CONTROL COULD RESULT FROM THE CONVERSION FROM FORTRAN TO PL/1, AS PL/1 IS THE MORE WIDELY USED PROGRAMMING LANGUAGE IN THE SUBJECT COMPANY. NO CURRENT PRIORITY, HOWEVER, IS BEING GIVEN TO THIS POSSIBLE TRANSLATION TASK, EVEN THOUGH SOME IBM PACKAGE PROGRAMS ARE AVAILABLE.

BECAUSE OF THE FOREGOING CONSIDERATIONS AND ENVIRONMENT, NO PROPOSAL IS BEING CURRENTLY MADE IN THIS RESEARCH INVESTIGATION FOR THE DESIGN AND DEVELOPMENT OF BASIC ACTUARIAL CALCULATION ROUTINES FOR GROUP PENSION BUSINESS. THE RECOMMENDED FRAMEWORK, HOWEVER, PROVIDES FOR THE INCORPORATION OF ROUTINES IN THIS AREA WHEN AND AS NEEDED AND JUSTIFIED.
# O. ACTUARIAL LIBRARY REFERENCE TABLES

AS NOTED EARLIER IN CHAPTER X , THE MAINTENANCE OF A LIBRARY OF ACTU-ARIAL REFERENCE TABLES IS PLANNED. USES OF THIS FILE INCLUDE THE PRIN-CIPAL ACTIVITY OF PROVIDING THE REQUIRED RATES AND VALUES FOR BUSINESS ADMINISTRATION, VALUATION, AND EXPERIMENTAL PURPOSES.

ACCORDINGLY, THE MAIN PROCEDURAL LOGIC ASSOCIATED WITH THE USE OF THESE FILES INVOLVES THE TABLE REFERENCE FOR FACTORS, GIVEN A SPECIFIC TABLE SEARCH ARGUMENT. FACILITIES ARE ALSO REQUIRED FOR SITUATIONS IN WHICH THE REQUESTED VALUES ARE NOT FOUND, INCLUDING THE AUTOMATIC USE OF BASIC ACTUARIAL CALCULATION EQUATIONS, WHERE PRACTICAL, TO COMPUTE THE MISSING VALUES, AND THE ADDITION OF THESE VALUES TO THE LIBRARY FILE.

A.91

P. MATHEMATICAL AND OTHER TABLES AND INFORMATION

AS NOTED EARLIER IN CHAPTER X , THE MAINTENANCE OF A FILE OF MATHEMA-TICAL AND OTHER TABLES AND INFORMATION IS PLANNED, AND SOME POSSIBLE EXAMPLES WERE CITED.

THE MAIN PROCEDURAL LOGIC ASSOCIATED WITH THE USE OF THESE FILES INVOLVES REFERENCING FOR FACTORS AS REQUIRED. CLOSELY-RELATED ROUTINES INCLUDE, FOR EXAMPLE, SELECTED INTERPOLATION FORMULAE TO OPERATE ON THE SELECTED TABULAR VALUES. (E.G., THE INTERPOLATIONS OF NORMAL AREA AND ORDINATE TABLE SELECTED VALUES, AS DESCRIBED IN SECTION M ON GROUP INSURANCE BASIC CALCULATIONS).

A.92

## NORMAL AREAS AND ORDINATES

		NUR	MAL AR	EAS ANU	URDINATES			A.9.	3
Z	P(Z)	F(Z)	Z	P(Z)	F(Z)	Z	P(Z)	F(Z)	
• 00	.39894	.00000	.45	.36053	.17364	- 90	.26609	31594	
.01	.39892	.00399	.46	.35889	.17724	. 91	26369	.31859	
.02	.39886	.00798	.47	.35723	.18082	. 92	.26129	32121	
.03	.39876	.01197	. 48	.35553	.18439	.93	25888	.32381	
.04	.39862	.01595	.49	.35381	.18793	.94	.25647	32639	
			• • •			• • •		002000	
۰05	.39844	.01994	.50	.35207	.19146	. 95	.25406	.32894	
.06	.39822	.02392	.51	.35029	.19497	. 96	.25164	.33147	
.07	.39797	.02790	.52	.34849	.19847	.97	°24923	.33398	
• 08	.39767	.03188	.53	.34667	.20194	. 98	.24681	<b>.</b> 33646	
.09	.39733	.03586	• 54	.34482	<b>.</b> 20540	. 99	。24439	.33891	
-10	.39695	.03983	• 55	<b>.</b> 34294	.20884	1.00	.24197	.34134	
.11	• 39654	<b>.</b> 04380	.56	.34105	.21226	1.01	°53955	<b>.</b> 34375	
•15	.39608	.04776	.57	。33912	.21566	1.02	.23713	.34614	
.13	.39559	.05172	• 58	.33718	.21904	1.03	.23471	<b>.3485</b> 0	
. 14	<b>39505</b>	.05567	• 59	.33521	₀22240	1.04	.23230	<b>.</b> 35083	
	~~ ~ ~								
.15	.39448	.05962	.60	.33322	°22575	1.05	.22988	.35314	
.16	.39387	.06356	.61	.33121	.22907	1.06	.22747	.35543	
.17	.39322	.06749	<u>.</u> 62	.32918	°53532	1.07	°52206	.35769	
.18	<u>.</u> 39253	•07142	.63	.32713	°23262	1.08	°5256°	• 35993	
.19	.39181	.07535	• 64	<b>.</b> 32506	.23891	1.09	°505°	.36214	
.20	.39104	.07926	.65	.32297	.24215	1.10	.21785	.36433	
• 21	<b>.</b> 39024	.08317	•66	°35086	°24232	1.11	<u>。21546</u>	<b>.36</b> 650	
•22	.38940	.08706	.67	.31874	·24857	1.12	.21307	<b>.</b> 36864	
°53	<b>.</b> 38853	<u>.09095</u>	•68	<b>.</b> 31659	.25175	1.13	°21069	.37076	
• 24	.38762	-09483	.69	.31443	.25490	1.14	<b>.</b> 20831	.37286	
.25	.38667	.09871	.70	.31225	.25804	1.15	20594	. 37493	
.26	.38568	.10257	.71	31006	.26115	1.16	20357	37698	
.27	.38466	10642	.72	.30785	26424	1,17	20121	37900	
28	.38361	.11026	.73	- 30563	- 26730	1.18	. 19886	38100	
29	.38251	.11409	.74	30339	27035	1.19	.19652	-38298	
			•••		021035		UL/OJE		
<b>.</b> 30	.38139	.11791	.75	<b>.</b> 30114	°24334	1.20	.19419	•38493	
.31	<b>.</b> 38023	<ul><li>12172</li></ul>	. 76	°5882	°57637	1.21	.19186	.38686	
<u>.</u> 32	<b>.</b> 37903	<b>₀12552</b>	.77	°59629	.27935	1.22	.18954	.38877	
.33	.37780	.12930	。78	.29431	.28230	1.23	.18724	.39065	
₀34	.37654	.13307	.79	.29200	.28524	1.24	.18494	.39251	
. 35	. 37524	13683	- 80	- 28969	28814	1 25	19265	20425	
36	27201	14058	. 81	28727	20102	1.76	12027	20417	
37	. 37255	14431	83	20101	20200	1020	17010	0 7 7 0 L / 2 0 7 0 4	
22	37116	14802	. 22	28240	027J07 20672	1021	01/01U 17505	• J7 (70 20077	
. 20	36973	15172	8A	°20207 79024	° 27075	1 20	17240	· 599/3	
017		017113	0 U S	0 L U U J 4	@ ムップリリ	1027	000110	04UI41	
•40	.36827	.15542	°85	.27798	<b>.</b> 30234	1.30	.17137	<b>₀</b> 40320	
•41	<b>.</b> 36678	.15910	<b>.</b> 86	°27262	<b>.</b> 30511	1.31	.16915	•40490	
•42	<b>.</b> 36526	.16276	.87	.27324	.30785	1.32	.16694	<b>•</b> 40658	
• 43	.36371	.16640	. 88	<b>.</b> 27086	.31057	1.33	.16474	•40824	
.44	.36213	.17003	. 89	.26848	.31327	1.34	.16256	.40988	

## NORMAL AREAS AND ORDINATES

			برید هانه میرد میک میده سرد خرد			-		
Z	P(Z)	F(Z)	Z	P(Z)	F(Z)	Z	P(Z)	F(Z)
1.35	.16038	41149	1.80	.07895	46407	2 25	03176	1.0770
1.36	15822	. 41309	1.91	07754	240407 46495	2 26	02102	49900
1.27	156022		1 07	07616	07070J	2020	•03103	•40009
1 30	15305	********	1.02	°0/014	• 40 702	2.021	.03034	•48840
1.00	·10090	-41021	1.83	01411	°40638	2.28	o02965	•48870
1.39	.15183	.41774	1.84	.07341	.46712	2.29	•02898	•48899
1.40	.14973	•41924	1.85	.07206	.46784	2.30	<b>°</b> 02833	•48928
1.41	.14764	<b>.</b> 42073	1.86	.07074	.46856	2.31	.02768	.48956
1.42	.14556	<b>.</b> 42220	1.87	.06943	.46926	2.32	02705	48983
1.43	.14350	. 42364	1.88	06814	46995	2.33	.02643	.49010
44	14146	42507	1.89	.06687	47042	2 24	02592	69036
	• • • • • •	0.2301	¥907		84100Z	20,04	0 Z J Z	• • • • 0 5 0
1-45	13943	. 42647	1.90	06562	67120	2 25	02522	60061
1.46	12742	42041	1 01	04/20	671220	2000	• 02 5 2 2	· 49001
1 47	12642	42100 42000	1071	· U0439	041173 17257	2.00	.02465	•49086
1.041	013342	******	1.92	.06516	.41251	2.31	.02406	.49111
1.48	.13344	•43096	1.95	06195	.47320	2.38	o2349	<b>.</b> 49134
1.49	.13147	.43189	1.94	。06077	.47381	2.39	°05584	•49158
1.50	.12952	。43319	1.95	°02226	.47441	2.40	o2239° •	•49180
1.51	.12758	。43448	1.96	.05844	°47200	2.41	.02186	•49202
1.52	.12566	。43574	1.97	.05730	.47558	2.42	.02134	.49224
1.53	.12376	。43699	1.98	.05618	.47615	2.43	°02083	. 49245
1.54	.12188	.43822	1.99	₀05508	.47670	2.44	.02033	49266
					•••••	2011	002000	0.7200
1.55	.12001	.43943	2.00	- 05399	-47725	2-45	. 01984	. 49286
1.56	.11816	.44062	2-01	.05292	. 47778	2 46	01026	49205
1.57	11632	44170	2 02	05196	671110	2040	01900	·********
1 50	11450	44217	2.02	05000	67031	2041	• UI007	• 49 3 2 4
1 50	11270	***275	2.00	° 00002	04100Z	2040	.01842	.49343
1007	0112 <i>1</i> U	• <del>• • • •</del> • 0 0	2004	.04980	.41932	2.49	.01/9/	.49361
1 60	11000	44520	2.05	0/070				
1.00	.11092	•44520	2.05	.04879	•47982	2.50	.01753	•49379
1.01	.10915	•44650	2.06	• 04 / 80	°48030	2.51	.01709	•49396
1.62	• 10741	.44738	2.07	.04682	。48077	2.52	.01667	•49413
1.63	.10567	。44845	2.08	<b>.</b> 04586	.48124	2.53	.01625	•49430
1.64	<b>.</b> 10396	<b>.</b> 44950	2.09	o04491	.48169	2.54	.01585	.49446
1.65	.10226	•45053	2.10	o04398	.48214	2.55	.01545	.49461
1.66	<u>.10059</u>	.45154	2.11	.04307	.48257	2.56	.01506	.49477
1.67	。09893	<b>•</b> 45254	2.12	.04217	.48300	2.57	01468	49492
1.68	.09728	.45352	2.13	-04128	. 48341	2.58	.01431	49506
1.69	.09566	45449	2.14	.04041	48382	2.59	01304	×9500
				001011	\$ 1030L	60))	0 L J 74	047720
1.70	-09405	45543	2.15	. 03955	48477	2 60	01259	60576
1.71	.09246	45627	2 1 6	02071	40422	2000	01330	****
1.72	007240	45720	20LU 7 17	02700	040401 10500	2.01	•UI323	• 4774 ( / 05 / 0
1 72	00007	077120 45010	2 10	· UJ / 00	• 407UU	2.02	• UI 289	•4956()
1013	000000 00000	**J010 *E047	2.10	00100	048751	2.63	.01256	•49573
1014	° 00180	a 43901	2.19	.03626	°48214	2.64	.01223	.49585
	00/00		<b>.</b>			_		
1.75	-U8028	.45444	2.20	.03547	•48610	2.65	.01191	•49598
1.76	08478	•46080	2.21	<b>.</b> 03470	。48645	2.66	.01160	•49609
1.77	。08329	•46164	2.22	.03394	.48679	2.67	.01130	.49621
1.78	.08183	<b>°46</b> 246	2.23	.03319	.48713	2.68	.01100	.49632
1.79	.08038	•46327	2.24	.03246	.48745	2.69	.01071	.49643

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## NORMAL AREAS AND ORDINATES

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	NORMAL AREAS AND ORDINATES A.95								
Z	P(Z)	F(Z)	Z	P(Z)	F(Z)	Z	P(Z)	F(Z)	
2.70	.01042	•49653	3.15	00279	.49918	3 60	00061	 (000/	
2.71	.01014	.49664	3.16	-00271	.49921	2 41	00001	» 47704	
2.72	.00987	49674	3,17	. 00262	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	2001	•00059	•49985	
2.73	-00961	49683	3.18	00202	**** 60026	3.02	.00057	•49985	
2.74	.00935	49603	3 10	00234 002((	• 49920	3.03	.00055	°49986	
2011	800755	0,000	2013	•00246	°49959	3.64	•00053	•49986	
2.75	•0090 <b>9</b>	<b>.</b> 49702	3.20	.00238	.49931	3.65	.00051	49987	
2.76	•00885	-49711	3.21	°00231	.49934	3.66	.00049	49987	
2.77	.00861	•49720	3.22	.00224	.49936	3.67	.00047	40000	
2.78	.00837	.49728	3.23	-00216	49938	3.69	00044	· · · · · · · · · · · · · · · · · · ·	
2.79	.00814	.49736	3.24	.00210	.49940	3.69	.00048	•49989 •49989	
2.80	.00792	. 49744	3,25	.00203	49042	2 70	00042	(0000	
2.81	.00770	49752	3.26	00106	40044	2010	•00042	•49989	
2.82	-00748	.49760	3.27	00100	677777 60044	2011	.00041	.49990	
2.83	.00727	49767	2 20	00190	*******	2.12	.00039	.49990	
2.84	-00707	40774	3 20	00130	• 4 7 7 4 8	3013	.00038	•49990	
2001	800101	84717 <del>4</del>	2027	.00178	°44420	3.14	•00037	.49991	
2.85	.00687	.49781	3.30	.00172	.49952	3.75	-00035	49991	
2.86	°00668	•49788	3.31	.00167	. 49953	3.76	.00034	40002	
2.87	.00649	.49795	3.32	.00161	49955	3.77	.00033	87777 <u>7</u>	
2.88	.00631	.49801	3.33	.00156	49957	2 79	0000000	******	
2.89	.00613	<b>.</b> 49807	3.34	.00151	° 49958	3.79	•00031 •00030	°49992 °49992	
2.90	.00595	.49813	3,35	.00146	49960	3 90	00000	(	
2.91	.00578	49819	3.36	-00141	49900	2.00	•00029	•49993	
2.92	-00562	- 49825	2 27	00124	• <del>•</del> • • • • • • • • • • • • • • • • •	2.01	.00028	.49993	
2.93	-00545	40021	7 70	• 00130	******	3.82	.00027	•49993	
2.94	00530	* 70 J L	2.20	.00132	.49964	3.83	o00026	<b>.</b> 49994	
2001	8000000	0,000	2027	°00127	•49965	3.84	.00025	<b>.</b> 49994	
2.95	<b>0051</b> 4	-49841	3.40	.00123	.49966	3.85	.00024	49994	
2.96	o00499	•49846	3.41	.00119	. 49968	3-86	-00023	60004	
2.97	o00485	<b>•</b> 49851	3.42	.00115	49969	3.87	00022	40005	
2.98	.00471	<b>•</b> 49856	3.43	.00111	.49970	3.88	00022	49999 40005	
2.99	.00457	.49861	3.44	.00107	49071	2 00	.00021	• 49995	
3 00	00440					2009	•00021	•49995	
3°00	.00443	·49865	3.45	.00104	۵49972°	3.90	<b>.</b> 00020	.49995	
3.01	.00430	•49869	3.46	.00100	.49973	3.91	.00019	.49995	
3.02	.00417	•49874	3.47	<b>00097</b>	.49974	3.92	.00018	.49996	
3.03	o0405 د	<b>.</b> 49878	3.48	.00094	<b>•</b> 49975	3.93	.00018	49996	
3.04	.00393	•49882	3.49	.00090	。49976	3.94	.00017	.49996	
3.05	.00381	• 49886	3.50	.00087	。49977	3.95	.00016	49996	
3.06	o0370	.49889	3.51	°00084	.49978	3,96	-00016	.40006	
3.07	°00328	.49893	3.52	.00081	49978	3,97	.00015	6 T 7 7 7 7 0 40004	
3.08	.00348	•49897	3.53	.00079	49979	3.00	00015	**7770 40007	
3.09	.00337	•49900	3.54	.00076	•49980	3.99	.00014	•47771 •49997	
3.10	°00327	.49903	3.55	.00073	49981				
3.11	.00317	.49906	3.56	.00071	. 40081				
3.12	.00307	.49910	3,57	.00049	- 4770L - 40003				
3.13	.00298	49912	3,50	000000	******* 4000*				
3.14	-00288	40014	200 2 EO	a00000	**************************************				
		0 7 7 7 1 O	ファウタ	°00003	*****3				

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# R. BUSINESS STATUS AND ACTIVITY INFORMATION - INDIVIDUAL

A SUBSTANTIAL PORTION OF THE RECORDKEEPING AND DATA PROCESSING WORK WITH RESPECT TO INDIVIDUAL LIFE, ANNUITY, AND HEALTH INSURANCE IS PERFORMED BY COMPUTER SYSTEMS. WHILE THE DIRECT RESPONSIBILITY FOR THE FILES AND OPERATING PROCEDURES RESTS WITH THE INDIVIDUAL INSURANCE ADMINISTRATION DEPARTMENTS, THERE IS A SUBSTANTIAL AMOUNT OF INFORMATION INVOLVED WHICH IS OF AN ACTUARIAL NATURE, AND THEREFORE AS SUCH WARRANTS CONSI-DERATION HERE.

THE CURRENT PROCESSING ROUTINES FOR THE INDIVIDUAL LIFE AND ANNUITY MASTER FILE ARE PERFORMED DAILY USING A BATCHED-TRANSACTION APPROACH. REQUESTS FOR MASTER FILE INFORMATION FOR USE IN TRANSACTION PREPARATION ARE PROCESSED AT THE SAME TIME, WITH THE RESULT THAT OVERNIGHT DELAYS ARE INEVITABLE. THE MASTER FILE IS STORED ON 7070 MAGNETIC TAPE.

A CURRENT PROJECT INVOLVES THE TRANSFER OF THE MASTER FILE TO DIRECT ACCESS STORAGE IN THE 360 COMPUTER. IN THIS ENVIRONMENT, IT CAN BE USED ALONG WITH TERMINAL DEVICES TO PRODUCE RESPONSES TO INFORMATION REQUESTS; MOREOVER, PAPER OR HARD-COPY OUTPUT IN SOME SITUATIONS MAY BE ADVANTAGEOUSLY REPLACED BY DISPLAYS ON 2260 VISUAL DISPLAY UNITS.

ONE COMMON PRACTICE AT PRESENT INVOLVES THE PRINTING OF ALL MASTER FILE DATA FOR A SPECIFIC POLICY, FOLLOWED BY THE MANUAL CALCULATION, USING PRINT-OUT DATA, OF SUCH INFORMATION AS THE TOTAL CASH VALUE OF THE POLICY AS OF A PARTICULAR DATE. THIS APPROACH SHOULD BE REPLACED BY A USER-ORIENTED METHOD IN WHICH THE COMPUTER PERFORMS THE CALCULATIONS (USING ACTUARIAL AND OTHER FACTORS), AND THE USER RECEIVES THE FINAL INFORMATION IN A FORM BETTER SUITED TO HIS NEEDS.

SINCE THE DISPLAY OF ACTUARIAL DATA WHICH IS EITHER DIRECTLY OBTAINED FROM MASTER FILE RECORDS OR DERIVED BY THE PROCESSING OF SUCH RECORDS, IT IS FELT JUSTIFIED TO OUTLINE HEREIN SOME OF THE POSSIBLE DATA DIS-PLAYS. THESE DISPLAYS ARE CONTAINED IN THE SECTION OF CHAPTER X ENTITLED \*\*DATA RETRIEVAL AND PROCESSING METHODS.\*\*

ANOTHER IMPORTANT POTENTIAL USE OF MASTER FILE DATA DEALS WITH THE EXTRACTION OF DETAILED RECORDS POSSESSING CERTAIN PARAMETERS OF INTE-REST (E.G., PLAN CODES, AGES AT ISSUE, OCCUPATIONS, ETC.), AND THE SUBSEQUENT USES OF THESE DATA IN DETAIL OR SUMMARY FORM AS GOVERNED BY THE RELATED OBJECTIVES. THE IMPLICATIONS OF THIS TYPE OF MASTER FILE USE ARE THAT THE PARAMETER SPECIFICATIONS MUST BE CAPABLE OF MAJOR ALTE-RATION FROM TIME TO TIME, AS DETERMINED BY THE UNDERLYING PURPOSE, AND THAT THE SYSTEM, IN TERMS OF FILE ORGANIZATION AND INVENTORYING LOGIC, MUST BE ABLE TO RESPOND IN AN EFFECTIVE, PRACTICAL, AND JUSTIFIABLE TIME INTERVAL.

THE PRECEDING COMMENTS ON HASTER FILE USES ARE EQUALLY APPLICABLE TO ACTIVITY RECORDS (I.E., NEW BUSINESS, CHANGES, AND TERMINATIONS).

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# S. BUSINESS STATUS AND ACTIVITY INFORMATION - GROUP INSURANCE A.97

THE GROUP INSURANCE MASTER FILE IS LOCATED IN DIRECT ACCESS STORAGE UNITS OF THE 360 COMPUTER, AND IS PROCESSED DAILY USING A BATCHED-TRANSACTION APPROACH. INFORMATION REQUESTS ARE PROCESSED AT THE SAME TIME.

INFORMATION RESPONSES BY MEANS OF 2260 VISUAL DISPLAY UNITS MAY BECOME ADVANTAGEOUS FOR AT LEAST SOME FORMS OF INQUIRY, BECAUSE OF THE MUCH-REDUCED TIME INTERVALS BETWEEN REQUESTS AND RESPONSES. THE EXTENSIVE-NESS OF THE DATA MAY REQUIRE MORE THAN ONE REPLY DISPLAY, BUT THIS SHOULD NOT CREATE ANY SERIOUS PRACTICAL PROBLEM. THE NEED FOR HARD-COPY INFORMATION REPLIES WILL NEED CAREFUL EVALUATION. SOME EXAMPLES OF THESE DISPLAYS ARE CONTAINED IN THE SECTION OF CHAPTER X ON "DATA RETRIEVAL AND PROCESSING METHODS."

ANOTHER IMPORTANT POTENTIAL USE OF THE GROUP INSURANCE MASTER RECORDS INVOLVES THE EXTRACTION OF DETAILED RECORDS POSSESSING CERTAIN PARA-METERS OF INTEREST (E.G., BENEFIT TYPE, EMPLOYEE CLASS CODES, ETC.), AND THE SUBSEQUENT USES OF THESE DATA IN DETAIL OR SUMMARY FORM AS REQUIRED. THE IMPLICATIONS OF THIS FORM OF FILE USE ARE THAT THE SELEC-TION PARAMETERS BE CAPABLE OF EASY ALTERATION, AND THAT THE SYSTEM RESPONSE TIME BE EFFECTIVE, PRACTICAL, AND JUSTIFIABLE.

THE PRECEDING COMMENTS ON MASTER FILE USES ARE EQUALLY APPLICABLE TO ACTIVITY RECORDS (I.E., NEW BUSINESS, CHANGES, TERMINATIONS, AND HEALTH CLAIMS).



T. BUSINESS STATUS AND ACTIVITY INFORMATION - GROUP PENSION A.98

THE GROUP PENSION MASTER FILE IS STORED ON MAGNETIC TAPE AND IS UPDATED DAILY IN A BATCHED-TRANSACTION MODE ON THE 7070. PLANS FOR COMPUTER SYSTEM DEVELOPMENTS IN THE IMMEDIATE FUTURE DO NOT INCLUDE THE TRANSFER OF GROUP PENSION SYSTEM LOGIC OR DATA FILES TO THE 360 COMPUTER.

IN THE EVENT THAT CONVERSION OF THE FILES TO THE 360 BECAME A HIGHER-PRIORITY TASK, INFORMATION RESPONSES BY MEANS OF 2260 VISUAL DISPLAY UNITS COULD BECOME ADVANTAGEOUS FOR AT LEAST SOME FORMS OF INQUIRY, BECAUSE OF THE MUCH-REDUCED TIME INTERVALS BETWEEN REQUESTS AND RES-PONSES. SOME EXAMPLES OF THESE DISPLAYS ARE CONTAINED IN THE SECTION OF CHAPTER X ON \*\*DATA RETRIEVAL AND PROCESSING METHODS.\*\*

ANOTHER IMPORTANT POTENTIAL USE OF THE GROUP PENSION MASTER RECORDS (IN COMMON WITH INDIVIDUAL AND GROUP INSURANCE RECORDS) INVOLVES THE EXTRAC-TION OF DETAILED RECORDS POSSESSING CERTAIN PARAMETERS OF INTEREST (E.G., PLAN TYPE, BENEFIT PROVISIONS, ETC.), AND THE SUBSEQUENT USES OF THESE DATA IN DETAIL OR SUMMARY FORM AS REQUIRED. THE IMPLICATIONS OF THIS TYPE OF FILE USE ARE THE NEEDS FOR EASE OF PARAMETER DEFINITION AND CHANGE, AND FOR EFFECTIVE, PRACTICAL, AND JUSTIFIABLE SYSTEM RESPONSE TIME.

