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THE UP-94 AND GAR-94 TABLES: ISSUES IN CHOOSING THE APPROPRIATE TABLE

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I. INTRODUCTION

In 1993 and 1994, two Society of Actuaries task forces were at work examining the mortality of healthy retirees. One task force was working on an update to the group annuity reserve standard—the 1983 Group Annuity Mortality Table (GAM-83). The other task force was attempting to provide an update to uninsured pensioner mortality. It was anticipated that this second task force would produce a table that reflected recent uninsured mortality experience, and thus could serve as an update to the UP-1984 Table (UP-84), although not expressed on a unisex basis. As the task forces' work progressed, a convergence of the data at retirement ages was noted, and so the same underlying data were used as the basis for the mortality in each table. These underlying data were based on Civil Service Retirement System (CSRS) mortality for lives under age 66 and group annuity mortality at ages 66 and over. Even though the underlying data are the same, based on the different uses for the table, the task forces strongly believe it is appropriate for separate tables to be produced as insurance reserving standards and as a general uninsured pensioner mortality table.

Each of the task forces is publishing a paper† describing the development and appropriate uses of the table it produces. This paper is intended to summarize the differences in the tables and to review issues that arise for actuaries in choosing the appropriate mortality table. In essence, this paper addresses:

- How do the tables differ?
- Why do the tables differ?

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†See "The Uninsured Pensioner Mortality Table" by the Society of Actuaries UP-94 Task Force on page 819 and the "1994 Group Annuity Mortality Table and 1994 Group Annuity Reserving Table" by the Society of Actuaries Group Annuity Valuation Table Task Force on page 865.

- What should actuaries consider when using tables for uninsured plans?
- What should actuaries consider when using tables for insured plans?

This paper is intended to supplement the two task force papers on the individual mortality tables. As such, this paper focuses primarily on the choice between versions of the UP-94 and GAR-94 mortality tables; the appropriateness of other tables is not reviewed in detail. Certain areas that are only referenced here are addressed at greater length in those papers.

II. HOW DO THE TABLES DIFFER?

A. Definitions

In this paper, we use the following short-hand notation to refer to the proposed tables:

GAR-94 (The 1994 Group Annuity Reserving Table). This table is the product of the 1994 Group Annuity Valuation Table Task Force. For conservatism, because it is proposed as a reserve standard, the table includes a 7% reduction in q_x's at all but the oldest ages (this is referred to in general through the rest of the paper as the "7% margin"). Mortality is specifically projected using a generational approach through the use of a set of mortality improvement factors incorporated as part of the table.

UP-94 (The Uninsured Pensioner 1994 Table). This has the same underlying mortality as the GAR-94 Table, but does not include the 7% margin. There are a number of different ways in which the mortality rates in the UP-94 Table can be projected for use in a particular valuation. The use of the table with the full range of mortality factors and projection scale AA applied on a generational basis, including projection from 1994 to the valuation date, is referred to as UP-94G. Alternatively, actuaries may prefer to use the table projected for a certain number of years. We refer to a static table produced by projection of each mortality rate to a particular year as "UP-94 @ year" (for example, the table with rates projected to the year 2000 would be referred to as UP-94 @ 2000). This notation is extended for use with generational tables to indicate the point of initial projection, when different from the valuation date. (For example, UP-94G @ 2000 refers to a generational table of q_x's that has already been projected to 2000 and that will continue to be projected to each future year. This differs from UP-94 @ 2000, which refers to a table of mortality rates projected to the year 2000 but assumed to remain static thereafter.)

B. Differences

As can be seen from the above definitions, the two tables differ in two ways. First, GAR-94 reflects explicit margins for longer lifetimes than expected. Second, GAR-94 incorporates explicit projection of mortality decreases over time, while the UP-94 Table is designed to be projected in whatever fashion is most appropriate to the particular task at hand.

1. Margins

The GAR-94 Table reduces assumed mortality rates by an explicit margin of 7%. This margin is due to two adjustments:

(a) A 5% reduction in mortality rates to cover 95% of the random deviations in mortality for groups as small as 3000 lives. The size of the group chosen (3000 lives) was based on the numbers of lives covered by contracts at various insurers. It is anticipated that almost all carriers providing group annuity insurance will have at least this level of coverage in force.

(b) A 2% further reduction in mortality to cover the risk of non-homogeneous insured populations whose longevity is greater than the typical insured plan.

2. Projections

GAR-94 incorporates a defined projection of mortality improvements (that is, decreases in mortality rates) over time. Unlike GAR-94, a projection scale was not directly built into the UP-94 Table mortality rates. However, Scale AA, used to project the GAR-94 mortality rates beyond 1994, is included in the UP-94 Table Report, as are projections of UP-94 to sample future years using Scale AA. The purpose is to supply pension actuaries with tools to project the UP-94 Table based on their judgment about future general mortality trends and the nature and demographic attributes of particular retirement plans.

