Actuarial Note on Workmen's Compensation Loss Reserves—25 Years Later

by Lee R. Steeneck, FCAS

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Abstract

In 1971 Ron Ferguson documented the annuity mathematics necessary to establish reserves for lifetime workmen's (now workers) compensation cases. This paper provides a quarter century update, complete with personal computer spreadsheet application to illustrate various features of a tabular reserving system. Since 1971 statutory aggregate amount and duration limitations have disappeared. Understanding the impact of inflation on catastrophic medical permanent and total disability cases is crucial from a reserving perspective.

Use of non-proportional reinsurance as a risk management tool is revisited. Layering of catastrophic claims is demonstrated, demystifying some oftentimes falsely held notions. Several illustrations provide some sensitivity analysis concerning the interaction of mortality and claim cost structure. Both indemnity and medical expenses are modeled by annuities.

An argument is made for the inclusion of escalation of indemnity (where applicable) and medical inflation within the annuity mathematics to provide a proper forecast of the individual gross loss and to layer that loss properly. This moves the "loss development" provision away from IBNR reserves and into case reserves, providing greater accuracy and clarity to experience. This applies to gross, retrocessional, and net claim reserves.

Since the reserve is a sum of future periodic payments (amount of future payment times probability of surviving to collect the benefit), an accurate discounting of the estimated payments is readily available.

Comparisons of company results with Reinsurance Association of America development statistics are shown, since traditional link ratio analysis has shortcomings. Traditional IBNR methods forecast insufficient future values on past loss events.

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Introduction

In 1971, Ron Ferguson[1] wrote an actuarial paper on the subject of establishing workers compensation periodic payment for life claims' reserving as a function of life insurance mathematical annuities. Annuitants receive specified payments for a period certain or contingent on their being alive. Survivor's benefits (in work related death cases) and Permanent Total Disability benefits are normally, statutorily provided for life, according to the laws of the various USA jurisdictions.

In the last two and one half decades workers compensation has undergone revolutionary change for at least the following reasons:

- increased weekly indemnity and medical expenses unrestricted in duration and amount,
- rapid inflation in wages and medical costs impacting all catastrophic claims,
- increasing use of expensive technology to sustain and enhance life,
- wider acceptance of the terms "reasonable and customary" in describing eligible treatments,
- attorney involvement,
- increased life expectancies (especially for catastrophically injured claimants), and

For these reasons, lifetime catastrophic medical cases in particular have a tremendous marginal financial effect on an insurer. These claims are infrequent and catastrophic, but can be effectively controlled through proper risk management and spread loss concepts associated with purchasing reinsurance (and retrocessions).

It is important to understand, properly analyze, and reserve catastrophic medical claims, otherwise there can be serious strategic real and opportunity costs associated with adverse development on the balance sheet, income statement, and inappropriate line operating policy. With escalation of indemnity in certain states and inflation on medical costs in all states, the workers compensation development "tail" can be "material" for well over 60 years if escalation/inflation on annual benefits and costs aren't annuitized into a claims forecasting model.

These impacts are to be modeled in this paper. By examining forecasted development, the insurer will be less reliant on IBNR reserves, can demonstrate client experience including claim specific anticipated development, and can properly value excess of loss layers as part of an effective risk management program through risk transfer to a reinsurer or retrocessionaire.

The reader is directed to Appendix 1 for a short, simple discourse on life tables and tabular reserving. Appendix 2 advances the treatment of tabular reserving to include increasing lifetime

[1] "Actuarial Note on Workmen's Compensation Loss Reserves", Ronald E. Ferguson, Proceedings of the Casualty Actuarial Society, LVIII, New York, 1971.

annuities and layering of claims, through both text and the application of a computer based reserving model. This Excel based model is available upon request. Snader[2] has also illustrated tabular claim phenomena.

Frequency of Catastrophic Medical Claim

To appreciate the infrequent but severe nature of these claims requires an understanding of the distribution of total indemnity and medical claims by type of injury. The NCCI has published[3] elements of the following chart of national average annual frequencies* and severities.

Chart 1

Type of Claim	frequency of Claim*	% Dist'n	Indemnity Average	Medical Average	Total Average	Total Cost	% Dist'n
Fatal	5	0.05	115,000	3,000	118,000	590,000	1.3
Perm total	20	0.20	186,000	135,350	321,350	6,427,000	13.7
Perm partial	750	8.00	24,000	4,071	28,071	21,053,000	45.0
Temp total	1,480	15.81	2,000	1,161	3,161	4,679,000	10.0
Medical only	7,102	75.90	0	1,976	1,976	14,036,000	30.0
Total	9,357	100.0	2,700	2,300	5,000	46,785,000	100.0

*per 100,000 workers. Some data derived.

The figure for permanent total disability (PTD) has been tripled to 20 to reflect subsequent (to NCCI accumulations) reclassification of claims from temporary to permanent total disability (PTD) status. These incurred values incorporate the time value of money, lowering the cost associated with fatal and catastrophic medical PTD cases.

A disproportional cost, 13.2% is associated with PTD claims (0.2%). Internal studies suggest that claims classified as PTD can be more finely divided into:

1) Largely indemnity oriented 15
2) Mix of indemnity/medical 3
3) Catastrophic medical cases 2 - i.e. - brain damage, spinal cord injury, serious burn cases

Consider a *"type 2)"* claim with a mixture of indemnity and a moderate amount of ongoing annual medical.

[2] "Reserving Long Term Medical Claims", Richard H. Snader, Proceedings of the Casualty Actuarial Society, LXXIV, New York, 1987.
[3] Statistical Abstract, National Council on Compensation Insurance, Boca Raton, Florida, 1995 edition.

The annuity model - sensitivities

The following illustrate several analyses of the impact inflating annuities have on claim reserves. Chart 2 displays a reserve comparison for a 30 year old male claimant, where the insurer has annuitized $10,000 of fixed indemnity per annum, but has not annuitized medical expenses of $5,000 per year for life subject to 5.5% inflation (choosing instead to post a $100,000 reserve). Annuitizing and inflation drive the claim beyond the claim adjuster's point estimate.

Chart 2

Age 30 claimant	Uninflated, Indemnity only Annuitized		Annuitizing both, inflation on medical	
Indemnity/Medical	I= 484,002	M=100,000	I=484,002	M=1,254,248
Case incurred	sum=584,002		sum=1,738,250	

Inflation driven reserves will "develop" upward over the lifetime of the medical claim unless an inflation forecasted annuity reserve replaces the uninflated reserve on the insurer's records.

Chart 3 displays this same claim, except that the insurer has annuitized the medical, but not subjected it to inflation of 5.5% per annum. While the annuity reserve is better than the previous point estimate, consideration of inflation in a quantitative way is crucial for an accurate forecast.

Chart 3

Age 30 claimant	Uninflated Annuitized Claim		Annuitizing both, inflation on medical	
Indemnity/Medical	I=484,002	M=242,001	I=484,002	M=1,254,248
Case incurred	sum=726,003		sum=1,738,250	

There are **4 factors** which drive catastrophic average claim values: Life expectancy trends, annual costs of acute and maintenance care, economic inflation, and technological/societal changes. Not only can fixed periodic indemnity be viewed as an annuity, but so can predicted annual inflating medical expenses, as the above example illustrates.

