ESTIMATING THE WORKERS' COMPENSATION TAIL

RICHARD E. SHERMAN AND GORDON F. DISS

Abstract

The workers' compensation tail largely consists of the medical component of permanent disability claims (MPD). Yet the nature of MPD payments is not widely understood and is counter to that presumed in common actuarial models.

This paper presents an analysis of medical payments based on 160,000 permanently disabled claimants—for accident years 1926-2002. It introduces a method for utilizing incremental payment data prior to the standard triangle to extend development factors beyond the end of the triangle.

A close-fitting model is presented that explicitly reflects the opposing effects of 1) medical cost escalation on average incremental payments, and 2) the force of mortality in closing claims. It clearly demonstrates that:

- *Paid development factors will tend to increase over many successive, "mature" years of development.*

- *Paid development factors and tails will trend upward over time—if past declines in mortality rates continue in the future.*

The paper also demonstrates that case reserves based on inflating payments until the expected year of death are significantly less than the expected value of such reserves. A method is introduced for realistically simulating the high expected value and variability of MPD reserves. It is based on a Markov chain model of annual payments on individual claims.

1. INTRODUCTION AND SUMMARY

Historically, the ability of workers' compensation (WC) insurers to reasonably estimate tail factors has been hampered by a dearth of available development experience at maturities beyond 10 to 20 years. Substantive advances in WC tail estimation are dependent on the availability of a substantial database extending to 50 or more years of development.

This paper presents the results of a thorough analysis of the extensive paid loss development database of the SAIF Corporation, Oregon's state fund. That database

extends out to 65 years of development—separately for medical and indemnity, separately ***by injury type***.

Some of the key findings from this analysis include:

- Medical tail factors calculated empirically are significantly greater than those derived from extrapolation techniques.

- There is an effective, systematic way (the Mueller Incremental Tail Method) to utilize incremental payment data prior to the standard triangle to extend paid development factors beyond the end of the triangle.

- Medical cost escalation and the force of mortality are the key drivers of tail factors.

- In the early stages of the tail, medical cost escalation overpowers the force of mortality, leading to increases in incremental paid losses.

- Mortality rates combined with medical inflation fit the empirical data very well out to 40 years of development, but then tend to understate losses for the next 15 years of development. This understatement appears to be due to the added costs of caring for the elderly—who make up a rapidly increasing percentage of surviving claimants.

- Declining mortality rates have a substantial effect on medical tail factors. Mortality improvement will also cause individual paid loss development factors to trend upward slowly for any given year of development.

- The expected value of an MPD case reserve is much greater than cumulative inflated payments through the expected year of death. This is similar to the situation that occurs when reinsurance contracts are commuted—where usage of the life expectancy of the claimant produces an estimate well below the weighted average of outcomes based on a mortality table[1].

- The variability of total MPD reserves can be gauged realistically by a Markov chain simulation model that separately estimates payments for each future year of development by claimant.

- The potential for common actuarial methods to understate the MPD reserve, and consequently, the entire WC reserve, is significant. This is also true regarding common methods for estimating the degree of variability in the WC reserve as well as its expected value.

This paper is divided into ten sections:
1. Introduction and Summary
2. MPD Tails Indicated by SAIF's Loss Experience
3. Incorporating the Static Mortality Model into the Incremental Paid to Prior Open Method
4. Mortality Improvement
5. The Trended Mortality Model
6. A Comparison of Indicated Tail Factors
7. Sensitivity Considerations
8. Estimating the Expected Value of MPD Reserves
9. Estimating the Variability of the MPD Reserve with a Markov Chain Simulation
10. Concluding Remarks

The paper also includes four appendices:
A. The Mueller Incremental Tail (MIT) Method
B. Historical PLDFs for All Other WC
C. Incorporating the Static Mortality Model into the Incremental Paid to Prior Open Method
D. Incorporating the Trended Mortality Model into the Incremental Paid to Prior Open Method

WC tail estimation would not be a problem if gross WC losses in the tail adhered to behavior anticipated by common actuarial methods. That, however, is not the case for ***medical losses for permanently disabled claimants*** (MPD). This is a serious concern because MPD loss reserves make up the bulk of total WC loss reserves for all but the most recent accident years.

The deviations from ordinary development patterns for MPD losses are persistent and substantial—because of the compounding effects of anticipated rates of future medical cost escalation on services provided to claimants until death.

A severely injured worker in his or her early twenties could receive medical benefits for up to 90 years in the future. Loss development data is usually available only for significantly shorter development periods. Schedule P data contains loss development for ten individual accident years. Financial Statistical calls provide loss development for twenty accident years. Consequently actuaries frequently have to estimate loss development factors with little or no experience in the tail beyond 20 years.

SAIF's data base for MPD tracks the paid loss development of over 160,000 PD claims for accident years 1926-2002. It thus provides a credible source for actuarial analysis.

Table 1.1 displays SAIF's historical paid loss development factors (PLDFs) for unlimited MPD up through the 15th year of development.

Table 1.1
Historical Age to Age Paid Loss Development Factors
Medical Losses of Permanently Disabled Claimants
(By Development Year)

AY	2	3	4	5	6	7	8	9	10	11	12	13	14	15
						Development Year								
4th Prior	6.645	1.516	1.169	1.061	1.042	1.024	1.012	1.028	1.016	1.011	1.009	1.011	1.008	1.010
3rd Prior	6.402	1.489	1.115	1.066	1.039	1.027	1.017	1.013	1.010	1.013	1.010	1.010	1.011	1.012
2nd Prior	5.745	1.539	1.153	1.058	1.036	1.017	1.022	1.015	1.011	1.010	1.014	1.013	1.011	1.010
1st Prior	6.867	1.509	1.113	1.064	1.045	1.035	1.012	1.027	1.020	1.011	1.013	1.016	1.010	1.009
Latest	7.460	1.572	1.149	1.111	1.041	1.031	1.030	1.018	1.020	1.016	1.012	1.014	1.018	1.011
Average	6.624	1.525	1.140	1.072	1.041	1.027	1.019	1.020	**1.015**	**1.013**	**1.012**	**1.013**	**1.012**	**1.010**

In Table 1.1, as well as throughout this paper, a PLDF for a given development year (DY) is denoted by the maturity at the end of that year. For example, the factors in the column headed by "2" are for development from 1 to 2 years of age—since this is the second year of development.

Ordinarily, it would be expected that PLDFs for subsequent development years would slowly decline below the last factor (1.010) as a continuation of the pattern of slowly decreasing factors exhibited, for example, during development years 10 through 15.

Table 1.2 displays SAIF's actual MPD PLDFs, calculated as the averages of the latest five factors. These historical factors generally increase during the 16th through the 26th development years.

Table 1.2
A Comparison of Historical MPD PLDFs with
Projections Based on Development Years 10 through 15

	16	17	18	19	20	21	22	23	24	25	26
					Development Year						
Historical	1.011	1.013	1.011	1.011	1.012	1.012	1.014	1.012	1.015	1.015	1.016
Projections Based on Development Years 10-15											
Linear Decay	1.009	1.008	1.007	1.006	1.005	1.004	1.003	1.002	1.001	1.000	1.000
Exp. Decay	1.009	1.009	1.008	1.007	1.007	1.006	1.006	1.005	1.005	1.005	1.004
Inverse Power	1.010	1.010	1.009	1.009	1.008	1.008	1.007	1.007	1.007	1.006	1.006

Projections of these PLDFs based on three common actuarial methods[2] applied to the historical PLDFs for development years 10 through 15 are also shown in Table 1.2.

Since each of these methods assumes that the pattern of declining factors for these development years will continue in the future, the projected PLDFs fall increasingly below the actual historical factors. This pattern of divergence continues during development years 27 through 37, as shown in Table 1.3.

Table 1.3
A Comparison of Historical MPD PLDFs with
Projections Based on Development Years 10 through 15

	Development Year										
	27	28	29	30	31	32	33	34	35	36	37
Historical	1.020	1.023	1.027	1.026	1.022	1.018	1.015	1.017	1.018	1.029	1.033
Projections Based on Development Years 10-15											
Linear Decay	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
Exp. Decay	1.004	1.004	1.003	1.003	1.003	1.003	1.003	1.002	1.002	1.002	1.002
Inverse Power	1.006	1.005	1.005	1.005	1.005	1.004	1.004	1.004	1.004	1.004	1.003

It is evident that these three common actuarial methods of projecting subsequent PLDFs will produce projections of MPD ultimate losses that are severely inadequate. Table 1.4 provides a direct comparison of the PLDF from 15 to 37 years indicated by SAIF's actual experience with those based on PLDFs extrapolated by common methods.

Table 1.4
A Comparison of SAIF's Historical Factor from 15 to 37 Years
with Those Based on Extrapolated Development Factors
(Based on a Fit to Historical PLDFs for DYs 10-15)

Extrapolation Method	Paid Development Factor from 15 to 37 Years
Linear Decay	1.046
Exponential Decay	1.108
Inverse Power Curve	1.145
SAIF's Historical Factor	1.471

It is natural to ask whether the phenomenon of increasing PLDFs from the 16th through the 37th development years might be due to some unusual cause peculiar to Oregon WC in general or the Oregon State Fund in particular. Medical PLDFs compiled by the California Workers Compensation Insurance Rating Bureau (WCIRB) [3] provide evidence that the phenomenon is widespread. While the PLDFs displayed in Table 1.5 for years of development 2.5 (18 to 30 months) through 15.5 (174 to 186 months)

consistently decline in a manner similar to the SAIF experience, the PLDFs shown in Table 1.6 for subsequent ages reflect definite upward movement.

Table 1.5
WCIRB Historical Medical Paid Loss Development Factors
for Development Years 2.5 Through 15.5

	Development Year													
	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5	12.5	13.5	14.5	15.5
Selected	1.740	1.296	1.152	1.104	1.069	1.058	1.030	1.022	1.015	1.012	1.009	1.007	1.006	1.005

Source for Tables 1.5 and 1.6: WCIRB Bulletin No. 2003-24, p. 9.

Table 1.6
WCIRB Historical Medical Paid Loss Development Factors
for Development Years 16.5 Through 28.5

	Development Year												
	16.5	17.5	18.5	19.5	20.5	21.5	22.5	23.5	24.5	25.5	26.5	27.5	28.5
Selected	1.006	1.005	1.005	1.005	1.008	1.006	1.007	1.007	1.007	1.009	1.010	1.008	1.009

The WCIRB factors are for all medical losses—including those for the large number of quickly settling claims. Consequently, the California factors would naturally be lower than SAIF's, which only include medical losses for the permanently disabled.

Additional confirmation of this phenomenon appears in the medical paid loss history of the Washington State Fund (for all types of claims)—shown in Tables 1.7 and 1.8.

Table 1.7
Washington State Fund Historical Medical Paid Loss
Development Factors for DYs 8 Through 21

	Development Year													
	8	9	10	11	12	13	14	15	16	17	18	19	20	21
Avg. Last 5	1.027	1.023	1.020	1.017	1.016	1.015	1.013	1.013	1.012	1.010	1.010	1.009	1.009	1.008

Table 1.8
Washington State Fund Historical Medical Paid Loss
Development Factors for DYs 22 Through 35

	Development Year													
	22	23	24	25	26	27	28	29	30	31	32	33	34	35
Avg. Last 5	1.009	1.009	1.009	1.009	1.008	1.009	1.009	1.011	1.009	1.010	1.013	1.013	1.015	1.010

When confronted with SAIF's historical pattern of PLDFs through 37 years of development, or the WCIRB's rising PLDFs through 28.5 years, or Washington's PLDFs through 35 years, what should one select for subsequent factors? Obviously, the standard pattern of declining factors does not apply to the 16th through 37th development years, but, absent pertinent data for later development years, how should one proceed to extrapolate these factors? Clearly, later PLDFs cannot continue to increase indefinitely. At some point these factors should start decreasing, if only because all claimants will eventually die. But how can one determine when, and by how much? A common approach has been to estimate such future development based on the ratio of incurred to paid at the most mature year of development. We will see that this approach may not always result in unbiased estimates of ultimate losses. This is particularly true when individual case reserves are established by multiplying *current* annual medical costs times the life expectancy of the claimant.

In addressing the problem of extrapolating paid development when the most mature PLDFs are increasing, some insurers or self-insureds may have data for longer periods of time than the latest 20 years. However, because of system changes or acquisitions, <u>cumulative</u> loss development data for old accident years is frequently lacking. In these cases <u>incremental</u> calendar year data for old accident years may be available because payments are still being made on the old open claims. Section 2 (and Appendix A) presents the Mueller Incremental Tail Method for making full use of the incremental data to calculate empirical tail factors. We have used this method to derive empirically based PLDFs out to 57 years of development based on SAIF's actual MPD loss experience.

This paper presents a reserving model that largely explains the seemingly anomalous behavior of increasing PLDFs at "mature" DYs. The model explicitly accounts for the separate effects of inflation and mortality on paid MPD during all years of development. This is done by directly incorporating *recent* mortality rates into an incremental paid per prior open loss reserving method. It will be referred to as the ***static mortality model*** and will be presented in Section 3.

In Figure 1.1, the PLDFs indicated by the static mortality model are compared with SAIF's empirical PLDFs. The static mortality model PLDFs are shown in the last column of Tables 3.2 and 3.5. The empirical PLDFs for the first 29 DYs are the averages of the latest 15 historical factors. For DYs 30-58, the PLDFs appear in Tables A.1, A.2 and A.3, where the Mueller Incremental Tail Method is applied.

As Figure 1.1 shows, SAIF's actual development experience for DYs 40-54 is consistently worse than the model predicts. While it may be speculated that this might simply be due to some unusual series of influences on SAIF's MPD payment experience, this same pattern is also evident in the medical PLDFs for the Washington State Fund.

Figure 1.1
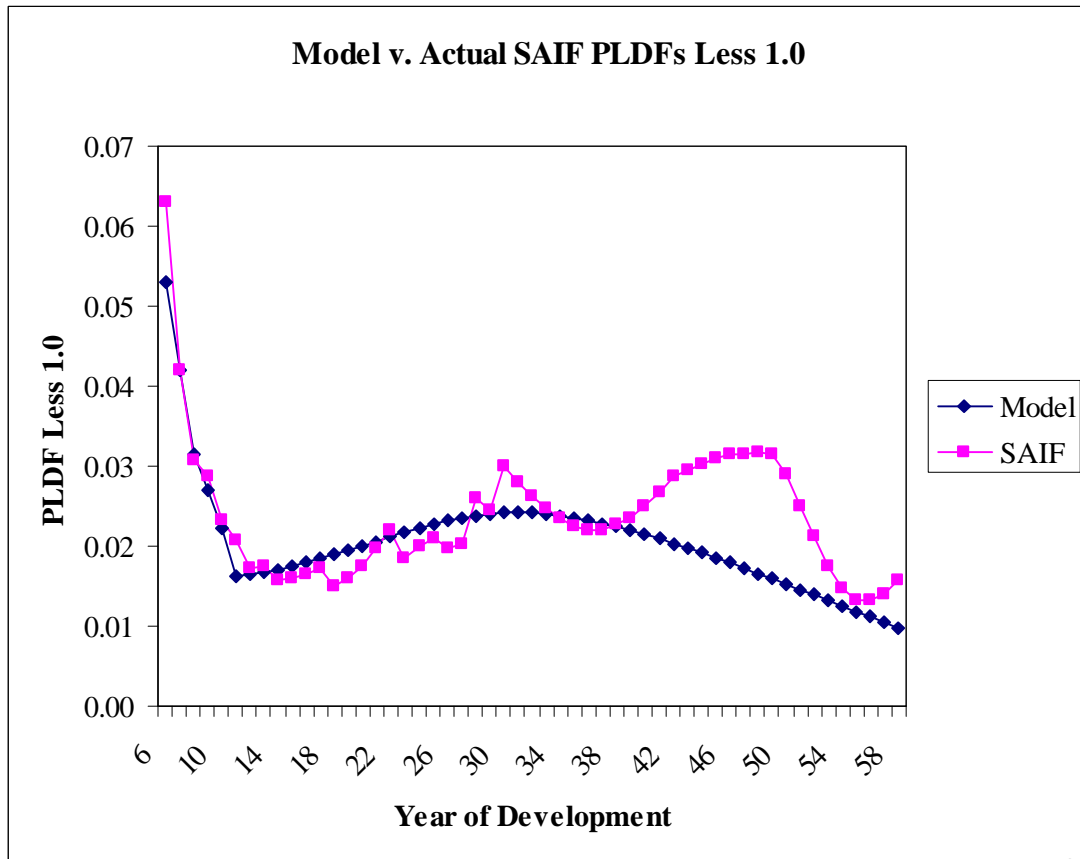
We also applied the Mueller Method to derive a comparable analysis out to 60 years of development based on the incremental payment experience of the Washington State Fund for medical losses—under the assumption that all medical payments after 20 years of development should be attributable to PD claimants. The phenomenon of worse than expected development for DYs 40-54 is even more pronounced in the Washington experience. (This is detailed in Tables A.7 and A.8 at the end of Appendix A.)

We believe that the bulge in adverse paid development evident for DYs 40-54 is attributable to the rapidly increasing percentage of surviving claimants who are elderly. Not uncommonly, elderly PD claimants simply require more extensive and expensive medical care than younger claimants. And as PD claimants age, so do their spouses. Often a spouse reaches an age where they can no longer provide as much care as previously, and the insurer then pays for the increased cost of hiring outside assistants. Table 1.9 indicates the percentage of surviving claimants who will be 80 or older at the beginning of various years of development. It also shows the percentage of surviving claimants expected to die within the succeeding five years. It has also been observed that incremental severities tend to undergo an increase during the last years before a claimant's death that exceeds normal rates of medical cost escalation.

Table 1.9
Two Indicators of an Increasing Proportion
of the Elderly Among Surviving Claimants

DY	% 80+ Years Old	% Who Will Die Within Five Years
0	0.0%	4.4%
10	0.9%	9.4%
20	10.9%	18.3%
30	36.5%	30.1%
40	51.2%	39.0%
50	64.7%	47.2%
60	100.0%	60.3%

Table 1.9 indicates that for DYs 40 and higher, over half of the surviving claimants will be 80 or more years old. Clearly, this fact could have been anticipated on an a priori basis. After all, if the average claimant were age 40 when injured, it should be expected that 40 years after the injury year, the average surviving claimant would be about 80 years old. However, the above table underscores a reality that casualty actuaries may not have heretofore given much consideration. The behavior of loss development for DYs 40+ may well differ noticeably from what would be expected on the basis of earlier DYs—because of the increasing infirmities of surviving claimants and their spouses. The percentages in Table 1.9 are based on 2000 mortality tables published by the Social Security Administration (SSA), assuming 75% of the claimants are male, and a census of SAIF's permanent total disability claimants by age-at-injury.

Paid loss development factors (PLDFs) for MPD are not monotonically decreasing. Because of this seemingly anomalous behavior, estimates of the MPD tail by common actuarial methods could be seriously understated. This potentially surprising behavior is due to the fact that medical inflation rates are expected to be greater than the rate of closure of PD claims due to death during these years of development. For the most mature years of development, the increasing force of mortality overtakes the effects of medical inflation and causes a slow reduction in incremental payments. That rate of reduction is surprisingly small.

Earlier a comparison was made in Table 1.4 of SAIF's actual PLDFs for DYs 16-37 with estimates of the same based on three different common extrapolation techniques, as applied to PLDFs through DY 15. Table 1.10 provides an analogous comparison of the tail factors at 15 years produced by those extrapolation techniques compare with that based on SAIF's historical experience.

Table 1.10
A Comparison of SAIF's Historical Factor
with Extrapolated Tail Factors At 15 Years
(Based on a Fit to Historical PLDFs for DYs 10-15)

Extrapolation Method	Indicated Tail Factor At 15 Years	Extrapolated Reserve as a %-age of the Reserve Indicated by SAIF's History
Linear Decay	1.046	3.5%
Exponential Decay	1.128	9.8%
Inverse Power Curve	1.234	17.9%
SAIF's Historical Factors	2.309	100.0%

As Table 1.10 shows, the extrapolated MPD loss reserves at 15 years of maturity are only a small fraction of the MPD reserve indicated by SAIF's development history.

As high as the paid tail factor at 15 years is (2.309), it is understated because it implicitly assumes that past mortality rates will continue indefinitely into the future. As noted in Section 4, mortality rates have been declining steadily for at least the past four decades, and the SSA reasonably expects such declines to continue throughout the next century.

A second reserving model is presented that explicitly accounts for the compounding effects of ***downward trends in future mortality rates*** and persistently high rates of future medical inflation. It will be referred to as the ***trended mortality model***, and will be described in Section 5.

