CASUALTY ACTUARIAL SOCIETY FORUM

Summer 1994

Including the Environmental Papers

CASUALTY ACTUARIAL SOCIETY
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CASUALTY ACTUARIAL SOCIETY

Date: July 1994

To: CAS Readership

Re: *The Forum*, 1994 Summer Edition

This edition of *The Forum* is largely devoted to the Environmental Call Paper Program. An introduction to the papers is provided by the Committee on Reserves.

This edition also includes two other original papers. We are also offering reprints of papers by Paul Samuelson and John Cozzolino. Dr. Cozzolino has provided an introduction to these reprints.

As always, any submissions, question or comments may be directed to me, or anyone on the Committee on *The Forum*.

Very Truly Yours,

Joel Kleinman
Chairperson, The Committee on *The Forum*

The Casualty Actuarial Society Forum

The Casualty Actuarial Society *Forum* is a non-refereed journal printed by the Casualty Actuarial Society. The viewpoints in it do not necessarily reflect the view of the Casualty Actuarial Society.

The *Casualty Actuarial Society Forum* is edited by the Committee for the *Casualty Actuarial Society Forum*. The Committee invites all members of the CAS to submit papers on topics of interest to the actuarial community. Articles need not be written by a member of the CAS, but should have content of interest to the CAS membership.

The Committee for the *Casualty Actuarial Society Forum* requests that the following procedures be followed when submitting an article to be published:

1. Authors should submit a camera-ready original paper, and two copies.

2. Authors should not number their pages.

3. All exhibits, tables, charts and graphs should be in original format and camera-ready.

4. Authors should avoid using a gray-shaded graph, table or exhibit.

5. Text and exhibits should be in black and white.

The *Casualty Actuarial Society Forum* is printed on a periodic basis, based on the number of articles submitted. Its goal is to publish two editions during the calendar year.

All comments or questions may be directed to the Committee for the *Casualty Actuarial Society Forum*.

Summer 1994 Forum

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Duration, Hiding in A Taylor Series

by Keith D. Holler

Introduction

Duration has been touted as a tool for measuring the sensitivity of the price, or value, of an asset, or liability, whose cash flows are fairly determinable, to changes in interest rates. This paper seeks to describe the above relationship in a concrete fashion by expressing the value of an asset or liability as a function of the current interest rate. This function is then expanded in a Taylor series to illustrate just where the duration concept fits in. After this presentation is made, the Taylor series is further employed to illustrate that one may obtain a level of immunization as close to complete as desired by essentially matching successive terms in the Taylor series, the second of which reflects duration.

The Fundamental Relationships

The formula below presents the price of a known stream of cash flows given an interest rate i. This paper will assume a flat yield curve for ease of presentation.

$$P(i) = \sum CF_t / (1+i)^t$$

$P(i)$ is the price of this cash flow and is expressed as a function of the interest rate i. CF_t is the cash flow at time t.

The Taylor series for the price at a new interest rate may be expressed as follows:

$$P(i + \Delta i) = P(i) + P'(i)\,\Delta i + \frac{P''(i)(\Delta i)}{2!} + \ldots$$

The change in the interest rate, Δi, has produced a change in the price of $P(i + \Delta i) - P(i)$. It is this change in price that is frequently estimated using duration.

The duration, $D(i)$, of a stream of cash flows as a function of the interest rate i is:

$$D(i) = \frac{\sum t\, CF_t/(1+i)^t}{\sum CF_t/(1+i)^t}$$

Note the denominator is the price of the cash flow. The second term in the Taylor series, $P'(i)\Delta i$, can be shown to consist of duration multiplied by a constant and the change in i.

$$P'(i) = \frac{d}{di}\sum CF_t(1+i)^{-t} = \frac{-1}{(1+i)}\sum tCF_t/(1+i)^t$$

$$P'(i) = -D(i)P(i)/(1+i)$$

Therefore, using only the first two terms of the Taylor series; the change in the price of the instrument, $P(i+\Delta i) - P(i)$, is often approximated by $-D(i)\ P(i)\ \Delta i\ /(1+i)$.

This approximation is refined when the third term is considered. However, this term essentially reflects the quantity known as convexity. Convexity is defined as:

$$C(i) = \frac{\sum t^2 CF_t/(1+i)^t}{\sum CF_t/(1+i)^t}$$

The relation to the Talyor series is revealed by determining the second derivative of the price as follows:

$$P''(i) = \frac{d}{di}(P'(i)) = -\frac{d}{di}\sum tCF_t(1+i)^{-(t+1)}$$

This equals:

$$P''(i) = \frac{1}{(1+i)^2} \times [\sum t^2 CF_t/(1+i)^t + \sum t\ CF_t/(1+i)^t]$$

OR

$$P''(i) = [C(i) + D(i)]\ P(i)/(1+i)^2$$

Therefore, the price of the instrument after a change in interest rates of Δi can be approximated by:

Original Price X {1 - Duration x$\Delta i/(1+i)$ + [Convexity + Duration] x $(\Delta i)^2$ X $.5/(1+i)^2$}

The use of duration, in the second term of the Taylor series, to determine the change in the instrument value is only an approximation. As more terms of the Taylor series are added the accuracy improves (note the limit of the series must exist).

By matching the cash flows of an asset to the cash flow of a liability one is assured that the gain or loss on the asset due to changes in the interest rate, will be exactly offset by changes in the value of the liability. The assets and liabilities are said to be completely matched or immunized against changes in interest rates. This assumes that the cash flows of the asset and the liability are fixed.

Often the duration of assets is matched to the duration of liabilities in an attempt to gain a level of immunization when the cash flows are not exactly matched. One of the primary purposes of matching duration rather than the entire cash flows is that some of the assets held can be of longer maturities to take advantage of the higher yields. When this is done it is often not realized that there is a trade-off. As duration matching principally accounts for only the first two terms in the Taylor series, the immunization is not complete. Therefore, the price of the investment gain from the higher yields is the potential loss resulting from the asset liability mismatch.

Immunization, to any Desired Level

By matching successive levels of "duration", thereby matching successive terms of the Taylor series, one may gain any given level of desired partial immunization. If one matches all of the "duration" terms, then all of the terms of the Taylor series are matched. When this occurs complete immunization is achieved and the cash flows are exactly matched.

To prove the first statement we must assume that the current price of an asset, $P_A(i)$, equals the price of the liability, $P_L(i)$, and that the price of these items at the interest rates $i + \Delta i$ exist. They can then be represented by:

$$P_A(i+\Delta i) = P_A(i) - D_A(i)\, P_A(i)\Delta i/(1+i) + [C_A(i) + D_A(i)]\, P_A(i)\, (\Delta i)^2 \times .5/(1+i)^2 \ldots$$

$$P_L(i+\Delta i) = P_L(i) - D_L(i)\, P_L(i)\Delta i/(1+i) + [C_L(i) + D_L(i)]\, P_L(i)\, (\Delta i)^2 \times .5/(1+i)^2 \ldots$$

Let us assume that the (n+1)st term of the Taylor series equals $(-1)^n K_n(i)\, P(i)\, (\Delta i)^n/n!/(1+i)^n$ where $K_n(i)$ is a linear function of the first n duration terms. The jth duration term is represented by:

$$D_j(i) = \frac{\sum t^j CF_t/(1+i)^t}{\sum CF_t/(1+i)^t}$$

Then given a desired maximum level of mismatch $\epsilon > 0$ there exists an integer m such that:

$$\left| \sum_{n>m} \frac{K_n(i)P(i)(\Delta i)^n}{n!(1+i)^n} \right| < \epsilon/2$$

for both the asset and the liability. Hence, if we match the first m-1 duration terms of the asset and the liability, thereby matching the first m-1 $K_n(i)$ terms, we see that the absolute value of P_A

$(i + \Delta i)$ - P_L $(i + \Delta i)$ is less than ϵ. That is to say the desired level of immunization has been achieved.

The Lemma

The lemma can be proven by induction. The earlier discussion on duration already illustrates the case where n=1. Let us assume that it is true for n+1 and prove the assertion for n+2 then the proof of the lemma will be complete. Thus the assumption for n+1 can be stated as:

$$\frac{(-1)^n K_n(i)P(i)(\Delta i)^n}{n!(1+i)^n} = \mathrm{P}^n(i)\frac{(\Delta i)^n}{n!}$$

For n+2 let us begin with the right side of the equation

$$\mathrm{P}^{n+1}(i)\,\frac{(\Delta i)^{n+1}}{(n+1)!} =$$

$$\frac{d}{di}\mathrm{P}^n(i)\ \mathrm{X}\ \frac{(\Delta i)^{n+1}}{(n+1)!} =$$

$$\frac{d}{di}\frac{(-1)^n K_n(i)P(i)}{(1+i)^n}\ \mathrm{X}\ \frac{(\Delta i)^{n+1}}{(n+1)!} =$$

$$\frac{(-1)^n}{(1+i)^{n+1}}\ \mathrm{X}\ [-nK_n(i)P(i)+(1+i)P(i)\frac{d}{di}K_n(i)+(1+i)K_n(i)\frac{d}{di}P(i)\ ]\ \mathrm{X}\ \frac{(\Delta i)^{n+1}}{(n+1)!} =$$

$$\frac{(-1)^n P(i)(\Delta i)^{n+1}}{(1+i)^{n+1}(n+1)!}\ \mathrm{X}\ [-nK_n(i)+(1+i)\frac{d}{di}K_n(i)-K_n(i)D(i)\ ] =$$

Unfortunately, we must now trail off on a further aside to confirm that the expression in the brackets is in fact equivalent to $K_{n+1}(i)$. In order to make this aside more presentable, we will not include the interest rate variable. This has been included, up until now, to stress the view that duration and price are functions of the interest rate.

One of our assumptions is that $K_n = a_1D + a_2C + a_3D_3 + \ldots + a_nD_n$. Therefore in order to differentiate K_n we must differentiate D_j.

$$\frac{d}{di}D_j = \frac{d}{di}\sum t^j CF_t(1+i)^{-t}P^{-1}$$

$$= \frac{-1}{1+i}\sum t^{j+1}CF_t(1+i)^{-t}P^{-1} + \frac{1}{1+i}\sum t^j CF_t(1+i)^{-t}DPP^{-2}$$

$$\frac{d}{di}D = \frac{1}{1+i}[-D_{j+1} + DD_j]$$

We can now restate the derivative of K_n as follows.

$$\frac{d}{di}K_n = \frac{1}{1+i}[(-a_1C + a_1D^2) + (-a_2D_3 + a_2DC) + (-a_3D_4 + a_3DD_3) + \ldots + (-a_{n-1}D_n + a_{n-1}DD_{n-1}) + (-a_nD_{n+1} + a_nDD_n)]$$

$$= \frac{-1}{1+i}[a_1C + a_2D_3 + a_3D_4 + \ldots + a_nD_{n+1}] + \frac{D}{1+i}K_n$$

Returning to the stage of the proof just before this aside, substituting the result of the aside for the derivative of K_n, and simplifying we see that:

$$P^{n+1}(i)\frac{(\Delta i)^{n+1}}{(n+1)!} = \frac{(-1)^n P(i)(\Delta i)^{n+1}}{(1+i)^{n+1}(n+1)!}\left[-nK_n(i) - (a_1C + a_2D_3 + a_3D_4 + \ldots + a_nD_{n+1})\right]$$

$$= \frac{(-1)^{n+1} P(i)(\Delta i)^{n+1}}{(1+i)^{n+1}(n+1)!}[na_1D + (na_2 + a_1)C + (na_3 + a_2)D_3 + \ldots + (na_n + a_{n-1})D_n + a_nD_{n+1}]$$

$$= \frac{(-1)^{n+1} P(i)(\Delta i)^{n+1}}{(1+i)^{n+1}(n+1)!}K_{n+1}(i)$$

and we have proved the lemma.

The Recursion Formula

There is an interesting recursive formula that exists for the duration term coefficients above. I would liken it to a type of Pascal's triangle. The triangle is built as follows:

$K_1 = D$ coefficient of 1

$K_2 = D+C$ coefficients of 1 and 1

The trick begins with K_3.

$K_3 = a_{31}D + a_{32}C + a_{33}D_3$

The coefficients for the previous term are:

1	1	

We multiply these by n-1, which is in 2 in this case. Then we shift the previous coefficients and add.

2	2	
	1	1

This produces the coefficients.

$K_3 = 2D + 3C + 1D_3$

The process would proceed for K_4 as follows.

2	3	1		multiplied by 3 yields
6	9	3		shift and add the prior coefficients
	2	3	1	and voila

$K_4 = 6D + 11C + 6D_3 + D_4$

The first term in the K_n expansion is always (n-1)!. The second last term is always the sum of the first n-1 positive integers. Finally, the last term is always 1.

The reader may have noticed that the expression of K_n as a linear combination of duration terms was not illustrated. This can be shown by induction as well.

A Little Hand Waving

I would like to diverge briefly from the mathematics and discuss the earlier statement that if all the duration terms of an asset and a liability are matched then the cash flows are matched. It has been pointed out to me that the history of asset liability matching proceeded from a primary level at which the goal was to match market values of assets ($P_A(i)$) and liabilities ($P_L(i)$). The next phase was the pairing of assets and liabilities with equivalent yields. Duration matching is the first step beyond this level. Duration matching begins to consider the probabilistic nature of the price of a stream of cash flows. Duration is often described as the mean timing of the cash flows. This interpretation is obtained by examining the definition of duration and assuming that the probability associated with a cash flow at time t is $[CF_t/(1+i)^t]/P(i)$. The matching of asset and liability durations may be thought of as the matching of the mean or first moment of the random variable associated with the timing of each cash flow.

Continuing along this line of reasoning, convexity can be viewed as a variance or second moment type quantity. Convexity is an indicator of the level of dispersion of the timing of the cash flows. By accounting for duration and convexity one has matched the mean and the variance of the timing of the cash flows.

Matching successive duration terms is equivalent to matching successive moments of t. Once all of the moments of t are matched, the timing of the cash flows will be matched. Hence, the cash flows are matched.

This last discussion is by no means "concrete", but rather a "kind of" type discussion. It is provided to suggest an additional view regarding duration and asset liability matching.

Conclusion

Some people are aware of the relation, as expressed by the Taylor series, between the price of an asset or liability and its duration. For those people who are just being introduced to the concept of duration, I hope the relations presented in this paper will provide some additional insight.

Using the Whole Triangle to Estimate Loss Reserves

by Frank Pierson

INTRODUCTION

This paper will suggest an easy, straightforward way to complement the basic methods currently used by most actuaries to estimate ultimate losses. Most actuaries use some variation of standard loss development or Bornheutter-Ferguson methods. These methods can be applied to a variety of data, e.g., paid, incurred, claim counts or average severities. The last step of most analyses is to apply a development pattern to the latest evaluation of data to estimate ultimate values.

All of these methods rely, to some degree, on analyzing "data triangles" to determine the appropriate development patterns. Most actuarial papers have concentrated on the appropriate adjustments to the underlying data(e.g., Berquist-Sherman) or determining the correct way to calculate these patterns(e.g., Sherman, Weller). There is not much written on how to improve the estimate of the forecasts after the actuary has developed the factors.

In this paper, I propose adding a step to the standard methods by applying the selected development pattern to all values in the data triangle. This step can be used in most methods in use by actuaries today and can be applied to data aggregated by policy year, underwriting year, accident year or report year. This paper uses accident year without loss of generality.

CRITIQUE OF STANDARD METHODS

There are a number of shortcomings associated with the typical actuarial analysis.

Although the historical data is used to select the development pattern, once selected, the development pattern is usually applied to the data as of the latest evaluation date only. This is particularly true when the development pattern is based solely on external data. The analysis ignores the fact that historical data other than those at the latest evaluation date ever existed, however, if the development pattern is correct then it should apply equally to data at evaluation dates other than the latest one.

Given that most projections are a function of the latest diagonal only, they are very sensitive to random movements from year to year in the known losses even if the selected development pattern remains unchanged. The projected ultimates will move up or down from year to year solely due to these random movements. There are times when these movements are substantial and, therefore, result in large movements in the projected ultimate loss. If the actuarial analysis truly measured the underlying losses and their development pattern, then twelve months of additional data should not alter significantly the actuary's view of the ultimate loss. At a minimum, there should be some credibility weighting between the latest indication and prior indications.

In many loss reserve analyses, the projections tend to creep up or down(mainly up) from one evaluation to the next. One standard explanation is that the change in ultimate loss was due to "unexpected adverse development." This explanation is valid once or twice, but is not valid year after year. At some point, continued unexpected development should alert the actuary that the method is not matching the data accurately.

METHODOLOGY

This section of the paper will outline the steps needed to add the proposed procedure to various standard actuarial techniques.

Before we start, let's define a little notation. For each accident year i, i=1,2,...,n, evaluated at the end of year t, t=1,2,...,n-i+1:

- Q = n-i+1, i.e., the latest evaluation date of each accident year (I will ignore the subscript unless needed in the context),
- L(i,t) = the cumulative loss for accident year i at evaluation date t,
- d(t) = factor to develop losses evaluated at year t to ultimate,
- U(i,t) = projected loss based on d(t) and L(i,t),
- Ult(i) = selected ultimate for year i,
- Pult(i)= a priori ultimate for year i,
- XL(i,t)= expected cumulative loss for accident year i evaluated at the end of year t,
- E(i,t) = error term, and
- BF(i,t)= Bornheutter-Ferguson estimate or accident year i evaluated at the end of year t.

The d(t)'s are based on the standard analysis and may be based solely on the company's actual data, i.e., L(i,t), external data or a combination of both.

For clarity during the discussions that follow, I refer to the "standard" method as the one under discussion without the proposed additional steps and the "augmented" method as the one with the additional steps.

Both the standard and augmented methods are highly dependent on accurate estimates of the loss development patterns including the selection of tail factors. The following discussion assumes that the selected pattern is accurate (including the appropriate tail factors) and that variability in projected ultimates is due to random fluctuations.

Loss Development Method

The standard loss development method sets the projected ultimate loss equal to:

$$Ult(i) = L(i,Q)*d(Q).$$

This method is criticized, as outlined above, for being much too sensitive to movements in losses over the latest calendar period. However, if there were multiple projections of ultimate for each accident year based on the selected development pattern at various evaluation points, this method would be much less sensitive to random noise.

Using the augmented method, one can calculate a "triangle" of projected ultimates for each accident year i, t=1,2,...,Q:

$$U(i,t) = L(i,t)*d(t).$$

The selected ultimate, Ult(i), could then be based on some or all of the U(i,t) and not just U(i,Q). Exhibit I shows how the proposed method could be used in analyzing industry-wide general liability paid losses.

Each U(i,t),t<Q, represents the projected ultimates from the standard method at prior evaluations, assuming that the most recently selected development pattern applied at all prior evaluation dates. The change in U(i,t) for a given accident year, say, 1985, approximates the change in the projected ultimate loss for 1985 using the standard method. If we assume, simplistically, that the ultimate loss under the augmented method equals the average of all U(i,j), j=1,...,t, then we can compare the variability of loss projections over time between the two methods. Exhibit II shows graphically the change over time in the projections of ultimate for accident year 1985 based on the standard loss development method versus the projections based on the proposed method. As you can see, the variability in the projected ultimates is less using the augmented method.

Bornheutter-Ferguson Method

The standard Bornheutter-Ferguson method sets the projected ultimate loss equal to:

$$Ult(i) = L(i,Q)+[Pult(i)-XL(i,Q)], \text{ where}$$

$$XL(i,Q)= Pult(i)/d(Q).$$

This method is commonly described as a combination of the loss development method and the expected loss ratio method. The major advantage of this method over the loss development method is that it is less sensitive to random noise in L(i,t). However, I believe that this method loses some of its advantage relative to the loss development method due to the fact that it is usually applied to the latest diagonal only. The assumption underlying adding expected IBNR to L(i,Q) is that future losses are more a function of the Pult(i) and d(t) than they are of L(i,Q) because of the effect of random noise on L(i,Q). Many times, in practice, Ult(i) is significantly different from Pult(i) which may indicate that either, or both of Pult(i) and d(q) are incorrect. If, however, one assumes that Pult(i) and d(t) are valid, then BF(i,t), t<Q, should produce valid estimates of Ult(i) as well.

Under the augmented method, one can calculate a "triangle" of ultimates for each accident year i, (t=1,2,...,Q):

$$BF(i,t) = L(i,t)+[Pult(i)-XL(i,t)].$$

The selected ultimate, Ult(i), is then based on all of the U(i,t) and not just U(i,Q). Exhibit III shows how the augmented method could be used for this method for industry-wide general liability paid losses. For the purposes of Exhibit III, Pult(i) is based on the results of the loss development analysis.

One of the major drawbacks of the Bornheutter-Ferguson method is that the actuary must select both the development pattern and the initial ultimate loss, Pult(i). The Pult(i) is usually calculated by multiplying the ultimate premium for accident year i times an expected loss ratio or is based on the result of the prior reserve study. If Pult(i) and d(Q) are correct, then Ult(i) should equal Pult(i). A significant difference between Ult(i) and Pult(i) would indicate that either Pult(i), d(Q) or both are wrong. Of course, the difference could be due to random noise and Pult(i) and d(Q) were correct. This determination is made easier by reviewing the triangle of BF(i,t) calculated above, e.g., seeing systematic increases or decreases in the projections over time.

ADVANTAGES OF THE AUGMENTED METHODOLOGY

Using the augmented methodology can improve the analysis in the following ways:

The actuary now has more than one estimate of ultimate on which to base his selections. This reduces the sensitivity of the selected ultimate to random fluctuation in L(i,t).

Many actuaries use some form of curve fitting to smooth out fluctuations in the observed data(for example, see Sherman, Weller, Clarke). The tail factor is usually extrapolated from this curve. Unfortunately, most curves in use today do not fit the data equally well over the entire historical period. For example, many curves do not fit well at early maturities (less than 36 months). This can be a significant problem since the largest reserves are usually associated with the most recent accident years which have data only at these early maturities.

To overcome this problem, two adjustments to the augmented method can be made, either individually or together. The first, assuming that data exists at early maturities for older accident years, is to analyze the historical relationship between the projected ultimates at the early maturities to those projected for later maturities, e.g., 12 months versus 36 months and subsequent. This analysis may indicate whether or not there is any significant and systematic bias in the projection at early maturities. The actuary now has information on which to adjust the projections for the less mature accident years based on a straight application of the underlying method.

The second adjustment compares the variation in the L(i,t) to the variation in the projected ultimates. In many cases, there is a relationship between L(i,t) or movements in L(i,t) from one accident year to the next and the distortion in projected ultimates at early maturities compared to those at later maturities. For example, the actuary may believe that for a given data set that even though there does not exist any apparent bias in the projected ultimates at early maturities, historically, the projected ultimates appear to be overstated whenever there is a significant increase in L(i,1) over l(i-1,1). Now the actuary is presented with the case where L(n,1) represents a significant increase over L(n-1,1). How should the projected ultimate for accident year n be adjusted? Exhibit IV shows how these adjustments might be calculated.

In addition to calculating an estimate of the expected reserve, there is a growing interest on the part of companies for a "range of reasonableness" or "confidence interval." This is very difficult to develop using most standard methods. The augmented method may help the actuary get a better feel for the variability in the estimates by analyzing the variance of the historical projections either in absolute dollar or relative "error" terms. The actual mechanics of this are beyond the scope of this paper.

Many times the actuary must deal with changes in either speed of payment/closure or case reserve adequacy. This is usually handled by either adjusting the data or selecting the development pattern based on the latest N diagonals. N is selected to include only the data that is consistent with current conditions. By reviewing the entire triangle of projected ultimates, the actuary can confirm the change by looking for a change in the pattern of ultimates. If there is no significant change in the ultimates, the suspected underlying change may not have had any significant impact on the development pattern. This procedure can also help identify unidentified changes which can lead to the need for further investigation.

For any of the standard methods, one can calculate a triangle of error terms for each accident year at each evaluation point, $t=1,2,\ldots,Q$, i.e.,

$$E(i,t) = [XL(i,t)-L(i,t)]/L(i,t),$$

where $XL(i,t)$ is calculated using the method underlying the projected ultimate losses.

If the selected development pattern truly fits the data, then the error terms should be randomly distributed with a mean near zero. Patterns in the error terms can highlight problems such as auto-correlation and other statistical problems. Since the standard loss development methods are linear estimators, then the assumptions underlying classic linear regression should apply to these methods. As such, if the development pattern is correct, then the error terms should have an expected value of zero, equal variance (for a given development period) and not be correlated with one another. Graphing E(i,t) can help the actuary determine whether there is any bias or auto-correlation in the estimates.

In addition to the standard view of error terms, the actuary can also compare expected to actual calendar year losses. This part of the analysis is rarely performed, but is one that is important to anyone who is concerned with the aggregate cash flow of losses across more than one accident year. Relatively small accident year errors may mask significant calendar year errors. A large calendar year "error" may indicate a significant structural change in the loss process during that year, e.g., a change in the claims handling or a large commutation.

The augmented method focuses attention where it belongs, i.e., on the variation in the estimated ultimates. We have, as a profession, tended to focus on variability in the development patterns and how to best evaluate these patterns. We have not looked at the variability in the resulting ultimates (one significant exception is Stanard).

I believe that the augmented method is an improvement over the standard method in meeting the four key attributes of a reserving system as outlined by Steven Lowe. This procedure improves the stability of the indication from year to year; it objectively combines more of the available information in deriving the current indication because it uses the entire historical data; and it is as integrated and interactive as the standard method.

DISADVANTAGES OF THE AUGMENTED METHOD

The augmented method may be less sensitive to changes in the underlying losses because the selected ultimate loss is based on more than data at the latest evaluation.

The augmented method does not, by itself, eliminate changes in Ult(i) from year to year due to changes in the assumed development pattern. If the basic analysis indicates a change in the assumed pattern, it is not clear whether the standard or augmented method would be affected more by such a change. If there is a large difference in the assumed development pattern from one year to the next without a significant change in the underlying business or claims handling practices, one should question the methodology used in selecting the development pattern.

PRACTICAL POINTS

I have used the augmented method for some time and have a few practical observations.

The augmented method can be used for most lines of business, even those that are inherently volatile such as Excess or Surplus Lines, or where data volume is sparse. In these lines, many actuaries apply Bornheutter-Ferguson for stability because other methods such as paid or incurred development methods are too sensitive to volatility in the latest value. Since the augmented method adds stability to most standard development methods, actuaries might be able to use methods other than Bornheutter-Ferguson. More than one approach can be more important for these lines of business than for lines that are very stable.

If the selected development pattern is based on the latest N diagonals because of a perceived change in the data, it is usually appropriate to base the selection of ultimate loss on no more than the latest N+1 projections. It is inconsistent to exclude historical data when calculating the development pattern and then to include projections based on the excluded data in selecting the final estimate of ultimate.

The selection of N is not always easy. Sometimes the correct value of N is apparent from the data or from discussions with management, e.g., the discussions may indicate that a change in claims handling took place three years ago and, therefore, the correct choice for N might be 2. When the choice for N is not so apparent, the augmented method can help the actuary select the optimal N, although the process might be iterative by viewing the effect of different values of N on the triangle of ultimates. Typically, the data fluctuates up and down period to period and, therefore, the standard method may over or understate the ultimate losses depending on whether the losses are at a peak or trough. Using more than one estimate will smooth out this "expected" variability in the estimates.

If d(t) is correct, then U(i,t) should converge to the true ultimate over time. Many times, however, some accident years converge while others do not. For example, the older accident years might converge while the later years do not. This might indicate that some unaccounted for change took place and the actuary should investigate further. It may be necessary to use a different pattern for the two groups of years. In other cases, the years that converge may be spread among years that do not. In addition, some years may trend up and others trend down while some years move up(or down) for a few evaluations and then down(up). The actuary must use his/her judgment to decide for which years the selected pattern is appropriate.

This procedure should be easy to incorporate into most analyses since all the needed elements are already calculated.

Although most of the above discussion deals with the loss development and Bornheutter-Ferguson methods, it can be adapted for other methods as well. For example, the method outlined by Clarke fits a curve to cumulative paid or incurred loss ratios for each accident year or groups of accident years. If we define R(i,t) as the fitted ratio at time t for accident year i, then we can calculate a triangle of U(i,t):

$$U(i,t) = L(i,t)*R(i,u)/R(i,t),$$

where u is when losses reach ultimate. R(i,u)/R(i,t) is equivalent to d(t) in this case. If the curve fit is correct, then the U(i,t)'s should be stable. Exhibit V reproduces the graph for the 1981 year of account contained in Mr. Clarke's paper(p. 30) with the U(i,t)'s superimposed on it. As expected, the U(i,t) begin to converge, but not until after the first 8 quarters.

In his discussion of Mr. Clarke's paper, John Narvell makes a number of observations that are germane to this paper:

1) "The difference between a simple LDF and the more sophisticated approach in this present paper is that the most current observation is not simply multiplied by the appropriate LDF to ultimate. Rather there is some consideration for a random error contained in the endpoint.... Effectively each historical data point is given equal credibility in the estimation of ultimate losses."

2) "...a major difference between the author's approach and the traditional LDF or B-F methods...[is that] the negative exponential considers only the development patterns for the particular year before year t...[and the] traditional LDF or B-F methods [consider] only development data (for other years) after age t...."

3) "... [a] major advantage is that the curve form naturally leads to graphical display and interpretation."

I believe that the augmented methods discussed above compare favorably to Clarke's "sophisticated approach" in that they:

1) consider the random error contained in the end-point,

2) give some credibility to historical data points,

3) consider development from both before and after age t, and

4) they lead naturally to graphical display and interpretation.

With respect to (2), I do not agree with the implication that giving equal credibility to each historical data point is desirable. Given how external and internal changes influence losses, the latest data points should probably, though not automatically, be given greater weight than earlier points. An augmented method would allow the actuary to give the appropriate weight to each data point.

With respect to (3), the augmented methods consider both development after age t in the calculation of the age-to-ultimate development factors and development before age t by selecting the ultimate losses as a function of historical projections.

With respect to (4), graphing the projected ultimates or error terms for an accident year is the quickest way to determine how well the development pattern fits the historical data. In addition, putting the projections from various methods together in a single graph can help the actuary assess the quality of his/her estimate. Exhibit VI shows the projected ultimates for two accident years based on standard paid and incurred development methods. As you can see, the paid and incurred projections for accident year 1985 (sheet B) are converging while for accident year 1983 (sheet A), only the paid projections are converging. The non-convergence of the incurred projections would lead me to dig deeper into the numbers for that year.

Different methods are more stable or they converge more quickly than others. Bornheutter-Ferguson, for example, tends to converge more quickly than paid or incurred development methods. This should be expected given the underlying theory of each method.

SIMULATION

Based on my usage of this procedure with a wide range of books of business, I believe that it increases the stability and predictability of the underlying, basic reserve methods. In order to put this hypothesis to a stricter test, I propose the following simulation of the loss development method (I have not had time to model this adequately)..

The reader should note that as I worked on the simulation, I found it extremely difficult to program the proposed procedure to work "correctly" for the latest two accident years in the wide range of outcomes created during the simulation because of the amount of judgment needed. Therefore, the simulation may have to be limited to all but the latest two years. One must keep in mind that the augmented method does not make loss reserving mechanical, particularly for the most immature accident years; it simply gives the actuary more information than the standard methods on which to base his/her judgment. The simulation, therefore, should be viewed as an approximation at best since it was impossible to include "actuarial judgment" for each iteration.

In order to test the augmented method against the standard method, the simulation would have to create a triangle of losses and then calculate loss development factors based on that triangle of data. Using those items, the simulation would then calculate ultimate losses based on the standard and augmented method at various points in time, e.g., t=Q-2, Q-1 and Q. Each method would produce ultimate losses very close to the true ultimates over a large number of iterations since both methods are not significantly biased. However, the variability in the ultimates from one iteration to the next may be significant. The following model would compare the variability in the ultimate losses from one evaluation point to the next for the standard versus the augmented methods.

Step 1.

Select the true ultimate loss for each accident year, L(i,u), and the underlying development pattern, d(t). The simulation should look at many different situations, e.g.:

a. L(i,u) = $100 million for all accident years,
b. L(i,u) increasing at a constant rate,
c. L(i,u) decreasing at a constant rate, and
d. L(i,u) = $100 million +/-10%(uniformly distributed).

Step 2.

Assume random noise around d(t) and calculate a "historical" loss triangle, i.e.,

$$L'(i,t) = L(i,u)/[d(t)+(RAND-.5)*2*RN(t)]$$

where RAND is a random number uniformly distributed over (0,1) and RN(t) is the selected range of random noise allowed at each evaluation point. RN(t) should decrease "over time" to reflect the fact that the random noise apparent in d(t) decreases as losses mature.

Step 3.

Calculate d'(t) based on the weighted average of all years. The tail could be set equal to the true d(n) in order to eliminate any distortion in the results of the simulation due to mis-estimation of the tail factor. This assumption should not affect the conclusions of this analysis because the simulation is designed to compare the relative stability and predictability of the augmented versus traditional loss development method.

Step 4.

Calculate triangle of U(i,t) based on the L'(i,t) simulated in step 2 and d'(t) calculated in step 3. For the standard method, set Ult(i) equal to U(i,Q). For the augmented method, set Ult(i) equal to the average of U(i,t), t=2,3...Q. U(i,1) is not used except when Q-2=1. The most variability is in U(i,1) and may require significant judgment. To minimize the need for judgment in the simulation, U(i,1) is not used unless it is the only projected ultimate available.

For each method, the average and standard deviation of the U(i,t) values are calculated by accident year. Although both methods produce an accurate estimate of the ultimate losses, on average, across all iterations, the hypothesis is that: 1) the standard method has a larger standard deviation at each point in time than that for the augmented method and 2) there is more variability in the ultimates based on the standard method from one evaluation to the next than for the augmented method.

CONCLUSIONS

The purpose of this paper is to outline a simple method to help actuaries do a better job of projecting ultimate losses, whether for pricing or reserving. I hope that it sparks some interest on the part of other actuaries.

I would like to thank John Narvell for the inspiration to write this paper and Carol Rennie for making it much easier to read.

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INDUSTRY COMPOSITE - MEDICAL MALPRACTICE

Exhibit I

Loss Development Method

Historical Paid Loss + ALAE at N months - L(i,t)

AY	12	24	36	48	60	72	84	96	108	120
1982	50	172	383	675	952	1,197	1,385	1,517	1,631	1,706
1983	67	218	487	800	1,121	1,397	1,604	1,772	1,898	
1984	104	298	609	973	1,337	1,612	1,836	2,000		
1985	43	254	602	1,025	1,406	1,736	1,924			
1986	52	261	626	1,006	1,362	1,621				
1987	37	267	635	1,029	1,348					
1988	56	338	733	1,092						
1989	79	396	853							
1990	88	445								
1991	98									
Cum LDFs = d(t)	64.485	11.674	4.747	2.729	1.941	1.569	1.369	1.251	1.178	1.129

Projected Ultimate Loss + ALAE at N months - U(i,t) = L(i,t)*d(t)

AY	12	24	36	48	60	72	84	96	108	120	Average of All	Average of last 4
1982	3,224	2,008	1,818	1,842	1,848	1,878	1,896	1,898	1,921	1,927	2,026	1,910
1983	4,320	2,545	2,312	2,183	2,176	2,192	2,195	2,217	2,235		2,486	2,210
1984	6,706	3,479	2,891	2,655	2,595	2,529	2,513	2,503			3,234	2,535
1985	2,773	2,965	2,858	2,797	2,729	2,723	2,633				2,783	2,721
1986	3,353	3,047	2,972	2,745	2,644	2,543					2,884	2,726
1987	2,386	3,117	3,014	2,808	2,617						2,788	2,889
1988	3,611	3,946	3,479	2,980							3,504	3,504
1989	5,094	4,623	4,049								4,589	4,589
1990	5,675	5,195									5,435	5,435
1991	6,319										6,319	6,319
Cum 1987 Avg	2,386	2,751	2,839	2,831	2,788							

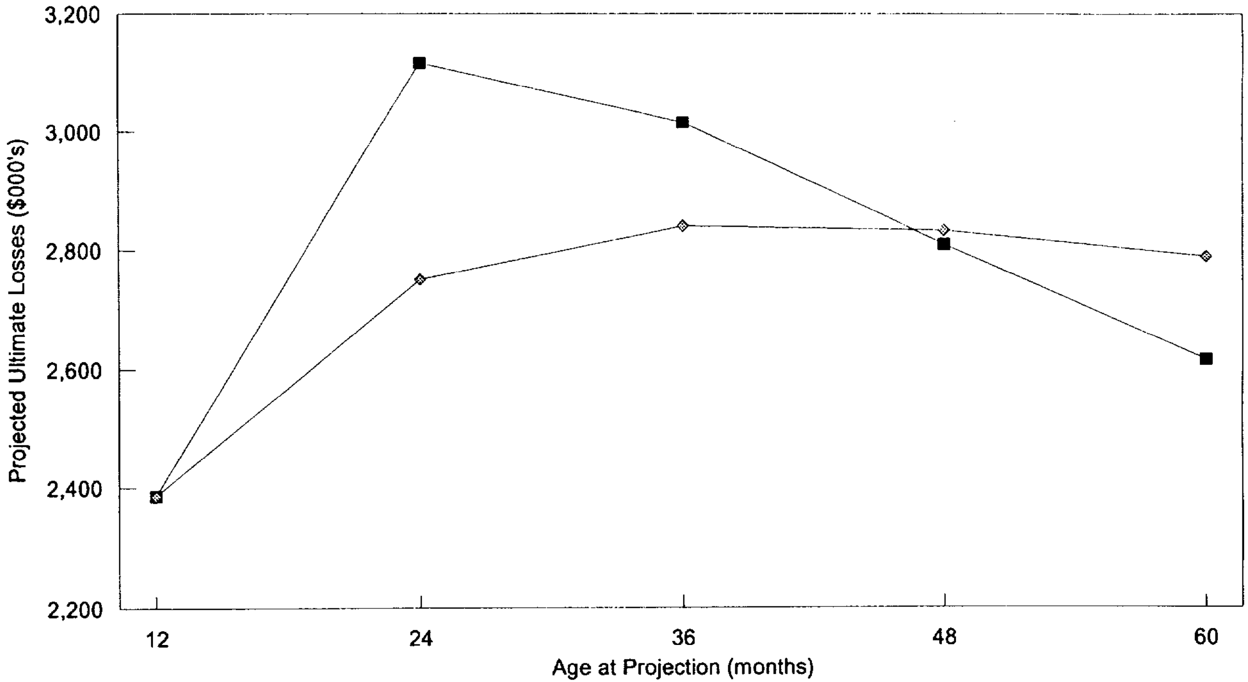
Notes: [1] Accident Year 1982 @12months: 3,224 = 50*64.485
[2] The 1987 AY is used in Exhibit 2 - A graphical comparison of the relative stability of the Standard and the Augmented methods

Data Source: Best's Aggregates & Averages - 1991

Exhibit II

Change in Projections of Ultimate Losses by Age - AY 87

Standard vs. Augmented



Source: Best's Aggregates & Averages - 1991
INDUSTRY COMPOSITE - MEDICAL MALPRACTICE

Exhibit III

INDUSTRY COMPOSITE - MEDICAL MALPRACTICE

Bornheutter-Ferguson Method

Historical Paid Loss + ALAE at N months - L(i,t)

AY	12	24	36	48	60	72	84	96	108	120	'Prior' Ult Pult(i)
1982	50	172	383	675	952	1,197	1,385	1,517	1,631	1,706	1,910
1983	67	218	487	800	1,121	1,397	1,604	1,772	1,898		2,210
1984	104	298	609	973	1,337	1,612	1,836	2,000			2,535
1985	43	254	602	1,025	1,406	1,736	1,924				2,721
1986	52	261	626	1,006	1,362	1,621					2,726
1987	37	267	635	1,029	1,348						2,889
1988	56	338	733	1,092							3,504
1989	79	396	853								4,589
1990	88	445									5,435
1991	98										6,319
Cum LDFs = d(t)	64.485	11.674	4.747	2.729	1.941	1.569	1.369	1.251	1.178	1.129	
% Reported	1.6%	8.6%	21.1%	36.6%	51.5%	63.7%	73.1%	79.9%	84.9%	88.5%	
% Unreported	98.4%	91.4%	78.9%	63.4%	48.5%	36.3%	26.9%	20.1%	15.1%	11.5%	

Projected Ultimate Loss + ALAE at N months - U(i,t) = L(i,t) + Pult(i)*(1-1/d(t))

AY	12	24	36	48	60	72	84	96	108	120	Average of All	Average of last 4
1982	1,931	1,919	1,891	1,885	1,878	1,890	1,900	1,901	1,919	1,925	1,904	1,911
1983	2,243	2,239	2,231	2,200	2,192	2,198	2,199	2,216	2,232		2,217	2,211
1984	2,600	2,616	2,610	2,579	2,566	2,531	2,519	2,509			2,566	2,531
1985	2,722	2,742	2,750	2,749	2,725	2,722	2,657				2,724	2,713
1986	2,736	2,753	2,778	2,733	2,684	2,609					2,715	2,701
1987	2,881	2,909	2,915	2,859	2,749						2,863	2,858
1988	3,506	3,542	3,499	3,312							3,465	3,465
1989	4,597	4,592	4,475								4,554	4,554
1990	5,438	5,414									5,426	5,426
1991	6,319										6,319	6,319

Notes: [1] Accident Year 1982 @12months: 1,931 = 50 + 1,910*(1-1/64.485)
[2] 'Prior' Ultimate equals the Average of the last 4 ultimates as projected by the LDF method

Data Source: Best's Aggregates & Averages - 1991

Adjustment of Indicated Ultimates
Based on Actual Company Data

Exhibit IVa

Historical Paid Loss +ALAE at N months - L(i,t)

AY	12	24	36	48	60	72	84	96	108	120
1	553	7,034	14,473	22,365	27,140	35,561	39,822	42,418	46,121	48,164
2	631	8,281	14,590	22,431	28,727	34,241	41,279	43,457	47,044	
3	682	6,431	17,260	26,945	34,464	40,194	45,640	50,271		
4	933	10,942	22,880	37,076	42,430	51,883	58,648			
5	999	11,208	21,225	30,108	38,568	43,636				
6	1,221	12,050	24,735	35,563	45,488					
7	1,369	14,689	29,190	40,431						
8	1,169	9,580	22,461							
9	878	7,819								
10	672									

Age-to-Age Development Factors

1	12.722	2.058	1.545	1.214	1.310	1.120	1.065	1.087	1.044	
2	13.114	1.762	1.537	1.281	1.192	1.206	1.053	1.083		
3	9.433	2.684	1.561	1.279	1.166	1.135	1.101			
4	11.727	2.091	1.620	1.144	1.223	1.130				
5	11.219	1.894	1.419	1.281	1.131					
6	9.869	2.053	1.438	1.279						
7	10.730	1.987	1.385							
8	8.195	2.345								
9	8.903									
Selected	10.436	2.080	1.489	1.243	1.200	1.145	1.074	1.085	1.044	
Cumulative = d(t)	72.028	6.902	3.319	2.229	1.794	1.496	1.306	1.216	1.121	1.073

Indicated Ultimates - U(i,t) = L(i,t)*d(t)

AY	12	24	36	48	60	72	84	96	108	120	Indicated @12 mths	Indicated @24 mths	Ult(i) Avg Indic 36 & Subseq
1	39,826	48,546	48,034	49,854	48,687	53,182	52,002	51,565	51,680	51,680	39,826	48,546	50,836
2	45,483	57,154	48,420	50,001	51,534	51,208	53,905	52,829	52,715		45,483	57,154	51,516
3	49,103	44,383	57,282	60,064	61,826	60,111	59,600	61,113			49,103	44,383	59,999
4	67,206	75,519	75,935	82,646	76,115	77,592	76,586				67,206	75,519	77,775
5	71,958	77,357	70,440	67,114	69,189	65,258					71,958	77,357	68,000
6	87,945	83,167	82,092	79,275	81,601						87,945	83,167	80,989
7	98,604	101,378	96,874	90,125							98,604	101,378	93,499
8	84,203	66,116	74,544								84,203	66,116	74,544
9	63,258	53,962											
10	48,433												

Adjustment of Indicated Ultimates

Exhibit IVb

Calculation of Adjustment Factors

AY	U(i,12)	U(i,24)	Avg of U(i) 36 & Subs
1	39,826	48,546	50,836
2	45,483	57,154	51,516
3	49,103	44,383	59,999
4	67,206	75,519	77,775
5	71,958	77,357	68,000
6	87,945	83,167	80,989
7	98,604	101,378	93,499
8	84,203	66,116	74,544
9	63,258	53,962	
10	48,433		

Adjustment Factors @ 12 mths

AY	Ult(i) / U(i,12)
1	1.28
2	1.13
3	1.22
4	1.16
5	0.95
6	0.92
7	0.95
8	0.89

Regression Output:

Constant	1.3168
Std Err of Y Est	6.79%
R Squared	83.09%
No. of Observations	8
Degrees of Freedom	6
X Coefficient(s)	-0.0569
Std Err of Coef.	1.05%

Adjustment Factors @ 24 mths

AY	Ult(i) / U(i,24)
1	1.05
2	0.90
3	1.35
4	1.03
5	0.88
6	0.97
7	0.92
8	1.13

Regression Output:

Constant	1.0622
Std Err of Y Est	16.59%
R Squared	1.36%
No. of Observations	8
Degrees of Freedom	6
X Coefficient(s)	-0.0074
Std Err of Coef.	2.56%

Application of Adjustment Factors

AY	U(i,12)	U(i,24)	Avg of U(i,t) t=36 & Subs	Selected Adjustment Factors @12 mths	Selected Adjustment Factors @24 mths	Ult(i)	
1	39,826	48,546	50,836			50,836	
2	45,483	57,154	51,516			51,516	
3	49,103	44,383	59,999			59,999	
4	67,206	75,519	77,775			77,775	
5	71,958	77,357	68,000			68,000	
6	87,945	83,167	80,989			80,989	
7	98,604	101,378	93,499			93,499	
8	84,203	66,116	74,544			74,544	
9	63,258	53,962		0.81	1.00	52,447	= Avg of 63,258*.81 & 53,962*1.00
10	48,433			0.75		36,242	= 48,433*.75

Notes: [1] The selected Adjustment Factors @ 12 months equal the regression predicted factors
[2] The selected Adjustment Factor @ 24 months equals 1.00. The regression fit has a very low R-Squared value (1.36%), and is, therefore, not used. The average of the prior factors equals 1.03 and the average of the prior factors excluding the high and the low equals 1.00. Hence, there does not appear to be sufficient evidence to justify an adjustment to Indicated ultimates @ 24 months.

Adjustment of Indicated Ultimates

Exhibit IVb

Calculation of Adjustment Factors

AY	U(i,12)	U(i,24)	Avg of U(i) 36 & Subs
1	39,826	48,546	50,836
2	45,483	57,154	51,516
3	49,103	44,383	59,999
4	67,206	75,519	77,775
5	71,958	77,357	68,000
6	87,945	83,167	80,989
7	98,604	101,378	93,499
8	84,203	66,116	74,544
9	63,258	53,962	
10	48,433		

Adjustment Factors @ 12 mths

AY	Ult(i) / U(i,12)
1	1.28
2	1.13
3	1.22
4	1.16
5	0.95
6	0.92
7	0.95
8	0.89

Regression Output:	
Constant	1.3168
Std Err of Y Est	6.79%
R Squared	83.09%
No. of Observations	8
Degrees of Freedom	6
X Coefficient(s)	-0.0569
Std Err of Coef.	1.05%

Adjustment Factors @ 24 mths

AY	Ult(i) / U(i,24)
1	1.05
2	0.90
3	1.35
4	1.03
5	0.88
6	0.97
7	0.92
8	1.13

Regression Output:	
Constant	1.0622
Std Err of Y Est	16.59%
R Squared	1.36%
No. of Observations	8
Degrees of Freedom	6
X Coefficient(s)	-0.0074
Std Err of Coef.	2.56%

Application of Adjustment Factors

AY	U(i,12)	U(i,24)	Avg of U(i,t) t=36 & Subs	Selected Adjustment Factors @12 mths	Selected Adjustment Factors @24 mths	Ult(i)	
1	39,826	48,546	50,836			50,836	
2	45,483	57,154	51,516			51,516	
3	49,103	44,383	59,999			59,999	
4	67,206	75,519	77,775			77,775	
5	71,958	77,357	68,000			68,000	
6	87,945	83,167	80,989			80,989	
7	98,604	101,378	93,499			93,499	
8	84,203	66,116	74,544			74,544	
9	63,258	53,962		0.81	1.00	52,447	= Avg of 63,258*.81 & 53,962*1.00
10	48,433			0.75		36,242	= 48,433*.75

Notes: [1] The selected Adjustment Factors @ 12 months equal the regression predicted factors
[2] The selected Adjustment Factor @ 24 months equals 1.00. The regression fit has a very low R-Squared value (1.36%), and is, therefore, not used. The average of the prior factors equals 1.03 and the average of the prior factors excluding the high and the low equals 1.00. Hence, there does not appear to be sufficient evidence to justify an adjustment to Indicated ultimates @ 24 months.

Exhibit V

Fitted Loss Ratios

1981 Year of Account

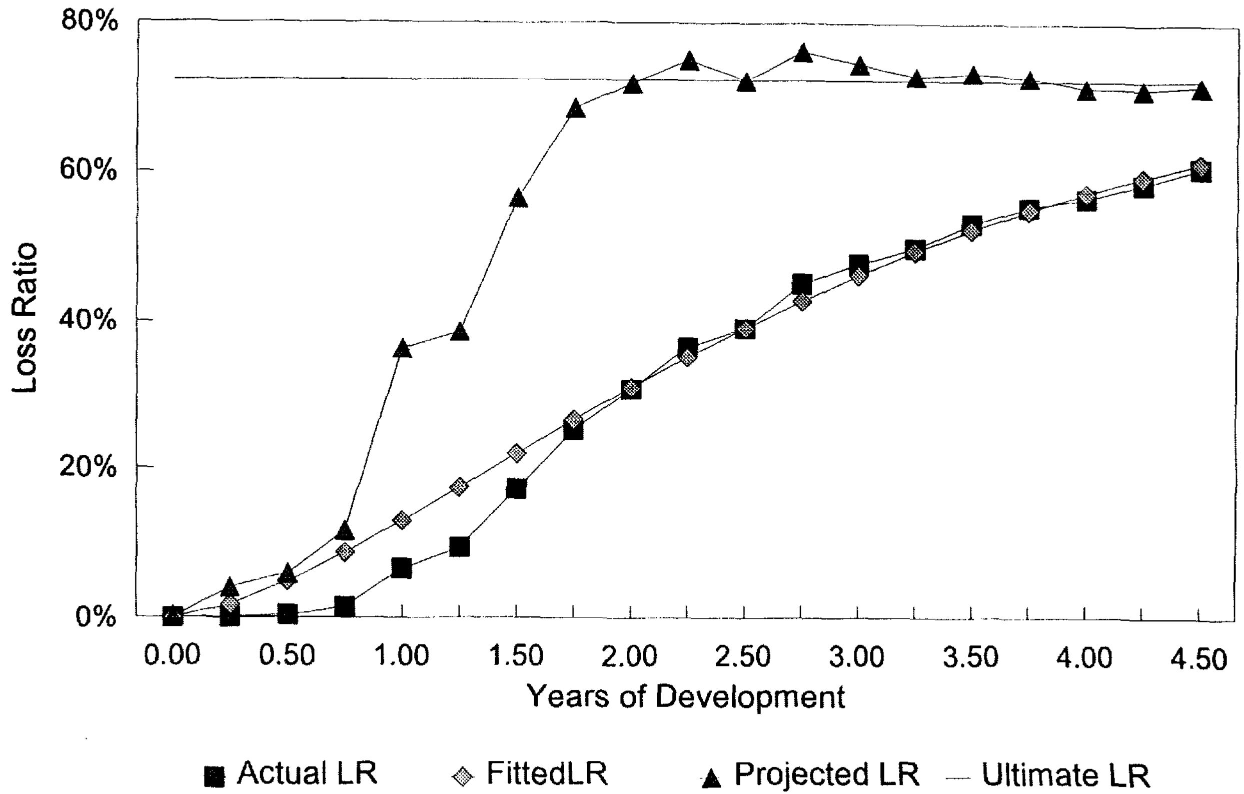


Exhibit VI
Sheet A

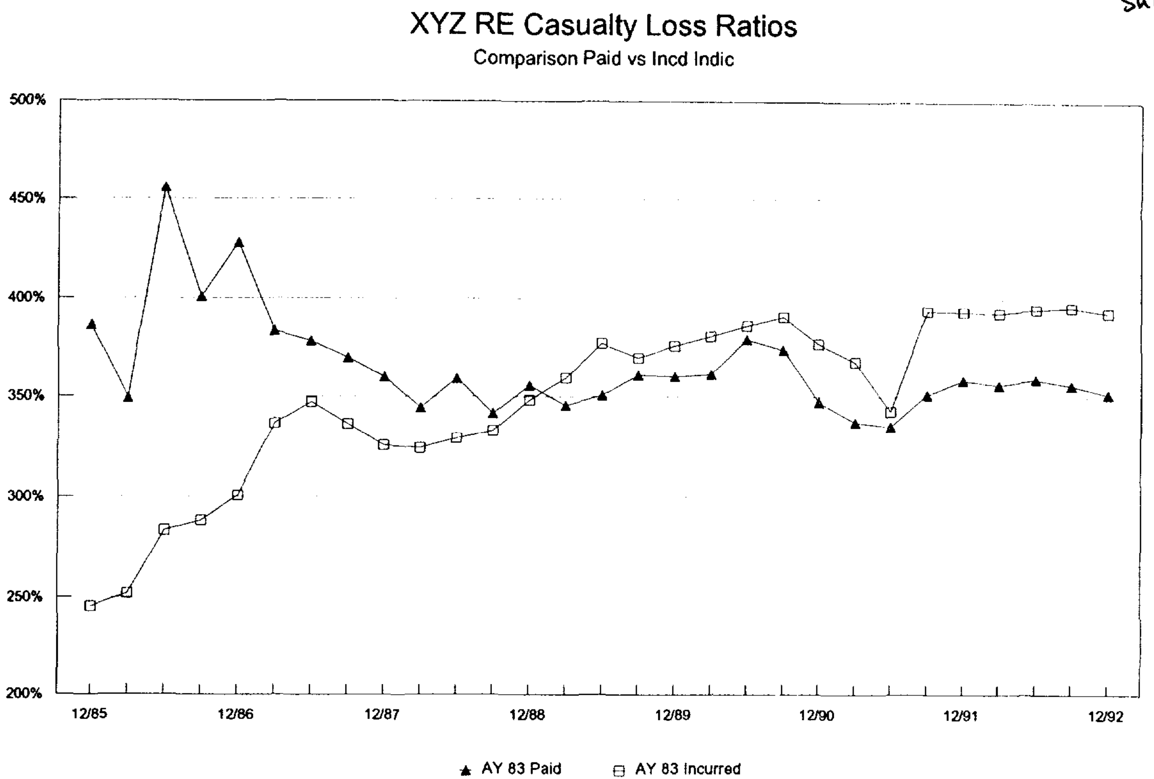
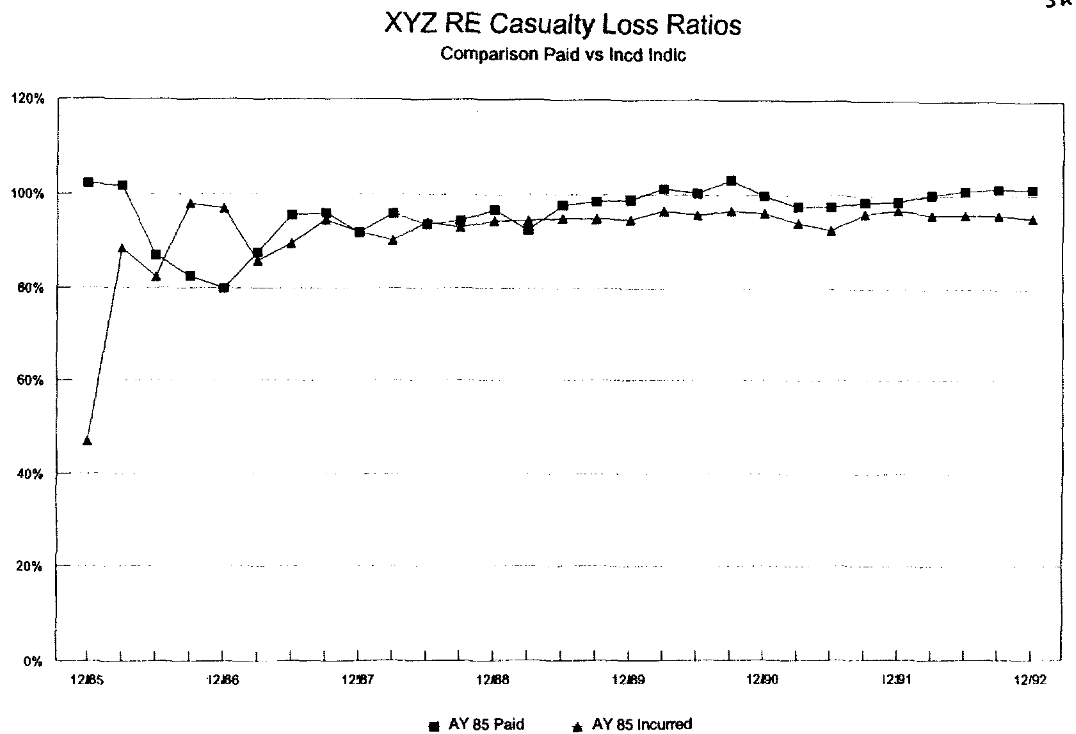


Exhibit VI
Sheet 6



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Introduction to Reprints of 'Risk and Uncertainty: A Fallacy of Large Numbers' and 'Portfolio of Risky Projects

by John M. Cozzolino

INTRODUCTION TO PAUL A. SAMUELSON'S "RISK AND UNCERTAINTY; A FALLACY OF LARGE NUMBERS"

JOHN M. COZZOLINO

The Paper "Risk and Uncertainty: A Fallacy of Large Numbers" by Paul A. Samuelson, was published in Scientia in April-May, 1963. It was later reprinted in the Collected Scientific Papers of Paul A. Samuelson, Volume 1, pp. 153-8, MIT Press, 1966. It had a very distinguished influence on the ideas of risk and portfolio for investment applications.

The paper first got the attention of Pratt, Zeckhauser, and other mathematical economists and thereby spawned several related papers. Unfortunately it apparently did not reach the one group most concerned with property and casualty insurance. We hope that the current republication will rectify this.

Samuelson's Paper proved that risk sharing, which is a fractional participation in one risk, is a more fundamental way to reduce risk than having a replication of identical, independent risks. He proved that if you would not accept one risk, then you would not accept any greater number of identical, independent risks. While people loosely say that the insurance institution exists because of the law of large numbers or because it can insure many risks, this is not the case; the real reason insurance exists is because insurers are risk averse, meaning that their utility curves are concave, and they take fractional participation. He also stated that within a sufficiently small interval of outcomes, the concave function is a linear function. So we are back to the fundamental role of the utility curve. If the expected monetary value is positive then there is a best share greater than zero.

Paul A. Samuelson said this with such clarity that it was obviously true to the reader.

After reading his, I wrote a paper that was published in Decision Sciences in 1974 "Portfolios of Risky Projects". While sharing was always looked at in the perspective of Pareto optimality; Samuelson's paper seemed to suggest that was unnecessary. I realized that the reason there was a best share was because it was assumed that both parties had a concave utility function. Others may have attributed the existence of the best share to the fact that there were two or more parties. In fact, for a partial share to be best for a single party, all you need is that the single party have a concave utility function (be risk averse).

But, you might say, how can you take a share without knowing the party with whom you share? The answer is that when there is an established, deep market for shares, exactly as there is in Lloyds. It is better to assume that you can always find the needed partner or set of needed partners, than to seek the best share for some specific partner who may or may not exist. Finding your preferred share is more to the point. The Paul A. Samuelson paper seems to suggest the framework of the single decision maker trying to find his best decision for himself. Perhaps other observers saw this differently and did not realize the fundamental nature of the "Best Share". From a pure mathematical perspective, share is just a number multiplying the random variable "loss". Therefore the variance of that product must be proportional to that multiplier squared. Cutting the share by one half cuts the variance by one quarter. That is risk reduction. Finance, both real and theoretical, has advanced from the dark ages by inventing markets.

My paper proves the existence of a best share by assuming only a concave utility function and a positive expected monetary value. Whether you speak of size of share retained or of the number of equal partners is up to you. It appears more realistic to solve this "best share" problem, at least in the insurance context. In any case it seems good to expose the casualty actuaries to Samuelson's insightful work so that they can draw their own conclusions.

John M Cozzolino

Risk and Uncertainty: A Fallacy of Large Numbers (Reprint)

by Paul A. Samuelson

RISK AND UNCERTAINTY: A FALLACY OF LARGE NUMBERS[1]

Experience shows that while a single event may have a probability spread, a large repetition of independent single events gives a greater approach toward certainty. This corresponds to the mathematically provable Law of Large Numbers of James Bernoulli. This valid property of large numbers is often given an invalid interpretation. Thus people say an insurance company reduces its risk by increasing the number of ships it insures. Or they refuse to accept a mathematically favorable bet, but agree to a large enough repetition of such bets: e. g., believing it is almost a sure thing that there will be a million heads when two million symmetric coins are tossed even though it is highly uncertain there will be one head out of two coins tossed. The correct relationship (that an insurer reduces total risk by *subdividing*) is pointed out and a strong theorem is proved: that a person whose utility schedule prevents him from ever taking a specific favorable bet when offered only once can never rationally take a large sequence of such fair bets, if expected utility is maximized. The intransitivity of alternative decision criteria-such as selecting out of any two situations that one which will more probably leave you better off-is also demonstrated.

1. Introduction. - « There is safety in numbers. » So people tell one. But is there? And in what possible sense?

The issue is of some importance for economic behavior. Is it true that an insurance company *reduces* its risk by *doubling* the number of ships it insures? Can one distinguish between risk and uncertainty by supposing that the former can count on some remorseless cancelling out of actuarial risks?