❶ Mortality

Life expectancies have been improving in each decade this century according to USA census statistics[4]. In 1900 the expectation of life was 49 years; in 1960 it was 70 years; in 1970 it was 71 years; in 1980 it was 74 years. And for persons born in 1990, the life expectancy is 75^{+} years. Improvements are comparable between male and female and by race. Health care, technology, and nutrition have continually improved. PTD workers compensation claimants have presumably benefited as much as the general population.

The distribution of PTD claimants is within a spectrum of whole-life to impaired-life categories. Most PTD claimants have little, if any maintenance medical costs or a medical condition affecting life expectancy. Comatose or ventilator dependent brain damage (BD) or spinal cord injury (SCI)

[4] Vital Statistics of the United States, National Center for Health Statistics, Public Health Service, Washington, D.C., 1994 edition.

claimants have significant medical and rehabilitation acute and maintenance costs with adverse medical conditions affecting life expectancy.

SCI claimant life expectancy depends on: sex, the level of lesion of the spine, age at date of onset and years since onset (a select period, perhaps 1 year, before ultimate mortality rates again apply). There has been a dramatic improvement in all such life expectancies since the 1940's (initially studying soldiers and civilians).

The following chart displays the results of 2 studies conducted on SCI patients, at US Veterans Hospitals[5] and at Lyndhurst Lodge Hospital, Toronto[6]. Patients were classified as either Complete or Incomplete, relating to the degree of lesion, and Paraplegic or Quadriplegic (Tetraplegic), relating to the degree of mobility and vertebrae affected. Quadriplegics have injuries to the upper cord/vertebrae C(ervical)1 - C8. Many are on ventilators and exhibit complete quadriplegia with *significantly* reduced life expectancy. As an aside, actor Christopher Reeve is a C-1,2 quadriplegic. Paraplegics have injury to T(horacic)1 - T12. Paraplegics have some use of arms and upper chest.

The Veterans study encompassed 5,743 patients admitted between 1946-55. The 3 Lyndhurst Lodge studies followed 1,510 patients between December 1973 - 1980, representing application of newer medical technologies.

The figures are multipliers, percent increase in annual mortality. Owing to improvements in technology, it would be prudent to provide for further improvements, perhaps averaging **160%** for paraplegics and quadriplegics and **600%** for Complete ventilator quadriplegics. We apply these figures to population mortality as a proxy for higher figures applying to select employed or insured mortality.

Studies also suggest that that mortality varies most during the 1-3 years after initial onset, then continues at much improved levels for the remainder of life, with mixed results at older ages. The leading causes of death are: heart disease, pulmonary embolism, suicide, and renal disorders.

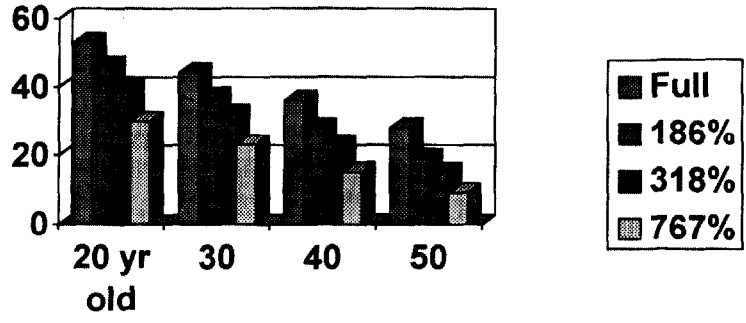
Chart 4	Complete		Incomplete	
Study, % of annual mortality	Para	Quad	Para	Quad
US Veterans Hospitals	600-900	1400-2900	250-520	620-840
Lyndhurst Hospital	318	767	186	209

Translating the Lyndhurst Hospital study into life expectancies for various aged persons at onset (after an initial acute period of 1-2 months) shows declining life expectancies of:

[5] Burke, Hicks, Robins, Kessler, "Survival of Patients with Injuries of the Spinal Cord", Journal of the American Medical Association, 1960.

[6] Geisler, Jousse, Wynne-Jones, Breithaupt, "Survival in Traumatic Spinal Cord Injury", Paraplegia, International Medical Society of Paraplegia, 1983. Also Canadian Medical Association Journal, 1961, 1968.

Graph 1 - LIFE EXPECTANCIES by impairment



Medical Cost Structure

It is "best practice" to consider the periodic, fixed, lifetime payment of wage replacement or more commonly, indemnity, as an annuity and to establish a case basis reserve using actuarial life-tabular techniques (described in Appendices 1, 2). Periodic, albeit unfixed in amount ongoing medical expenses can be viewed similarly, but as an increasing lifetime annuity.

Consider the paraplegic's needs and benefits provided. Acute hospital care and rehabilitation in the first 2 months currently cost approximately $US 90,000. Add maintenance costs of $10,000 for the remainder of the year, remodel the patient's home, suitably equip a car for a disabled driver, and buy pertinent equipment and this adds another $25,000. During the first 365 days after onset, this amounts to $125,000 in 1996 US dollars.

In year two, evaluations, upgrading, and maintenance add $60,000 of costs. Thereafter, costs of maintenance, depending on whether the injury is incomplete or complete, add $7,000 and 27,000 respectively, again in 1996 dollars. These will be subject to inflationary pressures as well as cost containment measures.

The following chart displays the medical cost structure for a well managed case. Without case management techniques costs increase.

Chart 5

$US 000	Para-plegia T1-12	Quadriplegic or Tetraplegic			Brain Damage		Serious 3rd degree Burns	
		C5-8	C4	Venti-lator	Comatose Vegetative	Other	Up to 1/3 of body	Up to 2/3 of body
First year	125	260	270	500	250	300	450	1,000
Second year	60	100	150	240	210	130	90	150
Next years	7 or 27	100	125	240	210	50	2	2

● **Indemnity and Medical Inflation**

One year after the Ferguson paper was printed in the PCAS, a Presidential Commission made essential recommendations (1972) to improve and upgrade WC laws. Perhaps the two most expensive recommendations were to: (1) remove time and aggregate amount limitations on both medical and indemnity benefits in lifetime cases, and (2) account for the loss of purchasing power by increasing indemnity benefits to prior claimants per year, based on statewide inflation in wages. This meant providing an increasing annuity on both indemnity (termed escalation of indemnity, on PTD and fatality cases) and unlimited medical expenses. Both incorporate decades of inflation on wages and on services purchased for permanently disabled claimants.

Appendix 3 charts the current status of state laws as respects escalation of indemnity and who will provide and fund the benefit.

Our recent studies of macroeconomic trends in the United States suggest that **future** indemnity escalation, tied to wage inflation, could average 4.0% per annum indefinitely. While annual medical inflation has exhibited wide swings in recent decades, we estimate that the long-term rate could average 5.5% per annum. This includes expected inflation rates in professional service fees, drugs, equipment, and hospital/custodial care, provided during the maintenance period of a catastrophically injured claimant's life. Other individuals have come to similar conclusions.

An article in Best's Review[7] updated the Masterson composite inflation time series and found the 10 year ending workers compensation claims cost trend per annum to average 5.6% (while the series of CPI All Items increased 3.6% per annum). A similar figure was cited by the NCCI at its Annual Meeting in April, 1995 for medical inflation during 1991-1993. Gary Venter conducted a study[8] of WCRB mostly catastrophic claims and stated, "Medical payments were inflated 4% each year in all states, which probably is too conservative".