THE PRECEDING COMMENTS ON MASTER FILE USES ARE EQUALLY APPLICABLE TO ACTIVITY RECORDS (I.E., NEW BUSINESS, CHANGES, WITHDRAWALS, DEATHS, AND RETIREMENTS).

THE USE OF 2260 TERMINALS FOR INQUIRY INTO THE GROUP PENSION SYSTEM COULD PROVIDE AN EFFECTIVE MEANS FOR ON-LINE SYSTEM AUDITING DURING THE YEAR, WITH THE OBJECTIVE OF REDUCING THE YEAR-END PROBLEMS ASSOCIATED WITH STATISTICAL AND VALUATION INFORMATION. W. RESEARCH - INDIVIDUAL

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# 1. EXPERIMENTAL CALCULATIONS OF PREMIUMS AND BENEFITS

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2. ASSET SHARE CALCULATIONS

3. MORTALITY AND MORBIDITY STUDIES

4. PERSISTENCY INVESTIGATIONS

5. SIMULATIONS AND PROJECTIONS

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X. RESEARCH - GROUP

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## 1. EXPERIMENTAL CALCULATIONS OF PREMIUMS AND BENEFITS

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2. ASSET SHARE CALCULATIONS

3. MORTALITY AND MORBIDITY STUDIES

4. PERSISTENCY INVESTIGATIONS

5. SIMULATIONS AND PROJECTIONS

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# APPENDIX B

B.1

## EXAMPLES OF 2260 DISPLAYS ILLUSTRATING DATA RETRIEVAL AND PROCESSING METHODS OF THE ACTUARIAL INFORMATION SYSTEM.

APPENDIX B. TABLE OF CONTENTS	B.2	
SUBJECT	DISPLAY SERIES	
OPERATOR SIGN-ON AND DISPLAY TYPE SELECTION	1.	
DETAILED (DISPLAY-BY-DISPLAY) METHOD OF PROCESSING ACTIVITY SELECTION		
BASIC ACTUARIAL CALCULATIONS	2.1.	
ACTUARIAL LIBRARY REFERENCE TABLES	2.2.	
MATHEMATICAL AND OTHER TABLES AND INFORMATION	2.3.	
BUSINESS STATUS AND ACTIVITY INFORMATION	2.4.	
RESEARCH	2.5.	

SUMMARY METHOD OF PROCESSING ACTIVITY SELECTION

BASIC ACTUARIAL CALCULATIONS	3.
ACTUARIAL LIBRARY REFERENCE TABLES	3.
MATHEMATICAL AND OTHER TABLES AND INFORMATION	3.
BUSINESS STATUS AND ACTIVITY INFORMATION	3.
RESEARCH	3.

# SYMBOL CONVENTIONS USED

> THIS SYMBOL AT THE BEGINNING OF THE OPERATOR'S REPLY IN EACH DISPLAY DENOTES THE START SYMBOL OF DATA BEING TRANSMITTED FROM THE 2260 KEYBOARD TO THE COMPUTER. THE ACTUAL SYMBOL AS IT APPEARS ON THE 2260 SCREEN IS A SOLID TRIANGLE, WITH THE SAME ORIENTATION.

< THIS SYMBOL, USED IN DISPLAY 3.2.3.1., DENOTES A NEW LINE. THE ACTUAL SYMBOL AS IT APPEARS ON THE 2260 SCREEN IS A SOLID TRIANGLE WITH A HORIZONTAL BASE AND A VERTICAL RIGHT-HAND SIDE. DISPLAY 1. OPERATOR SIGN-ON WITH SECURITY CODE

### OPERATOR SIGN-ON WITH SECURITY CODE

ENTER NEXT DISPLAY NUMBER/SECURITY CODE 2. DETAILED METHOD OF PROCESSING ACTIVITY SELECTION 3. SUMMARY METHOD OF PROCESSING ACTIVITY SELECTION >2/WXYZ\_

DISPLAY 2. DETAILED METHOD OF PROCESSING ACTIVITY SELECTION

DETAILED METHOD OF PROCESSING ACTIVITY SELECTION

ENTER LINE NUMBER 1. BASIC ACTUARIAL CALCULATIONS 2. ACTUARIAL LIBRARY REFERENCE TABLES 3. MATHEMATICAL AND OTHER TABLES AND INFORMATION 4. BUSINESS STATUS AND ACTIVITY INFORMATION 5. RESEARCH >1\_

DISPLAY 2.1. BASIC ACTUARIAL CALCULATIONS

### BASIC ACTUARIAL CALCULATIONS

ENTER LINE NUMBER 1. INTEREST AND ANNUITIES CERTAIN CALCULATIONS 2. INDIVIDUAL LIFE AND ANNUITY BASIC CALCULATIONS 3. INDIVIDUAL HEALTH INSURANCE BASIC CALCULATIONS 4. GROUP INSURANCE BASIC CALCULATIONS 5. GROUP PENSION BASIC CALCULATIONS >2\_





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DISPLAY 2.1.2. INDIVIDUAL LIFE AND ANNUITY BASIC CALCULATIONS B.4

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INDIVIDUAL LIFE AND ANNUITY BASIC CALCULATIONS

ENTER LINE NUMBER(S) 1. SINGLE LIFE FUNCTIONS 2. MULTIPLE LIFE FUNCTIONS 3. MULTIPLE DECREMENT FUNCTIONS >1\_

DISPLAY 2.1.2.1. SINGLE LIFE FUNCTIONS

SINGLE LIFE FUNCTIONS IND. LIFE & ANN.; SINGLE LIFE

ENTER LINE NUMBER(S) 1. THE MORTALITY TABLE 2. ANNUITY BENEFITS 3. INSURANCE BENEFITS 4. NET ANNUAL PREMIUMS 5. RESERVES 6. DIVIDENDS 7. GROSS PREMIUMS 8. NON-FORFEITURE BENEFITS >3\_

DISPLAY 2.1.2.1.3. INSURANCE BENEFITS

INSURANCE BENEFITS IND. LIFE & ANN.; SINGLE LIFE; INS. BENEFITS

\_ \_ \_ \_ \_ \_

ENTER LINE NUMBER 1. BASIC DATA 2. BASIC CALCULATIONS 3. SUPPLEMENTARY BASIC CALCULATIONS (AS NECESSARY) 4. INSURANCE BENEFIT CALCULATIONS (AS NECESSARY) 5. VARYING INSURANCES (AS NECESSARY) >5\_

ENTER E	INSURAN QUATION	CES (AS	NECESSA	RY) IN IN	ID. INS. & IS. BENEFIT	ANN.; SINGL S; VARYING	.E LIFE; INS.	
1. (IA) )	<	2 <b>. (</b> IA	1 )	3. (I-A) N X	4。(I	- A) 5 X	- 1 (IA) - X:N	
(M) 6. (I >2_	A) X	(M 7。(I	A) X	8. (IA) X				
	DISPL	AY 2.1.	2-1-3-5-;	2. CALCUL	ATION PARA	METERS		
EQUATION ENTER VA	LUATION	1 - = X:N BASIS/1 TO 50 B	{R - R X > NTEREST / 10,10/1	- (N)( (*N RATE/X VA L5/20/TO 6	M ))/D X+N X LUES/N VAL 0/TO 65/TO	UES 70_		
		AY 2.1.2	1.3.5.2	2. COMPUTI	ER RESPONSI	E -		
SELECTED	DI SPL.	AY 2.1.2 L	<pre>2.1.3.5.2 </pre> <pre>{R - R X X X</pre>	2. COMPUT	ER RESPONSI	E - Mortality Interest	Y - 58CSO - 2.75%	
SELECTED EQUATION X N>	DI SPL : (IA) 10	AY 2.1.2 L	<pre>2.1.3.5.2 {R - R X X 5</pre>	2. COMPUT - (N)(1 (+N 20	ER RESPONSI M ))/D X+N X TO 60	E - Mortality Interest TO 65	Y - 58CSO - 2.75% TD 70	

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DISPLAY 2.2. ACTUARIAL LIBRARY REFERENCE TABLES

### ACTUARIAL LIBRARY REFERENCE TABLES

ENTER SECTION CODE		
1. INSURANCE PAR CANADA	0.	REINS. COS. INS. & ANN. PAR
2. INSURANCE PAR U.S.A.	9.	REINS. COS. INS. & ANN. NON-PAR
3. INSURANCE NON-PAR CANADA	10.	INDIVIDUAL HEALTH INSURANCE
4. INSURANCE NON-PAR U.S.A.	11.	GROUP LIFE INSURANCE PAR
5. ANNUITY PAR CANADA	12.	GROUP LIFE INSURANCE NON-PAR
6. ANNUITY PAR U.S.A.	13.	GROUP HEALTH INSURANCE
7. ANNUITY NON-PAR CANADA	14.	GROUP PENSIONS PAR
8. ANNUITY NON-PAR U.S.A.	15.	GROUP PENSIONS NON-PAR
>3_		

DISPLAY 2.2.3. INSURANCE SUB-GROUPS

INSURANCE SUB-GROUPS INS. NON-PAR CAN. ENTER LINE NUMBER 1. BASIC POLICIES (BASIC) 2. LEVEL TERM RIDERS (LTR) 3. HOME SECURITY RIDERS (HSR) 4. FAMILY INSURANCE RIDERS (FIR) 5. FAMILY PROTECTION RIDERS (FPR) 6. SUPPLEMENTARY BENEFITS (SUPP) >1\_

DISPLAY 2.2.3.1. RESERVE MORTALITY TABLES

RESERVE MORTALITY TABLES INS. NON-PAR CAN.; BASIC

ENTER RESERVE MORTALITY TABLE CODE 1. HM 2. AM(5) 3. CSO (1941) 4. CSO (1958) (CURTATE) 5. CSO (1958) (IMMEDIATE PAYMENT OF CLAIMS) 6. CET (1958) (CURTATE) 7. CET (1958) (IMMEDIATE PAYMENT OF CLAIMS) 58CET(CURT) 58CET(IPC) 53\_

В.6

DISPLAY 2.2.3.1.3. RESERVE INTEREST RATES

B.7

al she have a second

RESERVE INTEREST RATES INS. NON-PAR CAN.; BASIC; 41CSO ENTER RESERVE INTEREST RATE CODE 0. 2.25% 3. 3.00% 6.3.75% 4. 3.25 5. 3.50 1. 2.50 7. 4.00 9. 2.00 2. 2.75 >3\_ DISPLAY 2.2.3.1.3.3. ISSUE DATE RANGES ISSUE DATE RANGES INS. NON-PAR CAN.; BASIC; 41CSD; 3.00% ENTER LINE NUMBER TERM AND ORD. LIFE PREF. RISK 1. JUNE 1, 1950 TO JAN. 28, 1951 2. JAN. 29, 1951 TO FEB. 14, 1954 3. FEB. 15, 1954 TO MAR. 13, 1955 4. MAR. 14, 1955 TO MAR. 31, 1956 5. APR. 1, 1956 TO MAR. 31, 1957 6. APR. 1, 1957 TO JUNE 30, 1958 7. AUG. 15, 1960 TO SEP. 30, 1963 FAMILY PROTECTION POLICIES >4\_ DISPLAY 2.2.3.1.3.3.4. FINAL BASIS CODE SELECTION FINAL BASIS CODE SELECTION INS. NON-PAR CAN ; BASIC; 41CSO; 3.00%; ISSUED MAR. 14, 1955 TO MAR. 31, 1956 ENTER LINE NUMBER 1. SPECIAL PREFERRED RISK (MINIMUM 20,000) 333131 2. ORDINARY LIFE PREFERRED RISK 333030 3. DOUBLE INSURANCE 333031

333130

333130

333030

6. PENSION AND TERM >5\_

4. OTHER LIFE

5. ENDOWMENT

DISPLAY 2.2.3.1.3.3.4.5. ENDOWMENT PLAN SELECTION

ENDOWMENT PLAN SELECTION	INPUT-	MACHINE
ENTER LINE NUMBER	UUIPUI CUDE	CUDE
ENTER LINE NUMBER		
1. SINGLE LIFE	ENDT	200
2. JOINT LIFE	ENDT JOINT	201
3. SECURITY SAVINGS	SCRT SAVGS	204
4. ESTATE BUILDER - FIRST VERSION, UNTIL	OEST BEFOR	205
EXCHANGE DATE		
5. ESTATE BUILDER - FIRST VERSION, AFTER	DEST ENDT	206
EXCHANGE DATE - ENDOWMENT OPTION		
6. SECURITY BUILDER - UNTIL EXCHANGE DATE	SEC8 BEFOR	207
(CONTINUED)>1_		
	والمكار وبرد بيريد بمبد جيبه مرية مجب يريد مخد بيريد محد مرده خانه مجد بري	

DISPLAY 2.2.3.1.3.3.4.5. (CONT D) ENDOWMENT PLAN SELECTION

ENDOWMENT PLAN SELECTION (CONT D)	INPUT- OUTPUT CODE	MACHINE
ENTER LINE NUMBER		
1. SECURITY BUILDER - AFTER EXCHANGE DATE	SECB AFTER	208
2. PURE ENDOWMENT	ENDT PURE	209
3. MULTIPLE OPTION - LIFE 20	MOPT LIF20	210
4. MULTIPLE OPTION - DOUBLE ENDOWMENT	MOPT DENDT	211
5. ODD PLAN; POLICY NUMBERS REQUIRED	ENDT ODD	299
(FND)>		

DISPLAY 2.2.3.1.3.3.4.5.1. PLAN DURATION DESIGNATION

IN FORCE DURATION PREMIUM-PAYING DURATION ENTER LINE NUMBER AND DATA ENTER LINE NUMBER AND DATA 1. TO AGE Y 4. TO AGE Z 2. N YEARS 5. M YEARS 3. LIFE PLANS (CODE 99) 6. PAID-UP (CODE 00) 7. SINGLE PREMIUM (CODE 01) 8. LIFE PLANS - PAYABLE FOR (CONTINUED FOR SPECIAL RULES) LIFE (CODE 99) >2/20,5/20\_

DISPLAY 2.2.3.1.3.3.4.5.1. (CONT °D) PLAN DURATION DESIGNATION B.9

1. FOR RIDERS NOT INVOLVING INTEGRAL DURATIONS, THE IN-FORCE OR PREMIUM DURATIONS SHOULD BE SUCH THAT WHEN ADDED TO THE INSURANCE BEGINS YEAR OF THE RIDER, THE YEAR OF TERMINATION WILL RESULT.

2. FOR YEARLY RENEWABLE TERM POLICIES, THE DURATION FROM ORIGINAL DATE OF ISSUE TO THE END OF THE LAST RENEWAL YEAR IS CODED FOR BOTH IN-FORCE AND PREMIUM DURATIONS. WHERE NO SPECIFIC RENEWAL PERIOD IS KNOWN, 98 WILL BE CODED IN BOTH FIELDS. THE SAME WILL BE TRUE FOR MODIFIED COINSURANCE.

(CONTINUED)

DISPLAY 2.2.3.1.3.3.4.5.1. (CONTO) PLAN DURATION DESIGNATION

-----

- 3. FOR 5 YEAR TERM RENEWABLE TO 65 POLICY THE DURATION FROM THE MOST RECENT RENEWAL DATE TO THE END OF THE FINAL RENEWAL PERIOD IS CODED FOR BOTH IN-FORCE AND PREMIUM DURATIONS.
- 4. FOR DOUBLE PROTECTION RIDER 5 YEAR TERM RENEWABLE, THE DURATION FROM THE MOST RECENT RENEWAL DATE TO THE END OF THE FINAL RENEWAL PERIOD IS CODED FOR BOTH IN-FORCE AND PREMIUM DURATIONS.

(END)

DISPLAY 2.2.3.1.3.3.4.5.1.2.5. AGE AT ISSUE SELECTION

\_\_\_\_\_

AGE AT ISSUE SELECTION

ENTER LINE NUMBER AND DATA 1. SPECIFIC AGES 2. AGE RANGE 3. AGE RANGE AND INTERVAL >1/30\_

**REPLY FORMAT** 

1/AA/BB/CC/----/JJ\_ 2/XX TO YY\_ 3/XX TO YY BY MM\_ DISPLAY 2.2.3.1.3.3.4.5.1.2,5.1. OUTPUT SELECTION

#### OUTPUT SELECTION

ENTER LINE NUMBER(S) 1. NET ANNUAL PREMIUMS 2. GROSS ANNUAL PREMIUMS (RATES AND LOADING FACTORS) 3. FRACTIONAL GROSS PREMIUMS 4. GROSS PREMIUM LOADING PERCENTAGE AND CONSTANT EXPENSE FACTORS 5. CASH VALUES 6. REDUCED PAID-UP AND EXTENDED TERM INSURANCE VALUES 7. DIVIDEND FACTORS (RATES, SUMS, ACCUMULATIONS, BONUS AND TERM DATA) 8. VALUATION FACTORS (TERMINAL AND MEDIAL RESERVES, NET ANNUAL PREMS.) >5\_

### DISPLAY 2.2.3.1.3.3.4.5.1.2,5.1.5. OUTPUT DURATION SELECTION

#### OUTPUT DURATION SELECTION

ENTER LINE NUMBER 1. SPECIFIC DURATIONS 2. DURATION RANGE 3. DURATION RANGE AND INTERVAL >3/5 TO 30 BY 5\_

REPLY FORMAT

1/AA/BB/CC/----/JJ\_ 2/XX TO YY 3/XX TO YY BY MM\_

------

DISPLAY 2.2.3.1.3.3.4.5.1.2,5.1.5.3. RECAPITULATION

#### RECAPITULATION

ENTER LINE NUMBER IF INCORRECT 1. ACTUARIAL LIBRARY REFERENCE TABLES 2. INSURANCE NON-PAR CANADA 3. BASIC POLICIES 4. CSO (1941) 5. 3.00% 6. MAR. 14, 1955 TC MAR. 31, 1956 7. ENDOWMENT 8. SINGLE LIFE (CONTINUED)

DISPLAY 2.2.3.1.3.3.4.5.1.2,5.1.5.3. RECAPITULATION (CONT D) B.11

### RECAPITULATION (CONT °D)

\_\_\_\_\_

ENTER LINE NUMBER IF INCORRECT; OTHERWISE PROCEED 1. IN FORCE DURATION 20 YEARS; PREMIUM-PAYING DURATION 20 YEARS 2. AGES AT ISSUE 30 3. OUTPUT CASH VALUES 4. OUTPUT DURATION 5 TO 30 BY 5 (END) >\_

DISPLAY 2.2.3.1.3.3.4.5.1.2,5.1.5.3. COMPUTER RESPONSE

INS. NON-PAR CAN.; BASIC; 41CSO; 3.00%; MAR. 14, 1955 TO MAR. 31, 1956; ENDOWMENT; SINGLE LIFE; IN FORCE DURATION 20 YEARS; PREMIUM-PAYING DURATION 20 YEARS; AGE AT ISSUE 30; OUTPUT CASH VALUES; OUTPUT DURATION 5 TO 30 BY 5.

VAL	UATION	BASIS	CODE	333130		PLAN C	ODE 2002020	
Х	N>	5		10	15	20	25	30
30		X <sub>2</sub>		X o XXX	XxXX	X,XXX	XvXXX	X <b>,</b> X X X

DISPLAY 2.3. MATHEMATICAL AND OTHER TABLES AND INFORMATION B.12

MATHEMATICAL AND OTHER TABLES AND INFORMATION 1. LOADING EXPENSE FACTORS FOR CALCULATING GROSS PREMIUMS 2. LOADING EXPENSE FACTORS FOR CALCULATING DIVIDEND RATES 3. PERCENTAGE DISTRIBUTION OF GROUP CERTIFICATEHOLDERS BY RESIDENCE 4. NORMAL AREAS AND ORDINATES 5. RANDOM NUMBERS 6. STATISTICAL DISTRIBUTIONS 7. INTERPOLATION FORMULAE >4\_

DISPLAY 2.3.4. NORMAL AREAS AND ORDINATES

NORMAL AREAS AND ORDINATES

ENTER	R LINE	NUN	4BER	CORRESPONDING	TO	DESIF	RED	RA	VGE	OF	STANDARD	UNITS	(Z)
1.	0.00		0.24	Ŷ		9.	2.0	0		2.2	4		
2.	0.25		0.49	Ð	1	.0.	2.2	25	-	2.4	.9		
з.	0.50	***	0.74	ý.	1	. 1 .	2.5	50	-	2.7	4		
4.0	0.75		0.99	)	1	. 2 .	2.7	15		2.9	9		
5.	1.00		1.24	\$	1	.3.	3.0	0	-	3.2	4		
6.	1.25		1.49	)	1	4.	3.2	25		3.4	9		
7.	1.50	-	1.74		1	5.	3.5	50		3.7	4		
8.	1.75	-	1.99	<b>}</b>	1	.6.	3.7	15	-	3.9	9		
>5_													

DISPLAY 2.3.4.5. COMPUTER RESPONSE

NORMA	L AREAS	AND ORDI	NATES						
Z	P(Z)	F(Z)	Z	P(Z)	F(Z)	Z	P(Z)	F(Z)	
			-						
1.00	.24197	.34134	1.09	<u>。22025</u>	.36214	1.17	-20121	.37900	
1.01	°23955	<b>.</b> 34375	1.10	.21785	<b>.</b> 36433	1.18	-19886	.38100	
1.02	<b>₀23713</b>	.34614	1.11	.21546	<b>.</b> 36650	1.19	<u>.19652</u>	<b>°</b> 38538	
1.03	.23471	<b>°</b> 34820	1.12	.21307	<b>•36864</b>	1.20	<b>.</b> 19419	<b>.</b> 38493	
1.04	•23230	<b>.</b> 35083	1.13	<b>.2106</b> 9	.37076	1.21	.19186	<b>.</b> 38686	
1.05	.22988	<b>.</b> 35314	1.14	.20831	.37286	1.22	<b>.</b> 18954	.38877	
1.06	° 22747	°35243	1.15	°20294	.37493	1.23	.18724	<b>°</b> 39065	
1.07	°22206	.35769	1.16	<u>。20357</u>	<b>.3769</b> 8	1.24	<b>.18494</b>	<b>.</b> 39251	
1.08	°22265	.35993							

DISPLAY 2.4. BUSINESS STATUS AND ACTIVITY INFORMATION B.13

#### BUSINESS STATUS AND ACTIVITY INFORMATION

ENTER LINE NUMBER(S) 1. INDIVIDUAL LIFE AND ANNUITY 2. INDIVIDUAL HEALTH INSURANCE 3. GROUP LIFE INSURANCE 4. GROUP HEALTH INSURANCE 5. GROUP PENSIONS >1\_

(IND. LIFE & ANN.) (IND. HEALTH) (GRP. LIFE) (GRP. HEALTH) (GRP. PENS.)

DISPLAY 2.4.1. STATUS OR ACTIVITY SELECTION

STATUS OR ACTIVITY SELECTION IND. LIFE & ANN.

ENTER LINE NUMBER(S) 1. IN FORCE 2. NEW ISSUED BUSINESS 3. TRANSACTION ACTIVITY >1

>1\_

(IN FORCE) (NEW ISS.) (TRANS. ACT.)

### DISPLAY 2.4.1.1. CONTROL DATE SELECTION

CONTROL DATE SELECTION IND. LIFE AND ANN.; IN FORCE

ENTER LINE NUMBER/DATA FOR SELECTED STATUS OR ACTIVITY. DATES ARE TO BE IN YEAR/MONTH/DAY (YY/MM/DD) NUMERIC FORMAT (E.G., 69/04/27). THE MONTH AND DAY CODES MAY BE OMITTED TO DENOTE THE DATE RANGES OF AN ENTIRE YEAR AND MONTH RESPECTIVELY. 1\_ IN FORCE (CURRENT) 2/YY/MM/DD\_ IN FORCE (AS AT YY/MM/DD) 3/ 44\_ 4/YY/MM\_

5/YY/MM/DD TO YY/MM/DD\_

NEW ISS. & TRANS. (FOR YEAR) NEW ISS. & TRANS. (FOR YEAR/MO.) NEW ISS. & TRANS. (FROM---TO---)



## DISPLAY 2.4.1.1.1. DATA CATEGORY SELECTION

## DATA CATEGORY SELECTION IND. LIFE & ANN.; IN FORCE; CURRENT

ENTER LINE NUMBER/DATA. THE OMISSION OF A SPECIFIC CODE FOLLOWING A SLASH (/) SYMBOL DENOTES THAT ALL CODES OF THAT PARAMETER APPLY. NO SLASH SYMBOLS FOR A PARTICULAR RESPONSE ARE TO BE OMITTED. 1/POLICY NUMBER\_ 2/BRANCH OFFICE/AGENT/INSURED OCCUPATION/INSURED ANNUAL INCOME\_ 3/VALUATION BASIS/PLAN/AGE AT ISSUE/YEAR OF ISSUE\_ >1/1234567\_

## DISPLAY 2.4.1.1.1.0 OUTPUT SELECTION

OUTPUT SELECTION IND. LIFE & ANN.; IN FORCE; CURRENT; POL. 1234567

ENTER LINE NUMBER OF REQUIRED OUTPUT 1. STATUS CARD 2. POLICY INFORMATION

(ETC.)