To throw light on a facet of this problem, I shall formulate and prove a theorem that should dispell one fallacy of wide currency.

2. A test of valor. - S. Ulam, already a distinguished mathematician when we were Junior Fellows together at Harvard a quarter century ago, once said: « I define a coward as someone who will not bet when you offer him two-to-one odds and let him choose *his* side.»

With the centuries-old St. Petersburg Paradox in my mind, I pedantically corrected him: « You mean will not make a *sufficiently small* bet (so that the change in the marginal utility of money[2] will not contaminate his choice). »

3. A guinea pig speaks. - Recalling this conversation, a few years ago I offered some lunch colleagues to bet each \$200 to \$100 that the side of a coin *they* specified would not appear at the first toss. One distingui-

[1] See the article of M. B. De Finetti, "La decisione nell' incertezza," in *Scientia*, April-May 1963, p. 61.

[2] I might have quibbled that the chap could have a corner in his Bernoulli-Ramsey-Neumann utility function at his initial point, and thus escape the charge of cowardice or (even worse) irrationality. This, however, would have been a quibble since Ulam could move him from the corner by giving him a dollar and then test his "courage." As for the "St. Petersburg Paradox," see footnote 2, Section 5.

shed scholar - who lays no claim to advanced mathematical skills - gave the following answer:

« I won't bet because I would feel the $100 loss more than the $200 gain. But I'll take you on if you promise to let me make 100 such bets».

What was behind this interesting answer? He, and many others, have given something like the following explanation. « One toss is not enough to make it reasonably sure that the law of averages will turn out in my favor. But in a hundred tosses of a coin, the law of large numbers will make it a darn good bet. I am, so to speak, virtually sure to come out ahead in such a sequence, and that is why I accept the sequence while rejecting the single toss. »

4. *Maximum loss and probable loss.* - What are we to think about this answer? Here are a few observations.

a) If it hurts much to lose $100, it must certainly hurt to lose 100 x $100 = $10,000. Yet there is a distinct *possibility* of so extreme a loss. Granted that the probability of so long a run of repetitions is, by most numerical calculations, extremely low: less than 1 in a million (or $1/2^{100}$), still, if a person is already at the very minimum of subsistence, with a marginal utility of income that becomes practically infinite for any loss, he might act like a minimaxer[1] and eschew options that could involve any losses at all. [Note: increasing the sequence from n = 100 to n = 1,000 or $n \to \infty$, will obviously not tempt such a minimaxer - even though the probability of any loss becomes gigantically tiny].

b) Shifting your focus from the maximum possible loss (which grows in full proportion to the length of the sequence), you may calculate the probability of making no loss at all. For the single toss, it is of course one-half. For 100 tosses, it is the probability of getting 34 or more correct heads (or, alternatively, tails) in 100 tosses. By the usual binomial calculation and normal approximation,[2] this probability of making a gain is found to be very large, $P_{100} = .99+$. If this has not reduced the probability of a loss by enough, it is evident that by increasing n from 100 to some larger number will succeed in reducing the probability of a loss to as low as you want to prescribe in advance.

c) Indeed, James Bernoulli's so-called Law of Large Numbers guarantees you this: « Suppose I offer you favorable odds at each toss so that your mathematical expectation of gain is k per cent in terms of the money you put at risk in each toss. Then you can choose a long-enough sequence of tosses to make the probability as near as you like to one that your earnings will be indefinitely near k per cent return on the total money you put at risk ».

[1] In the literature of statistical decision making, a minimaxer is defined as one who acts so as to insure that his maximum possible loss is at a minimum.

[2] I assume the coin is a reasonably new one. If it has developed some bias toward landing on one side, and if prior experimentation leads you to prefer one side to bet on, you can hope to do even better than as given above. Note: for definiteness I assume that when you decide to bet on a sequence of tosses, you are held to the full contract and cannot opt out in midstream; nor can you learn the coin's bias in the early tosses, since you are told immediately the result of your 100-toss play.

5. Irrationality of compounding a mistake. - The « virtual certainty » of making a large gain must at first glance seem a powerful argument in favor of the decision to contract for a long sequence of favorable bets. But should it be, when we recall that virtual certainty cannot be complete certainty and realize that the improbable loss will be very great indeed if it does occur?

If a person is concerned with maximizing the expected or average value of the utility of all possible outcomes[1] and my colleague assures me that he wants to stand with Daniel Bernoulli, Bentham, Ramsey, v. Neumann, Marschak, and Savage on this basic issue - it is simply not sufficient to look at the probability of a gain alone. *Each outcome must have its utility reckoned at the appropriate probability; and when this is done it will be found that no sequence is acceptable if each of its single plays is not acceptable.* This is a basic theorem.

One dramatic way of seeing this is to go back to the St. Petersburg Paradox itself. No matter how high a price my colleague agreed to pay to engage in this classic game, the probability will approach one that he will come out as much ahead as he cares to specify in advance.[2]

6. An alternative axiom system of maximizing probabilities. No slave can serve two independent masters. If one is an expected-utility-maximizer he cannot generally be a maximizer of the probability of some gain. However, economists ought to give serious attention to the merits of various alternative axiom systems. Here is one that, at first glance, has superficial attractiveness.

Axiom: In choosing between two decisions, A and B, select that one which will more probably leave you better off. *I.e.*, select A over B if it is more probable that the gain given by A is larger than that on B, or, in formulae:

$$\text{Prob}\left\{ \text{A's gain} > \text{B's gain} \right\} > \frac{1}{2}$$

[abbreviate the above to $A > B$].

Similarly with respect to any pair of (A, B, C, D, ...).

In terms of the above system, call A agreeing to bet on one toss; B deciding not to toss at all; and C agreeing to a long sequence of tosses. Then clearly,

$$A = B, \; C > B, \; C > A .$$

So my friend's decision to accept the long sequence turns out to agree with this axiom system. However, if D is the decision to accept a sequence of two tosses, my friend said he would not undertake it; and yet, in this

[1] *I. e.*, he acts to maximize $U = p_1 U_1 + p_2 U_2 + \ldots + p_n U_n$, where U_i represents the utility of each possible outcome and p_i represents its respective probability.

[2] The « Paradox » (Daniel Bernoulli, St. Petersburg, 1738) says, that turnig a coin until head appears for the first time, and to get $1, or 2, 4, . . . , 2^{n-1}, . . . according to the number of turns required, is a favorable bet no matter how large the amount to be paid for it. To avoid such a paradox, D. Bernoulli suggested dealing with the utilities rather than with money values (that is, with a concave scale with diminishing increments). To get rid of any initial infinity in the problem, see the modified sequence of finite tosses for the Petersburg situation in P. A. Samuelson, *The St. Petersburg Paradox as a Divergent Double Limit* « International Economic Review » Vol. 1, N. 1, January, 1960), pp. 31-37.

system, D > B. Moreover, call E the decision to accept the following bet: you win a million dollars with probability .51 but lose a million with probability .49. Few could accept such a bet; and of those who could, few would. Yet in this axiom system E > B.

There is a further fatal objection to this axiom system. It need not satisfy transitivity relations among 3 or more choices. Thus, it is quite possible to have X > Y, Y > Z and Z > X.

One example is enough to show this pathological possibility. Let X be a situation that is a shade more likely to give you a small gain rather than a large loss. By this axiom system you will prefer it to the Situation Y, which gives you no chance of a gain or loss. And you will prefer Y to Situation Z, which makes it a shade more likely that you will receive a small loss rather than a large gain. But now let us compare Z and X. Instead of acting transitively, you will prefer Z to X for the simple reason that Z will give you the better outcome in every situation except the one in which simultaneously the respective outcomes would be the small gain and the small loss, a compound event whose probability is not much more than about one-quarter (equal to the product of two independent probabilities that are respectively just above one-half).

7. PROOF THAT UNFAIRNESS CAN ONLY BREED UNFAIRNESS. - After the above digression, there remains the task to prove the basic theorem already enunciated.

Theorem. If at each income or wealth level within a range, the expected utility of a certain investment or bet is worse than abstention, then no sequence of such independent ventures (that leaves one within the specified range of income) can have a favorable expected utility.

Thus, if you would always refuse to take favorable odds on a single toss, you must rationally refuse to participate in any (finite) sequence of such tosses.

The logic of the proof can be briefly indicated. If you will not accept one toss, you cannot accept two - since the latter could be thought of as consisting of the (unwise) decision to accept one plus the open decision to accept a second. Even if you were stuck with the first outcome, you would cut your further (utility) losses and refuse the terminal throw. By extending the reasoning from 2 to 3 = 2 + 1, ..., and from n-1 to n, we rule out any sequence at all.[1]

[1] Mathematically, if you start at a known utility U_t, the probability of ending after one venture with at least U_{t+1} can be written as $F(U_{t+1}, U_t)$. By hypothesis, in the utility metric each toss is an unfair game (even though it may be more than fair game in the money metric). Or

$$E(U_{t+1}/U_t) = \int_{-\infty}^{\infty} U_{t+1}\, dF(U_{t+1}, U_t)\, U <_t.$$

It is an easy theorem that repeated (identical and independent) fair games yield a fair game; and repeated unfair games yield an unfair game. Specifically, the probability of getting at least $U_{t+k} = X$, *after starting out with* $U_t = Y$ *and playing a sequence of k games, is given by*

$F_k(X, Y) = F(X, Y) * F_{k-1}(X, Y) = \ldots = F(X, Y) * F(X, Y) * \ldots * F(X, Y)$, where $F(X, Y) * G(X, Y)$ is the integral $\int_{-\infty}^{\infty} F(X, S)\, dG(S, Y)$. And, if $\int_{-\infty}^{\infty} X dF(X, Y) < Y$ then necessarily $\int_{-\infty}^{\infty} X\, dF_2(X, Y) < Y$ and $\ldots \int_{\infty}^{\infty} X\, dF_k(X, Y) < Y$.

8. CONCLUSIONS. - Now that I have demonstrated the fallacy that there is safety in numbers - that actuarial risks must allegedly cancel out in the sense relevant for investment decisions - a few general remarks may be in order.

Firstly, when an insurance company doubles the number of ships it insures, it does also double the range of its possible losses or gains. (This does not deny that it reduces the probability of its losses.) If at the same time that it doubles the pool of its risks, it doubles the number of its owners, it has indeed left the maximum possible loss per owner unchanged; but - and this is the germ of truth in the expression « there is safety in numbers » - the insurance company has now succeeded in reducing the probability of each loss; the gain to each owner now becomes a more certain one.

In short, it is not so much by *adding* new risks as by *subdividing* risks among more people that insurance companies reduce the risk of each. To see this, do not double or change at all the original number of ships insured by the company: but let each owner sell half his shares to each new owner. Then the risk of loss to each owner per dollar now in the company will have indeed been reduced.

Undoubtedly this is what my colleague really had in mind. In refusing a bet of $100 against $200, he should not then have specified a sequence of 100 such bets. That is adding risks. He should have asked to subdivide the risk and asked for a sequence of 100 bets, each of which was 100th as big (or $1 against $2). If the *money* odds are favorable and if we can subdivide the bets enough, any expected-utility-maximizer can be coaxed into a favorable-odds bet - for the obvious reason that the utility function's curvature becomes more and more negligible in a sufficiently limited range around any initial position. For sufficiently small bets we get more-than-a-fair game in the utility space, and my basic theorem goes nicely into reverse.[1]

Secondly, and finally, some economists have tried to distinguish between risk and uncertainty in the belief that actuarial probabilities can reduce risk to « virtual » certainty. The limit laws of probability grind fine but they do not grind that exceeding fine. I suspect there is often confusion between two similar-sounding situations. One is the case where the owner of a lottery has sold out *all* the tickets; the buyers of the tickets then face some kind of risky uncertainty, but the owner has completely cancelled out his risks whatever the draw may show - which is not a case of risk as against uncertainty, but really reflects a case of certainty without any risks at all. Another case is that in which the management of Monte Carlo or of the « numbers game » do business with their customers. The management makes sure that the odds are in their favor; but they can never make *sure* that a run of luck will not go against them and break the house (even though they can reduce this probability of ruin to a *positive* fraction).

In every actuarial situation of mathematical probability, no matter

[1] Cf. my cited 1960 paper. I should warn against undue extrapolation of my theorem. It does not say one must always refuse a sequence if one refuses a single venture: if, at higher income levels the single tosses become acceptable, and at lower levels the penalty of losses does not become infinite, there might well be a long sequence that is optional.

how large the numbers in the sample, we are left with a finite sample: in the appropriate limit law of probability there will necessarily be left an epsilon of uncertainty even in so-called risk situations. As Gertrude Stein never said: Epsilon ain't zero. This virtual remark has great importance for the attempt to create a difference of kind between risk and uncertainty in the economics of investment and decision-making.

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Portfolio of Risky Projects (reprint)

by John M. Cozzolino

PORTFOLIOS OF RISKY PROJECTS

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ABSTRACT

The problem of selecting a portfolio from a set of independent risky business ventures is formulated in terms of maximization of the risk-adjusted (certainty-equivalent) profit of the portfolio, based upon the exponential utility function. Objects of investment include fractional participation (risk sharing) in projects with other firms, where costs and returns are shared in the same proportion. The method assumes that project costs are certain. Project revenues are uncertain, and any probability function for revenue can be used.

INTRODUCTION

Samuelson [7] has declared that no project having positive expected profit is so risky that a firm would want no share of it, however small. Sharing of risky projects with other firms or individuals is widely observed in the business world. Oil exploration is often undertaken by combines of individual firms; banks share certain loans; insurance companies reinsure policies to control their risk; investment bankers form syndicates to underwrite jointly security issues. These and many additional examples could be cited to illustrate business risk sharing.

In light of these applications, this paper proposes a utility-theory-based analysis of the problem of constructing optimum portfolios of fractional parts of risky projects.

This paper differs from conventional portfolio-selection methods in that no restrictions are placed upon the probability distribution of revenue. Since these distributions often have a nonsymmetric shape, it is important to define risk in a way that treats all shapes of distributions in a consistent way. The mean-variance approach does not satisfy this requirement, as shown by many authors, including Adelson [1], and Borch [2, pp. 60-61]. The other main limitation of conventional portfolio-selection methods is the single-period time structure. This will be retained here for simplicity.

The following section will review the needed definitions and results of utility theory. Then the properties of risk sharing, from the viewpoint of an individual firm, will be shown for an arbitrary risk-averse utility function. The properties of constant local risk-aversion function, which implies exponential utility, will be reviewed next. Finally, the portfolio problem will be defined and solved, both with and without a budget constraint, and an example will be given.

THE UTILITY FUNCTION

The theory of utility shows that, under reasonable assumptions of consistency or transitivity of preferences of a decision maker, his attitude toward risk can be represented by a utility function over the payoff space. The use of utility theory is consistent with the less restrictive criterion of stochastic dominance whenever that criterion is applicable.

Following the notation of Pratt [6], let x represent total wealth. Let $U(x)$ represent the decision maker's utility assigned to wealth x, and let $\tilde{z}$ represent the profit or net revenue of a specified business venture or "profit lottery." The tilde represents the consideration that the profit is uncertain and is represented by a random variable. The probability distribution of the lottery may be continuous, discrete, or mixed. However, without loss of generality, the notation used will refer to a continuous random variable z with probability density function $f(z)$. The problem of the determination of $f(z)$ will not be addressed here. It may represent a subjective or "objective" distribution determined by statistical methods, simulation, or pure introspection.

The expected utility of the lottery is

$$E\{U(x+\tilde{z})\} = \int U(x+z)\, f(z)\, dz \ ,$$

where the integral is over the whole space of z values and is replaced by a summation when that space is discrete. The problem of assigning a dollar value to the uncertain venture is finally solved by the use of the certainty equivalent. Let $\pi_a(x,\tilde{z})$ be the value at which the decision maker, already owning x plus the lottery, would be indifferent between selling or retaining it. The equation

$$U(x+\pi_a(x,\tilde{z})) = E\{U(x+\tilde{z})\} \qquad (1)$$

uniquely defines $\pi_a(x,\tilde{z})$ because the function $U(x)$ is monotonically increasing and thus has a unique inverse function.

The name "certainty-equivalent value" has meaning in terms of the theoretical structure. However, the name "risk-adjusted value" has great intuitive merit. The risk adjustment is the "risk premium", the amount by which the certainty equivalent is less than the expected value. It is

$$\pi(x,\tilde{z}) = E\{\tilde{z}\} - \pi_a(x,\tilde{z}) \ .$$

This is useful because the expected value is an important reference value, being the certainty-equivalent value assigned by a risk-neutral decision maker.

It will be assumed throughout this paper that the decision maker is strictly averse to risk and that, therefore, his utility function is strictly concave.

Pratt has shown that for a lottery having small variance and mean $E(\tilde{z})$, the risk premium is

$$\pi(x,\tilde{z}) = \tfrac{1}{2}\, r(x+E(\tilde{z}))\, \sigma_z^2 + o(\sigma_z^2) \ . \qquad (2)$$

In this expression, the last term represents a set of terms of order higher than σ_z^2. The $r(x)$ is defined by

$$r(x) = -\frac{U''(x)}{U'(x)} \ , \qquad (3)$$

where primes denote derivatives of the utility function. This function is called the local risk aversion function because it represents (twice) the risk premium per unit of variance for lotteries with small variance. Pratt has shown that $r(x)$ represents all of the risk preference information implied by the utility function.

RISK SHARING

Wilson [8] [9], extending the work of Borch [3], has determined conditions for the existence of a syndicate utility function under the assumption that the syndicate obeys the Pareto optimality criterion. He proves that if the sharing rule (the rule by which each member's payoff is determined from the outcome of the investment) is linear and determinate, then, in the absence of agreement on probability assessments, the individual members of the syndicate must have exponential utility functions in order that the syndicate will obey all of the axioms for consistent decision making under uncertainty.

Decision makers in one firm could not be expected to know what utility functions and probability beliefs were held by other possible risk-sharing syndicate members. Therefore, the Wilson model is difficult to apply. Our objective is the more limited one of determining the firm's desired share of participation in one or more proposed projects if the firm knows only its *own* utility function and probability assessments. While the firm may not be able to obtain the desired sharing partners, the analysis is still useful in evaluating all shares which are found to be feasible.

The sharing of risk means the dividing of costs and revenues among two or more firms or individuals. It is useful to consider that both costs and revenues are split in the same proportion, since it will be obvious how to proceed when occasionally this is not the case. The "retention share" or "participation share" of the decision maker will be denoted by α. Since the project or lottery has profit $\tilde{z}$, the profit from share α is a lottery with profit $\alpha\tilde{z}$. The share α is viewed as a decision variable, ignoring the possibility that not every value of α is equally available. The evaluation of alternate shares is based upon the maximization of expected utility

$$E\ \{U\ (x + \alpha\tilde{z})\}\ ,$$

with respect to the decision variable α. The certainty equivalent, or risk-adjusted value, of the share α is $\pi_a\ (x, \alpha\ \tilde{z})$. The share $\alpha = 0$ corresponds to no participation in the project. This has zero value; $\pi_a\ (x, 0) = 0$.

The Uniqueness of the Optimum Share

Theorem 1: If the utility function is strictly concave, then the expected utility,

$$E\ \{U\ (x + \alpha\tilde{z})\}$$

is a strictly concave function of α for $\alpha \geqslant 0$.

Proof: Let α_1 and α_2 be two positive numbers with $\alpha_1 \neq \alpha_2$. Let β be any number $0 < \beta < 1$. The expression

$$\beta E\{U(x+\alpha_1 z)\}+(1-\beta)E\{U(x+\alpha_2\tilde{z})\}$$

is equal to

$$= E\{\beta U(x+\alpha_1\tilde{z})+(1-\beta)U(x+\alpha_2\tilde{z})\}.$$

Now, since *U(x)* is strictly concave,

$$\beta U(x+\alpha_1\tilde{z})+(1-\beta)U(x+\alpha_2\tilde{z}) < U(\beta(x+\alpha_1\tilde{z})+(1-\beta)(x+\alpha_2\tilde{z}))$$

for every value of *z*.

This right-hand side is equal to

$$U(x+(\beta\alpha_1+(1-\beta)\alpha_2)\tilde{z}).$$

Therefore,

$$E\{U(x+(\beta\alpha_1+(1-\beta)\alpha_2)\tilde{z})\} > \beta E\{U(x+\alpha_1\tilde{z})\}+(1-\beta)E\{U(x+\alpha_2 z)\},$$

and the theorem is proved. This can be given an interpretation in terms of a chance selection of the share. Let β be the probability that share α_1 will be selected and $(1-\beta)$ for α_2. Then, the theorem states that a risk-averse decision maker would rather have the original lottery with share $\beta\alpha_1+(1-\beta)\alpha_2$ than have a random process select between the two possible shares α_1 and α_2.

The concavity property is extremely important because it implies that if a maximizing solution, α^*, is found, it gives the unique maximum. Furthermore, this solution is either the unique solution of equation

$$\frac{d}{d\alpha}E\{U(x+\alpha\tilde{z})\}=0 \tag{4}$$

or is at a boundary point of the set of possible α values if there is no solution to this equation. When this set is unbounded, there may be no solution.

However, when α is restricted to $0 \leqslant \alpha \leqslant 1$, then the lack of a solution to the above derivative equation implies a solution to 0 or 1. Hence, there is always a unique solution in this restricted range.

Small Shares of Large Risks

Theorem 2: If $E(\tilde{z})>0$, then $\alpha^*>0$.

Proof: Here it is necessary to examine the behavior of $\pi_a(x,\alpha\tilde{z})$ near the origin $\alpha=0$. The variance of the lottery $\alpha\tilde{z}$ is $\alpha^2\sigma_z^2$, in terms of the variance of $\tilde{z}$. Clearly this is small for sufficiently small α. The Pratt expansion for small variance can be used –

$$\pi_a(x,\alpha\tilde{z}) = \alpha E(\tilde{z}) - \tfrac{1}{2}\alpha^2\sigma_z^2\, r(x+\alpha E(\tilde{z})) - o(\alpha^2\sigma_z^2).$$

The local risk-aversion function $r(x)$ is positive everywhere for a strictly concave utility function. The third term represents terms of order higher than α^2. Thus, if $E(\tilde{z}) > 0$, a small enough $\alpha > 0$ can always be found to make the expression positive. Thus, $\alpha^* > 0$.

This result, stated by Samuelson, means that there is no venture with positive expected profit that is so risky that no positive share is desirable. This points out the fundamental nature of sharing as a method of reducing risk. Every project with positive expected value can be made desirable if the appropriate financial institutions and arrangements are available.

Constant Risk Aversion

Pratt has shown that, if the local risk aversion function $r(x)$ is a constant for all x, the utility function has exponential form. The assumption of constant $r(x)$ implies that the risk premium for any lottery is not a function of total wealth and will not change with wealth changes. While this is not likely to be true in a global sense, it does seem reasonable over a limited range of wealth. It does appear that this assumption gives the best first-order approximation to risk quantification, for the following reasons:

1. It gives a one-parameter representation of risk aversion. This allows a reasonable richness for representing a decision maker's risk attitude, while limiting the amount of effort required to determine it.
2. It gives a certainty equivalent which agrees with the mean-variance objective when the profit is normally distributed but is sensitive to the shape of the distribution when it is not normally distributed.
3. It gives great mathematical simplicity to many problems because it separates risk-aversion effects from the effects of changing wealth.
4. This utility function is concave (represents risk aversion) for any positive r, is convex for negative r, and approaches linearity (risk neutrality) as r approaches zero.

The utility function corresponding to

$$r(x) = r \text{ for all } x$$

is unique up to a positive linear transformation:

$$U(x) = \frac{1}{r}(1 - e^{-rx}). \tag{5}$$

The certainty equivalent for the random variable z is easily determined as follows from equations (1) and (5).

$$U(x + \pi_a(x, \tilde{z})) = E\{\frac{1}{r}(1 - e^{-r(x + \tilde{z})})\}$$

The result is

$$\pi_a(x, \tilde{z}) = -\frac{1}{r}\ln\ [E\{e^{-r\tilde{z}}\}] \tag{6}$$

It shows that the certainty equivalent is not a function of initial wealth when the utility function is exponential. The notation $\pi_a (x, \tilde{z})$ can be replaced by $\pi_a (\tilde{z})$. This result has been given by Wilson [8].

A very useful consequence of constant risk aversion is the additivity of certainty-equivalent values of independent lotteries.

Theorem 3: If profit lottery z is the sum $z = z_1 + z_2$, where z_1 and z_2 are independent random variables with p.d.f.'s $f_1(z_1)$ and $f_2(z_2)$, then $\pi_a(\tilde{z}) = \pi_a(\tilde{z}_1) + \pi_a(\tilde{z}_2)$.

Proof:

$$E\{U(x + \tilde{z}_1 + \tilde{z}_2)\} = \frac{1}{r}(1 - e^{-rx} \int\int e^{-r(z_1 + z_2)} f_1 (z_1) f_2 (z_2) dz_1 dz_2)$$

The exponential can be factored, and, therefore, the double integral can be factored into a product of integrals –

$$E \{ U (x + \tilde{z}_1 + \tilde{z}_2) \} = \frac{1}{r}(1 - e^{-rx} (\int e^{-rz_1} f_1 (z_1) dz_1) (\int e^{-rz_2} f_2 (z_2) dz_2)).$$

If π_a is defined as before for both z, z_1, and z_2 separately, the above equation, expressed in terms of certainty equivalents, is the desired result.

It should be observed that the similarity between the expected utility of any random variable and its moment-generating function or Laplace transform will simplify many calculations.

The importance of this theorem is due to the simplification which it implies for portfolio problems. The certainty equivalent of any portfolio of independent lotteries is simply the sum of the individual certainty equivalents. Under such conditions, the portfolio selection problem separates into a series of separate decisions related only through constraints such as the usual budget constraint.

Freund [4] shows that when the returns of the portfolio components are jointly, normally distributed, the resulting certainty equivalent of the portfolio is the same as the standard mean variance-covariance model.

THE PORTFOLIO PROBLEM

Suppose that there are n possible projects available. The i^{th} project has initial investment cost C_i and uncertain return $\tilde{Z}_i$ to be received at the end of the period. This return may be negative, since it includes costs incurred after the initial investment. The profit from the i^{th} project would be $Z_1, Z_2, \ldots, Z_n$ are independent random variables. Let $f_i (Z_i)$ represent the probability density function of the i^{th} project's return, $\tilde{Z}_i$.

Although risk sharing could take various forms, it is useful to consider the simplest one where both costs and returns are split in the same proportion. Thus, a firm taking share α_i of project i will have initial cost $\alpha_i C_i$ and return $\alpha_i Z_i$. In practice, one firm among the partners is usually designated as the active partner, or "operator" and receives a higher share of the returns in payment for managerial efforts. Another practical aspect not explicitly included here is the effect of taxation through which the government also shares in the risk.

Let $A_i(\alpha_i)$ represent the certainty equivalent of the uncertain return $\alpha_i \widetilde{Z}_i$, based upon the exponential utility function with local risk-aversion parameter r. Thus, it is found from equation (6) that

$$A_i(\alpha_i) = -\frac{1}{r} \ln E\{e^{-r\alpha_i Z_i}\}.$$

This will be referred to here as the "risk-adjusted return," a somewhat more self-explanatory term than "certainty-equivalent return." The risk-adjusted net value of profit of share α_i of project i is $A_i(\alpha_i) - \alpha_i C_i$.

The objective is to maximize the risk-adjusted value of the portfolio. The profit of the portfolio, as a function of the decision variables $\alpha_1, \alpha_2, \ldots, \alpha_n$ is

$$\widetilde{Z} = \sum_{i=1}^{n} \alpha_i (\widetilde{Z}_i - C_i).$$

The risk-adjusted value of the portfolio, $A(\alpha_1, \alpha_2, \ldots, \alpha_n)$, is the sum of the risk-adjusted profits of the individual projects under the two conditions of exponential utility and probability independence of the projects. Therefore,

$$A(\alpha_1, \alpha_2, \ldots, \alpha_n) = \sum_{i=1}^{n} [A_i(\alpha_i) - \alpha_i C_i].$$

This is to be maximized subject to the constraints that

$$0 \leqslant \alpha_i \leqslant 1 \text{ for all } i.$$

No Portfolio Constraints

The lack of portfolio constraints implies that every project can be decided upon independently, since A is a sum of terms where each term is a function of one decision variable. Thus there are n independent subproblems:

$$\max\ [A_i(\alpha_i) - \alpha_i C_i]$$
$$\text{subject to } 0 \leqslant \alpha_i \leqslant 1.$$

It has been shown by theorems 1 and 2 that if the expected profit is positive, then there is a unique solution to this problem, and that the optimum share α_i^* is greater than zero. The optimum share was shown to be at a stationary point if there is one in the unit interval, or at the end point $\alpha^* = 1$ otherwise. The optimum share, as a function of the initial cost $\alpha_i^*(C_i)$ will be of use in solving the constrained problem. If C_i is greater than or equal to $E(\widetilde{Z}_i)$, then $\alpha_i^*(C_i) = 0$. For C_i values below this point and such that $\alpha_i^* < 1$, $\alpha^*(C_i)$ is the stationary point of the function

$$A_i(\alpha_i) - \alpha_i C_i.$$

Therefore, it is the solution of

$$A_i'(\alpha_i) = C_i.$$

Differentiation with respect to C_i gives

$$A_i''(\alpha_i^*)\frac{d\,\alpha_i^*(C_i)}{dC_i} = 1. \tag{7}$$

Since $A_i''(\alpha_i)$ is negative at the optimum α_i, the above equation shows that the function $\alpha_i^*(C_i)$ must be a decreasing function of its argument at points where $0 < \alpha^*(C_i) < 1$. As C_i approaches the value $E(\tilde{Z}_i)$, the project's expected profit approaches zero and the optimum share $\alpha_i^*(C_i)$ also approaches zero.

If the firm is constrained to either accept fully ($\alpha_i = 1$) or reject ($\alpha_i = 0$) each project, then the solution is to accept if and only if $A_i(1) - C_i > 0$. In this case, many attractive but highly risky projects will be rejected. In considering all $0 < \alpha_i < 1$ as feasible solutions, the assumption is being made that the opportunity exists to find a group of partners willing to take up any remaining share of the project.

The Budget Constraint

The budget constraint is a constraint upon the total initial investment. This introduces dependency between the decisions. The problem is

$$\max \sum_{i=1}^{n} [A_i(\alpha_i) - \alpha_i C_i]$$

$$\text{subject to } \sum_{i=1}^{n} \alpha_i C_i \leqslant C$$

$$\text{and } 0 \leqslant \alpha_i \leqslant 1 \text{ for all i.}$$

This problem can be solved easily by dynamic programming. However, more insight is gained from use of the Lagrange multiplier. The Lagrangian function is

$$A(\alpha_1, \alpha_2, \ldots, \alpha_n) - \lambda\left(\sum_{i=1}^{n} \alpha_i C_i - C\right).$$

The problem becomes

$$\max \lambda C + \sum_{i=1}^{n} [A_i(\alpha_i) - \alpha_i C_i(1 + \lambda)] ,$$

$$\text{subject to } 0 \leqslant \alpha_i \leqslant 1 \text{ for all i.}$$

For fixed λ, this form also implies independent decisions. The effect of the budget constraint is the same as if the initial cost of each project were multiplied by $(1 + \lambda)$. Hence, the λ value can be viewed as an increase in the cost of capital, resulting from the capital constraint.

The first step is to solve the unconstrained problem, since if

$$\sum_{i=1}^{n} \alpha_i^*(C_i)C_i \leqslant C ,$$

then it is also the solution to the constrained problem. In this solution, all projects with positive expected profit are included in the portfolio. If the initial capital required by the unconstrained solution exceeds the budget C, then this problem can be solved by a one-dimensional search where λ is increased in value until

$$\sum_{i=1}^{n} \alpha_i^*(C_i(1+\lambda))C_i = C.$$

That this can be achieved is assured by equation (7), which shows that $\alpha^*(C_i)$ is a strictly decreasing function of its argument within the interval of argument values for which $0 < \alpha^*(C_i) < 1$.

As λ increases, the shares of each project may change from positive to zero participation. The λ value at which the ith project will drop out of the optimal portfolio is found from

$$E(\tilde{Z}_i) - C_i(1+\lambda) = 0.$$

Thus, the critical value is

$$\lambda_1^{(c)} = \frac{E(\tilde{Z}_i) - C_i}{C_i}.$$

The projects are dropped out of the optimal portfolio in order of increasing ranking of their rate of expected profit per dollar of initial cost.

EXAMPLE WITH TWO PROJECTS

An illustrative example will be given. The firm has two projects, and its attitude toward risk is described by the exponential utility with $r = .05$.

Project 1 has normal p.d.f. of return with mean μ and variance σ^2. Therefore,[1]

$$A_1(\alpha) = \alpha\mu - \tfrac{1}{2} r \alpha^2 \sigma^2$$

The derivative is

$$A_1'(\alpha) = \mu - r\,\alpha\,\sigma^2,$$

and

$$\alpha_1^*(C_1) = \begin{cases} 1 \text{ for } 0 < C_1 \leqslant \mu - r\,\sigma^2 \\ \dfrac{\mu - C_1}{r\,\sigma_2} \text{ for } \mu - r\,\sigma^2 < C_1 < \mu \\ 0 \text{ for } C_1 \geqslant \mu \end{cases}$$

[1]It is known from the moment-generating function of the normal p.d.f. with mean μ and variance σ^2 that

$$E\{e^{+r\alpha\tilde{z}}\} = e^{+r\alpha\mu + \frac{1}{2} r^2 \alpha^2 \sigma^2}$$

Suppose that μ = \$4. million, $\sigma^2 = 200$, and the initial cost is C_1 = \$1.5 million. Then

$$A_1(\alpha_1) = 4\alpha_1 - 5\alpha_1^2 .$$

Project 2 has gamma p.d.f. of return

$$f_2(Z_2) = \frac{a^b (Z_2)^{b-1} e^{-aZ_2}}{\Gamma(b)} \quad \text{for } Z_2 \geqslant 0,$$

with mean b/a and variance b/a^2. Therefore[2]

$$A_2(\alpha) = \frac{b}{r} \ln\left(1 + \frac{r\alpha}{a}\right),$$

and

$$A_2'(\alpha) = \frac{b}{a + \alpha r},$$

and

$$\alpha_2^*(C_2) = \left\{\begin{array}{l} 1 \text{ for } C_2 \leqslant \left(\frac{b}{a+r}\right) \\ \frac{1}{r}\left(\frac{b}{C_2} - a\right) \text{ for } \left(\frac{b}{a+r}\right) < C_2 < \left(\frac{b}{a}\right) \\ 0 \text{ for } C_2 \geqslant \frac{b}{a} \end{array}\right\}.$$

Suppose that $b = .08$ and $a = .02$, so that b/a = \$4 million and $b/a^2 = 200$. The initial cost is C_2 = \$1.6 million. Then,

$$A_2(\alpha_2) = (1.6) \ln\left(1 + \frac{5\alpha_2}{2}\right).$$

The Unconstrained Portfolio

The results when there are no constraints are

	Project 1	Project 2
$A_i(1)$	−1.0	+1.975
accept/reject	reject	accept
best share (α_i^*)	.25	.60
$A_i(\alpha_i^*)$	.6875	1.4661
$\alpha_i^* C_i$	.3750	.9600
$A_i(\alpha_i^*) - \alpha_i^* C_i$	.3125	.5061

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[2] It is known from the moment-generating function of the gamma p.d.f. with scale a and shape parameter b that

$$E\{e^{r\alpha\tilde{z}}\} = (a/(a - r\alpha))^b.$$

The optimal portfolio has a total risk-adjusted return of 2.1536, an initial cost of 1.3350, and a risk-adjusted profit of .8186. If sharing were not considered feasible, the best action would have been to accept the whole second project only, with a risk-adjusted profit of 1.975 – 1.600 = .375.

The Budget-Constrained Portfolio

For any budget exceeding 1.3350, the optimal solution is already known. For a budget of one million dollars, the constraint will be active. The results for this and a few other constraint levels are given in the following table.

Constraint	λ	Project 1 Share	Project 2 Share
C = 1.335	0	.250	.600
C = 1.001	.217	.218	.422
C = .689	.500	.175	.267
C = .310	1.000	.100	.100
C = .015	1.600	.010	0

Notice that project two drops out at $\lambda = 1.5$. Project one would drop out at $\lambda = 1.667$.

CONCLUSIONS

A formulation of the portfolio selection problem has been given for the selection of fractional participation levels for risky projects. The importance of this problem stems from the fact that the large risk involved often precludes individual firms from undertaking the whole project, and such projects would be rejected in the absence of the sharing opportunity. Such projects typically have very nonsymmetric probability distributions, and hence it is of practical significance to utilize the whole probability distribution in the analysis of risk. The method proposed here assumes constant local risk aversion and is able to handle any shape of probability distribution. The similarity of the risk-adjusted return to the moment-generating function allows exploitation of approximation techniques already known.

Practical applications will require present-value discounting when the cash flows are spread out over time. Also, the effects of taxation are important and require the after-tax basis to be used. Both deterministic and probabilistic interdependencies among projects have been ignored here but may be of importance in applications.

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Introduction

by the CAS Committee on Reserves

Introduction to the 1994 Committee on Reserves
Call Paper Program

Environmental liability has been an emerging issue for well over a decade. The property/casualty insurance industry's view of mass actions involving asbestos and similar products, and cleanup of hazardous waste sites, has been clouded with fundamental uncertainties as to potential costs, damages, coverage and apportionment. While some of the longer-standing legal issues have been adjudicated, many of these uncertainties remain unresolved.

From a financial reporting perspective, environmental liabilities present unique challenges to management, auditors, and actuaries. The issues and uncertainties are complex, and, therefore, not easily reduced to a "single number" for financial statement presentation, or to a few sentences for disclosure. Preparers of financial statements are legitimately concerned about misrepresentation and/or misuse by those who are unfamiliar with these complexities. At the same time, users of insurance company financial statements (including regulators, rating agencies, investors, and insurance buyers) have a need to understand the implications of these potential liabilities on future operating performance.

Recognizing the emerging need for actuarial support in this area, the CAS Committee on Reserves (COR) ran a call paper program starting last fall. The papers from that call are presented in this edition of the CAS Forum. Although they are an important first step in the process, more research and papers are needed on this critical topic. The papers present several approaches for estimating asbestos and pollution liabilities, and discuss the data and assumptions necessary to apply them. In keeping with the unique nature of the liabilities, the approaches are not all traditional, demonstrating innovative responses to new problems. The papers also provide a wealth of background information, useful to those who need to learn more about the issues.

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Measurement of US Pollution Liabilities

by Amy Bouska and Thomas McIntyre

MEASUREMENT OF U.S. POLLUTION LIABILITIES

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Abstract

This paper discusses methods and data that can be used to quantify insurers' potential liabilities arising from pollution (as specifically defined). It provides background information on the genesis of the liabilities and then discusses why traditional actuarial techniques fail in analyzing the problem and why analyses that rely on analogies to asbestos are weak. It outlines a typical analysis, including both aggregate quantification techniques and a more detailed model of the potential liabilities. It then comments on the critical issues involved in modelling reported claims and IBNR, data requirements and problems, and reinsurance issues. A list of references and a discussion of pollution claims database issues are also included.

Submitted in response to the 1993 CAS call for discussion papers on environmental liability and other mass action reserving topics.

Presented at the September, 1994, meeting of the Casualty Loss Reserve Seminar.

MEASUREMENT OF U.S. POLLUTION LIABILITIES

Amy S. Bouska

Thomas S. McIntyre

Introduction

"Your mission, should you choose to accept it, ..."[1]

The underlying message of this paper is that there are methods and data that can be used to quantify insurers' liabilities arising from pollution (as defined below). After clarifying the subset of environmental liabilities under discussion, we provide some background regarding the genesis of the liabilities; this is necessary since any analysis method must reflect the underlying loss process. We then briefly discuss why traditional actuarial techniques fail in analyzing this problem and why analyses that rely on analogies to asbestos are weak. After discussing the major influences on pollution liabilities, we outline a typical analysis, including aggregate quantification techniques. We then suggest one possible structure for a more detailed model of these liabilities and then examine and comment on the critical issues involved in modelling reported claims and IBNR, data requirements and problems, and reinsurance issues. Lastly, we provide a list of references for those who would like to learn

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[1] "Mission: Impossible"

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more about the problem. One appendix includes an extensive discussion of pollution claims database formats and fields.

This paper does not address issues of disclosure, statutory or GAAP accrual of liabilities, or actuarial standards of practice. In particular, the question of whether the results of the estimation techniques discussed herein satisfy the requirements of FAS 5 is beyond the scope of this paper. However, actuaries should be aware that both the AICPA and the SEC are showing increasing concern over these potential liabilities.

Definition

"A rose is a rose is a rose ..." [2]

Not every release of hazardous materials is "pollution" as we define it. In the context of this paper, "pollution" refers to the potential losses from "gradual" releases arising under general liability and other policies that were not specifically written to cover damage to the environment. Some examples of claims that are not included in our definition of pollution include:

- Claims arising under environmental impairment liability (*E/L*) policies. These policies are intentionally written to cover environmental releases (usually on a claims-made form) and do not generally involve coverage disputes, long latency periods, or multiple exposure periods. Where available, however, these policies may impact true pollution losses by drawing claims away from policies where coverage is more likely to be disputed;

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[2] Gertrude Stein

- Claims arising from "sudden and accidental" incidents, such as the 1984 explosion at Union Carbide's plant in Bhopal, India;
- Workers compensation claims arising from on-the-job exposure to hazardous materials;
- Claims arising from radon or "sick building syndrome";
- Claims arising from the seepage or release of silicone into the body from silicone implants;
- Claims arising from non-point-source releases, such as ozone depletion;
- Claims arising from exposure to or the removal of lead-based paint or asbestos-containing materials, unless they are commingled with other hazardous wastes at a pollution site; and
- Claims arising from the transport of hazardous materials (*hazmat*) or hazardous wastes (*hazwaste*) unless past illegal dumping is alleged or the disposal site is a "pollution" site.

Thus, we distinguish between "pollution" (generally characterized as old policies, gradual incidents, associated with a physical site, and with disputed coverage), "environmental impairment" (policies intentionally covering sudden releases into the environment), and various types of "release," "exposure," or "remediation" claims involving particular materials or groups of people.

In many insurers' organizational charts, "environmental claims" has come to mean "all claims that we don't want the field offices to handle." It is important to keep in mind that not all "environmental claims" are "pollution" for the purposes of this discussion. Clearly, asbestos, DES, and other products claims, which are usually part of the environmental claims unit, are not "pollution." As noted above, EIL losses are also not "pollution." These losses are generally subject to normal methods of actuarial analysis (with suitable caveats); as we will discuss later, pollution losses are not. While it may be tempting to mix the two for analytical purposes, this is not advisable, since there is no reason to believe that they develop similarly and many reasons to believe that they do not.

Any technique for analyzing potential liabilities has to make sense in the context of the development process underlying the claims and take into account any known peculiarities of that process. Therefore, it is first necessary to consider the background of "pollution" claims.

Background

Legislative and Social

"Fish gotta swim and birds gotta fly
but they don't last long if they try."[3]

In the 1960s, the air in many U.S. cities was growing dark and corrosive. In some places, the rivers burned; where they didn't, they could be fatal to swimmers. Rachel Carson's Silent Spring -- still regarded as a seminal book of the environmental/ecology movement -- brought the dangers of pesticides and bioaccumulation into the public consciousness. Earth Day and the Environmental Protection Agency (*EPA*) were both born in 1970. Industries and utilities were forced to clean up their smokestack emissions, and sewage and effluent treatment plants were built in places where raw waste discharge had been a long-accepted practice. The Clean Air and Clean Water Acts have had a noticeable

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[3] Tom Lehrer, "Pollution" (ASCAP, recorded 1965) on That Was The Year That Was

effect on air and water quality in the U.S. and have each been reauthorized several times since their original enactments, although not without serious discussion of the costs imposed on U.S. industries. The public support for these laws is best summed up by the 1990 poll that found that Americans rate a clean environment as "more important than a satisfactory sex life."[4]

The Resource Conservation and Recovery Act (*RCRA*) was originally passed in 1976 and has been reauthorized several times since then. Its many provisions included "cradle to grave" tracking of hazardous materials and engineering standards, permitting, and financial responsibility for hazwaste disposal facilities (including hazwaste landfills). Its general purpose is to control future pollution that was not regulated by the Clean Air or Clean Water Acts, although a remedial component was added in the 1984 reauthorization. There are thousands of RCRA-permitted sites in the U.S. and increasing attention is being paid to the potential costs associated with them, especially since the financial responsibility amounts put up for closure and post-closure at these sites are not intended to be sufficient for remediation.

In general (and with some exceptions), Clean Air, Clean Water, RCRA, and their many legislative kin have had little to do with "pollution" to date.

In Europe, the first great, widely-publicized environmental disasters were "sudden and accidental" -- the Amoco Cadiz spill in 1978, together with Chernobyl and the Sandoz-Rhine fire in 1986; as a result of this and the continent's reliance on surface waters for drinking,

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[4] "Cleaning Up," by Bruce Stutz in The Atlantic, October 1990, pp.46-50.

European attention initially focussed on the potential for large-scale accidents.[5] In the U.S., however, Love Canal became the archetype of the American environmental nightmare, with toxic wastes seeping into basements, and a nearby school and playground built on top of a disposal pit. Public outrage over Love Canal (officially recognized in 1978) led directly to the 1980 passage of the Comprehensive Environmental Restoration, Compensation and Liability Act (*CERCLA*), also known as the Superfund Act.

CERCLA has everything to do with "pollution."

CERCLA's purpose was to clean up (remediate) existing sites that posed a hazard to human health or the environment; where RCRA looked forward, CERCLA looked backward. It was intended to be -- and is -- a very punitive law, based on the principle of "polluter pays." The worst sites are placed on a National Priorities List (*NPL*). At these sites, CERCLA imposed strict and retroactive liability on potentially responsible parties (*PRPs*). Courts read joint and several liability into the act so quickly that it is widely considered to be part of the original legislation. Thus, any party responsible for the generation, transport, or disposal of any part (no matter how small) of the waste at a CERCLA site can theoretically be held liable for the entire cost of the remediation, even if that party's actions were both legal and state-of-the-art at the time.[6] Essentially any party coming in contact with the hazardous waste can be named as a PRP, including generators, transporters, storage facilities, treatment facilities, owners of

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[5] Greater information regarding the heavy pollution in eastern Europe, and particularly the former East Germany following reunification, has directed increased attention to the "Altlasten" (German: "old burdens").

[6] In practice, the situation is generally not quite that extreme, since the EPA has, from the beginning, recognized the existence of *de minimis* (and now *de micromis*) parties who were truly the small generators (generally less than 0.1% of the waste).

the site land, operators of the site, and lenders; as a practical matter, most PRPs with serious involvements are generators, past or present land owners, or past or present site operators.

In spite of its preference for "polluter pays," Congress recognized that there would be sites with no viable PRPs -- the so-called "orphan sites" -- and it authorized a tax on various chemical and petrochemical feedstocks to finance both the cleanup of these orphan sites and emergency measures at sites where costs could later be recovered from the PRPs. This "Superfund" gave the law its widely used nickname.

CERCLA imposes liability for remediation (including emergency response and removal) costs and natural resource damages (discussed later). It is important to remember that CERCLA does not create any cause of action for third parties claiming bodily injury or property damage (such as loss of property value). These third parties must pursue their claims under the ordinary tort law of negligence; however, the evidence discovered by the government in the course of naming PRPs or insurers in the course of disputing coverage may strengthen third parties' claims.

CERCLA was reauthorized in 1986 as SARA (the Superfund Amendment and Reauthorization Act) and again in 1990 as an undiscussed and unannounced part of the budget reconciliation bill (frequently referred to as "the midnight reauthorization"). SARA made CERCLA even more punitive. It greatly increased the preference for permanent treatment of wastes, as opposed to containment, and the cleanup process became even more lengthy, costly and litigious. Because SARA left cleanups subject to potential re-opening in the future (e.g., as detection technology increases in sensitivity), it led to the plaintive -- and unanswerable -- question of PRPs: "How clean is clean?"

A relatively small number of sites (currently about 1,286 out of 39,000 known sites) are on the NPL. (Cumulatively, 1,353 have been on the NPL.) The remainder are under the jurisdiction of the various states. CERCLA spawned a multitude of state "mini-Superfund" laws as the states struggled to deal with these sites. Like CERCLA itself, these laws tended to be very strict originally; unlike CERCLA, they have tended to become more pragmatic, and may, in fact, indicate the future direction of the federal Superfund law.[7] Estimation of the size, composition, and cost of the universe of state sites is one of the most important problems in the quantification of insurers' potential pollution liabilities.

Superfund reform is currently being debated as part of the 1994/95 reauthorization. The changes most likely to be incorporated into the ultimate reform bill appear to include: increased community participation, increased certainty with respect to share allocation (and quicker assignments), and implementation of national generic remediation standards and methods that recognize the intended future use of the land. The current version of the reform also includes taxes on insurers and reinsurers to fund reimbursements to PRPs in exchange for a reduction in coverage litigation; the fate of this change is less certain. It should be recognized that Superfund reform does not have a direct impact on non-NPL sites, but there is general agreement that, where they are possibly applicable, the changes will ultimately migrate into the non-NPL realm.

To the extent that insurers' potential pollution liabilities are replaced by a tax, the quantification problem will be "backed up" a step: Even if the tax is completely prospective

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[7] For example, New Jersey recently amended its Environmental Cleanup Responsibility Act (*ECRA*), one of the toughest of the state environmental laws. Renamed the Industrial Site Recovery Act (*ISRA*), the new law contained several provisions to streamline the ECRA process.

(and thus the same for all companies writing a coverage), questions of coverage and distribution of potential costs to individual insurers will be replaced by the issue of the overall adequacy of the tax, i.e., whether the initial level will have to be changed and how long it will persist. This does not require the methods outlined in this paper, although the questions raised in the ***External Data*** and ***IBNR*** sections will still be important. However, if the tax replaces potential liabilities for only some of the sites (e.g., NPL only) or some of the PRPs (i.e., if "opt-outs" are allowed) additional steps may be necessary in the estimation process in order to carve out the portions that have been replaced by the tax.

Sites, Costs, and Claims

"Mere anarchy is loosed upon the world,
The blood-dimmed tide is loosed, ..."[8]

Hazardous waste sites come in a wide range of sizes and problems. They can be as small as the local dry cleaner or as large as the hundreds of acres of mine tailings scattered throughout the west. The most common contaminants at NPL sites are solvents and other organic compounds, but they also include heavy metals, asbestos, wood treatment and leather tanning wastes, acids, explosives, paint, mining slag, and radioactive waste.

Whatever they contain, NPL sites all go through the same evaluation and remediation process, the so-called NPL "pipeline." The steps are generally described as:

- Preliminary assessment and listing on the NPL;
- Detailed assessment, called the remedial investigation and feasibility study (*RI/FS*);

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[8] W.B. Yeats, "The Second Coming"

- Remedy selection, which culminates in the EPA promulgation of a Record of Decision (*RoD*). The RoD summaries are the best source of information about site histories, characteristics, and estimated cleanup costs;
- Remedial design, i.e., development of engineering specifications for the cleanup;
- Remedial action, i.e., construction of the remedy (e.g., construction and operation of incinerators, construction of groundwater-containing slurry walls, transportation of soil to a hazwaste landfill, etc.);
- Construction completion;
- Continuing operations and monitoring (usually groundwater pumping and treatment); and
- De-listing.

Although not officially part of the pipeline, it is well known that the first four steps are liberally interspersed with extensive litigation, PRP vs. PRP, PRP(s) vs. EPA/state, and PRP vs. insurer(s).

The enactment of SARA in 1986 significantly lengthened the average travel time through the NPL pipeline, now generally estimated at approximately twelve years.[9] The length of time required to clean up an NPL site is one of the primary causes of the current reform movement. In the past, the EPA has tried various strategies to reduce travel time, from changing the definition of "complete" in 1991 to encouraging "mixed funding" (i.e., use of both public and private funds, which was supposed to reduce litigation), and developing accelerated cleanup protocols.

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[9] CBO, Total Costs of Cleaning Up Nonfederal Superfund Sites, p. 6; Acton, Understanding Superfund, p. 16.

The EPA maintains two lists of sites: the CERCLIS list and the National Priorities List. CERCLIS (the *CERCLA Information System*) list contains every known contaminated site in the U.S., currently numbering approximately 38,000. Not every CERCLIS site is remediated; in fact, approximately half are determined to require no work at all. The NPL is a subset of CERCLIS. Table 1 shows the CERCLIS and NPL counts since 1980.

Table 1[10]
CERCLIS/NPL Site Counts

Year	CERCLIS Sites	NPL Sites
1980	8,000	--
1981	10,500	--
1982	13,934	--
1983	16,307	419
1984	18,836	546
1985	22,455	818
1986	25,161	888
1987	27,507	951
1988	29,613	1,177
1989	31,522	1,224
1990	33,760	1,218
1991	34,790 (est)	1,211
1992	35,820	1,235
1993	37,506 (est)	1,270
1994	39,191	1,286

10 Because of different treatments of proposed and deleted sites, site counts frequently differ between sources. CERCLIS counts in this table are from the OTA (p. 11) and the EPA; NPL counts are from EPA Publication 9320.7-051, June 1993, "Supplementary Materials: National Priorities List, Proposed Rule, and EPA headquarters.

The EPA has stated that it plans to have listed 2,100 sites (cumulative) on the NPL by the year 2000.

Based on estimates published to date (RoDs and other sources), the distribution of expected cleanup costs for NPL sites is very skewed, as can be seen from **Appendix A**, which shows the percentage distribution of counts and site costs by site cost range. If five mega-sites are removed from the calculation, our current estimated average NPL site cost[11] drops from $57 million to $43 million. This skewness makes the use of averages for any sort of analysis very dangerous.

These sites are primarily -- although not completely, by any means -- a modern-day problem. The growth in the number of operating sites now on the NPL clearly reflects the post-World War II industrial growth of the U.S., as can be seen in **Appendix B**. The number of operating sites peaked in the late 1970s and then began to drop quickly, as the number of discoveries began to grow. Discoveries of NPL sites escalated rapidly in the early 1980s after the enactment of CERCLA and then dropped off; however, discovery continues into the present day (see **Appendix C**).

There are many known contaminated sites, both NPL and non-NPL, and this universe is growing daily. The most basic questions are: How big will it get, and how much is it going to cost to clean up?

Various studies have proposed ranges of answers to these questions with various levels of support for their estimates. In 1992, the University of Tennessee published the most

[11] Based on 646 sites.

sophisticated study of remediation costs to date (see ***References*** section; note that this study excludes all non-remediation costs and does not address insurers' potential liabilities). It divided the universe of polluted sites into six disjoint sets and, assuming the continuation of current remediation standards, reached the following conclusions regarding total cleanup costs:[12]

Table 2
University of Tennessee Remediation Estimates

(in billions)	Plausible Lower Bound	Best Guess	Plausible Upper Bound
NPL	$106	$151	$302
RCRA	170	234	377
Underground Tanks	32	67	67
Dep't of Defense	30	30	30
Dep't of Energy	110	240	240
State/Private	30	30	30
Total	$478	$752	$1,046

If the results of the less stringent and more stringent policy assumptions are included, the total range is from $373 billion to $1,694 billion.

Even if one accepts all of the results of the study without question, it is not appropriate to use these numbers without adjustment in an analysis of insurers' liabilities; further discussion of this point is included in the section on ***IBNR***.

[12] Hazardous Waste Remediation: The Task Ahead, p.16 (see reference list)

These numbers are material on almost any basis. They are significant enough for individual PRPs to cause them to look for financial assistance from every possible source, including their past and current insurers. Although there were earlier claims, the first important CERCLA claim was made by Shell in respect of the potential $4 billion cleanup at the Rocky Mountain Arsenal site in Colorado (now so infamous that it is frequently recorded in claim files only as "RMA"). Ten years later, the coverage decision is still under appeal.

RMA was followed by a resounding ... silence. Small numbers of claims were filed with insurers (especially primary insurers) each year. Except in a few specialty claims units, the issue of these "old" liabilities was a sleeper; when considered at all, it was generally raised in the context of the non-availability of current pollution coverage.[13] A 1991 GAO study of pollution closed claim activity through 1989 found low but growing claim counts and costs,[14] and by 1990,[15] the issue had taken on significant visibility within the U.S. insurance industry.

At first, there was relatively little reinsurance activity because the direct companies resisted putting up case reserves for fear that they might be considered an admission of coverage if discovered by insureds. However, as the discovery issue was defused and the pressure for recognition of these liabilities grew, precautionary notices began to move up

[13] See: "Environmental Liability Insurance" ("Report of the NAIC Advisory Committee on Environmental Liability Insurance"), September, 1986; GAO/RCED-88-2, Hazardous Waste: Issues Surrounding Insurance Availability; and GAO/PEMD-89-6, Hazardous Waste: The Cost and Availability of Pollution Insurance

[14] This study should be used with care, since the GAO did not define the word "claim"; as a result, the claim counts from different respondents may not be comparable. See discussion in the ***Internal Data*** section regarding different definitions of "claim."

[15] Somewhat earlier in London due to the business practices of the London Market.

through the reinsurance and retrocessional hierarchy like toxins up the food chain. The Reinsurance Association of America (*RAA*) publishes a bi-annual study of reinsurance loss development that has excluded asbestos-related losses since 1985 but did not exclude pollution until the 1991 study (based on year-end 1990 data). The 1993 study provided some additional information separately for pollution and asbestos but did not include detailed numerical data for these two causes of loss.[16]

The general position of U.S. insurers has been that their potential pollution liabilities are not quantifiable. Although the issue is receiving increasing attention from regulators, the primary force pushing for recognition (or at least disclosure) of potential pollution liabilities has been the Securities and Exchange Commission (*SEC*). The SEC has had a long-standing information exchange agreement with the EPA with respect to PRPs, and began to develop a noticeable interest in insurers in 1991. Quantification is also an issue in the mergers and acquisitions arena, where purchasers of insurance companies have become increasingly wary of "dirty" business. The IRS, which might be expected to act as a counter-force to accrual, has been silent to date on the issue as respects insurers.[17]

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[16] Reinsurance Association of America Loss Development Study, 1993 Edition.

[17] This is contrast to the situation in the U.K., where the Inland Revenue has significant expertise regarding U.S. pollution, primarily as a result of the three-year accounting rule at Lloyd's.

The Failure of Classical Actuarial Analytical Methods

"History is bunk."[18]

It is clear that triangulation is not an appropriate tool for analysis of pollution losses. This is true for several reasons:

- Calendar year phenomena are not susceptible to triangular analysis, which relies on the history of older accident years to predict the future of younger ones. Unfortunately, history is happening to all accident years simultaneously as time proceeds forward from the enactment of CERCLA.

- For horizontal triggers, the involvement of multiple policy years confounds accident year analysis, as the costs for a single dumpsite may be spread over twenty or more "accident" years, which then all experience the same development at the same time with respect to that site.

- The legislative, judicial, technological and site-specific environments are changing. This is a serious problem in the estimation of potential pollution liabilities. For example, only 20% of the NPL sites where remediation has been completed have groundwater involvement, while 70% of the total NPL sites do.[19] Thus, it is reasonable to assume that future remediations of known sites will take longer and cost more per site (barring any effects from Superfund reform and future improvements in remediation technology). On the other hand, future remediations of currently undiscovered sites are generally expected to

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[18] Usually attributed to Henry Ford.

[19] GAO/Future Challenges for Superfund Program, p. 48.

cost less per site (see section on ***IBNR***). Other examples of possible future changes include a decrease in coverage litigation as some issues are decided in key states.

- Even if triangles were meaningful, there is a lack of history. Recall that, for many companies, substantial claim activity did not really get underway at the insurance level until the late 1980s and early 1990s. Many of the largest insurers (especially among direct writers) recognized the unique qualities of these claims earlier and began to form separate specialty claims units (usually in conjunction with asbestos and other mass tort claims). However, the paid and incurred numbers were small enough to escape actuarial notice until the early 1990s, when they began to distort general liability and casualty triangles. Thus, there are only a few diagonals with any volume of claim activity.

Pollution and Asbestos

"Don't drink the water and don't breathe the air..." [20]

Pollution's resistance to traditional actuarial methods of analysis places it squarely with asbestos-related claims and other "mass torts." Like asbestos, it is a field of specialists, jargon-ridden and inaccessible. Like asbestos, it affects both very old and more recent policies. Like asbestos, it is pulled out of both analysis triangles and the normal claims processing flow. Like asbestos, it is perceived to be a significant threat to the insurance industry. In fact, pollution has so many similarities to asbestos, it is frequently thought to be asbestos ... only different and bigger.

[20] Lehrer, "Pollution"

We disagree. **Pollution is NOT asbestos.**

The single biggest difference between the two causes of loss is the existence of the products aggregate limit. Because asbestos losses are generally covered under the products section of the general liability policy, there is almost always an aggregate limit in effect in the primary policy.[21] To date, pollution claims have generally been filed under the premises/ operations coverage, which rarely had an aggregate limit prior to 1986. This means that, under the most commonly assumed pollution trigger and occurrence definition, there is one occurrence per PRP-site-involvement year with costs spread over all years of the insured's involvement. Thus, a primary company may be faced with many (perhaps hundreds) of sites from a single insured, none of which individually produces a loss per year sufficiently large to penetrate into its reinsurance protections, and which may not be subject to aggregation in order to trigger protections.

The general result of the asbestos aggregate limits -- all other things being equal and barring the successful use of vertical or aggregating triggers for pollution claims -- is that a given gross volume of asbestos losses will penetrate much further into high excess layers and reinsurance protections than the same gross volume of pollution losses. Thus, we would generally expect the impact of asbestos to increase relative to that of pollution as the attachment point above the ground increases. Assuming the general use of a horizontal trigger for pollution, and subject to variations in policy wording -- asbestos goes high, and pollution stays low.

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[21] There are exceptions. In some cases, this was resolved by the use of an "agreed aggregate" developed as part of the Wellington Agreement; see Cross & Doucette, "Measurement of Asbestos Bodily Injury Liabilities," p.13.