As an aside, the price of the average Ford motor vehicle has risen from $3,579 in 1970 to $14,046 in 1995. This is a compound average growth rate of 5.6% per annum. During this same time period, average income increased 5.5% p.a. from $9,867 to $37,526, while the price of a first class US postal stamp increased 7% p.a. from 6 to 32 cents.

● **Technology**

Technological inflation also affects this catastrophic claimant population. Clearly, the replacement of a worn, old technology manual wheelchair with a new electric one has costs outstripping economic inflation. Similarly, using computerized medication pumps versus oral ingestion is more expensive, if not more assured a method of treatment. Conversely, previously accepted treatments of electrical stimulation of muscles have not proven to be therapeutic, so these services are not being continued. It is probable that one of the differences why medical inflation is approximately 200 basis points in excess of *All Item* averages lies in specialization and technology.

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[7] Van Ark, William, "Gap in Claims Cost Trends Continues to Narrow", Best's Review, March, 1996.
[8] Venter, Gary G., "An Excessive Claim Tail", Best's Review, November, 1992.

Use of discount

The time value of money, investment income on funds withheld between premium collection and the stream of catastrophic loss payments, also must be considered in a competitive environment. A reasonable and accepted statutory rate in use today for reserving purposes is 4.5%. The actuarial reserve can be a discounted loss cash flow to present value in establishing the balance sheet liability. While discounting of tabular indemnity is expressly allowed by the NAIC, the statutory insurance regulatory body, one must receive domiciliary state approval to discount tabular medical reserves. Cash flows on medical expenses are less certain. Risk based capital calculations charge surplus immediately for medical discount to be recaptured into reserves.

While it is tempting to inflate $1 of indemnity owed next year to $1.04 and add it to $1 of medical owed next year, inflated to $1.055 = $2.095 and present value at 4.5% to $2; there is considerable value in isolating each component, rather than netting them to the negligible impact shown. Forecasting nominal losses by layer and then discounting provides the actuarially correct practice.

The annuity model - additional sensitivities

The following illustrate how age and impairment status affect gross claim values. Chart 6 displays six 1996 impaired-life male claim comparisons where the insurer has annuitized $10,000 of fixed indemnity per annum and average annual medical payments of:

Paraplegic $125,000 in year 1 following injury, $30,000 per annum thereafter,
Quadriplegic $500,000 in year 1 following injury, $240,000 thereafter.

Medical payments are subject to 5.5% inflation in the comparison. The age and injury effect on valuation is considerable.

Chart 6

	Impair	Uninflated Indemnity/Medical		Indemnity + Inflated Medical	
Age	Pctg.	Paraplegic	Quadriplegic	Paraplegic	Quadriplegic
20					
	160	2,150,647		11,474,453	
	600		8,509,994		32,413,203
40					
	160	1,514,210		4,197,103	
	600		5,913,128		12,953,894
60					
	160	852,209		1,381,689	
	600		2,800,094		3,810,864

Chart 7 displays the single highlighted claim above, except that the annuitized medical payments have been examined under differing medical inflation rates.

Chart 7

Age	Impair Pctg.	Uninflated Paraplegic	Indemnity + Inflated Medical 4%	5%	6%	7%
40						
	160	1,514,210	2,997,735	3,733,921	4,739,455	6,123,483
	600					

In some sense, future values are intimidating, if not misleading. The economic consequence or statutory rated, discounted valuation figure is useful.

Chart 8

Discounted Value*	807,242	1,246,927	1,440,247	1,690,585	2,017,776

*$125,000 first year medical+10,000 indemnity + present value of reserve

Let us also examine the outcome of this case should the state law mandate escalation of indemnity. Chart 9 illustrates the incremental impact that 4% escalation of indemnity has. Discounted values at 4.5% are also given.

Chart 9

Paraplegic	Uninflated Indemnity/Medical Indemnity	Medical	4% Inflated Indemnity + 5.5% Inflated Medical Indemnity	Medical
40 year old				
160%, Nominal	352,566	1,161,644	877,515	3,814,097
Discounted Value*	169,506	637,736	321,054	1,382,705

*$125,000 first year medical+10,000 indemnity + present value of reserve

The impact of the infrequent catastrophic medical PTD case can be managed through the purchase of excess of loss, also called non-proportional (hereinafter called N-P) reinsurance.

Reinsurance theory - diversification of risk and layering

Reinsurance (and retrocessions for reinsurers) is basically a method for diversifying risk. The reinsured companies pool ceded premiums and losses in a reinsurance company with the objective of smoothing their year to year profitability, making their net exposures more homogeneous and losses less volatile. In a "fair" transaction, the ceding company pays its own losses, its share of the overhead incurred by the reinsurer, and a small margin which allows the reinsurer to attract the capital it needs.

Generally, reinsurance rates can be responsive to a company's loss experience only to the extent that experience is predictive of future outcomes. This is most often true for working layers (layers which experience high claim frequency). This allows the reinsurer to use recent experience to forecast future outcomes within a tolerable level of accuracy. By incorporating anticipated inflation of annual costs into the claims reserving process, frequencies are enhanced as claims are forecasted into upper layers soon enough to be featured explicitly in client ratemaking.

Many reinsurance professionals believe that WC losses under $1,000,000 comprise the frequency driven area. Recall the distribution of losses by injury type and cost from Chart 1. N-P reinsurance purchased in layers (mostly above $100,000) up to $1,000,000 are said to be "working layers" of meaningful frequency. These N-P claims are certainly to involve fatality cases with lifetime survivor's benefits and claims for lifetime PTD benefits and medical expenses. But with medical inflation and escalation of indemnity, working layers extend to $2,000,000 for moderately sized companies. Catastrophic or "non-working" layers are expected to respond rarely, as in the case of the catastrophic medical case or the multiple person occurrence over high retentions.

A typical reinsurance program for a mid-size insurer could be layer rated as follows:
I. 5-year Adjustable Premium featured reinsurance in the amount of $800,000 xs 200,000
II. Guaranteed cost excess reinsurance in the amount of $1,000,000 xs 1,000,000
III. Guaranteed cost excess reinsurance in the amount of $8,000,000 xs 2,000,000

The first layer could have an expectation of 10 losses of $4,000,000 annually, or 50 losses over a 5 year period. The **net premium to limits** relationship or "**balance**" is 5:1. (Balance is a proxy for frequency and varies directly with the credibility assigned to the expected experience.) The cedant would be diversifying its losses chronologically over time and (1) the premium retained by the reinsurer would incorporate little profit and risk charge, (2) the cedant would be paying for his own losses, (3) the probability that losses were significantly above 50 would be low. There would be little overall process risk and a moderate amount of parameter risk reinsured.

Think of process risk by way of rolling a pair of fair dice. On one roll the range is 2-12 and it would be expensive to reinsure "excess 8" a 10/36 chance. After 50 rolls, the sum is very likely to be near 50 x 7 = 350. It is much less likely than 10/36 to roll a sum over 400 = 50 x 8. The process tends toward the mean with repetition. Financial theory suggests that process risk which can be diversified deserves no risk charge. In reinsurance we also consider parameter risk, since we can only guess that the dice are fair. If we mis-parameterize our pricing and reserving models we risk the "winner's curse". We would then only win business where we estimated expected losses below our competitors, most likely below the cost of providing the reinsurance. In WC reinsurance, we are making 60+ year estimates on the application of state law, medical inflation and technology, and the earning ability of assets on the balance sheet. WC reinsurance has perhaps the longest term risk on its *promise to pay* of all property and casualty lines of business.