Scale AA is wholly based on the historic experience of the CSRS and of Social Security—1977 through 1993, by age and sex—with a minimum 0.5% per year improvement at ages under 85. The period 1977 through 1993 was considered a representative historical period on which to base future mortality projections.

The manner in which a scale is used in a particular retirement plan valuation will depend on the actuary's judgment, including:

- Future changes in overall mortality improvement trends
- Future changes in mortality improvement patterns by age and sex from the 1977–1993 period
- The appropriate time period for projecting future mortality improvement
- Particular workforce attributes and anticipated changes in a particular workforce's composition.

Though the incorporation of explicit projection scales has not previously been standard practice in the valuation of retirement plans, we believe that actuaries should carefully consider using mortality trend projection if adopting a version of the UP-94 Table. The argument for use of mortality improvement trends is bolstered by the following observations:

- The trend of mortality improvement has been a long and relatively consistent one in the U.S. throughout this century. The length and consistency of this trend separate it from trends affecting the other experience-related decremental assumptions.
- The preponderance of scientific and demographic literature foresees continued mortality improvement, at least at some level.
- Unlike the UP-84 Table, which was issued in 1975 and projected to a future date (1984), the UP-94 Table will be issued in 1994 and incorporates no margins for mortality improvement after that date except as explicitly projected by the actuary using the table.

However, the need to consider mortality improvement trends in setting assumptions should not be taken to imply that the only appropriate model is one in which mortality improvement trends explicitly appear. In determining liabilities, the actuary must also consider the actual population expected to retire under the plan, the interaction of assumptions, the relevance of various assumptions given alternate plan designs, and the significance of a particular assumption given the overall level of precision in the liability model. Thus the decision to project mortality trends explicitly or implicitly should reflect both the actuary's estimate of the magnitude of future trends and the limitations and approximations inherent in the interaction of these trends with the actuarial model of the benefit plan. Depending on the model, a static table that includes an appropriate degree of mortality projection may be most consistent with the plan benefit and actuarial model.

III. WHY DO THE TABLES DIFFER?

The tables differ because of their intended uses. GAR-94 is constructed for use as an annuity reserve standard to be applied within the constraints

of insurance company reserve valuation laws promulgated by the states. As a reserve standard, it is designed to produce reasonably conservative estimates recognizing the statutory and business constraints of insurers. UP-94 is to be used as a tool to construct a table representing a best estimate of future mortality for a particular population under study. It is designed primarily for use by actuaries of uninsured plans. While the process for deriving a best estimate of future mortality may be difficult, the concept of best-estimate mortality is clear. A reserve mortality standard differs in a number of ways from this concept. The following section examines the differences between constraints on a reserve valuation standard and a best-estimate table.

A. GAR-94 and Reserving Standards

The GAR-94 Table would be used to compute statutory minimum reserves for group pension contracts for annuities established in the mid-1990s and later. For such uses, a mortality table must be consistent with both statutory constraints and actuarial standards of practice. Statutory constraints arise under Standard Valuation Laws (SVL) promulgated by the states. These define the use of a standard mortality component when reserves for a particular product or block of business are being established. Actuarial standards of practice include the following:

> *Adequacy of Reserves and Related Items.* In addition to meeting appropriate regulatory requirements, the appointed actuary should use professional judgment to be satisfied that the assets supporting the reserves and related items plus related future revenues, are adequate to cover obligations under moderately adverse conditions. To hold reserves so great that a company could withstand any conceivable circumstances, no matter how adverse, would usually imply an excessive level of reserves. [1]

While this paragraph explicitly discusses assets and related investment returns (whose performance is the most significant experience factor for annuities), it is reasonable to apply it to mortality tables as well. By focusing on the ability to withstand moderately adverse conditions, it seems clear that reserves, as with assets, should be determined on a basis that incorporates additional (but not excessive) conservatism.

Buyers of insurance policies and contracts expect their insurer to be able to deliver benefits many years after the insurer received premium payments. This expectation and contractual promise is helped in part by the insurer holding adequate reserves. These measure the present value of its benefit

liabilities and, in the aggregate, are usually determined on a moderately conservative basis.

Based on historical trends in the U.S. and Canada, it seems reasonable that reserves anticipate a continued improvement in mortality. Beyond national trends, a mortality table used for reserves should also be adequate for companies whose customers exhibit lower-than-average mortality and to cover the statistical variations that different moderately sized in-forces may exhibit.

To cover these moderate adverse conditions, the GAR-94 Table incorporates both explicit projection of mortality trends and an explicit reduction in q_x's by a 7% margin. This type of explicit margin is not provided by a best-estimate table like UP-94. Explicit reasonable levels of additional security margin are characteristic of reserve standards. The following section summarizes briefly the need for security margins in developing insurer reserves.