The second important distinction between asbestos and pollution is that asbestos has a smaller universe of "target" insureds, i.e., insureds with massive claims relative to other industrial concerns. Among known asbestos defendants, fewer than 75 are generally considered to have major involvements, while 476 PRPs are already publicly known to be involved in more than five NPL sites. It is possible that, as the extent of PRPs' involvements in non-NPL sites (especially owned sites) becomes clearer, a small group of "targets" will emerge; however, we believe that it is unlikely to be as small as the asbestos group. As a result, total asbestos losses for a given insurer are much more of a "crap shoot."

Lastly, there are significant coverage issues with respect to pollution claims that were never present in the asbestos arena. The question of "known loss" was and continues to be litigated in the claims of the major asbestos defendants, but, in general, the applicability of the general liability policy was not a significant issue for asbestos losses. The claims of thousands of injured third-parties clearly constituted "damages" and there was rarely a protective exclusion in place. On the other hand, the applicability of insurance and reinsurance coverage is one of the core problems in estimating pollution costs for both insureds and insurers. The industry's coverage defenses have been, on average, successful (see later), but this success has contributed to the quantification problem.

Overview of a Pollution Analysis Project

"The best way out is always through."[22]

No two of our many U.S. pollution analysis projects have proceeded in the same manner. Depending on the insurer's needs, they are done in greater or lesser detail; depending

[22] Robert Frost

on the cleanliness and detail of the available data, data preparation can be more or less time-consuming; depending on the results of the various methods, selection of the final range can require more or less testing and re-testing of assumptions. However, we would generally expect a project to proceed in approximately the following order:

1. General discussion with claims department regarding policy terms, claims practices and data availability

   This step is never omitted. It is very important because practices regarding case reserving, claim recording, settlements, and other important factors vary widely. As is discussed later, even the definition of a "claim" can vary between companies. The specialists handling the claims are crucial sources of information about these items as well as general policy terms, type of business written, changes in claim reporting patterns, etc.

   During this step, we also request the list of insureds with reported pollution claims. This helps us to form an initial impression of the likely magnitude of the problem relative to the insurer's other business (see section on ***Eyeballing the Problem***). This is important since potential pollution liabilities must be viewed in the context of the company's overall reserve position. In cases where it is clear that potential pollution losses are small compared to the total reserve position, the toxic claims are being handled well, and the total non-toxic reserves are adequate, further work may be unnecessary.

2. Decide which, if any, insureds to separate from the analysis

One large insured or unusual exposure (or a small number of them) can distort the results of both the model and aggregate techniques, and it may be advisable to remove them for separate analysis. The specialist claim unit is inevitably able to list any anomalously large exposures.

3. Do market share, aggregate loss development, and MCP tests

These are described in greater detail in the later section on ***Sophisticated Eyeballing***.

[If the analysis uses the detailed model, include steps 4 - 9; otherwise, go to step 10.]

4. Receive and clean-up claims data, add necessary supplemental identification fields

This is frequently the most time-consuming part of the analysis. For discussion of the internal data, see the later section on ***Internal Data***; the selection and construction of a company's pollution database are discussed further in **Appendix E.**

We note that data preparation on repeat assignments has proved to be much more difficult than we expected for three reasons: (1) Changes in our data. As we find additional public data, we also find new relationships between PRPs.

This sometimes leads us to change the standard form of the PRP's name used in our site database or to group two PRPs together, thus causing our identifiers to change over time; (2) Changes in the insurer's data. Obviously, we expect that, over time, new claims will be reported, some known claims will close, and recorded dollar amounts will change. However, other changes may cause significant reconciliation problems; and (3) Our model requires that every unique site and every unique PRP in a review be given a distinct identifier. On an initial review, the identifiers given to small sites and PRPs not in the national data are only required to be distinct from those already in use; a repeat review requires also that they be consistent with those of the first review.

5. [if necessary] Selection of a distribution of underlying limits to be used

As discussed later, the actual distance between the first dollar of loss and the insurer's attachment point is a critical variable, particularly for horizontal triggers. Where the available internal data does not capture this information, we will insert "assumed" underlying limits that are stochastically generated from an empirical distribution. This distribution is usually selected based on our experience and discussions with the insurer. It is difficult to over-emphasize how critical this variable is.

6. Run the model

An overview of the model used to evaluate the adequacy of reported reserves is given in the section on ***Beyond Eyeballing: A Model of Pollution Liabilities***.

7. Re-run the model

We are rarely comfortable with the results of a single model run (which involves multiple simulation passes through the same set of data with the same parameters). Any given pollution analysis usually requires multiple runs -- occasionally tens of runs -- in order to clarify questions that arise with respect to the behavior of the results.

8. Analyze model results and select estimate/range for reported claims

In making our selections, we examine both the stochastic variation in the model output and the results of the sensitivity tests selected to indicate potential parameter variation (see later section on ***Sensitivity Testing and Interpretation of Results***).

9. Add IBNR, adjusting the multiplier for book being analyzed

Sources of IBNR claims and issues related to IBNR multipliers are discussed in the later section on ***IBNR***.

10. Compare model results to results of the aggregate techniques and select an estimate/range for total potential ultimate pollution losses

Although we have not made any effort to adhere to pre-set "rules" in selecting the final estimated range of ultimate losses, we have found that the high end of the range is usually approximately twice the lower end. Individual results may differ significantly from this observation.

Eyeballing the Problem

"The curtain rises on a vast primitive wasteland, not unlike certain parts of New Jersey."[23]

Not all books of pollution claims are the same. For a direct writer, the two most important indicators of potentially large pollution losses are:

- Type of business: This attribute is recognized by various insurance industry idioms, such as "Main Street," "light commercial," and "heavy commercial." We prefer to distinguish between "national PRPs" and "local PRPs." If the list of pollution insureds is largely populated by well-known names such as Fortune 1000 companies ("national PRPs"), it is a significant warning sign because these PRPs are likely to have both multiple NPL and non-NPL involvements, and a consequent willingness to engage in expensive coverage litigation. "Local PRPs" (i.e., names we have not encountered before) are more likely to have only one or two sites, which are probably (but not necessarily) less expensive than those of the national PRPs; local PRPs also appear to be less likely to litigate coverage, probably because the expense involved would be disproportionate to the ultimate recovery.

- Average attachment point: High attachment points above the ground provide more protection against pollution claims than against asbestos. In rough terms,

[23] Woody Allen

we regard attachment points below $5 million as being in the working layer for a book of national PRPs, while it appears that there is significant safety in attachment points that are greater than $20 million. However, we note that the average can be misleading and the entire distribution of attachment points should be examined. For example, if a book of business is bimodal, i.e., is a mixture of very high and very low attachment points, the resulting high average gives a false sense of security because of the presence of the very low attachments.

Assuming the use of standard U.S. policy wording, the risk factors for potential pollution liabilities can be summarized as follows:

Table 3
Pollution Risk Factors

Characteristic	Low Risk	Medium Risk	High Risk
Policy Years (sites in operation)	Post-1985; pre-1945	1945-1970	1970-1985
Premium Volume	Varies with volume		
Exclusion Wording	Absolute pollution exclusion	"Sudden and accidental" exclusion	No pollution exclusion
Insureds	Offices, apts, only	Small/local businesses	Fortune 1000 companies
Layers Written	Very high (> $20 million above the ground)	High (between $5 and 20 million)	Low (< $5 million above the ground)
Expense Treatment (lower layers)	Indemnity only; expense only	Expense in the limit	Expense in addition to the limit
Paid Losses	Varies with losses		

In some cases, the risk factors are interdependent, e.g., the post-1985 years are safer because the absolute pollution exclusion came into wide usage with the ISO policy simplification in 1986. In some cases, the factors are interactive, e.g., fewer sites were operating per year prior to 1970 than in later years, but some excess policies attached much lower prior to 1970 and therefore may have more overall exposure in the earlier years. In other cases, the indicators are almost mutually exclusive, e.g., larger insureds would tend to buy coverage in higher layers than smaller insureds. In these cases, it is difficult to judge which factor will exert more influence. The model described below is intended to deal with such problems.

The inclusion of premiums and paid losses in the table of risk factors implies that there may be methods less onerous than the full application of our model that might be brought to bear on the problem. Three are discussed in the next section.

Sophisticated Eyeballing: Aggregate Techniques

"The time has come to realize that research is the highest human function, ..." [24]

Our analysis of pollution liabilities typically relies upon a number of methods ranging from "eyeballing" the situation through a comprehensive review utilizing the modelling techniques discussed in the next section. Between these two extremes lie several useful techniques based on aggregate data of one type or another, be it pollution claims as of a given date or net GL premiums written since 1960. We present three methods herein labeled, Market Share, Aggregate Loss Development (not to be confused with traditional development triangles), and Multiple of Current Payments.

[24] Pierre Teilhard de Chardin, Building the Earth

Market Share Analysis

Market share analysis is a relatively straight forward, intuitive way to estimate pollution liabilities. We begin with a range of estimated ultimate pollution losses for the insurance industry as a whole. (We are currently using $60 - 90 billion.) We then allocate the estimated ultimate losses based on the years of operation and/or discovery of waste sites, depending on the desired trigger.[25] An insurer's share of the industry losses is determined directly from the industry estimates based on the company's market share (i.e., percentage of industry GL premium) throughout the period. We generally calculate the market share over periods of irregular length that are selected to reflect any significant changes in the insurer's writings compared to the market as a whole.

There are several refinements that should be incorporated into a market share estimates. Adjustments for premium that does not give rise to pollution exposure (e.g., medical malpractice, D&O) but is reported with GL premium are appropriate in many cases. (Similar adjustments to the industry premium may not be possible.) It is also necessary to adjust the market share percentages to reflect qualitative factors such as the type of business and average attachment points written, as discussed in the previous section. (If premium by layer were available for both the insurer and the industry, it would be desirable to do the analysis by layer.)

We do not incorporate any additional adjustment for reinsurers beyond that indicated by their attachment points and type of business. It is clear that significant amounts of pollution losses will ultimately be passed to reinsurers, and, at this time, we have no data

[25]See **Appendices B** and **C**.

indicating that their potential losses are less than proportional to their premium. (This is in contrast to their ultimate asbestos losses, which we estimate to be greater than proportional to their premium.)

There is an open question as to how CMP premiums (adjusted to reflect only the general liability part of the package) should be treated in doing the market share analysis. Large industrial insureds have generally been written on monoline forms. However, the use of multiperil packages penetrated well into the types of insureds with pollution claims. We would therefore expect the liability portion of the packages to produce noticeable pollution claim activity. However, we note that the claim reporting from multiperil business is substantially below the expected level. The decision as to how to treat the multiperil premium is further complicated by the fact that some companies have historically reported some or all of their multiperil premium as decomposed into the constituent monolines in their annual statements.

We note that, despite all efforts, in a limited number of cases the market share estimates may never reconcile to other approaches. Problems with market share projections usually occur when the shares or number of years involved are very small.

Aggregate Loss Development

We have rejected **traditional** loss development methods (i.e., triangles) for reasons detailed earlier; however, this does not preclude the use of **non-traditional** loss development (i.e., no triangles). A non-traditional development approach ignores accident years and focuses on the aggregate losses paid (or reported) as of a given date and aggregate payment patterns associated with those claims.

Capturing the required aggregate pollution loss data from the insurer is quite simple, since it is only cumulative paid losses; however, we note that it is often instructive to project pollution losses from several recent evaluation dates (e.g., three or four recent year-ends) to produce a range of estimated ultimate losses.

Determining the appropriate payment patterns is more complicated. A payment pattern appropriate for projecting losses on NPL sites begins with calendar year 1980 (enactment of CERCLA/creation of the NPL). The actual past site discovery pattern is combined with projected growth in the number of sites and cost relativities by year of discovery as the starting point in determining a payment pattern. Having constructed a pattern in which sites are expected to emerge by discovery year, we then estimate the payout of costs from site discovery through final settlement of claims for each site.

We consider several elements of site costs that insurers face, including remediation studies, remediation costs, defense, coverage disputes, and third party liability. Estimated payment patterns for each component are weighted to determine the average payment pattern from discovery through payment of all claims on the site. These patterns will change for non-NPL sites and over time, so it is appropriate to vary the patterns by type of site and by discovery year. For example, we expect defense costs on a average site discovered in 1998 to be a smaller portion of the total and to pay out faster than defense costs on a site discovered in 1984. These patterns combined with the pattern of site emergence by discovery year result in expected pollution payments by calendar year.

A simplified example of how such an aggregate payment model could be constructed is shown in **Appendix D.**

Multiple of Current Payments (MCP)

Potential political and regulatory changes (e.g., Superfund reform, changes in technology or cleanup standards) may result in a level of uncertainty that precludes the determination of an estimated pollution liability that would satisfy the FAS 5 requirements for accrual. That is, while we can make projections of liabilities under alternative scenarios, we cannot say that a particular scenario is reasonably certain to occur. The MCP approach (called the "survival ratio" by A.M. Best) provides a relatively straightforward basis of comparison among insurers and appears to be emerging as a *de facto* standard.[26]

The MCP method sets pollution *reserves* equal to a selected multiple of average annual payments in recent years (e.g., the three most recent years). The selected average annual payment should consider the effect of unusual loss activity, large sites and/or PRPs. The selected number of reserved years is based on the type of business written with consideration of the distribution of attachment points, limits, shares of layers, policy years (e.g., pollution exclusions), and the type of exposure (e.g., geographic, type of insureds). It should be significantly greater for reinsurers and direct excess writers, where payment activity is less mature and is expected to increase at a faster rate than the payments of primary writers. At year-end 1993, the large primary stock companies were at approximately seven times average

[26] "While Travelers, as well as the industry, hasn't funded its environmental/asbestos reserves to its limit, A.M. Best believes that with a 7-to-1 reserve-to-paid position, its exposures being largely at primary vs. excess layers, and its aggressive resolution strategies, Travelers is ahead of the curve in addressing this problematic area." BestWeek P/C, February 7, 1994.

annual payments (asbestos and pollution combined), while the large stock reinsurers/excess writers had higher ratios. We note that disclosures generally indicate that these reserves are not fully funded to ultimate levels.

Beyond Eyeballing: A Model of Pollution Liabilities

"Computers are useless. They can only give you answers."[27]

As mentioned earlier, individual books of business may be sufficiently complicated that it is difficult to form an estimate based on aggregate information. For example, the market share and aggregate loss development methods may produce very different indications, or the net result of off-setting risk factors, such as type of business and layer of coverage, may not be clear.

In these cases, we believe that the use of a more sophisticated model is critical to movement from "guesstimates" to the development of supportable estimates of ultimate pollution liabilities. A model provides the following advantages:

- It allows explicit recognition of knowledge. Insurers have a great deal of information available to them, namely the list of their claiming insureds and the terms of coverage. However, because large corporations tend to keep larger SIRs and buy higher limits, the average attachment point tends to increase as the proportion of national PRPs increases; is the increase in protection from the higher attachment points outpacing the change in the book? Only a model can effectively answer that question in a book of 20,000 notices.

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[27] Pablo Picasso

- It allows explicit recognition of lack of knowledge. It is possible to form an estimate of the average success of coverage defenses but not the success of a single particular coverage case. In situations such as this, the model can simulate individual coverage decisions with the selected average success rate without knowing the outcome of the individual cases.

- It allows testing of alternative scenarios. What if the courts shift towards manifestation rather than an exposure-like trigger? What if the coverage defense success ratio is improved, but at the cost of a related increase in litigation costs?

- It allows documentation of assumptions and the effect of changes in assumptions over time. It is virtually certain that estimates of the various parameters in any pollution model will change over time as case law, technology, and the legal/social environments evolve. It is easier to document and explain the changes in model parameters than in 2,000 individual claim file evaluations.

So what does this "model" look like? Our model of potential pollution liabilities has two parts: reported claims and IBNR. Analysis of the reported claims is done mechanically in much greater detail, with an allowance for IBNR added outside of the detailed analysis. It is necessary to examine the reported claims carefully because the level of reserve adequacy can vary enormously between companies, even those writing similar layers and types of business.

Our model of reported pollution liabilities is claim-based (for reinsurers, notice-based), i.e., it looks at every policy exposure (separately by year and layer) for every reported PRP-site combination. For every reported site, the model accesses our site database, extracting the estimated cleanup cost, years of operation and discovery, PRPs, and groundwater involvement (Y/N). Where information regarding a specific PRP's involvement in a given site is available, from either the claim record or the site database, the model uses that information in preference to the more general site data. Where no information is available on a site, the required parameters are simulated from an empirical distribution constructed from available data from other sites.

The model simulates cleanup costs based on the database estimate and then adds defense and coverage defense costs and third-party indemnity. We are currently adding defense and coverage litigation costs as a percentage of the remediation costs (subject to a per-site maximum and minimum). Depending on the presence of groundwater contamination, we simulate the occurrence of third-party damages. If a third-party loss "occurs," we simulate the severity from a lognormal distribution with its mean selected based on the remediation costs. At this time, our model does not include natural resource damages.

For NPL sites, PRP shares are simulated based on the capped number of Fortune 1000 PRPs; for non-NPL sites, shares are simulated assuming a small number of PRPs.

Based on the trigger selected and the expense treatment indicated in the policy information, the costs for each PRP-site combination are distributed to year and compared to the coverage in order to determine the loss for that policy. Indemnity costs are set to zero if a successful coverage defense is simulated in that run; the probability of success depends on the site's state, the policy year, and the policy wording. We are currently using an average policyholder win factor of 35%, i.e., averaged over all years and all states, we estimate that 35% of the universe of policyholders will be granted coverage. (The current version of The Superfund Reform Act incorporates a 40% policyholder win factor for "average" states.)

The simulated losses for each trial are stored while additional simulation runs are completed. They can then be analyzed as desired. Because simulation is, by its nature, an averaging process, we discourage the use of detailed output (such as individual policy estimates).

This model of potential pollution liabilities requires unusually large and detailed amounts of both external and internal data. Because the problems associated with compiling the two data sources are quite different, we will deal with them separately. We will first examine the external parameters and data. We will then return to some of the issues associated with the internal data, and finally we will discuss sensitivity testing and interpretation of the results. Lastly, we will look at IBNR and reinsurance issues.

External Issues and Data

"The truth is out there."[28]

Any model of reported claims must include specific recognition of several external items. The following are discussed below:

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[28] "The X-Files"

- Remediation costs (including study costs), including the variability among sites and the uncertainty in the estimates of individual site costs;
- Third-party indemnity costs;
- Natural resource damages;
- The insured's share of the remediation and third-party costs;
- The years of the insured's involvement (or date of discovery) at the site;
- The cost of defending the insured, both in respect of the cleanup and in respect of third-party actions;
- *Coverage litigation costs;*
- The likelihood that coverage will be denied; and
- The trigger/definition of occurrence.

Development and continuous maintenance of a specialized database of external information is necessary in order to provide the required information. As is noted below, we have found that the basic information is available from several sources but that it requires extensive and careful cleanup to be usable.

Remediation Costs

NPL Sites: Records of Decision issued by the EPA are the single most important source of remediation cost data for NPL sites. Virtually everyone doing meaningful analysis of NPL costs maintains a library of RoD summaries. However, caution is indicated in the use of RoD data for three reasons:

- More than one RoD may be issued for a given site. This is due to three factors: (1) A site may be divided into several operating units, each with its own sequence of RoDs; (2) Currently, RoDs are being issued separately for source control and groundwater remediation at the same operating unit; and (3) RoDs may be classified as "interim" and "final." As a result, there can be significant development from the first RoD at a site to the last.

- The EPA provides estimates of various components of the costs, together with the grand total present worth. The latter figure is discounted. Unless you believe that discounted costs are the proper basis for allocation to layer, the discount should be removed before using these estimates. We have found that the RoD cost figures captured by many firms are not reliably compiled.

- In addition, there is on-going discussion of the reliability of the EPA estimates themselves. The EPA has stated that they believe the estimates to be accurate to within -30%/+50%. (The range is probably wider for earlier RoDs.)

Although the EPA also publishes Superfund Comprehensive Accomplishments Plan (*SCAP*) data on actual expenditures to date, the reporting is very slow. Further, it includes only EPA expenditures and so, except at a few sites, SCAP data is not at all indicative of the true remediation costs.

If aggregate estimates are used rather than per-site data, careful consideration should be given to how the orphans' share is distributed and the effect of federal sites. The federal sites are a particular problem, since some of the extreme variation in total NPL remediation cost estimates frequently reflects the impact of the DoD and DoE sites, some of which are expected to be very expensive to clean up. (Most notable among these are the high level nuclear sites at Hanford, Oak Ridge, Savannah River, and Fernald.) Although there is a potential for some private sector responsibility at the federal sites, at this time it does not appear to be unreasonable to assume that the amount will be small.

Non-NPL Sites: We have not found a good source of cleanup cost data for non-NPL sites. The usual approach is to use the NPL distribution, truncated and with a significantly reduced mean. These adjustments are judgmental and would benefit greatly from further research. There are some qualitative indications that the distribution is bimodal, i.e., that there are many small non-NPL sites but also a significant population of very expensive ones. The latter may be particularly dangerous to high layer covers, since there is some evidence that they tend to involve only one or two PRPs (i.e., are owned sites) and therefore likely to produce significant high-layer exposure even when spread over many operating years.

In the universe of non-NPL sites, consideration should be given to isolating LUST (Leaking Underground Storage Tank) sites, both because they are likely to have different characteristics than other sites (and therefore different cost distributions) and because there may be a material probability of subrogation recoveries from a state UST fund (depending on the state).

Third-Party Indemnity Costs

Third-party indemnity costs generally arise from claims for bodily injury or loss of property value. These suits seem to be prone to settle rather than go all the way to a jury verdict, and, as a result, details are scarce. The exact definition of "occurrence" and the basis of aggregation are critical to the issue of third-party costs, which tend to be multiple-plaintiff or class actions. Some reinsurers and high-layer direct excess writers believe that third-party indemnity will not be a problem for them because even large total awards produce relatively small amounts per claimant. While the ultimate allocation of these claims is still undecided, we have observed a few third-party claims in very high layers.

Third-party bodily injury claims associated with waste sites should not be confused with asbestos bodily injury. While it also produces a wide range of cancers that have been linked with asbestos but can occur in other circumstances, asbestos is best known for its "signature diseases," mesothelioma and asbestosis. With some isolated exceptions,[29] the materials disposed of at waste sites have no signature diseases. Establishing liability for bodily injury is further complicated by the fact that exposure to the contaminant rarely approaches historical levels of asbestos exposure. As a result, even where a carcinogen is present in drinking water and a cancer "hot spot" has developed, it may be impossible to

[29] Lead, mercury, asbestos, and chromium; however, these are present at relatively few waste sites in important quantities.

establish a statistical correlation, much less causation. Of course, this is not necessarily an impediment to substantial jury awards or settlements in preference to a jury trial.

In addition to claims for bodily injury, third parties can also claim non-remediation property damage. In some cases, this is direct property damage, e.g., when gasoline from a leaking underground tank migrates into the underground conduits for telephone cables and damages parts of the system. At this time, however, it appears likely that the more significant claims are likely to involve loss of property value. In some cases, the property becomes unusable, while in others the presence of a contaminated site nearby is alleged to cause a significant decrease in the value of the property.

Natural Resource Damages

Natural resource damages (*NRD*) arise under section 107(a)(4)(A) of CERCLA, as well as various other environmental laws (including the Clean Water and Oil Pollution Acts). They are intended to restore natural resources or compensate for their loss, where the term "natural resources" is quite broadly defined. This is distinct from the removal/remediation of the contamination; for example, the remedial action might require that trees or other wildlife habitat be stripped away, which would be a loss of natural resources. The valuation of the loss has frequently been done using the so-called "contingent valuation method," which is quite subjective; the EPA has publicly committed to a re-examination of the valuation method.

Only certain parties, including at least the U.S. Government (usually represented by the National Oceanic and Atmospheric Administration), states, and Indian tribes are clearly entitled to file NRD suits. The rights of other parties appear to be subject to some dispute. In addition, CERCLA imposes time limits for the filings; these differ for NPL vs. non-NPL sites.

Natural resource damages are different from other third-party damages in that they arise under CERCLA. However, unlike cleanup costs, they appear to be more clearly "damages" and, therefore, this coverage defense against natural resource damage claims is likely to be weaker than against cleanup costs.

The amount of information available on NRD is growing but is still quite limited relative to, say, remediation costs. There is not an obvious consensus on whether NRD will be significant, much less how they will be treated within the insurance side of the issue, i.e., success of coverage defenses, trigger, etc.

Share

In our opinion, PRP share is the most difficult parameter to estimate or simulate. Although an increasing amount of information is available from consent decrees between the EPA and PRPs, it is not clear that it is useful for the projection of future allocations. It is probably true that parties with limited assets will pay relatively little. However, allocations at the multi-party sites may give very small shares to many mega-corporations or a single PRP may pay a significant share of the costs.[30]

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[30] E.g., Coors will pay 90% of the remediation at the Lowry Landfill (estimated total remediation cost = $600 million); the State of California will pay 75% of the costs at Stringfellow (currently estimated at $800 million).

In spite of this, it is reasonable to assume that, on average, the presence of many other PRPs decreases the probability that an insured will pay a large share of the site costs. For this reason, the number of PRPs at the site is very useful information. Unfortunately, compilation of PRP information is a very time-consuming process. For various reasons, the EPA PRP lists are "dirty" and cannot be used directly, i.e., names are frequently misspelled, the same PRP may receive multiple notifications, etc. The PRP list published by EPA headquarters (the SETS database) is subject to a significant reporting delay; we have found that the EPA regions can supply PRP data on a more timely basis for nominal fees upon submission of a FOIA request.

Users of the EPA PRP lists may be tempted by their sheer volume into believing that they are complete. They are not. In order to minimize its own effort, the EPA has historically preferred to find one or two large PRPs and then let them attempt to decrease their share of the site costs by finding other PRPs. These "third-party" PRPs are added to the EPA lists only slowly, if at all. As a result, many insurance claims are from policyholders that are not officially PRPs. It is our experience that a significant proportion of claims related to NPL sites are from such PRPs.

Years of Involvement/Discovery

Actuaries with direct access to claim files may have significantly better data in this area than others, since the alleged dates of involvement may be recorded in the correspondence. Where the insured's specific years of involvement are not known or the data is not available, dates derived from the years of site operation are a reasonable proxy. We have found it necessary to insert a "date compression" routine in order to recognize that individual PRPs are generally not involved for the entire operational life of the site.

In order to test a manifestation or continuous trigger, it is necessary to know (or estimate or simulate) the date when the insured knew or should have known that it was causing damage. This is even more difficult to ascertain than the dates of involvement; however, a latest bound can be established by the date of the EPA's 104(e) letter.[31] This date is publicly available.

Defense of the Insured

Policyholders may require defense against the EPA (or corresponding state agency), other PRPs, and/or third-party claimants. In general, the duty to defend is broader than the duty to indemnify, so insurers may pay defense costs even if indemnity coverage can be denied. These costs can themselves be quite significant. Unfortunately, it is difficult to analyze actual historical costs since many insurers record coverage dispute costs in the same field as defense costs. As a result, it is necessary to base defense cost parameter selections on public studies such as the recent RAND studies[32]. In selecting the defense cost multiplier, it is important to remember that one should select an ultimate multiplier and not be unduly influenced by the actual current ratio of expenses to indemnity. This ratio is clearly distorted by the coverage litigation, which both accelerates legal costs and delays indemnity payments, leading to a double overstatement in the current ratio.

Policies can treat expense in many ways: pro-rata on indemnity, included in the limits, totally excluded, or expense-only. While this complicates the modelling process, it is essentially a technical problem. Even if they do not code the expense treatment by policy,

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[31] The so-called "Dear PRP" letter.

[32] See ***References***.

most insurers can describe their usual practice, either overall or by policy group (e.g., primary vs. excess).

Coverage Litigation Costs

As mentioned above, declaratory judgment action (*DJ or DJA*) costs are frequently recorded with pure defense costs (i.e., "real" allocated loss adjustment expenses). The RAND study is the best source of information on coverage litigation costs, but, again, current ratios to indemnity should not be confused with the likely ultimate ratios.

There are unresolved questions as to whether reinsurers will accept these costs, and, if so, to what extent; the question is particularly acute where large sums have been expended in a successful denial of coverage. This results in mammoth DJ costs associated with zero incurred indemnity, which complicates a pro-rata distribution. There appears to be a general open-mindedness with respect to discussing the issue. While not the most material item in developing the model, it is necessary to either make a general assumption as to how these costs will be treated or to build flexibility into the model.

Successful Denial of Coverage

As contract questions, coverage disputes are subject to state law rather than federal, producing widely varying results. As a result, it is important to consider the state law that is likely to be applied in selecting a probability of coverage to use in the model.[33]

[33] Sometimes called the "win factor," especially in the London Market. No consensus has developed as to the exact definition of the term, i.e., whose "win" is being referenced.

Coverage denials have generally been based on four arguments:

- "As damages": The standard industry general liability form says that it will indemnify the insured for amounts that it becomes liable to pay "as damages." Insurers originally argued that costs arising from governmental remediation requirements were not "damages." An analogy to other cleanup costs has frequently been made: "If the health department comes around and tells a restaurant owner to clean up the kitchen, we don't have to indemnify those costs, so why should we indemnify site cleanup costs?" The courts were generally unmoved by this argument, citing the coercive nature of government letters/notifications. The "damages" argument is still raised, but it is generally conceded that the insureds have won on this issue at sites where an enforcement letter has been sent. Even at sites where the cleanup has been undertaken voluntarily, this defense may not be effective.

- Pollution exclusions: In the early 1970s, the standard form was modified to include the "sudden and accidental exclusion," which -- in spite of its name -- was intended to exclude all pollution-related claims except those that were sudden and accidental. In 1986, this was replaced by the "absolute exclusion," which appears to be withstanding almost all attacks. The sudden and accidental wording is still an open issue, although there seems to be a slight swing in favor of insurers.

  In selecting a probability of coverage related to the pollution exclusion, it is necessary to ascertain if the insurer used U.S. standard wording or some variant. For example, some policies written in the London Market included exclusionary wording that was significantly stronger than the U.S. standard.[34]

If coverage is being sought under the personal and advertising injury coverage, this defense may be less effective, since the applicability of the exclusion to that coverage is being litigated.

- "Expected or intended" (fortuity): The standard coverage form excludes losses that are expected or intended by the insured. Litigation on this point is very fact-intensive,[35] examining the difference between whether the wording relates to the discharge itself or the resulting damage, as well as what the insured knew (or "should have known") at the time of the discharge. There is no obvious trend in these decisions. Even after the wording issues are litigated, this issue is less likely to be clearly determined by a state supreme court than the others because the facts are different for each insured and site.

- Owned property: General liability forms usually exclude coverage for the damage to the insured's own property; however, this can usually be circumvented where there is groundwater involvement (since groundwater is usually state property) or where there is a danger that the contamination will

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[34] Notably NMA 1684, which more closely resembles the U.S. absolute pollution exclusion than the "sudden and accidental" wording that was in use at that time in the U.S.

[35] E.g., was there any employee of the insured whose job description included the removal of ducks killed by swimming in the ponds? (the so-called "dead duck" defense in the Shell/Rocky Mountain Arsenal coverage litigation)

migrate off-site (which is almost everywhere). This has not been a strong coverage defense historically.

Recently, a fifth defense has taken on new power, namely:

- Late notice: Most policies require that the insured provide prompt notice of loss to its insurer; this has tended to be a weak defense, however, unless the insurer could show that its interests were prejudiced by the delay. Increasing pressure on PRPs by the SEC to quantify and disclose environmental liabilities may accelerate both reporting and the usefulness of this defense.

The likely success of the pollution exclusion and fortuity defenses varies by policy year. In the first case, the U.S. standard wording changed substantially in 1966, 1973, and 1986, and so policy year must be considered when evaluating the success of the pollution exclusion. This is also the case with fortuity, since, in general, the strength of the "expected/intended" argument should increase in more recent policy years: In the 1950s and 1960s, many insureds will be able to make strong arguments that they simply did not know (and could not have known) that they were causing damage; this argument weakens in the 1970s and especially in the 1980s, although this may be subject to more dispute for "mom and pop" insureds.

There is a last, implicit coverage defense: If the insured cannot prove (or at least strongly hint at) the existence of a policy, they have no coverage for that year. It follows that very early policy years (prior to 1955) are less at risk than more recent ones, since it will be more difficult to prove that there was a policy. There is relatively little gain from this, since the costs that would likely be allocated to the early years by even a horizontal trigger are minor due to the small number of sites in operation then.[36] It should be noted, however, that policies exposed in these years may suffer significant losses relative to their limits because the attachment points and limits were so low in those years.

Trigger/Definition of Occurrence/Basis of Aggregation

There are probably as many ways of allocating claims to policy years and layers as there are PRPs and insurers. However, we are aware of only four that are in widespread use:

- Exposure: Reasoning by analogy to asbestos, this triggers the years during which the insured was actively disposing of wastes at the site. The usual definition of occurrence is "*one occurrence per site per year.*"

- Manifestation: Again making an analogy to asbestos, this triggers the year in which the damage became manifest (e.g., the year the site was put on the NPL, although there are other possibilities). There is usually one occurrence per site in this one year, although there are more possibilities for aggregating all of an insured's sites into one occurrence.

- Continuous/triple trigger: This theory triggers all policy years from the time of the insured's first involvement in the site to the time the insured knew or should have

[36] Shell/Rocky Mountain Arsenal is the notable exception to this general rule and tends to cause a bulge in costs in the late 1940s and early 1950s; if an insurer has no exposure to Shell, it would be appropriate to remove this for analysis purposes.

known it was causing damage. There is usually one occurrence per site per year. This is the provisional allocation method used in the London Market.

- Fountain: This is a variant in which a set of policy years are triggered (either exposure or continuous, for example), but the insured selects a single year for its coverage (to minimize the number of SIRs applied); the insurers in this "target" year are then left to seek contributions from insurers in the other triggered years under the "other insurance" clause. This is also referred to as "all sums" (after the policy wording that stated that the insurer would pay "all sums" that the insured became legally obligated to pay as damages). The effect of the fountain is to push losses into higher layers than would otherwise be penetrated under a true exposure or continuous trigger.

In the case of the non-manifestation triggers, there is some indication of attempts to spread the total costs over a subset of the possible years (e.g., the years with weaker coverage defenses).

In modelling, it is important to have a clear distinction between the trigger, the definition of "occurrence," and the basis of aggregation before beginning any programming.

Although there are notable exceptions, most remediation costs are currently being allocated on either an exposure or a triple trigger. However, many of these allocations are provisional and may ultimately change when the outcomes of the claims are completely finalized. We note that the allocation of a settlement may not reflect where the costs would have finally come to rest if the claim had been allowed to pay out to its natural termination, either among years or among layers.

Even at one site, the trigger/definition of occurrence used for the third-party costs may differ from that used for the remediation costs. For example, if loss of property value is alleged, an insurer may consider that to be triggered by the announcement of the site's listing on the NPL, even though the remediation claim may be spread over the years of dumping.

Internal Data

"Ful wys is he that can himselven knowe."[37]

In estimating potential pollution liabilities, detailed claims data is essential. This is because any projection methodology must reflect the underlying business, including:

- Years and volume of business written;
- Type of business written;
- Policy wording, especially pollution exclusions used;
- Attachment and width of layers written and retained;
- Limits structure; and
- Expense treatment.

In order to do this, the model requires data that is not usually recorded in a normal claims system such as site name, underlying coverage, etc. Because this data is also required for claims handling, most insurers with a significant volume of pollution claims have built PC-based supplemental systems. These can be either stand-alone systems carrying a complete set of data or linked to the main claims database and containing only the supplemental data. We have included a discussion of database formats and contents as **Appendix E.**

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[37] Geoffrey Chaucer, The Monkes Tale in "The Canterbury Tales"

Where the necessary data fields have not been captured, the data compilation task can be formidable. Even where all of the necessary fields are available in some format, we have generally found that the data from these systems requires extensive cleanup before it is usable. In fact, data preparation is almost always the major part of the analysis. This arises from two general data issues: the definition of "claim" and data entry problems.

Pollution "Claims"

What is a claim?

The registration of pollution claims by the special claims unit may reflect convenience (one file is easier to track than thirty), the company's preferred trigger theory (a preference for manifestation would mean that only one year would be involved), or simply the department's usual practices (do BI and PD claims arising from the same incident get one claim number or two?). At one extreme, all of the activity for one insured PRP may be registered under a single master file number with references to other any other policies kept in the file. At the other extreme, separate files may be set up for each insured-site-claim type-year-policy combination. In practice, most companies' claim registration systems are somewhere between the two extremes.

Seemingly small differences in the claim system can give rise to significant data preparation effort. For example, assume that a unique combination of insured and year defines a pollution claim in the claims database, while the pollution model requires a record for each unique combination of insured/policy/year. In this case, it will be necessary to expand the claims database records, creating "filler" records for multiple policies within a given year. In the course of doing this, care must be taken to maintain whatever unique identifiers are required in a relational database (see **Appendix G**). If the model is based on one-year policies, it will be necessary to create expansion records if the claims database has only one record for a multi-year policy. Depending on the details of the model, records may have to be deleted from the claims database if BI and PD claims are registered separately or if multiple BI claimants are each assigned a distinct claim number. If the model assumes different triggers for BI vs. PD (see earlier section on ***Trigger***), it may require different registration systems from the claims database depending on the claim type.

Other Common Data Problems

Spelling is a common problem in pollution data. Inconsistent spellings impede both matching within the file and correlation with external data. The first step in preparing data for analysis is always a spelling "cleanup" so that PRP and site ID numbers can be validly and consistently assigned.

The second general class of problems arises from the use of text fields. Text fields are essentially useless for analysis purposes until they are parsed into a numeric format. While most date formats can be parsed mechanically into numeric fields, limits information in a text field creates a much greater problem, especially if the limits structure is complicated. We note that recording a limit as "3M" is usually unambiguous but it is still a text field that has to be re-formatted as numeric before it can be used.

The third type of data problem is inconsistency among records of a flat database or between tables of a relational database. These problems are can be difficult to find, sometimes escaping detection until the model crashes while looking for a non-existent policy number. The most common problem of this type is a link field such as the policy number that has an error or a slightly variant format in either the PRP table or the policy table. For example, a policy number might appear in the PRP table as AA-123456 and in the policy table as AA123456.

Data Suggestions

We have found that a few general guidelines facilitate the growth of a clean, usable pollution database:

- Use numeric entries in all possible fields (i.e., avoid entering dates or limits as text fields)
- Enter dates in a YYYYMMDD format
- Avoid abbreviations such as M or K for millions and thousands; always use the full, correct number of zeros
- Enter text fields in capital letters only (some applications alphabetize upper and lower cases separately)
- Develop a dictionary of standard abbreviations, insured names, and site names
- If possible, assign ID numbers to insureds and/or ceding companies if applicable
- Enter multiple year policies in multiple records (one record per year)
- Avoid entering single records corresponding to more than one site (i.e., a record for "5 various" sites should be split into five records)

- Periodically test databases to be sure that all fields that should be the same actually are the same (e.g., multiple entries for the same policy limits in a flat database, or link fields in a relational database)

Sensitivity Testing and Interpretation of Results

"Parameter risk, by its very nature, cannot be precisely estimated."[38]

Given the many sources of uncertainty in the analysis, it seems reasonable to conclude that the selected range of potential ultimate liabilities should reflect both stochastic and parametric variation. The model itself will produce information on stochastic variability, but it is necessary to do sensitivity testing in order to get an indication of the potential parametric variability.

For a given set of claims and parameter selections, we have found less stochastic variation in the results than we originally expected. On the other hand, the variation in results between the different triggers can be extreme. This is a particular problem for companies that began writing only in the late 1970s and, as a result, have significantly more exposure to the manifestation trigger than to others. This can be quite troublesome in estimating a reasonable range of outcomes.

Sensitivity testing on the parameters can be very time-consuming, since the model has to be re-run with each new parameter set. Two approaches are possible: (1) construct a meta-program that randomly selects values for each parameter from specified distributions for

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[38] Stephen W. Philbrick, "Accounting for Risk Margins" in the Spring 1994 CAS Forum, p. 5.

each meta-trial, (2) select a set "normal" set of sensitivity tests to be run, varying the parameters one at a time. The latter undoubtedly misses some parameter combinations that would produce extreme values but has the advantage of a shorter run-time.

The results produced by our simulation model tend to be quite stable, i.e., small changes in the parameter selections tend to produce proportionally smaller changes in the results. One exception to this general result is that, for a given population of claims, the results can be very sensitive to the level of assumed underlying limits. Because of this, we urge direct excess and reinsurance writers to capture as much information as possible about the underlying limits (i.e., the true distance between the attachment of their coverage and the first dollar of loss).

IBNR

"Yeah, ... imagined but not real"[39]

At some point in the development of IBNR estimates, it becomes necessary to confront the critical issue of the time horizon of the projection. This selection is deeply intertwined with questions of accounting and disclosure and may reflect an insurer's philosophy as much as or more than its actuaries' technical preference. While the questions of accrual under statutory and GAAP discounting as well as the professional standards applicable to loss reserves are beyond the scope of this paper, we note that there are several time horizons that are intuitively and/or technically appealing.

[39] Overheard at a meeting on indicated rate changes.

The first of these is "horizon = now," i.e., no IBNR. According to public disclosures of insurers, this has historically been a very popular choice. It has the advantage of accurately reflecting the perceived disorder and non-quantifiability of the pollution claims process. On the other hand, it is significantly lacking in intuitive appeal, given that the number of notices being received, while erratic, does not show any signs of dropping to zero in the near future.

At the other extreme, one could select "horizon = ∞." The primary problem with this selection is the massive uncertainty regarding the ultimate underlying cleanup costs. Even assuming continuation of the current legal, social, technological and judicial environments, the question of the number of sites that will ultimately be remediated (as distinct from the number requiring remediation) is essentially indeterminate at this time.

Having ruled out both zero and infinity as acceptable goals, we selected "horizon = the year 2000." That is, we currently project the costs associated with sites discovered through the year 2000. Of course, loss emergence and payment on those sites continue for many years after that. This was an entirely pragmatic selection based on the EPA's stated plan to have 2,100 sites (cumulative) on the NPL by 2000.[40] Other selections are clearly possible.

Even given a time horizon, the estimation of a reasonable IBNR allowance is subject to significant uncertainty. Having said that, we note that IBNR can be decomposed into distinct elements, each of which can be analyzed.

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[40] GAO/Future Challenges for Superfund Program, p. 12.

The components of pollution IBNR for direct writers are:

- undiscovered policies
- unreported PRPs
- discovered but unreported sites
- undiscovered sites (NPL and non-NPL)

For reinsurers, we must add to the list:

- known but unreported primary claims

The effect of undiscovered policies is easiest to quantify. For example, if a complete list of all insureds (such as all facultative certificates) ever written is available, the effect of future policy discoveries can reasonably be assumed to be zero. (Technically, it is not zero due to the possibility that coverage may have been provided to an affiliate under a different name.) Unless a complete list of historical insureds is available, there is a potential for additional policy discoveries that appears to increase as the attachment point increases.

A properly defined and consistently maintained database of pollution claims/notices will provide the data necessary to analyze policy discoveries. In the absence of this historical data, the claims department is usually willing to provide qualitative information.

As time goes on, unreported PRPs are increasingly exposed to the late notice defense. Nonetheless, it appears undisputable that there are still PRPs who have not yet begun the claims process. This is based on a comparison of the EPA list of PRPs and the Fortune 1000 list to known claimants. It is not yet clear to what extent the non-reporting varies by size of insured. However, the most intuitively comfortable argument is that the smaller PRPs are likely to be more under-reported as a group in the primary layer of coverage. Even if this is not true, it is could be argued that the late notice defense will, on average, be more successful against larger PRPs who "should have known" their policy obligations.

Even among reported PRPs, there is obvious under-reporting of known sites. Some of this may be based on the PRPs' analyses of likely remediation costs, with PRPs simply omitting low cost sites from their claims in order to save on paperwork. Additional "under-reporting" may actually be "under-recording" due to the understandable distaste of claims departments for recording each individual site, especially if a single insured reports hundreds of sites.

Whatever the cause, our analysis indicates a substantial potential for growth due to known but unreported sites, even at the primary level. There are conflicting arguments regarding the likely average severity of these sites. On the one hand, the fact that they are unreported by a reporting PRP would indicate that such sites should involve only low costs, since a potentially high-cost site would have been more thoroughly reported. On the other hand, it is clear that the unreported sites tend to be non-Superfund sites, and there is some evidence (albeit somewhat sketchy) that such sites may tend to be owned sites subject to voluntary cleanups. Owned sites can be dangerous to high layer covers, since the lack of spreading among PRPs means that the sites can penetrate to higher layers.

Once the selection of a projection horizon has been made, the issue of the number of undiscovered Superfund sites becomes manageable. Unfortunately, the question of their severity is less clear. One school of thought maintains that the average remediation cost (in current dollars) of sites to be added to the NPL list will be the same as those currently on the list; until recently, this was the position of the EPA. However, a consensus appears to be emerging that average per-site remediation costs will be lower for sites added to the NPL in the future for two reasons:

- As noted above, the cost distribution of known sites is highly skewed; deletion of the top 1% of the sites for which remediation cost estimates are available removes 31% of the costs and decreases the average per-site cost from $57 million to $40 million. There is a strong "gut feel" that it would be hard to overlook another site as expensive as these mega-sites. Put another way, the argument is "How many more Rocky Mountain Arsenals can there be?"[41]

- Even without any cost reduction effects from Superfund reform, the EPA is increasingly tolerant of innovative technologies, the use of which should decrease per-site costs over time.

It is frequently asserted that "undiscovered" NPL sites are actually only "unlisted," i.e., they are already known as state sites but are simply not yet on the NPL. For such sites, it is necessary only to estimate the additional costs not yet recognized. The increase arises from three causes: (1) under-estimation of the correct costs even as a non-NPL site, (2) poor remedy selection or inept implementation of a reasonable remedy[42]; and (3) the "load"

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[41] Referred to as "barrel scraping" by the CBO in their 1994 report (see **References**).

[42] The OTA (p. 11) asserts that many state sites are being remediated so poorly that substantial additional costs will be incurred in the future simply to correct current mistakes.

caused by listing on the NPL, which may as much as double the otherwise correctly estimated cost. Thus, some IBNR scenarios might assume that future NPL listings are already discovered and that all future listings are known but under-estimated.

The costs associated with undiscovered non-NPL sites are more problematic. Any analysis must consider the question of whether the inventory of non-NPL sites that will be remediated will grow in proportion to the growth in the NPL or at a faster or slower rate. For example, if the entire growth in the NPL is at the expense of the non-NPL inventory, then the non-NPL growth rate might be less than that of the NPL. On the other hand, if we accept the argument that the biggest sites have already been discovered, then it may be possible to infer that the smallest (i.e., non-NPL) site counts will grow faster than the other categories. Once an assumption (or range of assumptions) about the number of future non-NPL sites is selected, the projected costs per site must be selected so as to be compatible with the count assumptions.

If the University of Tennessee study is used in analyzing the non-NPL problem (both unreported and undiscovered), care should be taken to reflect the fact that most but not all RCRA sites have been subject to closure and post-closure financial responsibility requirements, and so additional resources may be available at these sites. Because the operating years of RCRA sites tend to be more recent than CERCLA sites, the effect of the absolute pollution exclusion will also be greater.

Reinsurance Issues

"Stick it to the next generation!"[43]

Although both outwards and inwards reinsurance pose interesting analytical problems, the outwards (ceded) side has fewer uncertainties because there are fewer data problems. On the ceded side, the basic problem tends to be one of detail: Because reinsurance programs can be very complicated, it is usually necessary to make some level of simplifying assumptions. Given the magnitude of the other uncertainties, this does not usually cause much discussion.

Having simplified the reinsurance protections into an understandable form, it is still necessary to consider the questions of aggregation/trigger/definition of occurrence and the treatment of coverage dispute costs (particularly when there is no indemnity). We note that it has been argued there was wording in some reinsurance treaties that might facilitate aggregation.

1993 SEC disclosures show an average net-to-gross ratio of approximately 0.60 (pollution and asbestos combined). Future movement in this ratio is subject to competing forces: As the larger, more complicated claims are finally settled and allocated to reinsurers, it will act to decrease the ratio. On the other hand, a move to settle with some of the smaller PRPs that are currently inactive might tend to increase the ratio, since these smaller costs would be more likely to be held net. If reinsurance treaties are fully penetrated but allow only limited reinstatements, this would first decrease and then increase the ratio.

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[43] Lucy in "Peanuts"

In analyzing a book of inwards (assumed) reinsurance, the same simplifying assumptions are likely to be necessary and the effect of different theories of aggregation becomes even more important. However, there are three even more basic problems caused by the data:

- (excess of loss covers) Even within a single book of assumed reinsurance, differences in reporting practices are obvious, with some cedents apparently reporting all or nearly all of their claims to essentially all of their reinsurers, while others are currently reporting very few claims and then only to their lower layer protections. Some ceding companies report only "various insureds, various sites."

  In analyzing a book of assumed reinsurance, the actuary should ask the claims personnel if the company has reporting agreements in place with any of its cedents. These agreements specify when and what should be reported. In exchange for more complete information on the claims that are reported, the reinsurer agrees not to assert a late notice defense against the rogue claims that penetrate into its cover without having been reported earlier. The generic version of the reporting agreement/form may be referred to as "the Preston form,"[44] but this is frequently customized by specific agreements between ceding and assuming companies. A copy of the generic agreement is included as **Appendix H.**

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[44] After Preston Gates Ellis & Rouvelas Meeds, the law firm that, together with Guy Carpenter, midwifed the generic agreement.

Of course, for actuarial purposes, complete precautionary reporting of all insureds and sites (or at least all insureds) would be much more desirable, but, where it has been attempted, the flow of paper becomes unmanageable, particularly in the retrocessional layers.

- (quota share covers) For quota share covers, the problem is even more basic: pollution losses are frequently not broken out from the "normal" losses at all, much less by claim. No consensus has emerged regarding the estimation of potential pollution losses within these books.

- (all reinsurance/retrocessions; also some direct excess) As was mentioned earlier, the model results can be quite sensitive to the attachment point used. This is a problem, since many attachment points are stated as "excess of underlying" or "excess of primary." The missing layer near the ground can be large and highly variable, reacting to both the insurer's usual practice, the year/decade of the policy, and the size of the insured.

The missing information affects the signed line/width of layer in addition to the attachment point. Where either average or specific underlyings are available, adjustments to all of the parameters are possible.[45] At the very least, some assumed underlyings should be simulated; discussions with the claims department will usually lead to a mutually agreeable distribution.

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[45] See Cross and Doucette, p.32.

Reinsurance analyses also raise the issue of "underlap," i.e., the possibility that the direct coverage limit is less than the top of the reinsurer's layer so that an indemnity loss could never fully exhaust the reinsurer's coverage. In some cases, the direct limit may be so low that *the reinsurer's coverage cannot be penetrated* by indemnity costs at all. Limited datasets that included primary coverage information indicate that underlap may be significant.

There are also issues of coverage, since the reinsurance wording may differ from that of the direct policy.

We note that any analysis using the aggregate loss development or MCP procedures needs to take into account that reporting to reinsurers is relatively slow for this type of loss. In particular, a significantly higher multiple of current payments is necessary in order to reflect the same survival time, since reinsurance payments will increase faster than those of their ceding companies.

References

***"All hope abandon, ye who enter here."*[46]**

There is a great deal of public material available on Superfund and the U.S. remediation problem. Unfortunately, very little of it directly addresses the question of potential insurance liabilities. Additional problems are caused by the fact that different studies are intended for different uses; as a result, studies that appear to address the same question (e.g., the total remediation cost at current Superfund sites) may produce very different results. For example,

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[46] Dante Alighieri, The Divine Comedy, Hell (Canto 3, line 9) (inscription at the gates of Hell)

users looking for cost information in the following references should be wary of the following differences:

- Are the costs total, only future, or only past?
- Are the costs total, only EPA, only EPA non-recovered? Do they include PRP transaction costs? PRP "shadow" costs?
- Are the costs in nominal dollars, current dollars, or discounted dollars? If discounted, what were the discount rate and time horizon?
- Are the costs total, for non-federal sites only, federal sites only, orphan sites only, non-municipal sites only?
- Are the costs for only the current Superfund or for the projected "ultimate" NPL? (How many sites are assumed to be on the "ultimate" list?)
- Do the estimates assume level, decreasing, or increasing per-site costs?

In short, although we have found the following references useful and recommend them for those seeking to learn more, we suggest that they be used carefully. In addition to the usual citations, we have included information on ordering the material, where available; for some of the older material, this information may have changed.

The following list is meant only as an introduction; it does not encompass every article that might possibly be of interest. For example, we have included only one general reference on legal issues and none devoted solely to engineering, environmental audits, or remediation technology. Because of the current legislative attention to Superfund, additional material is being published frequently.

1. Hazardous Waste Remediation: The Task Ahead (with six related volumes), by Milton Russell et al., University of Tennessee, 1992.
   order from: The University of Tennessee
   Waste Management Research and Education Institute
   327 South Stadium Hall
   Knoxville, TN 37996-0710
   615/974-4251
   cost: $56.00 (for all seven volumes)

2. Congressional Budget Office, various studies including:
   The Total Costs of Cleaning Up Nonfederal Superfund Sites (January, 1994)
   Analyzing the Duration of Cleanup at Sites on Superfund's National Priorities List (March 1994)
   order from: Congressional Budget Office Publications Office
   Second & D Streets, S.W.
   Washington, D.C. 20515
   202/226-2809
   cost: inquire

3. U.S. General Accounting Office, various studies, including:
   Superfund: Cleanups Nearing Completion Indicate Future Challenges (GAO/RCED-93-188)
   Superfund: EPA Cost Estimates Are Not Reliable or Timely (GAO/AFMD-92-40)
   Hazardous Waste: Pollution Claims Experience of Property/Casualty Insurers (GAO/RCED-91-59)
   order from: U.S. General Accounting Office
   P.O. Box 6015
   Gaithersburg, MD 20877
   202/275-6241
   cost: first copy of each report free; additional copies $2 each

4. RAND--The Institute for Civil Justice:
   Private-Sector Cleanup Expenditures and Transaction Costs at 18 Superfund Sites, by Lloyd S. Dixon, Deborah S. Drezner, and James K. Hammitt, 1993.
   Superfund and Transaction Costs: The Experience of Insurers and Very Large Industrial Firms, by Jan Paul Acton and Lloyd S. Dixon, 1992.
   Understanding Superfund: A Progress Report, by Jan Paul Acton, 1989.
   order from: RAND
   P.O. Box 2138
   Santa Monica, CA 90407-2138
   310/451-7002
   cost: inquire

5. U.S. EPA responses to July 19, 1993, request for information from Representatives Dingell and Swift, annotated as OSWER Directive 9200.2-21, dated January 28, 1994, and signed by Elliot P. Laws, Assistant Administrator

6. Superfund Handbook: A Guide to Managing Responses to Toxic Releases Under Superfund, by Gene Lucero et al., Sidley & Austin Law Offices and ENSR Corporation, 1989.
   order from: ENSR Corporation
   Marketing Department
   33 Nagog Park
   Acton, MA 60603
   508/635-9500
   cost: $45.00

7. Cleaning Up Hazardous Waste: Is There a Better Way?, by Orin Kramer and Prof. Richard Briffault, I.I.I. Press, 1993
   order from: Insurance Information Institute
   110 William Street
   New York, NY 10038
   212/669-9200
   cost: first copy to a company free

8. Coming Clean: Superfund Problems Can Be Solved ..., by the Office of Technology Assessment, 1989.
   order from: Superintendent of Documents
   Government Printing Office
   Washington, D.C. 20402-9325
   202/783-3238
   cite GPO stock #: 052-003-01166-2
   cost: call to verify; was $10.00

9. A Review of Environmental Coverage Case Law, by V. Jeffrey Purcell et al. (editors), American Re-Insurance Company, 1994.
   order from: American Re-Insurance Company
   American Re Plaza
   555 College Road East
   P.O. Box 5241
   Princeton, NJ 08543
   609/243-4200
   cost: call to verify; was free

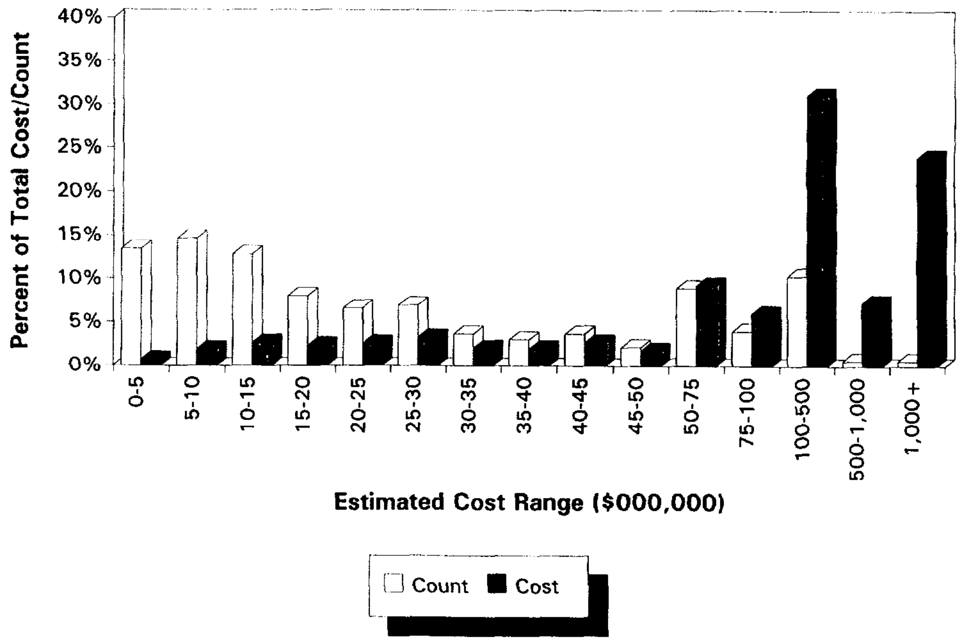
10. "U.S. Insurers' Potential Liabilities for Inactive Hazardous Waste Sites: Scenarios and Discussion" (testimony before the House Subcommittee on Policy Research and Insurance) by Amy S. Bouska, September 27, 1990.
   order from: Amy S. Bouska
   Tillinghast/Towers Perrin
   8300 Norman Center Dr., #600
   Minneapolis, MN 55437-1097
   612/897-3430
   cost: free

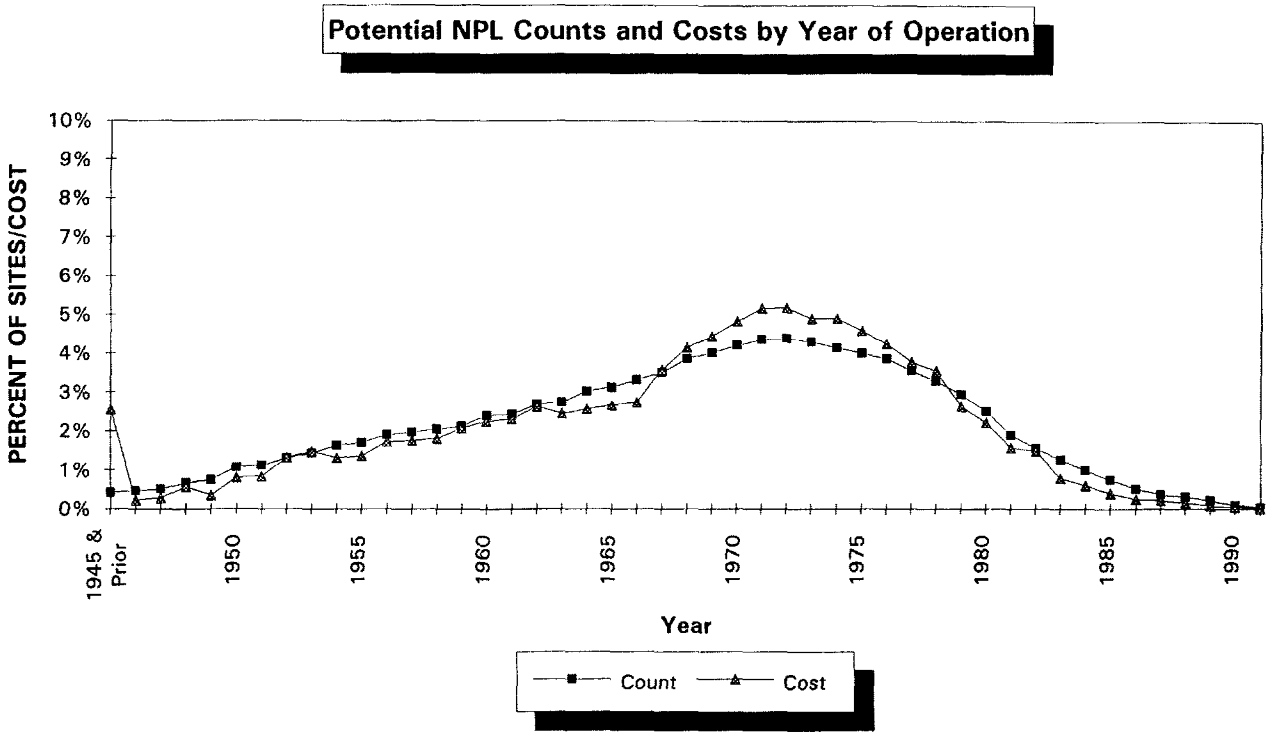
11. "Environmental/Asbestos Liability Exposures: A P/C Industry Black Hole" in BestWeek Property/Casualty Supplement, March 28, 1994.

12. "Defending a Natural Resources Damages Claim" by Roscoe Trimmier, Jr., in Environmental Claims Journal, Vol. 4, No. 2, Winter 1991/92, pp. 163-174.