A small insurer may have a similar program but with guaranteed cost premium for this first layer since the expected 5 year frequency may be too small to be self rated. The annual loss expectation might be 1 @ $480,000 and the balance would be low at 0.6:1. In this case, because of expected volatility, the insurer is seeking to diversify its risk against the portfolio of his reinsurer. A class and state sensitive guaranteed cost book rate is charged which reflects the cedant's specific risk profile. The occurrence of a loss to a specific reinsured does not give cause to reexamine the rate for the reinsured, but is incorporated into the portfolio rate analysis for the reinsurer's book of business.

Generally, if the balance is >5:1 the layer rating implies diversification over time. If the balance is <3:1 the results should be diversified across the portfolio of clients. Balances between 3 and 5:1 leave room for judgment. Stated another way, balance is a metric for predictability.

The second layer is likely sold as a diversification against the reinsurer's portfolio of similar risks presented by all its cedants. The reinsurer may price this layer to produce process and parameter risk adjusted profits per annum or over a multi-year horizon in an underwriting cycle.

The third layer is likely also sold as a diversification against a reinsurer's portfolio of risks presented by all its cedants. The reinsurer may price this catastrophe layer to produce greater process and parameter risk adjusted profits over an underwriting cycle of 3-10 years. A large reinsurer may be able to lower the process risk charge by passing through its favorable "retro" terms.

Let us examine several claims within the noted layering structure.

Chart 10 - ANNUITY VALUES of claims

	Widow receiving $10,000 p.a.			Widow receiving $25,000 p.a.		
Age	**800 xs 200 (000s)**	**1000 xs 1000**	**8000 xs 2000**	**800 xs 200 (000s)**	**1000 xs 1000**	**8000 xs 2000**
20	434,385	0	0	782,432	596,780	4,240
30	337,948	0	0	760,908	379,916	0
40	243,753	0	0	709,710	192,239	0
50	155,253	0	0	603,883	61,482	0
60	80,950	0	0	444,356	4,526	0

With our mortality tables going up to age 103, a widow age 20, receiving $10,000 per annum has no opportunity to survive long enough to receive an aggregate amount extending beyond the frequency layer. However, at an annual $25,000, there is significant probability that she will live 1,000,000/25,000 = 40 years, so that $1 M xs $1 M is a working layer for higher indemnified widows. There is a small probability that she will survive 80 years and attach to the third layer.

The 4.5% present value of that series of probabilistic payments at ages 101, 102, and 103 which total $4,240 is merely $120. Similarly, the 4.5% present value of the 1 M xs 1 M claim to the 20 year old of $596,780 is $57,704.

Let us now reexamine the 40 year old paraplegic in this layering structure (previously noted in Chart 6 as a gross loss). As expected, inflation drives the developing claim higher into the layers, to the point that the ceding company may actually completely exhaust the reinsurance, should the claimant survive toward the terminal age of 103. The distant payments, however, have the deepest discount to present value.

Chart 11

Age	Indemnity = 10,000 Medical = 125,000; then 30,000			Same figures, but including 5.5% medical inflation			
40	**800 xs 200 (000s)**	**1000 xs 1000**	**8000 xs 2000**	**800 xs 200 (000s)**	**1000 xs 1000**	**8000 xs 2000**	**xs10,000**
Nominal	746,432	545,040	23,083	761,709	856,132	2,329,306	50,297
Discounted Value	464,892	142,669	2,549	517,727	348,096	489,936	4,269

Reinsurance (and some retrocessional) treaties have claim reporting triggers that depend both on (a) amount of claim payments + company valued reserve and/or (b) injury type. Brain damage, serious burn, and SCI cases may be reportable under the injury criterion, even if uninflated claims reserves would not appear to breech the amount being >1/2 of retention criterion.

In the case cited above, the gross uninflated loss to the **reinsurer** writing 9800 xs 200 as highlighted sums to $1,314,555. This would trigger the amount criterion if the **retrocession** were attaching excess 1,800,000 (8 xs 2 M retroceded) but would not it the reinsurer were retaining more than $2,629,110. The reinsurer would likely place the retrocessionaire on notice that a potentially attaching claim had been made, but might not advise of loss amount - instead relying on an *incurred but not reported* loss provision when compiling ceded experience. By including inflation and by layering the loss, this reserving (IBNR) issue can be better framed.

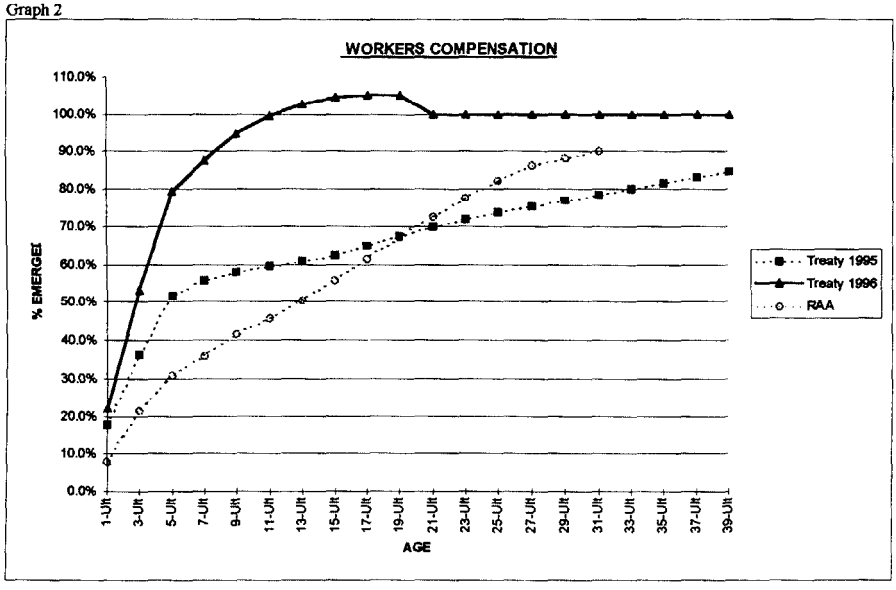
N-P (Xs) Reinsurance Claims Emergence

While the examination of individual claims provides a microcosm for understanding the various features of a workers compensation annuity based reserving system, it is also useful to view the macrocosm of the mixture of cedant layers, types and amounts of claims, over inflationary decades of maturing accident years. We will compare (a) the annuity case driven model (which isolates strictly IBNR claims) with (b) current non-inflationary practice applied to our company figures and (c) the mixture of reserving practices employed by members of the RAA and examined in Reinsurance Association of America Historic Loss Development Study[9].

Traditional chain ladder techniques, employing link ratios, typically neither capture 60+ years of empirical evidence in the "triangles" actuaries use, nor will they forecast lifetime inflating payments due to prior statutes' limitations on benefits.

[9] Reinsurance Association of America: Historic Loss Development Study, Washington, D.C., 1995 edition.