>1\_

### DISPLAY 2.4.1.1.1.1. COMPUTER RESPONSE

POLICY NO. 1234567 SURNAME THOMP STATUS CARD DATE PREPARED 03 DEC 68 DUPLICATE LIFE LANGUAGE ΕN NAME OF INSURED/ANNUITANT JOHN WILLIAM THOMPSON BIRTHDATE OF INSURED 13 DEC 41 AGE AT ISSUE & ADMISSION 20 Y NAME OF OWNER INSURED BRANCH WPGHO OWNERSHIP RESTRICTIONS PREF BEN REST BENEFICIARY WIFE HELEN JOAN THOMPSON (CONTINUED)

B.14

DISPLAY 2.4.1.1.1.1. COMPUTER RESPONSE (CONT D)

B.15

STATUS CARD MAILING (PREM PAYOR) NAME/ADD	POLICY NO. 1234567 SURNAME THOMP MR JOHN W THOMPSON
	WINNIPEG 1. MAN
LOAN INT. DUE ON PREM ANN.	LAST 8.40 68 NEXT 8.40 69
PRUP <sub>®</sub> PREMIUM INDICATOR	A
CURRENCY (\$)	CN
REGION	CN .
EDITION	P
POLICY LOAN AMOUNT	140 00
POLICY LOAN INTEREST PATE	£ 00
(CONTINUED)	0.00

# DISPLAY 2.4.1.1.1.1.1. COMPUTER RESPONSE (CONT D)

\_\_\_\_

STATUS CARD DIVDS ACCUM.AT INT	INT.	POLICY 5.29	NO.	1234567	SURNAME	ТНОМР
DIVD. OPTION - FIRST CURR. DIVD. AMT FIRST PREMIUM ANNIVERSARY DATE INSURANCE BEGINS DATE CONTRACT JURISDICTION TERMS OF ISSUE NON-FORFEITURE OPTION SERVICE AGENT (CONTINUED)	TOT.	105.87 ACCUM 19.75 18 DEC 18 DCT MAN STNON AUTOL 91259 S	61 Staff	-		

## DISPLAY 2.4.1.1.1.1. COMPUTER RESPONSE (CONT'D)

-----

STATUS CARD PLAN OR BENEFIT BENEFIT AND PREMIUM DURATIONS AMOUNT OR MONTHLY INCOME TOTAL PREMIUMS (BY BENEFIT) AGENT CODE	POLICY LIFE 99 45 5,000 84.70 912590	NO.	1234567	SURNAME THOMP
FIRST YEAR COMMISSION RATE	60.0			
POLICY ANNIV. CASH VALUES -	295.00	68		
-	360.00	69	CURRENT	ANNIV. YEAR)
-	425.00	70		
CASH VALUE DISCOUNT RATE	3.00			
(CONTINUED)				

# DISPLAY 2.4.1.1.1.1.1. COMPUTER RESPONSE (CONTO) B.16

STATUS CARDPOLICY NO. 1234567SURNAME THOMPPREPARATION REASON(S)REQUESTED BY WXYZANNUAL PREMIUM84.70BILLING METHODHOSTFPAYABLEATOTAL PREMIUMS (ALL BENEFITS)84.70(END)(All BENEFITS)

DISPLAY 2.5. RESEARCH

#### RESEARCH

ENTER LINE NUMBER(S) 1. INDIVIDUAL LIFE AND ANNUITY 2. INDIVIDUAL HEALTH INSURANCE 3. GROUP LIFE INSURANCE 4. GROUP HEALTH INSURANCE 5. GROUP PENSIONS >1\_

(IND. LIFE & ANN.) (IND. HEALTH) (GRP. LIFE) (GRP. HEALTH (GRP. PENS.)

DISPLAY 2.5.1. RESEARCH CATEGORY

RESEARCH CATEGORY IND. LIFE & ANN.

ENTER LINE NUMBER(S) 1. EXPERIMENTAL CALCULATIONS OF PREMIUMS AND BENEFITS (EXPERIMENTAL) 2. ASSET SHARE CALCULATIONS (ASSET SHARE) 3. MORTALITY AND MORBIDITY STUDIES (MORTALITY) 4. PERSISTENCY INVESTIGATIONS (PERSISTENCY) 5. SIMULATIONS AND PROJECTIONS (SIMULATION) >4\_

-----

DISPLAY 2.5.1.4. PERSISTENCY CATEGORY

PERSISTENCY CATEGORY IND. INS. & ANN.; PERSISTENCY

# DISPLAY 2.5.1.4.1. COMPUTER RESPONSE

IND. 1,2;	INS. & Agent 1	ANN.; PER 2345; AGE	SISTENC S AT IS	Y; ISSU SUE O T	E YEARS 0 69 BY	66, 67 10	; PERSI	STENCY	YEARS
ISS.	PERS。	AGES>	00-09	10-19	20-29	30-39	40-49	50-59	60-69
66	1		98%	100%	100%	90%	92%	100%	· · _
66	2		958	98%	100%	90%	92%	95%	- -
67	1		100%	978	98%	92%	95%	90%	878
67	2		98%	903	873	85%	90%	88%	85%
	-								

DISPLAY 3. SUMMARY METHOD OF PROCESSING ACTIVITY SELECTION B.19

شد هید بود چود هند مدرد برد. بود می مورد می مود می بود و بود می برد می بود می بود می مدر می می می می

SUMMARY METHOD OF PROCESSING ACTIVITY SELECTION ENTER DISPLAY RESPONSES SEPARATED BY + SYMBOLS >1+2+1+3+5+2+58CS0,2.75,20 TO 50 BY 10,10/15/20/TO 60/TO 65/TO 70+\_ (OR) >2+3+1+\_ (OR) >3+4+5+\_ (OR) >4+1+1+1/1234567+1+\_ (OR) >5+1+4+1/66,67/1,2//12345//0 TO 69 BY 10+\_ 

> DISPLAY 3.1.2.1.3.5.2. COMPUTER RESPONSE

----

CONTENTS ARE IDENTICAL TO THE COMPUTER RESPONSE FOR DISPLAY 2.1.2.1.3.5.2.

#### DISPLAY 3.2.3.1. INPUT SPECIFICATION

## INPUT SPECIFICATION

### ENTER THE FOLLOWING

>-----

VALUATION BASIS PLAN/IN FORCE DURATION/PREMIUM DURATION AGE AT ISSUE

DISPLAY 3.2.3.1. (CONT'D) INPUT SPECIFICATION 

#### INPUT SPECIFICATION

ENTER THE FOLLOWING >333130<

VALUATION BASIS 200/20/20<----- PLAN/IN FORCE DURATION/PREMIUM DURATION 30\_----- AGE AT ISSUE

## DISPLAY 3.2.3.1.1. OUTPUT SELECTION

### OUTPUT SELECTION

ENTER LINE NUMBER(S)/DURATIONS 1. NET ANNUAL PREMIUMS 2. GROSS ANNUAL PREMIUMS 3. FRACTIONAL GROSS PREMIUMS 4. GROSS PREMIUM LOADING PERCENTAGE AND CONSTANT EXPENSE FACTORS 5. CASH VALUES/DURATIONS 6. REDUCED PAID-UP AND EXTENDED TERM INSURANCE VALUES/DURATIONS 7. DIVIDEND FACTORS/DURATIONS 8. VALUATION FACTORS/DURATIONS >5/5 TO 30 BY 5\_



## DISPLAY 3.2.3.1.1.5. RECAPITULATION

### RECAPITULATION

----

ENTER LINE NUMBER IF INCORRECT; OTHERWISE PROCEED 1. ACTUARIAL LIBRARY REFERENCE TABLES 2. INSURANCE NON-PAR CANADA 3. BASIC POLICIES 4. 333130 5. 200/20/20 6. 30 7. CASH VALUES/5 TO 30 BY 5 >\_

DISPLAY 3.2.3.1.1.5. COMPUTER RESPONSE

CONTENTS ARE IDENTICAL TO THE COMPUTER RESPONSE FOR DISPLAY 2.2.3.1.3.3.4.5.1.2,5.1.5.3.



8

DISPLAY 3.3.4.5. COMPUTER RESPONSE

CONTENTS ARE IDENTICAL TO THE COMPUTER RESPONSE FOR DISPLAY 2.3.4.5.

-----

------

DISPLAY 3.4.1.1.1.1.1. COMPUTER RESPONSE

CONTENTS ARE IDENTICAL TO THE COMPUTER RESPONSE FOR DISPLAY 2.4.1.1.1.1.

DISPLAY 3.5.1.4.1. COMPUTER RESPONSE

CONTENTS ARE IDENTICAL TO THE COMPUTER RESPONSE FOR DISPLAY 2.5.1.4.1.

DISPLAY 2.4.1.1.1.1.1. ALTERNATIVE COMPUTER RESPONSE

03 DEC 68  Y EN THOMP JOHN WILLIAM T	HOMPSON		11234 567
13 DEC 411 20 YI INSURED			I WPGHO
I PREF BEN RESTI	1	1	
	1	1	1
WIFE HELEN JOAN THOMPSON			

DISPLAY 2.4.1.1.1.1.1. ALTERNATIVE COMPUTER RESPONSE (CONT D)

STATUS CARD		1234 567
 MR JOHN W THOMPSON 2743 HUDSON CRESCENT WINNIPEG 1, MAN	1	1
1		
	11	

					1		l	I		8.4016	8	8.40 69
	1	1	1	1	1	1	1	   Y	1    CN	I I CNIPI	 140.00	6.00
	1	1			1	5.291	1(	)5.87		ACCUM I		19.75
18 DE	і сі18 ост	1 61   MAN	   ST	NÖN		1	   		I AUTOL I		  91259 ST	4FF

DISPLAY 2.4.1.1.1.1.1. ALTERNATIVE COMPUTER RESPONSE (CONT D)

DISPLAY 2.4.1.1.1.1.1. ALTERNATIVE COMPUTER RESPONSE (CONT°D)



## ACTUAL STATUS CARD FORM TO WHICH DISPLAY 2.4.1.1.1.1. (ALTERNATIVE COMPUTER RESPONSE) IS RELATED.

STATUS CAP	۶D		DUP	ANG.	SURNAME	NAME (	of Ins	URED/ANNUI	TANT				POLICY	NUMBER
DATE PREPARED														
SIRTHDATE OF INSURED	AGE ISS	ADM NAI O WO	RE R NER									SEC ONR	BRANCH	
OWNERSHIP RESTRICTIONS										PCS TRU NUM	SION ST BER	NUI:	AUTOP/ ABER	NY Dep day
SPEC. INFO											DIRECTION FOR SETTLEMENT			
BENEFICIARY														

MAILING (PREMIUM PAYOR) NAME AND ADDRESS NAME AND ADDRESS OF AS

						N C A	UMBER OF DILATERAL SSIGNMENTS	Lt D P	DAN INTERF UE ON REM ANIV	ST LAS	1		14 X 1		
ASNULTY OP	110N	A NN A M	UIIY PO MON I	NC E	ADO ST	ATUS I DEPOSIT D	IDDITIONAL EPOSIT - RIB	PSA	OK 10 IRANSFLR	INDIC INDIC	PREN CUR ATOR -S	15/2.0 (12.2) Fr	DECY LOAN AMOUNT	POL	ICY LOAN RESTRATE
DIVIDE TOTAL FACE A	NDS PAID 40UNT	UP ADD	HIONS VL CASH	VALUE	DIVIDENDS - YEAR TERM	ONI DIV INS INT	IDENDS AC		AT INTERES TAL AMOUN	ſ	061 187 191A 185		CURRENS 191 DIV AND 200 BT OPTION 200		
PREMIUM AMNIVERSARY	ing BEC	SURANCI INS DAT	į	CONTRACT TURISDICTIO	SN H I	MS OF 1\$591	COMM	UTATION SHTS	Refering P	SPEC AAHS	NON FORE OPHON	DISABILITY CLAIM NIPARER	SERVICE AF	-INI	
PLAN OR BL!	ILF IT	BEN DUR	DUR DUR	АМО МОЧТНІ	JNT ÖR Y INCOME	EXTRA PREM TACTUDED	N 4	TÖTAL PREMIUN	15		CODI	AGENT FIRSTYK SHARL COMM RI	AGERI CODI	AGENT	FIRSTAR Come Fil
										POU ANN CAT YALL PREF	REY AND SA AND R S AND PARATION F	EASOPE SI	1 K Y R Y K	CURRENT ANNIV. YEAR	CASH YALUI DIS ##tt
CONVERSIO	N YEAR	1	AUNGA	FRIMUM	i di na constante di secono di s	(THOP PAYABLE									
BASIC	11.8													IDENT.	

B.25

APPENDIX C. EXAMPLES OF PROSPECTIVE PERFORMANCE CALCULATIONS C.1

### (A) FORMAT OF CONTENTS (TABLES 1 TO 106 INCLUSIVE)

-1.	BASIC INPUT DATA
-2.	BASIC CALCULATIONS
-3.	PLAN INPUT DATA
-4.	PLAN CALCULATIONS
-5.	POLICY INPUT DATA
-6.	POLICY CALCULATIONS

.. .. ..

### (B) DEFINITION OF EXAMPLES (ALL ARE AGE 25)

TABLE NUMBERS	PLAN DESCRIPTION	INTEREST RATE	LAPSE RATES (*)	MORTALITY RATES (*)
		and delta and and and and and and		
1 - 6	ENDOWMENT 15 YEARS	6.50 %	100 %	100 %
11 - 16	ENDOWMENT SINGLE Premium 15 years	6.50 %	100 %	100 %
21 - 26	TERM 15 YEARS	6.50 %	100 %	100 %
31 - 36	ENDOWMENT 15 YEARS	6.00 %	100 %	100 %
41 - 46	ENDOWMENT 15 YEARS	7.00 %	100 %	100 %
51 - 56	ENDOWMENT 15 YEARS	6.50 %	100 %	90 %
61 - 66	ENDOWMENT 15 YEARS	6.50 %	100 %	110 %
71 - 76	ENDOWMENT 15 YEARS	6.50 %	90 %	100 %
81 - 86	ENDOWMENT 15 YEARS	6.50 %	110 %	100 %
91 - 96	ENDOWMENT 15 YEARS	7.00 %	90 %	90 %
101 - 10	6 ENDOWMENT 15 YEARS	6.00 %	110 %	110 %

111 EFFECTS OF CHANGES IN INTEREST, LAPSE, AND MORTALITY RATES ON THE PROSPECTIVE PERFORMANCE FACTORS FOR AN ENDOWMENT 15 YEARS, AGE 25.

112 EFFECTS OF COMBINED CHANGES IN INTEREST, LAPSE, AND MORTALITY RATES ON ENDOWMENT 15 YEARS, AGE 25 PROSPECTIVE PERFORMANCE FACTORS.

113 EXAMPLE TO ILLUSTRATE THE ADJUSTMENT OF THE STARTING POINT DURATION FOR THE PERSISTENCY AND DISCOUNT FACTORS.

\* THE LAPSE AND MORTALITY RATE PERCENTAGES DENOTE THE PROPORTIONS OF THE ASSUMED RATES USED IN THE CALCULATIONS.
## 1. BASIC INPUT DATA - AGE 25

YEAR	MORTALITY RATE Q	LAPSE RATE W	INTEREST
	(X)+N-1	(X)+N-1	RATE
N 	(1)	(2)	(3)
1	<b>₀</b> 00085	.10	
2	.00090	.06	,0650
3	°00095	.05	.0650
4	•001C0	。05	.0650
5	.00100	°05	.0650
6	.00100	.04	.0650
7	.00102	.04	.0650
8	.00104	° 04	.0650
9	.00108	.04	.0650
10	.00114	.04	.0650
11	.00123	.03	.0650
12	.00134	.03	.0650
13	.00146	.03	.0650
14	.00159	.03	.0650
15	.00174	° 0 3	.0650
TOTALS	.01734	• 66	
:		===========	

#### 2. BASIC CALCULATIONS

			S			PERSISTENCY
	S	COMPOUND F	) =	DISCOUNT	PERSISTENCY	AND DISCOUNT
	Р		(X)	FACTOR	AND DISCOUNT	ACCUMULATION
	(X)+N-1				FACTOR =	FACTOR =
YEAR		(4) X(5)		N-1		
	= 1 - (1) - (2)	N-1 M	1-1	= V	(5) X (6)	1/(7)
N						
	(4)	(5)		(6)	(7)	(8)
1	.89915	1.00000	1	1.00000	1.00000	1.00000
2	.93910	.89915	i	.93897	.84427	1.18446
3	°94905	.84439	)	<b>.88166</b>	.74446	1.34326
4	<u>。</u> 94900	.80137	•	<b>.</b> 82785	.66341	1.50736
5	。94900	•7605C	)	.77732	.59115	1.69162
6	•95900	.72171		.72988	• 52676	1.89840
7	.95898	.69212		<b>.</b> 68533	•47433	2.10824
8	<b>°</b> 92886	<b>.6637</b> 3	ı.	.64351	<b>.</b> 42712	2.34126
9	<b>•</b> 95892	.63649	t i i i i i i i i i i i i i i i i i i i	•60423	·38459	2.60017
10	<b>• 95886</b>	·61034		.56735	<b>°</b> 34628	2.88784
11	。96877	•58523		•53273	<b>.</b> 31177	3.20749
12	。96866	<b>• 5669</b> 5		.50021	°28329	3.52622
13	。96854	• 54918		•46968	.25794	3.87687
14	。96841	• 53190	i i	<b>.44102</b>	°53428	4.26294
15	<b>.96826</b>	<b>°</b> 51510		.41410	.21330	4.68823

TOTAL 14.32266

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C.2

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#### 3. PLAN INPUT DATA

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#### ENDOWMENT 15 YEARS AGE 25

	CASH			EX	PENSE FAC	TORS	
YEAR	CSV N	DIVIDEND RATE	GROSS PREMIUM	GENERAL AND TAXES(%)	DOLLARS PER UNIT	DOLLARS PER POLICY	AMOUNT PER UNIT
N 	(11)	(12)	(13)	(14)	(15)	(16)	(17)
1	22	2.85	64.18	25	10.00	42.00	1,000
2	77	4.26	64.18	2	•20	7.00	1,000
3	135	5.71	64.18	2	°50	7.00	1,000
4	194	7.20	64.18	2	•20	7.00	1,000
5	256	8.74	64.18	2	<b>.</b> 20	7.00	1,000
6	320	10.31	64.18	2	۵20	7.00	1,000
7	385	11.94	64.18	2	•20	7.00	1,000
8	453	13.61	64.18	2	.20	7.00	1,000
9	524	15.31	64.18	2	.20	7.00	1,000
10	597	17.07	64.18	2	.20	7.00	1,000
11	672	18.85	64.18	2	<b>.</b> 20	7.00	1,000
12	750	20.70	64.18	2	.20	7.00	1,000
13	831	22.63	64.18	2	.20	7.00	1,000
14	914	24.58	64.18	2	.20	7.00	1,000
15	1000	26.61	64.18	2	•20	7.00	1,000
TOTALS	5 7130 =======	210.37	962.70		12.80	140.00	

C.3

4. PLAN CALCULATIONS - ENDOWMENT 15 YEARS AGE 25

YEAR	AMOUNT AT RISK	MORTALITY COST	END OF YEAR DEDUCTIONS =	BEGINNING OF YR. DEDUCTIONS
N	= (17) - (11)	$= (1) \times (21)$	(11)+(12)+(22)	= (23)/1+(3)
	(21)	(22)	(23)	(24)
1	978	.831	25.681	24.114
2	923	.831	82.091	77.081
3	865	.822	141.532	132.894
4	806	. 806	202.006	189.677
5	744	.744	265.484	249.281
6	680	.680	330.990	310.789
7	615	.627	397.567	373.302
8	547	• 56 9	467.179	438.666
9	476	• 514	539.824	506.877
10	403	۰459	614.529	577.023
11	328	. 403	691.253	649.064
12	250	.335	771.035	723.977
13	169	° 247	853.877	801.762
14	86	.137	938.717	881.424
15	0	· •••	1026.610	963.953
TOTALS	7870	8.005	7348.375	6899,884
		=======================================		***=========
	BASIC MARGIN =	BASIC MARGIN	ACCUMULATED BASIC MARGIN	BASIC MARGIN
YEAR	$\begin{array}{ccc} (11) & \div & (13) \\ N-1 \end{array}$	AT ISSUE =	AT ISSUE =	FACTORS =
AI	- (24)	(25) X (7)	SUM OF (26)	(27) X (8)
	(25)	(26)	(27)	(28)
,	40 044	40.044		
2	90.000	40.000	104-608	104.608
2	8-286	6 160	04•042 E( 0/0	18.441
4	9,503	6 304	50.86U	16.3/8
5	8,899	5 261	20.691	78.410
6	9,391	6 947	44.201	75.086
7	10,878	5.160	37.120	14.211
8	10,514	2 4 9 1	34.173	12.0008
9	10-303	3 962	27.679	01.941
10	11,157	3,863	270 566	03°///
11	12.116	3,777	16 702	270371 53 575
12	12,203	3_461	12 024	770717 45 500
13	12,418	3,203	12072D	40°280
14	13.756	3,227	7 0 7 0 J 6 , 7 4 7	20.077 26 605
15	14.227	3.035	3.035	20.077
TOTALS	192.816	104.608		923.147

#### 5. POLICY INPUT DATA

ENDOWMENT 15 YEARS AGE 25

INSURANCE AMOUNT	(40)	\$ 10,000
COMMISSION RATE - 1ST. YEAR	(41)	30%
COMMISSION RATE - 2ND. YEAR	(42)	10%
COMMISSION RATE - 3-10 YEARS	(43)	5%
POLICY FEE (TOTAL) CALCULATED FROM MASTER FILE DATA	(44)	\$ 9.00

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C.5

6. ==	POLICY CALCULAT	IONS - ENDOWMENT	15 YEARS AGE 25	C.6
	POLICY FEE PFR UNIT =	COMMISSION PER UNIT =	GENERAL AND Tax fxpfnsf =	EXPENSE PER POLICY/UNIT =
YEAR		((13) + (50))	((13) + (50))	
NI	(44)X(17)/(40)	X (41,42,43)	X (14)	(16)X(17)/(40)
	(50)	(51)	(52)	(53)
				(
1	•900	19.520	16.270	4.200
2	•900	0.010	1.300	-700
5	900	3 2 5 0	1 300	700
т. Б	900	3.250	1.300	700
5	900	3 250	1.300	700
7	900	2 250	1 300	.700
8	.900	3 250	1.300	.700
q	-900	3,250	1.300	.700
10	.900	3,250	1,300	-700
11	-900	-	1.300	.700
12	-900	-	1,300	.700
13	-900		1,300	.700
14	.900		1.300	.700
15	.900		1.300	.700
OTALS	13.500	52.030	34.470	14.000
			مورد شاه کال ماند الله بینه مید مید مید مید الله این ماند کار این ماند الله ا	
	MARGIN	MARGIN		MARGIN
	AD HISTMENT =	ADJUSTMENT	MARGIN ADJUST-	ADUUSTMENT
	AD0001 ALM	AT ISSUE =	MENT AT ISSUE	FACTORS =
FAR	(51)+(52)+(15)	AT 1990E		, Actors
	+(53)-(50)	(54) X (7)	= SUM OF (55)	(56) X (8)
N	{ 54 }	(55)	(56)	(57)
,	49 000	49 090	76 295	76 295
2	7 810	47.070 6 506	27 205	32.223
2	4.550	2 2 2 7	20.611	27.686
4	4-550	3,019	17.224	25-963
5	4,550	2,690	14,205	24.029
6	4,550	2,397	11,515	21.860
7	4,550	2,158	9.118	19.223
8	4.550	1,943	6.960	16.295
9	4.550	1.750	5.017	13.045
10	4.550	1.576	3.267	9.435
11	1.300	• 405	1.691	5.424
12	1.300	. 369	1.286	4.535
13	1.300	.335	.917	3.555
14	1.300	<b>.</b> 305	• 582	2.481
15	1.300	.277	•277	1.299
TOTALS	99.800	76.295		283.348
				***********

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6.	POLICY	CALCULAT	IONS -	ENDOWMENT	15	YEARS	AGE :	25 (CONT'D)
===	=======	==========	=======		===	=======	====:	

VEAD	PROSPECTIVE PERFORMANCE PER UNIT =	TOTAL PROSPECTIVE PERFORMANCE =
N	(28) - (57)	(58)X(40)/(17)
	(58)	(59)
1	28.313	283.13
2	44.224	442.24
3	48.692	486.92
4	50.447	504.47
5	51.057	510.57
6	52.417	524.17
7	52.835	528.35
8	51.646	516.46
9	50.732	507.32
10	49.956	499.56
11	48.151	481.51
12	41.045	410.45
13	33.140	331.40
14	24.214	242.14
15	12.930	129.30
TOTALS	639.799	6,397.99
	************	================

#### 11. BASIC INPUT DATA - AGE 25

	MORTALITY RATE	LAPSE RATE	
YEAR	Q	W	INTEREST
	(X)+N-1	(X) +N−1	RATE
N			
	(1)	(2)	(3)
1	•00085	.10	•0650
2	•00090	<b>.</b> 06	.0650
3	•00095	.05	.0650
4	.00100	°05	.0650
5	.00100	°05	.0650
6	.00100	。04	.0650
7	.00102	.04	.0650
8	.00104	。04	.0650
9	.00108	.04	.0650
10	.00114	。04	.0650
11	.00123	.03	.0650
12	.00134	.03	<b>.</b> 0650
13	o00146	.03	•0650
14	.00159	°03	.0650
15	.00174	.03	۰ <b>0650</b>
TOTALS	.01734	• 66	
=		*****	
	12. BASIC	CALCULATIONS	

`	S P (X)+N-1	COMPOUND P = (X)	DISCOUNT Factor	PERSISTENCY AND DISCOUNT FACTOR =	PERSISTENCY AND DISCOUNT ACCUMULATION FACTOR =
YEAR		(4) X(5)	N-1		
	= 1 - (1) - (2)	N-1 N-1	= V	(5) X (6)	1/(7)
N	(4)	(5)	(6)	(7)	(8)
1	.89915	1.00000	1.00000	1.00000	1.00000
2	.93910	.89915	。93897	.84427	1.18446
3	<b>.</b> 94905	.84439	.88166	74446	1.34326
4	.94900	.80137	.82785	.66341	1.50736
5	.94900	.76050	.77732	.59115	1.69162
6	<b>.9590</b> 0	.72171	.72988	.52676	1.89840
7	<b>.</b> 95898	.69212	<b>°</b> 68233	.47433	2.10824
8	• 95896	.66373	.64351	. 42712	2.34126
9	.95892	° 63649	.60423	.38459	2.60017
10	。95886	<b>°61034</b>	<b>.</b> 56735	.34628	2.88784
11	.96877	₅58523	.53273	.31177	3.20749
12	<b>-968</b> 66	<u>。56695</u>	<b>•</b> 50021	.28359	3.52622
13	.96854	.54918	.46968	.25794	3.87687
14	<b>•96841</b>	<b>°</b> 23130	.44102	.23458	4.26294
15	<b>°</b> 96826	.51510	.41410	°21330	4.68823