B. Need for Security Margins

While insurer surplus may contain provision for extreme adversity, such as short-term mortality variations (for example, random or low rates of influenza during some year), the insurance company reserve is anticipated to be established using a mortality standard with sufficient security margins to cover most situations. These margins help to lessen the likelihood that additional surplus allocation will be required.

The determination of the size of the margin appropriate to cover potentially adverse experience varies by the type of business being reserved for. There are several reasons why variation may exist. Among them are the following:

1. Size of Annuity Business In Force

As a result of size variation, there is not always the same need to hold conservative reserves. Companies with sufficient contracts in force to absorb adverse experience, by sheer volume, may not require any margin. However, companies with smaller amounts of in-force contracts may not have the ability to absorb adverse experience. To be assured that sufficient reserves are held, a larger margin may be desired for these smaller books of business.

2. Nature of Industry

Depending on the type of business undertaken by the employer of a given contract's participants, anticipated mortality differs from a "typical"

business group. Some businesses are inherently safer than other businesses (for example, desk jobs versus coal-mining) and would thus imply a longer life span for the employees being covered by the "safer" business group's contract. The "safer" businesses require a larger reserve be held to account for increased longevity, when compared to "less safe" businesses.

3. Other Demographic Factors

In addition to the type of employment, certain socioeconomic classes tend to experience different rates of mortality incidence. This inherent difference in mortality experience should be reflected in different reserve magnitudes. If we knew in advance which groups had higher or lower mortality and could hold an appropriate reserve, these different levels of experience would be properly addressed and sufficient assets would be allocated. Certainly, in some situations, the reserves should even be less extensive.

SVL requires that a minimum reserve be held by all companies based on standardized assumptions. If the reserve is to incorporate the ability to withstand the moderate adverse deviations anticipated under *ASOP No. 22,* margins must be built in to accommodate the types of variation above.

C. Why Should Future Mortality Improvement Be Incorporated?

Since SVL does not readily change over time, it is imperative that the SVL allow adequate group annuity reserves within the current framework of a given set of laws to minimize the need for future ad hoc reserve strengthening. Unfortunately, in the past, the SVL has not reflected the continuing improvement of mortality in reserve assumptions. While an adequate attempt has been made to modify the impact of artificially low interest rates (which produce unreasonably high reserves), there has been no effort to address the continued improvement in mortality. Since longer lifetimes produce a larger outflow of funds, the reserves allocated for any longer lived groups lose their adequacy over time. Future projection as part of an ongoing Valuation Standard helps to address this concern without resorting to the more difficult task of frequent SVL changes.

Improving mortality can easily erode a given reserve's sufficiency since the ultimate gain or loss of a contract is reflected in payments actually made under it to participants (in addition to what the underlying funds actually earn relative to the interest assumption). The inclusion of mortality

improvement in a new Valuation Standard allows the allocated reserve to keep pace with this potentially increasing liability.

Should the rate of mortality improvement change, reflection of recent improvements should at least make the resulting difference in liabilities less important, than had a static table been used.

Larger reserves produced by using mortality improvement factors may still be inadequate, if mortality improves greatly, but they would be less so than if mortality followed the pattern implied from the reserve assumptions. Furthermore, the reserve would undoubtedly be sufficient should mortality improvement slow down or even reverse.

By allowing for such improvement, the new Reserve Standard addresses a need that is not adequately accounted for with the current SVL. By reflecting improved mortality in the SVL, the laws would be better prepared to respond to changes in the likely lengthening of payout period that results from the mortality improvement. It better matches a rapidly improving mortality trend when compared to the current SVL, which does not allow for such mortality improvement. As an example, future mortality improvement shifts could be incorporated more readily by a simple change to the projection scale alone. This obviates the need for a new mortality table while simplifying the updating process.

D. Insurer Business Environment

There are other significant differences in the use of mortality assumptions when contemplating pension funding versus establishing group annuity reserves. The differences relate to timing and the desire to universally apply a set of assumptions as required values. They also relate to the inability for an insurer to request additional premium as initial estimates are revised in light of experience.

1. Reserve Assumptions Are Not Changed Annually

When an insurance company establishes a reserve, the mortality assumption is set by SVL. This SVL prescribes the use of a given interest rate, or set of rates, as well as the mortality table. For any company doing business within any given state, the reserves established for filing purposes must follow the SVL of that particular state. Since most states have adopted the Dynamic Valuation Law, these reserves are based on standard assumptions, which are not frequently modified. The process of changing statutes is typically a multiyear process.

While individual insurance companies may strengthen reserves as needed, there are significant financial and other hurdles in so doing. These include public relations effects, tax deferrals and surplus concerns. Thus it is preferable that reserves be initially established on a somewhat conservative basis.