Graph 2



This graph compares RAA accident year claims amount emergence by development age to our company's net claims emergence, both on a pre-inflation 1995 driven annuity case reserve structure and 1996 post-inflation driven reserve basis. The RAA emergence is neither as quickly reporting in the initial 20 years nor as tail data driven in the emergence from 29-ultimate.

The 1996 emergence exceeds ultimate during a period where settlement savings exceed strict IBNR emerging into known claims reserves. It is expected that at year 20 of an accident year's development, all claims are reported and reserved with inflation at unbiased amounts. Any residual development, up or down, is expected to be immaterial.

Values underlying Graph 2 can be found in Appendix 4. The RAA values for ages 1-29 as well as the stated "tail" come from the RAA graph and data.

Findings

- The average gross loss does not capture the distribution of possible outcomes. This distorts thinking about risk management and the role non-proportional reinsurance can play.
- Since carried reserves are oftentimes discounted for the time value of money, the size of loss is further distorted.
- Tabular mathematics impacts layering in oftentimes non-intuitive ways, especially that lower layers need not fill up fully before a higher layer becomes liable.
- Inflation is a driver of catastrophic medical PTD claims; that due to decades of compounding inflation, an annual rate of inflation is magnified into a compound rate on the claim.
- Escalation of indemnity, where applicable, also drives claim values, and that when medical and escalating indemnity are present, claims values are further compounded.
- Inflation captured in an IBNR reserve is not best practice, since individual claims are not properly forecast and chargeable to the (re)insured and don't layer properly.
- Historical inflation in loss triangles (and probably in IBNR forecasts) may not replicate future inflation rates, biasing the forecast, unless adjustments are made.
- Loss development in tabular cases can be forecast, although medical expenditures in the last years of life are highly volatile.
- Utilization of medical services can be cost controlled, somewhat offsetting medical inflation, but in some PTD claims, once relatives of a catastrophically injured claimant are unable or unwilling to care for the claimant, custodial costs act to increase case development considerably.
- Claims emergence to non-proportional reinsurers can be accelerated, with considerable informational and medical management value.

Appendix 1 **Tabular Reserving, a Primer**

Actuaries compile mortality tables by analyzing annual probabilities of surviving to one's next birthday. These are conveniently and **simply** portrayed in tabular form, such as the simplistic illustration given in Chart 12. Column 2 illustrates mortality detail from ages 90-100 expected from 100,000 births.

Chart 12

Age (x)	Living population (lx)	# payments at $1 per annum	Cumulative Payments/EOY	Remaining Payments/BOY
0	100,000 births			
and so on to	....			
90	10	1,1,1,1,1,1,1,1,1,1*	10	55
91	9	1,1,1,1,1,1,1,1,1	19	45
92	8	1,1,1,1,1,1,1,1	27	36
93	7	1,1,1,1,1,1,1	34	28
94	6	1,1,1,1,1,1	40	21
95	5	1,1,1,1,1	45	15
96	4	1,1,1,1	49	10
97	3	1,1,1	52	6
98	2	1,1	54	3
99	1	1**	55	1
100	0			

If we equate a year of life from age 90 to $1.00, then Columns 3, 4, and 5 illustrate the individual (**End Of Year**) and aggregation of (**Beginning Of Year**) $1 payments-to-go, contingent on reaching a particular birthday. At the margins:

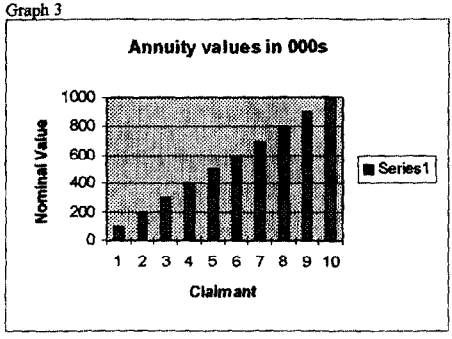
- *One person dies between his 90th and 91st birthday, receiving $1 in benefits only,
- **One person dies between his 99th and 100th birthday, receiving $10 in benefits (vertical highlighted column).

While no 90 year old can know in advance his particular life span, on average, this illustration portrays it as 5.5 years. The sum of lives (l_x) for "x" from 90 to 100 divided by (l_{90}) is the life expectancy of a ninety year old. The life expectation for payment is $5.50 per person.

Suppose each 90 year old begins getting a $100,000 pension on his 90th birthday and each surviving birthday thereafter. Again, no one can know his/her actual life span, so the following Graph 3 illustrates the amounts the annuity provider will pay to the 10 annuitants. The provider will establish a reserve based on Series 1 with: $100,000 x (55/10) = $550,000 for each claimant, or $5,500,000 in the aggregate.

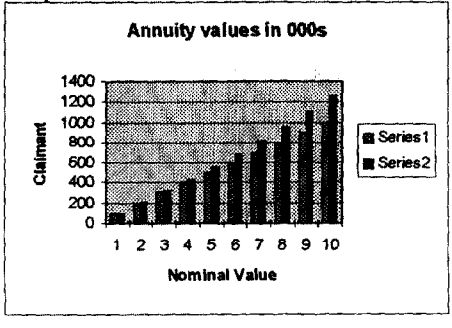
It is worthwhile to note that the variability around the $550,000 mean value will become very important when pensions are stratified, for example, into the $200,000 wide bands as illustrated.

Graph 3



Were this to be a 5% per annum increasing annuity, a Series 2 of actual annuity values would be paid. This illustrates, Graph 4, the compounding effect annual inflation has on a series of inflating payments. Appendix 2 will describe the higher level annuity mathematics necessary to perform various computations.

Graph 4



If Series 1 were to be "layered" for reinsurance and retrocession, the annuity mathematics is not intuitive. To illustrate:

Annuity company (call it a WC carrier) Retention:	200,000
Excess of Loss Reinsurance protection purchased:	800,000
Reinsurer Retention on its own account:	500,000
Retrocession (on gross loss ⇒ 300 xs [500 xs 200])	300,000

From Series 1, the initializing gross loss to the WC primary carrier is $5,500,000 from 10 claimants at $550,000 each. On a net basis, their retention is exhausted after 2 years and is termed a **temporary** (in duration) annuity. They will pay the equivalent of $100,000 x (55-36)/10 = $190,000 per claimant or $1,900,000 for all 10. This is clearly not the same as 2 years of

$100,000 for 10 claimants = $2,000,000 because 1 in 10 died "within retention" and was not paid a second $100,000.

This is oftentimes misunderstood. If the average gross loss is $550,000, and the retention is $200,000, why isn't the average net reserve $200,000? And the average ceded reserve $350,000? The answer lies in the dispersion around the average reserve, as explained above.

The reinsurer has losses associated with claimants living beyond 2 years, a **deferred** annuity. The reserves are 10 times the per person reserve of $100,000 x 36/10 = $360,000 or $3,600,000.

The sum of the WC company's net loss and the reinsurer's gross loss is the full gross loss.

What of the retrocessionaire's loss? It is tempting to say that with an $700,000 attachment and a $550,000 average life expectancy claim, that the retrocessionaire is removed from all loss. Again the deferred annuity calculation illustrates otherwise. The retrocessionaire will attach after 7 years of payment. So the individual reserve is $100,000 x 6/10 = $60,000 and the total 10 person reserve is $600,000 (as can easily be seen in column 2, the bottom 3 rows).