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TOTAL 14.32266

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#### 13. PLAN INPUT DATA

#### ENDOWMENT SINGLE PREMIUM 15 YEARS AGE 25

مجم بيها جينا ملك حلك الله حلك وكالقاط الته والمحتين التار التار التار التار التار التار

				EX	PENSE FAC	TORS	
YEAR	CSV	DIVIDEND Rate	GROSS PREMIUM	GENERAL	DOLLARS PER	DOLLARS PER	AMOUNT PER
	N			TAXES(%)	UNIT	POLICY	UNIT
N	(11)	(12)	(13)	(14)	(15)	(16)	(17)
1	645	13.13	699.30	7	10.00	42.00	1,000
2	665	13.61		-	°50	5.00	1,000
3	686	14.07	-	-	°50	5.00	1,000
4	707	14.56		-	<b>.</b> 20	5.00	1,000
5	730	15.05			<b>.</b> 20	5.00	1,000
6	753	15.59	-	-	•20	5.00	1,000
7	777	16.14	-	-	<b>。</b> 20	5.00	1,000
8	802	16.69		-	•20	5.00	1,000
° 9	827	17.26	-	-	.20	5.00	1,000
10	854	17.84	-	-	•20	5.00	1,000
11	881	18.46	-	-	<b>.</b> 20	5.00	1,000
12	909	19.07	-	-	<b>.</b> 20	5.00	1,000
13	939	19.72	-	-	<b>.</b> 20	5.00	1,000
14	969	20.40	-	-	.20	5.00	1,000
15	1000	21.08	_	-	. 20	5.00	1,000
TOTALS	12144	252.67	699.30		12.80	112.00	

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YEAR	AMOUNT AT RISK	MORTALITY COST	END OF YEAR DEDUCTIONS =	BEGINNING OF YR. DEDUCTIONS
NI	= (17) $-$ (11)	= (1) X (21)	(11)*(12)*(22)	= (23)/1+(3)
	(21)	(22)	(23)	(24)
1	355	. 302	658.432	618.246
2	335	. 302	678.912	637.476
3	314	. 298	700.368	657.623
4	293	° 293	721.853	677.796
5	270	.270	745.320	699.831
6	247	.247	768.837	721.913
7	223	.227	793.367	744.946
8	198	.206	818.896	768.916
9	173	.187	844.447	792.908
10	146	.166	872.006	818.785
11	119	.146	899.606	844.700
12	91	.122	928.192	871.542
13	61	-089	958.809	900,290
14	31	.049	989.449	929,060
15	-		1021.080	958.761
OTALS	2856	2.904	12399.574	11642.793
		*******		
	BASIC MARGIN =	BASIC MARGIN	ACCUMULATED BASIC MARGIN	BASIC MARGIN
EAR	N-1	AT 1550E =	AT ISSUE =	FACTORS =
N	- (24)	(25) X (7)	SUM OF (26)	(27) X (8)
	(25)	(26)	(27)	(28)
1	91 054	01 054	122 700	
2	7 624	61.004	132.198	132.798
3	7 277	5 402	21.0/44	61.289
4	8 204	5 443	42.542	00.973
5	7 169	2°443 6 229	37.457	6U.144 50.200
5	8 087	3°230 4 260	240421	20.280
7	8,054	3,820	200217 25 050	210208 57 720
8	8-084	3.453	220777 77 120	240128
9	9,092	3.407	460137 10 606	21.033 AD E07
0	8,215	2.845	15 190	400J01 62 062
1	9,300	2.899	12 264	~~>•00) 20 502
.2	9,458	2.682	120J77 Q 445	270272 22 20s
13	8,710	2,247	6.762	22.2U2 26 210
14	9,940	2,332	6 105 6 516	200217
15	10.239	2.184	2.184	10.239
TALS	200.507	132.798		758.478

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14. PLAN CALCULATIONS - ENDOWMENT SINGLE PREMIUM 15 YEARS AGE 25 C.10

#### 15. POLICY INPUT DATA

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#### ENDOWMENT SINGLE PREMIUM 15 YEARS AGE 25

INSURANCE AMOUNT	(40)	\$ 10,000
COMMISSION RATE - 1ST. YEAR	(41)	48
COMMISSION RATE - 2ND. YEAR	(42)	0
COMMISSION RATE - 3-10 YEARS	(43)	0
POLICY FEE (TOTAL) CALCULATED FROM MASTER FILE DATA	(44)	\$ 36.00

C.11

YEAR N	POLICY FEE PER UNIT = (44)X(17)/(40)	COMMISSION PER UNIT = {(13) + (50)) X (41,42,43)	GENERAL AND TAX EXPENSE = {(13) + (50)) X (14)	EXPENSE PER POLICY/UNIT = (16)X(17)/(40)
	(50)	(51)	(52)	(53)
			ی ہے جو برد بن مل من میں مرب میں <u>م</u>	
1	3.600	28.116	49.203	4.200
2	-	-	-	<b>.</b> 500
3	-	-		•500
4	-	-	-	• 500
5	-	-	-	•500
0 7		-	-	• 500
0	-	-	_	• 500
0 0			-	•500
10	-	_	-	• 500
11		_		•500
12			_	•500
13		_	-	• <b>5</b> 00
14	_	_		<b>500</b>
15	-	<del></del>		•500
TOTALS	3.600	28.116	49.203	11,200
		***********	*****	
	MARGIN Adjustment =	MARGIN ADJUSTMENT	ACCUMULATED Margin Adjust-	MARGIN ADJUSTMENT
YEAR	(51)*(52)*(15)	AT 1550E =	MENT AT ISSUE	FACIURS =
<b>A</b> I	+(53)-(50)	(54) X (7)	= SUM OF (55)	(56) X (8)
IN	(54)	(55)	(56)	(57)
		المراجع المراجع مروبه مروبه مروبه مروبه مروبه مروبه مروبه مراجع مروبه مروبه مروبه مروبه مروبه		
1	87.919	87.919	92.331	92.331
2	.700	.591	4.412	5.226
3	•700	• 521	3.821	5.133
4	· 700	. 464	3.300	4.974
5	.700	.414	2.836	4.797
0 7	° 100 700	• 369	2.422	4.598
7 8	° 700 700	• 332	2.053	4.328
0	700	0 C Y Y 36 0	1. (22	4.029
10	.700	° 2 0 7 2 4 2	1 152	2.220
11	,700	• < 42 2 ) Q	011 10122	20230
12	,700	100	6 7 I I 4 0 2	20766
13	.700	.191	دری. ۸۵۸ _	20444
14	.700	.164	213	1.224
15	.700	.149	.149	.699
TOTALS	97.719	92.331		141.757

. . . . . . . .

16. POLICY CALCULATIONS - ENDOWMENT SINGLE PREMIUM 15 YEARS AGE 25 C.12

16.	POLIC PRÉMI	Y CALCULATIONS UM 15 YEARS AG	- ENDOWMENT SINGLE E 25 (CONT°D)
====			=======================================
		PROSPECTIVE	TOTAL
		PERFORMANCE	PROSPECTIVE
		PER UNIT =	PERFORMANCE =
YEA	<b>I</b> R		
		(28) - (57)	(58)X(40)/(17)
N	1		
		(58)	(59)
1	L	40.467	404.67
2	2	56.063	560.63
3	3	55.840	558.40
4	8-	55.170	551.70
5	5	53.491	534.91
6	Ś	52.770	527.70
7	7	50.400	504.00
8	3	47.804	478.04
9	,	44.890	448.90
10	)	40.533	405.33
11	L	36.671	366.71
12	2	30.861	308.61
13	3	24.304	243.04
14	ŀ	17.917	179.17
15	5	9.540	95.40
тот	ALS	616.721	6,167.21
			*******

C.13

#### 21. BASIC INPUT DATA - AGE 25



.77732

.72988

.68533

.64351

.60423

.56735

•53273

.50021

.46968

.44102

.41410

TOTAL 14.32266

5

6

7

8

9

10

11

12

13

14

15

=============

.94900

.95900

.95898

.95896

.95892

.95886

.96877

.96866

.96854

.96841

.96826

.76050

.72171

**°69212** 

.66373

.63649

.61034

•58523

.56695

.54918

.53190

.51510

1.69162

1.89840

2.10824

2.34126

2.60017

2.88784

3.20749

3.52622

3.87687

4.26294

4.68823

.59115

.52676

.47433

.42712

.38459

•34628

.31177

.28359

.25794

.23458

.21330

#### 23. PLAN INPUT DATA

#### TERM 15 YEARS AGE 25

	CASH		05014 40	EX	PENSE FACT	ORS	
YEAR	CSV N	DIVIDEND RATE	REGULAR GROSS PREMIUM	GENERAL AND TAXES(%)	DOLLARS PER UNIT	DOLLARS PER POLICY	AMOUNT PER UNIT
	(11)	(12)	(13)	(14)	(15)	(16)	(17)
1	-	-	3.62	25	10.00	25.00	1,000
2		-	3.62	2	°20 20	5.00	1,000
4			3.62	2	.20	5.00	1,000
5		-	3.62	2	.20	5.00	1.000
6			3.62	2	.20	5.00	1,000
7	-	-	3.62	2	°50	5.00	1,000
8	-	-	3.62	2	<b>.</b> 20	5.00	1,000
9	-	-	3.62	2	<b>.</b> 20	5.00	1,000
10		-	3.62	2	• 20	5.00	1,000
11	-		3.62	2	<b>。</b> 20	5.00	1,000
12	-	-	3.62	2	<b>.</b> 20	5.00	1,000
13		-	3.62	2	<b>.</b> 20	5.00	1,000
14			3.62	2	<u>。</u> 20	5.00	1,000
15			3.62	2	.20	5.00	1,000
TOTALS			54.30		12.80	95.00 =======	

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C.15

24. PLAN CALCULATIONS - TERM 15 YEARS AGE 25

YEAR	AMOUNT AT RISK	MORTALITY COST	END OF YEAR DEDUCTIONS =	BEGINNING OF YR. DEDUCTIONS
<b>N</b> i	= (17) - (11)	$= (1) \times (21)$	(11) + (12) + (22)	= (23)/1+(3)
	(21)	(22)	(23)	(24)
_				
1	1000	.850	•850	.798
2	1000	° 900	.900	.845
3	1000	.950	•950	.892
4	1000	1.000	1.000	.939
5	1000	1.000	1.000	.939
6	1000	1.000	1.000	.939
1	1000	1.020	1.020	• 958
8	1000	1.040	1.040	.977
9.	1000	1.080	1.080	1.014
10	1000	1.140	1.140	1.070
11	1000	1.230	1.230	1.155
12	1000	1.340	1.340	1.258
13	1000	1.460	1.460	1.371
14	1000	1.590	1.590	1.493
15	1000	1.740	1.740	1.634
TOTALS	15000	17.340	17.340	16.282
				===================
	BASIC MARGIN =		ACCUMULATED	
		BASIC MARGIN	BASIC MARGIN	BASIC MARGIN
YEAR	(11) + (13) N-1	AT ISSUE =	AT ISSUE =	FACTORS =
ħ.	- (24)	(25) X (7)	SUM OF (26)	(27) X (8)
	(25)	(26)	(27)	(28)
3	2 922	2 6 2 3	10 101	10.101
2	2.0022	2.242	16 260	170171 10 709
2	2 7 7 9	2 0 2 1	16 026	17.000
6	2 6 7 2 0	1 770	14.020	
5	2 6 8 1	1 595	10 214	10.001
6	2.6001	1 410	10°710	160202
7	2 ° U O L 7 KK7	10414	0.031	10.000
Ŕ	2.6002	1 120	10217	120219
0	2073 7 &AL	1 003	2020	130747
10	20000 2 55A	1.0002	40021 2025	120771
11	2000	0000 740	3.043	11.040
12	2040J 7 343	0 107 K70	20742	¥ = 4 30 7 4 4 0
12	20302	• 0 / U	20113	1.002
17	20297	. 580	1.503	5.827
15	1.986	。 . 424	∘ <i>∀∠3</i> ∘424	3.935 1.988
TOTALS	38.018	19.191		190,777
	*********	***		

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### 25. POLICY INPUT DATA

#### TERM 15 YEARS AGE 25

INSURANCE AMOUNT	(40)	\$ 10,000
COMMISSION RATE - 1ST. YEAR	(41)	50%
COMMISSION RATE - 2ND. YEAR	(42)	10%
COMMISSION RATE - 3-10 YEARS	(43)	5%
POLICY FEE (TOTAL) CALCULATED FROM MASTER FILE DATA	(44)	\$ 9.00

VEAD	POLICY FEE PER UNIT =	COMMISSION PER UNIT =	GENERAL AND Tax expense =	EXPENSE PER POLICY/UNIT =
N	(44)X(17)/(40)	((13) + (50)) X (41,42,43)	((13) + (50)) X (14)	(16)X(17)/(40)
	(50)	(51)	(52)	(53)
1	•900	2.260	1.130	2.500
2	<b>•90</b> 0	。452	.090	.500
3	<b>•90</b> 0	• 226	.090	.500
4	•900	• 226	.090	•500
5	<b>•900</b>	• 226	.090	.500
6	<b>•9</b> 00	.226	.090	.500
7	•900	.226	.090	.500
8	•900	<b>₀226</b>	<u>• 09</u> 0	.500
9	<b>•9</b> 00	₀226	.090	.500
10	•900	°226	.090	.500
11	<u>•</u> 900	-	<b>.</b> 090	• 500
12	•900	-	۰ <b>0</b> 90	.500
13	<u>。</u> 900	-	۰ <b>090</b>	.500
14	•900	-	۰ <b>090</b>	• 500
15	•900		•090	.500
OTAL S	13.500	4.520	2.390	9.500
		****==========	= == == = = = = = = = = = = = = = = = =	***********
	MARGIN	MARGIN	ACCUMULATED	MARGIN
	ADJUSTMENT =	ADJUSTMENT	MARGIN ADJUST-	ADJUSTMENT
		AT ISSUE =	MENT AT ISSUE	FACTORS =
EAR	(51)*(52)*(15)			
N	+(53)-(50)	(54) X (7)	= SUM OF (55)	(56) X (8)
	(54)	(55)	(56)	(57)
1	14,990	14.990	15 620	15 (20
2	.342	2789	2202U	10.020
3	.116	.086	241	e (40 / E0
4	.116	077	. 255	394
5	.116	.069	.178	201
6	.116	.061	. 109	207
7	.116	.055	.048	101
8	.116	.050	007	016
9	.116	.045	057	- 148
10	.116	.040	102	- 295
11	110	034	142	455
12	110	031	108	381
13	110	028	077	- 299
14	110	026	049	- 209
15	110	023	023	108
DTALS	15.710	15.620		15,906
				~~~~

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26. POLICY CALCULATIONS - TERM 15 YEARS AGE 25 (CONT • D)

	PROSPECTIVE	TOTAL
	PERFORMANCE	PROSPECTIVE
	PER UNIT =	PERFORMANCE =
YEAR		
	(28) - (57)	(58)X(40)/(17)
N		
	(58)	(59)
1	3.571	35.71
2	18.642	186.42
3	18.383	183.83
4	17.697	176.97
5	16.981	169.81
6	16.178	161.78
7	15.118	151.18
8	13.961	139,61
9	12.699	126.99
10	11.341	113,41
11	9.891	98,91
12	8.043	80.43
13	6.126	61.26
14	4.144	41.64
15	2-096	20.96
TOTALS	174.871	1,748.71
	***============	

#### 31. BASIC INPUT DATA - AGE 25

YFAR	MORTALITY	RATE	LAPSE RATE		INTEDEST
( C A)	(X)+N-1		(X)+N-1		RATE
N					
	(1)		(2)		(3)
1	.00085		.10		.0600
2	°000A0		.06		.0600
د ،	°00030		°05		.0600
÷ ج	-00100		°05		-0600
6	00100		•05		.0600
7	00102		• U4 04		.0600
9	00102		°04 04		.0600
0 0	00104		₀ U4 04		.0000
10	00116		÷0،		.0600
11	.00122		.04		.0800
12	.00134		°05 02		.0600
12	.00146		°03 02		.0600
14	.001 59		°03		.0600
15	.00176		03		.0000
4.2					°0000
TOTALS	S01734		•66		
		32. BASIC CALCU	LATIONS		
		======================================	*****		PERSISTENCY
	S	COMPOUND P =	DISCOUNT	PERSISTENCY	AND DISCOUNT
	p	(X)	FACTOR	AND DISCOUNT	
	(X)+N-1			FACTOR =	FACTOR =
YEAR		(4) X(5)	N-1		
	= 1 - (1) - (2)	N-1 N-1	= V	(5) X (6)	1/(7)
N		· _ ·· _	·		
	(4)	(5)	(6)	(7)	(8)
1	.89915	1.00000	1.00000	1.00000	1.00000
2	.93910	.89915	.94340	•84826	1.17888
3	.94905	.84439	.89000	.75151	1.33066
4	·94900	.80137	.83962	.67285	1.48622
5	.94900	•76050	.79209	•60238	1.66008
6	.95900	.72171	.74726	.53931	1.85422
7	.95898	.69212	.70496	•48792	2.04952
8	.95896	.66373	•66506	.44142	2.26542
9	. 95892	.63649	.62741	.39934	2.50413
10	. 95886	•61034	.59190	• 36126	2.76809
11	° 70811	₀ 58523	• 55839	.32679	3.06007
12	A	~		· · · · · · · · · · · · · · · · · · ·	
	. 96866	• 56695	.52679	• 29800	3.34829
13	。96866 。96854	•56695 •54918	• 52679 • 49697	•29866	3.34829 3.66394
13 14	。96866 。96854 。96841	•56695 •54918 •53190	•52679 •49697 •46884	•29866 •27293 •24938	3.34829 3.66394 4.00994

TOTAL 14.32266

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C.20

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#### 33. PLAN INPUT DATA

#### ENDOWMENT 15 YEARS AGE 25

				EX	PENSE FAC	TORS	
YEAR	CSV N	DIVIDEND RATE	GROSS PREMIUM	GENERAL AND TAXES(%)	DOLLARS PER UNIT	DOLLARS PER POLICY	AMOUNT PER UNIT
	(11)	(12)	(13)	(14)	(15)	(16)	(17)
1	22	2.85	64.18	25	10.00	42.00	1,000
2	77	4.26	64.18	2	۰20 • 20	7.00	1,000
3	135	5.71	64.18	2	<b>.</b> 20	7.00	1,000
4	194	7.20	64.18	2	۰20	7.00	1,000
5	256	8.74	64.18	2	•20	7.00	1,000
6	320	10.31	64.18	2	•20	7.00	1,000
7	385	11.94	64.18	2	• 20	7.00	1,000
8	453	13.61	64.18	2	۰20	7.00	1,000
9	524	15.31	64.18	2	.20	7.00	1,000
10	597	17.07	64.18	2	<b>.</b> 20	7.00	1,000
11	672	18.85	64.18	2	•20	7.00	1,000
12	750	20.70	64.18	2	.20	7.00	1,000
13	831	22.63	64.18	2	•20	7.00	1,000
14	914	24.58	64.18	2	•20	7.00	1,000
15	1000	26.61	64.18	2	.20	7.00	1,000
TOTAL	S 7130	210.37	962.70		12.80	140.00	

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C.21

34. PLAN CALCULATIONS - ENDOWMENT 15 YEARS AGE 25

YEAR	AMOUNT AT RISK $= (17) - (11)$	MORTALITY COST	END OF YEAR DEDUCTIONS = (11)+(12)+(22)	BEGINNING OF YR. DEDUCTIONS = (23)/1+(3)
N				
	(21)	(22)	(23)	(24)
1	978	.831	25.681	24.227
2	923	.831	82.091	77.444
3	865	.822	141.532	133.521
4	806	.806	202.006	190.572
5	744	.744	265.484	250.457
6	680	<u>.680</u>	330.990	312.255
7	615	.627	397 <b>.</b> 567	375.063
8	547	. 569	467.179	440.735
9	476	.514	539.824	509.268
10	403	<b>.</b> 459	614.529	579.744
11	328	. 403	691.253	652.125
12	250	°332	771.035	727.392
13	169	.247	853.877	805.544
14	86	.137	938.717	885.582
15	0	-	1026.610	968.500
TOTALS	7870	8.005	7348.375	6932.429
			=================	
	BASIC MARGIN =	BASIC MARGIN	ACCUMULATED Basic Margin	BASIC MARGIN
VEAD	(11) + (13)	AT ISSUE =	AT ISSUE =	FACTORS =
TEAK	- (24)	(25) X (7)	SUM OF (26)	(27) X (8)
N	(25)	(26)	(27)	(28)
		میلیه الایک الایک الایک بالیک شنانه شنانه شایه ملکه الایک الایک میکه میران		
1	39.953	39.953	94.761	94.761
2	8.736	7.410	54.808	64.612
3	7.659	5.756	47.398	63.071
4	8-608	5.792	41.642	61.889
5	7.723	4.652	35.850	59.514
6	7.925	4.274	31.198	57.848
7	9.117	4 . 448	26.924	55.181
8	8.445	3.728	22.476	50.918
9	7.912	3.160	18.748	46.947
10	8.436	3.048	15.588	43.149
11	9.055	2.959	12.540	38.373
12	8.788	2.625	9.581	32.080
13	8.636	2.357	6.956	25.486
14	9.598	2.394	4.599	18.442
15	9.680	2.205	2.205	9.678
TOTALS	160.271	94.761		721.949

#### 35. POLICY INPUT DATA

#### ENDOWMENT 15 YEARS AGE 25

INSURANCE AMOUNT	(40)	\$ 10,000
COMMISSION RATE - IST. YEAR	(41)	30%
COMMISSION RATE - 2ND. YEAR	(42)	10%
COMMISSION RATE - 3-10 YEARS	(43)	5%
POLICY FEE (TOTAL) CALCULATED FROM MASTER FILE DATA	(44)	\$ 9.00

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C.23

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36. ===	POLICY CALCULAT	IONS - ENDOWMENT	15 YEARS AGE 25	C.24
	POLICY FEE PER UNIT =	COMMISSION PER UNIT =	GENERAL AND Tax expense =	EXPENSE PER POLICY/UNIT =
YEAR	(44)X(17)/(40)	((13) + (50)) X (41,42,43)	((13) + (50)) X (14)	(16)X(17)/(40)
N	(50)	(51)	(52)	(53)
		ي بين الي الي من مين من من من من الي	میں اینٹر میں میں میں میں میں این میں میں میں ایک	مسلم شنبة، تقلبه مثلية عند منه فقلة 1966 منه، تقلب الله عنه المراد المراد المراد الم
1	•900	19.520	16.270	4.200
2	<b>.</b> 900	6.510	1.300	<b>。</b> 700
3	。900	3.250	1.300	.700
4	<b>。</b> 900	3.250	1.300	.700
5	<b>°</b> 900	3.250	1.300	.700
6	•900	3.250	1.300	.700
7	<u>ه900</u>	3.250	1.300	.700
8	<u>ه 900</u>	3.250	1.300	.700
9	<b>.9</b> 00	3.250	1.300	.700
10	<b>。90</b> 0	3.250	1.300	.700
11	<u>ه</u> 900		1.300	₀700
12	<b>.</b> 900		1.300	.700
13	<u>ه</u> 900	-	1.300	.700
14	• 900		1.300	<b>.</b> 700
15	<u> </u>		1.300	.700
TOTALS	13.500	52.030	34.470	14.000
		~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~	================	
	MARCIN	MARCIN	ACCUMULATED	MADOVIN
	AD HISTMENT =		MADCIN AD HIST-	AD HICTMENT
			MENT AT ISSUE	EACTORS -
YFAR	(51)+(52)+(15)	AT 1330E -	HEAT AT 1550L	TACIURS =
	+(53)-(50)	(54) × (7)	= SUM DE (55)	(56) X (8)
N			- 3011-01-(755)	()01 × (01
	(54)	(55)	(56)	(57)
1	49,090	49,090	76.867	76 867
2	7.810	6.625	27,777	32,746
3	4,550	3,419	21,152	28-146
4	4.550	3,061	17,733	26-355
5	4,550	2.741	14.672	24,357
6	4,550	2.454	11,931	22,123
7	4.550	2.220	9,477	19,423
8	4.550	2.008	7.257	16.440
9	4.550	1.817	5.249	13.144
10	4.550	1.644	3.432	9,500
11	1.300	.425	1.788	5.471
12	1.300	.388	1.363	4.564
13	1.300	.355	.975	3.572
14	1.300	.324	.620	2.486
15	1.300	• 296	. 296	1.299
TOTALS	99.800	76.867		286,493
		**********		

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36. POLICY CALCULATIONS - ENDOWMENT 15 YEARS AGE 25 (CONT'D)

VEAD	PROSPECTIVE PERFORMANCE PER UNIT =	TOTAL PROSPECTIVE PERFORMANCE =
N	(28) - (57)	(58)X(40)/(17)
	(58)	(59)
1	17 894	179 0/
2	21 966	219 44
2	24 025	340.35
4	25 526	247027
~	25 157	377°34 351 57
4	35°L9( 35 735	371.77
7	37°123 35 750	351025
1	37. (78	351.58
8	34.418	344.8
9	33.803	338.03
10	33.649	336.49
11	32.902	329.02
12	27.516	275.16
13	21.914	219.14
14	15.956	159.56
15	8.379	83.79
TOTALS	435.456	4,354.56
		==================