2. Comparability

Reserves are also important components of insurer Annual Statements. There are many users of insurance company Annual Statements. A critical goal of an Annual Statement is to enable users to compare and evaluate general solvency and strength of a given group of insurers. The reserves shown in the Annual Statement are determined under the same minimum basis for all insurers. By applying a minimum reserve mortality standard, users can be assured that reported liabilities are not distorted, at least on a minimum basis. Of course, to the extent that a standard assumption does not represent the true underlying liabilities, comparability of the strength of given corporate entities is impaired.

3. Inability to Demand Additional Premium

An insurer's need for reserve adequacy is further caused by an inability to demand additional premium under many types of contracts, even if it is suffering losses. This is in direct contrast to the situation for uninsured plans, which are typically funded on an annual basis.

E. How Do Uninsured Plans Address Issues Such as Mortality Projection?

Unlike insurance company reserves, which must comply with SVL and other related laws, the adequacy of an uninsured pension plan's funding program is related to the plan-specific assumptions. These plan assumptions are based on an actuary's best estimate of each specific assumption employed in the funding process. Since the actuary has the opportunity to address and modify these assumptions on an annual basis, if necessary, the accuracy of each individual assumption can be addressed and consequently updated within a reasonable period.

1. Overall Adequacy of Funding Is the Primary Concern

The primary concern of pension funding is that adequate funds exist over the lifetime of a plan to satisfy the liabilities. The plan itself is an ongoing entity with generally a greater portion of liabilities dependent on a number

of future contingencies: future hires, salary increases, benefit accruals, turnover, and a wider variation of investment returns. In fact, these other assumptions may have a larger impact on the adequacy of the funding process than the ongoing mortality assumption. Therefore, while mortality improvement is as much of a concern to the uninsured pension plan sponsors as it is with an insurance company, there are other assumptions that must be addressed in conjunction with it.

2. Annual Observation Affects Future Funding Assumptions

By doing an annual gain or loss analysis, a pension plan actuary monitors results on an ongoing basis. Through this monitoring process, actuaries can modify the specific assumptions that are proving inadequate. Given the ongoing nature of an uninsured plan, it is likely that these assumptions will include more than just the mortality component. Of course, identification of mortality changes may be long deferred, particularly for a relatively young pension plan.

3. Practicality

The relative degree of uncertainty in significantly more important assumptions leads to a desire to keep the degree of complexity in the mortality assumption to a minimum. This may argue for the use of a static projected table as an approximation.

IV. WHAT SHOULD ACTUARIES CONSIDER WHEN USING TABLES FOR UNINSURED PLANS?

The role of mortality in determining liabilities for uninsured plans is different than the role of a reserve standard for insured plans. Typically, for financial reporting, for determining funding requirements and for calculating tax deductions, the uninsured pension plan actuary is focused on a best estimate of future experience under the plan. We believe that actuaries should directly consider trends in mortality improvement in setting such a best estimate. However, it is also important to recognize that the relevance of the mortality assumption can only be determined by reference to the total environment in which the plan is designed and operates.

Projection of future mortality trends is an issue that should be considered in setting up a best estimate of future experience. A considerable body of evidence has accumulated showing that continuous mortality improvements have occurred throughout most of this century. In our opinion, the continuing

pace of medical discovery presents a strong argument that provision should be made for mortality improvement in setting a best estimate—unless significant factors can be demonstrated that would justify not using an improvement trend for current and future retirees under a particular pension plan.

However, the need to consider mortality improvement trends in setting assumptions should not be taken to imply that the only appropriate model is one in which mortality improvement trends explicitly appear. In determining liabilities, actuaries must be concerned with a variety of issues. These include the actual population expected to retire under the plan, the interaction of assumptions, the relevance of various assumptions given alternate plan designs, and the significance of a particular assumption given the overall level of precision in the liability model. In the following sections we consider both the setting of the mortality trend and these other factors as they affect the choice of mortality tables.

A. Projection Scales

Table 1 illustrates the effect of mortality improvement Scale AA when applied to the UP-94 mortality table on a generation basis for a few sample calculations of the present value of an annuity. It shows the present value of benefits for a deferred annuity issued at age 32 and at age 47 with the annuity starting at age 62 and for an immediate annuity issued at age 62, assuming 7% interest. It shows the present values assuming that (1) there is no mortality improvement (UP-94 @ 1994), (2) Scale AA is applied on a generation basis starting in 1994 (UP-94G @ 1994), and (3) Scale AA is applied on a generation basis assuming that mortality rates have already been projected to 2004 (UP-94G @ 2004). It also shows the ratio of the latter two values to the present value assuming no mortality improvement.