The reinsurer's gross reserve of $360,000 is reduced by $60,000 to a net value of $300,000. This can be directly calculated as a **temporary, deferred annuity**: $100,000 x (36-6)/10 = $300,000.

The reinsurer's reserve is certainly not $550,000 - $200,000 (retention) either gross or net.

Appendix 2 **Advanced Tabular Reserving**

The chart associated with Series 2 from Appendix 1 is as follows. It represents $1 payments with 5% inflation.

Chart 13

Age (x)	Living population (lx)	payments at $1 per annum (D.)	Cumulative Payments	Remaining Payments (N.)
0	100,000 births	with 5% inflation		
and so on to	....			
90	10	10.00	10.00	64.12
91	9 x 1.05 =	9.45	19.45	54.12
92	8 etc.	8.82	28.27	44.67
93	7	8.10	36.37	35.85
94	6	7.29	43.66	27.75
95	5	6.38	50.04	20.46
96	4	5.36	55.40	14.08
97	3	4.22	59.62	8.72
98	2	2.95	62.57	4.50
99	1 x $(1.05)^9$ =	1.55	64.12	1.55
100	0			0

For actuarial convenience, we now introduce "commutation functions" or symbols used to shorten notation. The value of annuities are oftentimes increased by an annual *inflator*, i%, our example being 5%. For an age x: $D_{x+n} = l_x$ times $(1 + i)^n$. **(See * below.)** Similarly, the present value can be associated with a time value of money for *discounting* purposes, d%. So that similarly, for age x (n=0): $D_x = l_x$ times $[(1 + i)/(1+d)]^0$ and similarly $D_{x+n} = l_x$ times $[(1+i)/(1+d)]^n$

Uninflated payments made to the 90 year olds = $D_{90} = l_{90}$ since n=0 and any number raised to the zero power = 1. With 5% inflation $D_{91} = l_{91}$ x $(1.05)^1$.

We also provide for $N_x = \sum D_{x+n}$, for all integers, n = 0 up through a terminal value. The fifth column displays these figures.

These commutation functions can be attuned for payments made monthly, rather than annually at the start, with additional complication not introduced here. WC weekly indemnity and medical payment reimbursements are likely to be paid periodically during the year, perhaps monthly.

Let us repeat the exercise in Appendix 1, where each 90 year old begins getting a $100,000 pension on his 90th birthday and each surviving birthday thereafter. While no one can know their actual life span, the annuity provider will pay (from Series 1): $100,000 x (55/10) = $550,000 for each claimant, or $5,500,000 in the aggregate. From Series 2, using 5% inflation, and commutation symbols: $100,000 N_{90} /D_{90} = $641,200. And the aggregate reserve for the 10 claimants would be $6,412,000. So that 5% inflation has a 16.5% effect on the total payments.

We can carry the layering exercise of Series 2 as well with the following results.

Chart 14

Loss Layering,	**Uninflated**	**Inflated**	$100,000
Gross Loss	**$550,000**	**$641,200**	times (N-N)/D

Net 200,000	190,000	190,000	$(N_{90} - N_{92})/D_{90}$	less 4.5K*
Next 500,000	300,000	326,000	$(N_{92} - N_{97})/ D_{90}$	+4.5K -38K**
Next 300,000	60,000	120,300	$(N_{97} - N_{100})/ D_{90}$	+38K -4.9K***
Xs 1,000,000	0	4,900	N_{100} / D_{90}	+4.9K

* $(N_{90} - N_{92})/D_{90} = 19.45$, but the net payments are now $100,000 and specifically 105,000 in year 2, so that $5000 will not be paid to the 9 of 10 claimants surviving. $194,500 - 4,500.

** $(N_{92} - N_{97})/ D_{90} = 35.95$, but the net payments are 100K, 105K,110K,116K,122K,128K,134K so we add 9/10 of 5K and we subtract 4/10 of 95K (portion of 7th payment xs 500).

***$(N_{97} - N_{100})/ D_{90} = 8.72$, and again add in from below 38K and subtract out the top 1/10 of the maximum loss, 1,049K capped at 1,000K.

We notice that the leveraged effect of inflation is felt particularly on the higher layers. Furthermore, since the annuity provider only purchased 800 xs 200K in reinsurance, there is a 1 in 10 claim for $49,000 (or an average uncovered loss of $4,900 per original claimant) that goes beyond limits.

It is also clear that the retrocessionaire providing the 300,000 layer in excess of 700,000 is now very exposed to the loss, originally cited as a gross loss of $550,000. Without inflation, the tabular mathematical loss per claimant is $60,000 and with inflation it is $120,300.

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* The shorthand above must be corrected, in a technical sense, to expose certain values which become invisible when summarized as we have on the previous page. The actuarial definition of $D_{x+n} = [(1+i)/(1+d)]^{x+n}$ times l_{x+n} . When we calculate the annuity $N_x / D_x = [D_x + D_{x+1} + D_{x+2} + ... D_{100}] / D_x$, we essentially simplify into invisibility the value $[(1+i)/(1+d)]^x$. If we call this adjustment coefficient $[A]^x$ then the simplified expression for a whole life annuity to a 90 year old is given by $[l_{90} + Al_{91} + A^2 l_{92} + ...]/ l_{90}$ which is equivalent to $1 + A(l_{91} / l_{90}) + A^2 (l_{92} / l_{90}) +$ ... which we will recognize as the probability of surviving to get the Adjusted benefit.

Appendix 3 ***Summary of Workers Compensation Indemnity Escalation***

	Start Date	End Date	Max. Duration of Indemnity Benefits	Escalation Description	Social Security Offsets
Colorado -					
Fatal	7/1/91	6/30/94	Benefits end at age 65 during years		Benefits are reduced by 50% of initial
Permanent Total (PT)	7/1/91	6/30/94	when escalation is applicable.	Annual COLA equal to 2%.	Social Security disability benefits up to
Temporary Total (TT)	7/1/91	6/30/94			age 65.
Connecticut -					
Fatal	10/1/77	6/30/93	Fatal - death or remarriage of surviving	Annual increase equal to percentage	
Permanent Total (PT)	10/1/69	6/30/93	spouse.	change in maximum weekly benefit.	
Temporary Total (TT)	10/1/69	6/30/93	PT/TT - period of disability		
District of Columbia-					
Fatal	10/1/72		Fatal - death or remarriage of surviving	Annual increase equal to % change in	WC plus SS disability benefits may not
Permanent Total (PT)	10/1/72		spouse.	maximum weekly benefit capped at 5%.	exceed 80% of the injured workers
Temporary Total (TT)	10/1/72		PT/TT - period of disability	Prior to 7/26/82, the USL&HW provision applied.	gross wage.
Florida -					
Permanent Total (PT)	7/1/84		Period of disability	Supplemental benefit equals 5% of injured workers initial weekly benefit *times the number of calendar years* since the date of injury limited to the current maximum benefit.	SS disability plus WC benefit are capped at 80% of pre-disability wage. *For accidents occurring on or after* 7/1/90, the supplemental benefit ends at age 62 if the worker is eligible for SS retirement benefits, and benefits return to pre-supplement amount.
Idaho -					
Fatal	7/1/91		Fatal - 500 weeks or remarriage or	Annual escalation is equal to the dollar	
Permanent Total (PT)	1/1/72		death of surviving spouse.	change in the SAWW capped at 6%	
Major Permanent Partial (PP)	1/1/72		PT/TT - period of disability	change.	
Minor Permanent Partial (PP)	1/1/72		PP - as per schedule		
Temporary Total (TT)	1/1/72				