The indications of the trended mortality model for MPD are significant and troubling.

- Paid tail factors at the end of any selected year of development are not constant. They should be expected to increase slowly but steadily over successive accident years (AYs).

- Incremental PLDFs for any selected year of development are not constant. They will also trend upward slowly but inexorably for successive AYs.

- The above effects on MPD will cause corresponding upward trends in paid tails and incremental PLDFs ***for all WC losses in the aggregate. This finding is contrary to the common practice of assuming no trend in paid tails or PLDFs.***

We will see in Section 5 that the common practice of using constant tail factors and constant PLDFs for each development year is not properly founded. While this practice may be defended using intuitive reasoning, that reasoning is flawed. Unless the effects of downward trends in mortality rates are incorporated into a WC reserve analysis, the resulting reserve estimates will be low when numerous AYs are involved. Fortunately, this effect may not be material for net experience at retentions (such as $250,000) that are low enough to virtually eliminate paid development at later maturities.

We believe that the most appropriate approach to estimating gross WC loss reserves is to separately evaluate MPD loss reserves by one (or more) of the methods presented in this paper. Lacking separate MPD loss experience, the static mortality and trended mortality models, and the Mueller Incremental Tail method can be applied satisfactorily to total medical loss experience for DYs 20 and higher—since virtually all medical payments are MPD payments at such maturities.

2. MPD TAILS INDICATED BY SAIF'S LOSS EXPERIENCE

A careful analysis of SAIF's historical development of paid gross MPD losses through 65 years of development indicates a large paid tail factor of 1.581 from 37 to 65 years. This indication is higher than the 1.480 tail factor from the static mortality model presented in Section 3, as one would expect given the bulge in SAIF's empirical factors shown in Figure 1.1 for DYs 40-54. The trended mortality model supports a higher paid development factor (1.600) from 37 to 65 years. If the ratio of the tail factors for the trended vs. static mortality models were applied to the empirical tail factor of 1.581, a tail factor of 1.695 would be indicated when the effect of future mortality trends is reflected.

To get a sense of how such large paid tail factors are possible at 37 years, it is useful to review patterns in SAIF's actual incremental MPD paid at mature stages of development. Table 2.1 presents incremental paid MPD for different five year development periods for each of several five year groupings of AYs.

For example, consider the incremental payments for AYs 1951-55. During development years 35 through 39 $746 thousand was paid on open MPD. Surprisingly, $830 thousand was paid out in the five years after that and $943 thousand in the five years after that.

What is remarkable about the track record of actual five year incremental paid MPD at mature stages of development shown in Table 2.1 is that in 7 out of 15 cases (highlighted by shading and bold type), payments in the subsequent five development years are greater than in the preceding five years.

Table 2.1
Five Year Incremental Paid MPD ($000's)
for Five Year Groupings of AYs—SAIF Corporation

				Years of Development					
AYs	**20-24**	**25-29**	**30-34**	**35-39**	**40-44**	**45-49**	**50-54**	**55-59**	**60-64**
1931-35								10	8
1936-40							62	2	**5**
1941-45						259	**289**	204	
1946-50					327	**797**	302		
1951-55				746	**830**	**943**			
1956-60			1,570	1,506	**2,227**				
1961-65			2,933	1,908					
1966-70	6,818	6,583	5,121						
1971-75	10,227	**12,158**							

It was the fact that SAIF's actuaries were observing many instances of rising incremental MPD payments over successive development years that led to the recognition of the need for a more in depth review and analysis of MPD paid losses beyond 20 years of development.

Appendix A includes a compilation of SAIF's historical incremental MPD payments for AYs 1926-1965 during development years 29 through 60. This history reveals a high proportion of incidents where incremental payments increase from one development year to the next. This phenomenon is also apparent in the incremental medical payments of the Washington State Fund, as displayed in Table 2.2.

Table 2.2
Five Year Incremental Paid Medical Losses ($000's)
For Five Year Groupings of AYs—Washington State Fund

				Years of Development			
AYs	**20-24**	**25-29**	**30-34**	**35-39**	**40-44**	**45-49**	**50-54**	**55-59**
1940-44			149	**294**	271	243	101	**131**
1945-49		183	**258**	**384**	273	194	**291**	
1950-54	840	750	**989**	**1,115**	**1,757**	1,400		
1955-59	1,055	**2,244**	2,153	1,879	**2,170**			
1960-64	1,589	**1,765**	1,581	1,186				
1965-69	5,380	4,741	**5,318**					
1970-74	7,014	**8,383**						

As in Table 2.1, instances where total incremental payments for five calendar years exceeded those for the preceding five calendar years, are shown in bold type in shaded cells. This occurs 13 out of 25 possible times. It is also interesting to scan across each row and to note that incremental payments for the least mature block of five years of

development are often lower than during a number of the subsequent blocks of five years of development.

The Mueller Incremental Tail Method

Figure 2.1 provides a graphic summary of the portions of the incremental MPD payments experience of the SAIF Corporation that are available. A complete triangle of MPD payments exists for AYs 1966-2002. This region is the triangle labeled "C" to designate that <u>cumulative</u> paid losses are available for all of these AYs. In addition, since calendar year 1985, incremental MPD payments have been captured for AYs 1926-1965 for DYs 29 and higher. This region is the diagonally shaped area labeled "I" to designate that only incremental payments are available.

Figure 2.1
Configuration of SAIF's MPD Paid Loss Data
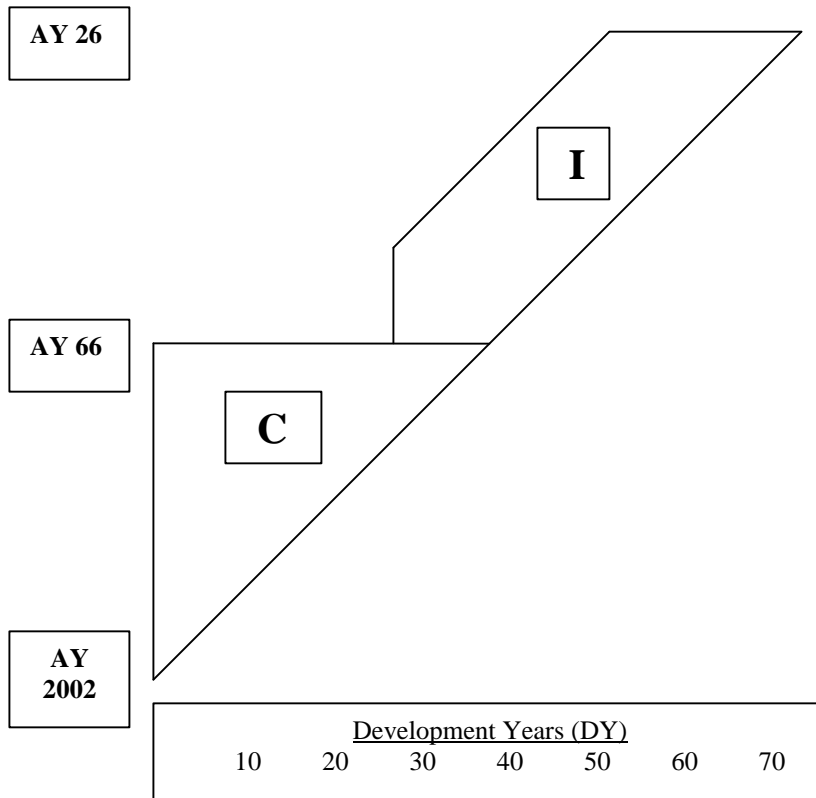
Since paid MPD for AYs 1926-1965 has only been available for calendar years since 1985, it was necessary to construct an actuarial method of estimating the tail factor based on decay ratios of incremental payments. This method is called the Mueller Incremental Tail (MIT) method, in recognition of the work done by Conrad Mueller, ACAS, in developing this method. We will use SAIF Corporation experience as an example. This section of the paper describes the method and provides key results.

13

Detailed calculations are included in Appendix A.

The MIT method was used to calculate empirical 37 to 65 tail factors using the incremental data on old accident years. We describe the method in three stages:

1. Incremental age-to-age factors
2. Anchored decay factors
3. Tail factors

1. **Incremental age-to-age factors.** The first step is to calculate incremental age to age factors. With the SAIF data, we are able to calculate incremental paid at age (n+1) to incremental paid at age (n) for n ranging from 29 to 57 years, using twenty-year weighted averages. A factor for 57 to 65 was calculated using the sum of the payments in years 57 to 65 relative to payments made in year 57.

   Because of the sparseness of claims of this age, the empirical development factors needed to be smoothed before they could be used. The smoothing was done using five year centered moving averages.

2. **Anchored decay factors.** After calculating incremental age to age factors, we then anchor them to a base year. We illustrate this using development year 37 as our anchor year. The anchored decay factors represent incremental payments made in year n relative to payments made in the anchor year. Table 2.3 shows the anchored decay factors for payments made in accident years of age 40, 45, 50 and 55 relative to payments made in an accident years of age 37 (our anchor year).

Table 2.3
Indicated Decay Factors Relative to Anchor Year 37 Incremental Payments

Year of Development	Decay Factors
55	.962
50	1.880
45	1.724
40	1.211
Anchor Year 37	1.000

For example – payments made in DY 50 are 88.0% greater than the payments made in DY 37. The main reason that incremental payments rise over time is because the force of medical cost escalation exceeds the force of mortality—until most of the claimants are fairly advanced in age, when the force of mortality becomes greater.

By summing the decay factors from 38 to 65, we get the payments made in age 38 to 65 relative to the payments made in year 37. The sums of the decay factors are similar to tail factors, but instead of being relative to cumulative payments they are relative to the incremental payments made in year 37.

The process can be repeated using a different anchor year. In addition to anchor year 37, the calculations were also performed using anchor years 36, 35, 34 and 33. In each case, the payments from 38 to 65 were compared to the payments made in the selected anchor year. Table 2.4 shows the cumulative decay factors for each of these anchor years:

Table 2.4
Cumulative Decay Factors Relative to
Incremental Payments During Different Anchor Years

Anchor Year	Cumulative Decay Factors
37	30.071
36	30.115
35	29.508
34	28.280
33	26.961

The cumulative decay factors can be interpreted as follows: Payments made in ages 38 to 65 are 30.071 times the payments made in age 37. Similarly, payments made in ages 38 to 65 are 30.115 times the payments made in age 36 etc.

3. **Tail Factors.** To convert these cumulative decay factors into tail factors, we make use of the selected cumulative loss development factors from the customary cumulative paid loss development triangle.

We illustrate the 37 to 65 tail factor calculation using the anchor year 37 cumulative decay factor and the 37:36 cumulative loss development factor (PLDF). SAIF's 37:36 PLDF was 1.03311.

The algebra is shown below:

The 37 to 36 PLDF of 1.03311 = $\dfrac{\text{Sum(1 to 37)}}{\text{Sum(1 to 36)}}$

Therefore .03311 = $\dfrac{\text{Sum(1 to 37)}}{\text{Sum(1 to 36)}} - \dfrac{\text{Sum(1 to 36)}}{\text{Sum(1 to 36)}} = \dfrac{\text{Paid in 37}}{\text{Sum(1 to 36)}}$

Consequently, $\dfrac{.03311}{1.03311} = \dfrac{\text{Paid in 37}}{\text{Sum(1 to 36)}}$ divided by $\dfrac{\text{Sum(1 to 37)}}{\text{Sum(1 to 36)}}$

$= \dfrac{\text{Paid in 37}}{\text{Sum(1 to 37)}}$

The cumulative decay factor of 30.071 = $\dfrac{\text{Sum(38 to 65)}}{\text{Paid in 37}}$

Therefore the product of the 30.071 and .03311 / 1.0331 = $\underline{\text{Sum(38 to 65)}}$ * $\underline{\text{Paid in 37}}$
                                                                                                                      Paid in 37   Sum(1 to 37)

$$= \frac{\text{Sum(38 to 65)}}{\text{Sum(1 to 37)}}$$

The 37 to 65 tail factor is $\underline{\text{Sum(1 to 65)}}$ = 1 + $\underline{\text{Sum(38 to 65)}}$ = 1 + 30.071 * $\underline{.03311}$
                                            Sum(1 to 37)   Sum(1 to 37)   1.03311

$$= 1.964$$

The general formula for the tail factor is:

$$\text{Tail factor}_n = f_n\, D_{n+1}/[1 + f_n],$$

where f_n is the paid loss development factor, less one, for the nth year of development, and D_{n+1} is the cumulative decay factor for payments made during years (n+1) to ultimate relative to payments made in anchor year n.

This method is sensitive to the 37:36 cumulative PLDF. For this reason the analysis can be repeated using the 36, 35, 34 or 33 anchor years. Table 2.5 shows the 37 to 65 tail factor calculated using each of these anchor years:

Table 2.5
37 to 65 MPD Tail Factors Based on Different Anchor Years

Anchor Year	37 to 65 MPD Tail Factors
37	1.964
36	1.808
35	1.496
34	1.439
33	1.369
Selected	1.581 *

* Average excluding the high and low.

The empirically calculated 37 to 65 MPD medical tail factors range from a low of 1.369 to a high of 1.964. The value is sensitive to relatively small changes either in incremental age-to-age factors in the tail or in the cumulative age to age factors at the end of the cumulative triangle.

Another approach for reducing the high level of volatility of the tail factors shown in Table 2.5 is presented in Table A.6 of Appendix A. Each of the average PLDFs for ages 30 through 36 are adjusted to what they would be for age 37—using the appropriate

products of incremental decay factors from AYs 1965 and prior. A weighted average of all of these adjusted PLDFs (1.022) is then used to replace the actual PLDF for DY 37 (1.0331). The final selected tail factor from age 37 to 65 is then 1.0 plus the product of the cumulative decay factor of 30.071 and .022/1.022 (1.647).

SAIF's Indicated Paid Tail Factors

When the indications from SAIF's incremental paid estimation of the tail from 37 years to 65 years are combined with those of a standard paid loss development approach up to 37 years of maturity, the MPD tails shown in the left column of Table 2.6 at different maturities were derived. The Total WC tail factors in Table 2.6 assume an ultimate mix of MPD and Other WC of 50% for each.

Table 2.6
SAIF's Indicated Paid Tail Factors

Maturity (Years)	MPD	Other WC	Total WC
10	2.469	1.263	1.671
15	2.328	1.234	1.613
25	2.054	1.129	1.457
35	1.680	1.052	1.294

In addition to MPD tail factors, Table 2.6 also displays indicated paid tail factors for all other types of WC losses, and for WC in total. Most of the Other WC tail factors are reflective of paid development for indemnity losses of permanently disabled claimants. A small portion is also due to paid development on fatal cases. The above table puts the impact of MPD paid tails in perspective relative to the indicated paid tail for all WC losses (i.e., for all injury types and for medical and indemnity combined).

Appendix B provides a comparison of SAIF's historical PLDFs for MPD, All Other WC and Total WC by DY. MPD is the primary reason why PLDFs for Total WC decline much more slowly than generally expected.

To gain an appreciation for the relative contribution of MPD versus All Other WC to the total loss reserves for a given AY at each of the above years of maturities, Table 2.7 provides a comparison of what the reserve would be, assuming that total ultimate losses for that AY were $100 million.

The MPD reserve makes up an increasing percentage of the total WC loss reserve at later maturities.

It should be borne in mind that Tables 2.6 and 2.7 provide indications specific to SAIF's loss experience in the state of Oregon, and not that of WC insurers in general.

Table 2.7
Indicated Loss Reserve at Different Maturities
(Dollars in millions)

Maturity (Years)	MPD Reserve	Other WC Reserve	MPD Reserve as a %-age of Total WC Reserve
10	$29.8	$10.4	74%
15	$28.5	$9.5	75%
25	$25.7	$5.7	82%
35	$20.2	$2.5	89%

Table 2.8 provides a comparison of indicated tails at different maturities for California WC experience, as projected by the WCIRB.

Table 2.8
WCIRB's Indicated California Paid Tail Factors

Maturity (Years)	Medical Tail	Indemnity Tail	Total WC Loss Tail
10	1.276	1.064	1.168
15	1.217	1.041	1.129
25	1.143	1.025	1.086

Source: WCIRB Bulletin No. 2003-24, pp. 8-9.

Although the California tails are consistently smaller than SAIF's, it is again true that the medical tails are decidedly greater than the indemnity tails. Table 2.9 provides a comparison of the size of the medical and indemnity loss reserves at different maturities, again assuming an AY with $100 million of ultimate losses.

Table 2.9
WCIRB Indicated Loss Reserve by Loss Type at Different Maturities
(Dollars in millions)

Maturity (Years)	Medical Loss Reserve	Indemnity Loss Reserve	Medical Reserve as a Percentage of Total Reserve
10	$11.7	$2.7	81%
15	9.6	1.8	84%
25	6.8	1.1	86%

In California, medical loss reserves make up an increasing percentage of the total WC loss reserve at later maturities.

3. INCORPORATING THE STATIC MORTALITY
MODEL INTO THE INCREMENTAL PAID TO PRIOR OPEN METHOD

This section presents the incremental paid to prior open method of reserve estimation. The basics of this method bear much resemblance to the structural methods developed by Fisher/Lange [4] and Adler/Kline [5]. In essence, incremental payments for every development year are estimated by taking the product of the number of open claims at the end of the prior development year and an estimated claim severity.

While this method is of limited value for early DYs, its merit relative to other reserving methods is substantial in estimating reserves for future MPD payments for more mature DYs. For such mature DYs, future incremental payments are essentially a function of how many claims are still open and the average size of incremental payments per open claim. In contrast, future incremental MPD payments have almost no causal linkage to payments for rapidly settled claims during early DYs.

Table 3.1 provides a specific example of how this method is applied. The specific steps to be taken in applying the incremental paid per prior open claim method are:
1) Incremental paid losses (A) and open counts (B) are compiled by AY and DY.
2) Historical averages of incremental paid per prior open (C) are computed as A) divided by B).
3) Each historical average is trended to the expected severity level for the first CY (2003) after the evaluation date (12/31/2002) and a representative average is selected for each DY (last row of D). A trend factor of 9% per year was assumed in this example.
4) Ratios of open counts at successive year-ends are computed (E).
5) The selected ratios from (E) by DY are used to project the number of open claims for each future DY of each AY, thereby completing (B).
6) Future values of incremental paid per prior open (C) are projected on the basis of the representative averages in the last row of (D).
7) Projections of incremental paid losses for future DYs for each AY (A) are determined as the product of the projected open counts from the lower right portion of (B) and the projected values of incremental paid per prior open from (C).

The descriptions in the lower right portion of sections A), B) and C) of Table 3.1 also detail how the estimates in that portion are derived.

Table 3.2 presents a sample application of this method in estimating incremental payments for accident year 2002—assuming 5,000 ultimate PD claims and a series of additional assumptions derived from SAIF's historical loss experience (as described in Appendix C).

Table 3.1
Sample Application of the Incremental Paid per Prior Open Method

A) Incremental Paid Losses ($000's)

AY	12	24	36	48	60	72
1997	2,822.8	15,936.1	9,182.3	4,281.6	2,063.8	1,411.4
1998	2,638.0	14,249.9	9,096.4	2,935.8	3,214.7	
1999	3,331.3	15,805.8	9,734.9	4,308.9		
2000	3,170.4	18,602.1	12,462.0			
2001	3,143.1	20,305.9		*Product of Projected B)*		
2002	4,263.1			*and Projected C).*		

B) Open Counts

AY	12	24	36	48	60	72
1997	362	1112	793	490	375	324
1998	338	888	628	431	352	
1999	343	840	664	492		
2000	268	867	731			
2001	276	897		*Use Ratios from (D) to*		
2002	333			*Project Future Open Counts*		

C) Incremental Paid per Prior Open

AY		24	36	48	60	72
1997		44,022	8,257	5,399	4,212	3,764
1998		42,159	10,244	4,675	7,459	
1999		46,081	11,589	6,489		
2000		69,411	14,374			
2001		73,572		*Selected Average at CY 2003*		
2002				*Level (E) Adjusted for 9% Inflation*		

D) Incremental Paid per Prior Open Trended to CY 2003 at 9%/Yr.