TABLE 1

MORTALITY IMPROVEMENT ASSUMPTION ANNUITY FACTORS DEFERRED TO AGE 62

Issue Age	Sex	(1) UP-94 @ 1994	(2) UP-94G @ 1994	(3) (2)/(1)	(4) UP-94G @ 2004	(5) (4)/(1)
32	Male	1.209	1.360	1.125	1.397	1.156
	Female	1.378	1.442	1.046	1.459	1.059
47	Male	3.396	3.646	1.074	3.761	1.107
	Female	3.844	3.950	1.028	3.995	1.039
62	Male	10.081	10.335	1.025	10.591	1.051
	Female	11.036	11.167	1.012	11.266	1.021

For a deferred annuity issued to a male age 32, the mortality improvement scale applied on a generation basis starting in 1994 causes the present value to increase by 12.5%, but the present value of an immediate annuity at age 62 increases by only 2.5%. Thus the use of generational mortality improvement is much more significant for uninsured pension valuations involving active lives than for valuations for retired lives only.

Because of the discount for interest, the present values for deferred annuities are significantly less than those for immediate annuities, but this difference would be reduced if a salary increase assumption were used during the deferral period. Nevertheless, the full impact of the long-term mortality improvement is somewhat lessened because of the discount for interest. In contrast, the mortality improvement assumption would have the greatest impact in long-term open group projections, such as are used for Social Security, because the future payments to beneficiaries are not discounted.

Some actuaries may wish to apply a different scale for projecting trend. Issues in choosing trend are more fully discussed in the UP-94 paper. However, given the relative scarcity of published material evaluating alternative methods of mortality trend projection, we encourage further research into this area.

B. Population Factors

The GAR-94 Table mortality table is unlikely to reflect a best estimate for current uninsured plan populations. This is, in part, because of the inherent conservatism in the table. First, rates are purposely reduced by 5% to ensure that annuity values will be sufficient to cover 95% of random variations in mortality assuming a group of as small as 3000 lives. Margins to cover random variation may lead to systematic overstatement of the expected value of liabilities. Also, when margins for future deviation from expected results are being set, mortality may well be among the least of the uninsured pension actuary's worries. Random deviations due to turnover, retirement, form of benefit distribution, salary scale, and particularly the asset earnings rate may all show more deviation than mortality.

In addition, the GAR-94 Table is loaded by an extra 2% to adjust for groups with better-than-expected mortality. For an uninsured plan, it is anticipated that any adjustment for better or worse mortality for certain groups will only be incorporated based on the experience of that particular group. Thus the *general* margin in the GAR-94 Table for the possibility of having a better-than-average group should be replaced by an adjustment to reflect

the likely ratio of experience for the *actual* group covered by the plan who are expected to retire and will elect an annuity form of benefit. The Retirement Plans Experience Committee report [2] demonstrates how mortality may vary for certain groups of average employees that share a particular characteristic.

But more importantly, actuaries should use a table that reflects anticipated experience of the population covered under the plan. Some considerations that may apply include industry, bargained status, and geographic region. Plans with sizable populations should be able to directly compare actual to expected rates.

C. Interaction of Assumptions

The impact of increases in longevity on other assumptions should also be considered. Longer life expectancies may delay retirements for economic reasons. In addition, if the increased longevity is accompanied by increased health, retirements may be further delayed, and disability and termination rates decreased. However, other factors will also affect these rates, including the economy, labor supply and demand, and changes in societal values.

Actuaries must take care to evaluate the significance of mortality improvements in setting other assumptions. Under the UP-94G @ 1994, life expectancies at age 60 for a male employee currently age 35 are approximately 3.5 years longer than under a static version of the table UP-94 @ 1994. This increase in life expectancy may have an impact on a participant's desire and ability to continue working as the cohort of younger workers nears retirement, compared to current workers near retirement. The Appendix demonstrates some simple examples of the effect on plan cost if the participant is assumed to spend some of the extra years of life employed at the same company. Depending on the degree of early-retirement subsidy, the use of projection and retirement at age 62 may provide very similar results to no projection and retirement at age 60 for certain active employees. Of course, the effect of projected longevity on a current retiree population will not be offset by changes in future retirement patterns, and the actuary must determine the extent to which perceived mortality improvement is already embedded in current retirement behavior. Further, the degree to which the extra life expectancy reflects greater health and ability to work must be considered, as must the other pressures urging work or retirement. However, participants' realization of additional life expectancies may well affect retirement and turnover patterns.

D. Plan Design

1. Forms of Benefit

It is not enough to consider the actual plan population and the interaction of longevity with other assumptions. An actuary must also consider the terms that govern payment of benefits under the plan. Most importantly, the actuary must consider the likelihood and value of alternative forms of payment under the plan.

Actual experience under the plan will reflect not only the mortality of annuitants but also the cost associated with election of non-annuity forms. If, for instance, lump sums are calculated on a basis only vaguely related to life expectancy (for example, a cash balance plan), annuitant mortality will matter only to the extent that annuity forms of benefit are elected. For a plan that aggressively communicates the lump-sum value of benefits, annuity forms of payment may be relatively rare. If the actuary does not explicitly model election rates for different forms of benefit, it is important that the mortality table chosen correctly reflect the mortality of future annuitants who will elect an annuity and reflect the implicit mortality of forms of benefit that are not annuity-based. Thus, in general, the annuity table chosen should reflect not just mortality experience but also the interaction of plan terms and participant election of alternative forms of benefit.