	Start Date	End Date	Max. Duration of Indemnity Benefits	Escalation Description	Social Security Offsets
Maine -					
Fatal	1/1/72	12/31/92	Fatal - 500 weeks or remarriage or death of surviving spouse. PT/TT - period of disability PP - 260 weeks for impairment ratings < 15%. No maximum otherwise.	As of 7/1/85, annual escalation is equal to the % change in the SAWW capped at 5%. As of 11/20/87 escalation of PT and TT benefits begins on 3rd anniversary of the injury (with the same annual change as above). Injured workers who's benefits are at the maximum rate do not have to wait 3 years for escalation.	SS retirement offset beginning at age 65, on all benefits except for fatal.
Permanent Total (PT)	1/1/72	12/31/92			
Major Permanent Partial (PP)	1/1/72	11/19/87			
Minor Permanent Partial (PP)	1/1/72	11/19/87			
Temporary Total (TT)	1/1/72	12/31/92			
Maryland -					
Permanent Total (PT)	1/1/88		Period of disability	Annual escalation is equal to the % change in the CPI capped at 5%	WC plus SS disability benefits capped at 80% of gross pre-injury wage.
Massachusetts -					
Fatal	10/1/86		Fatal - benefits are limited to a maximum aggregate of 250 times the SAWW, if self-sufficient. PT - period of disability PP - 260 weeks or 520 weeks for special serious cases.	As of 12/24/91, annual COLA at 10/1 (beginning two years after injury date) equal to the lesser of a) 5%, b) the North East region urban area CPI or c) the percentage change in the SAWW.	There is a SS disability offset applicable to PT escalation benefits that has the potential of capping escalation but only to age 65.
Permanent Total (PT)	10/1/86				
Major Permanent Partial (PP)	10/1/86	12/23/91			
Minor Permanent Partial (PP)	10/1/86	12/23/91			
Minnesota -					
Fatal	10/1/75		Fatal - 10 years or death of surviving spouse. PT/TT - Period of disability	Annual change equal to the change in the SAWW capped at 4% beginning after 2nd anniversary date of injury.	See note below.
Permanent Total (PT)	10/1/75				
Temporary Total (TT)	10/1/75				
Montana -					
Permanent Total (PT)	7/1/87		To age 65	Annual increase of 3% begins after 2 years and lasts no longer than 10 years.	WC benefits are reduced by 50% of SS disability benefits.

	Start Date	End Date	Max. Duration of Indemnity Benefits	Escalation Description	Social Security Offsets
Ohio -					
Permanent Total (PT)	1953		Period of disability	Annual increase equal to the Sept. change in CPI and paid by the Disabled Workers Relief Fund. See note below.	WC benefits are offset by SS disability benefits.
Oregon -					
Fatal	7/1/73		Fatal - Death or remarriage of surviving spouse.	Annual July 1 increases.	
Permanent Total (PT)	7/1/73				
Major Permanent Partial (PP)	7/1/73		Period of disability on remaining injury types.	See Note Below	
Minor Permanent Partial (PP)	7/1/73				
Temporary Total (TT)	7/1/73				
Rhode Island -					
Fatal	9/1/86		Fatal - Death or remarriage of surviving spouse.	Annual increase equal to 4% on fatal benefits. Annual increase on PT's and PP's is equal to the percentage change in the CPI applied every May 10th after the 1st year for PT's and after the 6th year for PP's.	Retirement offset applicable for workers past age 55 or within 5 years of retirement.
Permanent Total (PT)	see note		PT - Period of disability		
Major Permanent Partial (PP)	see note		PP - 312 weeks		
Minor Permanent Partial (PP)	see note				
South Dakota -					
Permanent Total (PT)	7/1/88		Period of disability	Annual increase equal to the change in the CPI capped at 3%.	After 7/1/93, workers who reach age 65 are subject to SS offset equal to 150% of the WC benefit minus the SS disability benefit.
Texas -					
Permanent Total (PT)	9/1/91		Period of disability	Annual increase equal to 3% on lifetime cases	

	Start Date	End Date	Max. Duration of Indemnity Benefits	Escalation Description	Social Security Offsets
Vermont -					
Fatal	7/1/83		Fatal - Surviving spouse benefit is limited		
Permanent Total (PT)	7/1/83		by age 62, death or remarriage.	Annual increase equal to change in	
Major Permanent Partial (PP)	7/1/83		PT/TT - Period of disability.	SAWW	
Minor Permanent Partial (PP)	7/1/83		PP - limited to a schedule		
Temporary Total (TT)	7/1/83		or 330 weeks if not a scheduled injury.		
Virginia -					
Fatal	7/1/75		Fatal and TT benefits are limited in	Annual increase equal to the change	Escalation available only if WC and SS
Permanent Total (PT)	7/1/75		duration to 500 weeks (or death or	in the CPI. The total benefit, including	(disability and survivorship) benefits
Temporary Total (TT)	7/1/75		remarriage of surviving spouse).	escalation is capped at the current	are less than 80% of the employees
			PT - Period of disability	maximum benefit.	average pre-injury monthly wage.
USL&HW -					
Fatal	10/1/72		Fatal - Death or remarriage of surviving	Annual increase equal to change in	
Permanent Total (PT)	10/1/72		spouse.	the National AWW limited to 5%.	
			PT - Period of disability.	Prior to 1984 there was no limitation.	
Fed. Black Lung Act, Title IV Fed Coal Mine Safety Act '69					
Fatal	12/30/69		Fatal - Death of surviving spouse	Increase dependent upon increases in	
Permanent Total (PT)	12/30/69		PT/TT - Period of disability	federal workers wage or an act of	SS disability offset.
Temporary Total (TT)	12/30/69			congress.	

Notes

COLA = Cost of living adjustment, SAWW = State Average Weekly Wage, SS = Social Security, CPI = Consumer Price Index

Connecticut: Escalation on outstanding fatal losses prior to 10/1/77 or total losses prior to 10/1/69 is picked up by the Second Injury and Compensation Assurance Fund.

Florida: Supplemental benefits payable on claims prior to 7/1/84 are paid by the Workers Compensation Administration Trust Fund.

Idaho: Injured workers receiving benefits of less than 45% (minimum) of the Average State Wage (ASW) will receive an increase on Jan 1 and on the first anniversary of the injury and annual increases thereafter.
Injured workers receiving benefits greater than 90% (maximum) of the ASW are eligible for an increase at Jan 1 unless benefits are greater than 90% of the injured workers AWW.
After 52 weeks, benefits are limited to the lesser of 67% of the current ASW for injuries occurring after 7/1/91 (60% injuries occurring before 7/1/91) or 90% of the injured workers original AWW.

Massachusetts: Benefits after application of the COLA are limited to a maximum of "three times the original benefit". COLA benefits payable on claims from occurrences prior to 10/1/86 and escalation above 5% on accidents on or after 10/1/86 are paid by the Workers Compensation Trust Fund.
Prior to 12/24/91, the annual COLA was equal to the change in the SAWW capped at 10% (with no wait period) except for PP's which were capped annually at 5%. Permanent Partial benefits during the period when escalation applied, were limited in duration to 600 weeks.