AY		24	36	48	60	72
1997		67,734	11,656	6,992	5,004	4,102
1998		59,511	13,266	5,554	8,130	
1999		59,676	13,769	7,073		
2000		82,467	15,667			
2001		80,194				
Avg. Latest 3		74,112	14,234	6,540	6,567	4,102

E) Ratio of Open Counts at Successive Year-Ends

AY		24	36	48	60	72
1997		3.072	0.713	0.618	0.765	0.864
1998		2.627	0.707	0.686	0.817	
1999		2.449	0.790	0.741		
2000		3.235	0.843			
2001		3.250				
Avg. Latest 3		2.978	0.780	0.682	0.791	0.864

Table 3.2
Estimation of Incremental Payments by Static Mortality Model
MPD Losses for Accident Year 2002

Development Year	# Prior Open	Paid/ Prior Open ($000's)	Incremental Paid Loss ($000,000's)	Cumulative Paid Loss ($000,000's)	PLDF	Paid Factor to Ultimate
1	460 *	13.5	6.2	6.2		44.579
2	460	78.4	36.1	42.3	6.8187	6.538
3	1531	16.6	25.4	67.7	1.6014	4.082
4	1366	8.4	11.5	79.2	1.1692	3.492
5	949	7.9	7.5	86.7	1.0948	3.189
6	677	6.8	4.6	91.2	1.0530	3.029
7	554	6.9	3.8	95.1	1.0420	2.907
8	396	7.5	3.0	98.1	1.0314	2.818
9	323	8.2	2.7	100.7	1.0271	2.744
10	249	9.0	2.2	103.0	1.0222	2.684
11	209	8.0	1.7	104.6	1.0163	2.641
12	197	8.8	1.7	106.4	1.0165	2.598
13	187	9.5	1.8	108.1	1.0167	2.556
14	178	10.4	1.8	110.0	1.0171	2.513
15	170	11.3	1.9	111.9	1.0175	2.469
16	163	12.4	2.0	113.9	1.0180	2.426
17	156	13.5	2.1	116.0	1.0185	2.382
18	150	14.7	2.2	118.2	1.0190	2.337
19	144	16.0	2.3	120.6	1.0195	2.293
20	139	17.5	2.4	123.0	1.0201	2.248
21	133	19.0	2.5	125.5	1.0205	2.202
22	128	20.7	2.7	128.2	1.0212	2.157
23	124	22.6	2.8	130.9	1.0218	2.111
24	119	24.6	2.9	133.9	1.0223	2.065
25	114	26.9	3.1	136.9	1.0228	2.018
26	109	29.3	3.2	140.1	1.0232	1.973
27	104	31.9	3.3	143.4	1.0236	1.927
28	98	34.8	3.4	146.8	1.0239	1.882
29	93	37.9	3.5	150.4	1.0241	1.838
30	88	41.3	3.6	154.0	1.0242	1.795
31	83	45.0	3.7	157.7	1.0242	1.752
32	78	49.1	3.8	161.5	1.0242	1.711
33	73	53.5	3.9	165.4	1.0240	1.671
34	68	58.3	3.9	169.4	1.0238	1.632
35	63	63.6	4.0	173.4	1.0236	1.594
36	58	69.3	4.0	177.4	1.0232	1.558
37	54	75.5	4.1	181.4	1.0229	1.523
38	49	82.3	4.1	185.5	1.0224	1.490
39	45	89.7	4.1	189.6	1.0220	1.458
40	42	97.8	4.1	193.7	1.0215	1.427
41	38	106.6	4.1	197.7	1.0209	1.398
42	35	116.2	4.0	201.7	1.0204	1.370
43	31	126.7	4.0	205.7	1.0198	1.343
44	29	138.1	3.9	209.7	1.0192	1.318
45	26	150.5	3.9	213.6	1.0185	1.294

* For the first development year only, the number of claims open at the end of the year is shown.

** The PLDFs in this table closely fit SAIF's ten year historical average factors.

Two striking phenomena are exhibited in Table 3.2. First, incremental payments consistently increase for every development year from the 11th through the 39rd, a counter-intuitive pattern. Second, the PLDFs consistently increase for every development year from the 11th through the 31st.

To understand why incremental payments, as well as PLDFs tend to increase during many "mature" years of development, it is helpful to examine how the two key components of the incremental paid to prior open method change over successive development years.

This section illustrates how a static mortality model has been incorporated into the incremental paid to prior open method. It describes the main framework of the method, while Appendix C covers the derivation of various assumptions that involve a complex analysis.

As is evident from Column (4) in Table 3.3, it was assumed that incremental payments per prior open claim would increase by 9% per year for every DY beyond the 7th, except for the 11th DY. This was based on an analysis of SAIF's historical incremental severities for these DYs (see Section C.2 of Appendix C). The fact that SAIF's historical PLDFs for DYs 40-54 are noticeably higher than those predicted by this model is evidence that the rate of medical cost escalation for these DYs was perceptibly higher than 9%.

The basis for our selection of 9% as the long-term rate of medical inflation is presented in Section C.3 of Appendix C. This assumed rate of increase also includes a provision for increases in utilization such as have occurred historically.

In Table 3.3 incremental payments continue to increase until age 39 because the impact of claims inflation [Column (4)] is greater than the force of mortality in closing existing claims [Column (2)]. Incremental payments first clearly decline when the product of the inflation factor (1.09) and the ratio of claims remaining open (0.915) is less than one—for development year 40.

Table 3.3
Estimation of Incremental Payments by Static Mortality Model

Development Year (DY)	(1) # Open at End of Prior DY	(2) % Decline in Prior Open Counts	(3) Increm. Pd/ Prior Open ($000's)	(4) % Severity Change
1	0.0		13.478	
2	460.0		78.425	481.9%
3	1531.0		16.607	-78.8%
4	1366.0	10.8%	8.388	-49.5%
5	949.0	30.5%	7.903	-5.8%
6	677.0	28.7%	6.781	-14.2%
7	554.0	18.2%	6.924	2.1%
8	396.0	28.5%	7.547	9.0%
9	323.0	18.4%	8.226	9.0%
10	249.0	22.9%	8.967	9.0%
11	209.0	16.1%	8.036	-10.4%
12	196.9	5.8%	8.759	9.0%
13	186.5	5.3%	9.548	9.0%
14	177.5	4.8%	10.407	9.0%
15	169.7	4.4%	11.343	9.0%
16	162.9	4.0%	12.364	9.0%
17	156.1	4.2%	13.477	9.0%
18	150.2	3.8%	14.690	9.0%
19	144.0	4.1%	16.012	9.0%
20	138.5	3.8%	17.453	9.0%
21	132.8	4.2%	19.024	9.0%
22	128.2	3.4%	20.736	9.0%
23	123.6	3.6%	22.603	9.0%
24	118.7	3.9%	24.637	9.0%
25	113.8	4.2%	26.854	9.0%
26	108.8	4.4%	29.271	9.0%
27	103.6	4.7%	31.905	9.0%
28	98.4	5.0%	34.777	9.0%
29	93.2	5.3%	37.907	9.0%
30	88.0	5.6%	41.318	9.0%
31	82.8	5.9%	45.037	9.0%
32	77.6	6.2%	49.090	9.0%
33	72.5	6.5%	53.509	9.0%
34	67.6	6.8%	58.324	9.0%
35	62.8	7.1%	63.574	9.0%
36	58.2	7.4%	69.295	9.0%
37	53.7	7.7%	75.532	9.0%
38	49.5	7.9%	82.330	9.0%
39	45.4	8.2%	89.739	9.0%
40	41.6	8.4%	97.816	9.0%
41	38.0	8.6%	106.619	9.0%
42	34.6	8.9%	116.215	9.0%
43	31.5	9.1%	126.674	9.0%
44	28.5	9.3%	138.075	9.0%
45	25.8	9.6%	150.502	9.0%

The percentage declines in prior open counts reflect the composite effects of three factors affecting the number of open claims: 1) increases due to newly reported claims; 2) decreases due to the death of a few claimants; and 3) net decreases due to other reasons (including increases due to reopened claims). After 20 years of development newly reported claims become negligible, as do net claim closures. Thus, after 20 years of development, virtually all claim closures are attributable to the death of claimants. Consequently, changes in the number of open claims at the end of each development year beyond 20 years can be predicted entirely on the basis of mortality rates. And changes in the number of open claims can be estimated beyond 15 years via mortality rates and inclusion of the small number of newly reported claims and net closures for other reasons. This is subject to fine-tuning due to the possibility that the mortality rates of disabled claimants might be higher than those of the general populace, although recent improvements in medical technology have reduced the influence of medical impairment on mortality rates.

Table 3.4 presents an accounting of how each of the above factors affect the number of open MPD claims during the development of a typical accident year. Derivation of these assumptions is disclosed in Appendix C.

SAIF's historical database only includes the total number of closed claims. So the number of claimant deaths was estimated based on mortality tables and any additional claim closures are presumed to be for other reasons. The breakdown was derived by estimating the number of claim closures due to death from the 2000 SSA mortality tables.

The SSA tables were not modified by a disabled lives scale factor because key values predicted by the model either: 1) closely fit SAIF's actual experience; or 2) underestimated actual development (e.g., DYs 40-54). Furthermore, prior actuarial inquiries into this question have been mixed regarding whether such a factor is justified. This is discussed in two papers in the Winter 1991 Edition of the CAS Forum ("*Injured Worker Mortality*" Gillam, William R. [6] and "*Review of Report of Committee on Mortality for Disabled Lives*" Venter, Gary G., Schill, Barbara, and Barnett, Jack [7]). It is quite possible that permanently disabled workers receive better medical care, on average, than do non-disabled people, helping to close a gap in mortality rates that would otherwise exist.

Table 3.4
Factors Affecting the Number of Open MPD Claims for a Single Accident Year

Develop-ment Year (DY)	(1) # Open at End of Prior DY [(5) of Prior DY End]	(2) Newly Reported Claims	(3) Estimated # of Claimant Deaths	(4) Estimated Claims Closed for Other Reasons	(5) # Open at End of Current DY [(1)+(2)-(3)-(4)]
1		926	3.5	462.5	460.0
2	460.0	2790	15.0	1704.0	1531.0
3	1531.0	866	17.3	1013.7	1366.0
4	1366.0	215	14.1	617.9	949.0
5	949.0	91	10.3	352.7	677.0
6	677.0	47	7.9	162.1	554.0
7	554.0	19	6.9	170.1	396.0
8	396.0	11	5.3	78.7	323.0
9	323.0	8	4.7	77.3	249.0
10	249.0	5	3.9	41.1	209.0
11	209.0	4	3.5	12.5	196.9
12	196.9	3	3.6	9.8	186.5
13	186.5	3	3.6	8.4	177.5
14	177.5	3	3.7	7.1	169.7
15	169.7	3	3.8	5.9	162.9
16	162.9	2	3.9	4.9	156.1
17	156.1	2	4.0	3.9	150.2
18	150.2	1	4.2	3.0	144.0
19	144.0	1	4.3	2.2	138.5
20	138.5	0	4.4	1.4	132.8
21	132.8	0	4.5	0.0	128.2
22	128.2	0	4.7	0.0	123.6
23	123.6	0	4.8	0.0	118.7
24	118.7	0	4.9	0.0	113.8
25	113.8	0	5.1	0.0	108.8

This method produces projected PLDFs out to 85 years of development. Such development is possible because a worker could be injured at age 16 and live to be over 100. Table 3.5 displays the basis for projections of incremental payments and PLDFs beyond 45 years of development. It is a continuation of Table 3.2.

Table 3.5
Estimation of Incremental Payments by Static Mortality Model
For Development Years 45 and Greater

Development Year	# Prior Open	Paid/ Pr Open ($000's)	Incremental Paid Loss ($000,000's)	Cumulative Paid Loss ($000,000's)	PLDF	Paid Factor to Ultimate
45	25.8	150.5	3.9	213.6	1.0185	1.2940
46	23.3	164.0	3.8	217.4	1.0179	1.2715
47	21.0	178.8	3.7	221.1	1.0172	1.2499
48	18.8	194.9	3.7	224.8	1.0166	1.2295
49	16.8	212.4	3.6	228.4	1.0159	1.2103
50	15.0	231.6	3.5	231.8	1.0152	1.1921
51	13.4	252.4	3.4	235.2	1.0146	1.1750
52	11.9	275.1	3.3	238.5	1.0139	1.1589
53	10.5	299.9	3.1	241.6	1.0132	1.1438
54	9.3	326.9	3.0	244.7	1.0125	1.1296
55	8.1	356.3	2.9	247.6	1.0118	1.1164
56	7.1	388.4	2.8	250.3	1.0112	1.1041
57	6.2	423.3	2.6	253.0	1.0105	1.0926
58	5.4	461.4	2.5	255.4	1.0098	1.0820
59	4.6	502.9	2.3	257.8	1.0091	1.0722
60	4.0	548.2	2.2	260.0	1.0085	1.0632
61	3.4	597.5	2.0	262.0	1.0078	1.0549
62	2.9	651.3	1.9	263.9	1.0072	1.0474
63	2.4	709.9	1.7	265.6	1.0065	1.0406
64	2.0	773.8	1.6	267.2	1.0059	1.0345
65	1.7	843.5	1.4	268.6	1.0053	1.0291
66	1.4	919.4	1.3	269.8	1.0047	1.0242
67	1.1	1,002.1	1.1	271.0	1.0042	1.0200
68	0.90	1,092.3	1.0	272.0	1.0036	1.0163
69	0.71	1,190.6	0.85	272.8	1.0031	1.0131
70	0.56	1,297.8	0.73	273.5	1.0027	1.0104
71	0.43	1,414.6	0.61	274.1	1.0022	1.0082
72	0.33	1,541.9	0.51	274.7	1.0019	1.0063
73	0.25	1,680.7	0.41	275.1	1.0015	1.0048
74	0.18	1,831.9	0.33	275.4	1.0012	1.0036
75	0.13	1,996.8	0.26	275.7	1.0009	1.0026
76	0.093	2,176.5	0.20	275.9	1.0007	1.0019
77	0.065	2,372.4	0.15	276.0	1.0006	1.0013
78	0.044	2,585.9	0.11	276.1	1.0004	1.0009
79	0.029	2,818.7	0.08	276.2	1.0003	1.0006
80	0.019	3,072.3	0.06	276.3	1.0002	1.0004
81	0.012	3,348.8	0.04	276.3	1.0001	1.0003
82	0.008	3,650.2	0.03	276.3	1.0001	1.0002
83	0.005	3,978.8	0.02	276.4	1.0001	1.0001
84	0.003	4,336.9	0.01	276.4	1.0000	1.0001
85	0.002	4,727.2	0.01	276.4	1.0000	1.0000

Incremental payments in Tables 3.2 and 3.5:

- Are at a local minimum of $1.68 million during the 11th year of development.
- Increase to a local maximum of $4.08 million during the 39th year of development.
- Do not decrease down below the local minimum of $1.68 million during the 11th year of development until the 64th year of development.

This is an example of the extreme degree to which the behavior of MPD payments departs from those of other WC loss costs (or those for other casualty coverages).

The paid factors to ultimate in the last column of Table 3.2 and 3.5 above are exceptionally sensitive to future rates of claim inflation. Table 3.6 provides a comparison of the indicated tail factors with and without inflation at various representative ages of development.

Table 3.6
Indicated Paid Factors to Ultimate

End of Year of Development	With 9% Inflation	Without Inflation	Ratio of 9% Inflation Reserve to Zero Inflation Reserve
10	2.684	1.152	11.1
15	2.469	1.110	13.4
25	2.019	1.054	18.9
35	1.594	1.022	27.0
50	1.192	1.003	64.0

An example will put the implications of Table 3.6 into practical terms. Suppose a claims adjuster reviews all PD claims open at the end of 25 years of development. For each PD claim, he estimates the medical portion by multiplying current medical payments times an annuity factor that is the life expectancy of the claimant at their current age. The ratio of 18.9 in the right column of Table 3.6 is saying is that future medical payments will be 18.9 times the case reserve derived by this method. One might think the error would decrease the more mature the accident year became, but in actuality the percentage error dramatically increases at high maturities. In addition, the mortality table used by the claims adjuster may be out of date.

Just as we have modeled the expected PLDF patterns for MPD losses, analogous ILDF patterns can be estimated if we define total case reserves as the product of the latest year's incremental payments times the average annuity factor for all living PD claimants. This is presented in Table 3.7.

Table 3.7
Expected ILDFs if Case Reserves are
Based on Zero Inflation Annuity Factors

DY	# Prior Open	Upward Sum of # Prior Open	Zero Inflation Annuity Factor	Increm-ental Pd/ Pr Open	Zero Inflation Case Reserve	Cum Paid	Zero Inflation Case Incurred	ILDF	Incurred Tail
5	949	6,912.6	6.28	7.9	47.1	86.7	133.8	0.9756	2.066
6	677	5,963.6	7.81	6.8	35.8	91.2	127.1	0.9500	2.175
7	554	5,286.6	8.54	6.9	32.8	95.1	127.9	1.0059	2.162
8	396	4,732.6	10.95	7.5	32.7	98.1	130.8	1.0231	2.113
9	323	4,336.6	12.43	8.2	33.0	100.7	133.7	1.0225	2.066
10	249	4,013.6	15.12	9.0	33.8	103.0	136.7	1.0222	2.022
11	209	3,764.6	17.01	8.0	28.6	104.6	133.2	0.9744	2.075
12	196.9	3,555.6	17.05	8.8	29.4	106.4	135.8	1.0193	2.035
13	186.5	3,358.7	17.01	9.5	30.3	108.1	138.4	1.0195	1.996
14	177.5	3,172.1	16.87	10.4	31.2	110.0	141.2	1.0197	1.958
15	169.7	2,994.6	16.65	11.3	32.0	111.9	144.0	1.0199	1.920
16	162.9	2,824.9	16.34	12.4	32.9	113.9	146.8	1.0200	1.882
17	156.1	2,662.0	16.05	13.5	33.8	116.0	149.8	1.0202	1.845
18	150.2	2,505.9	15.69	14.7	34.6	118.2	152.9	1.0203	1.808
19	144.0	2,355.8	15.36	16.0	35.4	120.6	156.0	1.0204	1.772
20	138.5	2,211.8	14.96	17.5	36.2	123.0	159.2	1.0204	1.737
21	132.8	2,073.2	14.62	19.0	36.9	125.5	162.4	1.0205	1.702
22	128.2	1,940.5	14.13	20.7	37.6	128.2	165.7	1.0205	1.668
23	123.6	1,812.2	13.67	22.6	38.2	130.9	169.1	1.0204	1.634
24	118.7	1,688.7	13.22	24.6	38.7	133.9	172.6	1.0203	1.602
25	113.8	1,569.9	12.80	26.9	39.1	136.9	176.0	1.0202	1.570
26	108.8	1,456.1	12.39	29.3	39.4	140.1	179.6	1.0200	1.539
27	103.6	1,347.4	12.00	31.9	39.7	143.4	183.1	1.0198	1.509
28	98.4	1,243.8	11.64	34.8	39.8	146.8	186.7	1.0195	1.481
29	93.2	1,145.4	11.29	37.9	39.9	150.4	190.3	1.0192	1.453
30	88.0	1,052.2	10.96	41.3	39.8	154.0	193.8	1.0189	1.426
31	82.8	964.2	10.65	45.0	39.7	157.7	197.4	1.0185	1.400
32	77.6	881.5	10.36	49.1	39.5	161.5	201.0	1.0181	1.375
33	72.5	803.9	10.08	53.5	39.1	165.4	204.6	1.0177	1.351
34	67.6	731.3	9.82	58.3	38.7	169.4	208.1	1.0172	1.328
35	62.8	663.7	9.57	63.6	38.2	173.4	211.6	1.0167	1.306
36	58.2	600.9	9.33	69.3	37.6	177.4	215.0	1.0163	1.286
37	53.7	542.8	9.11	75.5	36.9	181.4	218.4	1.0157	1.266
38	49.5	489.0	8.89	82.3	36.2	185.5	221.7	1.0152	1.247
39	45.4	439.6	8.68	89.7	35.4	189.6	225.0	1.0147	1.229
40	41.6	394.2	8.48	97.8	34.5	193.7	228.1	1.0142	1.211
41	38.0	352.6	8.28	106.6	33.5	197.7	231.3	1.0136	1.195
42	34.6	314.6	8.08	116.2	32.5	201.7	234.3	1.0131	1.180
43	31.5	279.9	7.89	126.7	31.5	205.7	237.2	1.0125	1.165
44	28.5	248.5	7.71	138.1	30.4	209.7	240.0	1.0119	1.151
45	25.8	219.9	7.52	150.5	29.2	213.6	242.8	1.0114	1.138
46	23.3	194.1	7.33	164.0	28.0	217.4	245.4	1.0108	1.126
47	21.0	170.8	7.15	178.8	26.8	221.1	247.9	1.0103	1.115
48	18.8	149.9	6.97	194.9	25.5	224.8	250.3	1.0097	1.104
49	16.8	131.0	6.78	212.4	24.3	228.4	252.6	1.0092	1.094
50	15.0	114.2	6.60	231.6	23.0	231.8	254.8	1.0086	1.085

A review of Table 3.7 reveals the following:

- Although there are ILDFs less than 1.0 for the 5th, 6th and 11th development years, subsequent factors become noticeably greater than 1.0—even up through the 50th year of development, and beyond.