#### BASIC INPUT DATA - AGE 25 41. C.26 \*\*=== \*\*======\*\*\*\*\* MORTALITY RATE LAPSE RATE YEAR Q W INTEREST (X) ♦N-1 $(X) \leftrightarrow N-1$ RATE Ν (1)(2)(3) .00085 1 .10 .0700 2 .00090 **°**06 .0700 3 .00095 .05 .0700 4 .00100 .05 .0700 5 .00100 .05 .0700 6 .001 00 .04 .0700 7 .00102 .04 .0700 8 .00104 .04 .0700 9 .00108 .04 .0700 10 .00114 •04 .0700 11 .00123 .03 .0700 12 .00134 .03 .0700 13 .00146 .03 .0700 14 .00159 .03 .0700 15 .00174 .03 .0700 TOTALS .01734 . 66 ================== -----------42. BASIC CALCULATIONS S PERSISTENCY S COMPOUND P Ξ DISCOUNT PERSISTENCY AND DISCOUNT Ð (X) FACTOR AND DISCOUNT ACCUMULATION (X)+N-1 FACTOR =FACTOR =YEAR (4) X(5) N-1= 1 - (1) - (2)N-1 N-1 = V (5) X (6) 1/(7) Ν (4) (5) (6)(7) (8)1 .89915 1.00000 1.00000 1.00000 1.00000 2 .93910 .89915 .93458 .84034 1.18999 3 .94905 .84439 .87344 .73752 1.35590 4 .94900 .80137 .81630 .65416 1.52868 5 .94900 .76050 .76290 .58019 1.72357 .95900 6 .72171 .71299 .51457 1.94337 7 .95898 .69212 .66634 .46119 2.16830 8 .95896 .66373 .62275 .41334 2.41932 9 。95892 .58201 .37044 .63649 2.69949 10 .95886 .61034 .54393 .33198 3.01223 11 .96877 .58523 .50835 .29750 3.36134

.47509

.44401

.41496

.38782

.26935

.24384

.22072

.19977

3.71264

4.10105

4.53063

5.00576

TOTAL 14.32266

12

13

14

15

.96866

.96854

.96841

.96826

.56695

.54918

.53190

.51510

#### 43. PLAN INPUT DATA

#### ENDOWMENT 15 YEARS AGE 25

	CASH		0.50141 4.0	EX	PENSE FACT	ORS	
YEAR		DIVIDEND RATE	GROSS PREMIUM	GENERAL AND			AMOUNT PER UNIT
N	13			TANCSIST	01411	( OEIGI	
	(11)	(12)	(13)	(14)	(15)	(16)	(17)
				<b></b>	10.00	(2.00	1 000
1	22	2.85	04.10	25	10.00	42.00	1,000
2	77	4.26	64.18	2	.20	7.00	1,000
3	135	5.71	64.18	2	.20	1.00	1,000
4	194	7.20	64.18	2	<b>.</b> 20	7.00	1,000
5	256	8.74	64.18	2	• 20	7.00	1,000
6	320	10.31	64.18	2	<b>.</b> 20	7.00	1,000
7	385	11.94	64.18	2	۵20 م	7.00	1,000
8	453	13.61	64.18	2	20 ه	7.00	1,000
9	524	15.31	64.18	2	20	7.00	1,000
10	597	17.07	64.18	2	<b>.</b> 20	7.00	1,000
11	672	18.85	64.18	2	<b>.</b> 20	7.00	1,000
12	750	20.70	64.18	2	.20	7.00	1,000
13	831	22.63	64.18	2	.20	7.00	1,000
14	914	24.58	64.18	2	.20	7.00	1,000
15	1000	26.61	64.18	2	.20	7.00	1,000
TOTAL	S 7130	210.37	962.70		12.80	140.00	

C.27

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44. PLAN CALCULATIONS - ENDOWMENT 15 YEARS AGE 25

YEAR	AMOUNT AT RISK	MORTALITY COST	END OF YEAR DEDUCTIONS =	BEGINNING DF YR. DEDUCTIONS
N	= (17) - (11)	$= (1) \times (21)$	(11)+(12)+(22)	= (23)/1*(3)
	(21)	(22)	(23)	(24)
1	978	.831	25.681	24.001
2	923	.831	82.091	76.721
3	865	<u>。</u> 822	141.532	132.273
40 E	806	• 806	202.006	188.791
2	744	.744	265.484	248.116
0 7	680	- 680	330.990	309.336
1	615	.627	397.567	371.558
0	547	• 569	467.179	436.616
30	4 /6	.514	539.824	504.508
10	403	.459	614.529	574.326
12	328	• 403	691.253	646.031
12	250	• 335	771.035	720.593
15	169	.247	853.877	798.016
19	86	.13/	938.717	877.306
17			1026.610	959.449
TOTALS	7870	8.005	7348.375	6867.641
			===============================	
	BASIC MARGIN =		ACCUMULATED	
		BASIC MARGIN	BASIC MARGIN	BASIC MARGIN
YEAR	(11) + (13) N-1	AT ISSUE =	AT ISSUE =	FACTORS =
NI	- (24)	(25) X (7)	SUM OF (26)	(27) X (8)
	(25)	(26)	(27)	(28)
1	40 170	(0.170		
2	90.179	40.179	113.552	113.552
2	8 907	1.949	13.313	87.313
4	10 389	6 704	67.424	88.708
5	10.064	5 2 2 0	20.022	89.970
6	10.844	5.580	52.0009	89.121
7	12-622	5.821	40.220	89.823
8	12,564	5,193	26 910	88.120
9	12,672	6.694	20 626	84.238
10	13,854	4.599	23.020	17.70
11	15,149	4,507	270 732	(2.101
12	15,587	4,198	200000	00°340 E0 754
13	16.164	3,941	11.678	200 (20 / 7 / 07
14	17.874	3,945	7.497	41.001
15	18.731	3.742	3.742	18.732
TOTALS	225.059	113.552		1114.875
	============			******

#### 45. POLICY INPUT DATA

ENDOWMENT 15 YEARS AGE 25

INSURANCE AMOUNT	(40)	\$ 10,000
COMMISSION RATE - 1ST. YEAR	(41)	30%
COMMISSION RATE - 2ND. YEAR	(42)	10%
COMMISSION RATE - 3-10 YEARS	(43)	5%
POLICY FEE (TOTAL) CALCULATED FROM MASTER FILE DATA	(44)	\$ 9.00

C.29

46 。 ===	POLICY CALCULAT	IONS - ENDOWMENT	15 YEARS AGE 25	C.30
NEAD	POLICY FEE PER UNIT =	COMMISSION PER UNIT =	GENERAL AND TAX EXPENSE =	EXPENSE PER POLICY/UNIT =
YEAR	(44)X(17)/(40)	((13) + (50)) X (4).42.43)	((13) + (50)) x (14)	(16) × (17) / (40)
N		~ (129-29-3)		
	(50)	(51)	(52)	(53)
1	° 900	19.520	16.270	4.200
2	•900	0°210	1.300	.700
5	•900	3.250	006.1	.700
5	° 900	3.250	1.300	.700
ر- م	.900	3.250	1.300	.700
7	.900	3.290	1.300	.700
0	° 200	3.290	1.300	.700
0	• 900	3.250	1.300	. 700
10	.900	3.250	1.300	.700
10	° 200	3.250	1.300	.700
11	000		1.300	.700
12	.900	-	1.300	• 700
13	.900		1.300	.700
19	- <del>9</del> 00		1.300	• 700
10	0000	یسی میں طاق طله جول مان خون میں علیہ میں	10300	• / 00
TOTALS	13.500	52.030	34.470	14.000
	MARGIN	MARGIN	ACCUMULATED	MARGIN
	ADJUSTMENT =	ADJUSTMENT	MARGIN ADJUST-	ADJUSTMENT
		AT ISSUE =	MENT AT ISSUE	FACTORS =
VEAR	(51) + (52) + (15)			
N	*(53)-(50)	(54) X (7)	= SUM OF (55)	(56) X (8)
	(54)	(55)	(56)	(57)
3	49-090	49,090	75 743	75 742
2	7,810	6.563	26.653	31.717
3	4,550	3, 356	20,090	27,240
4	4,550	2,976	16.734	25.581
5	4,550	2-640	13,758	23.713
6	4,550	2,341	11,118	21-606
7	4,550	2.098	8.777	19.031
8	4,550	1,881	6.679	16.159
9	4.550	1.686	4.798	12,952
10	4.550	1.511	3.112	9,374
11	1.300	. 387	1.601	5,382
12	1.300	.350	1.214	4,507
13	1.300	317	. 864	3,543
14	1.300	287	547	2.478
15	1.300	.260	• 260	1.301
τηται ς	99,800	75,743		280, 327
		*****		

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C.31

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# 46. POLICY CALCULATIONS - ENDOWMENT 15 YEARS AGE 25 (CONT'D)

VFAR	PROSPECTIVE PERFORMANCE PER UNIT =	TOTAL PROSPECTIVE PERFORMANCE =
	(28) - (57)	(58)X(40)/(17)
N 	(58)	(59)
3	33 000	
1	37.809	378.09
2	55.596	555.96
3	61.468	614.68
4	64.389	643.89
5	66.014	660.14
6	68.217	682.17
7	69.089	690.89
8	68.079	680.79
9	67.023	670.23
10	65.727	657.27
11	62.964	629.64
12	54.249	542.49
13	44.144	441.44
14	32.349	323,49
15	17.431	174.31
TOTALS	834.548	8,345.48



# 51. BASIC INPUT DATA - AGE 25

	MORTALITY RATE	LAPSE RATE	
YEAR	Q	W .	INTEREST
61	(X)+N-1	(X)+N-1	RATE
	(1)	(2)	(3)
1	•00076	.10	<u> </u>
2	.00081	<u>。</u> 06	•0650
3	.00085	.05	•0650
4	<u>。00090</u>	۰05	.0650
5	<u>。00090</u>	.05	°0620
6	.00090	。04	.0650
7	۰00092	<b>。</b> 04	.0650
8	·00094	。04	.0650
9	.00097	.04	.0650
10	.00103	.04	<b>.</b> 0650
11	.00111	.03	°0620
12	.00121	۰03	.0650
13	.00131	° 03	.0650
14	.00143	°03	.0650
15	.00157	.03	.0650
TOTAL	S .01561	° 66	
		*****	

#### 52. BASIC CALCULATIONS

		S			PERSISTENCY
	S	COMPOUND P =	DISCOUNT	PERSISTENCY	AND DISCOUNT
	Р	(X)	FACTOR	AND DISCOUNT	ACCUMULATION
	(X)+N-1			FACTOR =	FACTOR =
YEAR		(4) X(5)	N-1		
	= 1 - (1) - (2)	N-1 N-1	= V	(5) X (6)	1/(7)
N					
	(4)	(5)	(6)	(7)	(8)
				ورب برود بالد منه منه من خان خان منه الله من منه الله	
1	<b>。89924</b>	1.00000	1.00000	1.00000	1.00000
2	°93919	<b>.</b> 89924	.93897	<b>。</b> 84436	1.18433
3	.94915	<b>.</b> 84456	.88166	.74461	1.34298
4	。94910	.80161	.82785	.66361	1.50691
5	。94910	.76081	.77732	.59139	1.69093
6	<b>°95910</b>	.72208	.72988	<b>°</b> 2703	1.89743
7	<b>°</b> 95908	<b>°</b> 69255	<b>.68533</b>	.47463	2.10690
8	<b>•9590</b> 6	.66421	<b>.64351</b>	.42743	2.33956
9	。95903	<b>°</b> 63702	<b>°60423</b>	.38491	2.59801
10	.95897	.61092	.56735	.34661	2.88509
11	• 96889	<b>.</b> 58585	<b>°</b> 53273	.31210	3.20410
12	.96879	. 56762	.50021	°58393	3.52199
13	.96869	<b>.</b> 54990	.46968	<b>•25828</b>	3.87177
14	。96857	• 53268	.44102	·23492	4.25677
15	<b>。</b> 96843	.51594	.41410	.21365	4.68055

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TOTAL 14.32439

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#### 53. PLAN INPUT DATA

#### ENDOWMENT 15 YEARS AGE 25

			EXPENSE FACTORS				
YEAR	CSV N	DIVIDEND RATE	GROSS PREMIUM	GENERAL AND TAXES(%)	DOLLARS PER UNIT	DOLLARS PER POLICY	AMOUNT PER UNIT
[V]	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Ţ	22	2.85	64.18	25	10.00	42.00	1,000
2	77	4.26	64.18	2	• 20	7.00	1,000
3	135	5.71	64.18	2	°50	7.00	1,000
4	194	7.20	64.18	2	°50	7.00	1,000
5	256	8.74	64.18	2	•20	7.00	1,000
6	320	10.31	64.18	2	•20	7.00	1,000
7	385	11.94	64.18	2	<b>.</b> 20	7.00	1,000
8	453	13.61	64.18	2	°50	7.00	1,000
9	524	15.31	64.18	2	.20	7.00	1,000
10	597	17.07	64.18	2	<b>0</b> 20 و	7.00	1,000
11	672	18.85	64.18	2	<b>°</b> 20	7.00	1,000
12	750	20.70	64.18	2	°50	7.00	1,000
13	831	22.63	64.18	2	<b>。</b> 20	7.00	1,000
14	914	24.58	64.18	2	.20	7.00	1,000
15	1000	26.61	64.18	2	۰20	7.00	1,000
TOTALS	5 7130	210.37	962.70		12.80	140.00	

C.33

54. PLAN CALCULATIONS - ENDOWMENT 15 YEARS AGE 25

YEAR	AMOUNT AT RISK	MORTALITY COST	END OF YEAR DEDUCTIONS =	BEGINNING OF YR. DEDUCTIONS
N		- (1/ ~ (21/	(11)*(12)*(22)	= (23)/1+(3)
	(21)	(22)	(23)	(24)
1	978	.743	25.593	24.031
2	923	.748	82.008	77.003
3	865	.735	141.445	132.812
4	806	.725	201.925	189.601
5	744	.670	265.410	249.211
6	680	.612	330.922	310.725
7	615	<b>• 56</b> 6	397.506	373.245
8	547	.514	467.124	438.614
9	476	. 462	539.772	506.828
10	403	.415	614.485	576.981
11	328	. 364	691.214	649.027
12	250	.303	771.003	723.946
13	169	.221	853.851	801.738
14	86	.123	938.703	881.411
15	0	یونید موالب موجود منطقه موجود موجود موجود موجود موجود موجود موجود موجود موجود	1026.610	963.953
TOTALS	7870	7.201	7347.571	6899.126
	**********		******	
	BASIC MARGIN =	DACTC MADOTH	ACCUMULATED	
	8333 - 13 <b>7</b> 35	BASIL MAKGIN	BASIC MARGIN	BASIC MARGIN
YEAR	N-1	AT 1550E =	AT 1550E =	FACTORS =
N1	- (24)	(25) X (7)	SUM OF (26)	(27) X (8)
N	(25)	(26)	(27)	(28)
		and and the state and and the same and and any spin and and		مند می جود می باند با با وی جود بود بود بود این می می می با
1	40.149	40.149	105.102	105.102
2	9.177	7.749	64.953	76.926
3	8.368	6.231	57.204	76.824
49	9.579	6.357	50.973	76.812
5	8.969	5.304	44.616	75.443
6	9.405	4.983	39.312	74.592
1	10.935	5.190	34.329	72.328
8	10.566	4.516	29.139	68.172
10	10.352	3.985	24.623	63.971
11	110177 10 150	<b>⇒</b> •88∠	20.638	59.542
12	120105	30173	16.756	53.688
12	120234	30414	12.963	45.656
13	12 760	2°214	7.489	36.739
15	13.109	3.040	8°212 3°040	26.711 14.229
τηται ς	103 574	105 100		
IUIMLJ	======================================	107.102		720°(3) ==============

### 55. POLICY INPUT DATA

## ENDOWMENT 15 YEARS AGE 25

INSURANCE AMOUNT	(40)	\$ 10,000
COMMISSION RATE - 1ST. YEAR	(41)	30%
COMMISSION RATE - 2ND. YEAR	(42)	10%
COMMISSION RATE - 3-10 YEARS	(43)	5%
POLICY FEE (TOTAL) CALCULATED FROM MASTER FILE DATA	(44)	\$ 9.00

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C.35

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YEAR	POLICY FEE PER UNIT =	COMMISSION PER UNIT = {(13) + (50))	GENERAL AND TAX EXPENSE = {(13) + (50)}	EXPENSE PER POLICY/UNIT =
	(44)X(17)/(40)	X (41,42,43)	X (14)	(16)X(17)/(40)
N	(50)	(51)	(52)	(53)
1	-900	19.520	16.270	4.200
2	•900	6.510	1.300	.700
3	.900	3.250	1.300	.700
4 E	.900	3.250	1.300	.700
5	.900	3.250	1.300	.700
0 7	.900	3.250	1.300	.700
(	-900	3.250	1.300	.700
0	• 900	3.250	1.300	.700
10	° 200	3.250	1.300	.700
8 1 TO	s 900	3.250	1.300	.700
10	° 900	_	1.300	• 700
12			1.300	.700
13	000	_	1 300	.700
15	.900		1.300	.700
TOTALS	13.500	52.030	34.470	14.000
	*======			
	MARGIN	MARGIN	ACCUMULATED	MARGIN
	ADJUSTMENT =	ADJUSTMENT	MARGIN ADJUST-	ADJUSTMENT
VE 4 0	1511.1501.1151	AT ISSUE =	MENT AT ISSUE	FACTORS =
YEAK	{51}+(52)+(15)	(E/\ V (7)		
N	*1001-1001	(341 × (7)	= SUM UF (55)	(56) X (8)
••	(54)	(55)	(56)	(57)
1	49.090	49.090	76.307	76.307
2	7.810	6.594	27.217	32.234
3	4.550	3.388	20.623	27.696
4	4.550	3.019	17.235	25.972
5	4.550	2.691	14.216	24.038
6	4.550	2.398	11.525	21.868
r	4.550	2.160	9.127	19.230
8	4.550	1.945	6.967	16.300
9	4°220		5.022	13.04/
10	4.770	1.3//	3.211	9.431
11	1 200	• <del>4</del> 08	10094	D.428
12	1 200	×0C。 774	1.200	40730
15	1.200	2050	۰ 717 ۵ ۵ ۵	2°229
15	1.300	. 278	° 283 ° 278	1.301
TOTALS	99.800	76.307		283.434
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56. POLICY CALCULATIONS - ENDOWMENT 15 YEARS AGE 25

# 56. POLICY CALCULATIONS - ENDOWMENT 15 YEARS AGE 25 (CONT'D)

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VEAD	PROSPECTIVE PERFORMANCE PER UNIT =	TOTAL PROSPECTIVE PERFORMANCE =	
N	(28) - (57)	(58)X(40)/(17)	
	(58)	(59)	
1	28.795	287.95	
2	44.692	446.92	
3	49.128	491.28	
4	50.840	508.40	
5	51.405	514.05	
6	52.724	527.24	
7	53.098	530.98	
8	51.872	518.72	
9	50.924	509.24	
10	50.105	501.05	
11	48.260	482.60	
12	41.120	411.20	
13	33.181	331.81	
14	24.229	242.29	
15	12.928	129.28	
TOTALS	643.301	6,433.01	




## 61. BASIC INPUT DATA - AGE 25

YEAR	MORTALITY RATE	LAPSE RATE	INTEREST
N		12/+N-1	RATE
	(1)	(2)	(3)
1	.00094	. 10	
2	•00099	.06	-0650
3	.00105	.05	-0650
4	.00110	。05	.0650
5	.00110	.05	-0650
6	.00110	.04	0650
7	.00112	.04	-0650
8	.00114	.04	-0650
9	.00119	.04	-0650
10	.00125	.04	-0650
11	.00135	• 03	-0650
12	.00147	.03	-0650
13	.00161	.03	-0650
14	.00175	.03	-0650
15	.00191	.03	.0650
2 14707		and a state while these states while while while while while while while	
IUIALS	• 01401	· 66	
=			

## 62. BASIC CALCULATIONS

	_	S			PERSISTENCY
	S	COMPOUND P =	DISCOUNT	PERSISTENCY	AND DISCOUNT
	Р	(X)	FACTOR	AND DISCOUNT	ACCUMULATION
	(X)+N-1			FACTOR =	FACTOR =
YEAR		(4) X(5)	N-1		
	= 1 - (1) - (2)	N-1 N-1	= V	(5) X (6)	1/(7)
Ν					
	(4)	(5)	(6)	(7)	(8)
		while when well approved when allow allow data data data approved to an			
1	<b>.</b> 89906	1.00000	1.00000	1.00000	1.00000
2	<b>•93901</b>	<b>.</b> 89906	.93897	.84419	1.18457
3	。94895	<b>.</b> 84423	.88166	.74432	1,34351
4	。94890	.80113	<b>.</b> 82785	•66322	1.50780
5	。94890	.76019	.77732	• 59091	1.69231
6	.95890	.72134	.72988	. 52649	1.89937
7	<b>° 9288</b> 8	.69169	.68533	. 47404	2,10953
8	<b>•95886</b>	°66325	.64351	.42681	2.34296
9	。95881	۰ <b>63596</b>	<b>.60423</b>	.38427	2.60234
10	<b>。</b> 95875	<b>.</b> 60976	.56735	.34595	2.89059
11	<u>。</u> 96865	.58461	。53273	.31144	3,21089
12	。96853	<b>°</b> 56628	<b>°</b> 50021	.28326	3,53033
13	<u>。</u> 96839	<b>• 54846</b>	.46968	.25760	3,88199
14	<b>°96</b> 825	•53112	.44102	.23423	4.26931
15	<b>°</b> 96809	.51426	.41410	.21296	4.69572

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TOTAL 14.32093

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C.38

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### 63. PLAN INPUT DATA

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### ENDOWMENT 15 YEARS AGE 25

	CASH			EX	PENSE FACT	ORS	
YEAR	CSV N	DIVIDEND RATE	GROSS PREMIUM	GENERAL AND TAXES(%)	DOLLARS PER UNIT	DOLLARS PER POLICY	AMOUNT PER UNIT
N	(11)	(12)	(13)	(14)	(15)	(16)	(17)
9444	22	2.85	64.18	25	10.00	42.00	1,000
2	135	4°26 5°71	64.18 64.18	2	°20 °20	7.00	1,000
4	194	7.20	64.18	2	.20	7.00	1,000
5	256	8.74	64.18	2	° 20	7.00	1,000
6	320	10.31	64.18	2	.20	7.00	1,000
7	385	11.94	64.18	2	.20	7.00	1,000
8	453	13.61	64.18	2	.20	7.00	1,000
9	524	15.31	64.18	2	۵20	7.00	1,000
10	597	17.07	64.18	2	•20	7.00	1,000
11	672	18.85	64.18	2	° 20	7.00	1,000
12	750	20.70	64.18	2	°50	7.00	1,000
13	831	22.63	64.18	2	· 20	7.00	1,000
14	914	24.58	64.18	2	<b>.</b> 20	7.00	1,000
15	1000	26.61	64.18	2	.20	7.00	1,000
TOTAL	S 7130	210.37	962.70 ======		12.80	140.00	

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### C.39

64. PLAN CALCULATIONS - ENDOWMENT 15 YEARS AGE 25

YEAR	AMOUNT AT RISK	MORTALITY COST	END OF YEAR DEDUCTIONS =	BEGINNING OF YR. DEDUCTIONS
N	= (17) - (11)	$= (1) \times (21)$	(11)*(12)*(22)	= (23)/1+(3)
	(21)	(22)	(23)	(24)
1	978	.919	25.769	24.196
2	923	.914	82.174	77.159
2 4	865	• 908	141.618	132.975
ч Б	806	. 887	202.087	189.753
2	144	-818	265.558	249.350
7	080	• (48	331.058	310.853
7 Q	547	• 689	397.629	373.361
0	341		467.234	438.717
10	470	• 266	539.8/6	506.926
10	220	ه ۲U4 د د ۲	614.574	577.065
12	250	° 443	691.293	649.101
12	250	806.	//1.068	724.008
16	107	0212	853.902	801.786
15	. 0	• 1 7 1	938.731	881.438
~ /		یسید بیری سایی زیرین دادید اشته کاری میک سای سای با بیری میک میرد است.	1026.510	963.953
TOTALS	7870	8.811	7349.181	6900.641
			*****	******
	BASIC MARGIN =		ACCUMULATED	
		BASIC MARGIN	BASIC MARGIN	BASIC MARGIN
YEAR	(11) + (13) N-1	AT ISSUE =	AT ISSUE =	FACTORS =
A 1	- (24)	(25) X (7)	SUM OF (26)	(27) X (8)
N	(25)	(26)	(27)	(28)
	یں۔ وید <u>مدر میں سے م</u> لائے میں			المراجع
1	39.984	39.984	104.119	104.119
2	9.021	7.615	64.135	75.972
3	8.205	6.107	56.520	75.935
4	9.427	6.252	50.413	76.013
5	8.830	5.218	44.161	74.734
6 7	9.327	4.911	38.943	73.967
1	10.819	5.129	34.032	71.792
8	10.463	4.466	28.903	67.719
10	10-254	3.940	24.437	63.593
11	110115	3.845	20.497	59.248
12	120019	3.762	16.652	53.468
12	120112	3.448	12.890	45.506
10	120344	3.193	9.442	36.654
19	120142	3.219	6.249	26.679
10	140221	3.030	3.030	14.228
TOTALS	192.059	104.119		919.627

#### 65. POLICY INPUT DATA \_\_\_\_\_

#### ENDOWMENT 15 YEARS AGE 25 -----

INSURANCE AMOUNT	(40)	\$ 10,000
COMMISSION RATE - 1ST. YEAR	(41)	30%
COMMISSION RATE - 2ND. YEAR	(42)	10%
COMMISSION RATE - 3-10 YEARS	(43)	5%
POLICY FEE (TOTAL) CALCULATED FROM MASTER FILE DATA	(44)	\$ 9.00