2. Postretirement Benefits Other Than Pensions

The actuary must also consider the effect of mortality trend projection on postretirement benefits other than pensions that are provided to pensioners and sometimes to pensioner dependents. These benefits include life insurance, medical benefits, and extension of employee discounts and other fringe benefits. In evaluating the effect of longer lifetimes on a life insurance benefit, it appears that lower liabilities should result. However, the effect of longer lifetimes on medical benefits should be very carefully evaluated in the context of the actual benefits provided under the plan and the assumed linkage (if any) between decreases in mortality and decreases in morbidity.

Current U.S. accounting guidelines, particularly *FAS 106*, appear to assume that the postretirement medical benefit liability can be evaluated as an annuity for an average claim amount at each age. However, it is rare that a medical benefit plan performs precisely as does an annuity. Some plans (for example, pure catastrophic coverage plans with very high deductibles) may function more like life insurance benefits than annuities, whereas other plans (for example, Medicare Part B premium reimbursement programs) may

replicate a pure annuity. Actuaries will need to carefully review the use of mortality projection against the methodology for claim projection in evaluating these liabilities. Introduction of a mortality improvement trend into the mortality rates without corresponding changes to the age-related pattern of medical costs could significantly overstate liabilities in certain types of plans. This issue is further complicated by the lack of a consensus on the effects of improved longevity on morbidity patterns.

E. Model Sophistication Issues

The particular choice of mortality trend factors in the GAR-94 Table reflects both the underlying experience of the source pool of data and a desire for a fairly simple model. More complicated projections of mortality trends have been used for some purposes. For instance, Social Security uses a curve to represent mortality trends over the short-term, intermediate and long-term future.

The complications inherent in projecting mortality will interact with the intended use of the table. Social Security is concerned with a very long duration of benefit payout, in part because of issues surrounding the decision to discount or not to discount ultimate cash flows. Uninsured pension plans may be expected to have more interest in the long-term trend than would insured plans, since uninsured plans are more likely to have significant portions of the liability due to benefits yet to be earned.

Practicality issues interact with relative importance of longer term payout periods. To reflect a trend that changes over time requires a significantly greater amount of computer resources. Computer resources are cheap and getting cheaper; however, testing the correctness of increasingly complicated models does not appear to be realizing comparable decreases in cost.

The UP-94 Table paper illustrates how to approximate a fully projected table with a static table. Actuaries will want to consider the importance of the precision of the mortality assumption. As discussed above in the section on interaction of assumptions, in some situations a two-year difference in retirement age appears to be roughly equivalent to the difference between projecting mortality and assuming no mortality improvement. Relatively small changes in assumed rates of return on assets may also overwhelm the mortality projection. Using the same simplified plan and assumptions as in the Appendix, retiree mortality projection has approximately the same effect as a 0.2% to 0.3% change in rate of return assumption. Thus, approximation by a static table may often prove to provide reasonably accurate results.

V. WHAT SHOULD ACTUARIES CONSIDER WHEN USING TABLES FOR INSURED PLANS AND CONTRACTS?

Insurers use mortality tables for a number of purposes in addition to, or in conjunction with, valuing reserves in compliance with SVL. These include:

- Pricing
- Cash-flow testing
- Internal financial projections.

Tables selected by an insurer for these purposes would probably range from the UP-94 Table to the GAR-94 Table, as tempered by company experience and the need for approximations. It is possible that margins for poor experience or further improvement will be supplied by setbacks to static tables, higher profit charges (reduced interest assumption) or loading (a percentage increase to the premium).

A. Pricing

Many mortality patterns selected for nonparticipating annuities are likely to closely approximate the GAR-94 Table. Perhaps the pattern would be slightly less conservative than used for reserving, but still a nonparticipating premium basis should be expected to be adequate more often than not. However, overall company experience from its group annuities, any credible experience from the group being priced, and/or mortality applicable to a dominant socioeconomic group may influence the pattern.

Again, while pricing is likely to employ mortality improvement and contain margins, this may be accomplished using lower interest assumptions with approximately the same price impact, or by using a static table projected several years beyond the current year or by using set of static tables with the same price impact, or by using a series of age setbacks to a static table (the younger the annuitant, the greater the setback). Whatever method selected, females have traditionally been priced with a male table with a six-year setback. Actuaries may wish to reconsider this issue based on the mortality and improvements thereon that are incorporated in the GAR-94 Table, which shows this setback as age-dependent and decreasing over time.