- Incurred loss development factors are expected to increase during each development year from the 12th through the 21st years.

- The rate of decrease in ILDFs after the 21st development year is surprisingly small, resulting in very large incurred tails for nearly all ages.

This example raises concerns about the practice of estimating the paid tail by taking the ratio of incurred (perhaps with some modest upward adjustment) to paid at the most mature development year.

4. MORTALITY IMPROVEMENT

Life expectancies have been increasing steadily and noticeably for at least the past several decades, and are expected to continue to increase throughout the next century, if not beyond. Consider these trends in life expectancies that have occurred over past decades, and those projected by the Social Security Administration (SSA).

Table 4.1
Life Expectancies at Different Ages—Male
Based on Social Security Administration Mortality Tables

Current Age	1960	1980	2000	2020	2040	2060	2080
20	49.7	51.7	54.7	56.8	58.7	60.3	61.8
40	31.3	33.5	36.2	38.1	39.8	41.4	42.7
60	15.9	17.3	19.3	20.8	22.2	23.4	24.6
80	6.0	6.8	7.2	7.8	8.6	9.4	10.1

Table 4.1 presents male life expectancies since a high percentage of permanently disabled claimants are male. Table 4.2 displays the percentage increases in life expectancy corresponding to the estimates in Table 4.1.

Typically, PD claimants receive a percentage of replacement wages until their retirement age and coverage of their medical expenses related to their work injuries are paid until they die. Since medical expenses are expected to continue rising at high rates of inflation, coverage of such expenses significantly compounds the effects of expected increases in life expectancies.

Table 4.2
Percentage Increase in Male Life Expectancies
Based on Social Security Administration Mortality Tables

Current Age	1980 1960	2000 1980	2020 2000	2040 2020	2060 2040	2080 2060
20	4.2%	5.8%	3.7%	3.3%	2.8%	2.5%
40	7.0%	8.2%	5.2%	4.5%	3.8%	3.3%
60	9.1%	11.7%	7.6%	6.6%	5.6%	4.9%
80	11.9%	6.5%	8.7%	10.0%	8.6%	7.6%

Consequently, the difference between MPD reserves calculated using constant recent mortality rates and those calculated with trended mortality rates is substantial. The latter calculations are unusually complex. They can best be measured and understood with the aid of a heuristic model.

While the effects of declining mortality rates are almost undetectable over the short run, their magnitude over future decades is quite substantial on gross MPD reserves. However, the extent of these effects is negligible on net MPD when retentions are relatively low. The effect is also fairly small for indemnity loss reserves for permanently disabled claimants.

5. THE TRENDED MORTALITY MODEL

This method is similar to the static mortality model adaptation of the incremental paid to prior open method described in Section 3 and Appendix C. The key thing that differs is that the change in the number of open claims for every future development year of every AY is determined by applying mortality tables forecasted by the SSA for the appropriate future development year. The rest of the method is essentially unchanged. A sample of these differences is provided in Tables 5.1a and 5.1b for several different DYs for AY 2002.

As is evident from Tables 5.1a and 5.1b, small improvements in the annual survival rate of remaining claimants result in major differences in the number of claims still open at higher development years. Given that the greatest differences occur during development years in the distant future, when the effects of medical inflation have had an opportunity to compound over decades, the total reserve indicated by the trended mortality method is decidedly greater than that indicated by the static mortality method.

Table 5.1a
Comparison of Mortality Rates and Claims Open
at Different Development Years for Accident Year 2002

DY	Mortality Table Assumed		Group Survival Rate		Claims Open at Prior Year End		% Greater Open Claims
	Static	Trended	Static	Trended	Static	Trended	
30	2000	2031	0.941	0.946	88.0	91.5	4.0%
31	2000	2032	0.938	0.943	82.8	86.6	4.6%
32	2000	2033	0.935	0.941	77.6	81.6	5.2%
33	2000	2034	0.932	0.938	72.5	76.8	5.9%
34	2000	2035	0.929	0.935	67.6	72.0	6.6%
35	2000	2036	0.926	0.933	62.8	67.4	7.3%
36	2000	2037	0.923	0.931	58.2	62.9	8.1%
37	2000	2038	0.921	0.928	53.7	58.5	8.9%
38	2000	2039	0.918	0.926	49.5	54.3	9.8%
39	2000	2040	0.916	0.924	45.4	50.3	10.7%
40	2000	2041	0.914	0.922	41.6	46.5	11.7%
41	2000	2042	0.911	0.920	38.0	42.8	12.7%
42	2000	2043	0.909	0.918	34.6	39.4	13.8%
43	2000	2044	0.907	0.916	31.5	36.2	14.9%
44	2000	2045	0.904	0.914	28.5	33.1	16.1%
45	2000	2046	0.902	0.912	25.8	30.3	17.3%
46	2000	2047	0.900	0.910	23.3	27.6	18.5%
47	2000	2048	0.898	0.908	21.0	25.1	19.9%
48	2000	2049	0.895	0.906	18.8	22.8	21.2%
49	2000	2050	0.893	0.904	16.8	20.7	22.7%
50	2000	2051	0.890	0.902	15.0	18.7	24.2%
51	2000	2052	0.887	0.899	13.4	16.8	25.9%
52	2000	2053	0.885	0.897	11.9	15.1	27.6%
53	2000	2054	0.882	0.895	10.5	13.6	29.4%
54	2000	2055	0.878	0.892	9.3	12.2	31.3%
55	2000	2056	0.875	0.889	8.1	10.8	33.3%
56	2000	2057	0.871	0.886	7.12	9.6	35.5%
57	2000	2058	0.867	0.883	6.20	8.5	37.9%
58	2000	2059	0.863	0.880	5.38	7.6	40.4%
59	2000	2060	0.859	0.876	4.64	6.65	43.1%
60	2000	2061	0.853	0.872	3.99	5.82	46.1%

Table 5.1b
Comparison of Mortality Rates and Claims Open
at Different Development Years for Accident Year 2002

DY	Mortality Table Assumed Static	Mortality Table Assumed Trended	Group Survival Rate Static	Group Survival Rate Trended	Claims Open at Prior Year End Static	Claims Open at Prior Year End Trended	% Greater Open Claims
60	2000	2061	0.853	0.872	3.99	5.82	46.1%
61	2000	2062	0.848	0.868	3.40	5.08	49.3%
62	2000	2063	0.842	0.863	2.89	4.41	52.8%
63	2000	2064	0.835	0.858	2.43	3.81	56.7%
64	2000	2065	0.828	0.852	2.03	3.26	60.8%
65	2000	2066	0.821	0.846	1.68	2.78	65.4%
66	2000	2067	0.812	0.840	1.38	2.35	70.6%
67	2000	2068	0.803	0.833	1.12	1.98	76.3%
68	2000	2069	0.794	0.826	0.90	1.65	82.8%
69	2000	2070	0.783	0.819	0.715	1.36	90.3%
70	2000	2071	0.772	0.811	0.560	1.11	98.9%
71	2000	2072	0.761	0.803	0.432	0.90	108.8%
72	2000	2073	0.749	0.794	0.329	0.72	120.3%
73	2000	2074	0.736	0.785	0.246	0.576	133.7%
74	2000	2075	0.723	0.776	0.181	0.452	149.4%
75	2000	2076	0.709	0.767	0.131	0.351	167.9%
76	2000	2077	0.695	0.758	0.093	0.269	189.7%
77	2000	2078	0.681	0.748	0.065	0.204	215.7%
78	2000	2079	0.667	0.739	0.044	0.153	246.9%
79	2000	2080	0.652	0.729	0.029	0.113	284.4%
80	2000	2081	0.637	0.719	0.019	0.082	329.8%
81	2000	2082	0.621	0.756	0.012	0.059	385.3%
82	2000	2083	0.604	0.748	0.008	0.045	491.2%
83	2000	2084	0.586	0.738	0.005	0.033	632.3%
84	2000	2085	0.566	0.728	0.003	0.025	823.2%
85	2000	2086	0.545	0.716	0.002	0.018	1086.8%

To fully present the projections of the trended mortality model would require the display of arrays consisting of 37 rows and about 90 columns—the rows representing accident years and the columns years of development. Since this would be unwieldy, *__summary arrays in which data for every fifth accident year is shown at the end of every fifth development year__* will be presented. An example is presented below in Table 5.2.

Table 5.2 shows the calendar year mortality table that should be used in determining the probability of continuation of a claim for each AY-DY combination. If a current table (e.g., 2000) is used, differences between the static and trended mortality rates will increase the farther the year of the appropriate mortality table is from CY 2000.

Table 5.2
Sample Layout of Summarized Results

Calendar Year of Payments—
For Every Fifth Accident Year at Every Fifth Development Year

									Development Year							
AY	**5**	**10**	**15**	**20**	**25**	**30**	**35**	**40**	**45**	**50**	**55**	**60**	**65**	**70**	**75**	**80**
1970	1974	1979	1984	1989	1994	1999	2004	2009	2014	2019	2024	2029	2034	2039	2044	2049
1975	1979	1984	1989	1994	1999	2004	2009	2014	2019	2024	2029	2034	2039	2044	2049	2054
1980	1984	1989	1994	1999	2004	2009	2014	2019	2024	2029	2034	2039	2044	2049	2054	2059
1985	1989	1994	1999	2004	2009	2014	2019	2024	2029	2034	2039	2044	2049	2054	2059	2064
1990	1994	1999	2004	2009	2014	2019	2024	2029	2034	2039	2044	2049	2054	2059	2064	2069
1995	1999	2004	2009	2014	2019	2024	2029	2034	2039	2044	2049	2054	2059	2064	2069	2074
2000	2004	2009	2014	2019	2024	2029	2034	2039	2044	2049	2054	2059	2064	2069	2074	2079

What effects will the above trends in mortality have on MPD loss reserves? It is not hard to foresee the general effects. PD claimants for more recent accident years are expected to live longer than their counterparts from old accident years. This is a direct consequence of declining mortality rates. As a result, a higher percentage of PD claimants will still be alive at any given age of development. Therefore, the percentage of claims closed will decline at any given age and thus simple paid loss development projections will need to be adjusted upward to reflect these declines in claims disposal ratios. Hence, tail factors that reflect the effects of declining mortality rates must increase over successive accident years *for every possible development age*.

While the general effects of anticipated future mortality trends are easy to grasp, the best way to quantify these effects is to construct a heuristic model designed to isolate the effects of mortality trends on PLDFs and paid tails. The trended mortality model we have constructed is such that:

- The only thing that changes over time are mortality rates—as historically compiled and as officially forecasted by the Social Security Administration.

- Medical inflation is a constant 9% per year, both historically and prospectively. Support for this assumption is provided in Section C.3 of Appendix C.

- The number of ultimate reported claims for every accident year, from 1966 through 2002, is held at a constant level of 5,000 per year.

- Claim reporting and closure patterns for SAIF's PD claimants over the past ten calendar years served as the basis for these key assumptions—in order to make the model as realistic as possible.

By designing a model where claimant mortality rates are the only thing that changes from AY to AY, the effects of mortality trends can clearly be seen. Details of the model are presented in Appendices C and D.

Projections of the number of open claims were derived from the heuristic model for each accident year from 1966 through 2002 at the end of every development year from the first to the eightieth. As noted above, each accident year was assumed to have 5,000 ultimate reported claims. Claim closure patterns, for reasons other than death of the claimant, were held constant for all accident years. The only thing that varied from accident year to accident year in the model was the number of claims closed due to death. In this way the effects of mortality trends on the number of open claims at the end of each development year for each accident year can be isolated.

What is evident from the summarized results presented in Table 5.3 is that the expected number of open claims at any given year of development will slowly increase as one moves from the oldest accident years to the most recent—by scanning down any chosen column in this table.

Table 5.3
Number of Open Claims for Representative
Accident Years at Five Year Intervals of Development

	End of Development Year															
AY	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
1970	653	196	149	119	95	71	50	33	21	12	6.9	3.5	1.5	0.5	0.1	0.02
1975	655	197	150	120	97	73	52	34	22	13	7.2	3.7	1.6	0.6	0.1	0.03
1980	659	200	153	123	100	76	54	36	23	14	7.7	3.9	1.7	0.6	0.2	0.03
1985	662	202	156	126	103	79	56	38	24	14	8.1	4.2	1.9	0.7	0.2	0.04
1990	665	204	158	128	105	81	58	39	25	15	8.5	4.4	2.0	0.7	0.2	0.04
1995	668	206	160	130	108	83	60	41	26	16	9.0	4.7	2.1	0.8	0.2	0.05
2000	670	207	161	132	110	86	62	42	27	17	9.5	5.0	2.3	0.9	0.3	0.06

For example, at the end of 35 years of development, the number of open claims is expected to increase from 50 for accident year 1970 to 62 for accident year 2000. This is an increase of 24% in the number of open claims. And at the end of 60 years of development, the number of open claims is expected to increase from 3.5 to 5.0, an increase of 42.9%. The percentage rate of increase in the number of open claims for each given column increases as one moves from the earlier development years on the left to the later development years on the right. This is due to the compounding effect of expected declines in future mortality rates. Table 5.4 displays the total percentage increase for each development year column.

Table 5.4
Percentage Increases in the Number of Open Claims at the End of Representative Development Years—From Accident Year 1970 to Accident Year 2000

							End of Development Year								
5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
2.6%	5.6%	8.3%	11.6%	15.6%	19.8%	23.9%	27.4%	30.3%	33.5%	37.5%	43.7%	54.3%	73.2%	106.8%	164.5%

Since the number of open claims at any given development year will be increasing steadily over successive accident years, the total proportion of ultimate losses paid through that development year will decline slightly over time. Because of this we would naturally expect that the appropriate tail factors at any given development year will also increase steadily over time. The projected results are displayed in Table 5.5 below.

Table 5.5
Indicated Tail Factors

							End of Development Year								
AY	5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
1970	3.037	2.570	2.375	2.177	1.973	1.773	1.592	1.438	1.311	1.210	1.132	1.075	1.037	1.015	1.004	1.001
1975	3.108	2.628	2.428	2.223	2.012	1.805	1.617	1.456	1.325	1.220	1.139	1.080	1.040	1.016	1.005	1.001
1980	3.197	2.701	2.492	2.279	2.058	1.842	1.645	1.477	1.340	1.231	1.146	1.085	1.043	1.018	1.006	1.001
1985	3.286	2.774	2.558	2.336	2.106	1.879	1.674	1.499	1.356	1.242	1.154	1.090	1.046	1.020	1.007	1.002
1990	3.376	2.848	2.624	2.393	2.154	1.918	1.704	1.521	1.372	1.253	1.162	1.095	1.049	1.021	1.007	1.002
1995	3.466	2.921	2.690	2.451	2.203	1.957	1.733	1.543	1.388	1.265	1.170	1.101	1.053	1.023	1.008	1.002
2000	3.549	2.990	2.752	2.505	2.248	1.993	1.761	1.563	1.402	1.275	1.177	1.105	1.054	1.023	1.008	1.002

Table 5.6 displays the percentage understatement in AY 2000 loss reserves at different development ages—if such reserves were based on AY 1970 tail factors. It clearly indicates that the usage of constant tail factors will result in material inadequacies in the indicated loss reserves.

Table 5.6
Indicated Percentage Understatement in AY 2000 Loss Reserves
(If Based on AY 1970 Tail Factors)

							End of Development Year								
5	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80
25%	27%	27%	28%	28%	28%	28%	29%	29%	31%	34%	39%	47%	59%	85%	102%

The heuristic model also indicates that incremental PLDFs at any given maturity will trend upward over time. In Table 5.7 below, five year paid loss development factors, each of which are the cumulative products of five successive paid loss development factors, inch upward over time within any given development column.

Table 5.7
Trends in Five Year Paid Loss Development Factors

							Development Years									
AY	10/5	15/10	20/15	25/20	30/25	35/30	40/35	45/40	50/45	55/50	60/55	65/60	70/65	75/70	80/75	85/80
1970	1.182	1.082	1.091	1.103	1.113	1.114	1.107	1.097	1.084	1.069	1.053	1.037	1.022	1.010	1.004	1.001
1975	1.183	1.083	1.092	1.105	1.115	1.116	1.110	1.099	1.086	1.071	1.055	1.039	1.023	1.011	1.004	1.001
1980	1.184	1.084	1.094	1.107	1.118	1.119	1.114	1.103	1.089	1.073	1.057	1.040	1.024	1.012	1.004	1.001
1985	1.185	1.084	1.095	1.109	1.120	1.123	1.117	1.106	1.092	1.076	1.059	1.042	1.026	1.013	1.005	1.002
1990	1.186	1.085	1.096	1.111	1.123	1.126	1.120	1.109	1.094	1.078	1.061	1.044	1.027	1.014	1.005	1.002
1995	1.186	1.086	1.097	1.113	1.126	1.129	1.123	1.112	1.097	1.081	1.063	1.046	1.029	1.015	1.006	1.002
2000	1.187	1.087	1.098	1.114	1.128	1.132	1.126	1.115	1.100	1.083	1.065	1.048	1.030	1.015	1.006	1.002

Table 5.7 rebuts the conjecture that the paid loss development factors for earlier (as well as middle) development years will hold constant over successive accident years. However, it is also evident that the rate of increase in these paid development factors is small. It is small enough that it would not be detectable to an experienced actuary reviewing historical PLDFs. This becomes even more evident if we look at different sections of the typical triangle of paid loss development factors that are generated by the heuristic model. In Table 5.8 the individual PLDFs generated by the model are displayed for AYs 1990-2002 for the earliest development years.

Table 5.8
PLDFs Factors Indicated by the
Heuristic Model During Early Years of Development

					Years of Development						
AY	2	3	4	5	6	7	8	9	10	11	12
1990	6.81875	1.59471	1.16775	1.09383	1.05240	1.04154	1.03101	1.02670	1.02182	1.01604	1.01618
1991	6.81875	1.59488	1.16781	1.09387	1.05243	1.04157	1.03104	1.02673	1.02185	1.01607	1.01621
1992	6.81875	1.59505	1.16786	1.09392	1.05246	1.04160	1.03107	1.02676	1.02187	1.01609	1.01623
1993	6.81875	1.59522	1.16792	1.09396	1.05250	1.04163	1.03110	1.02679	1.02190	1.01611	1.01625
1994	6.81875	1.59539	1.16797	1.09400	1.05253	1.04166	1.03113	1.02681	1.02192	1.01613	1.01628
1995	6.81875	1.59557	1.16803	1.09405	1.05256	1.04169	1.03115	1.02684	1.02195	1.01615	1.01630
1996	6.81875	1.59571	1.16807	1.09408	1.05259	1.04172	1.03118	1.02686	1.02197	1.01617	1.01632
1997	6.81875	1.59586	1.16812	1.09412	1.05261	1.04174	1.03120	1.02688	1.02199	1.01618	1.01634
1998	6.81875	1.59601	1.16816	1.09415	1.05263	1.04176	1.03122	1.02691	1.02201	1.01620	1.01636
1999	6.81875	1.59616	1.16821	1.09419	1.05266	1.04179	1.03124	1.02693	1.02203	1.01622	1.01638
2000	6.81875	1.59631	1.16825	1.09422	1.05268	1.04181	1.03126	1.02695	1.02205	1.01623	1.01639
2001	6.81875	1.59647	1.16830	1.09426	1.05271	1.04184	1.03129	1.02697	1.02208	1.01625	1.01642
2002	6.81875	1.59662	1.16835	1.09430	1.05273	1.04186	1.03131	1.02699	1.02210	1.01627	1.01644

The constant PLDFs in the column for DY 2 merely reflect a simplifying assumption in the model.

In Table 5.9 individual PLDFs generated by the model are displayed for accident years 1966-1977 for the most mature historical development years. Projected PLDFs for the short term future are also shown below the diagonal.