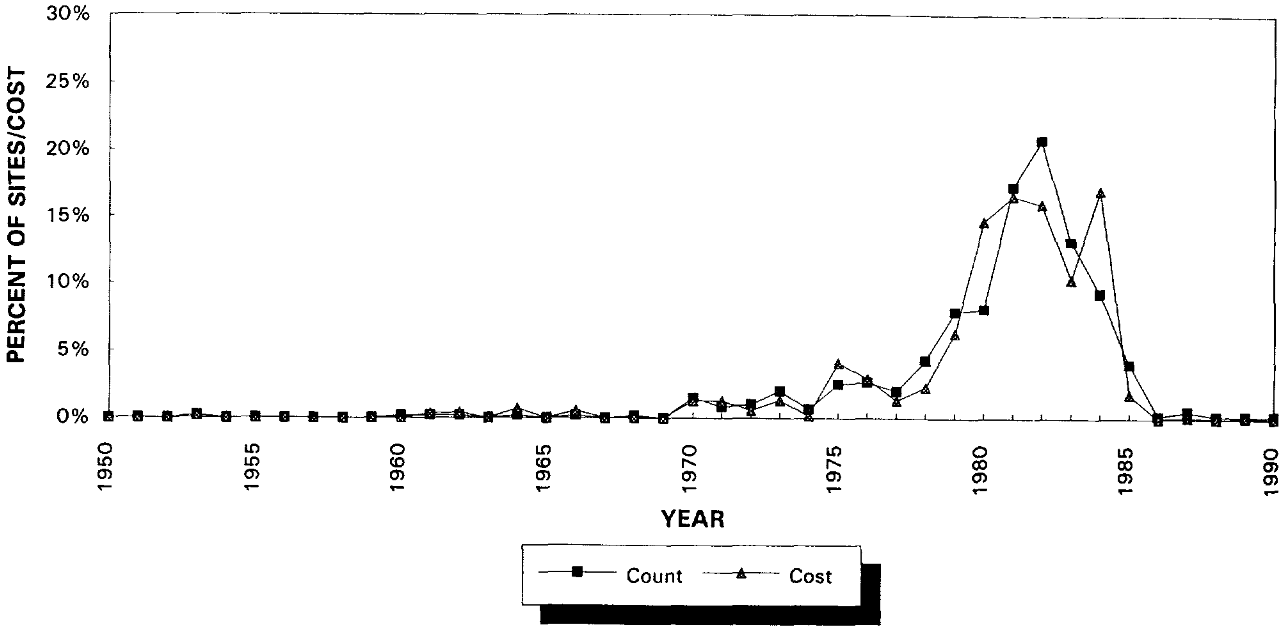
13. "Double Jeopardy" by Karen M. Tiemens, in Resources, January 1993, pp.3-5. (about natural resource damages)

Distribution of NPL Remediation Costs and Counts by Size




Potential NPL Counts and Costs by Year of Operation
10%
9%
8%
7%
6%
5%
4%
3%
2%
1%
0%
PERCENT OF SITES/COST
1945 & Prior
1950
1955
1960
1965
1970
1975
1980
1985
1990
Year
Count
Cost

Potential NPL Counts and Costs by Year of Discovery



Emergence of Sites by Discovery Year

Discovery Year	1990	1991	1992	Total
Number of Discovered Sites	10.0	25.0	15.0	50.0
Cost Relativity	1.10	1.00	0.90	
Estimated Relative Cost	11.0	25.0	13.5	49.5

Cost Distributions by Discovery Year

Discovery Year	1990	1991	1992
Cleanup Costs	50%	60%	60%
Defense Costs	50%	40%	40%
Total	100%	100%	100%

Percent of Estimated Relative Costs Paid by Discovery Year and Cost Component

Years since	Discovery Year: 1990			Discovery Years: 1991 & 1992		
Discovery	Cleanup	Defense	Average	Cleanup	Defense	Average
0	33%	50%	42%	50%	75%	60%
1	33%	40%	37%	30%	15%	24%
2	33%	10%	22%	20%	10%	16%

Note: Averages are weighted with the cost distributions by discovery year.

Calculation of Calendar Year Payment Pattern

Calendar	Estimated Relative Cost by Discovery Year			Estimated	Percent	Cumulative
Year	1990	1991	1992	Relative Cost Paid	Paid in the Year	Percent Paid
1990	4.6			4.6	9.3%	9.3%
1991	4.0	15.0		19.0	38.5%	47.7%
1992	2.4	6.0	8.1	16.5	33.3%	81.0%
1993		4.0	3.2	7.2	14.6%	95.6%
1994			2.2	2.2	4.4%	100.0%
Total	11.0	25.0	13.5	49.5		

Database Structure

Independent of the details of how claims are recorded, the claims database will be in one of two formats: flat or relational. Although we have come to prefer relational databases, there are advantages to each format relative to the four most important criteria:

- Simplicity
- Physical limitations of PCs and software
- Data quality
- Expandability

Flat files are two-dimensional matrices of data where each record (row) corresponds to a claim and each field (column) corresponds to a particular element of data (claim number, date of loss, insured name, ...).

Simplicity is the primary advantage of a flat database. They are easily understood and working with them requires little or no knowledge of database programming or software. In fact, their two-dimensional structure lends itself to use in spreadsheets assuming that the data is sufficiently small.

Unfortunately when using a flat file format, the physical limitations of PCs are a concern for all but the smallest pollution databases. Therefore, flat files have limited value beyond initially capturing data. Problems with random access memory (RAM), disk space, and processing time quickly arise due to the fact that flat files store too much data in each record and too many records to relate coverage to claims. For example, coverage information on a specific policy would appear in all claim records relating to that policy (see **Appendix F**), resulting in too much data per record. Also, extraneous claim records are included for individual claims that relate to more than one policy. (A detailed example of both effects is discussed below.) Physical limitations generally preclude any significant expansion of the scope of the sample flat file structure shown in **Appendix F.**

Our experience is that inconsistencies tend to occur more often and are more difficult to detect in flat files. Although this is somewhat anti-intuitive (since relational databases are more complex), it is easily explained by an example: If an insured is claiming five sites against a single policy, a flat file will have five records with the same policy information. Because the policy data has to be entered five times, small discrepancies are common. While this may be of little importance to the claims staff (who have the policy nearby), resolution of the differences is cumulatively time-consuming when each record has to be correct in order for the model to use it.

Relational databases consist of two or more two-dimensional matrices (called tables) of information that are related by one or more fields. The primary reason for using relational databases is to overcome the physical limitations of flat files. However, there are costs and secondary benefits associated with relational files that should be recognized.

The complex format (relative to flat files) of the data is the most significant "cost" of a relational database, which can be maintained and manipulated only with the help of a relational database management system such as dBase, SQL, Access, Paradox, or a custom-designed system. We note, however, that these systems can be hidden behind more user-friendly "shells" that make data entry and retrieval easy.

The main advantage of relational data is efficiency that helps to overcome physical barriers with respect to storage space and, more importantly, memory and processing speed. To illustrate the efficiency of relational databases, consider a single PRP having coverage from 5 policies on 10 waste sites. A flat file containing 50 records (5 policies x 10 sites) and 3 fields (policy, PRP, site) is required to store the data. The file contains 150 cells of data (50 records x 3 fields) most of which are extraneous. A relational format using the PRP in both a site table (10 records x 2 fields) and a policy table (5 records x 2 fields) requires only 30 cells of data, an 80% reduction in the volume of data. Hence, relational formats are much more efficient in storing data. The improved efficiency translates into faster processing time that allows us to work on larger bodies of data and/or to compare claim data to external databases.

As discussed above, improved data quality is an important secondary benefit of relational files.

Finally, the efficiency of the relational database format allows us to consider expanding the scope of the database beyond the limitations of flat files. This can be accomplished by either adding fields to existing tables or by adding entire tables to capture additional information. One possible expansion of the data that we propose below is a relational table containing loss transactions.

Database Content

Our discussion of pollution data fields considers a range of detail, from a minimal configuration through an extensive database including fields useful for researching the processes underlying pollution liabilities. We will also consider some current accounting practices that affect the data.

The most basic pollution claims database contains only coverage information (see Appendices E and F, fields marked with *) and assumes that all site involvement data will be supplied externally. While this configuration is easily maintained, we believe that it sacrifices a considerable amount of valuable data. As discussed in the section on *IBNR*, many insureds are involved at NPL sites where they are not a public PRP; in addition, claims records are the best source of non-NPL information.

The insured PRP name is the single most important field and consistent spelling is critical unless an insured ID number is added. The exact spelling is important, since, without the addition of some sort of fuzzy matching routine, most programs will not recognize that "Grace, WR" is the same as "The Grace Company".

Accurate coverage information is also critical to the analysis of pollution liabilities. All coverage information should be stated relative to the first dollar of loss to the PRP (i.e., "above the ground" or "ground up") including any self-insured retentions or deductibles. The ground up attachment point is particularly important to pollution liability analysis. The required coverage information includes effective date, the ground up attachment point, the width of the layer, and the percentage of the layer written. Additional useful coverage fields (marked with # in Appendices E and F) include expiration date, exclusion information, CSL vs. split limits, and expense treatment.

Unlike most claim files, the basic pollution database does not include amounts paid or outstanding. The reason for this is that losses are not relevant to the model analysis of potential ultimate losses, since the intent of the model simulation is to test the reported losses. The loss data required for the aggregate loss development and MCP approaches is usually available from the standard claims system, as are the amounts paid and outstanding by insured (for purposes of determining if certain insureds should be excluded from the analysis).

A mid-level pollution claims database captures site involvement information in addition to the basic or expanded coverage data. It is at this point that a claims system is likely to be converted to a relational database format, since addition of the site information generally causes a significant growth in the record count. The usual structure is illustrated in **Appendix G**; the insured name is associated with policy numbers and site IDs numbers, and these are the links to the coverage and claim (site) tables.

The addition of site data introduces even greater potential for spelling problems, since site names may have several aliases.[47] It is our experience that use of the EPA FINDS number solves most site identification problems. For sites where a FINDS number is not available, it is sufficient to assign a unique number to each different site (or site/PRP combination).

The optional (#) site fields contain data that can be directly extracted or simulated from external sources if necessary but which are useful if available specifically for that site/PRP combination. The specific information is always more desirable than simulated values, but cost/benefit decisions are required due to the data entry effort required. A compromise course is to enter the detailed site information only for PRPs/sites perceived to be potentially costly to the insurer.

An expanded pollution claims database adds claim transaction information or other data useful for conducting research on the claims or the underlying pollution loss process. For example, examination of the cash flows for a given site, type of claim, or groups of sites with certain characteristics (i.e., number of PRPs, cost,...) could develop useful basic information. The sample pollution database in **Appendix G** includes a claim transaction table layout that could be used to capture the data required for this analysis.

[47] For example, Hardage/Criner = Hardage = Royal = Royal Hardage = Criner = McClain = McClain County = FINDS OKD000400093

Introduction of dollar amounts into the database creates questions of allocation, both of indemnity and expenses (which may be allocated differently). All of the analysis methods described herein are insensitive to the allocation of dollar amounts, both among years and policies and between loss and expense. As a result, the allocations generally reflect a company's position on the coverage trigger and its level of reinsurance notification activity. We can, however, envision future methods of analysis that might develop as more data becomes available and that might be more sensitive to the exact allocation protocol used.

Sample Flat Database

<u>Field Name</u>

*	1.	Insured name
	2.	Insured ID number
*	3.	Claim number
*	4.	Policy number
*	5.	Policy effective date
#	6.	Policy expiration date
*	7.	Policy attachment point **ABOVE THE GROUND** *The terms "Above the Ground" or "Ground Up" indicate that losses should be stated from the first dollar of loss incurred by the insured including any self-insured retention or deductible.*
*	8.	Percent of layer **
*	9.	Width of layer** *** width x percent = maximum loss (excluding expenses)*
#	10.	Aggregate Limit
#	11.	Expense treatment *e.g., Expenses within limits, pro rata in addition to limits, indemnity only,...*
#	12.	Pollution exclusion indicator
#	13.	Limit type (CSL/split)
*	14.	Site name
	15.	Site ID number *US EPA FINDS numbers (alphanumeric) are ideal for NPL sites.*
	16.	Site city
#	17.	Site state
	18.	Site ZIP
#	19.	Site operation date (beginning)
#	20.	Site operation date (ending)
#	21.	Site discovery date
	22.	Report date (to insurer)
#	23.	Type of loss *e.g., Cleanup, third party BI, third party PD, natural resource damages,...*
	24.	Claimant *e.g., US EPA, Jane Doe, ...*
#	25.	Declaratory judgment action indicator
	26.	Loss Paid
	27.	Expense Paid
	28.	Loss Reserve
	29.	Expense Reserve

** Indicates fields required for the minimum configuration.*
 # Indicates fields of some importance that could be incorporated directly into the analysis but can be simulated or based on overall assumptions.

Appendix G
Sheet 1

Sample Relational Database

PRP Table

For each INSURED:

*	1.	Insured name
	2.	Insured identification number
*	3.	Claim number
*	4.	Policy number

Coverage Table

For each POLICY NUMBER referenced above:

*	1.	Policy number
*	2.	Policy effective date
#	3.	Policy expiration date
*	4.	Policy attachment point **ABOVE THE GROUND** *The terms "Above the Ground" or "Ground Up" indicate that losses should be stated from the first dollar of loss incurred by the insured including any self-insured retention or deductible.*
*	5.	Percent of layer **
*	6.	Width of layer** *** width x percent = maximum loss (excluding expenses)*
#	7.	Aggregate limit
#	8.	Expense treatment
#	9.	Pollution exclusion indicator
#	10.	Limit type (CSL/split)

Claim Table

For each CLAIM NUMBER:

*	1.	Claim number
*	2.	PRP number
*	3.	Site identification number
#	4.	Type of loss (e.g., clean up, 3rd party BI or PD, natural resource damages ...)
	5.	Claimant name (e.g., US EPA, Jane Doe,...)
#	6.	Declaratory judgment action indicator
	7.	Report date to insurer
	8.	Closed date
#	9.	Closed status (open, settled, defense verdict, plaintiff verdict,...)

** Indicates fields required for the minimum configuration.*
 # Indicates fields of some importance that could be incorporated directly into the analysis but can be simulated or based on overall assumptions.

Site Table

For each SITE NUMBER:

*	1.	Site name
*	2.	Site identification number (US EPA FINDS number if available)
	3.	Site city
#	4.	Site state
	5.	Site ZIP code
	6.	NPL (Y/N)
#	7.	Site operation date - beginning operations
#	8.	Site operation date - ending operations
#	9.	Site discovery date
	10.	Total estimated cleanup costs
	11.	Total estimated third-party costs

Claim Transaction Table

For each CLAIM NUMBER referenced above:

1. Claim number
2. Site identification number
3. Report date (to insurer)
4. Transaction date
5. Current indemnity payment
6. Current expense payment
7. Change in indemnity reserves
8. Change in expense reserves

STATEMENT OF UNDERSTANDING
REINSURANCE CLAIM REPORTING CRITERIA

The purpose of these guidelines is to provide generally agreed upon objective criteria for the initial reporting of pollution reinsurance claims. These guidelines may be amended or modified by individual cedents and reinsurers, but general adherence to these guidelines will permit efficient reporting and reduce the amount of paper and cost presently encountered.

These guidelines are not intended to, and do not, modify the legal relationship between cedents and reinsurers. The legal effect of use of these guidelines will be the subject of negotiation between individual cedents and reinsurers. This is being done as a mutual accommodation with the intent that it will result in agreement by the reinsurers not to assert late notice if the criteria are agreed to and adhered to by the cedent. Cedents will make good faith efforts to report on the Preston Form or on a report containing similar qualitative information, with supplemental information to be reported on an ongoing basis as warranted.

These guidelines are intended to identify those pollution claims which may have reinsurance exposure, and to provide early information to reinsurers so that they may evaluate those claims. Since the underlying claims are subject to coverage disputes, the criteria are keyed largely to the potential financial exposure of the policyholder, rather than the exposure to the cedent after resolution of coverage issues.

These guidelines do require cedents to notify reinsurers, as soon as practical, of those claims that meet the criteria. It is not expected that cedents will undertake investigation or evaluation of claims solely to determine whether they are subject to the criteria, and cedents shall be under no obligation to do so. The information utilized shall be that which is obtained by cedents in its normal course of business of investigating and managing pollution claims. Likewise, cedents shall be under no obligation to ascertain proportional share responsibilities of a policyholder, since determination of such shares are normally the subject of lengthy negotiations and/or litigation in the underlying claim, and require analysis of many factors, including toxicity, orphan shares and EPA enforcement strategy. When information identifying proportionate share is identified by the cedent, however, cedents shall have an obligation, as soon as practical, to provide reinsurance notice if the objective criteria are met.

A list identifying the non-NPL sites referenced in II(a) and (b) of the criteria will be compiled and distributed annually by a governmental or industry source.

As noted, these reporting criteria guidelines, except as agreed to by individual cedents and reinsurers, shall not modify the legal rights of the parties. Use of these reporting criteria will not waive contractual rights or defenses, and will not be deemed to be an interpretation of contract language or a course of performance under any contract.

The adoption of these criteria does not nullify the effect of any and all previously given notices to reinsurers.

DISCLAIMER:

Neither this report nor application of the "Reinsurance Claim Reporting Criteria" shall constitute the adoption of any position on any issue of coverage, including but not limited to the existence, date, number of claims or occurrences in a potential reinsurance claim.

In addition, this report and the use of this criteria shall not constitute an admission that the underlying claim involves one or more covered claims or occurrences under any policy of insurance. Furthermore, this report and the use of this criteria does not constitute any position or admission on the part of the policyholder.

This report contains information taken from EPA reports and other site and/or claimant documents. The information contained in such documents cannot, in every instance, be verified for accuracy. All information disclosed is for confidential use by the cedent's reinsurers.

CLAIM REPORTING CRITERIA:

I. All pollution-related DJ actions where paid DJ expenses is in excess of $_______ on a policyholder basis; or

II. Any pollution-related claim where the policyholder is:

   a. An alleged present or past owner or operator of an NPL site or any of the ten (10) most serious non-NPL sites in each of those states which promulgate and maintain a separate list of sites ranked in order of severity; or

   b. Alleged to be responsible for ______% or greater share of response costs at an NPL site or any non-NPL site described in a. above. Share may be determined by volume or some other basis as developed in the underlying case; or

   c. Alleged to have an exposure of greater then $_______. Exposure = alleged response cost x volumetric share, or some other cost-sharing criteria (based on something other than volumetric basis) as developed in the underlying case; or

   d. Named in third party private action(s) involving a certified class action or suits involving _____ or more named claimants/plaintiffs; or

III. Any pollution-related claim(s) where the cedent has paid indemnity and expenses, including DJ expense, in excess of $_____ on a policyholder basis, regardless of allocation methodology.

ENVIRONMENTAL CLAIMS REPORTING FORM

☐ FIRST REPORT — DATE: ____________
☐ UPDATE — LAST REPORT DATE: ____________

This form is solely for the purpose of assisting cedants to report environmental claims. Usage of this form is entirely voluntary, and no views are expressed or implied as to the applicability of insurance or reinsurance coverage to particular claims.

The use, non-use, or partial use of this form by any cedant or reinsurer shall not constitute an admission as to the time at which notice must be given, the appropriate form of such notice, or the items of information required to be included in such notice. Rather, all issues and disputes regarding notice must be determined solely by reference to the pertinent reinsurance contract and/or applicable law.

Complete all three pages of the form if this is a first report. If this is an update, identify the contract, insured, and site, and use rest of the form to report any change in the information previously provided.

I. CLAIMS SUMMARY

REINSURED: ____________

Reinsurance Contract: ____________ Broker and Ref. No. ____________

R/I Years To Which Claims Reported	R/I Limits	Retention

INSURED and/or Subsidiary Involved: ____________

INSURANCE COVERAGE PROFILE:

Policy No.	Policy Period	Policy Type	Policy Layer	Policy & Underlying Limits (BI, PD, CSL)	Defense Costs	Other Inuring R/I?

Policy Type		Layer	Limits	Defense Costs
GL = General Liability	C = Gen Liability (Claims-Made)	P = Primary	BI = Bodily Injury	AD = In Addition
EIL = Environ Impair Liability	DIC = Difference in Conditions	U = Umbrella	PD = Property Damage	IN = Inclusive
P-A = Property-All Risk	H = Homeowners	E = Excess	CSL = Combined Single Limit	PR = Pro Rata
P-A/M = Prop-All Risk/Manuscript	OM = Ocean Marine (Hull/P&I)			EX = Excluded
P-N = Property-Named Peril	SMP = Special Multi-Peril			

Underlying Carriers (if known): ____________

SITE: ____________ Superfund: YES ☐ NO ☐

Location: ____________ EPA ID No. ____________

CLAIMS INCLUDED IN THIS REPORT: *(You may include all claims against one insured at one site.)*

Claim No.	Claimant	Policy No.	D/L

CURRENT RESERVE: Indemnity: ☐ Expense: ☐

II. CLAIMS DETAIL

Please provide the information requested in Parts A and B. If the information requested is not yet available, enter "NYA". If the information requested is not applicable, enter "NA". If the information requested is privileged, so indicate.

PART A: SITE ANALYSIS

SITE/LOCATION: ______________________________ EPA ID No.: __________

Number of Defendants/PRPs at Site:

Years When Site in Active Use:

Alleged Date(s) Contamination Discovered:
(a) By gov't agency:
(b) By private third-party:
(c) By insured:

Alleged Cause (s) of Release: (check one or more)
- ☐ Factory emissions into air or water
- ☐ Spillage/Dumping/Leaching
- ☐ Leakage from tank, drum, barrel or other container
- ☐ Force of nature (flood, wind, fire, explosion, etc.)
- ☐ Other (specify):

Nature Of Claims:	TOTAL ESTIMATED COSTS	PAID TO DATE
Emergency (Short-Term) Removal Costs	$	$
Long-Term Remedial Action Costs	$	$
Natural Resources Damages	$	$
Third-Party BI Claims	$	$
Third-Party PD Claims	$	$

Clean-Up Claims Detail:

1. Remedial Investigation/Feasibility Study: ☐ In Progress ☐ Completed (Cost: $ ________) ☐ Not Applicable
2. Describe contamination alleged:

(A) ON-SITE

(B) OFF-SITE

Private Third-Party Claims Detail:

1. Number of Plaintiffs and Alleged Date (s) of Exposure:

2. Type of Injury/Damage Alleged:

Any Other Pertinent Site Information: *(attach separate sheet)*

Date: ____________________, 19 ______

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PART B: STATUS OF THE INSURED

INSURED: ______________________ SITE: ______________________

☐ GENERATOR ☐ Owned Site ☐ Non-Owned Site

Type of Business:

Date (s) When Site Allegedly Received Insured's Waste:

☐ TRANSPORTER Date (s) of Transport Alleged:

☐ SITE OWNER/OPERATOR Dates of Ownership/Operation Alleged:

Hazardous Substances Allegedly Contributed By Insured:

Insured's Share of Total Waste (by volume):

Status Of Clean-Up Claims Against Insured	Status Of Third-Party Claims Against Insured
1. Court:	1. Court:
2. Portion, if any, of amounts in Part A that are claimed solely against insured:	2. Portion, if any, of amounts in Part A that are claimed solely against insured:
3. Status of negotiation/litigation:	3. Status of negotiation/litigation:

Handling of Claims:

1. Date when insured gave notice:
2. Identify carriers participating in defense of insured:

   Your defense costs: Paid $ ______ Outstanding $ ______

3. D.J. action brought: YES ☐ NO ☐ By whom: ______ Court ______

   Your D.J. costs: Paid $ ______ Outstanding $ ______

4. Coverage defenses asserted/reserved: *(You may attach a copy of written reservation of rights or disclaimer)*

☐ Late Notice	☐ Owned Property Exclusion
☐ Trigger of Coverage	☐ Pollution Exclusion
☐ Exhaustion of Limits	☐ Misrepresentation
☐ Application of Deductibles	☐ Number of Occurrences
☐ Clean-Up Costs Not Covered	☐ Other (specify):

5. Status of negotiation/litigation:

Date: ______________, 19____

ECR Form PAGE 3

Measurement of Asbestos Bodily Injury Liabilities

by Susan Cross and John Doucette

MEASUREMENT OF ASBESTOS BODILY INJURY LIABILITIES

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Executive Summary

The model presented herein provides a formalized approach to projecting an insurer's or reinsurer's potential asbestos bodily injury (BI) liabilities through an analysis of exposed policy limits. The model projects the ground-up aggregate liabilities of individual insureds, allocates those liabilities to policy years and carves out the portion of the liabilities falling in the layers of coverage written by the insurer or reinsurer. That is, the underlying process of claim filings against the insureds is modeled and then compared to the insurer's or reinsurer's policy exposures.

Asbestos BI claims are currently being filed against asbestos producers at the rate of 2,000 to 2,500 per month. Claim filings are expected to continue at this rate for at least the next several years and at lower levels over the following 30 to 50 years. With claims aggregating under products liability policies over this length of time even high layer excess policies can be exposed, although perhaps not for 10, 20, or 30 years. Given the long latency periods for asbestos diseases, it is important to model the underlying claim process in order to determine the magnitude and timing of claims that will be allocated to specific insurance policies.

Well over 1,000 companies have been named as defendants in asbestos BI litigation. However, over 80% of the liabilities are expected to relate to fewer than 50 defendants and not all such defendants would have been insured by a given insurance company. Thus, the number of insureds presenting significant exposure to an insurer is relatively small, making it feasible to compile policy details (e.g., attachment point, limit, exclusions) on all policies providing products liability coverage to such insureds or to a representative sample group of insureds. In the paper, we describe a five tier system for categorizing defendants according to the nature (and thus magnitude) of their exposure to asbestos BI

claim activity. The tier system is useful in selecting a sample group for the model analysis and in extrapolating the results of the model analysis to include all insureds.

Through claim department records and public sources, it is possible to compile information on claim filings and payments for each insured in the sample group. Current claim information by insured as well as assumptions regarding future claim filing patterns, claim severity trends, and expense ratios are used in the model to project ground-up aggregate losses for each insured. The model allocates the projected costs to policy years using either specific information on the insured's coverage block or assumptions regarding the number of years over which an insured's claims will be allocated and the expected distribution by year.

Once projected costs are allocated to policy years, the ground-up costs per year are compared to the exposed policy limits in that year to determine the insurer's or reinsurer's share of the costs. In making this comparison, it may be necessary to restate the attachment point, limit, and participation percentages of exposed excess and reinsurance policies to be relative to the first dollar of loss. This adjustment to policy terms is discussed in detail in the paper.

The underlying process of claim filing is modeled at the insured level for each future calendar year. Comparing these projections to the insurer's or reinsurer's policy exposures produces a pattern for loss emergence under these policies. The loss emergence pattern can be useful in deriving cash flow projections. The pattern can also be used, along with other model results, to produce ultimate loss estimates for insureds not included in the model analysis, thus arriving at a measurement of an insurer's or reinsurer's total asbestos BI liabilities associated with identified exposures.

Once the policy exposures have been identified and coded in the model, assumptions regarding future claim emergence, claim severities, expense ratios, and procedures for allocating claims to years can be varied to produce a range of indications. Also, the model can be easily updated in future periods and the emergence and cash flow patterns derived from the model can be used to monitor future activity.

1. Introduction

This paper presents a methodology for estimating an insurer's or reinsurer's potential liabilities from asbestos-related bodily injury (BI) claims. Property damage (PD) claims resulting from asbestos are not considered in this model. The approach is a policy limits analysis on a sample group of insureds. The first step in developing the methodology is obtaining an understanding of the nature of the potential liabilities. Thus, our paper begins with a brief discussion of the significant historical developments relating to the emergence of asbestos-related BI claims. Section 2 presents historical uses of asbestos, problems arising from asbestos use, legal issues related to the asbestos problem, and insurance issues emerging from asbestos litigation. This information is important in order to understand how these claims differ from traditional products and general liability BI claims and, therefore, why traditional actuarial projection techniques are not directly applicable. Section 3 describes the asbestos diseases: mesothelioma, lung and other cancers, asbestosis, and pleural plaques. Knowledge of the unique characteristics of these diseases is necessary to understand the legal issues surrounding asbestos BI insurance coverage litigation.

Section 4 explains the motivation for the model presented in this paper as well as the requirements of any methodology that projects asbestos BI liabilities. Section 5 presents details on the steps in the asbestos BI model. The steps may be grouped into the following categories: 1) determine the sample group and collect data, 2) adjust the sample group data, 3) use the model to estimate the insurance or reinsurance company's liabilities for the sample group, 4) conduct sensitivity testing of model assumptions, and 5) extrapolate the model results to all insureds. To facilitate the discussion of the model, we run a fictitious reinsurer, ABC Re, through each of the steps of the asbestos BI model. Finally, Section 6 discusses strengths and weaknesses of the model and identifies areas related to asbestos liability projections requiring further research.

2. Background

Asbestos And Its Uses

What is asbestos? It is a generic term referring to a variety of naturally occurring minerals which share similar properties. There are six major recognized species of asbestos: chrysotile (white asbestos), amosite (brown asbestos), crocidolite (blue asbestos), anthophyllite, tremolite, and actinolite. These six species of asbestos come in two general forms: chrysotile comes in the serpentine form, the other five come in the amphibole form [1]. Chrysotile represents over 95% of all asbestos used in buildings [2]. Though each variety of asbestos has unique characteristics, in general, the asbestos minerals form fibers which are incombustible, flexible, durable, strong, and resistant to heat, corrosion and wear. Because of these properties, asbestos was targeted for use in an estimated 3,000 commercial, public, and industrial applications [3]. Examples include building insulation, pipe coverings, wire coatings, brake linings, roofing products, and flooring products. By the year 1900, asbestos was in use in the building construction industry. Asbestos was also used extensively in World War II ship building. Following the war, there was significant expansion of the use of asbestos products in construction and manufacturing. Figure 1 provides details on the uses and composition of asbestos-containing building products as of the mid-1980s. Friable means that the material can be reduced to powder by hand pressure.

Figure 1. Location, composition, and dates of use of asbestos-containing building products

Product	Location	Percent Asbestos	Dates of Use	Binder	Friable/ Nonfriable	How Fibers can be Released
Roofing and Siding						
Roofing felts	Flat, built-up roofs	10-15	1910-present	Asphalt	Nonfriable	Replacing, repairing, demolishing
Roof felt shingles	Roofs	1	1971-1974	Asphalt	Friable	Replacing, demolishing
Roofing Shingles	Roofs	20-32	1930-present	Portland cement	Nonfriable	Replacing, repairing, demolishing
Siding Shingles	Siding	12-14	?-present	Portland cement	Nonfriable	Replacing, repairing, demolishing
Clapboards	Siding	12-15	1944-1945	Portland cement	Nonfriable	Replacing, repairing, demolishing
Walls and ceilings						
Sprayed coating	Ceilings, walls, and steelwork	1-95	1935-1978	Portland cement, sodium silicate, organic binders	Friable	Water damage, deterioration, impact
Troweled coating	Ceilings, walls	1-95	1935-1978	Portland cement, sodium silicates	Friable	Water damage, deterioration, impact
Asbestos-cement sheet	Near heat sources such as fireplaces, boilers	20-50	1930-present	Portland cement	Nonfriable	Cutting, sanding, scraping
Spackle	Walls, ceilings	3-5	1930-1978	Starch, casein, syn. resins	Friable	Cutting, sanding, scraping
Joint compound	Walls, ceilings	3-5	1945-1977	Asphalt	Friable	Cutting, sanding, scraping
Textured paints	Walls, ceilings	4-15	?-1978		Friable	Cutting, sanding, scraping
Millboard, rollboard	Walls, commercial buildings	80-85	1925-?	Starch, lime, clay	Friable	Cutting, demolition
Vinyl wallpaper	Walls	6-8	?		Nonfriable	Removal, sanding, dryscraping, cutting
Insulation board	Walls	30	?	Silicates	Friable	Removal, sanding, dryscraping

Figure 1 - Continued

Product	Location	Percent Asbestos	Dates of Use	Binder	Friable/ Nonfriable	How fibers can be Released
Floors						
Vinyl-asbestos tile	Floors	21	1950-1980?	Poly(vinyl) chloride	Nonfriable	Removal, sanding, dryscaping, cutting
Asphalt-asbestos tiles	Floors	26-33	1920-1980?	Asphalt	Nonfriable	Removal, sanding dryscraping, cutting
Resilient sheet flooring	Floors	30	1950-1980?	Dry oils	Nonfriable	Removal, sanding, dryscraping, cutting
Mastic adhesives	Sheet and tile backing	5-25	1945-1980?	Asphalt	Friable	Removal, sanding, dryscraping, cutting
Pipes and boilers						
Cement pipe and fittings	Water and sewer	20-?	1935-present	Portland cement	Nonfriable	Demolition, cutting, removing
Block insulation	Boilers	6-15	1890-1978	Magnesium carbonate, calcium silicate	Friable	Damage, cutting, deterioration
Preformed pipe wrap	Pipes	50	1926-1975	Magnesium carbonate, calcium silicate	Friable	Damage, cutting, deterioration
Corrugated asbestos paper	Pipes	high temp. 90 mod. temp. 35-70	1935-1980? 1910 - 1980?	Sodium silicate, starch	Friable	Damage, cutting, deterioration
Paper tape	Furnaces, steam valves, flanges, electrical wiring	80	1901-1980?	Polymers, starches, silicates	Friable	Tearing, deterioration
Putty (Mudding)	Plumbing joints	20-100	1900-1973	Clay	Friable	Water damage, deterioration

Source: U.S. Environmental Protection Agency

Problems Arising From Asbestos Use

The virtually indestructible nature of asbestos fibers, which makes it so attractive in commercial applications, causes asbestos to be a health risk to humans. When airborne asbestos fibers are inhaled into the lungs, they tend to persist indefinitely. Thus, exposure to asbestos dust has been the cause of such diseases as mesothelioma, lung cancer, asbestosis, and pleural plaques. Historically, the population with the greatest exposure to asbestos dust was workers involved in the production or installation of asbestos [4].

The United States government did not take action to limit workers' exposure to asbestos until the early 1970's. Today, the permissible exposure limit for workers exposed to asbestos set forth in the Occupational Safety and Health Administration's (OSHA) Asbestos Regulations is approximately one-one hundredth of the average exposure level of an insulation worker prior to 1970 [5], [6]. Figure 2 shows the exposure standards over the past 20 years. In 1989, the Environmental Protection Agency (EPA) issued a ban on the manufacture, importation, processing, and distribution in commerce of asbestos in almost all products [7]. The legality of the ban is currently being addressed in court.

Figure 2

Year Enacted	Permissible Fibers/ Cubic Centimeter Exposure Standard 8 hour Average
1972	5 f/cc
1976	2 f/cc
1983	.5 f/cc
1988	.2 f/cc

Source: OSHA

Legal Issues Related to the Asbestos Problem

Prior to the asbestos litigation onslaught during the 1970s and 1980s, asbestos-related occupational diseases were traditionally compensated through workers' compensation insurance. Claims have been filed under workers' compensation since the 1950s for asbestos-related disease; the first significant liability lawsuit against asbestos manufacturers was not filed until 1970.

The first significant asbestos-related lawsuit, Borel v. Fibreboard, filed in 1970 and decided in 1973, was a landmark case in asbestos litigation. The decision held that a defendant manufacturer of insulation materials containing asbestos could be found liable when: 1) an individual's disease was caused by exposure to the defendant's product, and 2) despite the defendant's knowledge of the risk, the defendant failed to provide adequate warning to the individual. This decision opened the door for further actions against manufacturers [8].

As additional claims were filed in the late 1970s, defendants pursued coverage for these claims under their products liability insurance policies. The long latency period of asbestos-related diseases (i.e., an asbestos-related disease may not manifest itself for 40 or more years after first exposure [9]) required legal decisions regarding the date of occurrence of asbestos-related BI in order to determine which insurance policies were triggered. Consequently, beginning in 1980, insurance coverage decisions were handed down by the courts. The decisions have generally followed either 1) a continuous trigger (or injury-in-fact trigger interpreted similarly to a continuous trigger) or, in some cases, 2) an exposure trigger. There has been one case decided on a manifestation trigger basis [10]. Under the continuous trigger theory, injury is deemed to occur continuously from the first inhalation of the asbestos fibers through the manifestation of the disease. Thus, any and all policies in effect during this time period can be triggered and called upon to pay the claim. Under the exposure trigger theory, injury is assumed to occur only during the period of exposure to asbestos. Thus, the exposure theory triggers a subset of the policies triggered by the continuous theory. Under the manifestation trigger theory, no bodily injury occurs, and thus no insurance coverage is triggered, until the asbestos-related disease became reasonably capable of medical diagnosis. Thus, manifestation theory triggers policies in a single year. [11].

Since the early 1980s, the litigation for asbestos cases (lawsuits) has grown at a staggering rate. As of June 1991, there had been over 71,000 cases filed nationwide in federal courts. As of June 1992, there were at least 120,000 additional lawsuits pending in state courts. Despite defendants' attempts to settle lawsuits, many still face tens of thousands of pending suits. Note that these are number of lawsuits, not number of plaintiffs. The number of plaintiffs would be even higher, because some lawsuits are consolidations of hundreds or thousands of plaintiffs.

A plaintiff typically names several defendants in a suit, even dozens, therefore adding each defendant's reported number of claims together would overstate the total number of claims. Many defendants are being named in thousands of new cases each month. The asbestos litigation problem is not going away and cannot be ignored by potential defendants or their insurers [12], [13].

Insurance Coverage Issues

In practice, the method of handling claims and allocating loss and expense dollars to policies or self-insured periods is negotiated between the insured and its group of insurers. These negotiations are consistent with the applicable trigger theory. With the total filed claim count approaching 200,000 for some defendants, such agreements are necessary for the efficient processing of claims. For purposes of this paper, we define the defendant's insurance coverage block as the years of agreed-upon coverage. Given the predominant trigger theories, the coverage block generally begins with commencement of asbestos product manufacture or distribution and ends with either: 1) the end of the product's commercial use (often early to mid-1970s), or 2) the last year of products liability coverage without an asbestos exclusion (generally late 1970s or early to mid-1980s). In either case, the coverage block will likely span 15 or more years.

It is interesting to note that unlike the absolute pollution exclusion introduced into the Insurance Services Office's (ISO) Comprehensive General Liability (CGL) policy in 1986, an asbestos exclusion was not consistently incorporated into policies during a certain year. Rather, various forms of asbestos exclusions were phased in during the 1970s (generally late 1970s) and early 1980s, first for primary manufacturers and later for secondary manufacturers and distributors. This complicates determining the end of the coverage block for each insured.

Today there continues to be considerable unresolved insurance coverage litigation. This litigation tends to revolve around three issues: 1) existence and terms of lost policies, 2) interpretation of asbestos exclusion wordings, and 3) applicability of the known loss exclusion [14]. Although unresolved issues may hinder analysis of an insurer's potential liabilities for a particular insured related to specific years of coverage, case law is sufficiently established to permit the estimation of a range of total potential liabilities for the known asbestos defendant group.

The trend in asbestos litigation of an increasing universe of defendants must be understood before quantifying liabilities for a particular group of insureds. Early in the asbestos litigation process, only major manufacturers and distributors of asbestos were named as defendants in the suits. However, the asbestos defendant group has expanded considerably over time. This is due in large part to the bankruptcy of major asbestos defendants such as Johns-Manville and UNR Industries as well as the search by plaintiff attorneys for other sources of compensation. In addition, significant expansion occurred around 1989 when defendant Owens Corning Fiberglas drew a large number of companies into the asbestos litigation via third-party actions [15]. Companies identified as defendants only during the past five years are generally companies with more limited asbestos exposures due to the encapsulation of asbestos in their products or their involvement only as a local distributor (e.g., local hardware stores). However, these companies and their insurers are still facing potentially substantial indemnification and defense costs. A further expansion of the defendant group may yet occur. However, due to uncertainty regarding the nature and extent of such expansion, we do not try to quantify an IBNR provision associated with future identified defendants. It is not clear that such a provision is necessary because expansion of the defendant group would likely result in a reduction in the costs borne by the current defendant group.

Another insurance issue needing discussion is the type of coverage under which asbestos BI defendants are filing and the implications of limits under that coverage. Since the asbestos litigation explosion, insurers' asbestos-related costs under workers' compensation have been limited because employees have sued the manufacturers and distributors of asbestos products rather than file workers' compensation claims against employers. Asbestos BI claims have historically been filed by defendants as products and completed operations claims under general liability policies. The majority of such policies include an aggregate limit applicable to products claims. As thousands of claims are allocated across an insured's coverage block, the portion of the claims allocated to each policy accumulates to exhaust that policy's aggregate limit. Typically, courts have disallowed the theory that all manufacturing of asbestos products was a single occurrence. Thus, in situations where no aggregate limit was included in the policy, the insurer's liability is essentially unlimited.

In the mid-1980s, several defendants and insurers formed the Asbestos Claims Facility (ACF) to deal with the enormous number of asbestos claims. Participants in the ACF addressed the treatment of policies without aggregate limits, as well as other coverage issues, in the Wellington Agreement signed by insureds and insurers. The Wellington Agreement specified an aggregate limit as a multiple of the per occurrence limit, with the multiple varying with the magnitude of the per occurrence limit. Although the ACF was dissolved in 1988, the provisions of the Wellington Agreement remain [16]. Thus, most products liability coverage is subject to aggregate limits for indemnity.

A number of asbestos defendants owned subsidiaries that installed asbestos products as well as manufactured and/or distributed the products. As these defendants are exhausting their products liability coverage, they are seeking premises and operations coverage for claims related to the installation subsidiary. Since general liability policies did not generally contain aggregate limits for premises and operations claims, significant additional coverage could be available to defendants if they are successful in obtaining coverage on this basis. Also, the expansion of the defendant group to include property owners as discussed in a later section, has resulted in additional premises and operations claim filings.

3. Asbestos Diseases

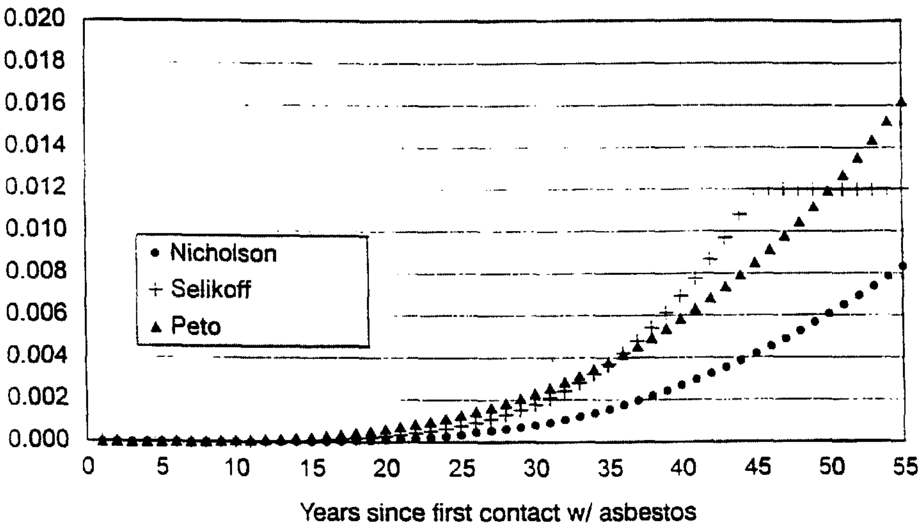
Life-threatening or disabling diseases can be caused by exposure to airborne asbestos, particularly at the high exposure levels in occupational settings during the first 70 years of this century. Diseases associated with asbestos exposure include mesothelioma, lung and other cancers such as gastrointestinal, asbestosis, and pleural plaques. Mesothelioma has been strongly associated with asbestos exposure. Lung cancer and other cancers have been associated with asbestos exposure at occupational levels. Asbestosis has been observed mainly after high occupational exposure to asbestos [17].

According to the Journal of the National Cancer Institute, "asbestos is the only known risk factor for mesothelioma, a tumor of the membranes lining the chest or abdominal cavities"[18]. It should be noted that cases of mesothelioma have been diagnosed in individuals without known asbestos exposure. However, if individuals can demonstrate exposure to asbestos, the courts appear to universally accept that mesothelioma was caused by such exposure.

Mesothelioma generally manifests itself 15 to 50 years from first exposure to asbestos and is almost always fatal within one to two years of diagnosis. Figure 3 shows three functions derived from epidemiological studies and used to project future mesothelioma incidence rates for an insulation worker with cumulative asbestos exposure of 250 fiber-years/ml [19].

Figure 3

Probability of Death due to Mesothelioma



Sources: Nicholson [20]. Adopted by Dunbar [21].
Selikoff [22]. Adopted by Tillinghast [23] and Peterson [24].
Peto [25]. Adopted by Walker [26].

The graph demonstrates the relationship between mesothelioma incidence rates and time since first exposure (i.e., the latency period). This helps explain why workers exposed in the 1950s and 1960s are just now filing claims and why, when incorporating exposures from the 1970s, claim reportings are expected to continue well into the next century.

Epidemiological studies have demonstrated an increased risk of lung and other cancers among workers exposed to asbestos. For insulation workers with cumulative exposure of 250 fiber-years/ml, the risk of lung cancer is two to seven times the normal risk. Following a minimum latency period of 8 to 10 years, the relative risk (i.e., the risk for an asbestos-exposed population versus an unexposed population) of developing lung cancer increases linearly until 35 to 40 years past first exposure and then begins to decrease [27].

Another asbestos-related disease is asbestosis. Asbestosis is a fibrotic or scarring process within the lung tissue, potentially causing an inflammatory response and fluid collection resulting in various levels of disability from respiratory problems. Severe cases of asbestosis are generally associated with heavy occupational exposure such as that of insulators or shipyard workers. The relative incidence of asbestosis has declined in recent years although we are not aware of any evidence showing a similar decrease in asbestosis claim filings.

The mildest of the asbestos related diseases is pleural plaques. Pleural plaques is a benign condition of the lungs which is generally not debilitating. However, pleural plaques is associated with asbestos exposure and claims are being filed by individuals with this condition.

Plaintiffs with mesothelioma generally receive the highest indemnity payments, averaging several hundred thousand dollars (though some individual awards total several million dollars). While certain lung cancer plaintiffs without contributing factors such as smoking receive average indemnity payments comparable to mesothelioma, the overall average indemnity for lung cancer plaintiffs is approximately 50% of the average mesothelioma payment. Non-fatal asbestosis plaintiffs receive payments averaging approximately 10% to 15% of mesothelioma payments[28].

4. Projection Considerations

One thing is clear with regard to projecting ultimate asbestos liabilities: traditional loss development techniques which rely on historical accident year loss development to derive development factors cannot be used. Traditional methodology is inappropriate for asbestos loss development because: 1) historical asbestos loss development is not representative of expected future development, 2) asbestos loss development is not a function of the age of the accident or policy year, 3) diseases caused by asbestos are latent for long periods of time, and 4) asbestos claims are allocated over many years based on the courts' decisions on occurrence of injury.

Any loss development patterns used in projecting asbestos liabilities should reflect what is happening at the underlying insured level as well as the insurance or reinsurance company's exposure. It will be shown in Section 5 that asbestos loss development for insurers and reinsurers does not relate to the age of the policy, but to factors such as the underlying claim allocation procedure and the attachment points and limits of the exposed policies.

Any methodology for projecting an insurer's or reinsurer's potential liabilities for asbestos BI claims must reflect the following elements of company's exposure:

- years and volume of general liability business underwritten,
- use and wording of asbestos exclusions,
- type of insureds underwritten,
- layers of liability underwritten and retained,
- use of aggregate limits, and
- expense treatment in policies.

Figure 4 is useful in doing a preliminary assessment of the level of an insurance or reinsurance company's potential asbestos BI liabilities. It gives several characteristics relating to the general liability (GL) insurance book of business. For each characteristic there is a typical answer for low risk, medium risk, and high risk. Low risk means the insurer or reinsurer is not likely to have significant potential asbestos liability. High risk means the insurer or reinsurer is likely to have significant potential asbestos liability. This is not a comprehensive list of factors to consider. Obviously, the number of asbestos claims for insureds, average indemnity for insureds, and similar information are required before the potential liability for an insurer or reinsurer can be quantified.

Figure 4

GL Book of Business Characteristic	Low Risk	Medium Risk	High Risk
Policy Years	1986 and subsequent	1976 - 1985	1975 and prior
Premium Volume (GL Market Share)	<0.5%	0.5%-1.5%	1.5%+
Asbestos Exclusion	Consistent use of comprehensive exclusion by early-1970s	Consistent use of comprehensive exclusion by late 1970s	Asbestosis exclusion and inconsistent applic. until mid 1980s
Type of Insureds	Small/Local Businesses	Regional Companies	Fortune 1000 Manufacturing/ Construction
Layers Written	Very High Excess (>$20 million)	High Excess (>$5 million)	Primary/Umbrella/ Low Excess
Aggregate Limits	No Exceptions	Few exceptions	Many Exceptions
Expense Treatment	Indemnity Only	Expense included in limit	Expense in addition to limit

Of course, these factors need to be considered in total, but insurers or reinsurers falling in the low risk category for all factors (unlikely, as small businesses purchasing coverage above $20 million is rare) and limited claim activity to date are most likely not facing significant liabilities. Likewise, insurance or reinsurance companies consistently rated high risk should carefully review their potentially significant liabilities.

To do a more detailed and rigorous analysis of an insurance or reinsurance company's liability, a projection methodology must be selected based on its appropriateness for the line of business being reviewed. Given the unique characteristics of asbestos losses, such as development being unrelated to age of policy or accident year, a policy limits analysis is a strong candidate for a methodology that can incorporate all of the necessary factors in an ultimate loss estimate. A policy limits analysis will be presented in the next section.

5. Policy Limits Analysis

Our model differs from most traditional actuarial loss development methods by explicitly quantifying the impact of each policy's limits when estimating the insurance or reinsurance company's liability. Patrik mentions the need for special consideration for certain long-tailed exposures such as asbestos [29].

In our model, ground-up losses for each insured are calculated using a frequency and severity approach. For each policy for each insured, the losses in the insurance layer are calculated based on the policy's limits and the ground-up losses. Other actuarial projection methods, such as the incurred loss development method, are assumed to implicitly take into account the insured's policy limits in the selection of loss development factors.

Our approach is more appropriate for asbestos losses because of the extremely long latency of asbestos diseases and the allocation of an asbestos claim across several policy years. If a court ruled that an asbestos-related injury had been caused by exposure spanning 30 years, all 30 years of insurance policies could be triggered. Typically over such a long period the defendant's policy limits have grown. A primary policy written in 1948 may have been $50,000 while a primary policy written in 1977 may have been $1 million. This change in limits needs to be reflected.

A policy limits analysis of a sample group of defendant companies can be supplemented with individual case estimates for defendants with unusual exposures to provide an assessment for all known asbestos defendants. Unusual exposures could be policies without aggregate limits or those with significant outstanding coverage issues.

In the remainder of this section, we discuss our asbestos BI model, from the initial stages involving the sample group determination to extrapolation of the model results. The steps of the policy limit analysis and their general categories are as follows:

I. Determine the sample group and collect data

1) determine the desired group of insured defendants to be included in the detailed analysis,
2) collect information on each defendant's claim experience and the company's exposure to the defendant's asbestos claims, and
3) re-evaluate which insureds to include in the sample group based on the compiled information.

II. Adjust the sample group data

4) adjust the sample group's policy information to restate it on a ground-up basis.

III. Use the model to estimate insurance or reinsurance company's liabilities for sample group

5) project future aggregate ground-up costs for each sample group defendant,
6) allocate the aggregate ground-up costs to years within the defendant's coverage block,
7) determine the amount of the ground-up loss and expense in each year falling in the layers of coverage provided by the insurer or reinsurer, and
8) sum the losses in the insurance layer across all sample group defendants.

IV. Conduct sensitivity testing of the model's parameters and make adjustments

9) test alternative scenarios regarding future claim activity and alternate claim allocation procedures,
10) develop a range of outcomes for the sample group based on the sensitivity analysis, and
11) consider the limitations of the model and make adjustments if necessary.

V. Extrapolate model results from sample group to all insureds

12) use the model results to develop assumptions applicable to the remaining group of insured defendants, and
13) incorporate individual case estimates for unusual exposures.

In the following sections, we discuss each of these steps.

Determine the Sample Group and Collect Data

The use of a sample group in estimating liabilities for a large group of insureds is sometimes desirable. For large insurers or reinsurers, it may not be feasible to model the future claim activity for all insured asbestos defendants. For these companies, the number of insureds who may have filed precautionary notices related to potential asbestos claim activity could easily total five hundred or one thousand insureds. Information may be limited on certain defendants, including a large number of defendants whose exposure to asbestos claims is small, due to a small market share or the use of encapsulated asbestos only. The sample group must be representative of the total exposures of the company so that an extrapolation of the model results to the remaining exposures can be done.

To facilitate selection of a sample group and extrapolation of model results for insurance and reinsurance companies, we categorized all potential defendants in the asbestos universe into five tiers. Each tier rating is based upon the nature and extent of potential asbestos liabilities of the defendant. Thus, the first step in determining the appropriate sample group for an insurer or reinsurer is to apply the tier rating to each of the insureds.

The first tier includes defendants who have been involved in asbestos litigation since its inception and who were the primary manufacturers or suppliers of asbestos products throughout North America. Each defendant in this category is estimated to face ultimate aggregate liabilities of $1 billion or more. Considering that fewer than 20 companies fall into this category and the required information on these defendants is generally available through the claim department and/or public sources, all of these defendants should be reviewed for inclusion in the sample group for detailed model analysis.

Our second tier includes defendants who have also been involved in asbestos litigation almost since inception, but due to lower market shares or more limited-use products, their estimated ultimate liabilities are in the $100 million to $1 billion range. The distinction between Tiers 1 and 2 is subject to some judgment depending on the projection assumptions. Based on our current estimates, there are approximately 50 Tier 2 defendants. A majority of a company's exposure to Tier 2 defendants should also be included in the sample group.

The third and fourth tiers are comprised of the remaining hundreds of non-railroad defendants that have been enjoined as third party defendants brought into the asbestos litigation as Tier 1 and Tier 2 defendants have filed for bankruptcy protection. Tier 3 includes those defendants whose exposure relates to encapsulated and similar low exposure asbestos products and local or regional distributors of asbestos products. As such, many Tier 3 defendants face substantial numbers of claims, high defense costs, and relatively low indemnity payments. In total, their potential liabilities are significant though well below the Tier 2 level. There are also a large number of Tier 3 defendants facing very small liabilities, e.g., in situations where exposure to a company's products will be difficult to establish by plaintiffs.

Tier 4 defendants are those who never manufactured or distributed asbestos products, but rather owned or operated property where asbestos products were used. A Tier 4 defendant's liability is thus related to contractors or third parties, other than employees, who were exposed to asbestos on the defendant's premises. An example of a Tier 4 defendant would be a utility or oil company.

The sample group should contain Tier 3 and 4 defendants for which the necessary claim statistics are available. In selecting the defendants from these tiers, policies providing coverage in various layers representing the type of coverage provided to insureds in Tiers 3 and 4 should be included.

Tier 5 has been reserved for railroads facing liabilities from exposed workers under FELA. Many railroads have reached settlement agreements with their insurers related to asbestos claims. Also, the involvement of attorneys and unions in identifying exposed workers and facilitating claim filings implies a much faster reporting of claims for railroads than for other types of defendants. To the extent that an insurance company has exposure to railroads not subject to a settlement agreement, a sampling of the railroad insureds should be included in the model analysis.

The goal of the sample group is to be representative of the insurer's or reinsurer's total exposure to asbestos liability from its insureds known to have asbestos exposure. If a defendant has an unusual exposure, such a coverage dispute, which is not representative of the other insureds in the tier, a separate analysis or adjustments to the defendant's policies may be necessary.

Once the sample group has been selected, data for each defendant in the sample group must be collected for input into the asbestos BI model. The following data elements should be compiled for each defendant:

1) number of claims filed, disposed and pending,
2) cumulative paid and reported indemnity,
3) expense-to-indemnity ratio,
4) dates of coverage block,
5) details of all products liability coverage provided by the insurer or reinsurer within the coverage block including -
    a) policy term,
    b) attachment point relative to the first dollar of loss,
    c) aggregate limit of liability,
    d) participation percentage or percentage share in the layer of liability,
    e) expense treatment under the policy,
    f) asbestos exclusions,
    g) erosion of limits by non-asbestos products claims, and
    h) (for reinsurers only) ceding company's policy information, i.e., (5a)-(5g) for the ceding company's policy.
6) details of negotiated settlement agreements, and
7) details of pending coverage disputes.

Note that these data do not completely describe every aspect of all insurance policies in the sample group. This is particularly true for reinsurance policies. However, the data collected does allow for a good estimate of the insurance or reinsurance company's asbestos exposure from each policy in the sample group.

The claim counts, indemnity payments, and expense ratio information are required at the defendant level in order to project the defendant's ground-up aggregate liabilities. Details regarding negotiated settlement agreements and pending coverage disputes are useful in determining whether an insured defendant should be included in the sample group (with or without adjustments to reflect uncertainty presented by pending coverage disputes) or if case reserves established by the claim department reflecting agreements/disputes should be relied upon instead.

Several potential sources for the required data exist, including: the claims department of the insurance company, annual reports of the various defendants, insurance company attorneys, and court documents. While some of the required data is relatively easy to obtain, certain information is difficult to get directly. Data for some potential candidates may not be available at all. It may be necessary to estimate missing information and test the sensitivity of the model results to alternative assumptions, or leave some insureds out of the sample group entirely. Ultimately, the decision to include each insured needs to be based on whether inclusion of that insured will help make the sample group representative and whether there is enough data on that insured for use in the model.

The policy information (attachment point, company's percentage share in the layer, and aggregate limit of liability) on a first dollar of loss (ground-up) basis may be difficult to collect. This data should be readily available from the policy files for primary companies. For excess writers and reinsurers, however, this information can be particularly difficult to obtain. For assumed reinsurance business, additional information is required on the ceding company's policies in order to identify the ground-up loss required to penetrate the reinsurer's layer. In other words, we need to restate the reinsurer's limit, percentage share, and attachment point relative to the first dollar of loss in order to determine when the policy is expected to be hit by the aggregate asbestos claims generated by the model.

Adjust the Sample Group Data

To effectively reflect the insurer's or reinsurer's exposure to asbestos loss on a policy, the policy information must be stated on a first dollar of loss, or ground-up, basis. This is necessary for the stated attachment point, percentage share, and policy limit. A first dollar policy does not require adjustment. For a direct excess policy, it may only be necessary to adjust the attachment point by adding the underlying primary limit to the stated attachment point. For an assumed reinsurance policy, especially treaty reinsurance, all three parameters might require a restatement to a first dollar of loss basis. Facultative reinsurance policy information may already be stated on a first dollar of loss basis for stated policy limit and participation share, thereby requiring only an attachment point adjustment similar to that mentioned for direct excess policies.

We examine the restatement of the three policy parameters first when the ceding company policy information is known, and then when it is unknown. To illustrate the adjustments necessary for reinsurance policies, we examine some policies of a reinsurer, ABC Re, with ceding insurer XYZ which wrote policies for insureds, Company 1 and Company 2.

If the cedent's policy information is known, then an adjustment such as the one in Exhibit 1 needs to be made. In Exhibit 1, there are three sets of policy information: cedent XYZ's direct policy information in columns (3) - (5), ABC Re's stated reinsurance policy information in columns (6) - (8), and the calculated ground-up reinsurance policy information for ABC Re in columns (9) - (11). Columns (3), (6), and (9) are the percentage shares. Columns (4), (7), and (10) are the attachment points. Columns (5), (8), and (11) are the policy limits. Expenses are ignored in Exhibit 1 for simplicity.

Definitions of the three restated policy parameters in the context of this paper are in order. All three are adjusted reinsurance policy parameters which express the ground-up exposure to loss for the reinsurer. The restated reinsurance percentage share is the amount that, when multiplied by the restated reinsurance policy limit, equals the reinsurer's maximum dollar share of the ground-up losses. The restated reinsurance attachment point equals the amount of ground-up losses which must be incurred before the reinsurance layer is penetrated. The restated reinsurance limit is the amount that, when added to the restated reinsurance attachment point, equals the amount of ground-up losses necessary to exhaust the reinsurance policy.

Exhibit 2 graphically illustrates the need to make the adjustment to ABC Re's policies shown in Exhibit 1. Note that for some policies, the reinsurer has no exposure to loss, even though the ceding company does. Again, expenses have been ignored in this example for simplicity.

The calculation of the restated reinsurance percentage share in Column (9) is straightforward. Ignoring expenses and extracontractual situations, the ceding company is limited to the percentage share stated in the policy. ABC Re's percentage share is a portion of the cedent's share of the insurance layer. Hence the restated percentage share relative to first dollar of loss must be the product of the two percentages, or Column (3) x Column (6).

The restated reinsurance attachment point in Column (10) follows similar logic. The ceding company's layer of liability begins at the attachment point in the primary policy. In order for the cedent to incur any losses, the ground-up losses must be greater than the attachment point in the ceding company's policy. Likewise, ABC Re's layer of liability begins at the attachment point on the reinsurance policy. Only when the cedent's losses have reached the reinsurance attachment point will ABC Re's layer be penetrated. If the cedent's percentage share was 100%, ABC Re's layer could only be penetrated if the ground-up losses exceeded the sum of the two attachment points. However, in cases where the cedent's percentage share is less than 100%, the reinsurance attachment point must be divided by the primary policy percentage share and then added to the primary attachment point to calculate the restated ground-up attachment point, or ([(7)/(3)] + (4)). The division by the primary percentage share is required because for every dollar of loss incurred by the cedent, the insured must have incurred the reciprocal of the primary percentage share.

The logic for restated ground-up attachment point and percentage share must be kept in mind to determine the appropriate calculation for the restated reinsurance limit in Column (11). We look at the interaction of the direct policy with the reinsurance policy to understand the calculation. The formula for Column (11) is comprised of two upper constraints, a lower constraint, and an adjustment for the direct policy's percentage share.

First, we examine the intuitive upper constraint of Column (11)'s formula. Ignoring expenses and again assuming the cedent's percentage share is 100%, the maximum restated reinsurance limit relative to first dollar of loss equals the reinsurance limit, or Column (8). Note that this is just the limit of the reinsurance policy; the maximum dollar share of the reinsurance layer would be the reinsurance limit times the reinsurance percentage share. Here we are just concerned with the calculation of the limit. If the ceding company participation share is less than 100%, then this maximum for the restated limit needs to be divided by the cedent's participation share, or (8)/(3), for the same reason this adjustment was made in calculating the restated attachment point.