It is assumed that the insurer cannot require additional premium if the mortality assumption or other pricing bases prove inadequate. However, in the case of participating purchase rates, it is possible that retention of gains or margins in the premiums can partially offset this inability. Nonetheless, with participating business, the value of participation rights and the risk the

insurer may distribute gains, but later face losses can lead to premiums in excess of nonparticipating levels. While such excesses implicitly consider mortality, they are quite likely to be developed with lower interest assumptions or higher loading (for example, the buyer must contribute the premium plus 10%).

B. Cash-Flow Testing

Often cash-flow projections are associated with tests of reserve adequacy. The conservatism of assumptions in a projection should not be inconsistent with the general philosophy of reserves quoted earlier in this paper.

Thus, a base case might employ a mortality table slightly less conservative but nonetheless similar to the GAR-94 Table. However, where extreme variations of other assumptions are being tested, it might be reasonable to be more liberal with the mortality to avoid the combination of assumptions tested being too extreme. Such tests should somehow consider mortality improvement and of course must utilize any tables required by statute or regulation.

Cash-flow projections are also utilized to measure the Macaulay duration of liability, measuring the extent of cash-flow mismatches, convexity risks, and investment planning. Here mortality tables without margins like UP-94, but with improvement factors, would seem most appropriate. Indeed, improvement may be most important if each year's cash flow is considered crucial, as opposed to approximating the dynamic table with a projected static one. Of course, static table approximations will be closer for immediate annuities than for deferred annuities.

C. Internal Financial Projections

For these purposes we again assume a "base case" projection, not one designed to measure the impact of adverse mortality. The longer the term of the projection, the more mortality improvement assumptions seem needed. However, for one- to five-year projections, a static table and/or UP-94 would probably produce reasonable results. Also, to the extent company experience differs from national levels, that might properly influence short-term projections.

VI. CONCLUSION

We believe that the explicit incorporation of mortality improvement in the GAR-94 Table represents an improvement in the overall level of actuarial

practice, made possible by the advent of less expensive computing resources. Actuaries should, in general, consider explicit inclusion of mortality trend in evaluating liabilities. In particular, the inclusion of mortality projection for the purposes of a standard reserving table appears to produce appropriate results, viewed over the duration of benefits covered by the reserving standard and in conjunction with the purposes of the Standard Valuation Laws.

As indicated in the above, however, the GAR-94 Table should not be blindly applied in all circumstances. Instead actuaries must carefully consider the interaction of mortality trend and other assumptions to ensure that the model of future liabilities is appropriately true to the actual liabilities in question. All modeling involves some simplification of underlying realities. It is important that appropriate care be taken in changing a basic feature of a model, to ensure that the model remains true to the underlying realities. Thus, actuaries incorporating an explicit mortality trend should also review models to ensure the model is consistent with an explicit trend.

Finally, it is anticipated that GAR-94 will not be used for projecting realistic best-estimate projections of mortality for most current populations, since—as a reserve standard—it is adjusted to cover the risk of additional longevity for *all* groups, including groups that may have significantly better longevity than the particular group under study. Of course, to the extent that the particular group under study is expected to be particularly long-lived, or if current projections of longevity turn out to be understated, the GAR-94 Table may become appropriate as a best-estimate table. The UP-94 Table differs from the GAR-94 Table by removing the additional explicit margins for conservatism in the GAR-94 Table, and by leaving the degree and duration of mortality projection to the actuary's judgment. Thus, with modification to reflect the underlying population, plan and model limitations, it is designed to be useful in projecting best-estimate liabilities.

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APPENDIX

TABLE A-1

VALUATION AT JANUARY 1, 1994
ENTRY AGE NORMAL COST METHOD
MORTALITY BASED ON THE STATIC UP-94 TABLE WITH NO PROJECTION (UP-94) AND A RETIREMENT AGE OF 60

Other Assumptions		Results	
Age	35	Normal Cost	$2,560
Service	10	Accrued Actuarial Liability	$29,985
Pay	$ 35,000		
Salary Scale Increase	5%		
Interest rate	8%		

Year	Age	Service	Pay	1.5% of FAP5	PVPAY	Ret date	Ret PVB
1984	25	0	21,487	0	484,947	0	35,467
1985	26	1	22,561	293	500,537	0	38,304
1986	27	2	23,689	615	516,214	0	41,369
1987	28	3	24,874	969	531,926	0	44,678
1988	29	4	26,118	1,357	547,617	0	48,252
1989	30	5	27,423	1,781	563,219	0	52,112
1990	31	6	28,795	2,244	578,659	0	56,281
1991	32	7	30,234	2,749	593,854	0	60,784
1992	33	8	31,746	3,299	608,709	0	65,647
1993	34	9	33,333	3,897	623,120	0	70,898
1994	35	10	35,000	4,546	636,970	0	76,570
1995	36	11	36,750	5,251	650,127	0	82,696
1996	37	12	38,588	6,014	662,448	0	89,312
1997	38	13	40,517	6,841	673,769	0	96,456
1998	39	14	42,543	7,736	683,912	0	104,173
1999	40	15	44,670	8,703	692,679	0	112,507
2000	41	16	46,903	9,747	699,850	0	121,507