Minnesota: If dependents are receiving Social Security benefits, then the fatal workers compensation benefit, before escalation, is limited to the deceased workers average weekly wage less the Social Security benefit. For total loss injury types judged to be permanent total, the workers compensation benefit is reduced by Social Security disability or retirement benefits after the first $25,000 of benefit is paid.

Montana: Conversion to PP is no longer allowed at age 65.

Ohio: All escalation benefits are paid by the Disabled Workers Relief Fund (DWRF). Self-insureds are billed for the amount paid to their eligible employees. DX insurer will reimburse self-insureds for DWRF assessments on claims with dates of accident occurring after 8/86. Ohio has a monopolistic state fund.

Oregon: Escalation on TT benefits is based on percentage change in SAWW. Escalation on Fatal, PT and PP's is computed and paid for by the Retroactive Reserve This is the only state where escalation on benefits is not the responsibility of the employer/insurer. Effective 6/7/95 (with SB 369), escalation on PP award granted on or after 6/7/95 for dates of injury prior to 7/1/71 are not eligible for reimbursement by the Retroactive Reserve.

Rhode Island: The COLA benefit on non-fatal claims with injury dates between 9/1/74 - 12/31/93 are reimbursed by the WC Administrative Fund. COLA benefits on cla occurring subsequent to 12/31/93 are not reimbursed by the fund. Claims occurring prior to 9/1/74 are subject to a maximum limitation.

USL&HW: Escalation payable on claims occurring prior to 10/1/72 are paid for by the USL&HW Special Fund.

Federal Black Lung: Claims filed under this act between 12/30/69 and 12/31/73 are paid for by the Federal Government. Employers are responsible for claims occurring after 12/31/73. If the Black Lung Benefits are greater than 37.5% of the lowest rate of pay for GS-2 federal employees, they will not increase with increases in the federal wage until the federal wage has caught up.

Appendix 4 **Link Ratio Comparison**

Treaty Workers Compensation
Emergence Comparison

	Without Inflation 12/95			With Inflation 1996			RAA		
	Age-to Age	Age-to Ult	IBNR Factor	Age-to Age	Age-to Ult	IBNR Factor	Age-to Age	Age-to Ult	IBNR Factor
1-2	1.800	5.695	0.824	2.000	4.510	0.778	2.050	12.676	0.921
2-3	1.150	3.164	0.684	1.200	2.255	0.557	1.325	6.183	0.838
3-4	1.270	2.751	0.637	1.300	1.879	0.468	1.250	4.667	0.786
4-5	1.120	2.166	0.538	1.150	1.446	0.308	1.150	3.733	0.732
5-6	1.050	1.934	0.483	1.050	1.257	0.204	1.080	3.246	0.692
6-7	1.030	1.842	0.457	1.050	1.197	0.165	1.080	3.006	0.667
7-8	1.020	1.788	0.441	1.040	1.140	0.123	1.080	2.783	0.641
8-9	1.015	1.753	0.430	1.040	1.096	0.088	1.070	2.577	0.612
9-10	1.015	1.727	0.421	1.030	1.054	0.051	1.050	2.408	0.585
10-11	1.015	1.702	0.412	1.020	1.023	0.023	1.050	2.294	0.564
11-12	1.010	1.677	0.404	1.020	1.003	0.003	1.050	2.185	0.542
12-13	1.010	1.660	0.398	1.010	0.984	-0.017	1.050	2.081	0.519
13-14	1.010	1.644	0.392	1.010	0.974	-0.027	1.050	1.981	0.495
14-15	1.015	1.627	0.386	1.010	0.964	-0.037	1.050	1.887	0.470
15-16	1.020	1.603	0.376	1.005	0.955	-0.047	1.050	1.797	0.444
16-17	1.020	1.572	0.364	1.000	0.950	-0.053	1.050	1.712	0.416
17-18	1.020	1.541	0.351	1.000	0.950	-0.053	1.050	1.630	0.387
18-19	1.020	1.511	0.338	1.000	0.950	-0.053	1.040	1.553	0.356
19-20	1.020	1.481	0.325	1.000	0.950	-0.053	1.040	1.493	0.330
20-21	1.015	1.452	0.311	0.950	0.950	-0.053	1.040	1.435	0.303
21-22	1.015	1.431	0.301	1.000	1.000	0.000	1.040	1.380	0.275
22-23	1.015	1.410	0.291	1.000	1.000	0.000	1.030	1.327	0.246
23-24	1.015	1.389	0.280	1.000	1.000	0.000	1.030	1.288	0.224
24-25	1.010	1.368	0.269	1.000	1.000	0.000	1.030	1.251	0.201
25-26	1.010	1.355	0.262	1.000	1.000	0.000	1.030	1.214	0.176
26-27	1.010	1.341	0.254	1.000	1.000	0.000	1.020	1.179	0.152
27-28	1.010	1.328	0.247	1.000	1.000	0.000	1.020	1.156	0.135
28-29	1.010	1.315	0.239	1.000	1.000	0.000	1.020	1.133	0.117
29	1.010	1.302	0.232	1.000	1.000	0.000	1.111	1.111	**0.100**
	1.010	1.289	0.224	1.000	1.000	0.000	-	-	RAA p18
	1.010	1.276	0.216	1.000	1.000	0.000	-	-	-
	1.010	1.264	0.209	1.000	1.000	0.000	-	-	-
	1.010	1.251	0.201	1.000	1.000	0.000	-	-	-
	1.010	1.239	0.193	1.000	1.000	0.000	-	-	-
	1.010	1.226	0.185	1.000	1.000	0.000	-	-	-
	1.010	1.214	0.176	1.000	1.000	0.000	-	-	-
	1.010	1.202	0.168	1.000	1.000	0.000	-	-	-
	1.010	1.190	0.160	1.000	1.000	0.000	-	-	-
	1.010	1.179	0.152	1.000	1.000	0.000	-	-	-
40 to Ultimate	**1.167**	1.167	0.143	1.000	1.000	0.000	-	-	-

factors represent a 60 or more year development pattern. 1995 values in the tail were selected in light of 1996 indications.

Appendix 5 **Navigating the Claim Spreadsheet**

Excel 5.0 spreadsheet **WCCASE.XLS**

A1	Sex of claimant	B1-B26
A2	Date of birth	Values input
A3	Current date	for the
A4	Age	Claimant
A5	Mortality assumption	
A7	Annual Meds	
A8	Annual Indemnity	
A10	Med Infl. rate	
A11	Indy. Infl rate	
A12	Discounting rate	
A14	Ground up paid losses to date	
A16-18	Layers 1, 2, 3	
A20-22	Attach ment,	
A24-26	width, and participation	
A30-33	Reins paid to date	Values
A35-38	Nominal reserves	calculated
A40-43	Reins Incurred	
A45-48	Discount	
A50-53	Reserves net of Disc	
A55-58	Max Life Payments	

A 115	Up to 103 years of claimant activity	B age at payment date	Columns C through K Indemnity and Medical Payments by year	Columns M through P, Summary of paid loss, discount and mortality	R-U, W-Z, AB-AE, AG-AI itemize Layer claim values
A219					221 = calculated reserves/incurred