The second upper constraint for the restated reinsurance limit is the maximum imposed by the ceding company's dollar share of the layer (i.e., cedent's percentage share times cedent's limit, or ((3)x(5)) less the cedent's retention (i.e., the reinsurer's unadjusted attachment point, or Column (7)), all divided by the cedent's percentage share, or Column (3). Once the reinsurance attachment point is exhausted and the reinsurance layer has been penetrated, every dollar which consumes the reinsurance limit is due to ground-up losses equal to the reciprocal of the cedent's percentage share, or $1/(3). Stated another way, the restated reinsurance limit cannot exceed the cedent's limit minus the quantity of the reinsurance attachment point divided by the cedent's percentage share, ((5) -[(7)/(3)]), equal to the second upper constraint. Remember, in calculating the restated reinsurance limit, we are trying to determine the amount of ground-up dollars that, when added to the restated reinsurance attachment point, will exhaust the reinsurance policy limits.

By including a lower constraint, we complete the formula for the restated reinsurance limit in Column (11). The lower constraint of the formula is zero; the restated reinsurance limit cannot be negative. Combining all the pieces of the restated reinsurance limit, we now have the formula used to derive Column (11), MAX [0, MIN {(8)/(3),(5)-((7)/(3))}]. Thus, if we know the cedent's policy information, we may adjust the reinsurance policy information to restate it on a first dollar of loss basis.

The two upper constraints discussed above contribute to what we refer to as "underlap." That is, the interaction of the cedent's policy terms with the reinsurer's policy terms may reduce the reinsurer's stated exposure. Exhibit 1 shows the calculation of the underlap for each of the policies presented and the underlap factor of 54.5% calculated in total for all policies related to Insureds 1 and 2.

If the ceding company's policy parameters are unknown, an estimation of the adjustment to the reinsurer's percentage share, limit, and attachment point must be made. Note that if the cedent's information is unknown, it is difficult to tell whether the reinsurance policy information is stated on a first dollar basis or not. Nonetheless, estimation of the policy parameters is necessary and requires a representative group of reinsurance policies for which the ceding policy information is known. Given the cedent's policy information and the reinsurance policy information, the restated reinsurance policy parameters for the representative group of policies are calculated using the methodology discussed above and shown in Exhibit 1. The relationships between each unadjusted reinsurance policy parameter and its restated reinsurance policy parameter are then determined for this group of policies.

For each of the three reinsurance parameters, a relationship between the unadjusted and adjusted parameter needs to determined. In our studies of representative sets of unadjusted and adjusted reinsurance policy parameters, we have found that the unadjusted reinsurance percentage share and the adjusted reinsurance percentage share have a linear relationship with a relatively high goodness-of-fit. Similarly, the relationship between the unadjusted limit and restated limit parameters is linear with a high goodness-of-fit. Unfortunately, a simple regression on the unadjusted attachment point and the restated attachment point yields a poor fit.

In one situation, we found that by separating the attachment point data into two segments, one with all sets of attachment points whose unadjusted reinsurance attachment point is $5 million or less and another with all sets whose unadjusted reinsurance attachment point is greater than $5 million, a much better fit is achieved. For the group with attachment points above $5 million, the best predictor of the restated attachment point was the unadjusted attachment point plus $1 million. For the group of policies with an unadjusted attachment point of less than $5 million, a distribution of additive amounts was required to estimate the adjusted attachment point.

We surmised that this discrepancy between the relationship for attachment points and the relationships for the other two parameters was due to a difference in reinsurance purchased by attachment point. Generally, facultative reinsurance is purchased with a higher ceding company retention, while treaty reinsurance is purchased with a lower ceding company retention. Facultative reinsurance is more likely to have its percentage share and policy limit stated on a first dollar of loss basis, needing only the addition of the underlying primary limit to its attachment point. On the other hand, treaty reinsurance policy parameters are not stated on a first dollar of loss basis. Furthermore, treaty reinsurance is written on portfolios of ceding company business with widely ranging attachment points. The combination of these factors causes relationships between unadjusted and adjusted attachment points to vary.

This estimation procedure is only to be used if policy information is unknown. Ideally, the ceding company policy information would be known. However, the estimated restated percentage share, attachment point, and limit are a more accurate reflection of the policy on a first dollar of loss basis than are the unadjusted policy parameters. Once the predictive relationships for calculating the restated policy information are determined in the representative group of policies, results are applied to the reinsurance policies for which the underlying primary policy information is unknown. For each policy of each insured in the selected sample group, a restated percentage share, limit, and attachment point is predicted based upon the unadjusted reinsurance information and the three relationships determined in the representative group.

Once the ground-up policy information for each of the defendants' products liability policies has been determined and other required information is obtained, the data preparation for the sample group is complete and the model can be used.

Use the Model to Estimate the Insurance or Reinsurance Company's Liability for the Sample Group

The asbestos BI model presented in this paper uses a frequency and severity approach to calculate ground-up losses and applies a policy limits analysis to the ground-up losses. It calculates an estimate of an insurance or reinsurance company's asbestos liability for a sample group of representative underlying insureds. This sample can later be used to estimate the total asbestos liability for the insurer or reinsurer. Whether we are analyzing liabilities for an insurer or a reinsurer, the underlying insureds are the manufacturers, installers, and distributors of asbestos products, and not the reinsured insurance companies. For simplicity of presentation, reinsurer ABC Re will be used in this section of the paper to demonstrate the model for both insurance and reinsurance companies.

For each underlying insured in ABC Re's selected sample group, the model projects by calendar year ground-up reported claim counts, ground-up average severity, and thus ground-up aggregate indemnity costs. Expenses are then loaded based on historical expense-to-indemnity ratios of the particular insured. The projected costs are spread over the policy years in the insured's coverage block. Having projected ground-up indemnity and expense costs for each calendar year by policy year, the model can then carve out ABC Re's liability from the ground-up costs for each policy of each insured in the sample group. Summing ABC Re's liability for all insureds gives ABC Re's estimated liability for the entire sample group.

Exhibit 3 presents a partial list of ABC Re's insureds with a known potential for asbestos loss. Insureds 1-15 are included in sample group; the remaining insureds are not. Exhibits 4-9 demonstrate the use of the asbestos BI model to calculate ABC Re's estimated asbestos liability for one insured company in the sample group, Insured 3. Exhibit 4 presents the required model policy input assumptions for Insured 3; Exhibit 5 presents the required model claim input assumptions for Insured 3. Exhibits 5.1 - 9.1 show the baseline scenario with selected severity trend of 5% and 15 year coverage block. Exhibits 5.2 - 9.2 have 0% and 15 years selected. Exhibits 5.3 - 9.3 have 5% and 25 years selected. Exhibits 5.4 - 9.4 have 0% and 25 years selected. Exhibit 10 shows the aggregate results of all insured defendants in ABC Re's sample group. ABC Re's percentage shares, limits, and attachment points for Insured 3, presented in Exhibits 4-8, have already been restated on a first dollar of loss basis.

The first step of the asbestos model is to calculate the future aggregate ground-up indemnity and expense costs for each sample insured. For ABC Re's Insured 3, this is done in Exhibit 5. Several inputs are necessary to estimate the future aggregate indemnity and expense costs: a claim count reporting pattern, an average severity, a severity trend, and future expense-to-indemnity ratios.

First, a claim count reporting pattern must be calculated for the insured companies in ABC Re's sample group to be used as input in Exhibit 5. This pattern is not ABC Re's claim reporting pattern but rather that of the underlying insureds. The selected pattern for Insured 3 is shown in Exhibits 5.1 - 5.4. Actual calculation of the reporting pattern is beyond the scope of this paper.

Ideally, the necessary claim count reporting pattern is derived from claim count projections developed by researchers expert in both the asbestos-exposed population and the mathematical models which tie claim incidences to such factors as exposure levels and latency period. Such studies are available through bankruptcy courts, who have overseen the formation of liability trust funds for companies undergoing restructuring, and in academic literature. Judgmental extrapolation of historical claim reporting patterns can alternatively be made, particularly if a shorter time horizon, such as ten years, rather than an ultimate run-off is selected for the review. If sufficient information is available, claim count patterns by tier should be calculated. However, this may be difficult particularly due to the limited available research on Tier 3 and Tier 4 companies.

The second required input on Exhibit 5 is a selected average severity. Dividing total indemnity paid by total closed claims gives a historical paid severity. Dividing indemnity paid in each recent year by its related number of closed claims gives a starting point for the selection of an average reported indemnity to be used for the projection of future costs. The most recent year's average reported severity should also be examined before making the selection.

The third input for Exhibit 5 is a selected severity trend. A 5% severity trend is chosen for Insured 3. Exhibits 5.1 - 10.1, and Exhibits 5.3 - 10.3 use this assumption. To show the impact of different severity trend selections, Exhibits 5.2 - 10.2 and Exhibits 5.4 - 10.4 use a 0% inflation rate.

The severity trend can be based on a review of historical average claim amounts, but should also consider expected future changes. For example, Tier 3 insureds may be expected to experience greater severity trends and consequently a larger share of the total cost, due to the bankruptcy of Tier 1 and 2 insureds and the impact of courts imposing joint-and-several liability. Changes in the mix of claims by disease type could also affect future trends. A decrease in severe asbestosis cases coupled with an increase in claims filed for pleural plaques would be expected to reduce future claim trends as plaintiffs with pleural plaques may receive little or no compensation. Given these potential impacts on future average severities, alternative claim trend assumptions should be tested to derive a range of estimated liabilities.

The fourth input required for Exhibit 5 is the selected expense-to-indemnity ratio for each calendar year. A 50% expense-to-indemnity ratio is selected for Insured 3 as shown on Exhibits 5.1 - 5.4 for all future calendar years.

The expense-to-indemnity ratio for each insured in the sample should be based on several factors. The historical expense-to-indemnity ratio for the particular insured is a good starting point. However, other factors must also be considered. The existence of legal precedents for many once hotly debated legal issues relating to asbestos personal injury liability suggests a declining trend in defense costs. The likelihood of out of court settlements must also be considered. A systematic approach by the underlying insured defendant to settlement of asbestos cases, such as a CCR or Johns-Manville matrix of specific dollar ranges for each disease, would suggest that more cases would settle than go to court, lowering defense costs. However, a Tier 3 or Tier 4 company increasingly being named in suits might start aggressively defending suits, thus raising defense costs. Each underlying insured must be examined carefully to determine reasonable expense-to-indemnity ratios for each projected calendar year. Fortunately, the model's flexibility allows different ratios by insured by calendar year.

The second step of the model is to allocate the projected aggregate ground-up indemnity and expense costs to policy years within the insured's coverage block. If an insured's actual coverage block is known, it should be used. Exhibit 6 presents the projected calendar year ground-up indemnity costs from Exhibit 5 spread across Insured 3's coverage block. Exhibit 7 differs from Exhibit 6 by including both indemnity and expense costs, calculated by applying the selected expense-to-indemnity ratios from Exhibit 5. Insured 3's coverage block is 1960 through 1974. There is a chance that Insured 3 will pursue a coverage block of 1960-1984 to get more insurance coverage. Exhibits 6.1 - 10.1 and Exhibits 6.2 - 10.2 use the 15 year coverage block. To demonstrate the impact of a different coverage block selection, Exhibits 6.3 - 10.3 and Exhibits 6.4 - 10.4 use a coverage block selection of 25 years, 1960 through 1984.

An insured's actual procedure for allocating costs to years within its coverage block should be used if known; otherwise the allocation should be based on a logical procedure. One possible allocation method is to weight each year within the block by the total limits of all insurance policies with all insurers during the coverage block years. However, because the limits from all of the insured's policies may be difficult to ascertain, some subjective weighting to all years in the coverage block may have to suffice. Another possible approach is to give larger weights for more recent years in the insured's coverage block to reflect the general increase in insurance limits purchased over time. A third alternative is to weight each year in the coverage block equally. For simplicity, each year in Insured 3's coverage block receives equal weighting in Exhibits 6 and 7.

The third step in the model is to calculate for each policy year the ground-up indemnity and expense dollars which fall into the insurance or reinsurance company's layers of coverage. ABC Re's liability for Insured 3 is calculated by carving out Insured 3's projected ground-up indemnity and expense dollars that hit ABC Re's layers of insurance as shown in Exhibit 8.

ABC Re's 1958 policy for Insured 3 is not included because policy year 1958 is outside Insured 3's coverage block, 1960 through 1974 for Exhibits 8.1 and 8.2, and 1960 through 1984 for Exhibits 8.3 and 8.4. As long as 1958 is outside Insured 3's coverage block, ABC Re's 1958 policy with Insured 3 is not exposed to potential asbestos losses. Seven ABC Re policies are within Insured 3's coverage block (both the 15 and 25 years). For simplicity of presentation, each of the policies in the example are in distinct policy years. If ABC Re had multiple layers of insurance coverage for Insured 3 in the same policy year, a simple adjustment to Exhibit 8 could be made: each policy's appropriate layer would be carved out of the total indemnity and expense costs allocated to that particular policy year.

To demonstrate the effects of different expense treatments on policies, Exhibit 8 shows each of the three most common expense treatments: indemnity only, expenses included in the limit, and pro-rata expenses in addition to limits. The attachment point, percentage share in the layer, and total limit of liability also vary in these seven policies to show the effects of each. Typically, for a given layer of insurance for a particular company, the expense treatment would be more consistent; expense treatment is varied here for illustrative purposes only. The determination of whether loss and expense hit a layer can be calculated in two ways for policies with expenses included in the limit: either add expenses before applying attachment point or add expenses once indemnity is in the layer. Both ways should be tested in the real world because the lower layer policies' expense treatment determines the appropriate method.

The projected loss and expense in ABC Re's layers shown on Exhibits 8.1 - 8.4 are calculated by carving out the appropriate ground-up loss and expense from Exhibits 5, 6, and 7. The method of carving out the loss and expense varies based on whether the policy for which the liability is being calculated has expense treatment of indemnity only, expenses included in the limit, or expenses in addition to the limit (pro rata). For all three types of policies, the general methodology to calculate Exhibit 8's cumulative reported liability in the layer is: the prior calendar year's liability in the layer for the policy year (the number to its left on Exhibit 8) added to the incremental increase in indemnity and expense (where appropriate), taking into account attachment point, limit, and percentage share. To illustrate this, the calculation of Exhibit 8.1 calendar year 2003's numbers for policy years 1971, 1969, and 1968 will be shown.

The 1971 policy is an indemnity only policy with a projected reported liability of $1,629 ($ in 000's). The $1,629 equals $1,455 from the prior calendar year added to $174. The $174 is 100% (the policy percentage share in 1971) times ($3,629 - $3,455), the incremental increase in indemnity shown on Exhibit 6.1. Development on this policy year continues until calendar year 2006 when the policy is projected to exhaust its 100% share of the $2 million limit.

The 1969 policy is an ultimate net loss, or expenses included in the limit, policy. As the footnote on Exhibit 8.1 indicates, the process of calculating when losses and expenses hit this layer varies depending on underlying policies. For all policies of this type in Exhibit 8.1, expenses are added to indemnity before applying the attachment point and limits. The $1,944 for policy year 1969 as of calendar year 2003 equals $1,683 from the prior calendar year plus $261. $261 is calculated as 100% (1969 policy's percentage share) times ($5,444 - $5,183), the incremental indemnity and expense during calendar year 2003 from Exhibit 7.1. Note that the 1969 policy is penetrated much earlier than the 1968 policy, one that is identical to the 1969 policy except for its expense treatment. Also note that the 1969 policy's ultimate liability is $4,000,(000), equaling 100% of $4 million.

The 1968 policy is a pro rata policy. In calendar year 2003 its reported liability is $194. Because this is the first calendar year in which the policy is penetrated, the calculation needs to take into account the attachment point of the policy. Therefore the calculation is $0 added to 100% times ($5,444 - $5,183), incremental indemnity and expense during calendar year 2003 from Exhibit 7.1, times ($3,629 - $3,500)/($3,629 - $3,455), the portion of indemnity that penetrated the 1968 policy layer of $4 million excess $3.5 million. These indemnity amounts come from Exhibit 6.1. Note that ultimately its liability is $5,163, greater than the 1969 liability of $4,000, because expenses are in addition to the limit on the 1968 pro rata policy. Furthermore, the 1970 policy is identical to the 1968 policy except that its percentage share is 25 percent. At every calendar year, the 1970 policy's reported liability is 25 percent of the 1968 policy's liability.

Contrasting the development of ground-up costs in Exhibits 6.1 and 7.1 with the development of costs in the insurance layers in Exhibit 8.1 provides much insight. As expected, Insured 3 has projected reported ground-up losses (in Exhibits 6.1 and 7.1) several years before ABC Re has reported losses in its layer. However ABC Re's loss reporting pattern is not necessarily faster or slower than Insured 3's. In Exhibit 9.1, ABC Re's pattern is ultimately faster because Insured 3 will exhaust some or all of ABC Re's retained layers and yet will continue to incur losses for several years. This is due primarily to ABC Re's attachment points (its ground-up attachment points are low relative to the total amount of ground-up losses) and the size of ABC Re's limits (its ground-up limits are small relative to total ground-up losses). Exhibit 9.2 demonstrates the reverse. If ABC Re's layers attached at a very high point relative to the total amount of ground-up losses, as is the case for some underlying sample insureds in Exhibit 3, ABC Re's pattern might be slower than the underlying insureds and policies might incur little or no loss, as seen in Exhibit 10. This relationship between attachment point, limit, and asbestos loss development is a point to be considered by both the underlying insureds and insurers in evaluating asbestos insurance coverage issues.

The comparison of the development of costs across policies in Exhibit 8.1 provides further insight. As would be expected, reported development is a function of the magnitude of the attachment point and total limits, while total liability is a function of the percentage share and total limits of the layer. Each of the policy years for Insured 3 were allocated the same ground-up cost. However, the different expense treatment in the 1965 and 1967 reinsurance policies (see Exhibit 8.1) causes the 1967 policy year to report over 200% more liability than the 1965 policy year in calendar year 2000. Furthermore, the 1965 policy year has $0.6 million more reported liability in calendar year 2000 than does the 1968 policy year, even though the 1968 policy has a larger total limit and the policies have the same expense treatment; this is because the higher attachment point on the 1968 policy causes less of the total ground-up indemnity and expenses to hit the layer in that year.

A comparison of the 1968 and 1970 policies in Exhibit 8.1 illustrates the effect of the percentage share. Each has the same attachment point and the same total limit, but the insurer's participation in 1968 was 100% while in 1970 it was 25%. Thus, for every dollar that penetrates these layers of $4.0 million excess $3.5 million, $1 hits the 1968 policy and only $.25 hits the 1970 policy.

The most important point illustrated on Exhibit 8.1 is that development for asbestos losses is not a function of the age of the accident or policy year. The least mature policy for ABC Re for Insured 3 is 1971. The 1971 policy year develops to ultimate faster than all but one other policy year, 1967. This pattern of development is not unusual because of the long latency of asbestos-related diseases and the allocation to policy year. Therefore, historical asbestos accident or policy year loss development is not representative of future development.

Exhibit 9 gives a comparison of Insured 3's allocation of costs on a ground-up basis versus ABC Re's liability in the layer. Exhibit 9 demonstrates the differences in development for policy year 1968 and across all policy years in the coverage block, both in dollars and as a percentage of ultimate.

The fourth step of the asbestos BI model is to sum the losses in the insurance layers across all sample group defendants. The steps performed in Exhibits 5 through 8 for Insured 3 under the four scenarios are repeated for all other insureds in ABC Re's sample group. The sum of these calculations for all insureds in the sample group is shown on Exhibit 10. The totals from Exhibit 10 represent the estimate of ABC Re's liability under the various scenarios for the sample group.

ABC Re's loss reporting pattern for each insured and for the entire sample group can be derived from Exhibit 10. The sum of the asbestos liabilities for all companies in the sample group gives an overall loss reporting pattern for ABC Re. If enough companies from each tier are included in the sample group to give credible results by tier, ABC Re's reporting pattern by tier can also be calculated from Exhibit 10. Using ABC Re's estimated reported losses in the insurance layers for each calendar year, overall loss development factors for ABC Re can be calculated.

Conduct Sensitivity Testing of Model

Due to the inherent uncertainty in the asbestos litigation, different scenarios should be examined to: 1) test the model's sensitivity to certain parameters or estimates, and 2) compute a range of estimates of liability for the sample group. The two parameters in the model with the most uncertainty are the future severity trend and the insureds' coverage blocks. Therefore, variations in the assumptions for both of these should be examined, as was done with the four scenarios included in Exhibits 5 - 10. Other parameters, such as the projected expense-to-indemnity ratio should be considered to determine if sensitivity testing is necessary.

Exhibit 10 also shows ABC Re's aggregate exposure to each underlying insured in the sample group. Given an aggregate exposure for each insured and ABC Re's estimated ultimate loss for each insured, a projected percentage of exposure eroded by claims for each insured can be calculated as well as subtotaled by tier. This can be helpful in extrapolating the model results to all of ABC Re's underlying insureds.

Using the results of the different scenarios, a range of estimates can be derived for the sample group's liability. Weights applied to each scenario should be based on the projected likelihood of the scenario. Exhibit 11 calculates the average ABC Re asbestos liability for its sample group insureds using the results from Exhibits 10.1 - 10.4. The size of the indicated range in Exhibit 11, about $50 million, is large both on a percentage and a dollar basis. However, note that approximately $20 million of the range comes solely from the selection of the severity trend. This emphasizes the need to do sensitivity testing when working with projections so far into the future. We have shown a selected range based on averages of the two 25 year coverage block projections and the two 15 year coverage block projections. Thus, we are averaging the 0% and 5% severity trend indications. Note that this gives a different indication then simply selecting a 2.5% severity trend assumption due to the interaction of the ground-up losses and the policy layers.

Our overall selected estimate is based on a 75%/25% weighting of the 15-year and 25-year coverage block indications. The 25% weight to the 25-year coverage block reflects the assumed likelihood of the insureds' success in pursuing an expanded coverage block.

There may be some final considerations before extrapolating the model results of the sample group to all insureds. First, the range of results may indicate the inappropriateness of some of the model's parameters. Changes to some parameters may be necessary; it is possible that new assumptions may need to be tested.

Second, the loss reporting pattern produced by the model will likely be faster than that experienced by the insurance or reinsurance company because of the inherent lag in reporting between the insured, the insurer, and the reinsurer. That is, the reporting pattern produced by the model is developed from each underlying insured's expected claim reporting pattern and does not reflect delays in the insurance reporting and reserving process. Likewise, if the insurance or reinsurance company establishes case reserves that incorporate a provision for IBNR claims (as is often the case when it is apparent that with continued claim reporting policy limits will be exhausted) then the model-produced pattern may be too slow. Both of these possibilities need to be considered.

Extrapolation of Model Results

With the model results for the sample group quantified, the estimated ultimate asbestos liabilities for all of ABC Re's underlying insureds can now be calculated. There are several ways to extrapolate the sample group model results to reflect ABC Re's total expected liabilities. The appropriateness of a particular method depends on the nature of the company's exposures as well as its claims handling and reserving procedures. Potential methods are: 1) percent of layer exhausted by tier, 2) development factor by tier, 3) percent of exposed limits exhausted by tier, 4) average ultimate loss by tier times number of insureds, and 5) extrapolation from Tiers 1 and 2.

The first method is a percent of layer exhausted method. By tier, develop estimates of the percent of layers expected to be exhausted by asbestos BI claims. That is, the sample group Tier 2 insureds could be run through the model with the company's policy limits and attachment points overwritten by the following layers:

- primary $500,000;
- $500,000 xs $500,000;

- $4 million xs $1 million;
- $5 million xs $5 million;
- $15 million xs $10 million;
- $25 million xs $25 million;
- $50 million xs $50 million.

The model output would provide an estimate of the percent of these layers expected to be exhausted by BI claims. Thus, exposures for non-sample Tier 2 insureds could be arrayed by layer and the selected percentages applied to derive estimates of the company's ultimate liabilities associated with all Tier 2 insureds. This could then be repeated for other tier categories.

Exhibit 12 provides an example of one part of this analysis, the calculation of ABC Re's liability for Insured 3 in the $5 million excess $5 million layer. To do this, the model is used for Insured 3 policies, with the policies' ground-up limits, attachment points, and percentage shares overridden by $5 million, $5 million, and 100%, respectively. This is done for all Insured 3 policies.

Exhibit 13 shows a grid which would ultimately be completed for use in extrapolation method one. In calculating the percent eroded by layer by tier, all insured's in the sample group would be run through the model using the desired policy layers in place of the actual policy exposures. The exposures from the insureds not in the sample group would be arrayed in a similar matrix as they are in Exhibit 13, by layer by tier. The matrix of exposures would be multiplied by each corresponding cell in the percent eroded matrix to determine the ultimate liability of the non-sample group. For example, assume ABC Re's exposure in the $5 million excess $5 million layer was $100 million for Tier 2 non-sample group companies. $100 million times 42% from Exhibit 13 gives projected ultimate liability of $42 million for the Tier 2, $5 million excess $5 million layer. This calculation would be repeated for each tier and layer combination and the results would be summed. It would then be necessary to combine this estimate for the non-sample group with the selected estimate of $153 million (Exhibit 11) for the sample group to produce an estimate of ABC Re's total liabilities.

This approach is likely better than the other approaches outlined below. However, it is also the most cumbersome as it requires attachment point and limits information on all exposures. The likelihood of asbestos exclusions applying in certain years or policies falling outside the insureds' coverage blocks should be considered.

The second method is performed by determining the development factor to ultimate by tier implied by the model output relative to the reported case incurred loss and expense held by the company for the sample group. The development factors are then applied to the total incurred loss and expense for each tier category. This approach assumes consistent case reserving for sample group insureds versus other insureds. Grouping the insureds by tier is expected to result in more homogeneous groupings with respect to case reserving and layers exposed, but differences between the sample and non-sample group should be explored in the extrapolation procedure. For example, if the information available for insureds in the sample group is more complete than the non-sample group, then an extrapolation might result in an understatement of total liability because too small a development factor is applied to the less developed losses. Likewise, if the company wrote policies with a wide range of attachment points and the sample group represents insureds with lower layer policies, case reserving may not be as adequate on the non-sample group with higher layer policies. Thus, the development factors may be expected to differ for the two groups due to the different layers exposed.

The reported case incurred loss and expense development factors by tier by scenario are found on Exhibit 10. The selection of development factors based on all four scenarios is shown on Exhibit 14. These factors by tier would be multiplied by the non-sample group reported loss and expense by tier to calculate an ultimate loss and expense for non-sample group insureds. For example, assuming ABC Re's non-sample group Tier 1's have reported loss and expense of $20 million dollars, the calculated non-sample group Tier 1 ultimate liability would be $20 million times 1.935 from Exhibit 14, or $39 million. This calculation would be repeated for each tier and summed. Adding to this sum the ultimate liability of the sample group, $153 million from Exhibit 11, would yield ABC Re's total asbestos BI liability based on extrapolation method two.

The third extrapolation method is to calculate by tier the percent of exposed policy limits ultimately exhausted by the asbestos BI claims, as projected in the model, and apply these percentages to the total exposed policy limits by tier. Differences in exposed limits by attachment point for the sample versus non-sample group should be considered in applying this procedure.

The ultimate loss and expense as a percentage of exposure can be found on Exhibit 10. The selection of percent of exposure factors based on all four scenarios is shown on Exhibit 15.

These factors by tier would be multiplied by the non-sample group exposure by tier to calculate the estimated liability for the non-sample group. For example, assuming ABC Re's non-sample group Tier 2's have exposure of $50 million for all layers, the estimated Tier 2 liability would be $50 million times 30.7%, or $15 million. This calculation would be repeated for each tier and summed. Note that the non-sample group exposure by tier is the sum of each tier's non-sample group exposure by layer which was used in extrapolation method one. Adding the sample group's ultimate liability of $153 million from Exhibit 11 to the summed estimated ultimate liability for the non-sample group yields ABC Re's total asbestos BI liability based on extrapolation method three.

The fourth method is a frequency times ultimate severity method. By tier, calculate an average ultimate loss and expense amount per insured in the sample group and multiply by the total number of insureds. This approach assumes that the sample group represents a typical distribution of limits written per insured and that the sample group and non-sample group are comprised of insureds with similar exposure distributions. In other words, the sample group should not be selected from the set of claims and the average results applied to the set of precautionary notices. However, extrapolation of the precautionary notice group could be accomplished by estimating the percentage of notices expected to become claims in the future. This could be accomplished by reviewing the magnitude of movement from the notice to the claim category over the past several years.

Exhibit 16 shows the average ultimate loss and expense by tier for each of the four scenarios. From these an average ultimate loss and expense by tier is selected, based on a 75% weight to the 15-year coverage block scenarios and a 25% weight to the 25-year coverage block scenarios.

This selected average amount by tier would be multiplied by the number of non-sample group insureds by tier. For example, if ABC Re had 50 Tier 3 insureds, then ABC Re's projected liability for non-sample group Tier 3 companies would be 50 times $794,000, or $40 million. The $794,000 is from Exhibit 16. This calculation would be repeated for each tier and summed. The sum, equal to the estimated liability for all non-sample group insureds would be added to $138 million, ABC Re's estimated sample group liability, to get the estimate of ABC Re's overall liability based on extrapolation method four.

The fifth method is an extrapolation of Tiers 1 and 2. Use one of the above methods for the Tier 1 and 2 exposures and extrapolate from the Tier 1 and 2 results to the remaining tiers. For example, given the following information for Tiers 1 and 2 versus Tier 3, an extrapolation of the percent of exposed limits exhausted may indicate a range of 6% to 10% for Tier 3 insureds. The selected percentage could then be applied to the aggregate of exposed policy limits for Tier 3 insureds. The assumptions used in this method are presented in Figure 5.

Figure 5

	Average Ground-Up Liabilities (in Millions)	Percent of Exposed Limits Exhausted
Tier 1	3,000	100%-110%
Tier 2	700	25%-35%
Tier 3	50	6%-10%

A subjective extrapolation could also be carried out using the expected percentage reported by tier. For example, if Tier 1 insureds are 55% reported and Tier 2 30% reported, we might estimate that Tier 3 insureds are 15% to 20% reported.

In extrapolating the model results to reflect the company's total liabilities, insureds presenting an unusual type or degree of exposure to the company should be considered separately. For example, an unusual degree of exposure would be when a vast majority of the company's products liability policies were written with aggregate limits but one old policy without an aggregate has surfaced with a Tier 1 named insured. Similarly, if the company generally insured risks categorized as "main street," but a Tier 1 or Tier 2 company was insured for a number of years on a first or second excess of loss layer, the magnitude of the potential asbestos BI liabilities could be substantial relative to other insureds. In addition, a pending dispute regarding significant amounts of potential coverage for a Tier 1 or 2 insured or an applicable settlement agreement would warrant separate consideration. Such cases require discussions with claims department personnel and a review of assumptions underlying case reserves. Estimates for these unusual exposures should be derived on a case-by-case basis and included in the total ultimate loss estimates for the company.

6. Summary and Conclusions

This paper demonstrates a methodology for modeling asbestos BI liabilities. While this policy limits methodology was designed specifically for modeling asbestos BI liability, there may be potential for application to other insurance situations where traditional actuarial techniques do not apply well. There are two clear strengths of this model: 1) its flexibility, and 2) enhanced documentation.

With the model's flexibility, any parameter can be changed for sensitivity analysis. As noted earlier, the average severity trend can be adjusted to test the impact of various inflation assumptions. The claim count reporting pattern for the sample group can be sped up or lagged. If evidence suggests that certain insureds' expenses are declining relative to indemnity (particularly now that the courts have already resolved many legal issues), the expense-to-indemnity ratio can be adjusted on a year-by-year basis. Finally, if the coverage block of the insured is unknown or changed in a court ruling, the number of years and the weighting of each year in the coverage block can be varied.

Enhanced documentation for modeling asbestos BI liability is another strength of the model and a benefit for claims professionals handling asbestos BI claims. These professionals are often requested to provide input into the process of estimating IBNR claim liabilities on known insureds or are specifically assigned the responsibility of establishing case reserves incorporating unreported claim activity for the foreseeable future. They are likely to follow an approach similar to that used in our model with insureds for which sufficient policy information is known. Benefits of a more formalized model analysis include: 1) an automated process which permits the testing of alternative scenarios and facilitates future updates as additional information emerges, 2) an aggregate view of the company's estimated liabilities to help analyze cash flow requirements or produce benchmarks when historical claims data is not available, and 3) enhanced documentation to support aggregate reserve levels to outside auditors and regulators.

Possible weaknesses of the model include: 1) it is a deterministic rather than a stochastic approach to estimation of the asbestos BI liabilities, and 2) it is dependent on reasonably accurate selection of model parameters. Both of these disadvantages can be minimized through sensitivity analysis. Several scenarios should be run through the model to estimate the range of potential liabilities and to minimize errors due to parameter mis-estimation.

Possible enhancements to the model or additional areas requiring research in projecting asbestos liabilities include: 1) the inclusion of extra parameters to more comprehensively describe the insurance or reinsurance policy and the potential asbestos exposure associated with the policy, 2) a provision for IBNR associated with insureds who have not yet notified their insurance carriers and are not yet identified by the company, 3) a stochastic approach for analyzing outcomes under different scenarios, 4) a methodology for estimating liabilities associated with premises and operations claims not subject to policy aggregates, and 5) a methodology for estimating property damage claims related to asbestos.

ASBESTOS.ART

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Adjustment to ABC Reinsurance Company's Policy Limits for Policies Assumed from XYZ Insurance Company — Exhibit 1

Indemnity only*

($ in Millions)

		XYZ Direct Policy Information			ABC Re's Stated Policy Information			ABC Re's Restated Policy Information			ABC Re's Stated Dollar Share	ABC Re's Restated Dollar Share	Underlap Amount
ABC Re Policy Number	Insured Company	Percentage Share	Attachment Point	Limit	Percentage Share	Attachment Point	Limit	Percentage Share	Attachment Point	Limit			
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
1	Insured 1	100.00%	60.00	10.00	7.25%	5.00	5.00	7.25%	65.00	5.00	0.36	0.36	0.00
2	Insured 1	100.00%	5.00	20.00	30.00%	5.00	10.00	30.00%	10.00	10.00	3.00	3.00	0.00
3	Insured 2	40.00%	10.00	20.00	50.00%	1.00	5.00	20.00%	12.50	12.50	2.50	2.50	0.00
4	Insured 2	10.00%	10.00	20.00	50.00%	1.00	5.00	5.00%	20.00	10.00	2.50	0.50	2.00
5	Insured 2	10.00%	10.00	20.00	50.00%	2.25	5.00	5.00%	32.50	0.00	2.50	0.00	2.50
6	Insured 2	50.00%	7.00	25.00	100.00%	5.00	15.00	50.00%	17.00	15.00	15.00	7.50	7.50
7	Insured 2	32.00%	7.00	10.00	100.00%	2.00	2.00	32.00%	13.25	3.75	2.00	1.20	0.80
8	Insured 2	100.00%	7.00	5.00	20.00%	5.00	5.00	20.00%	12.00	0.00	1.00	0.00	1.00
9	Insured 2	100.00%	7.00	5.00	20.00%	2.00	3.00	20.00%	9.00	3.00	0.60	0.60	0.00
10	Insured 2	65.00%	6.00	20.00	20.00%	10.00	5.00	13.00%	21.38	4.62	1.00	0.60	0.40
11	Insured 2	65.00%	11.00	20.00	20.00%	5.00	10.00	13.00%	18.69	12.31	2.00	1.60	0.40
12	Insured 2	10.00%	11.00	50.00	40.00%	4.00	5.00	4.00%	51.00	10.00	2.00	0.40	1.60
13	Insured 2	10.00%	11.00	50.00	40.00%	1.00	5.00	4.00%	21.00	40.00	2.00	1.60	0.40
											36.46	19.86	
									(15) Underlap Factor			54.5%	

Notes:

(3)−(5) Direct policy information. Given.

(6)−(8) Stated reinsurance policy information. Given.

(9) = (3) x (6).

(10) = [(7) / (3)] + (4).

(11) = Max [0 , Min { (8) / (3) , { (5) − ((7) / (3)) } }].

(12) = (6) x (8).

(13) = (9) x (11).

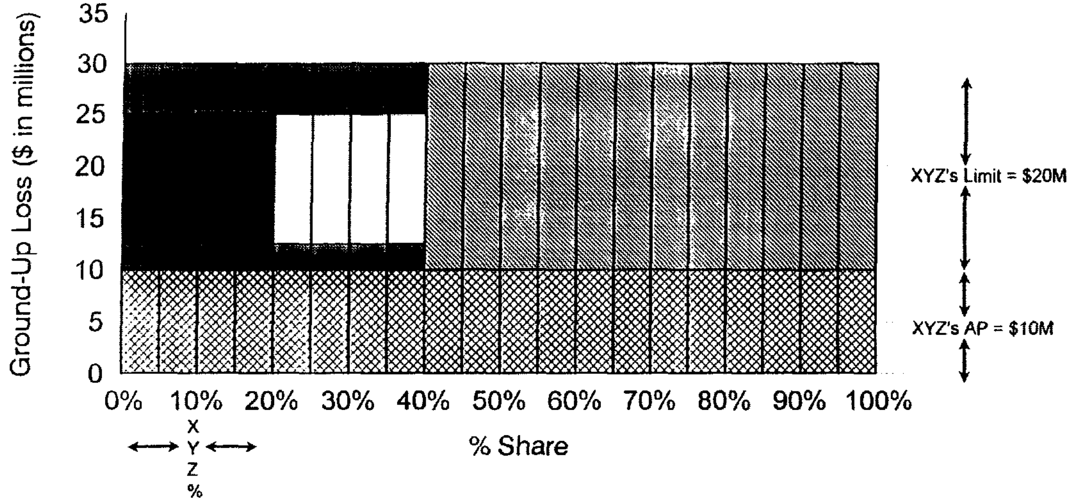
(14) = (12) − (13).

(15) = Total of (13) / Total of (12).

* Expenses are ignored for simplicity of presentation.

ABC Re's Restated Policy Terms for Policy 3 from Exhibit 1

Capped by Upper Constraint 1



a) XYZ attachment point = $10M

b) Other direct writers= 60% of $20M xs $10M

c) Retained by XYZ = 40% of $2.5M xs $10M (for its reinsurance AP), 40%of $5M xs $25M (above its reinsurance layer)

d) XYZ ceded to other reinsurers = 20% of $12.5M xs $12.5M

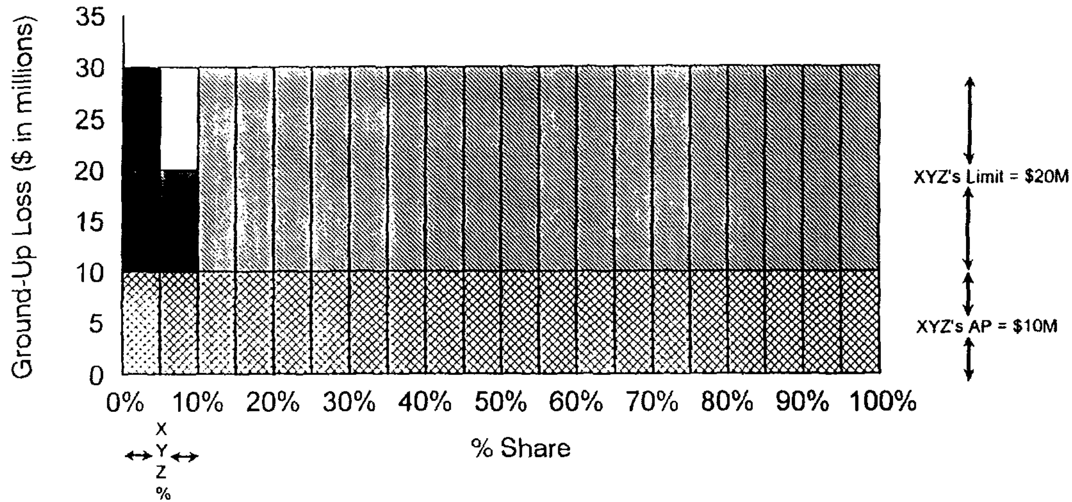
e) XYZ ceded to ABC = 20% of $12.5M xs $12.5M

(Assume XYZ purchased 1 layer of reinsurance, ABC is one writer of layer. Assume no expenses for simplicity.)

Exhibit 2.2

ABC Re's Restated Policy Terms for Policy 4 from Exhibit 1

Capped by Upper Constraint 2



a) XYZ attachment point = $10M

b) Other direct writers= 90%of $20M xs $10M

c) Retained by XYZ = 10% of $10M xs $10M (for its reinsurance AP)

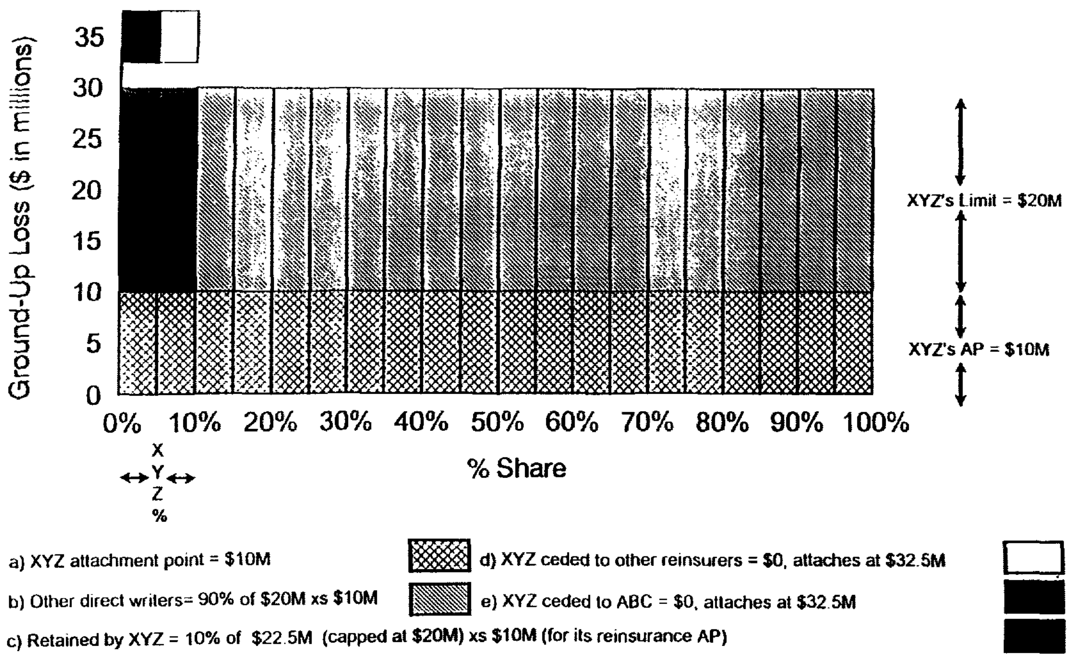
d) XYZ ceded to other reinsurers = 5% of $10M xs $20M

e) XYZ ceded to ABC = 5% of $10M xs $20M

(Assume XYZ purchased 1 layer of reinsurance, ABC is one writer of layer. Assume no expenses for simplicity.)

ABC Re's Restated Policy Terms for Policy 5 from Exhibit 1

Capped by Lower Constraint 1



(Assume XYZ purchased 1 layer of reinsurance, ABC is one writer of layer. Assume no expenses for simplicity.)

Partial List of ABC Re's Known Asbestos Defendants
($ in Millions)

Exhibit 3

Name of Company	Tier	Ceding Company Policy Information	ABC Re's Policy Information	Included in Sample Group
Insured 1	4	Known	Known	Yes
Insured 2	4	Known	Known	Yes
Insured 3	2	Known	Known	Yes
Insured 4	1	Known	Known	Yes
Insured 5	1	Known	Known	Yes
Insured 6	1	Known	Known	Yes
Insured 7	2	Known	Known	Yes
Insured 8	2	Known	Known	Yes
Insured 9	2	Known	Known	Yes
Insured 10	3	Known	Known	Yes
Insured 11	2	Known	Known	Yes
Insured 12	3	Known	Known	Yes
Insured 13	3	Unknown	Known	Yes
Insured 14	3	Unknown	Known	Yes
Insured 15	3	Unknown	Known	Yes
Insured 16	3	Unknown	Unknown	No
Insured 17	3	Unknown	Unknown	No
Insured 18	3	Unknown	Unknown	No
Insured 19	3	Unknown	Unknown	No
Insured 20	3	Unknown	Unknown	No
Insured 21	3	Unknown	Unknown	No
Insured 22	3	Unknown	Unknown	No
Insured 23	2	Unknown	Unknown	No

ABC Re

Exhibit 4

Asbestos BI Model Policy Information for Underlying Insured 3, a Tier 2 Company

Coverage Block under Baseline Scenario:	1960 – 1974
Coverage Block under Alternative Scenario:	1960 – 1984

25 Year Cov. Block	15 Year Cov. Block	Policy Year	ABC Re Policy w/Insured 3	Restated Percentage Share	Restated Attachment Point	Restated Limits	Expense Treatment
		1958	Yes	100.00%	3,500,000	4,000,000	Pro Rata in Addition to Limit
		1959	None				
1	1	1960	None				
2	2	1961	None				
3	3	1962	None				
4	4	1963	None				
5	5	1964	None				
6	6	1965	Yes	100.00%	2,700,000	2,000,000	Pro Rata in Addition to Limit
7	7	1966	Yes	100.00%	2,700,000	2,000,000	Pro Rata in Addition to Limit
8	8	1967	Yes	100.00%	2,700,000	2,000,000	Expenses included within Limit
9	9	1968	Yes	100.00%	3,500,000	4,000,000	Pro Rata in Addition to Limit
10	10	1969	Yes	100.00%	3,500,000	4,000,000	Expenses included within Limit
11	11	1970	Yes	25.00%	3,500,000	4,000,000	Pro Rata in Addition to Limit
12	12	1971	Yes	100.00%	2,000,000	2,000,000	Indemnity Only
13	13	1972	None				
14	14	1973	None				
15	15	1974	None				
16		1975	None				
17		1976	None				
18		1977	None				
19		1978	None				
20		1979	None				
21		1980	None				
22		1981	None				
23		1982	None				
24		1983	None				
25		1984	None				

Asbestos BI Model for ABC Re's Insured 3 Exhibit 5.1

Projection of Future Aggregate Ground-Up Indemnity and Expenses, Annual Inflation = 5.0% / Coverage Block = 15 Years

Inputs into Model	1993
1) Cumulative Reported Claims to Date	40,000
2) Cumulative Reported Indemnity	28,230,246
3) Historical Exp-to-Indem Ratio	0.5
4) Cumulative Reported Indem & Expense	42,345,369
5) Claims Closed in 1993	2,000
6) Indemnity and Expense Paid in 1993	1,800,000
7) Average Pd Indemnity & Expense in 1993	900
8) Selected average reported claim severity	1,000

	Calendar Year									
	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
9) Projected Incremental Reported Claims	2,500	2,200	2,200	2,200	2,100	2,000	1,900	1,800	1,700	1,600
10) Selected Annual Severity Trend	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
11) Trended Severity	1,050	1,103	1,158	1,216	1,276	1,340	1,407	1,477	1,551	1,629
12) Projected Incremental Indemnity Costs	2,625,000	2,425,500	2,546,775	2,674,114	2,680,191	2,680,191	2,673,491	2,659,420	2,637,258	2,606,231
13) Selected Expense-to-Indemnity Ratio	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%
14) Projected Incremental Indemnity & Expense Costs	3,937,500	3,638,250	3,820,163	4,011,171	4,020,287	4,020,287	4,010,236	3,989,130	3,955,887	3,909,347
15) Projected Cumulative Indemnity Costs	30,855,246	33,280,746	35,827,521	38,501,635	41,181,826	43,862,018	46,535,508	49,194,928	51,832,186	54,438,418
16) Projected Cumulative Indemnity & Expense Costs	46,282,869	49,921,119	53,741,282	57,752,453	61,772,739	65,793,026	69,803,263	73,792,392	77,748,279	81,657,626

	Calendar Year										Projected
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Ultimate*
9) Projected Incremental Reported Claims	1,500	1,400	1,300	1,200	1,100	1,000	900	800	700	600	
10) Selected Annual Severity Trend	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	
11) Trended Severity	1,710	1,796	1,886	1,980	2,079	2,183	2,292	2,407	2,527	2,653	
12) Projected Incremental Indemnity Costs	2,565,509	2,514,199	2,451,344	2,375,918	2,286,821	2,182,875	2,062,816	1,925,295	1,768,865	1,591,979	
13) Selected Expense-to-Indemnity Ratio	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	
14) Projected Incremental Indemnity & Expense Costs	3,848,264	3,771,298	3,677,016	3,563,877	3,430,231	3,274,312	3,094,225	2,887,943	2,653,298	2,387,968	
15) Projected Cumulative Indemnity Costs	57,003,927	59,518,125	61,969,469	64,345,387	66,632,208	68,815,083	70,877,899	72,803,195	74,572,060	76,164,038	104,131,118
16) Projected Cumulative Indemnity & Expense Costs	85,505,890	89,277,188	92,954,204	96,518,081	99,948,312	103,222,624	106,316,849	109,204,792	111,858,090	114,246,058	156,196,878

Notes:

(1)-(6) From Insured 3's claim experience.
(7) = (6) / (5).
(8),(10) Selected based on historical and anticipated claim severity trends.
(9) See paper for discussion of calculation of reporting pattern.
(11) = Prior (11) x (1.0 + Current (10)).
(12) = (9) x (11).
(13) Selected based on historical and anticipated claim expense to indemnity ratios.
(14) = (12) x (1.0 + (13)).
(15) = Cumulative (12).
(14) = Cumulative (14).

* Ultimate value is calculated by continuation of patterns beyond years shown.

Asbestos BI Model for ABC Re's Insured 3 — Exhibit 5.2

Projection of Future Aggregate Ground-Up Indemnity and Expenses, Annual Inflation = 0.0% / Coverage Block = 15 Years

Inputs into Model	1993
1) *Cumulative Reported Claims to Date*	40,000
2) Cumulative Reported Indemnity	28,230,246
3) Historical Exp - to - Indem Ratio	0.5
4) Cumulative Reported Indem & Expense	42,345,369
5) Claims Closed in 1993	2,000
6) Indemnity and Expense Paid in 1993	1,800,000
7) Average Pd Indemnity & Expense in 1993	900
8) Selected average reported claim severity	1,000

	Calendar Year									
	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
9) Projected Incremental Reported Claims	2,500	2,200	2,200	2,200	2,100	2,000	1,900	1,800	1,700	1,600
10) Selected Annual Severity Trend	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
11) *Trended Severity*	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
12) Projected Incremental Indemnity Costs	2,500,000	2,200,000	2,200,000	2,200,000	2,100,000	2,000,000	1,900,000	1,800,000	1,700,000	1,600,000
13) Selected Expense - to - Indemnity Ratio	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%
14) Projected Incremental Indemnity & Expense Costs	3,750,000	3,300,000	3,300,000	3,300,000	3,150,000	3,000,000	2,850,000	2,700,000	2,550,000	2,400,000
15) Projected Cumulative Indemnity Costs	30,730,246	32,930,246	35,130,246	37,330,246	39,430,246	41,430,246	43,330,246	45,130,246	46,830,246	48,430,246
16) Projected Cumulative Indemnity & Expense Costs	46,095,369	49,395,369	52,695,369	55,995,369	59,145,369	62,145,369	64,995,369	67,695,369	70,245,369	72,645,369

	Calendar Year										Projected
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Ultimate*
9) Projected Incremental Reported Claims	1,500	1,400	1,300	1,200	1,100	1,000	900	800	700	600	
10) Selected Annual Severity Trend	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	
11) *Trended Severity*	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
12) Projected Incremental Indemnity Costs	1,500,000	1,400,000	1,300,000	1,200,000	1,100,000	1,000,000	900,000	800,000	700,000	600,000	
13) Selected Expense - to - Indemnity Ratio	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	
14) Projected Incremental Indemnity & Expense Costs	2,250,000	2,100,000	1,950,000	1,800,000	1,650,000	1,500,000	1,350,000	1,200,000	1,050,000	900,000	
15) Projected Cumulative Indemnity Costs	49,930,246	51,330,246	52,630,246	53,830,246	54,930,246	55,930,246	56,830,246	57,630,246	58,330,246	58,930,246	65,755,246
16) Projected Cumulative Indemnity & Expense Costs	74,895,369	76,995,369	78,945,369	80,745,369	82,395,369	83,895,369	85,245,369	86,445,369	87,495,369	88,395,369	98,632,869

Notes:

(1) - (6) From insured 3's claim experience.
(7) = (6) / (5)
(8),(10) Selected based on historical and anticipated claim severity trends.
(9) See paper for discussion of calculation of reporting pattern.
(11) = Prior (11) x (1.0 + Current (10)).
(12) = (9) x (11).
(13) Selected based on historical and anticipated claim expense to indemnity ratios.
(14) = (12) x (1.0 + (13)).
(15) = *Cumulative (12).*
(14) = Cumulative (14).

* *Ultimate value is calculated by continuation of patterns beyond years shown.*

Asbestos BI Model for ABC Re's Insured 3

Projection of Future Aggregate Ground-Up Indemnity and Expenses, Annual Inflation = 5.0% / Coverage Block = 25 Years

Exhibit 5.3

Inputs into Model	1993
1) Cumulative Reported Claims to Date	40,000
2) Cumulative Reported Indemnity	28,230,246
3) Historical Exp-to-Indem Ratio	0.5
4) Cumulative Reported Indem & Expense	42,345,369
5) Claims Closed in 1993	2,000
6) Indemnity and Expense Paid in 1993	1,800,000
7) Average Pd Indemnity & Expense in 1993	900
8) Selected average reported claim severity	1,000

	Calendar Year									
	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
9) Projected Incremental Reported Claims	2,500	2,200	2,200	2,200	2,100	2,000	1,900	1,800	1,700	1,600
10) Selected Annual Severity Trend	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%
11) Trended Severity	1,050	1,103	1,158	1,216	1,276	1,340	1,407	1,477	1,551	1,629
12) Projected Incremental Indemnity Costs	2,625,000	2,425,500	2,546,775	2,674,114	2,680,191	2,680,191	2,673,491	2,659,420	2,637,256	2,606,231
13) Selected Expense-to-Indemnity Ratio	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%
14) Projected Incremental Indemnity & Expense Costs	3,937,500	3,638,250	3,820,163	4,011,171	4,020,287	4,020,287	4,010,236	3,989,130	3,955,887	3,909,347
15) Projected Cumulative Indemnity Costs	30,855,246	33,280,746	35,827,521	38,501,635	41,181,826	43,862,016	46,535,508	49,194,928	51,832,186	54,438,416
16) Projected Cumulative Indemnity & Expense Costs	46,282,869	49,921,119	53,741,282	57,752,453	61,772,739	65,793,026	69,803,263	73,792,392	77,748,279	81,657,626

	Calendar Year										Projected
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Ultimate*
9) Projected Incremental Reported Claims	1,500	1,400	1,300	1,200	1,100	1,000	900	800	700	600	
10) Selected Annual Severity Trend	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	
11) Trended Severity	1,710	1,796	1,886	1,980	2,079	2,183	2,292	2,407	2,527	2,653	
12) Projected Incremental Indemnity Costs	2,565,509	2,514,199	2,451,344	2,375,918	2,286,821	2,182,875	2,062,816	1,925,295	1,768,865	1,591,979	
13) Selected Expense-to-Indemnity Ratio	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	
14) Projected Incremental Indemnity & Expense Costs	3,848,264	3,771,298	3,677,016	3,563,877	3,430,231	3,274,312	3,094,225	2,887,943	2,653,298	2,387,968	
15) Projected Cumulative Indemnity Costs	57,003,927	59,518,125	61,969,469	64,345,387	66,632,208	68,815,083	70,877,899	72,803,195	74,572,060	76,164,038	104,131,118
16) Projected Cumulative Indemnity & Expense Costs	85,505,890	89,277,188	92,954,204	96,518,081	99,948,312	103,222,624	106,316,849	109,204,792	111,858,090	114,246,058	156,196,678

Notes:

(1)-(6) From Insured 3's claim experience.

(7) = (6) / (5).

(8),(10) Selected based on historical and anticipated claim severity trends.

(9) See paper for discussion of calculation of reporting pattern.

(11) = Prior (11) x (1.0 + Current (10)).

(12) = (9) x (11).

(13) Selected based on historical and anticipated claim expense to indemnity ratios.

(14) = (12) x (1.0 + (13)).

(15) = Cumulative (12).

(14) = Cumulative (14).

* Ultimate value is calculated by continuation of patterns beyond years shown.

Asbestos BI Model for ABC Re's Insured 3
Projection of Future Aggregate Ground-Up Indemnity and Expenses, Annual Inflation = 0.0% / Coverage Block = 25 Years

Exhibit 5.4

Inputs into Model	1993
1) Cumulative Reported Claims to Date	40,000
2) Cumulative Reported Indemnity	28,230,246
3) *Historical Exp-to-Indem Ratio*	0.5
4) Cumulative Reported Indem & Expense	42,345,369
5) Claims Closed in 1993	2,000
6) Indemnity and Expense Paid in 1993	1,800,000
7) Average Pd Indemnity & Expense in 1993	900
8) Selected average reported claim severity	1,000

	Calendar Year									
	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
9) Projected Incremental Reported Claims	2,500	2,200	2,200	2,200	2,100	2,000	1,900	1,800	1,700	1,600
10) Selected Annual Severity Trend	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
11) Trended Severity	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
12) Projected Incremental Indemnity Costs	2,500,000	2,200,000	2,200,000	2,200,000	2,100,000	2,000,000	1,900,000	1,800,000	1,700,000	1,600,000
13) Selected Expense-to-Indemnity Ratio	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%
14) Projected Incremental Indemnity & Expense Costs	*3,750,000*	*3,300,000*	*3,300,000*	*3,300,000*	*3,150,000*	*3,000,000*	*2,850,000*	*2,700,000*	*2,550,000*	*2,400,000*
15) Projected Cumulative Indemnity Costs	30,730,246	32,930,246	35,130,246	37,330,246	39,430,246	41,430,246	43,330,246	45,130,246	46,830,246	48,430,246
16) Projected Cumulative Indemnity & Expense Costs	46,095,369	49,395,369	52,695,369	55,995,369	59,145,369	62,145,369	64,995,369	67,695,369	70,245,369	72,645,369

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	Calendar Year										Projected
	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Ultimate*
9) Projected Incremental Reported Claims	1,500	1,400	1,300	1,200	1,100	1,000	900	800	700	600	
10) Selected Annual Severity Trend	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	*0.0%*	
11) Trended Severity	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	
12) Projected Incremental Indemnity Costs	1,500,000	1,400,000	1,300,000	1,200,000	1,100,000	1,000,000	900,000	800,000	700,000	600,000	
13) Selected Expense-to-Indemnity Ratio	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	50.0%	
14) Projected Incremental Indemnity & Expense Costs	2,250,000	2,100,000	1,950,000	1,800,000	1,650,000	1,500,000	1,350,000	1,200,000	1,050,000	900,000	
15) Projected Cumulative Indemnity Costs	49,930,246	51,330,246	52,630,246	53,830,246	54,930,246	55,930,246	56,830,246	57,630,246	58,330,246	58,930,246	65,755,246
16) Projected Cumulative Indemnity & Expense Costs	74,895,369	76,995,369	78,945,369	80,745,369	82,395,369	83,895,369	85,245,369	86,445,369	87,495,369	88,395,369	98,632,869

Notes:

(1)-(6) From Insured 3's claim experience.
(7) = (6) / (5).
(8),(10) Selected based on historical and anticipated claim severity trends.
(9) See paper for discussion of calculation of reporting pattern.
(11) = Prior (11) x (1.0 + Current (10)).

(12) = (9) x (11).
(13) Selected based on historical and anticipated claim expense to indemnity ratios.
(14) = (12) x (1.0 + (13)).
(15) = Cumulative (12).
(14) = Cumulative (14).