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C.41

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	POLICY FEE PER UNIT =	COMMISSION PER UNIT =	GENERAL AND TAX FXPFNSF =	EXPENSE PER
YEAR	(44)X(17)/(40)	((13) + (50)) X (41,42,43)	((13) + (50)) X (14)	(16)X(17)/(40)
	(50)	(51)	(52)	(53)
1	<b>•</b> 900	19.520	16.270	4 200
2	•900	6.510	1.300	700
3	<b>~90</b> 0	3.250	1,300	.700
4	<b>~</b> 900	3.250	1,300	700
5	<b>。</b> 900	3.250	1.300	700
6	<u>。</u> 900	3,250	1.300	700
7	<b>°</b> 900	3,250	1 300	.700
8	•900	3,250	1.300	- 700
9	<b>•90</b> 0	3.250	1-300	700
10	<b>.</b> 900	3.250	1,300	700
11	<b>•</b> 900		1.300	- 700
12	•900	-	1.300	.700
13	。900	-	1.300	-700
14	•900	-	1.300	- 700
15	.900	_	1.300	•700
TOTALS	13.500	52.030	34.470	14.000
			=======================================	=================
	MARGIN	MARGIN	ACCUMULATED	MARGIN
	ADJUSIMENI =	ADJUSTMENT	MARGIN ADJUST-	ADJUSTMENT
	/ 5 1 1 / ( 5 2 1 . ( 1 5 1	AT ISSUE =	MENT AT ISSUE	FACTORS =
CAR	(51) + (52) + (15)			
N	e(33)=(30)	(54) X (7)	= SUM OF (55)	(56) X (8)
	(54)	(55)	(56)	(57)
1	49.090	49.090	76,283	76 202
2	7.810	6.593	27.193	32.212
3	4.550	3.387	20.600	27.676
4	4.550	3.018	17.213	25,954
5	4.550	2.689	14,195	24.022
6	4.550	2.396	11.506	21-854
7	4.550	2.157	9.110	19,218
8	4.550	1.942	6.953	16,291
9	4.550	1.748	5.011	13,040
10	4.550	1.574	3.263	9,432
11	1.300	<b>.</b> 405	1.689	5.423
12	1.300	<b>• 368</b>	1.284	4.533
13	1.300	<b>°</b> 335	.916	3.556
14	1.300	.304	.581	2.480
15	1.300	.277.	. 277	1.301
OTALS	99.800	76.283		283.275
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C.43

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## 66. POLICY CALCULATIONS - ENDOWMENT 15 YEARS AGE 25 (CONT °D)

WEAD	PROSPECTIVE PERFORMANCE PER UNIT =	TOTAL PROSPECTIVE PERFORMANCE =
TEAK	(28) - (57)	(58)X(40)/(17)
N	(58)	(59)
Ł	27.836	278.36
2	43.760	437.60
3	48.259	482.59
4	50.059	500°23
5	50.712	507.12
6	52.113	521.13
7	52.574	525.74
8	51.428	514.28
9	50.553	505.53
10	49.816	498.16
11	48.045	480.45
12	40.973	409.73
13	33.098	330,98
14	24.199	241,99
15	12.927	129.27
TOTALS	636.352	6,363.52



71.	BASIC	INPUT	DATA -	AGE 25
====	======	======		=====

YEAR	ORTALITY RATE	LAPSE RATE	T N T C D C O T
N	(X)+N-1	(X)+N-1	RATE
	(1)	(2)	(3)
1	•00085	•090	
2	• 00090	.054	0650
3	°00095	.045	.0650
4	.00100	.045	-0650
5	.00100	°045	-0650
6	- 001 CO	.036	- 0650
7	.00102	.036	.0650
8	.00104	.036	.0650
9	.00108	036	0650
10	.00114	036	0650
11	.00123	.027	0650
12	-00134	-027	°0050
13	.00146	.027	°0050
14	.00159	.027	•0050 0450
15	。00174	.027	°0850 °0650
TOTALS	.01734		
=			

# 72. BASIC CALCULATIONS

	S P (X)+N-1	COMPOUND P = (X)	DI SCOUNT FACTOR	PERSISTENCY AND DISCOUNT FACTOR =	PERSISTENCY AND DISCOUNT ACCUMULATION FACTOR =
YEAR		(4) X(5)	N-1		
• ·	= 1 - (1) - (2)	N-1 N-1	= V	(5) X (6)	1/(7)
N					
	(4)	(5)	(6)	(7)	(8)
1	•90915	1.00000	1.00000	1.00000	1.00000
2	.94510	.90915	.93897	<b>°</b> 85366	1.17143
3	<b>•95405</b>	<b>.</b> 85924	.88166	.75756	1.32003
4	<b>.</b> 95400	.81976	<b>°82</b> 785	•67864	1.47354
5	•95400	.78205	.77732	.60790	1.64501
6	.96300	.74608	.72988	\$54455	1.83638
7	<b>.9629</b> 8	<b>~71848</b>	<b>•68533</b>	. 49240	2.03087
8	.96296	.69188	.64351	.44523	2.24603
9	。96292	•66625	.60423	.40257	2.48404
10	<b>°</b> 96286	.64155	.56735	.36398	2.76740
11	.97177	.61772	<b>°</b> 53273	.32908	3.03877
12	.97166	<b>°</b> 60028	.50021	.30027	3.33034
13	.97154	•58327	.46968	27395	3 65030
14	.97141	•56667	.44102	24991	4.00144
15	.97126	。55047	.41410	22795	4.38693
	وجرد بيبين برواب الشارموني فلنك خالك فاؤته فالاه وجرد ججه				

TOTAL 14.38866

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## 73. PLAN INPUT DATA

### ENDOWMENT 15 YEARS AGE 25

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			DECHI AD	E>	PENSE FACT	ORS	
YEAR	CSV N	DIVIDEND RATE	GROSS PREMIUM	GENERAL AND TAXES(%)	DOLLARS PER UNIT	DOLLARS PER POLICY	AMOUNT PER UNIT
	(11)	(12)	(13)	(14)	(15)	(16)	(17)
1	22	2.85	64.18	25	10.00	42.00	1,000
2	135	4°26 5°71	64.18 64.18	2	·20	7.00 7.00	1,000
4	194	7.20	64.18	2	.20	7.00	1,000
5	256 320	8.74	64.18	2	•20	7.00	1,000
7	385	11.94	64.18	2	•20	7.00	1,000
8 9	453 524	13.61	64.18	2	°20	7.00	1,000
10	597	17.07	64.18	2	.20	7.00	1,000
11 12	672 750	18.85 20.70	64.18 64.18	2	•20 •20	7.00	1,000
13	831	22.63	64.18	2	·20	7.00	1,000
14 15	914 1000	24.58 26.61	64.18 64.18	2 2	•20 •20	7.00 7.00	1,000 1,000
TOTAL	S 7130	210.37	962.70		12.80	140.00	

74. PLAN CALCULATIONS - ENDOWMENT 15 YEARS AGE 25

YEAR	AMOUNT AT RISK	MORTALITY COST	END OF YEAR Deductions =	BEGINNING OF YR. DEDUCTIONS
<b>A.</b> †	= (17) $-$ (11)	$=$ (1) $\times$ (21)	(11)*(12)*(22)	= (23)/1*(3)
	(21)	(22)	(23)	(24)
1	978	.831	25.681	24,114
2	923	.831	82.091	77.081
3	865	.822	141.532	132.894
4	806	<u>。806</u>	202.006	189.677
5	744	.744	265.484	249.281
6	680	.680	330.990	310.789
7	615	.627	397.567	373.302
8	547	<u>。</u> 569	467.179	438.666
9	476	.514	539.824	506.877
10	403	. 459	614.529	577.023
11	328	. 403	691.253	649.064
12	250	.335	771.035	723.977
13	169	.247	853.877	801.762
14	86	.137	938.717	881.424
15	0		1026.610	963.953
TOTALS	7870	8.005	7348.375	6899.884
	================	*====*******	=================	==================
	BASIC MARGIN =		ACCUMULATED	
		BASIC MARGIN	BASIC MARGIN	BASIC MARGIN
YEAR	(11) + (13) N-1	AT ISSUE =	AT ISSUE =	FACTORS =
	- (24)	(25) X (7)	SUM OF (26)	(27) X (8)
N	(25)	(26)	(27)	(28)
	مانتها التكليم بينانية التكليم المانية المانية المانية المانية المانية المانية المانية المانية الم			
1	40.066	40.066	107.063	107.063
2	9.099	7.767	66.997	78.482
3	8.286	6.277	59.230	78.185
4	9.503	6.449	52.953	78.028
5	8.899	5.410	46.504	76.500
6	9.391	5.114	41.094	75.464
7	10.878	5.356	35.980	73.071
8	10.514	4.681	30.624	68.782
9	10.303	4.148	25.943	64.443
10	11.157	4.061	21.795	59.880
11	12.116	3.987	17.734	53.890
12	12.203	3.664	13.747	45.782
13	12.418	3.402	10.083	36.806
14	13.756	3.438	6.681	26.734
15	14.227	3.243	3.243	14.227
TOTALS	192.816	107.063		937,337

## 75. POLICY INPUT DATA

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### ENDOWMENT 15 YEARS AGE 25

INSURANCE AMOUNT	(40)	\$ 10,000
COMMISSION RATE - 1ST. YEAR	(41)	30%
COMMISSION RATE - 2ND. YEAR	(42)	10%
COMMISSION RATE - 3-10 YEARS	(43)	5%
POLICY FEE (TOTAL) CALCULATED FROM MASTER FILE DATA	(44)	\$ 9.00

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YEAR	POLICY FEE PER UNIT = (44)X(17)/(40)	COMMISSION PER UNIT = {(13) + {50}) X {41,42,43}	GENERAL AND TAX EXPENSE = ((13) + (50)) X (14)	EXPENSE PER POLICY/UNIT = (16)X(17)/(40)
14	(50)	(51)	(52)	(53)
1	-900	19,520	16-270	<b>4</b> , 200
2	-900	6-510	1.300	.700
3	.900	3,250	1,300	.700
4	.900	3,250	1,300	-700
5	<u> </u>	3,250	1,300	.700
6	.900	3,250	1.300	.700
7	.900	3,250	1,300	.700
8	.900	3.250	1.300	.700
9	.900	3.250	1.300	.700
10	.900	3.250	1.300	.700
11	•900	-	1.300	.700
12	<b>。</b> 900	-	1.300	•700
13	<b>。</b> 900		1.300	.700
14	<b>₀</b> 900		1.300	.700
15	<u>。</u> 900		1.300	.700
TOTALS	13.500	52.030	34.470	14.000
	MARGIN	MARGIN		MADCIN
	ADJUSTMENT =	ADJUSTMENT	MARGIN ADJUST-	
		AT ISSUE =	MENT AT ISSUE	FACTORS =
YEAR	(51) + (52) + (15)			
	+(53)-(50)	(54) X (7)	= SUM OF (55)	(56) X (8)
N				
	(54)	(55)	(56)	(57)
1	49.090	49.090	77.085	77.085
2	7.810	6.667	27.995	32.794
3	4.550	3.447	21.328	28.154
4	4.550	3.088	17.881	26.348
5	4.550	2.766	14.793	24.335
5	4.550	2.478	12.027	22.086
1	4.550	2.240	9.549	19.393
0	4°DDA	2.020	1.307	10.410
10	9077U 4 550	1.052	<b>フ。</b>	15.125
10	1 200	1.000	3°471	90481 5 455
13	1 300	0 4 C O 2 A A	10/70	フ₀477 ८ ккэ
16	10300	0 V V C	10201	4.775
13	1,200	264	0//	2 5 7 7
13 14	1.300	• 356 • 325	.977	3,566

77.085

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TOTALS

99.800

286.573

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	*******	
	PROSPECTIVE	TOTAL
	PERFORMANCE	PROSPECTIVE
	PER UNIT =	PERFORMANCE =
YEAR		
	(28) - (57)	(58)X(40)/(17)
N		
	(58)	(59)
1	29.978	299.78
2	45.688	456.88
3	50.031	500.31
4	51.680	516.80
5	52.165	521.65
6	53.378	533.78
7	53.678	536.78
8	52.366	523.66
9	51.320	513.20
10	50.399	503.99
11	48.435	484.35
12	41.229	412.29
13	33.240	332.40
14	24.249	242.49
15	12.928	129.28
TOTALS		4 507 44
IUIALO		V1201004

76. POLICY CALCULATIONS - ENDOWMENT 15 YEARS AGE 25 (CONT'D)

C.49

## 81. BASIC INPUT DATA - AGE 25

YEAR	MORTALITY Q (X)∻N−1	RATE	LAPSE RATE W (X)+N-1		INTEREST RATE
N	(1)		(2)		(3)
1	•00085		.110		• 0650
2	<u>00090</u>		<b>.</b> 066		.0650
3	<u>00095</u>		.055		.0650
4	.00100		<b>.</b> 055		.0650
5	.00100		°055		.0650
6	.00100		.044		.0650
7	.00102		.044		.0650
8	.00104		.044		.0650
9	<b>.</b> 001C8		.044		.0650
10	.00114		.044		.0650
11	.00123		.033		• 0650
12	.00134		.033		• 0650
13	<b>• 00146</b>		.033		.0650
14	.00159		°033		.0650
15	<b>.</b> 00174		.033		.0650
TOTAL	S .01734		. 726		
	=============	****			
	1	82. BASIC CALCU	LATIONS		
MEAD	S P {X}+N-1	COMPOUND P = (X)	DISCOUNT FACTOR	PERSISTENCY AND DISCOUNT FACTOR =	PERSISTENCY AND DISCOUNT ACCUMULATION FACTOR =
YEAR	2 2 3 3 2 5 4	(4) X(5)	N-1		
N	= 1 - (1) - (2)	N-1 N-1	= V	(5) X (6)	1/(7)
	(4)	(5)	(6)	(7)	(8)
1	.88915	1.00000	1.00000	1.00000	1.00000
2	.93310	.88915	.93897	.83489	1.19776
3	.94405	.82967	.88166	.73149	1.36707

.82785

.77732

.72988

.68533

.64351

.60423

.56735

•53273

.50021

.46968

.44102

.41410

.64841

.57474

.50944

•45682

.40963

.36731

.32934

.29529

.26777

.24280

.22013

.19954

1.54223

1.73992

1.96294

2.18905

2.44123

2.72250

3.03638

3.38650

3.73455

4.11862

4.54277

5.01153

TOTAL 14.25666

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.63656

.60789

•58049

•55429

.53532

.51694

.49913

.48187

C.50

## 83. PLAN INPUT DATA

### ENDOWMENT 15 YEARS AGE 25

	CASH			EX	PENSE FACT	ORS	
YEAR	CSV N	DIVIDEND RATE	GROSS PREMIUM	GENERAL AND TAXES(%)	DOLLARS PER UNIT	DOLLARS PER POLICY	AMOUNT PER UNIT
	(11)	(12)	(13)	(14)	(15)	(16)	(17)
1	22	2.85	64.18	25	10.00	42.00	1,000
2	77	4.26	64.18	2	<b>°</b> 20	7.00	1,000
3	135	5.71	64.18	2	۵20 م	7.00	1,000
4	194	7.20	64.18	2	<u>ە</u> 20	7.00	1,000
5	256	8.74	64.18	2	.20	7.00	1,000
6	320	10.31	64.18	2	·20	7.00	1,000
7	385	11.94	64.18	2	.20	7.00	1,000
8	453	13.61	64.18	2	<b>.</b> 20	7.00	1.,000
9	524	15.31	64.18	2	<b>°</b> 20	7.00	1,000
10	597	17.07	64.18	2	•20	7.00	1,000
11	672	18.85	64.18	2	۰20	7.00	1,000
12	750	20.70	64.18	2	<b>.</b> 20	7.00	1,000
13	831	22.63	64.18	2	°20	7.00	1,000
14	914	24.58	64.18	2	.20	7.00	1,000
15	1000	26.61	64.18	2	۵20	7.00	1,000
TOTAL	S 7130	210.37	962.70		12.80	140.00	

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C.51

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84. PLAN CALCULATIONS - ENDOWMENT 15 YEARS AGE 25

YEAR	AMOUNT AT RISK	MORTALITY COST	END OF YEAR DEDUCTIONS =	BEGINNING OF YR. DEDUCTIONS
N1	= (17) $-$ (11)	$= (1) \times (21)$	(11)+(12)+(22)	= (23)/1+(3)
	(21)	(22)	(23)	(24)
1	978	.831	25.681	24.114
2	923	.831	82.091	77.081
3	865	.822	141.532	132.894
4	806	<b>.</b> 806	202.006	189.677
5	744	.744	265.484	249.281
6	680	.680	330.990	310.789
7	615	.627	397.567	373.302
8	547	.569	467.179	438.666
Ģ	476	.514	539.824	506.877
10	403	。459	614.529	577.023
11	328	. 403	691.253	649.064
12	250	<b>.</b> 335	771.035	723.977
13	169	. 247	853.877	801.762
14	86	.137	938.717	881.424
15	0	-	1026.610	963.953
TOTALS	7870	8.005	7348.375	6899,884
	=================	******		**====*==
	BASIC MARGIN =		ACCUMULATED	
		BASIC MARGIN	BASIC MARGIN	BASIC MARGIN
YEAR	(11) ÷ (13) N-1	AT ISSUE =	AT ISSUE =	FACTORS =
• /	- (24)	(25) X (7)	SUM OF (26)	(27) X (8)
N	(25)	(26)	(27)	(28)
1	40.066	40.066	102.247	102.247
2	9.099	7.597	62.181	74.478
3	8.286	6.061	54.584	74.620
4	9.503	6.162	48.523	74.834
5	8.899	5.115	42.361	73.705
6	9.391	4.784	37.246	73.112
7	10.878	4.969	32.462	71.061
8	10.514	4.307	27.493	67.117
9	10-303	3.784	23.186	63.124
10	11.157	3.674	19.402	58.912
11	12.116	3.578	15.728	53.263
12	12.203	3.268	12.150	45.375
13	12.418	3.015	8.882	36.582
14	13.756	3.028	5.867	26.652
15	14.227	2.839	2.839	14.228
TOTALS	192.816	102.247		909.310
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## 85. POLICY INPUT DATA

### ENDOWMENT 15 YEARS AGE 25

INSURANCE AMOUNT	(40)	\$ 10,000
COMMISSION RATE - 1ST. YEAR	(41)	30%
COMMISSION RATE - 2ND. YEAR	(42)	10%
COMMISSION RATE - 3-10 YEARS	(43)	58
POLICY FEE (TOTAL) CALCULATED FRCM MASTER FILE DATA	(44)	\$ 9.00

86 . ===	POLICY CALCULAT	IONS - ENDOWMENT	15 YEARS AGE 25	C.54
VEAD	POLICY FEE PER UNIT =	COMMISSION PER UNIT =	GENERAL AND TAX EXPENSE =	EXPENSE PER POLICY/UNIT =
	(44)X(17)/(40)	X (41,42,43)	((13) + (50)) X (14)	(16)X(17)/(40)
	(50)	(51)	(52)	(53)
			میں ہے۔ این کار ہے ہیں ہیں ہیں میں میں این کر میں این	
1	<b>。</b> 900	19.520	16.270	4.200
2	<b>~900</b>	6.510	1.300	•700
3	<b>•90</b> 0	3.250	1.300	.700
4	<u>۹00</u>	3.250	1.300	.700
5	° <b>9</b> 00	3.250	1.300	.700
6	<u>。</u> 900	3.250	1.300	.700
7	•900	3.250	1.300	.700
8	.900	3.250	1.300	.700
9	.900	3.250	1.300	.700
10	•900	3.250	1.300	.700
11	• 900	-	1.300	.700
12	• 900	-	1.300	<sub>°</sub> 700
13	.900		1.300	<b>。</b> 700
14	• 900		1.300	.700
15	•900		1.300	.700
TOTALS	13.500	52.030	34.470	14.000
				***********
	MARGIN	MARGIN		MADCIN
	ADJUSTMENT =	AD HISTMENT	MADGIN AD HIST-	AD HISTMENT
		AT ISSUE =	MENT AT ISSUE	EACTORS -
YEAR	(51)+(52)+(15)	AT 1550L -	MENT AT 1330L	TACTORS -
	+(53)-(50)	(54) X (7)	= SUM OF (55)	(56) Y (8)
N			- 3011 01 (33)1	
	(54)	(55)	(56)	(57)
7	49,090	49,090	75, 526	75.526
2	7.810	6,520	26.436	31,664
3	4,550	3,328	19,916	27,227
4	4,550	2,950	16.588	25-583
5	4,550	2.615	13,638	23,729
6	4.550	2,318	11,023	21-637
7	4.550	2.079	8.705	19.056
8	4,550	1.864	6-626	16,176
9	4.550	1.671	4.762	12,965
10	4.550	1.498	3,091	9,385
11	1.300	384	1,503	5,395
12	1.300	348	1,209	4,515
13	1.300	.316	. 861	3-546
14	1.300	.286	545	2,476
15	1.300	.259	.259	1.298
TOTALS	99.800	75.526		280.178
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86. POLICY CALCULATIONS - ENDOWMENT 15 YEARS AGE 25 (CONT'D)

	PROSPECTIVE PERFORMANCE PER UNIT =	TOTAL PROSPECTIVE PERFORMANCE =
YEAK	(28) - (57)	(58)X(40)/(17)
N.	(58)	(59)
	97 301	
1	26.721	267.21
2	42.814	428.14
3	47.393	473.93
4	49.251	492.51
5	49.976	499.76
6	51.475	514.75
7	52.005	520.05
8	50.941	509.41
9	50.159	501.59
10	49.527	495.27
11	47.868	478.68
12	40.860	408.60
13	33.036	330.36
14	24,176	241.76
15	12.930	129.30
TOTALS	629.132	6,291.32

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#### 91. BASIC INPUT DATA - AGE 25