Table 5.9
PLDFs Indicated by the
Heuristic Model During Later Years of Development

Year of Development

AY	27	28	29	30	31	32	33	34	35	36	37
1966	1.02103	1.02124	1.02139	1.02147	1.02149	1.02146	1.02136	1.02121	1.02101	1.02077	1.02049
1967	1.02112	1.02134	1.02149	1.02157	1.02160	1.02156	1.02147	1.02132	1.02113	1.02088	1.02060
1968	1.02121	1.02143	1.02159	1.02168	1.02170	1.02167	1.02158	1.02143	1.02124	1.02100	1.02072
1969	1.02130	1.02153	1.02168	1.02178	1.02181	1.02178	1.02169	1.02154	1.02135	1.02111	1.02083
1970	1.02140	1.02163	1.02179	1.02189	1.02192	1.02189	1.02180	**1.02166**	1.02147	1.02123	1.02095
1971	1.02148	1.02171	1.02187	1.02198	1.02201	1.02199	1.02190	1.02176	1.02157	1.02133	1.02106
1972	1.02155	1.02179	1.02196	1.02207	1.02211	1.02209	1.02200	1.02187	1.02168	1.02144	1.02116
1973	1.02163	1.02187	1.02205	1.02216	1.02220	1.02218	1.02211	1.02197	1.02178	1.02155	1.02127
1974	1.02170	1.02195	1.02213	1.02225	1.02230	1.02228	1.02221	1.02208	1.02189	1.02165	1.02138
1975	1.02178	1.02203	1.02222	1.02234	1.02239	1.02238	1.02231	**1.02218**	1.02200	1.02176	1.02148
1976	1.02188	1.02214	1.02233	1.02245	1.02250	1.02250	1.02243	1.02230	1.02211	1.02188	1.02160
1977	1.02199	1.02225	1.02244	1.02256	1.02262	1.02261	1.02254	1.02241	1.02223	1.02200	1.02172

Table 5.10 provides an example of the kinds of errors in estimating future incremental payments that can occur when it is assumed that PLDFs for each year of development hold constant. First, a PLDF of 1.02138 is selected as the average of the latest four historical factors during the 34th year of development (shaded in gray in Table 5.9). By comparing this selection with the true underlying trended PLDF, the percentage error in incremental payments for that development year is shown for every fifth AY. These errors assume, however, that other similar errors did not occur during preceding development years.

Table 5.10
Errors in PLDFs During 34th Year of Development
Due to Selecting a Constant Historical Average PLDF

Accident Year	Selected PLDF	True Underlying PLDF	% Error in Incremental Payments
1970	1.02138	**1.02166**	-1.3%
1975	1.02138	**1.02218**	-3.6%
1980	1.02138	1.02276	-6.1%
1985	1.02138	1.02336	-8.5%
1990	1.02138	1.02395	-10.7%
1995	1.02138	1.02452	-12.8%
2000	1.02138	1.02507	-14.7%

Though all of the errors above are small, these errors compound significantly in the calculation of tail factors, which are the product of numerous individual PLDFs.

Even though it is true that past declines in mortality rates are implicitly embedded in historical PLDFs, the above example clearly illustrates that it would be incorrect to assume that the selection of historical factors as estimates of future PLDFs would implicitly incorporate the effects of future declines in mortality rates. What would be more appropriate would be to select representative PLDFs for each development year based on recent historical factors and then to trend these upward in a manner parallel to the PLDFs indicated by a realistic model.

6. A COMPARISON OF INDICATED TAIL FACTORS

Table 6.1 provides a comparison of the MPD tails indicated by SAIF's own loss experience with those indicated by the static and trended mortality methods. This table repeats the MPD tails indicated by SAIF's experience in Table 2.6.

Table 6.1
A Comparison of Indicated MPD Tail Factors

Maturity (Years)	Based on SAIF's Experience	Based on Static Mortality Model	Based on Trended Mortality Model
10	2.469	2.684	3.025
15	2.328	2.469	2.783
25	2.054	2.019	2.271
35	1.680	1.594	1.776

As noted earlier, the indications of the static mortality model reasonably fit those from SAIF's historical loss experience—except that the model somewhat understates development for DYs 40-54.

The relative contribution of MPD versus All Other WC to the total loss reserves for a given AY is much greater if the trended mortality model is assumed. Those percentages at various maturities are shown in the last column of Table 6.2.

Table 6.2
Indicated Loss Reserve at Different Maturities
(Dollars in millions)

Maturity (Years)	MPD Reserve	Other WC Reserve	MPD Reserve as a %-age of Total WC Reserve
10	$41.3	$10.4	80%
15	39.6	9.5	81%
25	34.6	5.7	86%
35	27.0	2.5	92%

The above table is analogous to Table 2.8, which shows results based on SAIF's historical loss experience. In deriving these estimates, total AY ultimate losses of $100 million were assumed, together with a 50-50 split between MPD and Other WC. However, the $50 million figure for ultimate MPD was changed to the product of cumulative paid MPD at 10 years of development times the 10 to ultimate tail factor from the trended mortality model. That increased ultimate MPD to $61.75 million.

Table 6.3 provides a side-by-side comparison of the percentages of the total WC loss reserve attributable to MPD—as estimated using historical PLDFs and PLDFs indicated by the trended mortality model.

Table 6.3
Comparison of MPD Loss Reserve as a Percentage of the
Total WC Loss Reserve (Based on Different PLDF Assumptions)

Maturity (Years)	Indicated by Historical PLDFs	Indicated by Trended Mortality PLDFs	Percentage Increase in MPD Reserve Due to Using Trended Mortality Rates
10	$29.6	$41.3	+39.7%
15	28.3	39.6	+39.6
25	25.5	34.6	+35.8
35	20.0	27.0	+34.9

Clearly, the trended mortality model indicates MPD loss reserves that are significantly larger than straight historical experience would indicate.

7. SENSITIVITY CONSIDERATIONS

The most significant factor affecting the indications in this paper is the applicable retention. This paper presents indications on an unlimited basis. Tail factors and PLDFs at more mature years of development should be expected to be significantly less at relatively low retentions. This is evident on an a priori basis.

Consider a hypothetical PD claim injured on December 15, 2003 at age 35.9

years, with a life expectancy of 40 years. His medical costs are $5,000 during 2004, and future medical inflation is 9% per year. Indemnity losses are a flat $25,000 per year, beginning in 2004. Table 7.1 indicates what cumulative loss payments would total at the end of each of the first 41 years of development.

For this hypothetical PD claimant, net paid losses would top out by the end of the ninth year of development at a retention of $ $250,000; after 16 years with a $500,000 retention; after 26 years at a $1 million retention; and after 37 years at a $2 million retention.

While this dampening effect of retentions can obviously serve to greatly mitigate the magnitude of the applicable tail factors for different insurers and self-insureds, that effect can rapidly dissipate when retentions rise significantly from year to year. It is quite common for insurers as well as self-insureds to significantly increase retentions when faced with costs for excess coverage that have risen substantially as the market has hardened. The effect of recognizing the upward impact greater retentions will have on assumed tails can be sizeable.

Other factors that can have a material impact on MPD tail factors are:
- The assumed future rate of medical cost escalation.
- The observed tendency of medical losses to step up noticeably as a claimant nears death.
- The possibility that actual mortality rates of PD claimants might be higher (or lower) than those for the general populace.
- Variations in the gender mix and age-at-injury mix of PD claimants.

An entire paper could be devoted to quantifying the effects of changes in any or all of the above factors would have on indicated tail factors. Of the above factors, the first is the most significant. While some believe that the long term future rate of medical cost escalation will be less than the historical rate of 9%, others believe a constant 9% assumption is reasonable. Arguably, the differential between medical inflation and general inflation may lessen over future decades. However, long term general inflation may move upward as a result of shortages in critical commodities (such as petroleum) and their ubiquitous derivative products (e.g., plastics and synthetics).

We note that SAIF's actual age-at-injury distribution is weighted heavily toward the middle-age groups. If a much younger distribution were assumed, this would dramatically increase the survival probabilities during each year of development and the resulting tails would be considerably greater than those presented in this paper. The age-at-injury distribution can vary significantly depending on statutory provisions for qualification for a permanent disability award and the nature of the risks insured or self-insured.

Table 7.1
Cumulative Loss Payments for Hypothetical PD Claimant

(A) Age of Claim-Ant	(B) DY	(C) Incre-mental Medical Payments	(D) Cumu-lative Medical Payments	(E) Cumu-lative Indemnity Payments	(F) Cumu-lative Loss Payments	Effects of Retention on Development
35	1	0.0	0.0	0.0	0.0	
36	2	5.0	5.0	25.0	30.0	
37	3	5.5	10.5	50.0	60.5	
38	4	5.9	16.4	75.0	91.4	
39	5	6.5	22.9	100.0	122.9	
40	6	7.1	29.9	125.0	154.9	
41	7	7.7	37.6	150.0	187.6	
42	8	8.4	46.0	175.0	221.0	
43	9	9.1	55.1	200.0	255.1	Development Stops if Ret'n is $250K
44	10	10.0	65.1	225.0	290.1	
45	11	10.9	76.0	250.0	326.0	
46	12	11.8	87.8	275.0	362.8	
47	13	12.9	100.7	300.0	400.7	
48	14	14.1	114.8	325.0	439.8	
49	15	15.3	130.1	350.0	480.1	
50	16	16.7	146.8	375.0	521.8	Development Stops if Ret'n is $500K
51	17	18.2	165.0	400.0	565.0	
52	18	19.9	184.9	425.0	609.9	
53	19	21.6	206.5	450.0	656.5	
54	20	23.6	230.1	475.0	705.1	
55	21	25.7	255.8	500.0	755.8	
56	22	28.0	283.8	525.0	808.8	
57	23	30.5	314.4	550.0	864.4	
58	24	33.3	347.7	575.0	922.7	
59	25	36.3	383.9	600.0	983.9	
60	26	39.6	423.5	625.0	1,048.5	Development Stops if Ret'n is $1,000K
61	27	43.1	466.6	650.0	1,116.6	
62	28	47.0	513.6	675.0	1,188.6	
63	29	51.2	564.8	700.0	1,264.8	
64	30	55.8	620.7	725.0	1,345.7	
65	31	60.9	681.5	750.0	1,431.5	
66	32	66.3	747.9	775.0	1,522.9	
67	33	72.3	820.2	800.0	1,620.2	
68	34	78.8	899.0	825.0	1,724.0	
69	35	85.9	984.9	850.0	1,834.9	
70	36	93.6	1,078.6	875.0	1,953.6	
71	37	102.1	1,180.6	900.0	2,080.6	Development Stops if Ret'n is $2,000K
72	38	111.3	1,291.9	925.0	2,216.9	
73	39	121.3	1,413.1	950.0	2,363.1	
74	40	132.2	1,545.3	975.0	2,520.3	
75	41	144.1	1,689.4	1,000.0	2,689.4	

In the static mortality model, we started with the assumption of a beginning gender mix of 75% male and 25% female. Because of the higher mortality rates of males at all ages, by the 50th year of development, the percentage of surviving claimants that are male is expected to drop to 64.5%. By the 72nd year of development, a 50-50 gender split is expected.

8. ESTIMATING THE EXPECTED VALUE OF MPD RESERVES

In Table 7.1 cumulative loss payments for a hypothetical PD claimant are displayed. This might be a profile of paid losses for a male claimant injured on December 15, the reserve evaluation date. At age 35.9, the claimant is expected to live another 40 years. Two different methods of estimating the ***medical*** ***case reserve*** for this claimant at the end of the first year of development are common. They are:

1. **First Method:** *Zero Inflation Case Reserve Based on Projected Payments Through Expected Year of Death*. Estimated annual medical expenses of $5,000 per year (during the first full year of development) are multiplied by the life expectancy of 40 years to obtain a case reserve of $200,000.
2. **Second Method:** 9*% Inflation Case Reserve Based on Projected Payments Through Expected Year of Death*. Escalating medical expenses are cumulated up through age 75, yielding a total incurred of $1,689,000.

Two additional methods may also be applied. Each of these produces much higher, and more accurate, estimates of the expected value of the case reserve:

3. **Third Method:** *Expected Total Payout over Scenarios of All Possible Years of Death*. This method, described below, yields an expected reserve of $2,879,000.
4. **Fourth Method:** *Expected Value of Trials from a Markov Chain Simulation.* This method, described in Section 9, yields an expected reserve of $2,854,000.

In applying the third method, cumulative payments are calculated through each possible future year of death. Each of these estimates represents the scenario of the claimant's death during a specific (n-th) year of development. The probability of occurrence of the n-th scenario is the product of the probability the claimant will live through all prior years of development, and then die during the n-th year of development. The expected value of the case reserve is then the weighted average of all of these estimates of final cumulative payments, weighted by their associated probability of occurrence. In this example, the expected value of total incurred is $2,879,000, which is 70.5% higher than the second estimate. This kind of estimate is not customarily calculated for PD claimants. Yet it is in keeping with the standard definition of the expected value of total incurred.

The total case reserve based on this third approach is dramatically higher than that derived from the second approach because the cumulative paid amounts associated with death at ages beyond the claimant's expected year of death are given more weight—due to the compounding effects of medical cost escalation.

In Tables 8.1a and 8.1b the medical case reserve for the hypothetical PD claimant is calculated for the second and third methods. For the second method, Projected Payments Through Expected Year of Death, the cumulative payments from Column (F) at the end of the expected year of death (at age 75), yields the estimate of $1,689,000.

For the third method, each row is treated as a different scenario, with its probability of occurrence shown in Column (C). These probabilities are the weights applied to the estimates of cumulative medical payments in Column (F) to obtain the components of the expected total payout in Column (G) that are cumulated in Column (H). Hence, the expected value of the case reserve is the bottom number in Column (H) in Table 8.1b ($2,879,000).

The distribution of deaths by age of death (Column (C)) would be the same as the distribution of the different scenarios for the *indemnity* case reserve, since incremental indemnity payments are not subject to inflation. Figure 8.1 illustrates the shift in the distribution of the different scenarios for the *medical* case reserve (Column (I) decumulated, or Column (G)/(Total of Column (G))—due to the effects of compounding medical cost escalation in giving more dollar weight to scenarios where the claimant lives beyond his expected year of death.

The impact of medical cost escalation shifts the median age of death (and of total indemnity payments) from 77 to 87 (for total medical payments), or ten years. This can be seen by comparing the age corresponding to a cumulative probability of 50% in Column (D) to the age when Column (I) reaches 50%. To further appreciate the significance of this shift, consider the following observations drawn from Table 8.1b:

- While 83% of such claimants die before they reach the age of 87, medical payments to claimants who live beyond 86 years of age account for over half of total expected future medical payments.
- While 90% of such claimants die before they reach the age of 90, medical payments to claimants who live beyond 89 years of age account for over 30% of total expected medical losses.

The ratio of the estimated case reserve based on the second method to that from the first method varies dramatically with the age of the claimant at the reserve date. It is also dependent on gender. This is also true, though to a lesser degree, for the ratio of the third method case reserve to the second method reserve. These ratios are displayed in Table 8.2.

Table 8.1a
Calculation of Case Reserve by Second and Third Methods
Male Claimant, Age 35.9 at Reserve Date, 9% Future Inflation Assumed

	(A)	(B)	(C) Probability of Dying at Age x (B)/(A)@36	(D) Cumulative Probability of Dying at Age x	(E) Incre-mental Medical Paid	(F) Cumu-lative Medical Paid	(G) Expected Total Payout (C) x (G)	(H) Cumulative Expected Total Payout	(I) % of Expected Total Payout
Age	l(x)	d(x)							
36	96023	198	0.00206	0.206%	5	5	0.01	0.01	0.000%
37	95825	209	0.00218	0.424%	5	10	0.02	0.03	0.001%
38	95616	225	0.00234	0.658%	6	16	0.04	0.07	0.003%
39	95391	241	0.00251	0.909%	6	23	0.06	0.13	0.005%
40	95150	260	0.00271	1.180%	7	30	0.08	0.21	0.007%
41	94890	279	0.00291	1.470%	8	38	0.11	0.32	0.011%
42	94611	300	0.00312	1.783%	8	46	0.14	0.46	0.016%
43	94311	321	0.00334	2.117%	9	55	0.18	0.65	0.023%
44	93990	343	0.00357	2.474%	10	65	0.23	0.9	0.031%
45	93647	368	0.00383	2.858%	11	76	0.29	1.2	0.041%
46	93279	395	0.00411	3.269%	12	88	0.36	1.5	0.054%
47	92884	422	0.00439	3.708%	13	101	0.44	2.0	0.069%
48	92462	448	0.00467	4.175%	14	115	0.54	2.5	0.088%
49	92014	477	0.00497	4.672%	15	130	0.65	3.2	0.111%
50	91537	508	0.00529	5.201%	17	147	0.78	3.9	0.138%
51	91029	544	0.00567	5.767%	18	165	0.9	4.9	0.171%
52	90485	583	0.00607	6.375%	20	185	1.1	6.0	0.210%
53	89902	629	0.00655	7.030%	22	207	1.4	7.3	0.257%
54	89273	679	0.00707	7.737%	24	230	1.6	9	0.314%
55	88594	735	0.00765	8.502%	26	256	2.0	11	0.383%
56	87859	797	0.00830	9.332%	28	284	2.4	13	0.466%
57	87062	865	0.00901	10.233%	31	314	2.8	16	0.565%
58	86197	936	0.00975	11.208%	33	348	3.4	20	0.684%
59	85261	1014	0.01056	12.264%	36	384	4.1	24	0.826%
60	84247	1096	0.01141	13.405%	40	424	4.8	28	0.995%
61	83151	1184	0.01233	14.638%	43	467	5.8	34	1.197%
62	81967	1287	0.01340	15.978%	47	514	6.9	41	1.438%
63	80680	1405	0.01463	17.442%	51	565	8.3	49	1.728%
64	79275	1532	0.01595	19.037%	56	621	10	59	2.075%
65	77743	1669	0.01738	20.775%	61	682	12	71	2.490%
66	76074	1803	0.01878	22.653%	66	748	14	85	2.982%
67	74271	1923	0.02003	24.656%	72	820	16	102	3.558%
68	72348	2023	0.02107	26.762%	79	899	19	120	4.222%
69	70325	2109	0.02196	28.959%	86	985	22	142	4.980%
70	68216	2203	0.02294	31.253%	94	1,079	25	167	5.847%
71	66013	2305	0.02400	33.653%	102	1,181	28	195	6.840%
72	63708	2407	0.02507	36.160%	111	1,292	32	228	7.903%

Table 8.1b
Calculation of Case Reserve by Second and Third Methods
### Male Claimant, Age 35.9 at Reserve Date, 9% Future Inflation Assumed

	(A)	(B)	(C) Probability of Dying at Age x (B)/(A)@36	(D) Cumulative Probability of Dying at Age x	(E) Incre-mental Medical Paid	(F) Cumu-lative Medical Paid	(G) Expected Total Payout (C) x (G)	(H) Cumulative Expected Total Payout	(I) % of Expected Total Payout
Age	l(x)	d(x)							
73	61301	2504	0.02608	38.768%	121	1,413	37	264	9.182%
74	58797	2603	0.02711	41.479%	132	1,545	42	306	10.637%
75	56194	2704	0.02816	44.295%	144	1,689	48	354	12.289%
76	53490	2808	0.02924	47.219%	157	1,846	54	408	14.164%
77	50682	2915	0.03036	50.255%	171	2,018	61	469	16.292%
78	47767	3021	0.03146	53.401%	187	2,204	69	538	18.700%
79	44746	3119	0.03248	56.649%	203	2,408	78	617	21.416%
80	41627	3199	0.03331	59.980%	222	2,629	88	704	24.458%
81	38428	3253	0.03388	63.368%	242	2,871	97	802	27.836%
82	35175	3281	0.03417	66.785%	263	3,134	107	909	31.555%
83	31894	3276	0.03412	70.197%	287	3,421	117	1,025	35.609%
84	28618	3232	0.03366	73.563%	313	3,734	126	1,151	39.974%
85	25386	3147	0.03277	76.840%	341	4,075	134	1,285	44.612%
86	22239	3020	0.03145	79.985%	372	4,447	140	1,424	49.470%
87	19219	2852	0.02970	82.955%	405	4,852	144	1,569	54.475%
88	16367	2649	0.02759	85.714%	442	5,294	146	1,715	59.547%
89	13718	2414	0.02514	88.228%	481	5,776	145	1,860	64.589%
90	11304	2159	0.02248	90.476%	525	6,300	142	2,002	69.509%
91	9145	1890	0.01968	92.445%	572	6,873	135	2,137	74.207%
92	7255	1619	0.01686	94.131%	624	7,496	126	2,263	78.596%
93	5636	1355	0.01411	95.542%	680	8,176	115	2,379	82.603%
94	4281	1106	0.01152	96.694%	741	8,916	103	2,481	86.169%
95	3175	878	0.00914	97.608%	807	9,724	89	2,570	89.257%
96	2297	676	0.00704	98.312%	880	10,604	75	2,645	91.850%
97	1621	506	0.00527	98.839%	959	11,563	61	2,706	93.966%
98	1115	367	0.00382	99.221%	1,046	12,609	48	2,754	95.639%
99	748	258	0.00269	99.490%	1,140	13,749	37	2,791	96.922%
100	490	178	0.00185	99.675%	1,242	14,991	28	2,819	97.888%
101	312	119	0.00124	99.799%	1,354	16,346	20	2,839	98.591%
102	193	77	0.00080	99.879%	1,476	17,822	14	2,853	99.087%
103	116	49	0.00051	99.930%	1,609	19,431	10	2,863	99.432%
104	67	29	0.00030	99.960%	1,754	21,185	6	2,870	99.654%
105	38	18	0.00019	99.979%	1,912	23,096	4	2,874	99.804%
106	20	10	0.00010	99.990%	2,084	25,180	3	2,876	99.895%
107	10	5	0.00005	99.995%	2,271	27,451	1	2,878	99.945%
108	5	4	0.00004	99.999%	2,476	29,927	1	2,879	99.988%
109	1	1	0.00001	100.000%	2,698	32,625	0	2,879	100.00%