* *Ultimate value is calculated by continuation of patterns beyond years shown.*

Asbestos BI Model for ABC Re's Insured 3 — Exhibit 6.1

Insurer 3's Cumulative Ground-Up Losses, Indemnity Only, Annual Inflation = 5.0% / Coverage Block = 15 Years

($000's)

Policy Year	Selected Weights	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
		Calendar Year									
1960	6.67%	2,057	2,219	2,389	2,567	2,745	2,924	3,102	3,280	3,455	3,629
1961	6.67%	2,057	2,219	2,389	2,567	2,745	2,924	3,102	3,280	3,455	3,629
1962	6.67%	2,057	2,219	2,389	2,567	2,745	2,924	3,102	3,280	3,455	3,629
1963	6.67%	2,057	2,219	2,389	2,567	2,745	2,924	3,102	3,280	3,455	3,629
1964	6.67%	2,057	2,219	2,389	2,567	2,745	2,924	3,102	3,280	3,455	3,629
1965	6.67%	2,057	2,219	2,389	2,567	2,745	2,924	3,102	3,280	3,455	3,629
1966	6.67%	2,057	2,219	2,389	2,567	2,745	2,924	3,102	3,280	3,455	3,629
1967	6.67%	2,057	2,219	2,389	2,567	2,745	2,924	3,102	3,280	3,455	3,629
1968	6.67%	2,057	2,219	2,389	2,567	2,745	2,924	3,102	3,280	3,455	3,629
1969	6.67%	2,057	2,219	2,389	2,567	2,745	2,924	3,102	3,280	3,455	3,629
1970	6.67%	2,057	2,219	2,389	2,567	2,745	2,924	3,102	3,280	3,455	3,629
1971	6.67%	2,057	2,219	2,389	2,567	2,745	2,924	3,102	3,280	3,455	3,629
1972	6.67%	2,057	2,219	2,389	2,567	2,745	2,924	3,102	3,280	3,455	3,629
1973	6.67%	2,057	2,219	2,389	2,567	2,745	2,924	3,102	3,280	3,455	3,629
1974	6.67%	2,057	2,219	2,389	2,567	2,745	2,924	3,102	3,280	3,455	3,629
1975-84	0.00%	0	0	0	0	0	0	0	0	0	0
Total	100.00%	30,855	33,281	35,828	38,502	41,182	43,862	46,536	49,195	51,832	54,438

Policy Year	Selected Weights	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Ultimate
		Calendar Year										
1960	6.67%	3,800	3,968	4,131	4,290	4,442	4,588	4,725	4,854	4,971	5,078	6,942
1961	6.67%	3,800	3,968	4,131	4,290	4,442	4,588	4,725	4,854	4,971	5,078	6,942
1962	6.67%	3,800	3,968	4,131	4,290	4,442	4,588	4,725	4,854	4,971	5,078	6,942
1963	6.67%	3,800	3,968	4,131	4,290	4,442	4,588	4,725	4,854	4,971	5,078	6,942
1964	6.67%	3,800	3,968	4,131	4,290	4,442	4,588	4,725	4,854	4,971	5,078	6,942
1965	6.67%	3,800	3,968	4,131	4,290	4,442	4,588	4,725	4,854	4,971	5,078	6,942
1966	6.67%	3,800	3,968	4,131	4,290	4,442	4,588	4,725	4,854	4,971	5,078	6,942
1967	6.67%	3,800	3,968	4,131	4,290	4,442	4,588	4,725	4,854	4,971	5,078	6,942
1968	6.67%	3,800	3,968	4,131	4,290	4,442	4,588	4,725	4,854	4,971	5,078	6,942
1969	6.67%	3,800	3,968	4,131	4,290	4,442	4,588	4,725	4,854	4,971	5,078	6,942
1970	6.67%	3,800	3,968	4,131	4,290	4,442	4,588	4,725	4,854	4,971	5,078	6,942
1971	6.67%	3,800	3,968	4,131	4,290	4,442	4,588	4,725	4,854	4,971	5,078	6,942
1972	6.67%	3,800	3,968	4,131	4,290	4,442	4,588	4,725	4,854	4,971	5,078	6,942
1973	6.67%	3,800	3,968	4,131	4,290	4,442	4,588	4,725	4,854	4,971	5,078	6,942
1974	6.67%	3,800	3,968	4,131	4,290	4,442	4,588	4,725	4,854	4,971	5,078	6,942
1975-84	0.00%	0	0	0	0	0	0	0	0	0	0	0
Total	100.00%	57,004	59,518	61,969	64,345	66,632	68,815	70,878	72,803	74,572	76,164	104,131

Notes: - Cumulative projected calendar year ground-up indemnity costs losses from Exhibit 5.1, Item (15).
- Allocation method of calendar year losses to policy year is by equal weighting to each year.
- Ultimate value is calculated by continuation of patterns beyond months shown.

Asbestos BI Model for ABC Re's Insured 3 Exhibit 6.2

Insurer 3's Cumulative Ground-Up Losses, Indemnity Only, Annual Inflation = 0.0% / Coverage Block = 15 Years

($000's)

Policy Year	Selected Weights	Calendar Year 1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1960	6.67%	2,049	2,195	2,342	2,489	2,629	2,762	2,889	3,009	3,122	3,229
1961	6.67%	2,049	2,195	2,342	2,489	2,629	2,762	2,889	3,009	3,122	3,229
1962	6.67%	2,049	2,195	2,342	2,489	2,629	2,762	2,889	3,009	3,122	3,229
1963	6.67%	2,049	2,195	2,342	2,489	2,629	2,762	2,889	3,009	3,122	3,229
1964	6.67%	2,049	2,195	2,342	2,489	2,629	2,762	2,889	3,009	3,122	3,229
1965	6.67%	2,049	2,195	2,342	2,489	2,629	2,762	2,889	3,009	3,122	3,229
1966	6.67%	2,049	2,195	2,342	2,489	2,629	2,762	2,889	3,009	3,122	3,229
1967	6.67%	2,049	2,195	2,342	2,489	2,629	2,762	2,889	3,009	3,122	3,229
1968	6.67%	2,049	2,195	2,342	2,489	2,629	2,762	2,889	3,009	3,122	3,229
1969	6.67%	2,049	2,195	2,342	2,489	2,629	2,762	2,889	3,009	3,122	3,229
1970	6.67%	2,049	2,195	2,342	2,489	2,629	2,762	2,889	3,009	3,122	3,229
1971	6.67%	2,049	2,195	2,342	2,489	2,629	2,762	2,889	3,009	3,122	3,229
1972	6.67%	2,049	2,195	2,342	2,489	2,629	2,762	2,889	3,009	3,122	3,229
1973	6.67%	2,049	2,195	2,342	2,489	2,629	2,762	2,889	3,009	3,122	3,229
1974	6.67%	2,049	2,195	2,342	2,489	2,629	2,762	2,889	3,009	3,122	3,229
1975-84	0.00%	0	0	0	0	0	0	0	0	0	0
Total	100.00%	30,730	32,930	35,130	37,330	39,430	41,430	43,330	45,130	46,830	48,430

Policy Year	Selected Weights	Calendar Year 2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Ultimate
1960	6.67%	3,329	3,422	3,509	3,589	3,662	3,729	3,789	3,842	3,889	3,929	4,384
1961	6.67%	3,329	3,422	3,509	3,589	3,662	3,729	3,789	3,842	3,889	3,929	4,384
1962	6.67%	3,329	3,422	3,509	3,589	3,662	3,729	3,789	3,842	3,889	3,929	4,384
1963	6.67%	3,329	3,422	3,509	3,589	3,662	3,729	3,789	3,842	3,889	3,929	4,384
1964	6.67%	3,329	3,422	3,509	3,589	3,662	3,729	3,789	3,842	3,889	3,929	4,384
1965	6.67%	3,329	3,422	3,509	3,589	3,662	3,729	3,789	3,842	3,889	3,929	4,384
1966	6.67%	3,329	3,422	3,509	3,589	3,662	3,729	3,789	3,842	3,889	3,929	4,384
1967	6.67%	3,329	3,422	3,509	3,589	3,662	3,729	3,789	3,842	3,889	3,929	4,384
1968	6.67%	3,329	3,422	3,509	3,589	3,662	3,729	3,789	3,842	3,889	3,929	4,384
1969	6.67%	3,329	3,422	3,509	3,589	3,662	3,729	3,789	3,842	3,889	3,929	4,384
1970	6.67%	3,329	3,422	3,509	3,589	3,662	3,729	3,789	3,842	3,889	3,929	4,384
1971	6.67%	3,329	3,422	3,509	3,589	3,662	3,729	3,789	3,842	3,889	3,929	4,384
1972	6.67%	3,329	3,422	3,509	3,589	3,662	3,729	3,789	3,842	3,889	3,929	4,384
1973	6.67%	3,329	3,422	3,509	3,589	3,662	3,729	3,789	3,842	3,889	3,929	4,384
1974	6.67%	3,329	3,422	3,509	3,589	3,662	3,729	3,789	3,842	3,889	3,929	4,384
1975-84	0.00%	0	0	0	0	0	0	0	0	0	0	0
Total	100.00%	49,930	51,330	52,630	53,830	54,930	55,930	56,830	57,630	58,330	58,930	65,755

Notes:
- Cumulative projected calendar year ground-up indemnity costs losses from Exhibit 5.2, Item (15).
- Allocation method of calendar year losses to policy year is by equal weighting to each year.
- Ultimate value is calculated by continuation of patterns beyond months shown.

Asbestos BI Model for ABC Re's Insured 3
Insurer 3's Cumulative Ground-Up Losses, Indemnity Only, Annual Inflation = 5.0% / Coverage Block = 25 Years
($000's)

Exhibit 6.3

Policy Year	Selected Weights	Calendar Year 1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1960	4.00%	1,234	1,331	1,433	1,540	1,647	1,754	1,861	1,968	2,073	2,178
1961	4.00%	1,234	1,331	1,433	1,540	1,647	1,754	1,861	1,968	2,073	2,178
1962	4.00%	1,234	1,331	1,433	1,540	1,647	1,754	1,861	1,968	2,073	2,178
1963	4.00%	1,234	1,331	1,433	1,540	1,647	1,754	1,861	1,968	2,073	2,178
1964	4.00%	1,234	1,331	1,433	1,540	1,647	1,754	1,861	1,968	2,073	2,178
1965	4.00%	1,234	1,331	1,433	1,540	1,647	1,754	1,861	1,968	2,073	2,178
1966	4.00%	1,234	1,331	1,433	1,540	1,647	1,754	1,861	1,968	2,073	2,178
1967	4.00%	1,234	1,331	1,433	1,540	1,647	1,754	1,861	1,968	2,073	2,178
1968	4.00%	1,234	1,331	1,433	1,540	1,647	1,754	1,861	1,968	2,073	2,178
1969	4.00%	1,234	1,331	1,433	1,540	1,647	1,754	1,861	1,968	2,073	2,178
1970	4.00%	1,234	1,331	1,433	1,540	1,647	1,754	1,861	1,968	2,073	2,178
1971	4.00%	1,234	1,331	1,433	1,540	1,647	1,754	1,861	1,968	2,073	2,178
1972	4.00%	1,234	1,331	1,433	1,540	1,647	1,754	1,861	1,968	2,073	2,178
1973	4.00%	1,234	1,331	1,433	1,540	1,647	1,754	1,861	1,968	2,073	2,178
1974	4.00%	1,234	1,331	1,433	1,540	1,647	1,754	1,861	1,968	2,073	2,178
1975-84	40.00%	12,342	13,312	14,331	15,401	16,473	17,545	18,614	19,678	20,733	21,775
Total	100.00%	30,855	33,280	35,828	38,502	41,182	43,862	46,535	49,195	51,832	54,438

Policy Year	Selected Weights	Calendar Year 2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Ultimate
1960	4.00%	2,280	2,381	2,479	2,574	2,665	2,753	2,835	2,912	2,983	3,047	4,165
1961	4.00%	2,280	2,381	2,479	2,574	2,665	2,753	2,835	2,912	2,983	3,047	4,165
1962	4.00%	2,280	2,381	2,479	2,574	2,665	2,753	2,835	2,912	2,983	3,047	4,165
1963	4.00%	2,280	2,381	2,479	2,574	2,665	2,753	2,835	2,912	2,983	3,047	4,165
1964	4.00%	2,280	2,381	2,479	2,574	2,665	2,753	2,835	2,912	2,983	3,047	4,165
1965	4.00%	2,280	2,381	2,479	2,574	2,665	2,753	2,835	2,912	2,983	3,047	4,165
1966	4.00%	2,280	2,381	2,479	2,574	2,665	2,753	2,835	2,912	2,983	3,047	4,165
1967	4.00%	2,280	2,381	2,479	2,574	2,665	2,753	2,835	2,912	2,983	3,047	4,165
1968	4.00%	2,280	2,381	2,479	2,574	2,665	2,753	2,835	2,912	2,983	3,047	4,165
1969	4.00%	2,280	2,381	2,479	2,574	2,665	2,753	2,835	2,912	2,983	3,047	4,165
1970	4.00%	2,280	2,381	2,479	2,574	2,665	2,753	2,835	2,912	2,983	3,047	4,165
1971	4.00%	2,280	2,381	2,479	2,574	2,665	2,753	2,835	2,912	2,983	3,047	4,165
1972	4.00%	2,280	2,381	2,479	2,574	2,665	2,753	2,835	2,912	2,983	3,047	4,165
1973	4.00%	2,280	2,381	2,479	2,574	2,665	2,753	2,835	2,912	2,983	3,047	4,165
1974	4.00%	2,280	2,381	2,479	2,574	2,665	2,753	2,835	2,912	2,983	3,047	4,165
1975-84	40.00%	22,802	23,807	24,788	25,738	26,653	27,526	28,351	29,121	29,829	30,466	41,652
Total	100.00%	57,004	59,518	61,970	64,345	66,632	68,815	70,878	72,803	74,572	76,164	104,131

Notes: - Cumulative projected calendar year ground-up indemnity costs losses from Exhibit 5.3, Item (15).
- Allocation method of calendar year losses to policy year is by equal weighting to each year.
- Ultimate value is calculated by continuation of patterns beyond months shown.

Asbestos BI Model for ABC Re's Insured 3
Insurer 3's Cumulative Ground-Up Losses, Indemnity Only, Annual Inflation = 0.0% / Coverage Block = 25 Years
($000's)

Exhibit 6.4

Policy Year	Selected Weights	Calendar Year 1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1960	4.00%	1,229	1,317	1,405	1,493	1,577	1,657	1,733	1,805	1,873	1,937
1961	4.00%	1,229	1,317	1,405	1,493	1,577	1,657	1,733	1,805	1,873	1,937
1962	4.00%	1,229	1,317	1,405	1,493	1,577	1,657	1,733	1,805	1,873	1,937
1963	4.00%	1,229	1,317	1,405	1,493	1,577	1,657	1,733	1,805	1,873	1,937
1964	4.00%	1,229	1,317	1,405	1,493	1,577	1,657	1,733	1,805	1,873	1,937
1965	4.00%	1,229	1,317	1,405	1,493	1,577	1,657	1,733	1,805	1,873	1,937
1966	4.00%	1,229	1,317	1,405	1,493	1,577	1,657	1,733	1,805	1,873	1,937
1967	4.00%	1,229	1,317	1,405	1,493	1,577	1,657	1,733	1,805	1,873	1,937
1968	4.00%	1,229	1,317	1,405	1,493	1,577	1,657	1,733	1,805	1,873	1,937
1969	4.00%	1,229	1,317	1,405	1,493	1,577	1,657	1,733	1,805	1,873	1,937
1970	4.00%	1,229	1,317	1,405	1,493	1,577	1,657	1,733	1,805	1,873	1,937
1971	4.00%	1,229	1,317	1,405	1,493	1,577	1,657	1,733	1,805	1,873	1,937
1972	4.00%	1,229	1,317	1,405	1,493	1,577	1,657	1,733	1,805	1,873	1,937
1973	4.00%	1,229	1,317	1,405	1,493	1,577	1,657	1,733	1,805	1,873	1,937
1974	4.00%	1,229	1,317	1,405	1,493	1,577	1,657	1,733	1,805	1,873	1,937
1975-84	40.00%	12,292	13,172	14,052	14,932	15,772	16,572	17,332	18,052	18,732	19,372
Total	100.00%	30,730	32,930	35,130	37,330	39,430	41,430	43,330	45,130	46,830	48,430

Policy Year	Selected Weights	Calendar Year 2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Ultimate
1960	4.00%	1,997	2,053	2,105	2,153	2,197	2,237	2,273	2,305	2,333	2,357	2,630
1961	4.00%	1,997	2,053	2,105	2,153	2,197	2,237	2,273	2,305	2,333	2,357	2,630
1962	4.00%	1,997	2,053	2,105	2,153	2,197	2,237	2,273	2,305	2,333	2,357	2,630
1963	4.00%	1,997	2,053	2,105	2,153	2,197	2,237	2,273	2,305	2,333	2,357	2,630
1964	4.00%	1,997	2,053	2,105	2,153	2,197	2,237	2,273	2,305	2,333	2,357	2,630
1965	4.00%	1,997	2,053	2,105	2,153	2,197	2,237	2,273	2,305	2,333	2,357	2,630
1966	4.00%	1,997	2,053	2,105	2,153	2,197	2,237	2,273	2,305	2,333	2,357	2,630
1967	4.00%	1,997	2,053	2,105	2,153	2,197	2,237	2,273	2,305	2,333	2,357	2,630
1968	4.00%	1,997	2,053	2,105	2,153	2,197	2,237	2,273	2,305	2,333	2,357	2,630
1969	4.00%	1,997	2,053	2,105	2,153	2,197	2,237	2,273	2,305	2,333	2,357	2,630
1970	4.00%	1,997	2,053	2,105	2,153	2,197	2,237	2,273	2,305	2,333	2,357	2,630
1971	4.00%	1,997	2,053	2,105	2,153	2,197	2,237	2,273	2,305	2,333	2,357	2,630
1972	4.00%	1,997	2,053	2,105	2,153	2,197	2,237	2,273	2,305	2,333	2,357	2,630
1973	4.00%	1,997	2,053	2,105	2,153	2,197	2,237	2,273	2,305	2,333	2,357	2,630
1974	4.00%	1,997	2,053	2,105	2,153	2,197	2,237	2,273	2,305	2,333	2,357	2,630
1975-84	40.00%	19,972	20,532	21,052	21,532	21,972	22,372	22,732	23,052	23,332	23,572	26,302
Total	100.00%	49,930	51,330	52,630	53,830	54,930	55,930	56,830	57,630	58,330	58,930	65,755

Notes:
- Cumulative projected calendar year ground-up indemnity costs losses from Exhibit 5.4, Item (15).
- Allocation method of calendar year losses to policy year is by equal weighting to each year.
- Ultimate value is calculated by continuation of patterns beyond months shown.

Asbestos BI Model for ABC Re's Insured 3 Exhibit 7.1

Insurer 3's Cumulative Ground-Up Losses, Indemnity and Expenses, Annual Inflation = 5.0% / Coverage Block = 15 Years

($000's)

Policy Year	Selected Weights	Calendar Year 1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1960	6.67%	3,086	3,328	3,583	3,850	4,118	4,386	4,654	4,919	5,183	5,444
1961	6.67%	3,086	3,328	3,583	3,850	4,118	4,386	4,654	4,919	5,183	5,444
1962	6.67%	3,086	3,328	3,583	3,850	4,118	4,386	4,654	4,919	5,183	5,444
1963	6.67%	3,086	3,328	3,583	3,850	4,118	4,386	4,654	4,919	5,183	5,444
1964	6.67%	3,086	3,328	3,583	3,850	4,118	4,386	4,654	4,919	5,183	5,444
1965	6.67%	3,086	3,328	3,583	3,850	4,118	4,386	4,654	4,919	5,183	5,444
1966	6.67%	3,086	3,328	3,583	3,850	4,118	4,386	4,654	4,919	5,183	5,444
1967	6.67%	3,086	3,328	3,583	3,850	4,118	4,386	4,654	4,919	5,183	5,444
1968	6.67%	3,086	3,328	3,583	3,850	4,118	4,386	4,654	4,919	5,183	5,444
1969	6.67%	3,086	3,328	3,583	3,850	4,118	4,386	4,654	4,919	5,183	5,444
1970	6.67%	3,086	3,328	3,583	3,850	4,118	4,386	4,654	4,919	5,183	5,444
1971	6.67%	3,086	3,328	3,583	3,850	4,118	4,386	4,654	4,919	5,183	5,444
1972	6.67%	3,086	3,328	3,583	3,850	4,118	4,386	4,654	4,919	5,183	5,444
1973	6.67%	3,086	3,328	3,583	3,850	4,118	4,386	4,654	4,919	5,183	5,444
1974	6.67%	3,086	3,328	3,583	3,850	4,118	4,386	4,654	4,919	5,183	5,444
1975–84	0.00%	0	0	0	0	0	0	0	0	0	0
Total	100.00%	46,283	49,921	53,741	57,752	61,773	65,793	69,803	73,792	77,748	81,658

Policy Year	Selected Weights	Calendar Year 2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Ultimate
1960	6.67%	5,700	5,952	6,197	6,435	6,663	6,882	7,088	7,280	7,457	7,616	10,413
1961	6.67%	5,700	5,952	6,197	6,435	6,663	6,882	7,088	7,280	7,457	7,616	10,413
1962	6.67%	5,700	5,952	6,197	6,435	6,663	6,882	7,088	7,280	7,457	7,616	10,413
1963	6.67%	5,700	5,952	6,197	6,435	6,663	6,882	7,088	7,280	7,457	7,616	10,413
1964	6.67%	5,700	5,952	6,197	6,435	6,663	6,882	7,088	7,280	7,457	7,616	10,413
1965	6.67%	5,700	5,952	6,197	6,435	6,663	6,882	7,088	7,280	7,457	7,616	10,413
1966	6.67%	5,700	5,952	6,197	6,435	6,663	6,882	7,088	7,280	7,457	7,616	10,413
1967	6.67%	5,700	5,952	6,197	6,435	6,663	6,882	7,088	7,280	7,457	7,616	10,413
1968	6.67%	5,700	5,952	6,197	6,435	6,663	6,882	7,088	7,280	7,457	7,616	10,413
1969	6.67%	5,700	5,952	6,197	6,435	6,663	6,882	7,088	7,280	7,457	7,616	10,413
1970	6.67%	5,700	5,952	6,197	6,435	6,663	6,882	7,088	7,280	7,457	7,616	10,413
1971	6.67%	5,700	5,952	6,197	6,435	6,663	6,882	7,088	7,280	7,457	7,616	10,413
1972	6.67%	5,700	5,952	6,197	6,435	6,663	6,882	7,088	7,280	7,457	7,616	10,413
1973	6.67%	5,700	5,952	6,197	6,435	6,663	6,882	7,088	7,280	7,457	7,616	10,413
1974	6.67%	5,700	5,952	6,197	6,435	6,663	6,882	7,088	7,280	7,457	7,616	10,413
1975–84	0.00%	0	0	0	0	0	0	0	0	0	0	0
Total	100.00%	85,506	89,277	92,954	96,518	99,948	103,223	106,317	109,205	111,658	114,246	156,197

Notes:
- Cumulative projected calendar year ground-up indemnity costs losses from Exhibit 5.1, Item (16).
- Allocation method of calendar year losses to policy year is by equal weighting to each year.
- Ultimate value is calculated by continuation of patterns beyond months shown.

Asbestos BI Model for ABC Re's Insured 3 Exhibit 7.2

Insurer 3's Cumulative Ground-Up Losses, Indemnity and Expenses, Annual Inflation = 0.0% / Coverage Block -- 15 Years
($000's)

Policy Year	Selected Weights	Calendar Year 1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1960	6.67%	3,073	3,293	3,513	3,733	3,943	4,143	4,333	4,513	4,683	4,843
1961	6.67%	3,073	3,293	3,513	3,733	3,943	4,143	4,333	4,513	4,683	4,843
1962	6.67%	3,073	3,293	3,513	3,733	3,943	4,143	4,333	4,513	4,683	4,843
1963	6.67%	3,073	3,293	3,513	3,733	3,943	4,143	4,333	4,513	4,683	4,843
1964	6.67%	3,073	3,293	3,513	3,733	3,943	4,143	4,333	4,513	4,683	4,843
1965	6.67%	3,073	3,293	3,513	3,733	3,943	4,143	4,333	4,513	4,683	4,843
1966	6.67%	3,073	3,293	3,513	3,733	3,943	4,143	4,333	4,513	4,683	4,843
1967	6.67%	3,073	3,293	3,513	3,733	3,943	4,143	4,333	4,513	4,683	4,843
1968	6.67%	3,073	3,293	3,513	3,733	3,943	4,143	4,333	4,513	4,683	4,843
1969	6.67%	3,073	3,293	3,513	3,733	3,943	4,143	4,333	4,513	4,683	4,843
1970	6.67%	3,073	3,293	3,513	3,733	3,943	4,143	4,333	4,513	4,683	4,843
1971	6.67%	3,073	3,293	3,513	3,733	3,943	4,143	4,333	4,513	4,683	4,843
1972	6.67%	3,073	3,293	3,513	3,733	3,943	4,143	4,333	4,513	4,683	4,843
1973	6.67%	3,073	3,293	3,513	3,733	3,943	4,143	4,333	4,513	4,683	4,843
1974	6.67%	3,073	3,293	3,513	3,733	3,943	4,143	4,333	4,513	4,683	4,843
1975-84	0.00%	0	0	0	0	0	0	0	0	0	0
Total	100.00%	46,095	49,395	52,695	55,995	59,145	62,145	64,995	67,695	70,245	72,645

Policy Year	Selected Weights	Calendar Year 2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Ultimate
1960	6.67%	4,993	5,133	5,263	5,383	5,493	5,593	5,683	5,763	5,833	5,893	6,576
1961	6.67%	4,993	5,133	5,263	5,383	5,493	5,593	5,683	5,763	5,833	5,893	6,576
1962	6.67%	4,993	5,133	5,263	5,383	5,493	5,593	5,683	5,763	5,833	5,893	6,576
1963	6.67%	4,993	5,133	5,263	5,383	5,493	5,593	5,683	5,763	5,833	5,893	6,576
1964	6.67%	4,993	5,133	5,263	5,383	5,493	5,593	5,683	5,763	5,833	5,893	6,576
1965	6.67%	4,993	5,133	5,263	5,383	5,493	5,593	5,683	5,763	5,833	5,893	6,576
1966	6.67%	4,993	5,133	5,263	5,383	5,493	5,593	5,683	5,763	5,833	5,893	6,576
1967	6.67%	4,993	5,133	5,263	5,383	5,493	5,593	5,683	5,763	5,833	5,893	6,576
1968	6.67%	4,993	5,133	5,263	5,383	5,493	5,593	5,683	5,763	5,833	5,893	6,576
1969	6.67%	4,993	5,133	5,263	5,383	5,493	5,593	5,683	5,763	5,833	5,893	6,576
1970	6.67%	4,993	5,133	5,263	5,383	5,493	5,593	5,683	5,763	5,833	5,893	6,576
1971	6.67%	4,993	5,133	5,263	5,383	5,493	5,593	5,683	5,763	5,833	5,893	6,576
1972	6.67%	4,993	5,133	5,263	5,383	5,493	5,593	5,683	5,763	5,833	5,893	6,576
1973	6.67%	4,993	5,133	5,263	5,383	5,493	5,593	5,683	5,763	5,833	5,893	6,576
1974	6.67%	4,993	5,133	5,263	5,383	5,493	5,593	5,683	5,763	5,833	5,893	6,576
1975-84	0.00%	0	0	0	0	0	0	0	0	0	0	0
Total	100.00%	74,895	76,995	78,945	80,745	82,395	83,895	85,245	86,445	87,495	88,395	98,633

Notes:
- Cumulative projected calendar year ground-up indemnity costs losses from Exhibit 5.2, Item (16).
- Allocation method of calendar year losses to policy year is by equal weighting to each year.
- *Ultimate value is calculated by continuation of patterns beyond months shown.*

Asbestos BI Model for ABC Re's Insured 3 Exhibit 7.3
Insurer 3's Cumulative Ground-Up Losses, Indemnity and Expenses, Annual Inflation = 5.0% / Coverage Block = 25 Years
($000's)

						Calendar Year				
Policy Year	Selected Weights	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1960	4.00%	1,851	1,997	2,150	2,310	2,471	2,632	2,792	2,952	3,110	3,266
1961	4.00%	1,851	1,997	2,150	2,310	2,471	2,632	2,792	2,952	3,110	3,266
1962	4.00%	1,851	1,997	2,150	2,310	2,471	2,632	2,792	2,952	3,110	3,266
1963	4.00%	1,851	1,997	2,150	2,310	2,471	2,632	2,792	2,952	3,110	3,266
1964	4.00%	1,851	1,997	2,150	2,310	2,471	2,632	2,792	2,952	3,110	3,266
1965	4.00%	1,851	1,997	2,150	2,310	2,471	2,632	2,792	2,952	3,110	3,266
1966	4.00%	1,851	1,997	2,150	2,310	2,471	2,632	2,792	2,952	3,110	3,266
1967	4.00%	1,851	1,997	2,150	2,310	2,471	2,632	2,792	2,952	3,110	3,266
1968	4.00%	1,851	1,997	2,150	2,310	2,471	2,632	2,792	2,952	3,110	3,266
1969	4.00%	1,851	1,997	2,150	2,310	2,471	2,632	2,792	2,952	3,110	3,266
1970	4.00%	1,851	1,997	2,150	2,310	2,471	2,632	2,792	2,952	3,110	3,266
1971	4.00%	1,851	1,997	2,150	2,310	2,471	2,632	2,792	2,952	3,110	3,266
1972	4.00%	1,851	1,997	2,150	2,310	2,471	2,632	2,792	2,952	3,110	3,266
1973	4.00%	1,851	1,997	2,150	2,310	2,471	2,632	2,792	2,952	3,110	3,266
1974	4.00%	1,851	1,997	2,150	2,310	2,471	2,632	2,792	2,952	3,110	3,266
1975-84	40.00%	18,513	19,968	21,497	23,101	24,709	26,317	27,921	29,517	31,099	32,663
Total	100.00%	46,283	49,921	53,742	57,752	61,773	65,793	69,803	73,792	77,748	81,658

						Calendar Year					
Policy Year	Selected Weights	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Ultimate
1960	4.00%	3,420	3,571	3,718	3,861	3,998	4,129	4,253	4,368	4,474	4,570	6,248
1961	4.00%	3,420	3,571	3,718	3,861	3,998	4,129	4,253	4,368	4,474	4,570	6,248
1962	4.00%	3,420	3,571	3,718	3,861	3,998	4,129	4,253	4,368	4,474	4,570	6,248
1963	4.00%	3,420	3,571	3,718	3,861	3,998	4,129	4,253	4,368	4,474	4,570	6,248
1964	4.00%	3,420	3,571	3,718	3,861	3,998	4,129	4,253	4,368	4,474	4,570	6,248
1965	4.00%	3,420	3,571	3,718	3,861	3,998	4,129	4,253	4,368	4,474	4,570	6,248
1966	4.00%	3,420	3,571	3,718	3,861	3,998	4,129	4,253	4,368	4,474	4,570	6,248
1967	4.00%	3,420	3,571	3,718	3,861	3,998	4,129	4,253	4,368	4,474	4,570	6,248
1968	4.00%	3,420	3,571	3,718	3,861	3,998	4,129	4,253	4,368	4,474	4,570	6,248
1969	4.00%	3,420	3,571	3,718	3,861	3,998	4,129	4,253	4,368	4,474	4,570	6,248
1970	4.00%	3,420	3,571	3,718	3,861	3,998	4,129	4,253	4,368	4,474	4,570	6,248
1971	4.00%	3,420	3,571	3,718	3,861	3,998	4,129	4,253	4,368	4,474	4,570	6,248
1972	4.00%	3,420	3,571	3,718	3,861	3,998	4,129	4,253	4,368	4,474	4,570	6,248
1973	4.00%	3,420	3,571	3,718	3,861	3,998	4,129	4,253	4,368	4,474	4,570	6,248
1974	4.00%	3,420	3,571	3,718	3,861	3,998	4,129	4,253	4,368	4,474	4,570	6,248
1975-84	40.00%	34,202	35,711	37,182	38,607	39,979	41,289	42,527	43,682	44,743	45,698	62,479
Total	100.00%	85,506	89,277	92,955	96,518	99,948	103,223	106,317	109,205	111,858	114,246	156,197

Notes: - Cumulative projected calendar year ground-up indemnity costs losses from Exhibit 5.3, Item (16).
- Allocation method of calendar year losses to policy year is by equal weighting to each year.
- Ultimate value is calculated by continuation of patterns beyond months shown.

Asbestos BI Model for ABC Re's Insured 3 Exhibit 7.4

Insurer 3's Cumulative Ground-Up Losses, Indemnity and Expenses, Annual Inflation = 0.0% / Coverage Block = 25 Years

($000's)

Policy Year	Selected Weights	Calendar Year 1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1960	4.00%	1,844	1,976	2,108	2,240	2,366	2,486	2,600	2,708	2,810	2,906
1961	4.00%	1,844	1,976	2,108	2,240	2,366	2,486	2,600	2,708	2,810	2,906
1962	4.00%	1,844	1,976	2,108	2,240	2,366	2,486	2,600	2,708	2,810	2,906
1963	4.00%	1,844	1,976	2,108	2,240	2,366	2,486	2,600	2,708	2,810	2,906
1964	4.00%	1,844	1,976	2,108	2,240	2,366	2,486	2,600	2,708	2,810	2,906
1965	4.00%	1,844	1,976	2,108	2,240	2,366	2,486	2,600	2,708	2,810	2,906
1966	4.00%	1,844	1,976	2,108	2,240	2,366	2,486	2,600	2,708	2,810	2,906
1967	4.00%	1,844	1,976	2,108	2,240	2,366	2,486	2,600	2,708	2,810	2,906
1968	4.00%	1,844	1,976	2,108	2,240	2,366	2,486	2,600	2,708	2,810	2,906
1969	4.00%	1,844	1,976	2,108	2,240	2,366	2,486	2,600	2,708	2,810	2,906
1970	4.00%	1,844	1,976	2,108	2,240	2,366	2,486	2,600	2,708	2,810	2,906
1971	4.00%	1,844	1,976	2,108	2,240	2,366	2,486	2,600	2,708	2,810	2,906
1972	4.00%	1,844	1,976	2,108	2,240	2,366	2,486	2,600	2,708	2,810	2,906
1973	4.00%	1,844	1,976	2,108	2,240	2,366	2,486	2,600	2,708	2,810	2,906
1974	4.00%	1,844	1,976	2,108	2,240	2,366	2,486	2,600	2,708	2,810	2,906
1975-84	40.00%	18,438	19,758	21,078	22,398	23,658	24,858	25,998	27,078	28,098	29,058
Total	100.00%	46,095	49,395	52,695	55,995	59,145	62,145	64,995	67,695	70,245	72,645

Policy Year	Selected Weights	Calendar Year 2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Ultimate
1960	4.00%	2,996	3,080	3,158	3,230	3,296	3,356	3,410	3,458	3,500	3,536	3,945
1961	4.00%	2,996	3,080	3,158	3,230	3,296	3,356	3,410	3,458	3,500	3,536	3,945
1962	4.00%	2,996	3,080	3,158	3,230	3,296	3,356	3,410	3,458	3,500	3,536	3,945
1963	4.00%	2,996	3,080	3,158	3,230	3,296	3,356	3,410	3,458	3,500	3,536	3,945
1964	4.00%	2,996	3,080	3,158	3,230	3,296	3,356	3,410	3,458	3,500	3,536	3,945
1965	4.00%	2,996	3,080	3,158	3,230	3,296	3,356	3,410	3,458	3,500	3,536	3,945
1966	4.00%	2,996	3,080	3,158	3,230	3,296	3,356	3,410	3,458	3,500	3,536	3,945
1967	4.00%	2,996	3,080	3,158	3,230	3,296	3,356	3,410	3,458	3,500	3,536	3,945
1968	4.00%	2,996	3,080	3,158	3,230	3,296	3,356	3,410	3,458	3,500	3,536	3,945
1969	4.00%	2,996	3,080	3,158	3,230	3,296	3,356	3,410	3,458	3,500	3,536	3,945
1970	4.00%	2,996	3,080	3,158	3,230	3,296	3,356	3,410	3,458	3,500	3,536	3,945
1971	4.00%	2,996	3,080	3,158	3,230	3,296	3,356	3,410	3,458	3,500	3,536	3,945
1972	4.00%	2,996	3,080	3,158	3,230	3,296	3,356	3,410	3,458	3,500	3,536	3,945
1973	4.00%	2,996	3,080	3,158	3,230	3,296	3,356	3,410	3,458	3,500	3,536	3,945
1974	4.00%	2,996	3,080	3,158	3,230	3,296	3,356	3,410	3,458	3,500	3,536	3,945
1975-84	40.00%	29,958	30,798	31,578	32,298	32,958	33,558	34,098	34,578	34,998	35,358	39,453
Total	100.00%	74,895	76,995	78,945	80,745	82,395	83,895	85,245	86,445	87,495	88,395	98,633

Notes: - Cumulative projected calendar year ground-up indemnity costs losses from Exhibit 5.4, Item (16).
- *Allocation method of calendar year losses to policy year is by equal weighting to each year.*
- Ultimate value is calculated by continuation of patterns beyond months shown.

Asbestos BI Model for ABC Re's Insured 3 — Exhibit 8.1

Insured 3's Losses in ABC Re's Reinsurance Layer, Indemnity and Expenses, Annual Inflation = 5.0% / Coverage Block = 15 Years
($000's)

Policy Year	Width/Attch Pt/ % Share / Expenses ($ in millions)	Calendar Year 1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1960	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1961	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1962	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1963	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1964	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1965	2.0/2.7/100.0% / Pro Rata	0	0	0	0	68	336	604	869	1,133	1,394
1966	2.0/2.7/100.0% / Pro Rata	0	0	0	0	68	336	604	869	1,133	1,394
1967	2.0/2.7/100.0% / Included in Limit	386	628	883	1,150	1,418	1,686	1,954	2,000	2,000	2,000
1968	4.0/3.5/100.0% / Pro Rata	0	0	0	0	0	0	0	0	0	194
1969	4.0/3.5/100.0% / Included in Limit	0	0	83	350	618	886	1,154	1,419	1,683	1,944
1970	4.0/3.5/25.0% / Pro Rata	0	0	0	0	0	0	0	0	0	48
1971	2.0/2.0/100.0% / Indem Only	57	219	389	567	745	924	1,102	1,280	1,455	1,629
1972	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1973	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1974	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1975–84	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
Total		443	847	1,354	2,067	2,918	4,169	5,417	6,438	7,405	8,603

Policy Year	Width/Attch Pt/ % Share / Expenses ($ in millions)	Calendar Year 2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Ultimate
1960	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1961	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1962	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1963	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1964	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1965	2.0/2.7/100.0% / Pro Rata	1,650	1,902	2,147	2,385	2,613	2,832	3,000	3,000	3,000	3,000	3,000
1966	2.0/2.7/100.0% / Pro Rata	1,650	1,902	2,147	2,385	2,613	2,832	3,000	3,000	3,000	3,000	3,000
1967	2.0/2.7/100.0% / Included in Limit	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
1968	4.0/3.5/100.0% / Pro Rata	450	702	947	1,185	1,413	1,632	1,838	2,030	2,207	2,366	5,163
1969	4.0/3.5/100.0% / Included in Limit	2,200	2,452	2,697	2,935	3,163	3,382	3,588	3,780	3,957	4,000	4,000
1970	4.0/3.5/25.0% / Pro Rata	113	175	237	296	353	408	459	508	552	592	1,291
1971	2.0/2.0/100.0% / Indem Only	1,800	1,968	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
1972	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1973	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1974	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1975–84	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
Total		9,864	11,101	12,175	13,184	14,156	15,084	15,885	16,318	16,716	16,958	20,454

Notes:
- Policy information from Exhibit 4. Only policies in Insured 3's coverage block for this scenario, 1960 through 1974, are included.
- Losses in layer are calculated by using the policy information to carve out losses and expenses from Exhibits 5.1, 6.1, and 7.1.
- Expenses are added to indemnity before applying attachment point and limits for expenses included in limits policies. (Policy Years 1967 and 1969).

When all lower layer policies are indemnity only or pro rata, this would not be true. In this case, indemnity only should be used to determine if the attachment point is reached.
In the real world the true answer is somewhere between adding expenses to indemnity or just indemnity in determining satisfaction of the attachment point.
Both scenarios should be examined.
Ultimate value is calculated by continuation of patterns beyond months shown.

Asbestos BI Model for ABC Re's Insured 3 Exhibit 8.2

Insured 3's Losses in ABC Re's Reinsurance Layer, Indemnity and Expenses, Annual Inflation = 0.0% / Coverage Block = 15 Years

($000's)

Policy Year	Width/Attch Pt/ % Share / Expenses ($ in millions)	Calendar Year 1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1960	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1961	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1962	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1963	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1964	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1965	2.0/2.7/100.0% / Pro Rata	0	0	0	0	0	93	283	463	633	793
1966	2.0/2.7/100.0% / Pro Rata	0	0	0	0	0	93	283	463	633	793
1967	2.0/2.7/100.0% / Included in Limit	373	593	813	1,033	1,243	1,443	1,633	1,813	1,983	2,000
1968	4.0/3.5/100.0% / Pro Rata	0	0	0	0	0	0	0	0	0	0
1969	4.0/3.5/100.0% / Included in Limit	0	0	13	233	443	643	833	1,013	1,183	1,343
1970	4.0/3.5/25.0% / Pro Rata	0	0	0	0	0	0	0	0	0	0
1971	2.0/2.0/100.0% / Indem Only	49	195	342	489	629	762	889	1,009	1,122	1,229
1972	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1973	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1974	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1975–84	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
Total		422	788	1,168	1,755	2,315	3,034	3,921	4,761	5,554	6,158

Policy Year	Width/Attch Pt/ % Share / Expenses ($ in millions)	Calendar Year 2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Ultimate
1960	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1961	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1962	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1963	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1964	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1965	2.0/2.7/100.0% / Pro Rata	943	1,083	1,213	1,333	1,443	1,543	1,633	1,713	1,783	1,843	2,526
1966	2.0/2.7/100.0% / Pro Rata	943	1,083	1,213	1,333	1,443	1,543	1,633	1,713	1,783	1,843	2,526
1967	2.0/2.7/100.0% / Included in Limit	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000	2,000
1968	4.0/3.5/100.0% / Pro Rata	0	0	13	133	243	343	433	513	583	643	1,326
1969	4.0/3.5/100.0% / Included in Limit	1,493	1,633	1,763	1,883	1,993	2,093	2,183	2,263	2,333	2,393	3,076
1970	4.0/3.5/25.0% / Pro Rata	0	0	3	33	61	86	108	128	146	161	331
1971	2.0/2.0/100.0% / Indem Only	1,329	1,422	1,509	1,589	1,662	1,729	1,789	1,842	1,889	1,929	2,000
1972	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1973	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1974	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1975–84	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
Total		6,708	7,221	7,714	8,304	8,845	9,337	9,779	10,172	10,517	10,812	13,783

Notes:
- Policy information from Exhibit 4. Only policies in Insured 3's coverage block for this scenario, 1960 through 1974, are included.
- Losses in layer are calculated by using the policy information to carve out losses and expenses from Exhibits 5.2, 6.2, and 7.2.
- Expenses are added to indemnity before applying attachment point and limits for expenses included in limits policies. (Policy Years 1967 and 1969).
  When all lower layer policies are indemnity only or pro rata, this would not be true. In this case, indemnity only should be used to determine if the attachment point is reached.
  In the real world the true answer is somewhere between adding expenses to indemnity or just indemnity in determining satisfaction of the attachment point.
  Both scenarios should be examined.
- Ultimate value is calculated by continuation of patterns beyond months shown.

Asbestos BI Model for ABC Re's Insured 3 Exhibit 8.3
Insured 3's Losses in ABC Re's Reinsurance Layer, Indemnity and Expenses, Annual Inflation = 5.0% / Coverage Block = 25 Years
($000's)

Policy Year	Width/Attch Pt/ % Share / Expenses ($ in millions)	Calendar Year 1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1960	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1961	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1962	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1963	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1964	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1965	2.0/2.7/100.0% / Pro Rata	0	0	0	0	0	0	0	0	0	0
1966	2.0/2.7/100.0% / Pro Rata	0	0	0	0	0	0	0	0	0	0
1967	2.0/2.7/100.0% / Included in Limit	0	0	0	0	0	0	92	252	410	566
1968	4.0/3.5/100.0% / Pro Rata	0	0	0	0	0	0	0	0	0	0
1969	4.0/3.5/100.0% / Included in Limit	0	0	0	0	0	0	0	0	0	0
1970	4.0/3.5/25.0% / Pro Rata	0	0	0	0	0	0	0	0	0	0
1971	2.0/2.0/100.0% / Indem Only	0	0	0	0	0	0	0	0	73	178
1972	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1973	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1974	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1975-84	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
Total		0	0	0	0	0	0	92	252	483	744

Policy Year	Width/Attch Pt/ % Share / Expenses ($ in millions)	Calendar Year 2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Ultimate
1960	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1961	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1962	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1963	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1964	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1965	2.0/2.7/100.0% / Pro Rata	0	0	0	0	0	79	203	318	424	520	2,198
1966	2.0/2.7/100.0% / Pro Rata	0	0	0	0	0	79	203	318	424	520	2,198
1967	2.0/2.7/100.0% / Included in Limit	720	871	1,018	1,161	1,298	1,429	1,553	1,668	1,774	1,870	2,000
1968	4.0/3.5/100.0% / Pro Rata	0	0	0	0	0	0	0	0	0	0	998
1969	4.0/3.5/100.0% / Included in Limit	0	71	218	361	498	629	753	868	974	1,070	2,748
1970	4.0/3.5/25.0% / Pro Rata	0	0	0	0	0	0	0	0	0	0	249
1971	2.0/2.0/100.0% / Indem Only	280	381	479	574	665	753	835	912	983	1,047	2,000
1972	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1973	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1974	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1975-84	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
Total		1,000	1,323	1,715	2,095	2,461	2,968	3,546	4,085	4,580	5,026	12,391

Notes: – Policy information from Exhibit 4. Only policies in Insured 3's coverage block for this scenario, 1960 through 1984, are included.
– Losses in layer are calculated by using the policy information to carve out losses and expenses from Exhibits 5.3, 6.3, and 7.3.
– Expenses are added to indemnity before applying attachment point and limits for expenses included in limits policies. (Policy Years 1967 and 1969).
When all lower layer policies are indemnity only or pro rata, this would not be true. In this case, indemnity only should be used to determine if the attachment point is reached.
In the real world the true answer is somewhere between adding expenses to indemnity or just indemnity in determining satisfaction of the attachment point.
Both scenarios should be examined.
– Ultimate value is calculated by continuation of patterns beyond months shown.

Asbestos BI Model for ABC Re's Insured 3 Exhibit 8.4

Insured 3's Losses in ABC Re's Reinsurance Layer, Indemnity and Expenses, Annual Inflation = 0.0% / Coverage Block = 25 Years

($000's)

Policy Year	Width/Attch Pt/ % Share / Expenses ($ in millions)	Calendar Year 1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1960	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1961	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1962	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1963	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1964	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1965	2.0/2.7/100.0% / Pro Rata	0	0	0	0	0	0	0	0	0	0
1966	2.0/2.7/100.0% / Pro Rata	0	0	0	0	0	0	0	0	0	0
1967	2.0/2.7/100.0% / Included in Limit	0	0	0	0	0	0	0	8	110	206
1968	4.0/3.5/100.0% / Pro Rata	0	0	0	0	0	0	0	0	0	0
1969	4.0/3.5/100.0% / Included in Limit	0	0	0	0	0	0	0	0	0	0
1970	4.0/3.5/25.0% / Pro Rata	0	0	0	0	0	0	0	0	0	0
1971	2.0/2.0/100.0% / Indem Only	0	0	0	0	0	0	0	0	0	0
1972	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1973	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1974	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1975–84	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
Total		0	0	0	0	0	0	0	8	110	206

Policy Year	Width/Attch Pt/ % Share / Expenses ($ in millions)	Calendar Year 2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Ultimate
1960	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1961	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1962	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1963	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1964	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1965	2.0/2.7/100.0% / Pro Rata	0	0	0	0	0	0	0	0	0	0	0
1966	2.0/2.7/100.0% / Pro Rata	0	0	0	0	0	0	0	0	0	0	0
1967	2.0/2.7/100.0% / Included in Limit	296	380	458	530	596	656	710	758	800	836	1,245
1968	4.0/3.5/100.0% / Pro Rata	0	0	0	0	0	0	0	0	0	0	0
1969	4.0/3.5/100.0% / Included in Limit	0	0	0	0	0	0	0	0	0	36	445
1970	4.0/3.5/25.0% / Pro Rata	0	0	0	0	0	0	0	0	0	0	0
1971	2.0/2.0/100.0% / Indem Only	0	53	105	153	197	237	273	305	333	357	630
1972	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1973	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1974	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1975–84	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
Total		296	433	563	683	793	893	983	1,063	1,133	1,229	2,321

Notes:
- Policy information from Exhibit 4. Only policies in Insured 3's coverage block for this scenario, 1960 through 1984, are included.
- Losses in layer are calculated by using the policy information to carve out losses and expenses from Exhibits 5.4, 6.4, and 7.4.
- Expenses are added to indemnity before applying attachment point and limits for expenses included in limits policies. (Policy Years 1967 and 1969).
  When all lower layer policies are indemnity only or pro rata, this would not be true. In this case, indemnity only should be used to determine if the attachment point is reached.
  In the real world the true answer is somewhere between adding expenses to indemnity or just indemnity in determining satisfaction of the attachment point.
  Both scenarios should be examined.
- Ultimate value is calculated by continuation of patterns beyond months shown.

Asbestos BI Model for ABC Re's Insured 3
Comparison of Ground-Up Indemnity & Expense vs. Indemnity & Expense in Layer
Annual Inflation = 5.0% / Coverage Block = 15 Years
($000's)

Exhibit 9.1

Calendar Year (1)	Insured 3's 1968 Policy Year Cumulative Indemnity and Expense: On a Ground-Up $ Basis (2)	*Implied* Ground-Up Reporting Pattern (3)	In ABC Re's Reinsurance Layer (4)	ABC Re's Implied Reporting Pattern (5)	All Policy Years for Insured 3 in its Coverage Block Cumulative Indemnity and Expense: On a Ground-Up $ Basis (6)	*Implied* Ground-Up Reporting Pattern (7)	In ABC Re's Reinsurance Layer (8)	ABC Re's Implied Reporting Pattern (9)
1994	3,086	29.63%	0	0.00%	46,283	29.63%	443	2.16%
1995	3,328	31.96%	0	0.00%	49,921	31.96%	847	4.14%
1996	3,583	34.41%	0	0.00%	53,741	34.41%	1,354	6.62%
1997	3,850	36.97%	0	0.00%	57,752	36.97%	2,067	10.11%
1998	4,118	39.55%	0	0.00%	61,773	39.55%	2,918	14.27%
1999	4,386	42.12%	0	0.00%	65,793	42.12%	4,169	20.38%
2000	4,654	44.69%	0	0.00%	69,803	44.69%	5,417	26.48%
2001	4,919	47.24%	0	0.00%	73,792	47.24%	6,438	31.48%
2002	5,183	49.78%	0	0.00%	77,748	49.78%	7,405	36.20%
2003	5,444	52.28%	194	3.75%	81,658	52.28%	8,603	42.06%
2004	5,700	54.74%	450	8.72%	85,506	54.74%	9,864	48.23%
2005	5,952	57.16%	702	13.59%	89,277	57.16%	11,101	54.27%
2006	6,197	59.51%	947	18.34%	92,954	59.51%	12,175	59.52%
2007	6,435	61.79%	1,185	22.94%	96,518	61.79%	13,184	64.46%
2008	6,663	63.99%	1,413	27.37%	99,948	63.99%	14,156	69.21%
2009	6,882	66.09%	1,632	31.60%	103,223	66.09%	15,084	73.75%
2010	7,088	68.07%	1,838	35.59%	106,317	68.07%	15,885	77.66%
2011	7,280	69.91%	2,030	39.32%	109,205	69.91%	16,318	79.78%
2012	7,457	71.61%	2,207	42.75%	111,858	71.61%	16,716	81.73%
2013	7,616	73.14%	2,366	45.83%	114,246	73.14%	16,958	82.91%
Ultimate	10,413	100.00%	5,163	100.00%	156,197	100.00%	20,454	100.00%

Notes:
(2),(6) From Exhibit 7.1.
(3) = (2) / (2) at Ultimate.
(4),(8) From Exhibit 8.1.
(5) = (4) / (4) at Ultimate.
(7) = (6) / (6) at Ultimate.
(9) = (8) / (8) at Ultimate.

Asbestos BI Model for ABC Re's Insured 3
Comparison of Ground-Up Indemnity & Expense vs. Indemnity & Expense in Layer
Annual Inflation = 0.0% / Coverage Block = 15 Years
($000's)

Exhibit 9.2

	Insured 3's 1968 Policy Year Cumulative Indemnity and Expense				All Policy Years for Insured 3 in its Coverage Block Cumulative Indemnity and Expense			
Calendar Year (1)	On a Ground-Up $ Basis (2)	Implied Ground-Up Reporting Pattern (3)	In ABC Re's Reinsurance Layer (4)	ABC Re's Implied Reporting Pattern (5)	On a Ground-Up $ Basis (6)	Implied Ground-Up Reporting Pattern (7)	In ABC Re's Reinsurance Layer (8)	ABC Re's Implied Reporting Pattern (9)
1994	3,073	46.73%	0	0.00%	46,095	46.73%	422	3.06%
1995	3,293	50.08%	0	0.00%	49,395	50.08%	788	5.72%
1996	3,513	53.43%	0	0.00%	52,695	53.43%	1,168	8.47%
1997	3,733	56.77%	0	0.00%	55,995	56.77%	1,755	12.73%
1998	3,943	59.97%	0	0.00%	59,145	59.97%	2,315	16.79%
1999	4,143	63.01%	0	0.00%	62,145	63.01%	3,034	22.01%
2000	4,333	65.90%	0	0.00%	64,995	65.90%	3,921	28.45%
2001	4,513	68.63%	0	0.00%	67,695	68.63%	4,761	34.54%
2002	4,683	71.22%	0	0.00%	70,245	71.22%	5,554	40.30%
2003	4,843	73.65%	0	0.00%	72,645	73.65%	6,158	44.67%
2004	4,993	75.93%	0	0.00%	74,895	75.93%	6,708	48.67%
2005	5,133	78.06%	0	0.00%	76,995	78.06%	7,221	52.39%
2006	5,263	80.04%	13	0.98%	78,945	80.04%	7,714	55.97%
2007	5,383	81.86%	133	10.04%	80,745	81.86%	8,304	60.25%
2008	5,493	83.54%	243	18.33%	82,395	83.54%	8,845	64.17%
2009	5,593	85.06%	343	25.88%	83,895	85.06%	9,337	67.74%
2010	5,683	86.43%	433	32.67%	85,245	86.43%	9,779	70.95%
2011	5,763	87.64%	513	38.70%	86,445	87.64%	10,172	73.80%
2012	5,833	88.71%	583	43.98%	87,495	88.71%	10,517	76.30%
2013	5,893	89.62%	643	48.51%	88,395	89.62%	10,812	78.44%
Ultimate	6,576	100.00%	1,326	100.00%	98,633	100.00%	13,783	100.00%

Notes:
(2),(6) From Exhibit 7.2.
(3) = (2) / (2) at Ultimate.
(4),(8) From Exhibit 8.2.
(5) = (4) / (4) at Ultimate.
(7) = (6) / (6) at Ultimate.
(9) = (8) / (8) at Ultimate.

Asbestos BI Model for ABC Re's Insured 3
Comparison of Ground-Up Indemnity & Expense vs. Indemnity & Expense in Layer
Annual Inflation = 5.0% / Coverage Block = 25 Years
($000's)

Exhibit 9.3

	Insured 3's 1968 Policy Year Cumulative Indemnity and Expense				All Policy Years for Insured 3 in its Coverage Block Cumulative Indemnity and Expense			
Calendar Year (1)	On a Ground-Up $ Basis (2)	Implied Ground-Up Reporting Pattern (3)	In ABC Re's Reinsurance Layer (4)	ABC Re's Implied Reporting Pattern (5)	On a Ground-Up $ Basis (6)	Implied Ground-Up Reporting Pattern (7)	In ABC Re's Reinsurance Layer (8)	ABC Re's Implied Reporting Pattern (9)
1994	1,851	29.63%	0	0.00%	46,283	29.63%	0	0.00%
1995	1,997	31.96%	0	0.00%	49,921	31.96%	0	0.00%
1996	2,150	34.41%	0	0.00%	53,742	34.41%	0	0.00%
1997	2,310	36.97%	0	0.00%	57,752	36.97%	0	0.00%
1998	2,471	39.55%	0	0.00%	61,773	39.55%	0	0.00%
1999	2,632	42.12%	0	0.00%	65,793	42.12%	0	0.00%
2000	2,792	44.69%	0	0.00%	69,803	44.69%	92	0.74%
2001	2,952	47.24%	0	0.00%	73,792	47.24%	252	2.03%
2002	3,110	49.78%	0	0.00%	77,748	49.78%	483	3.90%
2003	3,266	52.28%	0	0.00%	81,658	52.28%	744	6.00%
2004	3,420	54.74%	0	0.00%	85,506	54.74%	1,000	8.07%
2005	3,571	57.16%	0	0.00%	89,277	57.16%	1,323	10.68%
2006	3,718	59.51%	0	0.00%	92,955	59.51%	1,715	13.84%
2007	3,861	61.79%	0	0.00%	96,518	61.79%	2,095	16.91%
2008	3,998	63.99%	0	0.00%	99,948	63.99%	2,461	19.86%
2009	4,129	66.09%	0	0.00%	103,223	66.08%	2,968	23.95%
2010	4,253	68.07%	0	0.00%	106,317	68.07%	3,546	28.62%
2011	4,368	69.91%	0	0.00%	109,205	69.91%	4,085	32.97%
2012	4,474	71.61%	0	0.00%	111,858	71.61%	4,580	36.96%
2013	4,570	73.14%	0	0.00%	114,246	73.14%	5,026	40.56%
Ultimate	6,248	100.00%	998	100.00%	156,197	100.00%	12,391	100.00%

Notes:
(2),(6) From Exhibit 7.3.
(3) = (2) / (2) at Ultimate.
(4),(8) From Exhibit 8.3.
(5) = (4) / (4) at Ultimate.
(7) = (6) / (6) at Ultimate.
(9) = (8) / (8) at Ultimate.

Asbestos BI Model for ABC Re's Insured 3
Comparison of Ground-Up Indemnity & Expense vs. Indemnity & Expense in Layer
Annual Inflation = 0.0% / Coverage Block = 25 Years
($000's)

Exhibit 9.4

	Insured 3's 1968 Policy Year Cumulative Indemnity and Expense				All Policy Years for Insured 3 in its Coverage Block Cumulative Indemnity and Expense			
Calendar Year (1)	On a Ground-Up $ Basis (2)	Implied Ground-Up Reporting Pattern (3)	In ABC Re's Reinsurance Layer (4)	ABC Re's Implied Reporting Pattern (5)	On a Ground-Up $ Basis (6)	Implied Ground-Up Reporting Pattern (7)	In ABC Re's Reinsurance Layer (8)	ABC Re's Implied Reporting Pattern (9)
1994	1,844	46.73%	0	NA	46,095	46.73%	0	0.00%
1995	1,976	50.08%	0	NA	49,395	50.08%	0	0.00%
1996	2,108	53.43%	0	NA	52,695	53.43%	0	0.00%
1997	2,240	56.77%	0	NA	55,995	56.77%	0	0.00%
1998	2,366	59.97%	0	NA	59,145	59.97%	0	0.00%
1999	2,486	63.01%	0	NA	62,145	63.01%	0	0.00%
2000	2,600	65.90%	0	NA	64,995	65.90%	0	0.00%
2001	2,708	68.63%	0	NA	67,695	68.63%	8	0.34%
2002	2,810	71.22%	0	NA	70,245	71.22%	110	4.73%
2003	2,906	73.65%	0	NA	72,645	73.65%	206	8.87%
2004	2,996	75.93%	0	NA	74,895	75.93%	296	12.75%
2005	3,080	78.06%	0	NA	76,995	78.06%	433	18.66%
2006	3,158	80.04%	0	NA	78,945	80.04%	563	24.26%
2007	3,230	81.86%	0	NA	80,745	81.86%	683	29.43%
2008	3,296	83.54%	0	NA	82,395	83.54%	793	34.17%
2009	3,356	85.06%	0	NA	83,895	85.06%	893	38.48%
2010	3,410	86.43%	0	NA	85,245	86.43%	983	42.36%
2011	3,458	87.64%	0	NA	86,445	87.64%	1,063	45.80%
2012	3,500	88.71%	0	NA	87,495	88.71%	1,133	48.82%
2013	3,536	89.62%	0	NA	88,395	89.62%	1,229	52.95%
Ultimate	3,945	100.00%	0	NA	98,633	100.00%	2,321	100.00%

Notes:
(2),(6) From Exhibit 7.4.
(3) = (2) / (2) at Ultimate.
(4),(8) From Exhibit 8.4.
(5) = (4) / (4) at Ultimate.
(7) = (6) / (6) at Ultimate.
(9) = (8) / (8) at Ultimate.