	MORTALITY	RATE	LAPSE RATE			
YEAR	Q		ы		INTEREST	
	(X)*N-1		(X)+N-1		RATE	
N	(1)		(2)		(3)	
1	.00076		.090		.0700	
2	.00081		°054		.0700	
3	°00082		.045		.0700	
4	.00090		.045		<u>0700</u>	
5	.00090		o45 ،		.0700	
6	.00090		.036		•0700	
7	o0092		.036		.0700	
8	。00094		°036		.0700	
9	<u>.</u> 00097		.036		.0700	
10	.00103		.036		•0700	
11	.00111		<b>.</b> 027		.0700	
12	.00121		°027		.0700	
13	.00131		o27°		.0700	
14	<b>₀</b> 00143		.027		₀0700	
15	.00157		<b>₀</b> 027		.0700	
TOTALS	01561	- valas sinte antido vales	594			
		92. BASIC CALCU	LATIONS			
		92. BASIC CALCU	LATIONS ======		DEDCICTENCY	
	ç	92. BASIC CALCU		BEDGISTENCY	PERSISTENCY	
	S	92. BASIC CALCU	DISCOUNT	PERSISTENCY	PERSISTENCY AND DISCOUNT	
	S P (Y)+N=1	92. BASIC CALCU S COMPOUND P = (X)	LATIONS ====== DISCOUNT FACTOR	PERSISTENCY AND DISCOUNT	PERSISTENCY AND DISCOUNT ACCUMULATION	
AEVB	S P (X)*N-1	92. BASIC CALCU S COMPOUND P = (X) (4) X(5)	LATIONS DISCOUNT FACTOR N-1	PERSISTENCY AND DISCOUNT FACTOR =	PERSISTENCY AND DISCOUNT ACCUMULATION FACTOR =	
YEAR	S P (X)*N-1 = 1-(1)-(2)	92. BASIC CALCU S COMPOUND P = (X) (4) X(5) N-1 N-1	LATIONS ====== DISCOUNT FACTOR N-1 = V	PERSISTENCY AND DISCOUNT FACTOR =	PERSISTENCY AND DISCOUNT ACCUMULATION FACTOR =	
YEAR	S P (X)*N-1 = 1-(1)-(2)	92. BASIC CALCU S COMPOUND P = (X) (4) X(5) N-1 N-1	LATIONS ====== DISCOUNT FACTOR N-1 = V	PERSISTENCY AND DISCOUNT FACTOR = (5) X (6)	PERSISTENCY AND DISCOUNT ACCUMULATION FACTOR = 1/(7)	
YEAR N	S P (X)*N-1 = 1-(1)-(2) (4)	92. BASIC CALCU S COMPOUND P = (X) (4) X(5) N-1 N-1 (5)	LATIONS DISCOUNT FACTOR N-1 = V (6)	PERSISTENCY AND DISCOUNT FACTOR = (5) X (6) (7)	PERSISTENCY AND DISCOUNT ACCUMULATION FACTOR = 1/(7) (8)	
YEAR N 	$S = \frac{S}{(X) + N - 1} = 1 - (1) - (2) = \frac{(4)}{$	92. BASIC CALCU S COMPOUND P = (X) (4) X(5) N-1 N-1 (5) 1.00000	LATIONS ====== DISCOUNT FACTOR N-1 = V (6) 1.00000	PERSISTENCY AND DISCOUNT FACTOR = (5) X (6) (7) 1.00000	PERSISTENCY AND DISCOUNT ACCUMULATION FACTOR = 1/(7) (8) 1.00000	
YEAR N  1 2	S = 1 - (1) - (2) $= 1 - (1) - (2)$ $= (4)$ $= 90924$ $= 94519$	92. BASIC CALCU S COMPOUND P = (X) (4) X(5) N-1 N-1 (5) 1.00000 .90924	LATIONS ====== DISCOUNT FACTOR N-1 = V (6) 1.00000 .93458	PERSISTENCY AND DISCOUNT FACTOR = (5) X (6) (7) 1.00000 .84976	PERSISTENCY AND DISCOUNT ACCUMULATION FACTOR = 1/(7) (8) 1.00000 1.17680	
YEAR N  1 2 3	S P (X)*N-1 = 1-(1)-(2) (4) 	92. BASIC CALCU S COMPOUND P = (X) (4) X(5) N-1 N-1 (5) 1.00000 .90924 .85940	LATIONS ====== DISCOUNT FACTOR N-1 = V (6) 1.00000 .93458 .87344	PERSISTENCY AND DISCOUNT FACTOR = (5) X (6) (7) 1.00000 .84976 .75063	PERSISTENCY AND DISCOUNT ACCUMULATION FACTOR = 1/(7) (8) 1.00000 1.17680 1.33221	
YEAR N  1 2 3 4	S P (X)*N-1 = 1-(1)-(2) (4) 	92. BASIC CALCU S COMPOUND P = (X) (4) X(5) N-1 N-1 (5) 1.00000 .90924 .85940 .82000	LATIONS ====== DISCOUNT FACTOR N-1 = V (6) 1.00000 .93458 .87344 .81630	PERSISTENCY AND DISCOUNT FACTOR = (5) X (6) (7) 1.00000 .84976 .75063 .66937	PERSISTENCY AND DISCOUNT ACCUMULATION FACTOR = 1/(7) (8) 1.00000 1.17680 1.33221 1.49394	
YEAR N  1 2 3 4 5	S P (X)*N-1 = 1-(1)-(2) (4) 	92. BASIC CALCU S COMPOUND P = (X) (4) X(5) N-1 N-1 (5) 1.00000 .90924 .85940 .82000 .78236	LATIONS ====== DISCOUNT FACTOR N-1 = V (6) 1.00000 .93458 .87344 .81630 .76290	PERSISTENCY AND DISCOUNT FACTOR = (5) X (6) (7) 1.00000 .84976 .75063 .66937 .59686	PERSISTENCY AND DISCOUNT ACCUMULATION FACTOR = 1/(7) (8) 1.00000 1.17680 1.33221 1.49394 1.67543	
YEAR N  1 2 3 4 5 6	S P (X)+N-1 = 1-(1)-(2) (4) 	92. BASIC CALCU S COMPOUND P = (X) (4) X(5) N-1 N-1 (5) 1.00000 .90924 .85940 .82000 .78236 .74645	LATIONS ====== DISCOUNT FACTOR N-1 = V (6) 1.00000 .93458 .87344 .81630 .76290 .71299	PERSISTENCY AND DISCOUNT FACTOR = (5) X (6) (7) 1.00000 .84976 .75063 .66937 .59686 .53221	PERSISTENCY AND DISCOUNT ACCUMULATION FACTOR = 1/(7) (8) 1.00000 1.17680 1.33221 1.49394 1.67543 1.87896	
YEAR N  1 2 3 4 5 6 7	S P (X)+N-1 = 1-(1)-(2) (4) 	92. BASIC CALCU S COMPOUND P = (X) (4) X(5) N-1 N-1 (5) 1.00000 .90924 .85940 .82000 .78236 .74645 .71891	LATIONS ====== DISCOUNT FACTOR N-1 = V (6) 1.00000 .93458 .87344 .81630 .76290 .71299 .66634	PERSISTENCY AND DISCOUNT FACTOR = (5) X (6) (7) 1.00000 .84976 .75063 .66937 .59686 .53221 .47904	PERSISTENCY AND DISCOUNT ACCUMULATION FACTOR = 1/(7) (8) 1.00000 1.17680 1.33221 1.49394 1.67543 1.87896 2.08751	
YEAR N  2 3 4 5 6 7 8	S P (X)+N-1 = 1-(1)-(2) (4) 	92. BASIC CALCU S COMPOUND P = (X) (4) X(5) N-1 N-1 (5) 1.00000 .90924 .85940 .82000 .78236 .74645 .71891 .69237	LATIONS ====== DISCOUNT FACTOR N-1 = V (6) 1.00000 .93458 .87344 .81630 .76290 .71299 .66634 .62275	PERSISTENCY AND DISCOUNT FACTOR = (5) X (6) (7) 1.00000 .84976 .75063 .66937 .59686 .53221 .47904 .43117	PERSISTENCY AND DISCOUNT ACCUMULATION FACTOR = 1/(7) (8) 1.00000 1.17680 1.33221 1.49394 1.67543 1.87896 2.08751 2.31927	
YEAR N  2 3 4 5 6 7 8 9	S P (X)+N-1 = 1-(1)-(2) (4) 	92. BASIC CALCU S COMPOUND P = (X) (4) X(5) N-1 N-1 (5) 1.00000 .90924 .85940 .82000 .78236 .74645 .71891 .69237 .66679	LATIONS ====== DISCOUNT FACTOR N-1 = V (6) 1.00000 .93458 .87344 .81630 .76290 .71299 .66634 .62275 .58201	PERSISTENCY AND DISCOUNT FACTOR = (5) X (6) (7) 1.00000 .84976 .75063 .66937 .59686 .53221 .47904 .43117 .38808	PERSISTENCY AND DISCOUNT ACCUMULATION FACTOR = 1/(7) (8) 1.00000 1.17680 1.33221 1.49394 1.67543 1.87896 2.08751 2.31927 2.57679	
YEAR N  2 3 4 5 6 7 8 9 10	S P (X)+N-1 = 1-(1)-(2) (4) 	92. BASIC CALCU S COMPOUND P = (X) (4) X(5) N-1 N-1 (5) 1.00000 .90924 .85940 .82000 .78236 .74645 .71891 .69237 .66679 .64214	LATIONS ====== DISCOUNT FACTOR N-1 = V (6) 1.00000 .93458 .87344 .81630 .76290 .71299 .66634 .62275 .58201 .54393	PERSISTENCY AND DISCOUNT FACTOR = (5) X (6) (7) 1.00000 .84976 .75063 .66937 .59686 .53221 .47904 .43117 .38808 .34928	PERSISTENCY AND DISCOUNT ACCUMULATION FACTOR = 1/(7) (8) 1.00000 1.17680 1.33221 1.49394 1.67543 1.87896 2.08751 2.31927 2.57679 2.86303	
YEAR N  2 3 4 5 6 7 8 9 10 11	S P (X)+N-1 = 1-(1)-(2) (4) 	92. BASIC CALCU S COMPOUND P = (X) (4) X(5) N-1 N-1 (5) 1.00000 .90924 .85940 .82000 .78236 .74645 .71891 .69237 .66679 .64214 .61836	LATIONS ====== DISCOUNT FACTOR N-1 = V (6) 1.00000 .93458 .87344 .81630 .76290 .71299 .66634 .62275 .58201 .54393 .50835	PERSISTENCY AND DISCOUNT FACTOR = (5) X (6) (7) 1.00000 .84976 .75063 .66937 .59686 .53221 .47904 .43117 .38808 .34928 .31434	PERSISTENCY AND DISCOUNT ACCUMULATION FACTOR = 1/(7) (8) 1.00000 1.17680 1.33221 1.49394 1.67543 1.87896 2.08751 2.31927 2.57679 2.86303 3.18127	
YEAR N  1 2 3 4 5 6 7 8 9 10 11 12	S P (X)+N-1 = 1-(1)-(2) (4) 	92. BASIC CALCU S COMPOUND P = (X) (4) X(5) N-1 N-1 (5) 1.00000 .90924 .85940 .82000 .78236 .74645 .71891 .69237 .66679 .64214 .61836 .60098	LATIONS ====== DISCOUNT FACTOR N-1 = V (6) 1.00000 .93458 .87344 .81630 .76290 .71299 .66634 .62275 .58201 .54393 .50835 .47509	PERSISTENCY AND DISCOUNT FACTOR = (5) X (6) (7) 1.00000 .84976 .75063 .66937 .59686 .53221 .47904 .43117 .38808 .34928 .31434 .28552	PERSISTENCY AND DISCOUNT ACCUMULATION FACTOR = 1/(7) (8) 1.00000 1.17680 1.33221 1.49394 1.67543 1.87896 2.08751 2.31927 2.57679 2.86303 3.18127 3.50238	
YEAR N  1 2 3 4 5 6 7 8 9 10 11 12 13	S P (X)+N-1 = 1-(1)-(2) (4) 	92. BASIC CALCU S COMPOUND P = (X) (4) X(5) N-1 N-1 (5) 1.00000 .90924 .85940 .82000 .78236 .74645 .71891 .69237 .66679 .64214 .61836 .60098 .58403	LATIONS ====== DISCOUNT FACTOR N-1 = V (6) 1.00000 .93458 .87344 .81630 .76290 .71299 .66634 .62275 .58201 .54393 .50835 .47509 .44401	PERSISTENCY AND DISCOUNT FACTOR = (5) X (6) (7) 1.00000 .84976 .75063 .66937 .59686 .53221 .47904 .43117 .38808 .34928 .31434 .28552 .25932	PERSISTENCY AND DISCOUNT ACCUMULATION FACTOR = 1/(7) (8) 1.00000 1.17680 1.33221 1.49394 1.67543 1.87896 2.08751 2.31927 2.57679 2.86303 3.18127 3.50238 3.85624	

.38782

TOTAL 14.39039

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## 93. PLAN INPUT DATA

### ENDOWMENT 15 YEARS AGE 25

				EX	PENSE FACT	ORS	
YEAR	CSV N	DIVIDEND RATE	GROSS PREMIUM	GENERAL AND TAXES(%)	DOLLARS PER UNIT	DOLLARS PER POLICY	AMOUNT PER UNIT
	(11)	(12)	(13)	(14)	(15)	(16)	(17)
1	22	2.85	64.18	25	10.00	42.00	1,000
2	77	4.26	64.18	2	•20	7.00	1,000
3	135	5.71	64.18	2	<b>.</b> 20	7.00	1,000
4	194	7.20	64.18	2	.20	7.00	1,000
5	256	8.74	64.18	2	.20	7.00	1,000
6	320	10.31	64.18	2	•20	7.00	1,000
7	385	11.94	64.18	2	.20	7.00	1,000
8	453	13.61	64.18	2	°50	7.00	1,000
9	524	15.31	64.18	2	.20	7.00	1,000
10	597	17.07	64.18	2	.20	7.00	1,000
11	672	18.85	64.18	2	<b>.</b> 20	7.00	1,000
12	750	20.70	64.18	2	.20	7.00	1,000
13	831	22.63	64.18	2	.20	7.00	1,000
14	914	24.58	64.18	2	•20	7.00	1,000
15	1000	26.61	64.18	2	•20	7.00	1,000
TOTAL	S 7130	210.37	962.70		12.80	140.00	

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94. PLAN CALCULATIONS - ENDOWMENT 15 YEARS AGE 25

YEAR	AMOUNT AT RISK	MORTALITY COST	END OF YEAR DEDUCTIONS =	BEGINNING OF YR. DEDUCTIONS
NI	= (17) $-$ (11)	$= (1) \times (21)$	(11)+(12)+(22)	= (23)/1+(3)
	(21)	(22)	(23)	(24)
1	978	.743	25.593	23.919
2	923	.748	82.008	76.643
3	865	. 735	141.445	132.192
4	806	. 725	201.925	188.715
5	144	.670	265.410	248.047
6	680	.612	330.922	309.273
1	615	• 566	391.506	3/1.501
8	541	• 514	467.124	430.504
9	4 16	• 462	539.112	504.460
10	403	• 415	014.485	514.285
11	328	• 364	691.214	545.994
12	250	• 303	771.003	120.564
13	169	• 221	853.851	191.992
14	86	.123	938.103	811.293
12	U 		1020.010	939.449
TOTALS	7870	7.201	7347.571	6866.891
	BASIC MARGIN =	BASIC MARGIN	ACCUMULATED Basic Margin	BASIC MARGIN
	(11) + (13)	AT ISSUE =	AT ISSUE =	FACTORS =
YEAR	N-1 - (24)	(25) X (7)	SUM OF (26)	(27) X (8)
N	(25)	1761	1271	1201
				(20)
1	40.261	40,261	116.921	116.921
2	9.537	8.104	76.660	90.213
3	8.988	6.747	68.556	91.331
4	10.465	7.005	61.809	92.339
5	10.133	6.048	54.804	91.820
6	10.907	5.805	48.756	91.611
7	12.679	6.074	42.951	89.661
8	12.616	5.440	36.877	85.528
9	12.720	4.936	31.437	81.007
10	13.895	4.853	26.501	75.873
11	15.186	4.774	21.648	68.868
12	15.616	4.459	16.874	59.099
13	16.188	4.198	12.415	47.875
14	17.887	4.212	8.217	34.893
15	18.731	4.005	4.005	18.730
TOTALS	225.809	116.921		1135.769

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## 95. POLICY INPUT DATA

### ENDOWMENT 15 YEARS AGE 25

INSURANCE AMOUNT	(40)	\$ 10,000
COMMISSION RATE - 1ST. YEAR	(41)	30%
COMMISSION RATE - 2ND. YEAR	(42)	10%
COMMISSION RATE - 3-10 YEARS	(43)	5%
POLICY FEE (TOTAL) CALCULATED FRCM MASTER FILE DATA	(44)	\$ 9.00

96。 ===	POLICY CALCULAT	IONS - ENDOWMENT	15 YEARS AGE 25	C.60
	POLICY FEE	COMMISSION	GENERAL AND	EXPENSE PER
/CAD	PER UNIT =	PER UNIT =	TAX EXPENSE =	POLICY/UNIT =
EAN	(44)X(17)/(40)	X (41,42,43)	X (14)	(16)X(17)/(40)
N	(50)	(51)	(52)	(53)
	میں میں بارے <del>ای</del> ل میں		uurite hähle-1950 valar vaaa vada väitti väitti vala väitti vala väitti vaaa aksin häää väätti	ungan ungan makan makan utakin pilakin akalan daripa dapikin dakin akalap ungan akanan dikak
1	.900	19.520	16.270	4.200
2	•900	6.510	1.300	۰700 ·
3	<u>ه 900</u>	3.250	1.300	。700
4	<b>°</b> 900	3.250	1.300	.700
5	<b>。</b> 900	3.250	1.300	。700
6	<b>•90</b> 0	3.250	1.300	₀700
7	<b>.90</b> 0	3.250	1.300	.700
8	•900	3.250	1.300	.700
9	.900	3.250	1.300	。700
10	.900	3.250	1.300	.700
11	.900	_	1.300	.700
12	.900		1.300	.700
13	- 900	_	1.300	- 700
14	.900		1.300	700
15	.900		1.300	.700
OTALS	13.500	52.030	34.470	14.000
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	MARGIN	MARGIN	ACCUMULATED	MARGIN
	ADJUSTMENT =	ADJUSTMENT	MARGIN ADJUST-	ADJUSTMENT
		AT ISSUE =	MENT AT ISSUE	FACTORS =
EAR	(51) + (52) + (15)			
	+(53)-(50)	(54) X (7)	= SUM OF (55)	(56) X (8)
N				
	(54)	(55)	(56)	(57)
1	49.090	49.090	76.524	76.524
2	7.810	6.637	27.434	32.284
3	4.550	3.415	20.797	27.706
4	4,550	3.046	17,382	25,968
5	4,550	2.716	14.336	24,019
6	4.550	2.422	11 620	21 824
7	4.550	2,180	0 108	10 201
8	4 550	1 962	7 019	1 2 0 2 0 1
a	4 5 5 0 4 5 5 0	10702	COULD S ASL	13 030
7	90JJU 4 550	1 500	2.020	13.028
11		T © 202	2°27U	70417
11	1 200	° 407	1.701	2.411
12	1.300	• 5/1	1.292	4.525 7
15	1.300	.331	. 921	3.552
14 15	1.300	。306 。278	。584 、278	2.480
	*********		5 L I U	10,000
UTALS	AA*800	16.524		283.528
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## 96. POLICY CALCULATIONS - ENDOWMENT 15 YEARS AGE 25 (CONT'D)

	PROSPECTIVE PERFORMANCE PER UNIT =	TOTAL PROSPECTIVE PERFORMANCE =
YEAR	(28) - (57)	(58)X(40)/(17)
	(58)	(59)
9	40 207	402 07
1	57 020	403.97
2	31.929	519.29
3	63.625	636.25
4	66.371	663.71
5	67.801	678.01
6	69.777	697.77
7	70.460	704.60
8	69.251	692.51
9	67.979	679.79
10	66.454	664.54
11	63.457	634.57
12	54.574	545.74
13	44.323	443.23
14	32,413	324,13
15	17.430	174.30
TOTALS	852.241	8,522.41

### 101. BASIC INPUT DATA - AGE 25

YEAR Q W INTEREST (X)+N-1 (X)+N-1 RATE N (1) (2) (3)	
(X)+N-1 (X)+N-1 RATE	
N (1) (2) (3)	
(1) (2) (3)	
1 .00094 110 0600	
· · · · · · · · · · · · · · · · · · ·	
4 • 00110 • 055 • 0600	
5 .00110 .055 .0600	
6 .00110 .044 .0600	
7 .00112 .044 .0600	
8 .00114 .044 .0600	
9 .00119 .044 .0600	
10 .00125 .044 .0600	
ll .00135 .033 .0600	
12 .00147 .033 .0600	
13 .00161 .033 .0600	
14 <b>.</b> 00175 <b>.</b> 033 <b>.</b> 0600	
15 .00191 .033 .0600	

## 102. BASIC CALCULATIONS

		S			PERSISTENCY
	S	COMPOUND P =	DISCOUNT	PERSISTENCY	AND DISCOUNT
	Р	(X)	FACTOR	AND DISCOUNT	ACCUMULATION
	(X)+N-1			FACTOR =	FACTOR =
YEAR		(4) X(5)	N-1		
	= 1 - (1) - (2)	N-1 N-1	= V	(5) X (6)	1/(7)
N					
	(4)	(5)	(6)	(7)	(8)
1	.88906	1.00000	1.00000	1.00000	1.00000
2	。93301	<b>.</b> 88906	.94340	.83874	1.19226
3	.94395	•82 <b>950</b>	<u>89000</u>	.73826	1.35454
4	。94390	.78301	<b>.83962</b>	<b>°</b> 65743	1.52107
5	<b>°</b> 94390	<b>.</b> 73908	<b>.7</b> 9209	•58542	1.70818
6	<u>。95490</u>	<b>•</b> 69762	.74726	.52130	1.91828
7	• 95488	.66616	.70496	<b>• 46962</b>	2.12938
8	• 95486	<b>-6361</b> 0	<b>。</b> 66506	<b>.</b> 42304	2.36384
9	<b>°</b> 95481	.60739	.62741	.38108	2.62412
10	<b>.</b> 95475	。57994	<b>.</b> 59190	<b>.</b> 34327	2.91316
11	。96565	<u>- 55370</u>	<b>°</b> 55839	.30918	3.23436
12	°96553	• 53468	•52679	.28166	3.55038
13	。96539	<b>•</b> 51625	.49697	· 25656	3.89772
14	•96525	<b>~</b> 49838	<b>• 468</b> 84	°23366	4.27972
15	°96209	<b>~</b> 48106	<b>.</b> 44230	.21277	4.69991

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TOTAL 14.25493

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C.62

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## 103. PLAN INPUT DATA

### ENDOWMENT 15 YEARS AGE 25

				EX	PENSE FACT	ORS	
YEÅR	CSV N	DIVIDEND RATE	GROSS PREMIUM	GENERAL AND TAXES(%)	DOLLARS PER UNIT	DOLLARS PER POLICY	AMOUNT PER UNIT
	(11)	(12)	(13)	(14)	(15)	(16)	(17)
1	22	2.85	64.18	25	10.00	42.00	1,000
2	77	4.26	64.18	2	•20	7.00	1,000
3	135	5.71	64.18	2	<b>.</b> 20	7.00	1,000
4	194	7.20	64.18	2	•20	7.00	1,000
5	256	8.74	64.18	2	<b>،</b> 20	7.00	1,000
6	320	10.31	64.18	2	.20	7.00	1,000
7	385	11.94	64.18	2	<b>۵</b> 20	7.00	1,000
8	453	13.61	64.18	2	°20	7.00	1,000
9	524	15.31	64.18	2	•20	7.00	1,000
10	597	17.07	64.18	2	°50	7.00	1,000
11	672	18.85	64.18	2	<b>°</b> 20	7.00	1,000
12	750	20.70	64.18	2	.20	7.00	1,000
13	831	22.63	64.18	2	<b>.</b> 20	7.00	1,000
14	914	24.58	64.18	2	•20	7.00	1,000
15	1000	26.61	64.18	2	۵20	7.00	1,000
TOTALS	5 7130	210.37	962.70		12.80	140.00	

104. PLAN CALCULATIONS - ENDOWMENT 15 YEARS AGE 25

YEAR	AMOUNT AT RISK	MORTALITY COST	END OF YEAR DEDUCTIONS =	BEGINNING OF YR. DEDUCTIONS
N	= (17) $-$ (11)	= (1) X (21)	(11)+(12)+(22)	= (23)/1+(3)
	(21)	(22)	(23)	(24)
	070			
1	978	.919	25.769	24.310
2	925	. 914	82.174	11.523
2	002	° 708		133.602
	744	000°	202.087	190.648
5	144 6 8 0	• 010 749	2020220	250.526
7	616	• 740 490	207 (20	312.317
0	547	• 00 7 6 3 6	571.027	5150122
a	241 476	• 024 546	401°234 E30 074	4400707
10	470	• J00 504	JJ70010 414 574	570 707
11	329	» ۲۲۰ ۸۸۵	601 203	2190101
12	320	340	771 069	777 (77
12	2.50	° ⊃00 070	111.000	1210423
14	107	0212	020 721	803.368
14	88	• 1 9 1	9000101	882.595
19			1020.010	968.500
TOTALS	7870	8.811	7349.181	6933.190
		=================		
	DACTC MADCIN			
	BASIC MARGIN =		ACCUMULATED	
		BASIC MARGIN	BASIC MARGIN	BASIC MARGIN
VEAD	(11) + (13)	AT ISSUE =	AT ISSUE =	FACTORS =
YEAK	N-1			
A1	- (24)	(25) X (7)	SUM UF (26)	(27) X (8)
N	125)	1 3 4 3	( 27 )	(20)
	(2)/	1207	(27)	(28)
1	39.870	39.870	92.359	92.359
2	8.657	7.261	52.489	62.581
3	7.578	5.595	45.228	61.263
4	8.532	5.609	39.633	60.285
5	7.654	4.481	34.024	58.119
6	7.861	4.098	29.543	56.672
7	9.058	4.254	25.445	54.182
8	8.393	3.551	21.191	50.092
9	7.863	2.996	17.640	46.289
10	8.393	2.881	14.644	42.660
11	9.017	2.788	11.763	38.046
12	8.757	2.466	8.975	31.865
13	8.612	2.209	6.509	25.370
14	9.585	2.240	4.300	18.403
15	9.680	2.060	2.060	9.682
TOTALS	159,510	92,359		707.868

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## 105. POLICY INPUT DATA

### ENDOWMENT 15 YEARS AGE 25

INSURANCE AMOUNT	(40)	\$ 10,000
COMMISSION RATE - 1ST. YEAR	(41)	30%
COMMISSION RATE - 2ND. YEAR	(42)	10%
COMMISSION RATE - 3-10 YEARS	(43)	5%
POLICY FEE (TOTAL) CALCULATED FROM MASTER FILE DATA	(44)	\$ 9.00

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C.65

106. ====	POLICY CALCULAT	IONS - ENDOWMENT	15 YEARS AGE 25	C.66
	POLICY FEE	COMMISSION	GENERAL AND	EXPENSE PER
VEAD	PER UNIV =	PER UNIT =	TAX EXPENSE =	POLICY/UNIT =
TEAR	(44)X(17)/(40)	(113) + (50)) X (41,42,43)	((13) + (50)) X (14)	(16)X(17)/(40)
N	(60)	(	150)	(
	(507	(51)		(53)
1	.900	19,520	16,270	4 - 200
2	.900	6,510	1.300	-700
3	.900	3,250	1,300	.700
4	.900	3,250	1-300	-700
5	.900	3,250	1,300	.700
6	.900	3,250	1,300	.700
7	.900	3.250	1.300	.700
8	.900	3.250	1.300	.700
9	.900	3.250	1.300	.700
10	.900	3.250	1.300	.700
11	<b>。</b> 900	_	1.300	.700
12	.900	-	1.300	.700
13	.900	_	1.300	.700
14	<b>°</b> 900	-	1.300	.700
15	<b>.</b> 900	-	1.300	.700
TOTALS	13.500	52.030	34.470	14.000
		==================		
		MADORA		MAD 0 7.1
	MAKGIN	MARGIN		MARGIN
	ADJUSIMENI =	AUJUSIMENI	MARGIN AUJUSI-	ADJUSIMENI
VCAD	15114152141351	AT 1550E =	MENT AT ISSUE	FACIURS =
TEAR	(JI)*(JZ)*(IJ)	1543 V 171		
N	*())/~()0/	(34) A (7)	= 30M UP (35)	1201 X 181
	(54)	(55)	(56)	(57)
1	49 090	49 090	76 069	76 069
2	7,810	4,551	100000 26 078	100000
3	4,550	3_350	208970	27.660
4	4,550	2,991	17,068	25,962
5	4,550	2.664	14.077	24.046
6	4,550	2,372	11,413	21,893
7	4,550	2.137	9,041	19,252
8	4.550	1.925	6.904	16.320
9	4.550	1.734	4,979	13.065
10	4.550	1.562	3.245	9.453
11	1.300	<b>•</b> 402	1.683	5.443
12	1.300	. 366	1.281	4.548
13	1.300	.334	.915	3.566
14	1.300	.304	.581	2.487
15	1.300	.277	.277	1.302
TOTALS	99.800	76.068	1	283.239

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## 106. POLICY CALCULATIONS - ENDOWMENT 15 YEARS AGE 25 (CONT'D)

	PROSPECTIVE PERFORMANCE PER UNIT =	TOTAL PROSPECTIVE PERFORMANCE =
YEAR	(28) - (57)	(58)X(40)/(17)
	(58)	(59)
_		
1	16.291	162.91
2	30.416	304.16
3	33.594	335.94
4	34.323	343.23
5	34.073	340.73
6	34.779	347.79
7	34.930	349.30
8	33.772	337.72
9	33.224	332.24
10	33.207	332.07
11	32.603	326.03
12	27.317	273.17
13	21.804	218.04
14	15.916	159.16
15	8.380	83.80
TOTALS	424.629	4,246.29

C.67

EFFECTS OF CHANGES IN INTEREST, LAPSE, AND MORTALITY RATES ON THE C.68 111. PROSPECTIVE PERFORMANCE FACTORS FOR AN ENDOWMENT 15 YEARS, AGE 25.