TABLE A-1—*Continued*

Year	Age	Service	Pay	1.5% of FAP5	PVPAY	Ret date	Ret PVB
2001	42	17	49,249	10,874	705,182	0	131,228
2002	43	18	51,711	12,090	708,408	0	141,726
2003	44	19	54,296	13,399	709,233	0	153,064
2004	45	20	57,011	14,810	707,332	0	165,309
2005	46	21	59,862	16,328	702,346	0	178,534
2006	47	22	62,855	17,961	693,883	0	192,817
2007	48	23	65,998	19,716	681,510	0	208,242
2008	49	24	69,298	21,602	664,753	0	224,902
2009	50	25	72,762	23,627	643,092	0	242,894
2010	51	26	76,401	25,800	615,956	0	262,325
2011	52	27	80,221	28,132	582,720	0	283,311
2012	53	28	84,232	30,633	542,699	0	305,976
2013	54	29	88,443	33,313	495,145	0	330,454
2014	55	30	92,865	36,185	439,238	0	356,891
2015	56	31	97,509	39,261	374,082	0	385,442
2016	57	32	102,384	42,554	298,699	0	416,277
2017	58	33	107,503	46,078	212,020	0	449,579
2018	59	34	112,878	49,848	112,878	0	485,546
2019	60	35	118,522	53,880	0	1	524,389
2020	61	36	124,449	58,190	0	0	0
2021	62	37	130,671	62,797	0	0	0
2022	63	38	137,205	67,719	0	0	0
2023	64	39	144,065	72,976	0	0	0

TABLE A-2

VALUATION AT JANUARY 1, 1994
ENTRY AGE NORMAL COST METHOD
MORTALITY BASED ON A FULLY GENERATIONAL VERSION OF THE UP-94 TABLE (UP-94G @ 1994)
BUT WITH A RETIREMENT AGE OF 60

Other Assumptions		Results	
Age	35	Normal Cost	$2,580
Service	10	Accrued Actuarial Liability	$30,219
Pay	$35,000		
Salary Scale Increase	5%		
Interest rate	8%		

Year	Age	Service	Pay	1.5% of FAP5	PVPAY	Ret date	Ret PVB
1984	25	0	21,487	0	500,757	0	36,908
1985	26	1	22,561	293	517,612	0	39,861
1986	27	2	23,689	615	534,654	0	43,050
1987	28	3	24,874	969	551,842	0	46,494
1988	29	4	26,118	1,357	569,126	0	50,213
1989	30	5	27,423	1,781	586,449	0	54,230
1990	31	6	28,795	2,244	603,747	0	58,569
1991	32	7	30,234	2,749	620,949	0	63,254
1992	33	8	31,746	3,299	637,972	0	68,315
1993	34	9	33,333	3,897	654,724	0	73,780
1994	35	10	35,000	4,546	671,102	0	79,682
1995	36	11	36,750	5,251	686,990	0	86,057
1996	37	12	38,588	6,014	702,259	0	92,942
1997	38	13	40,517	6,841	716,765	0	100,377
1998	39	14	42,543	7,736	730,348	0	108,407
1999	40	15	44,670	8,703	742,830	0	117,080
2000	41	16	46,903	9,747	754,013	0	126,446

TABLE A-2—*Continued*

Year	Age	Service	Pay	1.5% of FAP5	PVPAY	Ret date	Ret PVB
2001	42	17	49,249	10,874	763,679	0	136,562
2002	43	18	51,711	12,090	771,584	0	147,487
2003	44	19	54,296	13,399	777,463	0	159,285
2004	45	20	57,011	14,810	781,020	0	172,028
2005	46	21	59,862	16,328	781,930	0	185,791
2006	47	22	62,855	17,961	779,833	0	200,654
2007	48	23	65,998	19,716	774,336	0	216,706
2008	49	24	69,298	21,602	765,006	0	234,043
2009	50	25	72,762	23,627	751,365	0	252,766
2010	51	26	76,401	25,800	732,891	0	272,987
2011	52	27	80,221	28,132	709,009	0	294,826
2012	53	28	84,232	30,633	679,092	0	318,412
2013	54	29	88,443	33,313	642,449	0	343,885
2014	55	30	92,865	36,185	598,326	0	371,396
2015	56	31	97,509	39,261	545,897	0	401,108
2016	57	32	102,384	42,554	484,260	0	433,196
2017	58	33	107,503	46,078	412,426	0	467,852
2018	59	34	112,878	49,848	329,316	0	505,280
2019	60	35	118,522	53,880	233,753	0	545,703
2020	61	36	124,449	58,190	124,449	0	589,359
2021	62	37	130,671	62,797	0	1	636,508
2022	63	38	137,205	67,719	0	0	0
2023	64	39	144,065	72,976	0	0	0