Asbestos BI Model for ABC Re's Sample Group

Indemnity and Expenses with ABC Re's Layer of Coverage for All Sample Insureds , Annual Inflation = 5.0% / Coverage Block = 15 Years

($000's)

Exhibit 10.1

Sample Insureds	Tier	Average Ground-Up Attachment Pt	Total Exposure	ABC Re's Reported Loss & Exp	Projected losses and expenses from all policies with Insured in calendar year: 1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Insured 1	4	37,500	3,363	0	0	0	0	0	0	0	0	0	0	0
Insured 2	4	20,757	19,863	20	143	158	173	188	203	218	233	248	263	278
Insured 3	2	2,943	17,000	2,300	443	847	1,354	2,067	2,918	4,169	5,417	6,438	7,405	8,603
Insured 4	1	48,750	38,480	21,500	44,301	46,334	46,334	46,334	46,334	46,334	46,334	46,334	46,334	46,334
Insured 5	1	50,357	30,280	19,300	30,212	30,344	30,344	30,344	30,344	30,344	30,344	30,344	30,344	30,344
Insured 6	1	48,333	40,680	22,450	44,059	45,224	46,371	47,233	47,233	47,233	47,233	47,233	47,233	47,233
Insured 7	2	37,813	13,581	1,500	1,500	1,500	1,500	1,556	1,668	1,777	2,394	3,473	4,482	5,008
Insured 8	2	40,000	14,290	300	300	300	300	300	300	529	869	1,198	1,317	1,423
Insured 9	2	40,313	10,233	300	300	300	300	300	457	673	858	937	1,016	1,093
Insured 10	3	17,143	6,000	150	186	190	193	197	279	391	488	531	574	618
Insured 11	2	37,813	31,940	200	281	300	300	300	300	300	300	300	300	300
Insured 12	3	26,429	16,300	0	0	0	0	0	0	0	0	0	0	0
Insured 13	3	25,938	24,800	15	0	0	0	0	0	0	7	47	87	127
Insured 14	3	21,111	9,500	15	0	0	0	0	0	42	86	129	172	200
Insured 15	3	25,313	6,400	200	236	253	270	312	415	533	644	714	750	788
Subtotal Tier 1			109,440	63,250										
Subtotal Tier 2			87,045	4,600										
Subtotal Tier 3			63,000	380										
Subtotal Tier 4			23,225	20										
Total			282,710	68,250	121,961	125,750	127,439	129,132	130,452	132,544	135,207	137,927	140,257	142,344
% of Ultimate					70.48%	72.67%	73.65%	74.62%	75.39%	76.60%	78.13%	79.71%	81.05%	82.26%

Sample Insureds	Tier	Projected losses and expenses from all policies with insured in calendar year: 2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Ultimate	Ultimate as % of Exposure	Case Inc'd Loss Devel. Factor
Insured 1	4	0	0	0	0	0	0	0	0	0	0	0	0.0%	0.000
Insured 2	4	292	306	320	334	346	359	371	383	395	403	411	2.1%	20.529
Insured 3	2	9,864	11,101	12,175	13,184	14,156	15,084	15,885	16,318	16,716	16,958	20,454	120.3%	8.893
Insured 4	1	46,334	46,334	46,334	46,334	46,334	46,334	46,334	46,334	46,334	46,334	46,334	120.4%	2.155
Insured 5	1	30,344	30,344	30,344	30,344	30,344	30,344	30,344	30,344	30,344	30,344	30,344	100.2%	1.572
Insured 6	1	47,233	47,233	47,233	47,233	47,233	47,233	47,233	47,233	47,233	47,233	47,233	116.1%	2.104
Insured 7	2	5,258	5,503	5,741	5,972	6,195	6,407	6,619	6,830	7,039	7,246	7,449	54.8%	4.966
Insured 8	2	1,527	1,629	1,729	1,825	1,918	2,007	2,095	2,183	2,270	2,357	5,475	38.3%	18.250
Insured 9	2	1,169	1,243	1,316	1,387	1,454	1,519	1,584	1,648	1,691	1,709	3,314	32.4%	11.045
Insured 10	3	658	698	738	777	831	892	953	1,013	1,063	1,099	1,928	32.1%	12.853
Insured 11	2	300	300	300	300	300	300	313	1,027	1,735	2,435	4,290	13.4%	21.450
Insured 12	3	0	0	0	0	0	0	0	0	0	0	586	3.6%	0.000
Insured 13	3	166	200	200	200	200	200	200	200	200	200	2,057	8.3%	137.164
Insured 14	3	200	200	200	200	200	200	200	200	200	200	1,595	16.8%	106.351
Insured 15	3	821	856	889	922	962	1,005	1,047	1,090	1,126	1,152	1,575	24.6%	7.873
Subtotal Tier 1												123,911	113.2%	1.959
Subtotal Tier 2												40,981	47.1%	8.909
Subtotal Tier 3												7,741	12.3%	20.372
Subtotal Tier 4												411	1.8%	20.127
Total		144,166	145,947	147,519	149,011	150,474	151,883	153,179	154,804	156,348	157,670	173,044	61.2%	2.535
% of Ultimate		83.31%	84.34%	85.25%	86.11%	86.96%	87.77%	88.52%	89.46%	90.35%	91.12%	100.00%		

Notes: – This exhibit is a compilation of Exhibit 8.1 for each insured in the sample group.

– Average ground-up attachment point and total exposure from insured policy information are given.

– ABC Re's reported loss & expense from ABC Re's claim files are given. The amount could be lower than implied by model because of reporting lags to ABC Re or higher because of additional reserves.

Asbestos BI Model for ABC Re's Sample Group Exhibit 10.2

Indemnity and Expenses with ABC Re's Layer of Coverage for All Sample Insureds , Annual Inflation = 0.0% / Coverage Block = 15 Years

($000's)

Sample Insureds	Tier	Average Ground-Up Attachment Pt	Total Exposure	ABC Re's Reported Loss & Exp	Projected losses and expenses from all policies with insured in calender year: 1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Insured 1	4	37,500	3,363	0	0	0	0	0	0	0	0	0	0	0
Insured 2	4	20,757	19,863	20	141	154	168	178	190	200	210	220	229	238
Insured 3	2	2,943	17,000	2,300	422	788	1,168	1,755	2,315	3,034	3,921	4,781	5,554	6,158
Insured 4	1	48,750	38,480	21,500	43,967	45,678	46,318	46,318	46,318	46,318	46,318	46,318	46,318	46,318
Insured 5	1	50,357	30,280	19,300	30,115	30,344	30,344	30,344	30,344	30,344	30,344	30,344	30,344	30,344
Insured 6	1	48,333	40,680	22,450	43,890	44,901	45,845	46,728	47,200	47,200	47,200	47,200	47,200	47,200
Insured 7	2	37,813	13,581	1,500	1,500	1,500	1,500	1,500	1,564	1,642	1,714	1,781	1,943	2,574
Insured 8	2	40,000	14,290	300	300	300	300	300	300	300	320	532	733	922
Insured 9	2	40,313	10,233	300	300	300	300	300	300	401	543	674	799	871
Insured 10	3	17,143	6,000	150	185	189	192	195	197	250	324	392	457	495
Insured 11	2	37,813	31,940	200	269	300	300	300	300	300	300	300	300	300
Insured 12	3	26,429	16,300	0	0	0	0	0	0	0	0	0	0	0
Insured 13	3	25,938	24,800	15	0	0	0	0	0	0	0	0	0	18
Insured 14	3	21,111	9,500	15	0	0	0	0	0	0	19	47	73	98
Insured 15	3	25,313	6,400	200	234	248	262	276	318	388	467	541	611	665
Subtotal Tier 1			109,440	63,250										
Subtotal Tier 2			67,045	4,600										
Subtotal Tier 3			63,000	380										
Subtotal Tier 4			23,225	20										
Total			282,710	68,250	121,323	124,903	126,695	128,193	129,346	130,378	131,660	133,111	134,560	136,202
% of Ultimate					81.33%	83.73%	84.93%	85.94%	86.71%	87.40%	88.27%	89.23%	90.20%	91.30%

Sample Insureds	Tier	Projected losses and expenses from all policies with insured in calendar year: 2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Ultimate	Ultimate as % of Exposure	Case Inc'd Loss Devel. Factor
Insured 1	4	0	0	0	0	0	0	0	0	0	0	0	0.0%	0.000
Insured 2	4	246	253	260	267	273	278	283	288	292	297	301	1.5%	15.034
Insured 3	2	6,708	7,221	7,714	8,304	8,845	9,337	9,779	10,172	10,517	10,812	13,783	81.1%	5.993
Insured 4	1	46,318	46,318	46,318	46,318	46,318	46,318	46,318	46,318	46,318	46,318	46,318	120.4%	2.154
Insured 5	1	30,344	30,344	30,344	30,344	30,344	30,344	30,344	30,344	30,344	30,344	30,344	100.2%	1.572
Insured 6	1	47,200	47,200	47,200	47,200	47,200	47,200	47,200	47,200	47,200	47,200	47,200	116.0%	2.102
Insured 7	2	3,161	3,661	4,128	4,555	4,873	4,966	5,054	5,137	5,216	5,290	5,359	39.5%	3.573
Insured 8	2	1,099	1,231	1,281	1,328	1,370	1,409	1,446	1,481	1,514	1,544	1,958	13.7%	6.528
Insured 9	2	914	953	990	1,024	1,055	1,083	1,110	1,135	1,159	1,182	1,484	14.5%	4.946
Insured 10	3	518	540	560	578	595	611	628	640	653	665	817	13.6%	5.447
Insured 11	2	300	300	300	300	300	300	300	300	300	300	300	0.9%	1.500
Insured 12	3	0	0	0	0	0	0	0	0	0	0	0	0.0%	0.000
Insured 13	3	40	60	79	96	112	127	141	154	166	177	200	0.8%	13.333
Insured 14	3	122	143	164	182	200	200	200	200	200	200	200	2.1%	13.333
Insured 15	3	705	723	740	756	770	783	796	806	819	829	909	14.2%	4.546
Subtotal Tier 1												123,862	113.2%	1.958
Subtotal Tier 2												22,885	26.3%	4.975
Subtotal Tier 3												2,126	3.4%	5.595
Subtotal Tier 4												301	1.3%	14.739
Total		137,674	138,949	140,077	141,253	142,255	142,956	143,598	144,176	144,697	145,158	149,174	52.8%	2.186
% of Ultimate		92.29%	93.15%	93.90%	94.69%	95.36%	95.83%	96.26%	96.65%	97.00%	97.31%	100.00%		

Notes: – This exhibit is a compilation of Exhibit 8.2 for each insured in the sample group.
– Average ground-up attachment point and total exposure from insured policy information are given.
– ABC Re's reported loss & expense from ABC Re's claim files are given. The amount could be lower than implied by model because of reporting lags to ABC Re or higher because of additional reserves.

Asbestos BI Model for ABC Re's Sample Group
Indemnity and Expenses with ABC Re's Layer of Coverage for All Sample Insureds , Annual Inflation = 5.0% / Coverage Block = 25 Years
($000's)

Exhibit 10.3

Sample Insureds	Tier	Average Ground-Up Attachment Pt	Total Exposure	ABC Re's Reported Loss & Exp	Projected losses and expenses from all policies with insured in calendar year: 1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Insured 1	4	37,500	3,363	0	0	0	0	0	0	0	0	0	0	0
Insured 2	4	20,757	19,863	20	40	46	53	60	67	74	83	92	101	110
Insured 3	2	2,943	17,000	2,300	0	0	0	0	0	0	92	252	483	744
Insured 4	1	48,750	38,480	21,500	21,011	22,026	23,025	24,566	26,127	27,780	29,616	31,398	33,186	34,913
Insured 5	1	50,357	30,280	19,300	19,628	20,344	20,344	20,778	21,365	22,253	23,165	24,091	24,990	25,878
Insured 6	1	48,333	40,680	22,450	22,484	24,860	26,048	27,015	28,367	29,968	31,567	33,101	34,623	36,127
Insured 7	2	37,813	13,581	1,500	0	0	333	675	1,011	1,339	1,500	1,500	1,500	1,500
Insured 8	2	40,000	14,290	300	0	62	135	207	277	300	300	300	300	300
Insured 9	2	40,313	10,233	300	52	129	205	279	300	300	300	300	300	300
Insured 10	3	17,143	6,000	150	36	76	118	155	167	168	171	173	175	178
Insured 11	2	37,813	31,840	200	0	0	0	0	0	0	0	0	0	11
Insured 12	3	26,429	16,300	0	0	0	0	0	0	0	0	0	0	0
Insured 13	3	25,938	24,800	15	0	0	0	0	0	0	0	0	0	0
Insured 14	3	21,111	9,500	15	0	0	0	0	0	0	0	0	0	0
Insured 15	3	25,313	6,400	200	58	84	111	137	150	158	168	178	189	199
	Subtotal Tier 1		109,440	63,250										
	Subtotal Tier 2		87,045	4,600										
	Subtotal Tier 3		63,000	380										
	Subtotal Tier 4		23,225	20										
	Total		282,710	68,250	63,309	67,627	70,370	73,892	77,830	82,360	86,982	91,386	95,827	100,259
	% of Ultimate				45.36%	48.45%	50.41%	52.94%	55.76%	59.00%	62.32%	65.47%	68.65%	71.83%

Sample Insureds	Tier	Projected losses and expenses from all policies with insured in calendar year: 2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Ultimate	Ultimate as % of Exposure	Case Inc'd Loss Devel. Factor
Insured 1	4	0	0	0	0	0	0	0	0	0	0	0	0.0%	0.000
Insured 2	4	119	128	136	144	152	159	167	174	181	188	195	1.0%	9.770
Insured 3	2	1,000	1,323	1,715	2,095	2,461	2,968	3,546	4,085	4,580	5,026	12,391	72.9%	5.387
Insured 4	1	36,633	38,318	39,961	41,554	42,774	43,683	43,975	44,182	44,182	44,182	44,182	114.8%	2.055
Insured 5	1	26,752	27,608	28,443	29,252	29,769	30,068	30,344	30,344	30,344	30,344	30,344	100.2%	1.572
Insured 6	1	37,607	39,058	40,472	41,843	42,948	43,754	44,312	44,812	45,307	45,548	45,548	112.0%	2.029
Insured 7	2	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,502	1,552	1,601	11.8%	1.067
Insured 8	2	300	300	300	300	300	300	300	300	300	300	1,848	12.9%	6.161
Insured 9	2	300	300	300	300	300	300	300	300	300	300	1,403	13.7%	4.678
Insured 10	3	180	182	184	186	188	190	192	193	195	197	751	12.5%	5.004
Insured 11	2	56	100	143	184	224	263	300	300	300	300	300	0.9%	1.500
Insured 12	3	0	0	0	0	0	0	0	0	0	0	0	0.0%	0.000
Insured 13	3	0	0	0	0	0	0	0	0	0	0	200	0.8%	13.333
Insured 14	3	0	0	0	0	0	0	0	0	0	0	200	2.1%	13.333
Insured 15	3	209	219	228	237	246	254	262	271	282	313	618	9.7%	3.092
	Subtotal Tier 1											120,074	109.7%	1.898
	Subtotal Tier 2											17,543	20.2%	3.814
	Subtotal Tier 3											1,769	2.8%	4.655
	Subtotal Tier 4											195	0.8%	9.578
	Total	104,655	109,035	113,383	117,596	120,862	123,438	125,197	126,460	127,474	128,250	139,581	49.4%	2.045
	% of Ultimate	74.98%	78.12%	81.23%	84.25%	86.59%	88.43%	89.69%	90.60%	91.33%	91.88%	100.00%		

Notes: – This exhibit is a compilation of Exhibit 8.3 for each insured in the sample group.
– Average ground-up attachment point and total exposure from insured policy information are given.
– ABC Re's reported loss & expense from ABC Re's claim files are given. The amount could be lower than implied by model because of reporting lags to ABC Re or higher because of additional reserves.

Asbestos BI Model for ABC Re's Sample Group

Indemnity and Expenses with ABC Re's Layer of Coverage for All Sample Insureds , Annual Inflation = 0.0% / Coverage Block = 25 Years

($000's)

Exhibit 10.4

Sample Insureds	Tier	Average Ground-Up Attachment Pt	Total Exposure	ABC Re's Reported Loss & Exp	Projected losses and expenses from all policies with insured in calendar year: 1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Insured 1	4	37,500	3,363	0	0	0	0	0	0	0	0	0	0	0
Insured 2	4	20,757	19,863	20	39	45	50	55	61	65	70	75	80	85
Insured 3	*2*	*2,943*	*17,000*	*2,300*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*8*	*110*	*206*
Insured 4	1	48,750	38,460	21,500	20,868	21,744	22,567	23,512	24,662	25,732	26,726	27,796	28,861	29,903
Insured 5	1	50,357	30,280	19,300	19,395	20,344	20,344	20,369	20,807	21,215	21,677	22,261	22,812	23,331
Insured 6	1	48,333	40,680	22,450	22,149	24,201	25,732	26,262	27,077	27,953	29,012	30,001	30,835	31,814
Insured 7	*2*	*37,813*	*13,581*	*1,500*	*0*	*0*	*173*	*442*	*692*	*925*	*1,142*	*1,342*	*1,500*	*1,500*
Insured 8	2	40,000	14,290	300	0	42	102	158	210	259	300	300	300	300
Insured 9	2	40,313	10,233	300	41	107	170	228	283	300	300	300	300	300
Insured 10	3	17,143	6,000	150	30	65	97	128	156	166	168	169	170	171
Insured 11	*2*	*37,813*	*31,940*	*200*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
Insured 12	3	26,429	16,300	0	0	0	0	0	0	0	0	0	0	0
Insured 13	3	25,938	24,800	15	0	0	0	0	0	0	0	0	0	0
Insured 14	3	21,111	9,500	15	0	0	0	0	0	0	0	0	0	0
Insured 15	*3*	*25,313*	*6,400*	*200*	*54*	*77*	*99*	*119*	*139*	*149*	*154*	*159*	*165*	*171*
	Subtotal Tier 1		109,440	63,250										
	Subtotal Tier 2		87,045	4,600										
	Subtotal Tier 3		63,000	380										
	Subtotal Tier 4		23,225	20										
	Total		282,710	68,250	62,577	66,625	69,334	71,273	74,086	76,764	79,547	82,409	85,253	87,782
	% of Ultimate				51.44%	54.77%	57.00%	58.59%	60.91%	63.11%	65.39%	67.75%	70.09%	72.16%

Sample Insureds	Tier	Projected losses and expenses from all policies with insured in calendar year: 2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Ultimate	Ultimate as % of Exposure	Case Inc'd Loss Devel. Factor
Insured 1	4	0	0	0	0	0	0	0	0	0	0	0	0.0%	0.000
Insured 2	4	90	95	99	103	107	110	113	116	119	122	124	0.6%	6.206
Insured 3	2	296	433	563	683	793	893	983	1,063	1,133	1,229	2,321	13.7%	1.009
Insured 4	1	30,860	31,754	32,584	33,350	34,052	34,691	35,297	35,872	36,414	36,925	43,240	112.4%	2.011
Insured 5	1	23,818	24,272	24,694	25,083	25,440	25,764	26,073	26,365	26,640	26,900	29,904	98.8%	1.549
Insured 6	1	32,638	33,408	34,122	34,781	35,386	35,935	36,457	36,952	37,419	37,858	43,315	106.5%	1.929
Insured 7	2	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	1,500	11.0%	1.000
Insured 8	2	300	300	300	300	300	300	300	300	300	300	300	2.1%	1.000
Insured 9	2	300	300	300	300	300	300	300	300	300	300	300	2.9%	1.000
Insured 10	3	173	174	175	176	177	178	178	179	180	180	181	3.0%	1.207
Insured 11	2	0	0	0	0	0	5	21	36	50	64	242	0.8%	1.209
Insured 12	3	0	0	0	0	0	0	0	0	0	0	0	0.0%	0.000
Insured 13	3	0	0	0	0	0	0	0	0	0	0	0	0.0%	0.000
Insured 14	3	0	0	0	0	0	0	0	0	0	0	0	0.0%	0.000
Insured 15	3	177	182	187	191	195	199	202	206	209	212	215	3.4%	1.073
	Subtotal Tier 1											116,459	106.4%	1.841
	Subtotal Tier 2											4,663	5.4%	1.014
	Subtotal Tier 3											396	0.6%	1.041
	Subtotal Tier 4											124	0.5%	6.085
	Total	90,152	92,417	94,523	96,468	98,250	99,875	101,425	102,888	104,264	105,590	121,842	43.0%	1.762
	% of Ultimate	74.11%	75.97%	77.71%	79.30%	80.77%	82.11%	83.38%	84.58%	85.71%	86.80%	100.00%		

Notes: – This exhibit is a compilation of Exhibit 6.4 for each insured in the sample group.
– Average ground-up attachment point and total exposure from insured policy information are given.
– ABC Re's reported loss & expense from ABC Re's claim files are given. The amount could be lower than implied by model because of reporting lags to ABC Re or higher because of additional reserves.

Asbestos BI Model for ABC Re's Sample Group Exhibit 11
Calculation of Range of Estimates of ABC Re's Liabilities for the Sample Group
($000's)

Estimated Ultimate Loss & Expense for Sample Group of ABC Re's policies			
Inflation=5.0% 15 yr Cov Blck Baseline Scenario (1)	Inflation=0.0% 15 yr Cov Blck Scenario (2)	Inflation=5.0% 25 yr Cov Blck Scenario (3)	Inflation=0.0% 25 yr Cov Blck Scenario (4)
$173,044	$149,174	$139,581	$121,642

(5) Selected Low End of Range	$130,612
(6) Selected High End of Range	$161,109
(7) Selected Best Estimate	$153,485

Notes:
(1) From Exhibit 10.1.
(2) From Exhibit 10.2.
(3) From Exhibit 10.3.
(4) From Exhibit 10.4.
(5) Average of Columns (3) and (4).
(6) Average of Columns (1) and (2).
(7) Weighted average of Items (5) and (6). The weights are 25% and 75% respectively.
The weights were selected based on likelihood of each scenario.

Asbestos BI Model for ABC Re's Insured 3 Exhibit 12.1

Insured 3's Losses in $5M XS $5M Layer, Indemnity and Expenses, Annual Inflation = 5.0% / Coverage Block = 15 Years

($000's)

Policy Year	Width/Attch Pt/ % Share / Expenses ($ in millions)	Calendar Year 1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1960	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1961	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1962	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1963	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1964	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1965	5 / 5 / 100% / Pro Rata	0	0	0	0	0	0	0	0	0	0
1966	5 / 5 / 100% / Pro Rata	0	0	0	0	0	0	0	0	0	0
1967	5 / 5 / 100% / Included in Limit	0	0	0	0	0	0	0	0	183	444
1968	5 / 5 / 100% / Pro Rata	0	0	0	0	0	0	0	0	0	0
1969	5 / 5 / 100% / Included in Limit	0	0	0	0	0	0	0	0	183	444
1970	5 / 5 / 100% / Pro Rata	0	0	0	0	0	0	0	0	0	0
1971	5 / 5 / 100% / Indem Only	0	0	0	0	0	0	0	0	0	0
1972	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1973	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1974	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1975 – 84	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
Total		0	0	0	0	0	0	0	0	366	888

Policy Year	Width/Attch Pt/ % Share / Expenses ($ in millions)	Calendar Year 2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Ultimate
1960	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1961	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1962	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1963	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1964	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1965	5 / 5 / 100% / Pro Rata	0	0	0	0	0	0	0	0	0	116	2,913
1966	5 / 5 / 100% / Pro Rata	0	0	0	0	0	0	0	0	0	116	2,913
1967	5 / 5 / 100% / Included in Limit	700	952	1,197	1,435	1,663	1,882	2,088	2,280	2,457	2,616	5,000
1968	5 / 5 / 100% / Pro Rata	0	0	0	0	0	0	0	0	0	116	2,913
1969	5 / 5 / 100% / Included in Limit	700	952	1,197	1,435	1,663	1,882	2,088	2,280	2,457	2,616	5,000
1970	5 / 5 / 100% / Pro Rata	0	0	0	0	0	0	0	0	0	116	2,913
1971	5 / 5 / 100% / Indem Only	0	0	0	0	0	0	0	0	0	78	1,942
1972	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1973	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1974	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1975 – 84	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
Total		1,401	1,904	2,394	2,869	3,326	3,763	4,176	4,561	4,914	5,776	23,595

Notes:
- $5M XS $5M layer for all policies. Only policies in Insured 3's coverage block for this scenario, 1960 through 1974, are included.
- Losses in layer are calculated by using $5M XS $5M to carve out losses and expenses from Exhibits 5.1, 6.1, and 7.1.
- Expenses are added to indemnity before applying attachment point and limits for expenses included in limits policies. (Policy Years 1967 and 1969).
  When all lower layer policies are indemnity only or pro rata, this would not be true. In this case, indemnity only should be used to determine if the attachment point is reached.
  In the real world the true answer is somewhere between adding expenses to indemnity or just indemnity in determining satisfaction of the attachment point.
  Both scenarios should be examined.
- Ultimate value is calculated by continuation of patterns beyond months shown.

Asbestos BI Model for ABC Re's Insured 3 Exhibit 12.2

Insured 3's Losses in $5M XS $5M Layer, Indemnity and Expenses, Annual Inflation = 0.0% / Coverage Block = 15 Years

($000's)

Policy Year	Width/Attch Pt/ % Share / Expenses ($ in millions)	Calendar Year 1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1960	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1961	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1962	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1963	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1964	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1965	5 / 5 / 100% / Pro Rata	0	0	0	0	0	0	0	0	0	0
1966	5 / 5 / 100% / Pro Rata	0	0	0	0	0	0	0	0	0	0
1967	5 / 5 / 100% / Included in Limit	0	0	0	0	0	0	0	0	0	0
1968	5 / 5 / 100% / Pro Rata	0	0	0	0	0	0	0	0	0	0
1969	5 / 5 / 100% / Included in Limit	0	0	0	0	0	0	0	0	0	0
1970	5 / 5 / 100% / Pro Rata	0	0	0	0	0	0	0	0	0	0
1971	5 / 5 / 100% / Indem Only	0	0	0	0	0	0	0	0	0	0
1972	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1973	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1974	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1975–84	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
Total		0	0	0	0	0	0	0	0	0	0

Policy Year	Width/Attch Pt/ % Share / Expenses ($ in millions)	Calendar Year 2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Ultimate
1960	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1961	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1962	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1963	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1964	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1965	5 / 5 / 100% / Pro Rata	0	0	0	0	0	0	0	0	0	0	0
1966	5 / 5 / 100% / Pro Rata	0	0	0	0	0	0	0	0	0	0	0
1967	5 / 5 / 100% / Included in Limit	0	133	263	383	493	593	683	763	833	893	1,576
1968	5 / 5 / 100% / Pro Rata	0	0	0	0	0	0	0	0	0	0	0
1969	5 / 5 / 100% / Included in Limit	0	133	263	383	493	593	683	763	833	893	1,576
1970	5 / 5 / 100% / Pro Rata	0	0	0	0	0	0	0	0	0	0	0
1971	5 / 5 / 100% / Indem Only	0	0	0	0	0	0	0	0	0	0	0
1972	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1973	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1974	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1975–84	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
Total		0	266	526	766	986	1,186	1,366	1,526	1,666	1,786	3,151

Notes:
- $5M XS $5M layer for all policies. Only policies in Insured 3's coverage block for this scenario, 1960 through 1974, are included.
- Losses in layer are calculated by using $5M XS $5M to carve out losses and expenses from Exhibits 5.2, 6.2, and 7.2.
- Expenses are added to indemnity before applying attachment point and limits for expenses included in limits policies. (Policy Years 1967 and 1969). When all lower layer policies are indemnity only or pro rata, this would not be true. In this case, indemnity only should be used to determine if the attachment point is reached. In the real world the true answer is somewhere between adding expenses to indemnity or just indemnity in determining satisfaction of the attachment point. Both scenarios should be examined.
- Ultimate value is calculated by continuation of patterns beyond months shown.

Asbestos BI Model for ABC Re's Insured 3 Exhibit 12.3

Insured 3's Losses in $5M XS $5M Layer, Indemnity and Expenses, Annual Inflation = 5.0% / Coverage Block = 25 Years

($000's)

Policy Year	Width/Attch Pt/ % Share / Expenses ($ in millions)	Calendar Year 1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1960	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1961	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1962	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1963	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1964	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1965	5 / 5 / 100% / Pro Rata	0	0	0	0	0	0	0	0	0	0
1966	5 / 5 / 100% / Pro Rata	0	0	0	0	0	0	0	0	0	0
1967	5 / 5 / 100% / Included in Limit	0	0	0	0	0	0	0	0	0	0
1968	5 / 5 / 100% / Pro Rata	0	0	0	0	0	0	0	0	0	0
1969	5 / 5 / 100% / Included in Limit	0	0	0	0	0	0	0	0	0	0
1970	5 / 5 / 100% / Pro Rata	0	0	0	0	0	0	0	0	0	0
1971	5 / 5 / 100% / Indem Only	0	0	0	0	0	0	0	0	0	0
1972	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1973	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1974	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1975~84	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
Total		0	0	0	0	0	0	0	0	0	0

Policy Year	Width/Attch Pt/ % Share / Expenses ($ in millions)	Calendar Year 2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Ultimate
1960	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1961	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1962	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1963	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1964	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1965	5 / 5 / 100% / Pro Rata	0	0	0	0	0	0	0	0	0	0	0
1966	5 / 5 / 100% / Pro Rata	0	0	0	0	0	0	0	0	0	0	0
1967	5 / 5 / 100% / Included in Limit	0	0	0	0	0	0	0	0	0	0	1,248
1968	5 / 5 / 100% / Pro Rata	0	0	0	0	0	0	0	0	0	0	0
1969	5 / 5 / 100% / Included in Limit	0	0	0	0	0	0	0	0	0	0	1,248
1970	5 / 5 / 100% / Pro Rata	0	0	0	0	0	0	0	0	0	0	0
1971	5 / 5 / 100% / Indem Only	0	0	0	0	0	0	0	0	0	0	0
1972	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1973	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1974	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1975~84	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
Total		0	0	0	0	0	0	0	0	0	0	2,496

Notes:
- $5M XS $5M layer for all policies. Only policies in Insured 3's coverage block for this scenario, 1960 through 1984, are included.
- Losses in layer are calculated by using $5M XS $5M to carve out losses and expenses from Exhibits 5.3, 6.3, and 7.3.
- Expenses are added to indemnity before applying attachment point and limits for expenses included in limits policies. (Policy Years 1967 and 1969).
  When all lower layer policies are indemnity only or pro rata, this would not be true. In this case, indemnity only should be used to determine if the attachment point is reached.
  In the real world the true answer is somewhere between adding expenses to indemnity or just indemnity in determining satisfaction of the attachment point.
  Both scenarios should be examined.
- Ultimate value is calculated by continuation of patterns beyond months shown.

Asbestos BI Model for ABC Re's Insured 3 Exhibit 12.4

Insured 3's Losses in $5M XS $5M Layer, Indemnity and Expenses, Annual Inflation = 0.0% / Coverage Block = 25 Years

($000's)

Policy Year	Width/Attch Pt/ % Share / Expenses ($ in millions)	Calendar Year 1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
1960	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1961	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1962	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1963	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1964	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1965	5 / 5 / 100% / Pro Rata	0	0	0	0	0	0	0	0	0	0
1966	5 / 5 / 100% / Pro Rata	0	0	0	0	0	0	0	0	0	0
1967	5 / 5 / 100% / Included in Limit	0	0	0	0	0	0	0	0	0	0
1968	5 / 5 / 100% / Pro Rata	0	0	0	0	0	0	0	0	0	0
1969	5 / 5 / 100% / Included in Limit	0	0	0	0	0	0	0	0	0	0
1970	5 / 5 / 100% / Pro Rata	0	0	0	0	0	0	0	0	0	0
1971	5 / 5 / 100% / Indem Only	0	0	0	0	0	0	0	0	0	0
1972	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1973	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1974	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
1975-84	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0
Total		0	0	0	0	0	0	0	0	0	0

Policy Year	Width/Attch Pt/ % Share / Expenses ($ in millions)	Calendar Year 2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Ultimate
1960	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1961	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1962	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1963	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1964	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1965	5 / 5 / 100% / Pro Rata	0	0	0	0	0	0	0	0	0	0	0
1966	5 / 5 / 100% / Pro Rata	0	0	0	0	0	0	0	0	0	0	0
1967	5 / 5 / 100% / Included in Limit	0	0	0	0	0	0	0	0	0	0	0
1968	5 / 5 / 100% / Pro Rata	0	0	0	0	0	0	0	0	0	0	0
1969	5 / 5 / 100% / Included in Limit	0	0	0	0	0	0	0	0	0	0	0
1970	5 / 5 / 100% / Pro Rata	0	0	0	0	0	0	0	0	0	0	0
1971	5 / 5 / 100% / Indem Only	0	0	0	0	0	0	0	0	0	0	0
1972	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1973	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1974	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
1975-84	No ABC Re Policy	0	0	0	0	0	0	0	0	0	0	0
Total		0	0	0	0	0	0	0	0	0	0	0

Notes: – $5M XS $5M layer for all policies. Only policies in Insured 3's coverage block for this scenario, 1960 through 1984, are included.
- Losses in layer are calculated by using $5M XS $5M to carve out losses and expenses from Exhibits 5.4, 6.4, and 7.4.
- Expenses are added to indemnity before applying attachment point and limits for expenses included in limits policies. (Policy Years 1967 and 1969).
  When all lower layer policies are indemnity only or pro rata, this would not be true. In this case, indemnity only should be used to determine if the attachment point is reached.
  In the real world the true answer is somewhere between adding expenses to indemnity or just indemnity in determining satisfaction of the attachment point.
  Both scenarios should be examined.
- Ultimate value is calculated by continuation of patterns beyond months shown.

Extrapolation Method 1 using ABC Re's Sample Group
Calclation of Percent of Exposure Eroded by Layer by Tier

Exhibit 13

Example Calculation of Matrix Box for Tier 2, $5M XS $5M

Name	Tier	Exposure Assuming each Policy $5M XS $5 M	Projected Ultimate Loss and Expense from BI Model in the Layer Assuming each ABC Re Policy is $5M XS $5M: 5 % Infltn 15 Yr Spread Scenario	0 % Infltn 15 Yr Spread Scenario	Average of 15 Yr Spread Scenarios	5 % Infltn 25 Yr Spread Scenario	0 % Infltn 25 Yr Spread Scenario	Average of 25 Yr Spread Scenarios	Wtd 75% 15 Yr Wtd 25% 25 Yr Average	Percent of $5M XS $5M Layer Eroded
Insured Co 3	2	35.0	23.6	3.2	13.4	2.5	0.0	1.3	10.4	30%
Insured Co 7	2	40.0	33.6	7.8	20.7	6.0	0.0	3.0	16.3	41%
Insured Co 8	2	40.0	37.9	10.9	24.4	8.5	0.0	4.3	19.4	48%
Insured Co 9	2	40.0	35.7	9.4	22.6	7.2	0.0	3.6	17.8	45%
Insured Co 11	2	40.0	35.7	9.4	22.6	7.2	0.0	3.6	17.8	45%
		195.0	166.5	40.7	103.6	31.4	0.0	15.7	81.6	42%

Selected Percent of Layer Eroded

Tier	Layer .5M xs 0	.5M xs .5M	4M xs 1M	5M xs 5M	15M xs 10M	25M xs 25M	50M xs 50M
1							
2				42%			
3							
4							

Notes:
- The exposure for an insured here is the number of policies with the insured times the $5M layer.
- *Ultimate loss and expense from Exhibit 12 for each Tier 2 insured in the sample group.*
- Average ultimate loss and expense judgmentally selected based upon weighted average of four scenarios.

Extrapolation Method 2 using ABC Re's Sample Group
Calculation of Case Incurred Loss Development Factors

Exhibit 14

Tier	Case Incurred Loss and Expense Development Factor by Tier for: 5 % Infltn 15 Yr Spread Scenario	0 % Infltn 15 Yr Spread Scenario	5 % Infltn 25 Yr Spread Scenario	0 % Infltn 25 Yr Spread Scenario
Tier 1	1.959	1.958	1.898	1.841
Tier 2	8.909	4.975	3.814	1.014
Tier 3	20.372	5.595	4.655	1.041
Tier 4	20.127	14.739	9.578	6.085

Tier	Case Incurred Loss and Expense Percent Reported by Tier for: 5 % Infltn 15 Yr Spread Scenario	0 % Infltn 15 Yr Spread Scenario	Average of 15 Yr Spread Scenarios	5 % Infltn 25 Yr Spread Scenario	0 % Infltn 25 Yr Spread Scenario	Average of 25 Yr Spread Scenarios	Wtd 75% 15 Yr Wtd 25% 25 Yr Average % Reported by Tier	Selected Development Factor by Tier
Tier 1	51.05%	51.07%	51.06%	52.69%	54.32%	53.50%	51.67%	1.935
Tier 2	11.22%	20.10%	15.66%	26.22%	98.62%	62.42%	27.35%	3.656
Tier 3	4.91%	17.87%	11.39%	21.48%	96.06%	58.77%	23.24%	4.304
Tier 4	4.97%	6.78%	5.88%	10.44%	16.43%	13.44%	7.77%	12.875

Notes:
- Development factors from Exhibit 10.
- Percent reported equals reciprocal of appropriate development factor.
- Weighted average of percent reported for the four scenarios judgmentally selected.
- Selected development factor equals reciprocal of weighted average percent reported.

Extrapolation Method 3 using ABC Re's Sample Group
Calculation of Percent of Exposure Exhausted by Tier

Exhibit 15

	Ultimate Loss & Expense as a Percent of Exposure for						Wtd 75% 15 Yr Wtd 25% 25 Yr
Tier	5 % Infltn 15 Yr Spread Scenario	0 % Infltn 15 Yr Spread Scenario	Average of 15 Yr Spread Scenarios	5 % Infltn 25 Yr Spread Scenario	0 % Infltn 25 Yr Spread Scenario	Average of 25 Yr Spread Scenarios	Average Percent of Exposure Exhausted by Tier
Tier 1	113.2%	113.2%	113.2%	109.7%	106.4%	108.1%	111.9%
Tier 2	47.1%	26.3%	36.7%	20.2%	5.4%	12.8%	30.7%
Tier 3	12.3%	3.4%	7.9%	2.8%	0.6%	1.7%	6.3%
Tier 4	1.8%	1.3%	1.6%	0.8%	0.5%	0.7%	1.3%

Notes:
- Percent of exposure factors from Exhibit 10.
- Weighted average of four scenarios judgmentally selected.
- Some percent of exposure factors bigger than 100% because of policies with pro rata expense treatment.

Extrapolation Method 4 using ABC Re's Sample Group
Calculation of Average Ultimate Loss and Expense by Tier
($ in 000's)

Exhibit 16

	Ultimate Loss & Expense by Scenario by Tier				
Tier	5 % Inflttn 15 Yr Spread Scenario	0 % Inflttn 15 Yr Spread Scenario	5 % Inflttn 25 Yr Spread Scenario	0 % Inflttn 25 Yr Spread Scenario	Number of Sample Group Insureds by Tier
Tier 1	123,911	123,862	120,074	116,459	3
Tier 2	40,981	22,885	17,543	4,663	5
Tier 3	7,741	2,126	1,769	396	5
Tier 4	411	301	195	124	2

	Average Ultimate Loss & Expense by Scenario by Tier						
Tier	5 % Inflttn 15 Yr Spread Scenario	0 % Inflttn 15 Yr Spread Scenario	Average of 15 Yr Spread Scenarios	5 % Inflttn 25 Yr Spread Scenario	0 % Inflttn 25 Yr Spread Scenario	Average of 25 Yr Spread Scenarios	Wtd 75% 15 Yr Wtd 25% 25 Yr Average Ultimate Loss & Expense
Tier 1	41,304	41,287	41,296	40,025	38,820	39,422	40,827
Tier 2	8,196	4,577	6,387	3,509	933	2,221	5,345
Tier 3	1,548	425	987	354	79	217	794
Tier 4	206	151	178	98	62	80	153

Notes:
- Ultimate loss and expense from Exhibit 10.
- Number of sample group insureds by Tier from Exhibit 10.
- Weighted average of four scenarios judgmentally selected.

Forecasting Mass Action Losses Using a Hybrid Development Model

by Roger Hayne

FORECASTING MASS ACTION LOSSES USING A HYBRID DEVELOPMENT MODEL

by Roger M. Hayne

Abstract

Mass action losses often emerge differently than other losses for a line of business. Using asbestos as an example, general liability development began to show some unexpected late development in the late 1970's and early 1980's. After some investigation it was concluded that much of this development could be attributed to asbestos related claims. In addition these claims did not seem to exhibit the dependence on accident year age that other general liability losses usually experience. Thus, it could be concluded that normal development methods may not be appropriate for forecasting such losses.

One alternative that has been considered is to assume that future emergence of asbestos losses will depend not on the age of the particular accident year, but on the valuation year of the particular losses. This assumes future development of all losses would be the same, independent of the accident year. In this paper we will propose an alternative, hybrid, of these two models (pure accident year and pure calendar year). In the hybrid model we will allow the data to dictate what mix of the two models best fits the experience emerged to date. The method itself is not very difficult to implement in practice. Given numerical solution methods available in current personal computer spreadsheet software, PC solutions can be generated in a very short amount of time.

We discuss the concept and support the discussion with examples applied to some real-but-disguised data. We then explore an approach that to apply what is learned from this asbestos example to other situations with example hazardous waste data as an example. The concepts could apply to other mass action types of exposure and provide a separate, independent, test of results implied by other forecast methods.

Biography

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FORECASTING MASS ACTION LOSSES USING A HYBRID DEVELOPMENT MODEL

1. Introduction

Mass action losses, such as those arising from asbestos, DES, or hazardous waste exposure, often emerge differently than other losses for a line of business, and may affect usual actuarial projection methods for that coverage. Insurer experience with these various sources of claims are not all at the same stage of maturity. The industry has been dealing with asbestos related claims for some time, whereas claims from hazardous waste sites, DES, or potentially silicone implants, are not quite as mature. The emergence of asbestos claims may provide some insight into the potential future emergence for other claims from other sources.

For example, general liability development began to show some unexpected late development in the late 1970's and early 1980's. After some investigation, insurers began to conclude that much of this development could be attributed to asbestos related claims. When such unusual events affect development patterns, it is not unusual for the actuary to consider such claims separately when analyzing the experience for reserves. First attempts to deal with such losses may have been to separate asbestos losses from other claims and develop them separately, possibly using development from some other, longer tail, business.

However, the asbestos claims did not seem to exhibit the dependence on accident year age that other general liability losses usually experience. Rather, it seemed that asbestos claims emerged for most accident years, whether relatively old or relatively new, at pretty much the same time. For example, the percentage increase in asbestos related claims coded to 1968 accidents during 1982, might have looked very similar to that for asbestos related claims coded to 1975 accidents during that same year.

There are many characteristics of these claims that could help explain this. One problem is in identifying the "accident date" for a particular claim. Claimants may have been exposed over a span of years, with asbestos related injury not manifesting itself for many more years. Compounded with this are various court decisions regarding coverage triggers and indicating which policies are to respond to what losses. Thus, there may be practical questions as to which accident year or years the losses for a particular claim should be assigned.

Technical elements were not the only influence. With the emergence of asbestos related claims came increased notoriety of the hazards of asbestos exposure, and the likelihood that compensation may be available for injured claimants. Thus, claims may have been reported more because of this notoriety than, because of the time lag from the accident.

Still another complication arises from additional "waves" of asbestos related losses. For example, losses related to asbestos abatement, or containment, have been emerging recently. There are also recent reports of claims being advanced against owners', landlords' and tenants' policies, and liability policies for coverage other than products liability, which were thought to be relatively free of asbestos risk.

Thus, it could be concluded that normal development methods may not be appropriate for forecasting such losses. Compounding this difficulty in the past has been the relative scarcity of data available. Thus actuaries, as in many similar situations, have constructed models of the underlying exposure, latency period, emergence and costs of asbestos claims to estimate reserves for carriers. These models are often very sophisticated and may incorporate both the potential exposure of all workers and an insurer's exposure based on its insureds over time.

One particularly difficult aspect of such models, however, is incorporating them with losses that are emerging to the insurer. Often the insurer's own data base may be too large to ignore and may be exhibiting loss emergence different from what would be predicted by these models. Thus, some alternative may need to be found to incorporate the insurer's experience. This leads us to consider alternative models that incorporate the insurer's own development experience.

One alternative to the traditional accident period loss development method that has been considered is to assume that future emergence of asbestos losses will depend on the valuation year of the particular losses, rather than on the age of the particular accident year. This assumes that the future rate of development of all losses would be the same, independent of the accident year. This assumption potentially ignores latency periods inherent in asbestos claims.

Of course, aggregating all claims of a particular age loses the advantage of the traditional accident year development method of being able to "learn" from the emergence of older accident years. With this approach there is but one "accident" year, composed of all claims. Several alternatives have been advanced to deal with this problem. One is to assume a particular loss runoff curve and fit it to the data. Another is to assume that asbestos claims are somewhat similar to general liability claims, or to some other group of claims with more or less well known emergence characteristics. One could then assume that future asbestos emergence would be similar to the emergence of an appropriately mature accident year for the selected coverage.

There may be some attractiveness to this approach. It could be argued that now the legal climate for asbestos claims may be much more settled and may actually be similar to that for other liability claims. Hence, the argument would proceed, that one could expect future movement of these total asbestos claims that have been known for, say, five years, to be similar to future movement of a five-year-old accident year of liability claims.

In this paper we will propose an alternative, hybrid, of these two development models (pure accident year and pure calendar or valuation year). In the hybrid model, we will allow the data to dictate what mix of the two models best fits the experience emerged to date. The method itself is not very difficult to implement in practice. Given numerical solution methods available in current personal computer spreadsheet software, PC solutions can be generated in a very short amount of time.

Stepping back for a moment, we note that the above discussion indicates that asbestos claims experience has passed through several stages:

1. General liability losses started to experience some late development, though the losses were not separately analyzed.

2. Unusual development continued with the cause identified as asbestos claims, those claims removed from general liability data and developed separately, possibly using some other, longer tail, development.

3. Exposure based models were developed to estimate asbestos losses, often from an all-industry or individual insured basis. These models often required significant amounts of exposure and claims data and are based on the underlying asbestos exposure, health effects, and assumptions regarding costs.

4. Insurers have developed more experience in dealing with asbestos claims, and the legal environment is more certain than in the early stages of asbestos litigation. Insurers are collecting separate asbestos loss data and there may be differences between actual emerged experience and that expected by exposure models.

5. There may be sufficient data to consider emergence models based on those data. These models could be used to augment exposure based model estimates.

It may not be unreasonable to expect that other mass action claims would follow a similar life cycle. If this is the case, we could draw from what we have learned from asbestos movement, to obtain a better understanding of the future development potential for other mass action claims. For example, it appears that hazardous waste claims are in the third stage above, but there is claim experience emerging. Other loss causes, such as DES, or silicone implants are, of course, at other stages of maturity. It is possible, however, to consider the models used to analyze asbestos emergence, to gain additional insight into future emergence for these other loss causes. Rather than proposing these alternatives as replacement for other methods, we believe that they can be used as separate, independent, tests of results implied by other forecast methods.

In the remainder of this paper, we will first discuss the use of development from other coverages as a model of future asbestos experience. At this point we will introduce a hybrid of pure calendar year and pure accident year models. We will then discuss fitting this hybrid model to asbestos loss data, rather than depending on the emergence from other sources. Finally, we will present an example of using this fitted asbestos emergence pattern to estimate future hazardous waste losses.

2. *Notation and Definitions*

We will denote by X_{ij} cumulative losses for accident year i at j years of development and by D_{ij} the development factor for accident year i from year j to year j+1, i.e. $D_{ij} = X_{ij+1}/X_{ij}$. The traditional accident year development model selects factors $d_1, d_2, \ldots, d_\infty$, with the forecast for a particular accident year at age j:

(2.1)
$$X_{i\infty} = X_{ij}\prod_{k=j}^{\infty} d_k = X_{ij}\,f(j)$$

In the traditional methods, the factors $d_1, d_2, \ldots, d_\infty$ are usually selected using the historical factors D_{ij}, with d_j usually selected considering historical factors at age j; D_{ij}.

Implicit in this method is the assumption that the development of losses for each accident year is dependent only on the age of that accident year. So, under these assumptions, the movement of older accident years at a particular age is indicative of movement to be expected for more recent years at that same age. In the usual development triangle format, this assumes that, except for random fluctuations, development factors at a give age are constant.

As discussed in the first section (*Introduction*) above, there are many characteristics of asbestos, hazardous waste, and other mass action losses, that may violate this implicit assumption. Thus we search for alternatives.

One such alternative assumes that the accident date assigned to a claim is not particularly relevant to its potential for future development, but rather, it is the valuation date that determines future development. Under this alternative, all claims will experience the same future development. In the case of asbestos and hazardous waste, there may be some attraction to this model. In both cases, the date of the occurrence may have less of an influence on future development than for most other claims. If we were to accept this assumption, we would then model future development, by assuming that all losses are at the same age. In this case for accident year i, currently at age j, the forecast becomes:

(2.2)
$$X_{i\infty} = X_{ij}\prod_{k=j+i}^{\infty} d_k = X_{ij}f(j+i)$$

In the usual development triangle, the quantity $i+j$ is constant along the diagonal with $i+j=n+1$, where n is the number of columns (assuming annual development of annual data). In this case, the estimates of the development factors d_k might not follow the traditional approach, but are similar to the problem of estimating a factor to account for development beyond that available in historical data. Such factors are often dubbed "tail" factors.

Neither set of assumptions, however, appear to be completely satisfied. On the one hand, we would probably not expect the future development on accident year 1975 asbestos claims after 1994, to be the same as the development of accident year 1965 asbestos claims after 1984. If this is the case, the pure accident year method may not be appropriate. On the other hand, we may expect that there is more development potential after 1994 for accident year 1985 asbestos claims, than for 1965 claims. If this is case, the pure calendar year method may not be appropriate.

Reviewing formulae (2.1) and (2.2), we note that they can be thought of as two extremes of the more general model:

(2.3)
$$X_{i\infty} = X_{ij}f(j+\alpha i),\ 0 \le \alpha \le 1$$

The pure accident year model results from the case $\alpha = 0$ and the pure valuation year model results from the case $\alpha = 1$. The factor estimates in this case are less clear, especially since, at least theoretically, we could require factors at non-integral ages. However, given f, the corresponding development factors can be calculated as:

(2.4)
$$d(j+\alpha i)=\frac{f(j+\alpha i)}{f(j+\alpha i+1)}$$

If α is between 0 and 1, the model will fall between the development implied by either the pure accident year or the pure valuation year model. In this case, later accident years will be considered as less mature than earlier accident years, but not at the normal one-for-one rate inherent in the pure accident year model.

For example, in the pure accident year model, the future development for accident year 1972 after 1996 would be the same as that for accident year 1970 after 1994. If α = 0.5 in the hybrid model, the future development for accident year 1972 after 1996 would be the same as that for accident year 1970 after 1995.

Hence, if α is between 0 and 1, implicit in this hybrid model is the assumption that each accident year is successively less mature than the prior year, but only by a fraction of a year. Similar to the pure accident year and pure valuation year models, we implicitly assume that, except for this difference in maturity, all accident years will develop the same.

If we assume that the underlying development model is hybrid, as opposed to purely accident year or purely valuation year, then estimating the development factors is not as readily apparent as in the usual development factor method. In the pure accident year case, actuaries often consider the factors for older accident years at a given stage of development, to estimate the development for later years. The hybrid model, however, loses this convenient means of estimation since, without prior assumptions regarding α, we do not know the differences in relative maturity between accident years.

For this reason, in the applications we will present, we will use smoothed development models and allow the data to provide an estimate of α, along with the other parameters of the smooth models. We again caution that this proposed approach is not a substitute for a thorough understanding of the exposures being reserved for. Rather, it is an attempt to provide another check on other methods, incorporating loss experience that has already emerged.

3. *Development Models*

Lacking sufficient development information, a first approximation actuaries often make is to use development for another, and possibly related, coverage or group of insurers writing similar business. Actuaries often consider the development from peer companies as available from such sources as A.M. Best Company, Inc., the Reinsurance Association of America, published financials or rate filing materials.

It could be argued that asbestos claims have been known for some time and that the legal basis for such claims is relatively well defined. It would follow that general liability development experience (excluding pollution, asbestos, and other mass action claims) may provide a reasonable basis for extrapolating future development. The first column of Exhibit 1 shows some sample general liability development.

These sample factors show some continued movement even far out in the tail. Thus we will not assume that the development is finished, but rather we will fit some sample development curves to smooth the factors and extrapolate future development. We acknowledge that there are a wide variety of models available, so for illustrative purposes, we have confined this discussion to three, fairly simple, models. We emphasize, however, that the methods we will present here are not restricted to these three simple models, but can be adapted to a wide range of assumed future development.

There have been several forms of future development mentioned in the literature. For example, Sherman [1] suggests the use of an inverse power function to model future development and also discusses an exponential variation of this curve among others, Weller [2] in his discussion of generalized Bondy development suggests an exponential decay model for development factors, and Zehnwirth [3] suggests the use of Hoerl curves to model loss runoff and in [4] suggests various regression models. In addition, we have found that a Weibull distribution often provides a reasonable model of loss runoff over time for certain coverages.

3.1. Exponential Development Model

In this model we assume that the development factor from age t to t+1 is given by:

(3.1.1) $$d^{(e)}(t) = 1 + ae^{-bt}$$

where a and b are constants. We usually require $b > 0$ to assure that the factors decay over time.

3.2. Inverse Power Curve Model

In this model we assume that the development factor from age t to age t+1 is given by:

(3.2.1) $$d^{(p)}(t) = 1 + at^{-b}$$

where a and b are constants. Again we require $b > 0$ to assure that the factors decay over time. It is clear that these two models are related, in fact, d(t) is inverse power, if and only if d(ln t) is exponential.

3.3. Weibull Model

In this case, we note that a Weibull distribution can be parameterized such that the cumulative density function can be written as:

$$F(t) = 1 - e^{-\left(\frac{t}{a}\right)^{b}} \tag{3.3.1}$$

If we then assume that the percentage of losses at time *t* equals F(*t*), then we obtain:

$$d^{(w)}(t) = \frac{1 - e^{-\left(\frac{t+1}{a}\right)^{b}}}{1 - e^{-\left(\frac{t}{a}\right)^{b}}} \tag{3.3.2}$$

Again, to assure convergence, we require that *a*>0. In addition, to assure that F(*t*) is increasing, we will require that *b*>0.

We will include example calculations with exponential, inverse power and exponential models. Again, we emphasize that these three models are selected here more for convenience, than due to any inherent limitation in the methods we will discuss. The same methods could be used for a wide range of smooth development models.

Exhibit 1 also shows fits of these three models to the sample development data shown in the first column. Rather than linearizing the exponential and power models, as is usually done, we selected parameters that directly minimized the total weighted square errors between the sample and fitted factors. For this we used numerical methods to minimize the appropriate error function. Since our primary interest will be in the "tail" development, we selected the square of the number of years of development as the weights in our fits, thereby giving more weight to fitting of the tail in the various distributions. Also shown in Exhibit 1 are the resulting residuals, the total of the residuals (or bias), and the weighted total square residuals for the three fits. From these fits we conclude that the inverse power curve provides the best fit of those sampled.

As an aside, the following table compares the results of fitting a power and an exponential to these factors, minimizing the simple sum of the squared residuals, sometimes called nonlinear regression, with the results of the "usual" linearized approach, i.e. applying linear regression to the natural logs of the development factors minus 1:

COMPARISON OF LINEARIZED AND NON-LINEAR REGRESSION FITS

	Linearized Fit		Nonlinear Fit	
	Power	Exponential	Power	Exponential
a	1.497	0.314	1.970	4.971
b	1.522	0.153	1.636	0.942
Total Error	0.646	2.041	-0.024	0.719
Square Error	0.245	3.084	0.006	0.067

We note that the nonlinear fit used in the above table gives equal weight to the square of each of the errors, which is the assumption of usual linear regression. Thus, the parameters and error terms do not agree with those shown in Exhibit 1.

3.4 Additional Notation

Our first approximation, then, will assume that future asbestos development patterns will be the same as general liability development, that is, we will use the curves from Exhibit 1 as the basic development model, but we will select the parameters based on actual emerged asbestos losses. Thus we will assume that $f(j+\alpha i)$ will have the form:

(3.4.1)

$$f(j+\alpha i) = d^{(m)}(\beta + j + \alpha i) \times d^{(m)}(\beta + j + \alpha i + 1) \times \ldots$$

$$= \prod_{k=\beta+j+\alpha i}^{\infty} d^{(m)}(k)$$

for some possibly negative value of the parameter β. Here β adjusts for any lag that may be inherent in the actual development experience, from that inherent in the un-lagged model. In this section we consider three of many possible representations for the function $d^{(m)}(k)$.

Of course, the actual model selected will significantly influence the ultimate loss projections for this method. This is no different than any other actuarial projection method. In practice we would select the development model that we would expect to most closely follow the expected future development. For example, if we found that general liability development patterns closely paralleled a power curve and we assumed that mass action losses would develop similar to general liability losses, then a power model would be the natural first choice for asbestos development. In addition, if we suspected additional complications in the mass action losses, for example additional "waves" of asbestos claims, we could modify the model accordingly. Thus the nature of the exposure, and the development inherent in the various models, should be considered in selecting the development model to use.

Exhibit 2 shows example asbestos loss development based roughly on some actual emerged experience. Although these are asbestos data, we note that these methods could also be applied to estimate development data for other mass action type of claims.

Though a bit of a digression at this point, Exhibit 3 shows the resulting development factors with selections corresponding to the "column sum" method as described by Stanard [6]. These factors may be similar to those we would select if we use a traditional development factor method to forecast losses.

The factor for development after 312 months is based on the fit of an exponential curve to the selected development factors less 1. Though not shown, this method results in an ultimate loss estimate of approximately $136 million for all years combined, based on a total of $13.3 million in incurred losses. Had we used the inverse power curve as suggested by Sherman in [1] to estimate the "tail," the resulting factor would have been approximately 11.5 with an ultimate loss estimate of more than $500 million. If the observations in section 1 (*Introduction*) above regarding the emergence of these claims are correct, the emergence of these losses do not satisfy the assumptions of the development factor method; thus, the resulting estimates would not be appropriate.

If, now, we were to use the fitted power curve from Exhibit 1 and the pure valuation year approach described above, we would set $\alpha = 1$. If we assume that since the first losses emerged in 1984, then all losses would develop as would general liability for accident year 1984. Here we would have $\beta = -18$ since accident year 1968 at 1984 is at 17 years of development. If we select the power model, this results in an indicated age-to-ultimate factor of 1.617 and ultimate loss forecast of $21.5 million.

These estimates also ignore information present in the data. We could assume that the emergence will follow the fitted power curve from Exhibit 1 but with α and β values fitted to the development factors in Exhibit 3. We address our approach to estimating these parameters in the next section.

4. Parameter Estimation

Our problem now is to estimate the parameters α and β using historical data. We will use numerical methods to minimize a selected error function that compares actual loss emergence with that expected from the particular model. One error function that suggests itself is the usual square error:

$$Err = \sum (A_i - E_i)^2$$

Of course, least squares regression is based on minimizing this error function. We note, however, that if we would expect different values to have different variances, this particular error function may not be appropriate since all differences will be given equal weight. We thus select an error function that is more akin to a chi-squared test:

$$Err = \sum_{ij} \frac{\left(X_{ij} - P_{ij}\right)^2}{P_{ij}} \tag{4.1}$$

Here we compare the actual payments for accident year i, age j; X_{ij}, with the (one period) forecast from the model; P_{ij}, using an error term like that used in chi-squared tests.

If we assume that the expected losses at age j can be given by:

$$P_{ij}(\alpha,\beta) = X_{ij-1} d^{(m)}\left(\beta + j - 1 + \alpha i \middle| a,b\right) \tag{4.2}$$

where m could refer to any of the models described above and we let D_{ij-1} denote the actual development factor from time j-1 to time j for accident year i, then the error function in (4.1) becomes:

$$\begin{aligned} Err &= \sum_{ij} \frac{\left(X_{ij-1}D_{ij-1} - X_{ij-1}d^{(m)}(\beta + j - 1 + \alpha i)\right)^2}{X_{ij-1}d^{(m)}(\beta + j - 1 + \alpha i)} \\ &= \sum_{ij} \frac{X_{ij-1}}{d^{(m)}(\beta + j - 1 + \alpha i)} \left(D_{ij-1} - d^{(m)}(\beta + j - 1 + \alpha i)\right)^2 \end{aligned} \tag{4.3}$$

Thus, our selected error function weights the square of the difference between observed and fitted development factors proportionate to the size of the prior losses and inversely proportionate to the size of the fitted development factor itself. Given the general expectation that the lower the initial losses or the higher the development factor, the more variation is inherent in that factor, this may indeed be a reasonable weighting of the factors and is probably preferable to the uniform weighting provided in the usual sum-of-squares error function.

We acknowledge that this is simply one approach to weighting the individual errors and that others are possible. Following Klugman [5], we note that practical considerations are often valid reasons for weighting errors differently than what may be "optimal" from purely statistical reasoning. We note that this weighting scheme gives more weight to more mature (larger) data in the development tail. The resulting fitted surfaces will tend to track the tail more closely than a pure regression model and hence may be more useful for extrapolating future development.

5. Example Calculations

Page 1 of Exhibit 4 shows the results of using the power curve parameters a and b from Exhibit 1 and fitting the parameters α and β using the error function discussed in section 4 (*Estimating Parameters*). Page 2 of Exhibit 4 shows the forecast future factors along with the resulting loss forecast of $20.4 million. Page 3 of Exhibit 4 shows the one-year forecast error for this model; that is, the difference between the actual losses in the cell with the one-year model forecast for that cell. For example, on page 1 we see the fitted factor for accident year 1970 development through 1987 is 1.242. When applied to the losses through 1986 of $600 thousand, this provides an estimate through 1987 of $745 thousand, which is $155 thousand above the actual $590 thousand for that age.

This example assumes that the fitted power curve from Exhibit 1 is the proper development model to be used to estimate future development. This ignores, however, development data in the data. There is nothing in the foregoing discussion that requires us to use that fitted curve. We will use the data and estimate the three parameters *a*, *b*, and α. Since we are estimating all the parameters, we will take $\beta = 0$. We again minimize the error function from section 4 (*Estimating Parameters*) for each of the three models. Exhibits 5 through 7 parallel Exhibit 4 but use the fitted exponential, power, and Weibull curves respectively.

We see that the power curve again results in the smallest of the error functions; 3,378 compared with 3,404 for the exponential and 3,561 for the Weibull. The forecast accuracy test shown on page 3 of those exhibits show a slightly different picture. In this case the exponential model has the smallest absolute total error, with the Weibull second and power third. Without additional assumptions regarding the underlying distributions for these models, we cannot now say if these differences are statistically significant. We note, however, that the inclusion of the parameter α does affect the fits as summarized by the following table:

COMPARISON OF RESULTS FOR VARIOUS MODELS

	Model		
	Exponential	Power	Weibull
Pure CY Model (α = 1)			
Weighed Error	3,701	3,669	3,831
Bias	-$1,650	-$1,621	-$1,848
Forecast	$22,687	$29,050	$15,285
Pure AY Model (α = 0)			
Weighed Error	3,722	3,719	3,724
Bias	-$1,738	-$1,917	-$1,907
Forecast	$101,224	$338,523	$88,321
Hybrid Model (α fitted to data)			
Weighed Error	3,404	3,378	3,561
Bias	-$1,539	-$1,580	-$1,577
Forecast	$22,710	$30,866	$16,183

NOTE:
1. Dollar amounts are in thousands.

Since our primary concern is to forecast future development, we note that the one-year forecast error of 1993 losses for the Weibull model is positive, indicating that the model, on the average, underestimated the development during that year. On the other hand, the one-year errors for the exponential and power models are negative, indicating an average overstatement. If these errors hold for future forecasts, they may lead to the conclusion that the exponential and power models may slightly overestimate the tail while the Weibull model may understate it.

Exhibit 8 provides another, "ex-ante," test of the models. In this exhibit we compare the actual calendar year 1993 factors by accident year with the forecasts from the three models. In this case, however, the models were fitted to data through calendar year 1992 only. That is, this exhibit shows the actual forecast accuracy of the three models considered. The total errors are reasonably small with the exponential having the smallest absolute total prediction error, followed by the power model, with the Weibull model third. As above, the power and exponential models tended to overstate losses while the Weibull model tended to underestimate it.