YEAR	(36)	(86)	(66)	(6)	(56)	(76)	(46) 
1	17.894	26.721	27.836	28.313	28.795	29.978	37.809
2	31.866	42.814	43.760	44.224	44.692	45.688	55.596
3	34.925	47.393	48.259	48.692	49.128	50.031	61.468
4	35.534	49.251	50.059	50.447	50.840	51.680	64.389
5	35.157	49.976	50.712	51.057	51.405	52.165	66.014
6	35.725	51.475	52.113	52.417	52.724	53.378	68.217
7	35.758	52.005	52.574	52.835	53.098	53.678	69.089
8	34.478	50.941	51.428	51.646	51.872	52.366	68.079
9	33.803	50.159	50.553	50.732	50.924	51.320	67.023
10	33.649	49.527	49.816	49.956	50.105	50.399	65.727
11	32.902	47.868	48.045	48.151	48.260	48.435	62.964
12	27.516	40.860	40.973	41.045	41.120	41.229	54.249
13	21.914	33.036	33.098	33.140	33.181	33.240	44.144
14	15.956	24.176	24.199	24.214	24.229	24.249	32.349
15	8.379	12.930	12.927	12.930	12.928	12.928	17.431
TOTALS	435.456	629.132	636.352	639.799	643.301	650.764	834.548
MEANS	29.030	41.942	42.423	42.653	42.887	43.384	55.637
					ار برای برای سب برای برای برای برای برای برای	and while while while have some some w	
INT. RATE	6.0 %	6.5 %	6.5%	6.5 %	6.5 %	6.5 %	7.0 %
LAPSE RATE	100 %	110 %	100 %	100 %	100 %	90 %	1 100 %
MORT. RATE	1 100 %	1 100 %	1 110 %	1 100 %	90 %	100 %	100 %
YEAR B	• PROSPEC	TIVE PERF	DRMANCES	EXPRESSED	AS COLUM	N (6) PER	CENTAGES
1	63.2	94.4	98.3	100.0	101.7	105.9	133.5
2	72.1	96.8	99.0	100.0	101.1	103.3	125.7
3	71.7	97.3	99.1	100.0	100.9	102.7	126.2
4	70.4	97.6	99.2	100.0	100.8	102.4	127.6
5	68.9	97.9	99.3	100.0	100.7	1 102.2	129.3
6	68.2	98.2	99.4	100.0	100.6	101.8	130.1
7	67.7	98.4	99.5	100.0	100.5	101.6	130.8
8	66.8	98.6	99.6	100.0	100.4	101.4	131.8
9	66.6	98.9	99.6	100.0	100.4	1 101.2	132.1
10	67.4	99.1	99.7	100.0	100.3	100.9	131.6
11	68.3	99.4	99.8	100.0	100.2	100.6	130.8
12	67.0	99.5	99.8	100.0	1 100.2	1 100.4	132.2
13	66.1	99.7	99.9	1 100.0	100.1	100.3	133.2
14	65.9	99.8	99.9	100.0	1 100.1	100.1	133.6
15	64.8	100.0	100.0	100.0	100.0	100.0	134.8
TOTALS	1015.1	1475.6	1492.1	1500.0	1508.0	1524.8	1963.3
MEANS	67.7	98.4	99.5	100.0	100.5	101.7	130.9

A. PROSPECTIVE PERFORMANCE PER UNIT FACTORS (COLUMN 58) FROM TABLE



EFFECTS OF COMBINED CHANGES IN INTEREST, LAPSE, AND MORTALITY RATES C.69 112. ON ENDOWMENT 15 YEARS, AGE 25 PROSPECTIVE PERFORMANCE FACTORS.

A. PROSPE	CTIVE PERFORMANCE	PER UNIT FACTORS	(COLUMN 58) FROM TABLE
YEAR	(106)	(6)	(96)
	1/ 201		
	10.291	28.313	40.397
2	30.410	44.224	1 57.929
3	33.594	48.692	
4 E	340323	50.44/	
5	34.073	51.057	
0	34.070	52.417	
1	34.930	52.835	
8	33.112	51.646	69.251
9	33.224	50.132	61.919
10	33.207	49.956	66.454
	32.603	48.151	63.45/
12	21.311	41.045	54.5/4
13	21.804	33.140	44.323
14	15.916	24.214	32.413
15	8.380	12.930	17.430
TOTALS	424.629	639.799	852.241
MEANS	28.309	42.653	56.816
INT. RATE	6.0 %	6.5 %	7.0 %
LAPSE RATE	110 %	100 %	90 %
MORT. RATE	110 %	100 %	90 %
YEAR B. PRC	SPECTIVE PERFORMAN	NCES EXPRESSED AS	COLUMN (6) PERCENTAGES
<u></u>	57.5	100.0	1 142.7
2	68.8	100.0	1 131.0
3	69.0	100.0	130.7
4	68.0	100.0	131.6
5	66.7	100.0	132.8
6	66.4	100.0	1 133.1
7	66.1	100.0	133.4
8	65.4	100.0	134.1
9	65.5	100.0	134.0
10	66-5	100.0	133.0
11	67.7	100.0	1 131.8
12	66-6	100-0	1 133.0
13	65-8	100-0	1 133.7
14	65.7	100-0	1 133.9
15	64.8	100.0	134.8
TOTALS	990.5	1500.0	2003.6
-			

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EXAMPLE TO ILLUSTRATE THE ADJUSTMENT OF THE STARTING C.70 113. POINT DURATION FOR THE PERSISTENCY AND DISCOUNT FACTORS

### (A). BASIC INPUT DATA - AGE 25

YEAR N	MORTALITY RATE Q (x)+N-1 (1)	LAPSE RATE W (X)+N-1 (2)	INTEREST RATE (3)
1	<b>.</b> 00085	.10	<b>₀0650</b>
2	.00090	°06	.0650
3	.00095	.05	°0620
4	.00100	۵05	<u>。0650</u>
5	.00100	•05	<b>.</b> 0650
6	.00100	.04	<u>。0650</u>
7	.00102	• 04	.0650
8	.00104	°04	°0620
-		and with the ante the same and the same with the	
TOTALS	₀00776	. 43	
:			

### (B). BASIC CALCULATIONS

	S P {X}*N-}	COMPOUND P = (x)	DISCOUNT Factor	PERSISTENCY AND DISCOUNT FACTOR =	PERSISTENCY AND DISCOUNT ACCUMULATION FACTOR =
YEAR		(4) X(5)	N-1		
	= 1 - (1) - (2)	N-1 N-1	= V	(5) X (6)	1/(7)
N					
	(4)	(5)	(6)	(7)	(8)
1	.89915	1.00000	1.00000	1.00000	1.00000
2	.93910	.89915	.93897	.84427	1.18446
3	.94905	.84439	.88166	.74446	1.34326
4	<b>°</b> 94900	.80137	<b>.</b> 82785	.66341	1.50736
5	<b>.</b> 94900	.76050	.77732	.59115	1.69162
6	.95900	.72171	.72988	。52676	1.89840
7	.95898	.69212	<b>.</b> 68533	.47433	2.10824
8	.95896	.66373	.64351	.42712	2.34126

TOTALS 7.56224

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EXAMPLE TO ILLUSTRATE THE ADJUSTMENT OF THE STARTING <sup>C.71</sup> 113(CONT'D). POINT DURATION FOR THE PERSISTENCY AND DISCOUNT FACTORS

> TO CONVERT TABLE B PERSISTENCY AND DISCOUNT FACTORS TO START AT DURATION R, DIVIDE THE VALUES IN COLUMN (7) FOR DURATIONS R AND HIGHER BY THE VALUE OF (7) . THE PER-

R

SISTENCY AND ACCUMULATION FACTORS IN COLUMN (8) CAN THEN BE RE-COMPUTED FROM THE NEW COLUMN (7) VALUES. HOWEVER, COLUMN (8) VALUES MAY NOT REALLY BE USED IN PRACTICE, AS THE PROCESS OF MULTIPLYING BY COLUMN (8) DATA GIVES THE SAME RESULTS AS DIVIDING BY CORRESPONDING COLUMN (7) DATA. NEVERTHELESS, IT IS REGARDED AS USEFUL TO INCLUDE COLUMN (8) DATA IN THE ILLUSTRATIONS, AS THEY REPRESENT ACCUMU-LATIONS WITH BENEFITS OF INTEREST AND SURVIVORSHIP, AND AS SUCH ARE OBVIOUSLY STANDARD ACTUARIAL CALCULATING DATA.

COLUMN (8) DATA TO START AT DURATION R MAY ALSO BE CALCU-LATED BY DIVIDING THE VALUES IN COLUMN (8) FOR DURATIONS R AND HIGHER BY THE VALUE OF (8) .

(C). THE FOLLOWING DATA ARE BASED ON R = 5, FOR WHICH THE VALUES OF (7) AND (8) ARE .59115 AND 1.69162. 5 5

		S			PERSISTENCY
	S	COMPOUND P =	DISCOUNT	PERSISTENCY	AND DISCOUNT
	Р	(X)	FACTOR	AND DISCOUNT	ACCUMULATION
	(X)∻N-1			FACTOR =	FACTOR =
YEAR		(4) X(5)	N-1		
	= 1 - (1) - (2)	N-1 N-1	= V	(5) X (6)	1/(7)
N					
	(4)	(5)	(6)	(7)	(8)
5				1.00000	1.00000
6				.89108	1.12224
7				<b>.</b> 80239	1.24629
8				.72252	1.38404

(D). THE FOLLOWING VALUES WERE COMPUTED FROM FIRST PRIN-CIPLES, AND DEMONSTRATE THE EQUIVALENCE TO THE VALUES DERIVED BY THE METHOD OUTLINED IN (C) ABOVE.

YEAR	(4)	(5)	(6)	(7)	(8)
5	<b>.949</b> 00	1.00000	1.00000	1.00000	1.00000
6	<b>。959</b> 00	<b>.</b> 94900	.93897	.89108	1.12223
7	.95898	.91009	.88166	.80239	1.24628
8	<b>•95896</b>	.87276	.82785	.72251	1.38406

DIFFERENCES IN (C) AND (D) RESULTS ARE DUE TO ROUNDING AND TO THE NUMBER OF SIGNIFICANT DIGITS USED. THE DEGREE OF REQUIRED PRECISION REMAINS TO BE DETERMINED IN THESE AND ALL OTHER CALCULATION PROCESSES OF THE SYSTEM.

#### APPENDIX D

### EXAMPLES OF INSURANCE FORMS USED IN RECORD ADMINISTRATION

### AND CONTAINING ACTUARIAL DATA

All forms are produced by computer systems, in response to inquiries or as a result of transaction activity processing. They provide data required in administrative processing.

### Description

Page

Individual Insurance

Policy	Informat	ion Form			D.2
Policy	Writing	Document	(New	Business)	D.3

### Group Life and Health Insurance

Policy Particulars FormD.4Certificate Information FormD.5

### Group Pension

Plan	Information	Form	(Policy	Data)		D.6
Cert:	ificate Info	rmatio	n Form		•	D.7

D.1

		NAME OF FORM					TE PREPARED DEPARTMENT	CLK POLICY NUMBER
$\bigcirc$	0	01 BRANCH SURNAME TOTAL	MODAL PREMIUM DUP YEAR LIFE PLACED		PREMIUM ANNIV. FREQ. PAID TO	D DATE NON-FORF, OPT, BILLING TYPE SP	EC. BILLING CONTROL	
U	BASIC C	03 LANG CURRENCY EDN SEX LEAD	PRE HIT DATE ACTIVITY HIT DATE	CONTRACTUAL CHANGE YR. 04	VE CODE EFFECTIVE DATE	TITLES TRAIL DATE PREMIUM TRAIL DATE		SPEC. BILL JON' COLL
		05 TERMS OF ISSUE LANT COE	CLAIM NUMBER TAX/TRUST OWNER'S TA) PREMIUM WAIVER CODE	KIDENT. NO. PURE ENDOW. AMT. LIFE GUAR.	ITY CONTRACTUAL ANNUITY OPT.		SERVICING AGENT	SX DEP AUTOPAY NUMBER
	Ċ	77	SPECIAL INFORMATION DATA	ORIGINAL	RESIDENCE CURRENT RESIDENCE	CONTRACT JURISDICTION		
	INDICATORS	DB POL OK TO P.S.A. CED GTD. ISS. & RPB & OR STA TRAN EXISTED IND TRM DV RT	G CLS BGN. DAY DUE NO.   DEPT.   CLK. P	TURITY TITLE CHG. SPECIAL WAR	ling	OWNEDSHIP RESTRICTIONS		
	L	INSURED/ANNUITANT. OWNER,						RRSP. DIR. FOR COMMUTATION RIGHTS
	TITLES	2 BEN REL	NAME OF	BENEFICIARY	11	NAME OF OWNER(S)		SECONDARY OWNER
	DATA1	4 NO. COLL. 4 ASMTS.	NAME OF COLLATERAL ASSIGNEE	CAN. BANK	ADDRESS OF CO	13 BEN/DIR. REVIEW YR.	DOCUMENT FILE LOCATION	
<u>ب</u>	L			COLL. ASMT.	[15]	GELATERAL ASSIGNEE - LINE ONE	ADDRESS OF COLLATERA	L ASSIGNEE - LINE TWO
	MAILING	MAILING (PREMIUM PAYOR) NAME AN	ID RE-LINE COMMISSI	AGENT'S PARTICIPATION COL RES	T. INS. BEGINS DATE CONT. E FPR-HSR-DPR-FPIB TYPE SHARE	15T 2ND 3RD SUB RATE RATE RATE RATE	COMMISSION EXTR EXPIRY DATE EXTRA 1 EXTR	A PREMIUM INDICATORS
	NAME 10 AND 1	6 7		22 23				
1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 - 1997 -	ADDRESS	MAILING ADDRESS		24 25				
	18	8		26				
	20	0		27 BIR INDATE INSURED AGE ADM-INS.	BIRTHDATE APPLICANT	BIRTHDATE FPIB		
		CARD PREM PLN NO. STA. TRN PLAN	DURATION AGE BASIS RTE	INSURANCE BEGINS	4 DATA	GODSS ANNUAL		NUMBER
	BASIC	28	FORCE ISSUE CODE BAS	DAY MON YR. NDICATOR RSN D	UR ASSOC. OFFICIAL AMOUNT		MODAL T PREMIUM	
	PLAN.							
	RIDERS AND							
	EATRAS							
		CARD PLAN OFFIC	IAL CURR. PREV. TERM	CURR. TERM NEXT TERM TUDO		AL MODAL PREMIUM (INCLUDING EXTRAS)	<u>&gt;</u>	
		64 BASIC	VIII T.R. YR. RES./UNIT	RES./UNIT RES./UNIT CSV YR.	CSV/UNIT CSV/UNIT	NEXT GROSS ANNUAL NET / CSV/UNIT PREMIUM/UNIT PREMIU	NNUAL DEFICIENCY PREVIO NET ANNUAL MEDIA PREMIUM/UNIT ANNUIT	US CURRENT L MEDIAL Y ANNUITY
	FACTORS							
177 177 177	AUTOPAY 76	CHEQUE HISTORY 0/S CHEQUE IND;	SUSPENSE AMOUNT LOAN REPAYMENT	AMT. BANK TRANSIT NO. BANK TRANS. INDEX NO	BANK ACCOUNT TYPE BANK ACC	OUNT NUMBER	BANK ACCOUNT	
t sector Sec		GUARANTEED FUND	AMT. GUAR. INT. RTE GUAR. INT. CREDITED 1	GUAR, INT. CREDITED		777		
)	A.D.U. 78		NEXT PREM. ANNIV.	LAST PREM. ANNIY. ELIG. ENDMT.	PSA 1 79 PSA 2 80	INT. LAST ANNIV. INT. NEXT ANNIV.	FIRST FIRST PSA SECOND PSA INT. DUR INT. RATE INT, RATE	SURRENDER DEPOSIT DATE
50a	A.D.P. 81	TOTAL DEPOSITS OFFICIAL AMOU	NT PD-UP RIB DTH BEN (BASIC ONLY) OFF. AM	T./UNIT ANNUAL ANNUITY PREV. TERM. RES./	J CURR. TERM RES./U NEX	KT TERM RES./U		
рт.		CURR. DIV. OPT. CURRENT DIVIDEND						
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#### APPENDIX E

### GLOSSARY OF TERMS

This Appendix contains definitions of insurance and data processing terms which are referenced in or are applicable to the thesis contents.

Sources: (1) Computer Dictionary and Handbook, C. J. Sippl, H. M. Sams and Co., Inc., and The Bobbs-Merrill Company, Inc., New York, 1966.

> (2) Life Insurance Fact Book 1968, Institute of Life Insurance, New York.

#### E.1

### GLOSSARY OF TERMS

Accidental Death Benefit: A provision added to an insurance policy for payment of an additional benefit in case of death by accidental means. This benefit is also referred to as "double indemnity."

<u>Analog-to-Digital Converter</u>: A class of devices associated with computer systems in which information measured by physical quantities such as lengths, temperatures, and voltages is converted to digital form as required for computer processing.

Asset Share: A special type of insurance fund, used in actuarial calculations, in which the true expense pattern is recognized in testing the adequacy of premium rate assumptions. The calculations of asset shares involve the allocation of realistic interest and expense elements on a year-by-year basis.

Audio-Response Device: A device which can link a computer system to a telephone communication network to provide computer responses in voice or audio form to inquiries made from telephone-type terminals. The audio responses are composed from a prerecorded vocabulary stored in direct access computer devices.

Back-up System: A secondary means of performing required work processes, by clerical or computer methods or a combination of both, in the event that the primary means cannot be used (e.g., In the event of an extended period of malfunction of a computer system, it may be necessary to perform the necessary work processes by a back-up system which may be essentially manual in nature).

Byte: A unit of measurement of the capacity of computer storage. One byte can contain one character or two digits of information.

Cash Surrender Value: The amount of money available in cash to a policyholder upon his voluntary termination of his policy before it becomes payable by death or maturity or in the case of term insurance, before it automatically terminates at the end of the contractual term insurance period.

<u>Certificate</u>: The printed document, associated with group insurance policies, which identifies a particular life insured and provides insurance and other information pertaining to that life.

Character: One symbol of a set of basic symbols used in computer systems. The usual characters are the twenty-six letters, the ten numerals, and a varying number of special symbols such as dollar and percent signs. Data Bank: A computer-stored file of data, to which users can have access as required, often by means of computer terminal devices.

Data Base: A computer-stored file of data and procedures which provides the primary foundation elements of systems which use these facilities to provide information (i.e., data selected, processed, and structured so as to serve a particular purpose).

Dial Device: A facility, similar to a telephone, whereby a user may initiate and use direct connections to a computer for inquiry or processing purposes.

Digital-to-Analog Converter: A class of devices associated with computer systems in which information stored in digital form in a computer is converted to physical quantities such as lengths, temperatures, and voltages.

Direct-Access Storage: A type of computer data storage device wherein access to a particular location for information is not dependent upon the location from which previous information was obtained.

Dividend: A return of part of the premium of an insurance policy to reflect the difference between the premium charged and the actual company experience, in terms of mortality, expense, and interest elements.

Electronic Data Processing: Data processing which is performed principally by electronic computers and associated equipment.

Expiry: The contractual termination of a term insurance policy at the end of its stipulated insurance period.

Face Amount: The amount stated on the first, or face, page of an insurance policy that will be paid in the case of death or maturity of the contract. Excluded are dividends and other special amounts and provisions.

File Maintenance: The processes whereby a file of data is modified to reflect additions, changes, and deletions of contents.

Forecasting: The processes of predicting events and conditions pertaining to future points of time and time periods, based on analysis and evaluation of current and historical data.

Format: A predetermined organization of characters, symbols, or data.

Game Theory: A mathematical process in which one participant is seeking an optimum strategy or course of action, in the face of one or more opposing participants with their own strategy considerations.

Gross Premium Valuation: The series of actuarial processes in which insurance policies are evaluated in terms of realistic mortality, interest, and expense assumptions.

<u>Group Health Insurance</u>: Health insurance, providing benefits for loss of work time and for hospital and similar expenses arising from sickness and accident, and issued on a group of lives under a single master policy.

Group Life Insurance: Life insurance issued on a group of lives under a single master policy.

Group Pension: A pension or annuity plan providing retirement benefits to a group of lives under a single master policy.

<u>Health Claims-Versus-Premiums Studies</u>: The processes of compiling, analyzing, and evaluating the experience on health insurance business, in terms of the adequacy of premium rates in support of the actual health claim payments.

Hospital Benefit: A health insurance benefit in which the insured life will be reimbursed for hospital room and expense charges arising from sickness and accident.

Income Indemnity: A health insurance benefit, in which the insured is reimbursed, to a stipulated maximum level, for loss of income due to accident or sickness.

Individual Health Insurance: Health insurance benefits, providing for loss of work time and for hospital and similar health-oriented expenses on a single life.

Individual Life Insurance: Life insurance benefits issued on a single life basis (in contrast to Group).

Input: The data to be transferred from an external source into the internal storage of a computer; and the processes involved in effecting this transfer.

Insurance Rider: A supplementary term insurance provision attached to a basic insurance policy, and providing the additional insurance for the term period. Instalment Refund: A method of payment of policy benefits in which the amount available is paid in instalments rather than as one sum.

Lapse: The voluntary termination of a policy, by non-payment of premiums, which has no surrender value to the policyholder.

Life Annuity: A method of payment of policy benefits which provides an income for life.

Light Pen: A device, associated with a computer visual display terminal, that can detect information displayed on the screen and send a response to the computer, which, in turn, applies program logic to the particular portion of the display detected. This facility enables a terminal user to change displayed information under program control.

Linear Programming: The analysis and/or solution of problems in which the linear function of a number of variables is to be minimized or maximized, when the variables are subject to a number of constraints in the form of linear inequalities.

Loan: A loan made by an insurance company to a policyholder, in which the cash value of his policy provides the security.

Lump Sum: A method of payment of policy benefits in which the amount is paid as a single sum.

Magnetic Card: A card with a magnetic surface on which data can be stored by selective magnetization of its surface, and with the capability of use in computer systems.

<u>Magnetic Drum</u>: A cylinder, with a magnetic surface on which data can be stored by selective magnetization of its surface, and with the capability of use in computer systems. Commonly, the drum is rotating at a high rate of speed past a series of reading and writing heads.

<u>Magnetic Tape</u>: A reel of metallic or plastic tape, with a magnetic surface on which data can be stored by selective magnetization of its surface, and with the capability of use in computer systems.

Maturity: The contractual termination of a policy at the end of its specified number of years, at which point the amount of insurance is payable to the insured (e.g., endowment).

Medical Benefit: A health insurance benefit in which the insured life will be reimbursed for medical expenses arising from sickness and accident. Mortality Study: The processes of compiling, analyzing, and evaluating mortality experience on life insurance business, by comparing actual to expected data for various business groupings.

Non-forfeiture Benefit: One of the choices available to the policyholder if he discontinues the required premium payments. The policy value may be taken in cash, or may be used to provide either paid-up term insurance for as long a period as the cash value provides (called extended term insurance), or paid-up insurance on the same basis as the original insurance, but of reduced amount (called reduced paidup insurance).

Non-Preventable Termination: The involuntary termination of insurance policy by maturity, expiry, or death.

On-Line: A term applied to a system and peripheral devices in which the operations are under the control of a central processing unit or computer.

Operations Research: The uses of analytical methods and scientific techniques in the solution of operational problems.

Optical Character Reader: A device which reads data printed in a variety of formats on documents and converts the data into a format in which they are processable by a computer.

Output: The results produced by computer processes.

Paper Tape Reader: A device that reads the holes, which are punched in paper tape to denote data, and converts the data to a form which is processable by computer.

Persistency Study: The processes of compiling, analyzing, and evaluating the degree to which insurance policies remain effective or persist.

<u>Plan of Insurance</u>: A term used to describe the basic nature of benefits provided in an insurance policy (e.g., endowment, term, and annuity), and also the premium payment environment (e.g., single premium, paidup, premiums payable for life, and premiums limited to a specified number of years).

<u>Policy</u>: The printed document which contains the terms of contract between the policyholder and the insurance company, in terms of benefits, premiums, and other provisions.

Premium: The payment made by the policyholder in return for the insurance company's provision of the contractual benefits of his policy.

Preventable Termination: The termination of an insurance policy by voluntary surrender by the policyholder.

<u>Real-Time</u>: A term used to describe a problem-solving environment, usually of a computer system, in which the answer is provided with sufficient speed in order to comply with the problem-solving time limit.

Record: A group of related pieces of data.

<u>Reserve</u>: This term denotes the funds that an insurance company must have available at any time which, together with future payments to be received, assure the payment of all future benefits guaranteed in each policy contract.

<u>Simulation</u>: A technique that involves setting up a model of a real situation and performing experiments on the model. When used in relation to data processing operations, the term denotes numerical techniques and the use of a digital computer.

Supplementary Benefit: A supplementary benefit provision, incorporated in a basic insurance policy, that provides benefits such as the payment of double the policy amount in the event of death by accidental means, and the waiver of future premium payments in the event that the policyholder becomes disabled.

Surgical Benefit: A health insurance benefit in which the insured will be reimbursed for surgical expenses arising from sickness and accident.

Surrender: The voluntary termination of an insurance policy by the policyholder, in return for which he is entitled to such surrender benefits as the policy contract may contain.

Terminal: A device, connected to a computer by means of communication lines, which enables the user to enter data for computer processing and to receive results of computer processing.

<u>Touch-Tone Telephone</u>: A special form of telephone, in which the characteristics of the dial facilities are such as to enable the direct entry of data thereby into computer storage.

Valuation Basis: The assumptions as to mortality table and interest rate which are inherent in the calculations of policy premiums and benefits. Visual Display Unit: A computer-linked terminal in which data are displayed in visual form, similar to the pictorial concept of television sets.