Figure 8.1

Deaths and Expected Payouts by Age
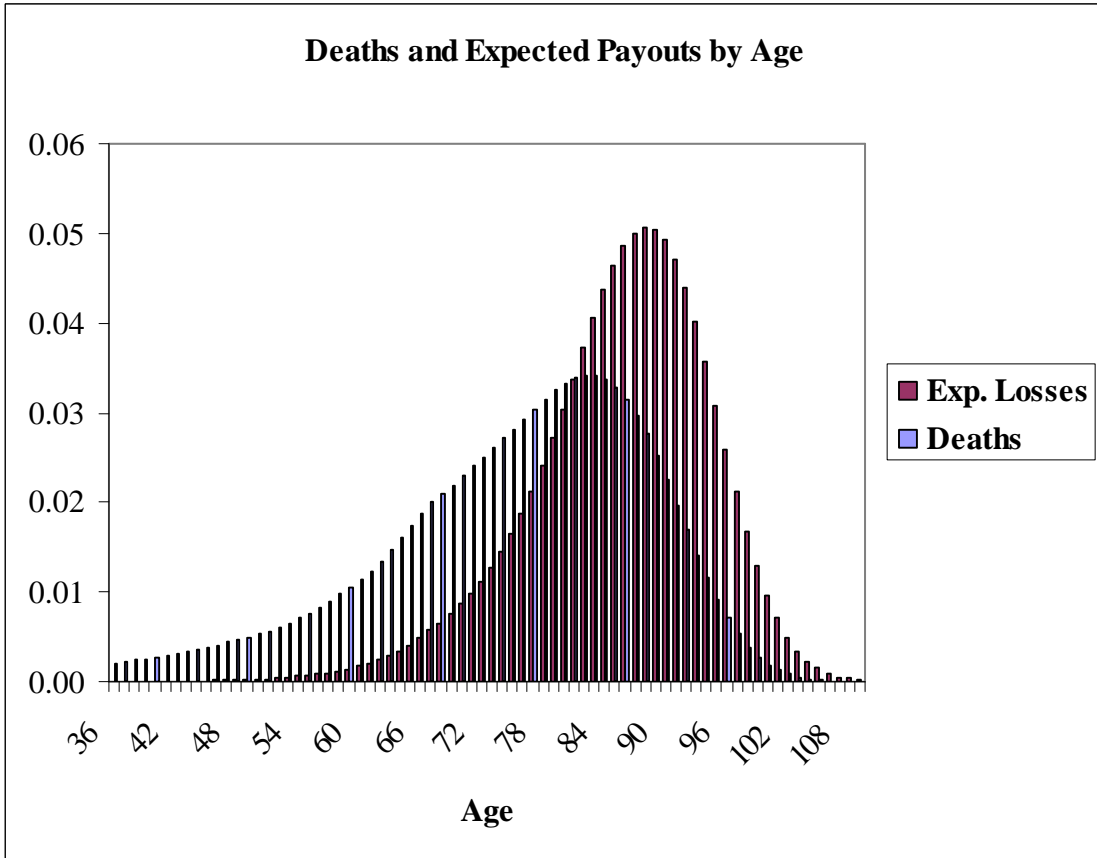
There are a number of reasons to believe that the reserve estimates produced by the static mortality model presented in Section 3 are analogous to estimates produced by the second method. If that is true, then it would be necessary to multiply reserve estimates based on the static mortality model by some weighted average of the ratios in Column (E) of Table 8.2 to arrive at an estimated reserve at the expected level. Whether that ratio is 1.25 or 1.40 or 1.55, it represents a substantial add-on to a reserve estimate that is likely higher than what would be obtained using more traditional methods.

Why are reserve estimates based on the static mortality model similar to those produced by the second method? A fundamental assumption of the model is that all claimants die according to a schedule dictated by current mortality tables. When an expected value of the reserve is calculated, it is based on a weighted average of a full range of scenarios, including those where many claimants die earlier than plan and others die later. Total future payments for those claimants that die later will be given more dollar weight. Hence, the expected value of the reserve will be correspondingly greater than that projected by the static mortality model.

Table 8.2

Comparison of Different Types of MPD Reserve Estimates

Assuming SSA 2000 Male & Female Mortality Tables and 9% Medical Cost Escalation

	(A)	(B)	(C)	(D)	(E)
	Reserve ($000's) at Eval. Date				
				Ratio of	Ratio of
	First	Second	Third	Second	Third
	Method	Method	Method	Method	Method
	(Zero	(9%	(Total	Reserve	Reserve
Age at	Inflation	Inflation	Expected	to First	to Second
Reserve	Case	Case	Future	Method	Method
Date	Reserve)	Reserve)	Payout)	Reserve	Reserve
Male Claimants					
20	273.7	7,333.9	11,318.1	26.795	1.543
30	227.3	2,989.5	4,816.3	13.155	1.611
40	181.2	1,321.0	2,042.3	7.290	1.546
50	137.3	590.0	864.0	4.298	1.464
60	96.7	265.3	362.9	2.744	1.368
70	62.9	123.5	153.2	1.965	1.240
80	36.0	57.1	63.4	1.587	1.110
Female Claimants					
20	301.0	10,796.0	16,724.2	35.867	1.549
30	252.4	4,641.7	7,069.1	18.390	1.523
40	204.7	2,005.7	2,983.6	9.800	1.488
50	158.4	873.8	1,254.5	5.516	1.436
60	115.1	384.3	524.0	3.341	1.363
70	77.0	165.0	217.3	2.144	1.317
80	45.2	76.3	87.2	1.690	1.142

9. ESTIMATING THE VARIABILITY OF THE MPD RESERVE WITH A MARKOV CHAIN SIMULATION

The size of loss distribution for the medical component of a single PD claim is far more skewed to the right than can be modeled by distributions commonly used by casualty actuaries. This distribution can be described by the ultimate costs in Column (F) of Tables 8.a and 8.b, with the associated confidence levels taken from Column (D). In attempting to find a distribution that produced a reasonable fit, it was necessary to first transform the ultimate cost amounts by taking the natural log of the natural log of the natural log and then taking the n-th root—before a common distribution could be found. Taking the fifth root of the triple natural log appears to produce a distribution of ultimate costs that conforms well with an extreme value distribution. The fact that such intense

transformations were needed suggests that a totally different approach than fitting commonly used distributions should be used.

As is indicated from Table 8.2, the ratio of the Expected Value of the individual case reserve to the Projected Payments Through Expected Year of Death estimate varies dramatically according to the gender and current age of each claimant. This suggests that the variability of the total MPD reserve can best be modeled by simulating the variability of the future payout for each claim separately. Table 9.1 provides a sample framework for this type of simulation. The example insurer has ten open PD claims.

Table 9.1
Layout for Simulation of Variability of Total MPD Reserve at Year-End 2003

Claim Num-ber	Gen-der	Cur-rent Age	Projected Annual Medical Costs ($000's) During:										Total Future Medical Payments
			2004	2005	2006	...	2038	2039	2040	...	2068	2069	2070	
1	F	75	3.2	3.5	3.8		0	0	0		0	0	0	10.5
2	F	47	5.6	6.1	6.7		105	114	125		0	0	0	2,354.8
3	M	22	1.9	2.1	2.3		35.6	38.8	42.2		472	515	0	6,211.4
4	M	46	0.7	0.8	0.8		13.1	14.3	15.6		0	0	0	312.1
5	M	55	12.7	13.8	15.1		0	0	0		0	0	0	181.4
6	F	82	6.3	6.9	7.5		0	0	0		0	0	0	55.2
7	M	66	8.1	8.8	9.6		0	0	0		0	0	0	99.7
8	M	34	1.2	1.3	1.4		22.5	24.5	26.7		0	0	0	443.8
9	F	57	4.4	4.8	5.2		82.4	0	0		0	0	0	949.1
10	M	71	3.6	3.9	4.3		67.4	73.5	80.1		0	0	0	1,468.3
												Total:		12,086.3

An individual row in Table 9.1 is devoted to each open claim. Census data on the gender and current age of each living PD claimants appears in two columns on the left side of the table. Consider claim number 1 in the top row. Actual medical payments in 2003 were $3,000. A random number between 0 and 1 is generated. If that number is between 0 and q_{75}, the claimant dies during 2004. If the random number is greater than q_{75}, the claimant lives throughout 2004.

In effect, in Table 9.1, projected annual medical costs for each future year are estimated via a Markov chain simulation model. The state space consists of two outcomes from each trial: 1) the claimant does not die during a given future DY; or 2) the claimant dies during that DY. The transition probabilities in this model are simply the $(1 - q_x)$ and q_x values from a mortality table. The outcome of any trial depends at most upon the outcome of the immediately preceding trial and not upon any other previous outcome. Death is an "absorbing" state, since one cannot transition out of it.

An assumed rate of medical cost escalation of 9% per year is applied to the prior year's payments if the claimant lives throughout the year. Otherwise, if the claimant dies

during the year, projected medical payments for the year are still shown, after which medical losses drop to zero for every future year of development. While projected medical payments may arguably be only for half a year, assuming the average claimant dies in the middle of the final year of development, in reality medical costs are often higher during the year of death. So assuming a full year's worth of medical payments is a reasonable assumption.

For each trial, total projected future payments from the cell at the bottom right are recorded and confidence levels for the reserve can be derived from a ranking of all of the simulated total reserve estimates. If this is done for a single claim, the resulting probability distribution closely conforms to that described in the first paragraph of this section.

Simulating the variability of the MPD reserve for unreported claims is naturally more complicated. First, the total number of IBNR claims should be represented by a Poisson (or similar) distribution. Then census data of the age at injury of recent claimants can be used to randomly generate these ages for unreported claimants. Then additional rows can be added to Table 9.1 to further simulate future payments for each unreported claimant. The degree of variability of the MPD reserve for unreported claimants is exceptionally high—because some of those claimants may have been quite young when injured, and the total expected future payment for workers injured at a young age is dramatically higher than for those injured at an older age. An appreciation for this can be gained by reviewing either Columns (B) or (C) of Table 8.2. For example, the total expected future payout for a female who is 20 at the reserve date is $16.7 million, while it is only $3.0 million if she is 40.

10. CONCLUDING REMARKS

In this paper we have seen that common actuarial methods will tend to underestimate the true MPD loss reserve. This is also the case for typical methods of estimating MPD reserves at higher confidence levels—based on commonly used size-of-loss distributions. The need to develop and apply new methods that directly reflect the characteristics of MPD payments is substantial.

REFERENCES

[1] Blumsohn, Gary, "Levels of Determinism in Workers' Compensation Reinsurance Commutations", *Proceedings of the Casualty Actuarial Society,* 1999 Vol. LXXXVI, Part I, pp. 1 – 79.

[2] Sherman, Richard E., "Extrapolating, Smoothing and Interpolating Development Factors", *Proceedings of the Casualty Actuarial Society,* 1984 Vol: LXXI pp. 122-155

[3] Workers' Compensation Insurance Rating Bureau of California Bulletin No. 2003-24, p. 1-38.

[4] Fisher, W.H.; and Lange, J.T., "Loss Reserve Testing: A Report Year Approach," *PCAS* LX, 1973, pp. 189-207

[5] Adler, M.; and Kline, C.D. Jr., "Evaluating Bodily Injury Liabilities Using a Claims Closure Model," *Evaluating Insurance Company Liabilities*, Casualty Actuarial Society *Discussion Paper Program*, 1988, pp. 1-66

[6] Gillam, William R., "Injured Worker Mortality", *Casualty Actuarial Society Forum,* Winter 1991, pp.89-114.

[7] Venter, Gary G., Schill, Barbara, and Barnett, Jack, "Review of Report of Committee on Mortality for Disabled Lives", *Casualty Actuarial Society Forum,* Winter 1991, pp.115-137.

APPENDIX A
THE MUELLER INCREMENTAL TAIL (MIT) METHOD

The MIT method calculates tail factors based of cumulative paid loss development triangles augmented by incremental calendar year payments from older accident years.

The method was described in Section 2 of the paper as consisting of three stages:

1 Incremental age-to-age factors
2 Anchored decay factors
3 Tail factors

This appendix provides more specifics regarding the first two stages.

1. **Incremental age-to-age factors.** The first step is to calculate incremental age to age factors. With the SAIF data, we can calculate incremental paid at age (n+1) to incremental paid at age (n) for n ranging from 29 to 57 years, using twenty-year weighted averages.

Tables A.1 through A.3 display incremental MPD payments for DYs 29 through 40, 40 through 50, and 50 through 60 respectively.

Because the underlying data for any individual accident year is volatile, the age to age factors were smoothed using centered moving averages. The empirical age to age decay factors and smoothed factors are shown in Table A.4.

The empirical factors are calculated directly from the raw data. The centered average is a simple five year average based on the empirical factor averaged with the two factors above and the two below. When it was not possible to calculate a five year average, shorter term centered averages were used.

The weighted average is similar but uses corresponding paid losses as weights. The geometric mean provides another level of smoothing. It is also a five year centered average, but it is the fifth root of the product of the five weighted average factors.

2. **Anchored decay factors.** After selecting the geometric mean incremental age to age factors, they are then anchored to a base year. Table A.5 shows the anchored decay factors using five different anchor years. The anchored decay factors represent incremental payments made in year n relative to payments made in the anchor year.

Table A.1
Derivation of Incremental Age-to-Age Decay Factors for DYs 30 to 40

AY	Incremental Payments ($000's) During Development Year X:											
	29	30	31	32	33	34	35	36	37	38	39	40
1943												4
1944											1	3
1945										16	14	20
1946									1	11	19	5
1947								0	0	3	1	5
1948							7	3	9	16	6	17
1949						49	27	52	29	12	15	48
1950					16	28	20	26	8	30	16	22
1951				17	16	5	7	6	16	6	2	11
1952			4	3	16	11	9	26	32	16	62	9
1953		32	21	14	17	16	28	11	11	9	31	17
1954	54	43	48	59	80	52	109	44	65	81	59	63
1955	25	16	20	14	13	26	33	8	41	22	12	14
1956	45	66	35	68	44	48	24	68	17	40	36	13
1957	53	57	51	35	21	20	39	60	38	36	79	51
1958	26	30	29	33	23	24	30	14	9	75	7	4
1959	110	138	75	81	81	195	122	161	127	148	116	84
1960	47	89	56	71	107	94	69	46	30	26	89	203
1961	97	97	146	118	140	105	101	109	91	121	81	95
1962	96	80	60	46	55	114	57	23	85	108	64	118
1963	82	239	84	81	82	101	85	47	48	36	56	46
1964	465	177	210	178	28	65	106	34	36	55	168	
1965	143	123	107	191	150	153	53	75	69	93		
A) Sum x 1st:		1155	943	994	874	1056	919	812	762	942	933	847
B) Sum Prior x Last:		1241	1187	947	1011	890	1105	926	812	763	865	766
C) Indicated Decay Ratios:		0.931	0.794	1.050	0.864	1.187	0.832	0.877	0.938	1.235	1.079	1.106
D) Selected Decay Ratios:	0.930	0.933	0.937	0.937	0.953	0.958	0.980	1.001	1.048	1.063	1.088	
PLDF - 1.0:	0.025	0.030	0.028	0.026	0.025	0.023	0.023	0.022	0.022	0.023	0.022	0.021
PLDF:	1.025	1.030	1.028	1.026	1.025	1.023	1.023	1.022	1.022	1.023	1.022	1.021
Model:	1.024	1.024	1.024	1.024	1.024	1.024	1.024	1.023	1.023	1.022	1.022	1.021

Notes:
1) The selected decay ratios were derived in Table A.4. See last column.
2) The PLDFs for DYs 29-37 were derived in Table A.6. See Row I).
3) The (PLDF - 1.0)'s for ages 38 through 40 were computed as the product of the previous (PLDF - 1.0) and the current decay ratio, divided by the prior PLDF.

.

Table A.2
Derivation of Incremental Age-to-Age Decay Factors for DYs 40 to 50

AY	Incremental Payments ($000's) During Development Year X:										
	40	41	42	43	44	45	46	47	48	49	50
1933											2
1934										2	0
1935									1	4	14
1936								15	0	3	5
1937							0	4	0	1	0
1938						0	0	1	1	0	2
1939					0	3	0	1	0	0	0
1940				1	2	1	3	0	0	4	0
1941			4	1	1	0	0	0	0	0	1
1942		0	7	8	3	1	16	2	0	2	0
1943	4	1	11	4	3	2	4	1	6	7	8
1944	3	3	6	2	1	3	1	1	0	0	0
1945	20	24	17	14	6	15	(1)	50	73	75	63
1946	5	5	(5)	4	9	4	2	30	31	29	31
1947	5	(2)	0	4	0	32	0	0	0	3	5
1948	17	7	2	1	1	12	0	6	7	14	3
1949	48	42	17	9	39	7	20	41	83	225	116
1950	22	18	43	24	11	165	71	9	2	4	1
1951	11	32	12	13	6	4	23	26	19	10	18
1952	9	48	7	7	170	44	12	1	1	22	1
1953	17	10	7	23	13	18	37	15	43	70	68
1954	63	83	49	67	70	142	67	62	96	101	
1955	14	21	26	28	26	21	67	15	13		
1956	13	9	15	21	35	17	8	33			
1957	51	66	367	116	51	28	94				
1958	4	10	19	32	41	21					
1959	84	93	88	83	87						
1960	203	133	181	230							
1961	95	74	158								
1962	118	105									
1963	46										
Sum x 1st:	782	1027	691	575	540	424	298	375	574	336	
Sum Prior x Last:	806	677	873	462	488	519	330	280	363	475	
Indicated Decay Ratios:	0.970	1.517	0.792	1.245	1.107	0.817	0.903	1.339	1.581	0.707	
Selected Decay Ratios:	1.098	1.101	1.056	1.054	1.058	1.044	1.031	1.047	1.023	0.946	
PLDF - 1.0:	0.025	0.027	0.029	0.029	0.030	0.031	0.031	0.031	0.032	0.032	0.029
PLDF:	1.025	1.027	1.029	1.029	1.030	1.031	1.031	1.031	1.032	1.032	1.029
Model:	1.021	1.021	1.020	1.020	1.019	1.019	1.018	1.017	1.017	1.016	1.015

Notes: 1) The selected decay ratios were derived in Table A.4. See last column.
2) The (PLDF - 1.0)'s for ages 40 through 50 were computed as the product of the
previous (PLDF - 1.0) and the current decay ratio, divided by the prior PLDF.

Table A.3
Derivation of Incremental Age-to-Age Decay Factors for DYs 50 to 60

AY	Incremental Payments During Development Year X:										
	50	51	52	53	54	55	56	57	58	59	60
1926								0	3	0	0
1927							0	0	2	0	0
1928						0	0	0	0	0	15
1929					9	5	1	4	0	0	0
1930				0	0	0	0	0	0	0	0
1931			0	0	0	0	0	0	0	0	0
1932		0	0	0	0	0	0	0	0	0	0
1933	2	0	0	0	0	0	0	0	0	0	0
1934	0	0	0	0	0	0	0	0	0	0	0
1935	14	4	0	1	0	0	0	9	0	0	1
1936	5	2	7	1	0	0	0	0	0	0	4
1937	0	0	15	13	0	0	0	0	0	0	0
1938	2	10	0	3	4	0	0	1	0	0	0
1939	0	0	0	0	0	0	0	0	0	0	0
1940	0	0	0	0	0	0	0	0	0	0	0
1941	1	1	0	1	5	4	10	37	9	0	0
1942	0	0	1	1	0	0	0	0	0	0	0
1943	8	2	7	8	3	1	0	0	10	0	0
1944	0	0	0	0	0	1	3	1	4	2	
1945	63	63	48	43	35	34	71	11	6		
1946	31	32	7	14	23	6	1	2			
1947	5	0	0	4	0	1	0				
1948	3	0	4	0	35	5					
1949	116	5	8	1	0						
1950	1	3		2							
1951	18	44	32								
1952	1	1									
1953	68										

	50	51	52	53	54	55	56	57	58	59	60
Sum x 1st:	167	129	92	105	57	86	65	34	2	20	
Sum Prior x Last:	270	166	97	90	114	52	86	63	28	0	
Indicated Decay Ratios:	0.619	0.777	0.948	1.167	0.500	1.654	0.756	0.540	0.071		
Selected Decay Ratios:	0.888	0.868	0.850	0.851	0.919	1.002	1.067	1.151			
PLDF - 1.0:	0.029	0.025	0.021	0.018	0.015	0.013	0.013	0.014	0.016		
PLDF:	1.029	1.025	1.021	1.018	1.015	1.013	1.013	1.014	1.016		
Model:	1.015	1.015	1.014	1.013	1.013	1.012	1.011	1.010	1.010		

Notes: 1) The selected decay ratios were derived in Table A.4. See last column.

2) The (PLDF - 1.0)'s for ages 50 through 58 were computed as the product of the previous (PLDF - 1.0) and the current decay ratio, divided by the prior PLDF.

Table A.4
Calculation of Age to Age Decay Factors

Age to Age	Empirical	Centered Average	Weighted Average	Geometric Mean
58+	1.151	1.151	1.151	1.151
57/56	0.744	1.186	1.108	1.067
56/55	1.661	1.046	0.952	1.002
55/54	0.502	1.001	0.918	0.919
54/53	1.171	1.011	0.907	0.851
53/52	0.928	0.801	0.745	0.850
52/51	0.792	0.843	0.756	0.868
51/50	0.610	0.924	0.946	0.888
50/49	0.712	1.008	1.019	0.946
49/48	1.579	1.028	1.016	1.023
48/47	1.345	1.070	1.022	1.047
47/46	0.892	1.149	1.117	1.031
46/45	0.824	1.081	1.063	1.044
45/44	1.107	0.971	0.946	1.058
44/43	1.237	1.096	1.080	1.054
43/42	0.793	1.125	1.093	1.056
42/41	1.516	1.125	1.094	1.101
41/40	0.970	1.093	1.074	1.098
40/39	1.108	1.182	1.169	1.088
39/38	1.079	1.066	1.064	1.063
38/37	1.235	1.047	1.040	1.048
37/36	0.939	0.992	0.977	1.001
36/35	0.877	1.014	0.999	0.980
35/34	0.832	0.940	0.932	0.958
34/33	1.186	0.962	0.954	0.953
33/32	0.864	0.945	0.931	0.937
32/31	1.049	0.965	0.952	0.937
31/30	0.795	0.925	0.916	0.933
30/29	0.930	0.930	0.930	0.930

For example – payments made in year of development 50 are 88.0% greater than the payments made in year 37 etc. The main reason that payments rise over time is because the force of medical cost escalation exceeds the force of mortality—until most of the claimants are fairly advanced in age, when the force of mortality becomes stronger than the force of medical cost escalation.

By summing the decay factors from 38 to 65, we get the payments made in age 38 to 65 relative to the payments made in the selected anchor year. The sums of the decay factors are similar to tail factors, but instead of being relative to cumulative payments they are relative to the incremental payments made in given anchor year.

The cumulative decay factors can be interpreted as follows: Payments made in ages 38 to 65 are 30.071 times the payments made in age 37. Similarly, payments made in ages 38 to 65 are 26.961 times the payments made in age 33 etc.

Table A.5
Anchored Decay Factors

Year of Development	Anchor Year				
	37	36	35	34	33
> 57	1.184	1.186	1.162	1.113	1.062
57	1.028	1.030	1.009	0.967	0.922
56	0.964	0.966	0.946	0.907	0.864
55	0.962	0.964	0.944	0.905	0.863
54	1.047	1.049	1.028	0.985	0.939
53	1.231	1.233	1.208	1.158	1.104
52	1.448	1.450	1.421	1.362	1.298
51	1.669	1.671	1.637	1.569	1.496
50	1.880	1.882	1.844	1.768	1.685
49	1.987	1.990	1.950	1.869	1.782
48	1.943	1.946	1.907	1.827	1.742
47	1.856	1.859	1.821	1.746	1.664
46	1.800	1.803	1.766	1.693	1.614
45	1.724	1.727	1.692	1.622	1.546
44	1.630	1.633	1.600	1.533	1.462
43	1.547	1.550	1.518	1.455	1.387
42	1.466	1.468	1.438	1.378	1.314
41	1.331	1.332	1.306	1.251	1.193
40	1.211	1.213	1.189	1.139	1.086
39	1.114	1.116	1.093	1.048	0.999
38	1.048	1.049	1.028	0.985	0.939
37	1.000	1.001	0.981	0.940	0.897
36		1.000	0.980	0.939	0.895
35			1.000	0.958	0.914
34				1.000	0.953
33					1.000
Totals (38 to ultimate)	30.071	30.115	29.508	28.280	26.961
Relative to anchor year	37	36	35	34	33

Because this approach produces volatile indicated tail factors, Table A.6 presents an approach for stabilizing those indications (see Table 2.6). Each of the average PLDFs for ages 30 through 36 are adjusted to what they would be for age 37—using the appropriate products of incremental decay factors from AYs 1965 and prior. A weighted average of all of these adjusted PLDFs is then used to replace the actual PLDF for DY 37. In this way, the PLDF for DY 37 is changed from being entirely determined by only one

historical PLDF for one AY, to being an indication based on all 36 PLDFs for DYs 30 through 37. This results in a reduction of the PLDF for anchor year 37 from 1.0331 to 1.022. The final selected tail factor from age 37 to 65 is then the product of 0.022/1.022 and the cumulative decay factor of 30.071 and .022/1.022 (= 1.634).

Table A.6
Using the Mueller Incremental Tail Method to Produce
a More Stable Estimate of the PLDF for Anchor Year 37

AY	29	30	31	32	33	34	35	36	37
1966	1.015	1.025	1.020	1.017	1.021	1.017	1.026	1.027	1.033
1967	1.019	1.030	1.026	1.026	1.023	1.025	1.025	1.030	
1968	1.013	1.009	1.006	1.004	1.003	1.003	1.004		
1969	1.018	1.017	1.019	1.021	1.013	1.023			
1970	1.017	1.016	1.030	1.013	1.017				
1971	1.014	1.040	1.040	1.026					
1972	1.036	1.021	1.015						
1973	1.042	1.037							
1974	1.025								
A) Average	1.022	1.024	1.023	1.018	1.015	1.017	1.018	1.029	1.033
B) Avg. - 1.0	0.022	0.024	0.023	0.018	0.015	0.017	0.018	0.029	0.033
C) Decay Ratios		0.930	0.933	0.937	0.937	0.953	0.958	0.980	1.001
D) Adjustment Factor to Age 37		0.734	0.787	0.840	0.897	0.940	0.981	1.001	1.000
E) B) Adjusted to Age 37	0.018	0.018	0.015	0.014	0.016	0.018	0.029	0.033	
F) Weights for E)		5%	5%	10%	10%	15%	15%	20%	20%
G) Weighted Avg. of E)									0.022
H) Revised B)		0.030	0.028	0.026	0.025	0.023	0.023	0.022	0.022
I) Revised PLDFs		1.030	1.028	1.026	1.025	1.023	1.023	1.022	**1.022**

Notes: C) From Table A.4, Last Column.
                    D) Product of all decay ratios to the right of given age.
                    E) B) x D).
                    H) G) / D).

Once the best estimate of the PLDF for the anchor year (DY 37) is selected, then all of the subsequent PLDFs can be easily generated using the iterative formula:

$$f_{n+1} = f_n \, d_{n+1}/[1 + f_n],$$

where f_n is the paid loss development factor, less one, for the nth year of development, and d_{n+1} is the decay ratio between incremental paid during year (n+1) and year (n).

Figure 1.1 provides a comparison between SAIF's indicated PLDFs and those based on the static mortality model presented in Section 3 and Appendix C of this paper. The indicated PLDFs for the more mature DYs in Figure 1.1 were derived using the above iterative formula and the revised PLDF of 1.022 for anchor year 37 (as derived in Table A.6.

Table A.7 documents the calculation of decay factors from the medical paid loss experience of the Washington State Fund in the same manner as Table A.4. The Washington experience was for all medical losses, but it should be virtually the same as the Oregon experience for DYs 20 and higher—on the assumption that all medical payments made for those more mature years are associated with PD claimants.

The Washington decay factors are quite similar to SAIF's, as shown in the comparison provided in Table A.8.

While SAIF's average annual decay factors tend to be slightly higher than those for the Washington State Fund for DYs 21-45, the WA factors are higher for DYs 46-55. This would suggest that a comparison graph such as that provided in Figure 1.1 for the Washington State Fund would show an even more pronounced bulge for the most mature DYs than is the case for SAIF.

Table A.7
Age to Age Decay Factors for the Washington State Fund

Age	Total ($000's) (ex last)	Total ($000's) (ex first)	Age to Age to	Age to age Factors	Averages # of years	Simple Average	Weighted Average	Geometric Mean
60	14	14	60/59	0.502	5	0.567	0.675	0.615
59	28	28	59/58	0.881	5	0.796	1.086	0.925
58	31	35	58/57	0.816	5	1.107	1.277	1.083
57	42	138	57/56	1.648	5	1.160	1.219	1.215
56	84	92	56/55	1.687	5	1.285	1.306	1.213
55	55	57	55/54	0.767	5	1.311	1.199	1.131
54	75	86	54/53	1.506	5	1.192	1.076	1.095
53	57	184	53/52	0.945	5	1.001	0.902	1.051
52	195	440	52/51	1.054	5	1.131	1.038	1.024
51	417	417	51/50	0.732	5	1.078	1.061	1.019
50	570	594	50/49	1.416	5	1.083	1.052	1.063
49	419	439	49/48	1.243	5	1.082	1.051	1.055
48	353	451	48/47	0.968	5	1.130	1.117	1.032
47	465	480	47/46	1.050	5	1.016	0.997	1.013
46	458	471	46/45	0.972	5	0.956	0.950	0.998
45	484	493	45/44	0.849	5	0.961	0.958	0.961
44	581	859	44/43	0.944	5	0.968	0.976	0.952
43	911	939	43/42	0.989	5	0.928	0.924	0.962
42	949	920	42/41	1.087	5	0.958	0.950	0.979
41	847	874	41/40	0.771	5	1.013	1.005	0.991
40	1,133	1,164	40/39	0.998	5	1.056	1.042	1.019
39	1,166	1,240	39/38	1.220	5	1.055	1.042	1.028
38	1,017	1,039	38/37	1.205	5	1.072	1.061	1.020
37	862	948	37/36	1.081	5	1.031	0.991	0.989
36	876	954	36/35	0.855	5	0.992	0.966	0.965
35	1,116	1,394	35/34	0.794	5	0.914	0.894	0.941
34	1,756	1,969	34/33	1.027	5	0.912	0.921	0.940
33	1,917	2,036	33/32	0.813	5	0.934	0.938	0.947
32	2,504	2,580	32/31	1.071	5	0.985	0.985	0.975
31	2,409	2,613	31/30	0.965	5	0.994	1.000	0.997
30	2,709	3,092	30/29	1.050	5	1.036	1.037	1.019
29	2,944	3,676	29/28	1.072	5	1.028	1.030	1.030
28	3,430	3,787	28/27	1.024	5	1.046	1.046	1.032
27	3,696	4,519	27/26	1.027	5	1.039	1.037	1.021
26	4,400	4,877	26/25	1.058	5	1.017	1.014	1.008
25	4,611	5,347	25/24	1.013	5	0.993	0.981	0.986
24	5,281	5,965	24/23	0.965	5	0.975	0.964	0.963
23	6,178	6,876	23/22	0.901	5	0.946	0.939	0.943
22	7,634	8,313	22/21	0.940	3	0.918	0.918	0.923
21	8,840	9,518	21/20	0.912	1	0.912	0.912	0.912
20	10,433	11,398						

Table A.8
Comparison of Average Annual Decay Factors
for the Oregon and Washington State Funds

DYs	Average Annual Decay Factor		WA Avg. Factor as a %-age of SAIF's
	SAIF	WA	
21-25	1.059	0.945	-10.7%
26-30	1.098	1.022	-6.9%
31-35	0.969	0.960	-0.9%
36-40	1.044	1.004	-3.9%
41-45	1.073	0.969	-9.7%
46-50	1.018	1.032	1.4%
51-55	0.875	1.063	21.5%
56-60	1.072	0.981	-8.5%

APPENDIX B
HISTORICAL PLDFs FOR ALL OTHER WC

This section presents SAIF's historical PLDFs for MPD losses as well as WC losses other than MPD. The averages of the latest five PLDFs are shown for each development year in Table B.1. These factors are counterparts to the MPD PLDFs shown in Tables 1.1, 1.2 and 1.3.

Table B.1
A Comparison of Historical Age to Age Paid Loss
Development Factors (By Year of Development)

	Years of Development													
	2	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
MPD	6.624	1.525	1.140	1.072	1.041	1.027	1.019	1.020	1.015	1.013	1.012	1.013	1.012	1.010
Other WC	1.843	1.131	1.043	1.023	1.018	1.013	1.009	1.006	1.005	1.004	1.004	1.004	1.005	1.006
Total WC	2.168	1.213	1.069	1.036	1.025	1.017	1.012	1.010	1.008	1.007	1.006	1.007	1.007	1.007

	Year of Development										
	16	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**
MPD	1.011	1.013	1.011	1.011	1.012	1.012	1.014	1.012	1.015	1.015	1.016
Other WC	1.006	1.008	1.010	1.009	1.009	1.009	1.008	1.009	1.010	1.010	1.010
Total WC	1.008	1.010	1.010	1.010	1.010	1.010	1.010	1.010	1.012	1.011	1.012

	Year of Development										
	27	**28**	**29**	**30**	**31**	**32**	**33**	**34**	**35**	**36**	**37**
MPD	1.020	1.023	1.027	1.026	1.022	1.018	1.015	1.017	1.018	1.029	1.033
Other WC	1.009	1.008	1.008	1.007	1.007	1.006	1.006	1.005	1.004	1.006	1.006
Total WC	1.012	1.012	1.013	1.013	1.011	1.010	1.009	1.009	1.009	1.013	1.014

The 37 to 65 tail factor indicated for other WC is 1.039. In Oregon, escalation of indemnity benefits is paid out of a second injury fund. The above Other WC development factors do not include the escalation of indemnity benefits. The Other than MPD tail factor of 1.039 can be compared to the MPD tail factor of 1.581. It is medical losses that contribute significantly to the tail factor and it is the medical cost escalation component of the medical tail factor that that contributes significantly to the medical tail factor. Without medical cost escalation, the medical factor drops from 1.581 to 1.030 when put on a current cost basis.

The above PLDFs serve as the basis for the tail factors presented in Tables 2.7 and 2.8.

APPENDIX C
INCORPORATING THE STATIC MORTALITY MODEL
INTO THE INCREMENTAL PAID TO PRIOR OPEN METHOD

SECTION C.1 OVERVIEW

Given the complexity of this method, Table C.1 provides a roadmap to the key steps involved in the application of the method and the location of tables and/or narrative describing those steps. The method was originally introduced in Section 3 by presenting Step 11)—since this is easily understood.

Table C.1
Guide to Location of Description and/or Display of Key Steps of Method

Step	Appendix C	Section 3 of Main Text
1) Select representative historical claim reporting pattern	Section C.5	
2) Select representative historical claim closing pattern	Section C.5	
3) Derive historical open count pattern by subtracting 2) from 1)	Section C.5	
4) Derive projections of number of claims closed due to death	Section C.2	Table 3.4
5) Derive assumptions regarding %-age of claims closed for other reasons	Section C.5	Table 3.4
6) Synchronize open count estimates of historical experience and mortality model	Section C.5	Table 3.4
7) Select appropriate medical inflation assumption	Section C.4	
8) Trend historical incremental paid to prior open averages to current level	Section C.3	
9) Select representative paid severities	Section C.3	
10) Trend paid severities to year of payment	Section C.3	Tables 3.2 and 3.5
11) Estimate incremental payments as the product of trended paid severities and projections of the number of prior open claims		Tables 3.2 and 3.5

As is evident from Table C.1, this method has been presented in reverse order to how it is applied.

This appendix consists of four sections: 1) Derivation of Number of Open Claims at the End of Each Development Year; 2) Selection of Representative Values of Incremental Paid per Prior Open; 3) Basis for Selection of Future Medical Inflation Assumption of 9%; and 4) Derivation of Assumed Claim Reporting and Closure Patterns.

SECTION C.2 DERIVATION OF NUMBER OF OPEN CLAIMS AT THE END OF EACH DEVELOPMENT YEAR

The first part of this appendix describes the derivation of the estimated number of PD claimant deaths shown in Column (3) of Table 3.4. Such estimates also directly become the number by which total open claims declines for each development year after the twentieth year. After that year, it is assumed that no new claims will be reported and that the number of claim closures for reasons other than death will be cancelled out by the number of reopened claims for each development year.

The survival probabilities for each development year were derived from a claimant mortality model and these were compared with the actual probabilities of a claim remaining open throughout each given development year. For each development year under 10, the probability of a claim remaining open during a given development year was substantially less than the survival probability—since most (or many) claims will close for reasons other than death of the claimant. However, these two sets of probabilities converge for increasing development years until they are virtually identical—for development years 20 and higher.

Mortality rates were used to derive a claims closure pattern (due to death) by development year in the following way. A two-dimensional array was created, with the age-at-injury down the leftmost column and the development years as column headings.

Table C.2.1 presents a small portion of the array, including only ages-at-injury from 40 through 49 shown at the beginning of the first five development years, and at the beginning of the 10th and 20th development years.

Appendix D provides a more detailed description of the array structure. The arrays described in these two appendices differ only in the applicable mortality tables. For the static method, the 2000 mortality table is assumed for all future years. In the trended method (Appendix D), projections of future mortality tables are used.

Table C.2.1 is a segment of the male lives array. We assumed that the initial PD claimant population consisted of 750 males and 250 females. A corresponding array was used for the female claimants.

Table C.2.1
Number of Living Male Claimants for Accident Year 2002
At Successive Year-Ends Assuming a 2000 Mortality Table

Age-at-Injury	Beginning of Development Year						
	1	**2**	**3**	**4**	**5**	**10**	**20**
40	12.99	12.96	12.92	12.88	12.83	12.56	11.50
41	14.71	14.66	14.62	14.57	14.51	14.19	12.89
42	16.09	16.04	15.99	15.93	15.87	15.48	13.94
43	16.03	15.97	15.91	15.85	15.78	15.38	13.71
44	17.48	17.41	17.34	17.27	17.19	16.72	14.74
45	18.86	18.79	18.71	18.62	18.53	17.98	15.66
46	20.12	20.03	19.94	19.84	19.74	19.10	16.41
47	21.43	21.34	21.23	21.12	21.01	20.27	17.14
48	22.69	22.58	22.46	22.34	22.20	21.36	17.75
49	23.02	22.90	22.77	22.63	22.49	21.56	17.59
40-49	**183.41**	**182.68**	**181.89**	**181.06**	**180.16**	**174.61**	**154.38**

The first column to the right of the age-at-injury values is a portion of the distribution of 750 male PD claimants by age—based on individual permanent total disability (PTD) claimant data from SAIF for accident years 1975-1990. By doing so, we assumed that the age-at-injury distribution for PD claims would be the same as for PTD claims. The actual census data was smoothed among different age-at-injury categories to derive the numbers in Column "1".

Consider the row for the age-at-injury of 40. Suppose that 12.99 of the 1000 total claimants were injured at age 40. The probability of living from age 40 to age 41 from the male 2000 SSA mortality table is used to calculate the expected number of male claimants still alive one year after the accident, and so forth for each subsequent age and year of development out to development year 90. In this way each age-at-injury row is filled out in the array. For each development year column, the expected total number of surviving claimants is simply the sum of the expected number of surviving claimants for each age-at-injury ranging from 40 through 49.

The same calculations were performed for all possible ages-at-injury and all development years from 1 through 90. The resulting estimates of the number of surviving male claimants is summarized in Table C.2.2 for different age-at-injury groupings at different selected years of development. The totals derived in Table C.2.1 immediately above are displayed below in bold type in shaded boxes.

Table C.2.2
Number of Surviving Male Claimants at the Beginning
of Various Development Years for Accident Year 2002

Age-at-Injury	Number of Surviving Male Claimants at the Beginning of Development Year											
	1	5	10	15	20	25	30	40	50	60	70	80
16-29	30.7	30.5	30.2	29.9	29.4	28.8	27.9	24.6	18.0	8.7	1.5	0.0
30-39	78.9	78.2	77.0	75.4	73.0	69.5	64.3	47.3	22.8	4.0	0.1	0.0
40-49	**183.4**	**180.2**	**174.6**	166.5	**154.4**	137.0	114.3	56.2	10.2	0.3	0.0	0.0
50-59	321.3	309.0	286.9	255.0	213.4	162.7	106.1	19.7	0.6	0.0	0.0	0.0
60+	135.7	124.2	105.6	83.2	58.0	33.0	13.8	0.6	0.0	0.0	0.0	0.0
TOTAL	750.0	722.1	674.4	609.9	528.1	431.0	326.4	148.3	51.7	13.0	1.6	0.0
Survival Probability		96.3%	93.4%	90.4%	86.6%	81.6%	75.7%	45.4%	34.8%	25.1%	12.3%	2.6%

The expected number of surviving claimants at the beginning of development year 5 is 722.1 and at development age 10 is 674.4. Hence the probability of survival during the fifth through ninth development years for all male claimants is 93.4%. It is evident from a review of the bottom row of Table C.2.2 that the survival probabilities steadily decline as the claimant population ages.

Table C.2.3 displays the survival probabilities for each age-at-injury grouping during each grouping of development years.

Table C.2.3
Indicated Male Claimant Survival Probabilities

Range of Ages-at-Injury	Beginning of Development Year										
	5	10	15	20	25	30	40	50	60	70	80
16-29	99.4%	99.2%	98.9%	98.5%	97.8%	96.9%	88.1%	73.4%	48.0%	17.0%	2.8%
30-39	99.1%	98.5%	97.8%	96.9%	95.2%	92.5%	73.5%	48.2%	17.5%	3.0%	0.2%
40-49	98.2%	96.9%	95.4%	92.7%	88.7%	83.5%	49.1%	18.2%	3.1%	0.2%	0.0%
50-59	96.2%	92.8%	88.9%	83.7%	76.3%	65.2%	18.6%	3.1%	0.2%	0.0%	
60+	91.6%	85.0%	78.8%	69.7%	56.9%	41.8%	4.1%	0.2%	0.0%		

Given that survival probabilities vary significantly for different ages-at-injury groups, it is clear that the group survival probabilities will be highly sensitive to the distribution of claimants by age-at-injury. The greater the proportion of younger claimants, the bigger the MPD tail.

SECTION C.3 SELECTION OF REPRESENTATIVE
VALUES OF INCREMENTAL PAID PER PRIOR OPEN

Historical incremental paid per prior open claim averages were trended to CY 2003 cost level using an assumed annual medical inflation rate of 9% per year. The resultant on-leveled averages are displayed in Tables C.3.1 and C.3.2.

Table C.3.1
Incremental Paid/Prior Open Averages Trended to 2003 Cost Level

AY	1	2	3	4	5	6	7	8	9	10	11	12	13
1979													9.50
1980												6.90	6.86
1981											8.22	3.80	3.00
1982										6.34	6.49	2.45	3.08
1983									10.42	4.92	3.11	3.28	3.05
1984								6.93	5.43	3.86	3.77	2.95	2.40
1985							6.51	4.64	4.72	2.70	2.65	3.66	2.21
1986						10.22	6.21	5.36	2.76	4.48	3.52	3.14	3.12
1987					8.50	6.05	3.67	2.30	2.69	1.91	2.60	2.38	3.10
1988				11.58	6.11	5.88	2.83	2.18	2.62	3.33	3.03	3.13	4.47
1989			20.00	9.42	7.03	4.79	3.02	2.90	3.26	3.67	3.46	4.05	5.43
1990		84.33	18.60	8.04	5.93	3.68	2.89	3.65	4.90	2.31	2.74	4.60	4.74
1991	13.41	85.99	16.21	5.03	5.69	3.25	2.05	1.84	2.44	2.47	2.89	3.09	
1992	13.20	70.53	14.73	5.69	3.16	3.59	3.34	3.18	3.65	6.05	4.69		
1993	12.95	76.82	13.62	6.66	4.01	4.70	3.96	4.12	7.13	5.78			
1994	11.46	68.64	12.33	3.58	4.26	4.11	2.39	2.31	4.10				
1995	12.52	66.15	10.24	7.55	4.77	4.25	5.63	5.49					
1996	12.17	67.86	13.15	5.24	4.82	5.54	4.52						
1997	14.25	73.83	12.71	7.62	5.45	4.47							
1998	13.09	64.87	14.46	6.05	8.86								
1999	14.94	65.05	15.01	7.71									
2000	16.70	89.89	17.08										
2001	14.75	87.41											
2002	15.21												
Average	13.59	75.11	14.84	7.01	5.72	5.05	3.92	3.74	4.51	3.99	3.93	3.62	4.25
X Hi/Lo	13.48	74.66	14.79	6.90	5.66	4.71	3.85	3.61	4.13	3.96	3.64	3.41	3.92
Avg. Last 3	15.46	80.78	15.52	7.13	6.38	4.76	4.18	3.97	4.96	4.77	3.44	3.91	4.88
Wtd. Avg.	14.69	78.42	15.24	7.06	6.10	4.80	4.06	3.85	4.70	4.45	3.58	3.75	4.56
Selected	14.69	78.42	15.24	7.06	6.10	4.80	4.50	4.50	4.50	4.50	3.70	3.70	3.70

Table C.3.2
Incremental Paid/Prior Open Averages Trended to 2003 Cost Level

AY	17	18	19	20	21	22	23	24	25	26	27	28	29	30
1966										3.68	4.79	4.24	2.75	4.31
1967									7.66	6.49	7.71	11.75	4.00	6.04
1968								11.84	13.27	9.82	2.97	2.69	2.94	2.03
1969							5.31	7.53	5.22	5.70	3.46	5.69	3.00	2.98
1970						4.34	3.23	3.87	3.51	2.55	2.90	2.95	2.66	2.45
1971					6.17	4.87	3.35	2.60	2.57	2.10	2.16	2.63	2.12	5.88
1972				4.45	3.22	3.05	2.66	2.93	1.55	1.30	1.89	2.30	6.07	3.50
1973			7.38	5.53	4.26	3.99	4.16	4.55	4.56	5.19	6.55	7.27	7.90	6.90
1974		5.35	4.28	4.47	2.95	4.18	2.30	2.43	4.00	0.99	2.80	3.84	4.33	
1975	5.69	4.28	4.52	4.65	6.11	3.91	3.85	4.18	3.44	3.96	5.33	4.56		
1976	5.28	3.46	3.77	2.91	2.89	3.41	2.73	2.48	2.11	2.44	1.77			
1977	3.56	2.80	2.73	3.48	3.03	2.77	3.02	3.36	2.86	3.97				
1978	3.22	3.81	2.85	3.33	3.05	4.55	4.39	3.79	3.74					
1979	5.90	4.58	4.14	4.89	3.97	4.73	4.17	4.10						
1980	3.47	3.49	2.98	2.49	3.53	3.15	2.22							
1981	3.25	3.37	3.43	3.28	2.79	4.54								
1982	3.00	2.86	3.15	4.05	3.55									
1983	3.69	3.93	4.98	3.27										
1984	4.19	3.28	2.87											
1985	5.89	4.77												
1986	4.69													
Average	4.32	3.83	3.92	3.90	3.79	3.96	3.45	4.47	4.54	4.02	3.85	4.79	3.97	4.26
X Hi/Lo	4.29	3.78	3.70	3.88	3.66	3.99	3.39	3.94	3.97	3.74	3.65	4.23	3.68	4.19
Avg. Last 3	4.93	3.99	3.67	3.53	3.29	4.14	3.59	3.75	2.90	3.46	3.30	5.22	6.10	5.42
Wtd. Avg.	4.68	3.92	3.72	3.68	3.46	4.07	3.52	3.93	3.44	3.63	3.48	4.94	5.19	4.94
Selected	3.70	3.70	3.70	3.70	3.70	3.70	3.70	3.70	3.70	3.70	3.70	3.70	3.70	3.70

SECTION C.4 BASIS FOR SELECTION OF FUTURE MEDICAL INFLATION ASSUMPTION OF 9%

Future medical inflation rate forecasts are based on an analysis of medical severity since 1966. Future medical severity is expected to grow on average at the same rate observed over this 37 year period. Internal studies have shown that the best predictor of long term medical cost escalation is the long term historical average itself. Short term medical escalation rates are more accurately predicted using shorter term historical averages.

SAIF has two ways of estimating future medical escalation rates:

1. The average severity growth of medical-only claims.

2. The average severity growth of medical on indemnity claims.

The medical-only method is straight-forward because Medical-Only claims develop very quickly and the ultimate average medical only cost by accident year can be accurately calculated.

Table C.4.1 shows the medical only severity by accident year, the growth rates of this index and the mean, median and geometric mean of the series.

Table C.4.1
Medical Only Severity Escalation Rates

Accident Year	Medical Severity	Escalation Rate
1966	$28	
1967	32	13.9%
1968	34	4.4
1969	37	11.1
1970	37	0.0
1971	42	12.2
1972	46	9.5
1973	48	5.8
1974	56	15.7
1975	63	12.2
1976	73	16.3
1977	79	7.9
1978	88	12.1
1979	99	11.8
1980	114	15.5
1981	144	26.5
1982	162	12.2
1983	188	16.2
1984	205	8.9
1985	230	12.1
1986	247	7.4
1987	258	4.6
1988	264	2.4
1989	268	1.4
1990	279	4.4
1991	298	6.8
1992	335	12.3
1993	361	7.7
1994	372	3.0
1995	383	3.1
1996	403	5.1
1997	434	7.7
1998	454	4.5
1999	501	10.4
2000	540	7.7
2001	604	12.0
2002	658	9.0
Mean		9.3%
Median		9.0%
Geometric mean		9.2%

Although the severities of medical only claims give an indication of medical escalation trends, the types of services provided to medical only claimants are not the same as the services provided to permanently disabled claimants. SAIF has developed a technique to compute medical escalation indices for the MPD claims. In this paper, we describe the method.

Given a triangle of incremental MPD payments and claim counts, it is possible to compute triangles of MPD severities. For any particular calendar year (one of the diagonals of the triangle) one can calculate the growth in severity for each age of development. The escalation rate for the calendar year is the weighted average of the severities for each age of development, where the weights are the calendar year paid losses by accident age.

Using SAIF's data on MPD claims, the mean, median and geometric means of the MPD index is shown in comparison to the Medical Only index in Table C.4.2.

Table C.4.2
Medical Escalation Rates
(Average from 1966 to 2002)

	Medical Only claims	**MPD claims**
Mean	9.3%	9.7%
Median	9.0	9.5
Geometric mean	9.2	9.8

Medical escalation rates on MPD claims have been even higher than the Medical Only inflation rates and have averaged in the 9 to 10% range over a period of 37 years.

SECTION C.5   DERIVATION OF ASSUMED
CLAIM REPORTING AND CLOSURE PATTERNS

Exhibits C.5.1 and C.5.2 disclose the SAIF specific assumptions that form the basis for the PLDF static and trended mortality model estimates. These assumptions are held constant for all accident years in the model:

- 5,000 ultimately reported PD claims.
- A claim reporting pattern based on recent historical experience.
- Percentages of cumulative reported claims still open at the end of each DY—based on recent historical experience.
- Estimates of PD claims closed by death—based on SSA mortality tables.
- Estimates of PD claims closed for reasons other than death—calculated as total claim closures less expected deaths.

From the above, the percentage of claims available for closure that closed for reasons other than death was derived from AY 2002 for the static mortality model. These percentages were also assumed for the trended mortality model. Consequently, the only thing difference between the two models is the expected number of claimant deaths during each DY.

Table C.5.1

Derivation of Key Assumptions of the Static and Trended Models

Accident Year 2002 MPD Losses

	Development Year						
	1	2	3	4	5	6	7
1) % of Claims Reported	18.52%	74.33%	91.64%	95.93%	97.77%	98.69%	99.08%
2) Selected Reported Counts	926	3,716	4,582	4,797	4,888	4,935	4,954
3) % of Reported Still Open	49.65%	41.20%	29.82%	19.78%	13.85%	11.23%	8.00%
4) Selected Open Counts	460	1,531	1,366	949	677	554	396
5) Group Survival Probability	0.993	0.992	0.991	0.990	0.990	0.989	0.988
6) Number Closed by Death	3.46	15.05	17.30	14.09	10.33	7.89	6.88
7) Total Closed Counts	466	2185	3216	3848	4211	4381	4558
8) Closed for Other Causes	462.54	1703.95	1013.70	617.91	352.67	162.11	170.12
9) Newly Reported Counts	926	2,790	866	215	91	47	19
10) Open + Newly Reported	926	3,250	2,397	1,581	1,040	724	573
11) Indicated % Closed (Other)	99.26%	52.43%	42.29%	39.08%	33.91%	22.39%	29.69%
12) Selected % Closed (Other)	99.26%	52.43%	42.29%	39.08%	33.91%	22.39%	29.69%

NOTES:

1) Based on average reported count development factors for the latest 10 CYs.

2) 5,000 x 1). The constant ultimate claim count of 5,000 was assumed for all years.

3) Based on the average percentage open for the most recent CYs.

4) 2) x 3), for DYs 1-10; [Prior 4) + 9) – 6 – 8)], for later DYs.

5) See Section C.1 of Appendix C.

6) [4) + 0.5 x 9)] x (1 - 5)).

7) 2) - 4).

8) [Change in 7)] - 6).

9) Change in 2).

10) 4) + 9).

11) 8) / 10).

12) Selected on the basis of 11). Actual %-ages were selected for the 1st 10 DYs.

Table C.5.2

Derivation of Key Assumptions of the Static and Trended Models

Accident Year 2002 MPD Losses

	8	**9**	**10**	**11**	**12**	**13**	**14**
				Development Year			
1) % of Claims Reported	99.30%	99.46%	99.56%	99.64%	99.69%	99.76%	99.81%
2) Selected Reported Counts	4,965	4,973	4,978	4,982	4,985	4,988	4,991
3) % of Reported Still Open	6.50%	5.00%	4.20%	3.95%	3.74%	3.56%	3.40%
4) Selected Open Counts	323	249	209	197	187	178	170
5) Group Survival Probability	0.987	0.986	0.985	0.983	0.982	0.981	0.979
6) Number Closed by Death	5.31	4.68	3.89	3.52	3.56	3.63	3.72
7) Total Closed Counts	4642	4724	4769	4785	4798	4810	4821
8) Closed for Other Causes	78.69	77.32	41.11	12.54	9.85	8.39	7.10
9) Newly Reported Counts	11	8	5	4	3	3	3
10) Open + Newly Reported	407	331	254	213	200	190	181
11) Indicated % Closed (Other)	19.33%	23.36%	16.19%	5.89%	4.92%	4.43%	3.93%
12) Selected % Closed (Other)	19.33%	23.36%	16.19%	6.00%	5.00%	4.50%	4.00%

APPENDIX D
INCORPORATING THE TRENDED MORTALITY MODEL
INTO THE INCREMENTAL PAID TO PRIOR OPEN METHOD

Table C.1 displays each of the steps taken in incorporating the static mortality model into the incremental paid to prior open method. The trended mortality method is the same as the static mortality method, except for step 4), where projections of the number of claims closed due to death are derived. In the trended method, mortality tables forecasted by the SSA for the appropriate future development year are used instead of some fixed historical mortality table. The differences between these tables grows exponentially for development years that are decades into the future. A sample of these differences is disclosed in Tables 5.1a and 5.1b of Section 5. These differences are compounded by medical costs that have risen dramatically due to expected high future rates of medical inflation.

The focus of this appendix is to disclose the specific manner by which a series of 90 different mortality tables were derived and applied to the expected number of surviving claimants by age-at-injury for every future development year. The final result is a slowly evolving and elongating series of claims closure patterns for each AY out to 90 years of development.

Standard mortality tables for each decade since 1970 and projected tables for each decade through 2080 were obtained from the SSA web site (http://www.ssa.gov/OACT/NOTES/as116/as116_Tbl_6_2020.html#wp1085674).

The separate male and female tables were combined into one using an assumed 75%/25% male/female mix, the proportion indicated from SAIF's PD claimant census data. The resulting weighted mortality rates were then compiled into an array of expected mortality rates for each age at each future calendar year.

Six models of the number of PD claimants who would still be alive at the end of each future development year were derived—separately for accident years 1975, 1980, 1985, 1990, 1995 and 2000. Each of these models consists of a separate two-dimensional array, such as presented in Tables C.2 and C.3 of Appendix C.

The first step in deriving these arrays was to compile mortality rates from the SSA tables. Table D.1 displays a sampling of these $q(x)$, or probability of death, values.

Each of the one-year $q(x)$ values were converted into survival rates by taking their complement, yielding the ratios in Table D.2.

The entire array of resulting one-year $l(x)$'s was then shifted so that the rows of the original array became the diagonals of a new array – i.e., each successive column was shifted up one row. After the shift, the $l(x)$'s were arranged as shown in Table D.3.

Table D.1
Sample Q(x) Values

Age	Calendar Year						
	1970	**1980**	**1990**	**2000**	**2020**	**2040**	**2060**
20	.00175	.00156	.00130	.00110	.00091	.00078	.00066
35	.00239	.00187	.00217	.00172	.00154	.00130	.00110
50	.00861	.00685	.00556	.00496	.00397	.00330	.00278
65	.02961	.02524	.02206	.01938	.01615	.01371	.01182
80	.09386	.08308	.07604	.07028	.05929	.04976	.04261

Table D.2
Sample One Year L(x) Values

Age	Calendar Year						
	1970	**1980**	**1990**	**2000**	**2020**	**2040**	**2060**
20	.99825	.99844	.99870	.99890	.99909	.99922	.99934
35	.99761	.99813	.99783	.99828	.99846	.99870	.99890
50	.99139	.99315	.99444	.99504	.99603	.9967	.99722
65	.97039	.97476	.97794	.98062	.98385	.98629	.98818
80	.90614	.91692	.92396	.92972	.94071	.95024	.95739

Table D.3
Shifted L(x) Array: Age

Age at Injury	Year of Development						
	1	**2**	**3**	**4**	**5**	**6**	**7**
20	21	22	23	24	25	26	27
21	22	23	24	25	26	27	28
22	23	24	25	26	27	28	29
23	24	25	26	27	28	29	30
24	25	26	27	28	29	30	31

Each row thus has a structure similar to an accident year reporting format, as displayed below.

This shift facilitated multiplication of the survival ratios times the preceding number of surviving claimants for each age-at-injury row, working successively from left to right within each age-at-injury row.

Table D.5 provides a side-by-side comparison of parallel calculations of the expected number of surviving claimants at the end of each calendar year—for the static and trended mortality methods. The example presented is for claimants who were 50 years old when they were injured (during AY 2002).

Table D.4
Calendar Year of Payments and Applicable Mortality Table—
For Each Accident Year and Development Year

				Year of Development					
AY	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1996	1996	1997	1998	1999	2000	2001	2002	2003	2004
1997	1997	1998	1999	2000	2001	2002	2003	2004	2005
1998	1998	1999	2000	2001	2002	2003	2004	2005	2006
1999	1999	2000	2001	2002	2003	2004	2005	2006	2007
2000	2000	2001	2002	2003	2004	2005	2006	2007	2008
2001	2001	2002	2003	2004	2005	2006	2007	2008	2009
2002	2002	2003	2004	2005	2006	2007	2008	2009	2010

Table D.5
Comparison of the Estimation of the Number of
Living Claimants with Age-at-Injury of 50 for
Accident Year 2002 At Successive Year-Ends—
Under the Static and Trended Mortality Methods

STATIC MORTALITY METHOD					
	Calendar Year				
	2031	**2032**	**2033**	**2034**	**2035**
Number of Surviving Claimants	100.00	93.63	87.05	80.30	73.42
CY of Mortality Table	**2000**	**2000**	**2000**	**2000**	**2000**
Survival Probability	.93633	.92972	.92242	.91439	.90562
TRENDED MORTALITY METHOD					
	Calendar Year				
	2031	**2032**	**2033**	**2034**	**2035**
Number of Surviving Claimants	100.00	95.12	90.05	84.79	79.30
CY of Mortality Table	**2031**	**2032**	**2033**	**2034**	**2035**
Survival Probability	.95121	.94671	.94152	.93526	.92769

In Table D.5 we started with the same number of surviving claimants at the beginning of CY 2031 (100.00). Nevertheless, at the beginning of CY 2035, we would be expecting 73.42 such claimants to still be alive using a 2000 mortality table while 79.30 claimants would be alive using a series of mortality tables corresponding to CYs 2031 through 2034. In this example, we would be expecting 8% more claimants to still be alive at the beginning of CY 2035 assuming the trended mortality method (versus the static method).

Although there is little difference in the survival probabilities shown in Table D.5, these differences become fairly significant during future decades. This can be seen by comparing these rates in the fourth and fifth columns of Tables 5.1a and 5.1b.