The projections from the three models, as shown on page 2 of Exhibits 5 through 8, are $30.9 million for the power, $22.7 million for the exponential and $16.2 million for the Weibull. The above tests tend to suggest the power and exponential models may be better predictors in this case, with the Weibull generally lacking in all regards. One final test may tend to confirm these observations. If we compare the actual factors at the top of page 2 of these exhibits with the forecast factors shown in the bottom portion, we may conclude that the Weibull model decays more rapidly than we would expect, given the data in the top portions. The same observation could arguably be made regarding the exponential model, though it is not as apparent. Based on these observations, we may thus conclude ultimate losses in this case to be in the neighborhood of $25 to $30 million.

6. Application to Example Pollution Development

Exhibit 9 shows some example pollution development data. As with the asbestos data in Exhibit 2, these data are roughly based on some actual emerged experience. We will assume that each of the fitted asbestos models provide reasonable approximation to the future development of these pollution losses, but that the development is lagged by some unknown amount. As with the general liability development data from Exhibit 1, we will use the fitted curves but solve for the single added lag parameter β using numerical methods to minimize the error function (4.3).

Exhibits 10 through 12 summarize the results for these fits. These exhibits contain the same information as Exhibits 5 through 7; however, since the pollution data have only been available for the past three years, we are able to compress the format. All three models seem to indicate an approximate 3.5 year lag in pollution emergence relative to asbestos (β values near -3.5).

That is, under these very specific assumptions, pollution now is expected to develop as asbestos did three and one-half years ago, even though the actual emergence lag shown is seven years.

In this case the exponential model has the smallest error function, followed by the power and then the Weibull. All of the models had a tendency of underestimating 1992 losses and overestimating 1993 losses. This is due to the relatively mild development experienced during 1993. Overall, the exponential has the lowest absolute total bias of -$797 thousand for the two years, followed by the Weibull with -$813 thousand and the power with -$819 thousand. The forecasts range between $7.2 million and $13.5 million. We did not, however, perform the ex-ante test described above due to the limited data available.

7. Other Applications

These two approaches can also be useful in estimating development of losses from other causes. Just as our first approach used general liability data to extrapolate asbestos losses, if we assume that the development of other loss causes, say DES claims, will generally follow the asbestos model, but with a different lag, we can derive estimates of future development for those other losses as we did with the pollution example above.

These general techniques could also be used with more complex models. For example, if after testing simpler models such as these we find evidence for a "second wave" in the data, we could specify compound models that include such a wave by, for example, adding two simpler models with a lag reflecting the timing of the second wave. Again, these numeric techniques could be used to estimate the parameters for those models.

Again we reiterate that these approaches can provide a different view of potential development for unusual loss causes. They are relatively easy to apply, but rely critically on the choice of underlying development model. It is possible that more detailed models of pollution and asbestos exposure could provide useful insight as to the appropriate model. Given this insight and model choice, these methods can readily be used to derive additional loss estimates that incorporate actual development experienced.

8. Acknowledgments

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Exhibit 1

SAMPLE FITTED GENERAL LIABILITY DEVELOPMENT

Year of Development	Sample Factors	Fitted Factors Power	Exponential	Weibull	Indicated Error Power	Exponential	Weibull
1	2.969	2.946	2.413	2.214	0.023	0.556	0.755
2	1.633	1.628	1.794	1.550	0.005	-0.161	0.083
3	1.321	1.324	1.446	1.339	-0.003	-0.125	-0.018
4	1.249	1.203	1.250	1.235	0.046	-0.001	0.014
5	1.156	1.141	1.141	1.173	0.015	0.015	-0.017
6	1.096	1.105	1.079	1.133	-0.009	0.017	-0.037
7	1.060	1.081	1.044	1.104	-0.021	0.016	-0.044
8	1.043	1.066	1.025	1.083	-0.023	0.018	-0.040
9	1.025	1.054	1.014	1.068	-0.029	0.011	-0.043
10	1.027	1.046	1.008	1.055	-0.019	0.019	-0.028
11	1.029	1.039	1.004	1.045	-0.010	0.025	-0.016
12	1.032	1.034	1.002	1.037	-0.002	0.030	-0.005
13	1.018	1.030	1.001	1.031	-0.012	0.017	-0.013
14	1.026	1.026	1.001	1.026	0.000	0.025	0.000
15	1.015	1.023	1.000	1.021	-0.008	0.015	-0.006
16	1.017	1.021	1.000	1.018	-0.004	0.017	-0.001
17	1.035	1.019	1.000	1.015	0.016	0.035	0.020
18	1.018	1.017	1.000	1.012	0.001	0.018	0.006
19	1.014	1.016	1.000	1.010	-0.002	0.014	0.004
20	1.029	1.015	1.000	1.008	0.014	0.029	0.021
21	1.027	1.014	1.000	1.007	0.013	0.027	0.020
22	1.024	1.013	1.000	1.006	0.011	0.024	0.018
23	1.019	1.012	1.000	1.005	0.007	0.019	0.014
24	1.011	1.011	1.000	1.004	0.000	0.011	0.007
25+		1.161	1.000	1.018			
Total					0.009	0.670	0.693
Weighted Square Error					0.584	2.859	1.935
Fitted Parameters:							
a		1.946	2.516	8.013			
b		1.631	0.577	1.221			

EXAMPLE ASBESTOS INCURRED LOSS EMERGENCE

Accident Year	12	24	36	48	60	72	84	96	108	120	132	144	156	168	180	192
	Months of Development															
1968	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
1969	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	120
1970	0	0	0	0	0	0	0	0	0	0	0	0	0	0	250	360
1971	0	0	0	0	0	0	0	0	0	0	0	0	0	190	280	310
1972	0	0	0	0	0	0	0	0	0	0	0	0	90	180	280	400
1973	0	0	0	0	0	0	0	0	0	0	0	120	190	200	230	250
1974	0	0	0	0	0	0	0	0	0	0	90	180	200	240	270	340
1975	0	0	0	0	0	0	0	0	0	40	90	150	200	230	250	330
1976	0	0	0	0	0	0	0	0	10	110	160	190	230	240	410	480
1977	0	0	0	0	0	0	0	50	150	190	190	340	320	410	460	590
1978	0	0	0	0	0	0	110	310	200	280	420	550	700	910	850	900
1979	0	0	0	0	0	40	120	120	150	280	350	470	460	550	800	
1980	0	0	0	0	10	30	30	100	150	170	240	400	510	600		
1981	0	0	0	0	0	0	70	120	90	200	350	530	700			
1982	0	0	0	0	0	10	20	40	20	180	240	300				
1983	0	0	0	0	0	90	50	40	130	70	100					
1984	0	0	0	0	80	110	100	100	100	100						
1985	0	0	0	0	0	0	0	0	0							
1986	0	0	0	0	0	0	0	0								
1987	0	0	0	0	0	0	0									
1988	0	0	0	0	0	0										
1989	0	0	0	0	0											
1990	0	0	0	0												
1991	0	0	0													
1992	0	0														
1993	0															

Accident Year	204	216	228	240	252	264	276	288	300	312
	Months of Development									
1968	$180	$390	$630	$650	$830	$1,130	$1,330	$1,580	$1,850	$2,000
1969	210	290	330	410	640	760	910	1,000	1,200	
1970	600	590	710	930	1,070	1,180	1,260	1,400		
1971	580	670	820	900	960	1,060	1,200			
1972	430	550	600	650	700	800				
1973	340	450	420	580	600					
1974	400	680	780	900						
1975	480	540	600							
1976	590	500								
1977	600									

NOTE:
1. All amounts are in thousands.

EXAMPLE ASBESTOS INCURRED DEVELOPMENT FACTORS

Accident Year	Months of Development															
Year	24/12	36/24	48/36	60/48	72/60	84/72	96/84	108/96	120/108	132/120	144/132	156/144	168/156	180/168	192/180	204/192
1968	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
1969	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.750
1970	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1.440	1.667
1971	–	–	–	–	–	–	–	–	–	–	–	–	–	1.474	1.107	1.871
1972	–	–	–	–	–	–	–	–	–	–	–	–	2.000	1.556	1.429	1.075
1973	–	–	–	–	–	–	–	–	–	–	–	1.583	1.053	1.150	1.087	1.360
1974	–	–	–	–	–	–	–	–	–	–	2.000	1.111	1.200	1.125	1.259	1.176
1975	–	–	–	–	–	–	–	–	–	2.250	1.667	1.333	1.150	1.087	1.320	1.455
1976	–	–	–	–	–	–	–	–	11.000	1.455	1.188	1.211	1.043	1.708	1.171	1.229
1977	–	–	–	–	–	–	–	3.000	1.267	1.000	1.789	0.941	1.281	1.122	1.283	1.017
1978	–	–	–	–	–	–	2.818	0.645	1.400	1.500	1.310	1.273	1.300	0.934	1.059	
1979	–	–	–	–	–	3.000	1.000	1.250	1.867	1.250	1.343	0.979	1.196	1.455		
1980	–	–	–	–	3.000	1.000	3.333	1.500	1.133	1.412	1.667	1.275	1.176			
1981	–	–	–	–	–	–	1.714	0.750	2.222	1.750	1.514	1.321				
1982	–	–	–	–	–	2.000	2.000	0.500	9.000	1.333	1.250					
1983	–	–	–	–	–	0.556	0.800	3.250	0.538	1.429						
1984	–	–	–	–	1.375	0.909	1.000	1.000	1.000							
1985	–	–	–	–	–	–	–	–								
1986	–	–	–	–	–	–	–									
1987	–	–	–	–	–	–										
1988	–	–	–	–	–											
1989	–	–	–	–												
1990	–	–	–													
1991	–	–														
1992	–															
Weighted Average Age to Age	–	–	–	–	2.667	1.393	1.660	1.125	1.580	1.408	1.460	1.198	1.228	1.216	1.207	1.330
Cumulative Age to Ultimate					760.450	285.133	204.690	123.307	109.606	69.371	49.269	33.746	28.169	22.939	18.864	15.629

Accident Year	Months of Development									
Year	216/204	228/216	240/228	252/240	264/252	276/264	288/276	300/288	312/300	Ultimate/312
1968	2.167	1.615	1.032	1.277	1.361	1.177	1.188	1.171	1.081	
1969	1.361	1.138	1.242	1.561	1.188	1.197	1.099	1.200		
1970	0.983	1.203	1.310	1.151	1.103	1.068	1.111			
1971	1.155	1.224	1.098	1.067	1.104	1.132				
1972	1.279	1.091	1.083	1.077	1.143					
1973	1.324	0.933	1.381	1.034						
1974	1.700	1.147	1.154							
1975	1.125	1.111								
1976	0.847									
Weighted Average Age to Age	1.223	1.175	1.170	1.165	1.174	1.138	1.137	1.182	1.081	
Cumulative Age to Ultimate	11.751	9.608	8.177	6.989	5.999	5.110	4.490	3.949	3.341	3.091

NOTE:

COMPARISON OF ACTUAL AND FITTED DEVELOPMENT

Power Model Using General Liability Fit

Accident Year	Actual Annual Development Through Year Ending 12/31/ 1985	1986	1987	1988	1989	1990	1991	1992	1993
1968	2.167	1.615	1.032	1.277	1.361	1.177	1.188	1.171	1.081
1969	1.750	1.381	1.138	1.242	1.561	1.188	1.197	1.099	1.200
1970	1.440	1.667	0.983	1.203	1.310	1.151	1.103	1.068	1.111
1971	1.474	1.107	1.871	1.155	1.224	1.098	1.067	1.104	1.132
1972	2.000	1.556	1.429	1.075	1.279	1.091	1.083	1.077	1.143
1973	1.583	1.053	1.150	1.087	1.360	1.324	0.933	1.381	1.034
1974	2.000	1.111	1.200	1.125	1.259	1.176	1.700	1.147	1.154
1975	2.250	1.667	1.333	1.150	1.087	1.320	1.455	1.125	1.111
1976	11.000	1.455	1.188	1.211	1.043	1.708	1.171	1.229	0.847
1977	3.000	1.267	1.000	1.789	0.941	1.281	1.122	1.283	1.017
1978	2.818	0.645	1.400	1.500	1.310	1.273	1.300	0.934	1.059
1979	3.000	1.000	1.250	1.867	1.250	1.343	0.979	1.196	1.455
1980	3.000	1.000	3.333	1.500	1.133	1.412	1.667	1.275	1.176
1981	--	--	--	1.714	0.750	2.222	1.750	1.514	1.321
1982	--	--	--	2.000	2.000	0.500	9.000	1.333	1.250
1983	--	--	--	--	0.556	0.800	3.250	0.538	1.429
1984	--	--	--	--	1.375	0.909	1.000	1.000	1.000

Accident Year	Fitted Annual Development Through Year Ending 12/31/ 1985	1986	1987	1988	1989	1990	1991	1992	1993
1968	1.777	1.372	1.225	1.153	1.112	1.086	1.069	1.057	1.047
1969	1.839	1.391	1.233	1.157	1.115	1.088	1.070	1.057	1.048
1970	1.911	1.411	1.242	1.162	1.117	1.090	1.071	1.058	1.049
1971	1.993	1.434	1.251	1.167	1.120	1.092	1.073	1.059	1.049
1972	2.087	1.458	1.261	1.172	1.123	1.094	1.074	1.060	1.050
1973	2.197	1.484	1.271	1.177	1.126	1.096	1.075	1.061	1.051
1974	2.326	1.513	1.282	1.183	1.130	1.098	1.077	1.062	1.052
1975	2.478	1.545	1.294	1.189	1.133	1.100	1.078	1.063	1.052
1976	2.662	1.579	1.307	1.195	1.136	1.102	1.080	1.064	1.053
1977	2.884	1.618	1.321	1.201	1.140	1.104	1.081	1.065	1.054
1978	3.160	1.661	1.336	1.208	1.144	1.107	1.083	1.066	1.055
1979	3.506	1.710	1.351	1.215	1.148	1.109	1.084	1.067	1.055
1980	3.953	1.764	1.368	1.223	1.152	1.111	1.086	1.069	1.056
1981	4.542	1.825	1.387	1.231	1.156	1.114	1.088	1.070	1.057
1982	5.349	1.894	1.407	1.240	1.161	1.117	1.089	1.071	1.058
1983	6.498	1.974	1.429	1.249	1.166	1.120	1.091	1.072	1.059
1984	8.232	2.065	1.452	1.259	1.171	1.123	1.093	1.074	1.060

Selected Model Parameters:

a = 1.946 b = 1.631 α = 0.918 β = -17.998 Error = 3,924

COMPARISON OF ACTUAL AND FORECAST DEVELOPMENT

Power Model Using General Liability Fit

Accident Year	Actual Annual Development Through Year Ending 12/31/ 1985	1986	1987	1988	1989	1990	1991	1992	1993
1968	2.167	1.615	1.032	1.277	1.361	1.177	1.188	1.171	1.081
1969	1.750	1.381	1.138	1.242	1.561	1.188	1.197	1.099	1.200
1970	1.440	1.667	0.983	1.203	1.310	1.151	1.103	1.068	1.111
1971	1.474	1.107	1.871	1.155	1.224	1.098	1.067	1.104	1.132
1972	2.000	1.556	1.429	1.075	1.279	1.091	1.083	1.077	1.143
1973	1.583	1.053	1.150	1.087	1.360	1.324	0.933	1.381	1.034
1974	2.000	1.111	1.200	1.125	1.259	1.176	1.700	1.147	1.154
1975	2.250	1.667	1.333	1.150	1.087	1.320	1.455	1.125	1.111
1976	11.000	1.455	1.188	1.211	1.043	1.708	1.171	1.229	0.847
1977	3.000	1.267	1.000	1.789	0.941	1.281	1.122	1.283	1.017
1978	2.818	0.645	1.400	1.500	1.310	1.273	1.300	0.934	1.059
1979	3.000	1.000	1.250	1.867	1.250	1.343	0.979	1.196	1.455
1980	3.000	1.000	3.333	1.500	1.133	1.412	1.667	1.275	1.176
1981	–	–	–	1.714	0.750	2.222	1.750	1.514	1.321
1982	–	–	–	2.000	2.000	0.500	9.000	1.333	1.250
1983	–	–	–	–	0.556	0.800	3.250	0.538	1.429
1984	–	–	–	–	1.375	0.909	1.000	1.000	1.000

Accident Year	Forecast Annual Development Through Year Ending 12/31/ 1994	1995	1996	1997	1998	1999	2000+	1994+	Forecast Ultimate
1968	1.040	1.035	1.031	1.027	1.024	1.022	1.226	1.462	$2,924
1969	1.041	1.035	1.031	1.027	1.024	1.022	1.235	1.474	1,769
1970	1.041	1.036	1.031	1.028	1.025	1.022	1.243	1.488	2,083
1971	1.042	1.036	1.032	1.028	1.025	1.022	1.251	1.501	1,801
1972	1.043	1.037	1.032	1.028	1.025	1.022	1.259	1.513	1,210
1973	1.043	1.037	1.032	1.028	1.025	1.023	1.267	1.524	914
1974	1.044	1.037	1.033	1.029	1.026	1.023	1.275	1.540	1,386
1975	1.044	1.038	1.033	1.029	1.026	1.023	1.282	1.550	930
1976	1.045	1.038	1.033	1.029	1.026	1.023	1.289	1.560	780
1977	1.045	1.039	1.034	1.030	1.026	1.023	1.297	1.574	944
1978	1.046	1.039	1.034	1.030	1.026	1.024	1.304	1.586	1,427
1979	1.047	1.040	1.034	1.030	1.027	1.024	1.311	1.599	1,279
1980	1.047	1.040	1.035	1.031	1.027	1.024	1.318	1.611	967
1981	1.048	1.041	1.035	1.031	1.027	1.024	1.325	1.622	1,135
1982	1.049	1.041	1.036	1.031	1.028	1.025	1.332	1.637	491
1983	1.049	1.042	1.036	1.032	1.028	1.025	1.339	1.649	165
1984	1.050	1.042	1.037	1.032	1.028	1.025	1.345	1.659	166
									$20,371

Selected Model Parameters:

a = 1.946 b = 1.631 α = 0.918 β = -17.998 Error = 3,924

NOTE:
1. The forecast ultimate losses are in thousands of dollars.

ACTUAL LOSSES MINUS ONE YEAR FITTED DEVELOPMENT FORECAST

Power Model Using General Liability Fit

Accident	Comparison for Year Ending 12/31/									
Year	1985	1986	1987	1988	1989	1990	1991	1992	1993	Total
1968	$70	$95	-$122	$81	$207	$103	$158	$180	$63	$835
1969	-11	-2	-28	28	183	64	97	38	152	521
1970	-118	92	-155	24	137	57	34	12	78	161
1971	-99	-92	192	-7	70	5	-5	43	88	195
1972	-8	18	47	-39	67	-2	5	11	65	164
1973	-74	-82	-24	-21	59	78	-64	134	-10	-4
1974	-29	-72	-16	-14	35	27	249	58	80	318
1975	-9	11	6	-8	-11	55	124	30	32	230
1976	83	-14	-19	3	-21	145	37	79	-122	171
1977	6	-53	-61	112	-68	57	17	100	-22	88
1978	-38	-315	13	82	70	91	152	-120	3	-62
1979	-20	-85	-12	98	29	82	-49	59	220	322
1980	-10	-23	59	28	-3	51	139	82	61	384
1981	--	--	--	34	-49	100	132	155	140	512
1982	--	--	--	8	17	-25	158	47	46	251
1983	--	--	--	--	-55	-16	86	-69	26	-28
1984	--	--	--	--	16	-24	-9	-7	-6	-30
Total	-$257	-$522	-$120	$409	$683	$848	$1,261	$832	$894	$4,028
Percent	-19.8%	-20.1%	-3.6%	9.7%	12.4%	12.3%	15.0%	8.1%	7.6%	

NOTE:
1. Dollar amounts are in thousands.

COMPARISON OF ACTUAL AND FITTED DEVELOPMENT

Exponential Model

Accident Year	Actual Annual Development Through Year Ending 12/31/ 1985	1986	1987	1988	1989	1990	1991	1992	1993
1968	2.167	1.615	1.032	1.277	1.361	1.177	1.188	1.171	1.081
1969	1.750	1.381	1.138	1.242	1.561	1.188	1.197	1.099	1.200
1970	1.440	1.667	0.983	1.203	1.310	1.151	1.103	1.068	1.111
1971	1.474	1.107	1.871	1.155	1.224	1.098	1.067	1.104	1.132
1972	2.000	1.556	1.429	1.075	1.279	1.091	1.083	1.077	1.143
1973	1.583	1.053	1.150	1.087	1.360	1.324	0.933	1.381	1.034
1974	2.000	1.111	1.200	1.125	1.259	1.176	1.700	1.147	1.154
1975	2.250	1.667	1.333	1.150	1.087	1.320	1.455	1.125	1.111
1976	11.000	1.455	1.188	1.211	1.043	1.708	1.171	1.229	0.847
1977	3.000	1.267	1.000	1.789	0.941	1.281	1.122	1.283	1.017
1978	2.818	0.645	1.400	1.500	1.310	1.273	1.300	0.934	1.059
1979	3.000	1.000	1.250	1.867	1.250	1.343	0.979	1.196	1.455
1980	3.000	1.000	3.333	1.500	1.133	1.412	1.667	1.275	1.176
1981	–	–	–	1.714	0.750	2.222	1.750	1.514	1.321
1982	–	–	–	2.000	2.000	0.500	9.000	1.333	1.250
1983	–	–	–	–	0.556	0.800	3.250	0.538	1.429
1984	–	–	–	–	1.375	0.909	1.000	1.000	1.000

Accident Year	Fitted Annual Development Through Year Ending 12/31/ 1985	1986	1987	1988	1989	1990	1991	1992	1993
1968	1.461	1.370	1.297	1.239	1.192	1.154	1.124	1.099	1.080
1969	1.498	1.400	1.321	1.258	1.207	1.166	1.134	1.107	1.086
1970	1.538	1.432	1.347	1.279	1.224	1.180	1.144	1.116	1.093
1971	1.581	1.467	1.375	1.301	1.242	1.194	1.156	1.125	1.101
1972	1.628	1.504	1.405	1.325	1.261	1.210	1.169	1.135	1.109
1973	1.678	1.545	1.438	1.351	1.282	1.227	1.182	1.146	1.118
1974	1.733	1.589	1.473	1.380	1.305	1.245	1.197	1.158	1.127
1975	1.792	1.636	1.511	1.410	1.330	1.265	1.213	1.171	1.137
1976	1.855	1.687	1.552	1.443	1.356	1.286	1.230	1.185	1.148
1977	1.924	1.742	1.596	1.479	1.385	1.309	1.248	1.199	1.160
1978	1.999	1.802	1.644	1.517	1.416	1.334	1.268	1.215	1.173
1979	2.079	1.867	1.696	1.559	1.449	1.361	1.290	1.233	1.187
1980	2.166	1.936	1.752	1.604	1.485	1.390	1.313	1.251	1.202
1981	2.259	2.012	1.813	1.653	1.524	1.421	1.338	1.272	1.218
1982	2.361	2.093	1.878	1.705	1.566	1.455	1.365	1.294	1.236
1983	2.470	2.181	1.949	1.762	1.612	1.492	1.395	1.317	1.255
1984	2.589	2.276	2.025	1.823	1.661	1.531	1.427	1.343	1.275

Selected Model Parameters:
a = 29.233 b = 0.219 α = 0.647 Error = 3,404

COMPARISON OF ACTUAL AND FORECAST DEVELOPMENT

Exponential Model

Accident Year	Actual Annual Development Through Year Ending 12/31/ 1985	1986	1987	1988	1989	1990	1991	1992	1993
1968	2.167	1.615	1.032	1.277	1.361	1.177	1.188	1.171	1.081
1969	1.750	1.381	1.138	1.242	1.561	1.188	1.197	1.099	1.200
1970	1.440	1.667	0.983	1.203	1.310	1.151	1.103	1.068	1.111
1971	1.474	1.107	1.871	1.155	1.224	1.098	1.067	1.104	1.132
1972	2.000	1.556	1.429	1.075	1.279	1.091	1.083	1.077	1.143
1973	1.583	1.053	1.150	1.087	1.360	1.324	0.933	1.381	1.034
1974	2.000	1.111	1.200	1.125	1.259	1.176	1.700	1.147	1.154
1975	2.250	1.667	1.333	1.150	1.087	1.320	1.455	1.125	1.111
1976	11.000	1.455	1.188	1.211	1.043	1.708	1.171	1.229	0.847
1977	3.000	1.267	1.000	1.789	0.941	1.281	1.122	1.283	1.017
1978	2.818	0.645	1.400	1.500	1.310	1.273	1.300	0.934	1.059
1979	3.000	1.000	1.250	1.867	1.250	1.343	0.979	1.196	1.455
1980	3.000	1.000	3.333	1.500	1.133	1.412	1.667	1.275	1.176
1981	–	–	–	1.714	0.750	2.222	1.750	1.514	1.321
1982	–	–	–	2.000	2.000	0.500	9.000	1.333	1.250
1983	–	–	–	–	0.556	0.800	3.250	0.538	1.429
1984	–	–	–	–	1.375	0.909	1.000	1.000	1.000

Accident Year	Forecast Annual Development Through Year Ending 12/31/ 1994	1995	1996	1997	1998	1999	2000+	1994+	Forecast Ultimate
1968	1.064	1.051	1.041	1.033	1.027	1.021	1.089	1.373	$2,746
1969	1.069	1.056	1.045	1.036	1.029	1.023	1.097	1.411	1,693
1970	1.075	1.060	1.048	1.039	1.031	1.025	1.106	1.450	2,030
1971	1.081	1.065	1.052	1.042	1.034	1.027	1.115	1.494	1,793
1972	1.087	1.070	1.056	1.045	1.036	1.029	1.125	1.539	1,231
1973	1.094	1.076	1.061	1.049	1.039	1.032	1.136	1.596	958
1974	1.102	1.082	1.066	1.053	1.042	1.034	1.147	1.654	1,489
1975	1.110	1.089	1.071	1.057	1.046	1.037	1.160	1.722	1,033
1976	1.119	1.096	1.077	1.062	1.050	1.040	1.174	1.798	899
1977	1.129	1.103	1.083	1.067	1.054	1.043	1.189	1.881	1,129
1978	1.139	1.112	1.090	1.072	1.058	1.046	1.206	1.975	1,778
1979	1.150	1.121	1.097	1.078	1.062	1.050	1.224	2.081	1,665
1980	1.162	1.130	1.105	1.084	1.068	1.054	1.244	2.202	1,321
1981	1.175	1.141	1.113	1.091	1.073	1.059	1.266	2.342	1,639
1982	1.189	1.152	1.122	1.098	1.079	1.063	1.290	2.497	749
1983	1.205	1.164	1.132	1.106	1.085	1.068	1.316	2.678	268
1984	1.221	1.178	1.143	1.115	1.092	1.074	1.345	2.892	289
									$22,710

Selected Model Parameters:

a = 29.233 b = 0.219 α = 0.647 Error = 3,404

NOTE:
1. The forecast ultimate losses are in thousands of dollars.

ACTUAL LOSSES MINUS ONE YEAR FITTED DEVELOPMENT FORECAST

Exponential Model

Accident Year	Comparison for Year Ending 12/31/ 1985	1986	1987	1988	1989	1990	1991	1992	1993	Total
1968	$127	$96	-$167	$25	$140	$26	$85	$114	$2	$448
1969	30	-4	-53	-5	145	14	48	-7	114	282
1970	-25	85	-218	-45	61	-27	-44	-57	23	-247
1971	-20	-101	154	-85	-12	-79	-80	-20	33	-210
1972	33	9	7	-100	8	-65	-52	-38	24	-174
1973	-11	-93	-58	-61	20	33	-112	99	-49	-232
1974	24	-86	-55	-61	-12	-23	201	-7	21	2
1975	18	3	-27	-52	-56	14	80	-22	-14	-56
1976	91	-26	-58	-44	-72	101	-24	21	-178	-189
1977	54	-71	-113	59	-151	-9	-52	39	-84	-328
1978	90	-359	-49	-5	-45	-34	22	-256	-97	-733
1979	37	-104	-54	46	-56	-6	-146	-17	147	-153
1980	8	-28	47	-10	-53	4	85	10	-13	50
1981	–	–	–	4	-93	72	82	85	55	205
1982	–	–	–	3	9	-38	153	7	3	137
1983	–	–	–	–	-95	-35	74	-101	12	-145
1984	–	–	–	–	-23	-68	-43	-34	-28	-196
Total	$456	-$679	-$644	-$331	-$285	-$120	$277	-$184	-$29	-$1,539
Percent	35.1%	-26.1%	-19.2%	-7.9%	-5.2%	-1.7%	3.3%	-1.8%	-0.2%	

NOTE:
1. Dollar amounts are in thousands.

COMPARISON OF ACTUAL AND FITTED DEVELOPMENT

Power Model

Accident Year	Actual Annual Development Through Year Ending 12/31/ 1985	1986	1987	1988	1989	1990	1991	1992	1993
1968	2.167	1.615	1.032	1.277	1.361	1.177	1.188	1.171	1.081
1969	1.750	1.381	1.138	1.242	1.561	1.188	1.197	1.099	1.200
1970	1.440	1.667	0.983	1.203	1.310	1.151	1.103	1.068	1.111
1971	1.474	1.107	1.871	1.155	1.224	1.098	1.067	1.104	1.132
1972	2.000	1.556	1.429	1.075	1.279	1.091	1.083	1.077	1.143
1973	1.583	1.053	1.150	1.087	1.360	1.324	0.933	1.381	1.034
1974	2.000	1.111	1.200	1.125	1.259	1.176	1.700	1.147	1.154
1975	2.250	1.667	1.333	1.150	1.087	1.320	1.455	1.125	1.111
1976	11.000	1.455	1.188	1.211	1.043	1.708	1.171	1.229	0.847
1977	3.000	1.267	1.000	1.789	0.941	1.281	1.122	1.283	1.017
1978	2.818	0.645	1.400	1.500	1.310	1.273	1.300	0.934	1.059
1979	3.000	1.000	1.250	1.867	1.250	1.343	0.979	1.196	1.455
1980	3.000	1.000	3.333	1.500	1.133	1.412	1.667	1.275	1.176
1981	–	–	–	1.714	0.750	2.222	1.750	1.514	1.321
1982	–	–	–	2.000	2.000	0.500	9.000	1.333	1.250
1983	–	–	–	–	0.556	0.800	3.250	0.538	1.429
1984	–	–	–	–	1.375	0.909	1.000	1.000	1.000

Accident Year	Fitted Annual Development Through Year Ending 12/31/ 1985	1986	1987	1988	1989	1990	1991	1992	1993
1968	1.456	1.362	1.291	1.236	1.193	1.160	1.133	1.111	1.094
1969	1.495	1.391	1.313	1.253	1.207	1.170	1.141	1.118	1.100
1970	1.538	1.424	1.338	1.272	1.221	1.182	1.151	1.126	1.106
1971	1.586	1.459	1.365	1.293	1.237	1.194	1.160	1.134	1.112
1972	1.639	1.499	1.394	1.315	1.255	1.208	1.171	1.142	1.119
1973	1.698	1.542	1.427	1.340	1.274	1.223	1.183	1.151	1.126
1974	1.764	1.590	1.463	1.367	1.295	1.239	1.195	1.161	1.134
1975	1.837	1.644	1.502	1.397	1.317	1.256	1.209	1.172	1.143
1976	1.920	1.703	1.546	1.430	1.342	1.276	1.224	1.184	1.152
1977	2.013	1.770	1.595	1.466	1.369	1.296	1.240	1.197	1.162
1978	2.117	1.844	1.649	1.506	1.400	1.319	1.258	1.210	1.173
1979	2.235	1.928	1.709	1.550	1.433	1.344	1.277	1.225	1.185
1980	2.368	2.021	1.776	1.599	1.469	1.372	1.298	1.242	1.198
1981	2.520	2.127	1.851	1.654	1.509	1.402	1.321	1.260	1.212
1982	2.692	2.246	1.935	1.714	1.554	1.436	1.347	1.279	1.227
1983	2.889	2.380	2.030	1.782	1.604	1.472	1.374	1.300	1.243
1984	3.114	2.534	2.136	1.858	1.659	1.513	1.405	1.323	1.261

Selected Model Parameters:

a = 248,731 b = 4.489 α = 0.657 Error = 3,378

COMPARISON OF ACTUAL AND FORECAST DEVELOPMENT

Power Model

Accident Year	Actual Annual Development Through Year Ending 12/31/ 1985	1986	1987	1988	1989	1990	1991	1992	1993
1968	2.167	1.615	1.032	1.277	1.361	1.177	1.188	1.171	1.081
1969	1.750	1.381	1.138	1.242	1.561	1.188	1.197	1.099	1.200
1970	1.440	1.667	0.983	1.203	1.310	1.151	1.103	1.068	1.111
1971	1.474	1.107	1.871	1.155	1.224	1.098	1.067	1.104	1.132
1972	2.000	1.558	1.429	1.075	1.279	1.091	1.083	1.077	1.143
1973	1.583	1.053	1.150	1.087	1.360	1.324	0.933	1.381	1.034
1974	2.000	1.111	1.200	1.125	1.259	1.176	1.700	1.147	1.154
1975	2.250	1.667	1.333	1.150	1.087	1.320	1.455	1.125	1.111
1976	11.000	1.455	1.188	1.211	1.043	1.708	1.171	1.229	0.847
1977	3.000	1.267	1.000	1.789	0.941	1.281	1.122	1.283	1.017
1978	2.818	0.845	1.400	1.500	1.310	1.273	1.300	0.934	1.059
1979	3.000	1.000	1.250	1.867	1.250	1.343	0.979	1.196	1.455
1980	3.000	1.000	3.333	1.500	1.133	1.412	1.667	1.275	1.176
1981	–	–	–	1.714	0.750	2.222	1.750	1.514	1.321
1982	–	–	–	2.000	2.000	0.500	9.000	1.333	1.250
1983	–	–	–	–	0.556	0.800	3.250	0.538	1.429
1984	–	–	–	–	1.375	0.909	1.000	1.000	1.000

Accident Year	Forecast Annual Development Through Year Ending 12/31/ 1994	1995	1996	1997	1998	1999	2000+	1994+	Forecast Ultimate
1968	1.080	1.068	1.059	1.051	1.044	1.038	1.308	1.820	$3,640
1969	1.084	1.072	1.062	1.053	1.046	1.040	1.328	1.877	2,252
1970	1.089	1.076	1.065	1.058	1.048	1.042	1.349	1.941	2,717
1971	1.094	1.080	1.068	1.059	1.051	1.044	1.371	2.010	2,412
1972	1.100	1.085	1.072	1.062	1.053	1.046	1.394	2.086	1,669
1973	1.106	1.090	1.076	1.065	1.056	1.049	1.418	2.170	1,302
1974	1.113	1.095	1.081	1.069	1.059	1.051	1.443	2.262	2,036
1975	1.119	1.101	1.085	1.073	1.062	1.054	1.470	2.360	1,416
1976	1.127	1.107	1.090	1.077	1.066	1.056	1.499	2.471	1,236
1977	1.135	1.113	1.095	1.081	1.069	1.059	1.529	2.588	1,553
1978	1.144	1.120	1.101	1.086	1.073	1.062	1.561	2.725	2,453
1979	1.153	1.128	1.107	1.091	1.077	1.066	1.595	2.876	2,301
1980	1.163	1.136	1.114	1.096	1.081	1.069	1.631	3.040	1,824
1981	1.174	1.144	1.121	1.102	1.086	1.073	1.670	3.229	2,260
1982	1.186	1.154	1.128	1.108	1.091	1.077	1.712	3.441	1,032
1983	1.199	1.164	1.136	1.114	1.096	1.082	1.757	3.680	368
1984	1.213	1.175	1.145	1.121	1.102	1.086	1.805	3.952	395
									$30,866

Selected Model Parameters:

a = 248,731 b = 4.489 α = 0.657 Error = 3,378

NOTE:

1. The forecast ultimate losses are in thousands of dollars.

ACTUAL LOSSES MINUS ONE YEAR FITTED DEVELOPMENT FORECAST

Power Model

Accident	Comparison for Year Ending 12/31/									
Year	1985	1986	1987	1988	1989	1990	1991	1992	1993	Total
1968	$128	$99	-$163	$27	$139	$19	$73	$95	-$24	$393
1969	31	-2	-51	-4	145	12	43	-17	100	257
1970	-25	87	-213	-41	63	-29	-51	-68	6	-271
1971	-21	-99	157	-80	-9	-79	-84	-29	21	-223
1972	32	10	10	-96	10	-64	-53	-42	17	-176
1973	-14	-93	-55	-58	22	34	-113	97	-53	-233
1974	21	-86	-53	-58	-10	-21	202	-10	16	1
1975	17	2	-25	-49	-53	16	81	-23	-17	-51
1976	91	-27	-57	-42	-69	104	-22	22	-180	-180
1977	49	-75	-113	61	-146	-5	-48	40	-86	-323
1978	77	-372	-50	-2	-38	-25	29	-251	-97	-729
1979	31	-111	-55	48	-51	0	-140	-13	149	-142
1980	6	-31	47	-10	-50	7	89	13	-11	60
1981	—	—	—	4	-91	74	86	89	58	220
1982	—	—	—	3	9	-37	153	10	6	144
1983	—	—	—	—	-94	-34	75	-99	13	-139
1984	—	—	—	—	-23	-66	-41	-32	-26	-188
Total	$423	-$698	-$621	-$297	-$246	-$94	$279	-$218	-$108	-$1,580
Percent	32.5%	-26.8%	-18.5%	-7.1%	-4.4%	-1.4%	3.3%	-2.1%	-0.9%	

NOTE:
1. Dollar amounts are in thousands.

COMPARISON OF ACTUAL AND FITTED DEVELOPMENT

Weibull Model

Accident Year	Actual Annual Development Through Year Ending 12/31/								
	1985	1986	1987	1988	1989	1990	1991	1992	1993
1968	2.167	1.615	1.032	1.277	1.361	1.177	1.188	1.171	1.081
1969	1.750	1.381	1.138	1.242	1.561	1.188	1.197	1.099	1.200
1970	1.440	1.667	0.983	1.203	1.310	1.151	1.103	1.068	1.111
1971	1.474	1.107	1.871	1.155	1.224	1.098	1.067	1.104	1.132
1972	2.000	1.556	1.429	1.075	1.279	1.091	1.083	1.077	1.143
1973	1.583	1.053	1.150	1.087	1.360	1.324	0.933	1.381	1.034
1974	2.000	1.111	1.200	1.125	1.259	1.176	1.700	1.147	1.154
1975	2.250	1.667	1.333	1.150	1.087	1.320	1.455	1.125	1.111
1976	11.000	1.455	1.188	1.211	1.043	1.708	1.171	1.229	0.847
1977	3.000	1.267	1.000	1.789	0.941	1.281	1.122	1.283	1.017
1978	2.818	0.645	1.400	1.500	1.310	1.273	1.300	0.934	1.059
1979	3.000	1.000	1.250	1.867	1.250	1.343	0.979	1.196	1.455
1980	3.000	1.000	3.333	1.500	1.133	1.412	1.667	1.275	1.176
1981	–	–	–	1.714	0.750	2.222	1.750	1.514	1.321
1982	–	–	–	2.000	2.000	0.500	9.000	1.333	1.250
1983	–	–	–	–	0.556	0.800	3.250	0.538	1.429
1984	–	–	–	–	1.375	0.909	1.000	1.000	1.000

Accident Year	Fitted Annual Development Through Year Ending 12/31/								
	1985	1986	1987	1988	1989	1990	1991	1992	1993
1968	1.437	1.383	1.328	1.270	1.212	1.155	1.103	1.060	1.029
1969	1.457	1.404	1.349	1.292	1.234	1.177	1.122	1.075	1.039
1970	1.478	1.425	1.371	1.315	1.257	1.199	1.142	1.092	1.052
1971	1.498	1.445	1.392	1.337	1.279	1.221	1.164	1.111	1.066
1972	1.519	1.466	1.413	1.358	1.302	1.244	1.186	1.130	1.082
1973	1.539	1.486	1.433	1.379	1.324	1.266	1.208	1.151	1.100
1974	1.560	1.507	1.454	1.400	1.345	1.289	1.230	1.173	1.119
1975	1.582	1.527	1.474	1.421	1.367	1.311	1.253	1.195	1.139
1976	1.604	1.548	1.495	1.442	1.388	1.333	1.275	1.217	1.160
1977	1.627	1.569	1.515	1.462	1.409	1.354	1.298	1.240	1.182
1978	1.650	1.591	1.536	1.482	1.430	1.376	1.320	1.262	1.204
1979	1.675	1.613	1.557	1.503	1.450	1.397	1.342	1.285	1.226
1980	1.700	1.636	1.578	1.523	1.470	1.417	1.363	1.307	1.249
1981	1.727	1.660	1.600	1.544	1.491	1.438	1.384	1.329	1.271
1982	1.756	1.685	1.622	1.565	1.511	1.458	1.405	1.350	1.294
1983	1.786	1.711	1.646	1.587	1.532	1.479	1.426	1.372	1.316
1984	1.818	1.739	1.670	1.609	1.553	1.499	1.446	1.393	1.338

Selected Model Parameters:

$a = 23.214$ $b = 7.909$ $\alpha = 0.614$ Error = 3,561

COMPARISON OF ACTUAL AND FORECAST DEVELOPMENT

Weibull Model

Accident Year	Actual Annual Development Through Year Ending 12/31/ 1985	1986	1987	1988	1989	1990	1991	1992	1993
1968	2.167	1.615	1.032	1.277	1.361	1.177	1.188	1.171	1.081
1969	1.750	1.381	1.138	1.242	1.561	1.188	1.197	1.099	1.200
1970	1.440	1.667	0.983	1.203	1.310	1.151	1.103	1.068	1.111
1971	1.474	1.107	1.871	1.155	1.224	1.098	1.067	1.104	1.132
1972	2.000	1.556	1.429	1.075	1.279	1.091	1.083	1.077	1.143
1973	1.583	1.053	1.150	1.087	1.360	1.324	0.933	1.381	1.034
1974	2.000	1.111	1.200	1.125	1.259	1.176	1.700	1.147	1.154
1975	2.250	1.667	1.333	1.150	1.087	1.320	1.455	1.125	1.111
1976	11.000	1.455	1.188	1.211	1.043	1.708	1.171	1.229	0.847
1977	3.000	1.267	1.000	1.789	0.941	1.281	1.122	1.283	1.017
1978	2.818	0.645	1.400	1.500	1.310	1.273	1.300	0.934	1.059
1979	3.000	1.000	1.250	1.867	1.250	1.343	0.979	1.196	1.455
1980	3.000	1.000	3.333	1.500	1.133	1.412	1.667	1.275	1.176
1981	–	–	–	1.714	0.750	2.222	1.750	1.514	1.321
1982	–	–	–	2.000	2.000	0.500	9.000	1.333	1.250
1983	–	–	–	–	0.556	0.800	3.250	0.538	1.429
1984	–	–	–	–	1.375	0.909	1.000	1.000	1.000

Accident Year	Forecast Annual Development Through Year Ending 12/31/ 1994	1995	1996	1997	1998	1999	2000+	1994+	Forecast Ultimate
1968	1.011	1.003	1.001	1.000	1.000	1.000	1.000	1.015	$2,030
1969	1.017	1.005	1.001	1.000	1.000	1.000	1.000	1.023	1,228
1970	1.024	1.009	1.002	1.000	1.000	1.000	1.000	1.035	1,449
1971	1.033	1.013	1.004	1.001	1.000	1.000	1.000	1.052	1,262
1972	1.044	1.019	1.007	1.002	1.000	1.000	1.000	1.073	858
1973	1.057	1.028	1.010	1.003	1.001	1.000	1.000	1.102	661
1974	1.072	1.037	1.016	1.005	1.001	1.000	1.000	1.136	1,022
1975	1.089	1.049	1.023	1.008	1.002	1.000	1.000	1.180	708
1976	1.107	1.063	1.031	1.012	1.004	1.001	1.000	1.234	617
1977	1.127	1.079	1.042	1.018	1.006	1.001	1.000	1.299	779
1978	1.147	1.096	1.055	1.026	1.010	1.003	1.001	1.380	1,242
1979	1.169	1.115	1.070	1.036	1.015	1.004	1.001	1.474	1,179
1980	1.191	1.135	1.086	1.047	1.021	1.007	1.002	1.583	950
1981	1.213	1.156	1.104	1.061	1.030	1.011	1.004	1.717	1,202
1982	1.236	1.178	1.123	1.076	1.040	1.017	1.007	1.874	562
1983	1.258	1.200	1.144	1.093	1.052	1.024	1.012	2.058	206
1984	1.281	1.222	1.165	1.112	1.067	1.034	1.019	2.280	228
									$16,183

Selected Model Parameters:

a = 23.214 b = 7.909 α = 0.614 Error = 3,561

NOTE:
1. The forecast ultimate losses are in thousands of dollars.

ACTUAL LOSSES MINUS ONE YEAR FITTED DEVELOPMENT FORECAST

Weibull Model

Accident Year	Comparison for Year Ending 12/31/ 1985	1986	1987	1988	1989	1990	1991	1992	1993	Total
1968	$131	$90	-$186	$5	$124	$25	$113	$175	$96	$573
1969	35	-5	-61	-17	134	7	57	22	161	333
1970	-10	87	-233	-66	38	-45	-42	-28	74	-225
1971	-5	-95	148	-106	-37	-101	-87	-7	70	-220
1972	43	16	4	-113	-10	-84	-62	-34	43	-197
1973	5	-82	-57	-67	9	20	-124	97	-38	-237
1974	40	-71	-51	-66	-23	-38	188	-18	27	-12
1975	27	13	-21	-54	-64	2	67	-34	-15	-79
1976	94	-10	-49	-44	-79	90	-43	6	-185	-220
1977	69	-45	-98	62	-159	-23	-72	20	-97	-343
1978	128	-293	-27	5	-50	-57	-14	-298	-123	-729
1979	53	-74	-37	55	-56	-19	-171	-41	126	-164
1980	13	-19	53	-2	-51	-1	73	-13	-37	16
1981	--	--	--	12	-89	71	73	65	27	159
1982	--	--	--	4	10	-38	152	-3	-11	114
1983	--	--	--	--	-88	-34	73	-108	8	-149
1984	--	--	--	--	-14	-65	-45	-39	-34	-197
Total	$623	-$488	-$615	-$392	-$405	-$290	$136	-$238	$92	-$1,577
Percent	47.9%	-18.8%	-18.3%	-9.3%	-7.3%	-4.2%	1.6%	-2.3%	0.8%	

NOTE:
1. Dollar amounts are in thousands.

COMPARISON OF ACTUAL 1993 DEVELOPMENT
WITH FORECASTS FITTED THROUGH 1992

Accident	Actual	Fitted Factors			1993 Loss Forecast Error		
Year	Factor	Exponential	Power	Weibull	Exponential	Power	Weibull
1968	1.081	1.079	1.095	1.120	$4	-$26	-$72
1969	1.200	1.086	1.101	1.120	114	99	80
1970	1.111	1.093	1.107	1.120	23	5	-11
1971	1.132	1.100	1.113	1.120	34	20	13
1972	1.143	1.108	1.120	1.120	24	16	16
1973	1.034	1.117	1.128	1.120	-48	-54	-50
1974	1.154	1.127	1.136	1.120	21	14	26
1975	1.111	1.137	1.144	1.120	-14	-18	-5
1976	0.847	1.148	1.154	1.120	-177	-181	-161
1977	1.017	1.160	1.164	1.120	-84	-87	-61
1978	1.059	1.173	1.175	1.120	-97	-99	-52
1979	1.455	1.187	1.187	1.120	147	147	184
1980	1.176	1.202	1.200	1.120	-13	-12	29
1981	1.321	1.219	1.214	1.120	54	57	106
1982	1.250	1.237	1.229	1.120	3	5	31
1983	1.429	1.256	1.245	1.120	12	13	22
1984	1.000	1.276	1.263	1.120	-28	-26	-12
Total Error					-$25	-$127	$83
Percentage Error					-0.2%	-1.0%	0.6%

NOTE:
1. Dollar amounts are in thousands

Exhibit 9

SAMPLE POLLUTION DEVELOPMENT DATA

Accident Year	As of 12/31/ 1991	1992	1993	Development Factors 92/91	93/92
1968	$320	$460	$530	1.4375	1.1522
1969	120	240	300	2.0000	1.2500
1970	320	530	620	1.6563	1.1698
1971	240	330	430	1.3750	1.3030
1972	100	110	110	1.1000	1.0000
1973	80	120	110	1.5000	0.9167
1974	110	150	110	1.3636	0.7333
1975	100	110	90	1.1000	0.8182
1976	50	50	40	1.0000	0.8000
1977	90	60	60	0.6667	1.0000
1978	10	20	30	2.0000	1.5000
1979	110	110	120	1.0000	1.0909
1980	0	0	0	–	–
1981	40	70	40	1.7500	0.5714
1982	40	50	70	1.2500	1.4000
1983	50	150	120	3.0000	0.8000
1984	160	320	170	2.0000	0.5313
1985	170	170	150	1.0000	0.8824

NOTE:
1. Dollar amounts are in thousands.

Exhibit 10

COMPARISON OF ACTUAL AND FITTED SAMPLE POLLUTION DEVELOPMENT

Exponential Model

Accident Year	Actual Through 12/ 1992	Actual Through 12/ 1993	Fitted Annual Development Through Year Ending 12/31/ 1992	1993	1994	1995	1996	1997	1998	1999	2000+	1994+	Forecast Ultimate	One-Year Error 1992	One-Year Error 1993
1968	1.438	1.152	1.215	1.172	1.138	1.111	1.089	1.072	1.058	1.046	1.202	1.963	$1,040	$71	-$9
1969	2.000	1.250	1.232	1.186	1.150	1.120	1.097	1.078	1.062	1.050	1.221	2.074	622	92	15
1970	1.656	1.170	1.251	1.201	1.162	1.130	1.104	1.084	1.067	1.054	1.241	2.193	1,360	130	-17
1971	1.375	1.303	1.271	1.217	1.175	1.140	1.113	1.091	1.073	1.058	1.263	2.332	1,003	25	28
1972	1.100	1.000	1.293	1.235	1.189	1.152	1.122	1.098	1.079	1.063	1.287	2.491	274	-19	-26
1973	1.500	0.917	1.316	1.254	1.204	1.164	1.132	1.106	1.085	1.068	1.314	2.672	294	15	-40
1974	1.364	0.733	1.341	1.274	1.220	1.177	1.142	1.114	1.092	1.074	1.343	2.877	316	2	-81
1975	1.100	0.818	1.369	1.296	1.238	1.191	1.154	1.123	1.099	1.080	1.375	3.118	281	-27	-53
1976	1.000	0.800	1.399	1.320	1.257	1.207	1.166	1.133	1.107	1.086	1.410	3.398	136	-20	-26
1977	0.667	1.000	1.431	1.346	1.278	1.223	1.179	1.144	1.116	1.093	1.449	3.726	224	-69	-21
1978	2.000	1.500	1.465	1.374	1.300	1.241	1.194	1.156	1.125	1.100	1.492	4.111	123	5	3
1979	1.000	1.091	1.503	1.404	1.324	1.261	1.209	1.168	1.135	1.108	1.540	4.566	548	-55	-34
1980	–	–	1.543	1.436	1.350	1.282	1.226	1.182	1.146	1.117	1.593	5.114	0	–	–
1981	1.750	0.571	1.587	1.471	1.379	1.304	1.244	1.196	1.158	1.127	1.653	5.772	231	7	-63
1982	1.250	1.400	1.634	1.509	1.409	1.329	1.264	1.212	1.170	1.137	1.719	6.560	459	-15	-5
1983	3.000	0.800	1.685	1.550	1.442	1.355	1.285	1.229	1.184	1.148	1.793	7.520	902	66	-113
1984	2.000	0.531	1.740	1.595	1.478	1.384	1.308	1.247	1.199	1.160	1.877	8.710	1,481	42	-340
1985	1.000	0.882	1.800	1.642	1.516	1.414	1.333	1.267	1.215	1.173	1.971	10.170	1,526	-136	-129
Total													$9,294	$114	-$911
Percent														5.9%	-31.6%

Selected Model Parameters:

a = 29.233 b = 0.219 $\alpha = 0.647$ $\beta = -3.515$ Error = 2,357

NOTE:

1. Dollar amounts are in thousands.

Exhibit 11

COMPARISON OF ACTUAL AND FITTED SAMPLE POLLUTION DEVELOPMENT

Power Model

Accident	Actual Through 12/		Fitted Annual Development Through Year Ending 12/31/										Forecast	One-Year Error	
Year	1992	1993	1992	1993	1994	1995	1996	1997	1998	1999	2000+	1994+	Ultimate	1992	1993
1968	1.438	1.152	1.200	1.166	1.139	1.117	1.099	1.085	1.073	1.063	1.528	2.644	$1,401	$76	-$6
1969	2.000	1.250	1.215	1.178	1.149	1.125	1.106	1.090	1.077	1.067	1.570	2.811	843	94	17
1970	1.656	1.170	1.233	1.192	1.160	1.134	1.113	1.096	1.082	1.071	1.616	3.005	1,863	135	-12
1971	1.375	1.303	1.252	1.207	1.172	1.144	1.121	1.103	1.087	1.075	1.665	3.225	1,387	30	32
1972	1.100	1.000	1.273	1.224	1.185	1.154	1.129	1.109	1.093	1.080	1.718	3.472	382	-17	-25
1973	1.500	0.917	1.296	1.242	1.199	1.166	1.139	1.117	1.099	1.085	1.775	3.765	414	16	-39
1974	1.364	0.733	1.322	1.262	1.215	1.178	1.149	1.125	1.106	1.090	1.837	4.097	451	5	-79
1975	1.100	0.818	1.351	1.284	1.232	1.192	1.160	1.134	1.113	1.096	1.904	4.487	404	-25	-51
1976	1.000	0.800	1.383	1.309	1.251	1.207	1.172	1.143	1.121	1.102	1.978	4.943	198	-19	-25
1977	0.667	1.000	1.418	1.336	1.272	1.223	1.185	1.154	1.129	1.109	2.058	5.482	329	-68	-20
1978	2.000	1.500	1.458	1.366	1.296	1.241	1.199	1.165	1.138	1.117	2.147	6.131	184	5	3
1979	1.000	1.091	1.502	1.399	1.321	1.261	1.215	1.178	1.148	1.125	2.244	6.910	829	-55	-34
1980	–	–	1.552	1.437	1.350	1.283	1.232	1.191	1.159	1.134	2.352	7.856	0	–	–
1981	1.750	0.571	1.608	1.479	1.382	1.308	1.251	1.206	1.171	1.143	2.473	9.027	361	6	-64
1982	1.250	1.400	1.672	1.526	1.417	1.335	1.272	1.223	1.184	1.154	2.607	10.482	734	-17	-6
1983	3.000	0.800	1.744	1.579	1.457	1.365	1.295	1.241	1.199	1.165	2.758	12.313	1,478	63	-117
1984	2.000	0.531	1.825	1.638	1.501	1.399	1.321	1.261	1.214	1.177	2.928	14.635	2,488	28	-354
1985	1.000	0.882	1.918	1.706	1.551	1.436	1.349	1.283	1.231	1.191	3.121	17.639	2,646	-156	-140
Total													$13,746	$101	-$920
Percent														5.2%	-31.9%

Selected Model Parameters:

a = 108,782 b = 4.247 α = 0.602 β = -3.382 Error = 2,378

NOTE:

1. Dollar amounts are in thousands.

COMPARISON OF ACTUAL AND FITTED SAMPLE POLLUTION DEVELOPMENT

Weibull Model

Accident	Actual Through 12/		Fitted Annual Development Through Year Ending 12/31/										Forecast	One-Year Error	
Year	1992	1993	1992	1993	1994	1995	1996	1997	1998	1999	2000+	1994+	Ultimate	1992	1993
1968	1.438	1.152	1.246	1.188	1.133	1.084	1.046	1.020	1.007	1.002	1.000	1.322	$701	$61	-$16
1969	2.000	1.250	1.269	1.211	1.154	1.102	1.059	1.029	1.011	1.003	1.001	1.407	422	88	9
1970	1.656	1.170	1.291	1.233	1.175	1.121	1.074	1.039	1.016	1.005	1.001	1.502	931	117	-33
1971	1.375	1.303	1.313	1.256	1.197	1.141	1.091	1.051	1.024	1.008	1.003	1.621	697	15	16
1972	1.100	1.000	1.335	1.278	1.220	1.163	1.110	1.065	1.033	1.013	1.005	1.764	194	-24	-31
1973	1.500	0.917	1.357	1.300	1.242	1.184	1.129	1.081	1.044	1.019	1.008	1.925	212	11	-46
1974	1.364	0.733	1.378	1.322	1.265	1.207	1.150	1.099	1.057	1.027	1.013	2.122	233	-2	-88
1975	1.100	0.818	1.399	1.344	1.287	1.229	1.171	1.118	1.071	1.037	1.021	2.348	211	-30	-58
1976	1.000	0.800	1.420	1.366	1.310	1.252	1.194	1.138	1.088	1.049	1.032	2.625	105	-21	-28
1977	0.667	1.000	1.441	1.387	1.331	1.274	1.216	1.159	1.106	1.062	1.048	2.942	177	-70	-23
1978	2.000	1.500	1.461	1.408	1.353	1.296	1.238	1.180	1.126	1.078	1.068	3.321	100	5	2
1979	1.000	1.091	1.481	1.428	1.374	1.319	1.261	1.203	1.146	1.095	1.094	3.774	453	-53	-37
1980	–	–	1.502	1.449	1.396	1.340	1.283	1.225	1.168	1.114	1.128	4.315	0	–	–
1981	1.750	0.571	1.522	1.469	1.416	1.362	1.306	1.248	1.190	1.134	1.170	4.963	199	9	-63
1982	1.250	1.400	1.543	1.490	1.437	1.383	1.328	1.270	1.212	1.155	1.221	5.729	401	-12	-5
1983	3.000	0.800	1.564	1.510	1.457	1.404	1.349	1.293	1.234	1.177	1.284	6.654	798	72	-107
1984	2.000	0.531	1.586	1.531	1.478	1.425	1.371	1.315	1.257	1.199	1.359	7.777	1,322	66	-320
1985	1.000	0.882	1.608	1.552	1.498	1.445	1.392	1.337	1.279	1.221	1.449	9.116	1,367	-103	-114
Total													$7,156	$129	-$942
Percent														6.6%	-32.7%

Selected Model Parameters:
a = 23.214 b = 7.909 α = 0.614 β = -3.593 Error = 2,391

NOTE:
1. Dollar amounts are in thousands.

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Estimation of Liabilities Due to Inactive Hazardous Waste Sites

by Raja Bhagavatula, Brian Brown, and Kevin Murphy

"ESTIMATION OF LIABILITIES DUE TO INACTIVE HAZARDOUS WASTE SITES"

Abstract:

The potential liability associated with inactive hazardous waste sites can be large for both policyholders and insurance companies. Our paper outlines several methods that can be used to estimate and monitor insurance company and/or policyholder liabilities associated with inactive hazardous waste sites. We have outlined several publicly available data elements which can be helpful in evaluating environmental liabilities.

None of the procedures described in this paper provide "the method" to analyze environmental liability exposures. For financial reporting purposes, company management needs to evaluate the details of its own exposures and judge the ultimate cost based on current facts and financial reporting principles.

Additionally, this paper summarizes the legal issues involved in environmental coverage disputes between insureds and insurance companies. For the past ten years issuers of CGL policies and their policyholders have engaged in a protracted struggle to determine whether or not environmental liabilities are entitled to defense and indemnity under CGL policies. This paper discusses major coverage issues such as what constitutes a "suit", whether it results in "damages", whether it was "sudden and accidental", etc., upon which the primary battle lines between insurers and insureds are drawn. Although the legal landscape of environmental insurance coverage is becoming clearer, many of these and other issues have not been decided in a number of jurisdictions.

Biography:

Raja Bhagavatula is a Fellow of the Casualty Actuarial Society, a Member of the American Academy of Actuaries and a Consulting Actuary in the New York office of Milliman & Robertson, Inc. Raja serves on the CAS Reserve Committee and has a Masters degree in Pure Mathematics from Osmania University, India. She has worked on consulting assignments involving mergers and acquisitions, reserving, pricing and financial analysis for insurers and self insurers. Many of her assignments involve estimation of environmental liabilities for insurance companies and insureds.

Brian Brown is a Fellow of the Casualty Actuarial Society, a Member of the American Academy of Actuaries and a Consulting Actuary in the Milwaukee office of Milliman & Robertson, Inc. Brian serves on the CLRS committee and has a Bachelors degree in Economics from Illinois State University. Brian's area of expertise is property and casualty insurance, especially in ratemaking, loss reserve analysis, and actuarial appraisals for mergers and acquisitions. Brian is an active member of the Milliman & Robertson research group on environmental liabilities and has previously authored three papers.

Kevin Murphy is a partner in the Chicago office of Latham & Watkins. He graduated from the law school of the University of Chicago in 1981. He chairs the Chicago office's environmental liability department and specializes in environmental law and litigation with a focus on hazardous waste sites. He has represented policyholders in complex environmental insurance coverage litigation in numerous jurisdictions.

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"ESTIMATION OF LIABILITIES DUE TO INACTIVE HAZARDOUS WASTE SITES"

INTRODUCTION

Property and casualty insurance companies are under increasing pressure to set aside large sums for clean-up costs and other damages associated with inactive hazardous waste sites. A significant portion of this potential liability arises from commercial general liability (CGL) policies issued between ten and thirty years ago or more.

The clean-up cost liabilities arise from the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) passed in 1980. This act is commonly known as Superfund and it provided a financial mechanism for funding the clean-up of inactive hazardous waste sites. This act was reauthorized and amended in 1986 by the Superfund Amendments and Reauthorization Act (SARA) and is again up for reauthorization in 1994.

Transporters and generators of hazardous waste as well as owners of dump sites are potentially responsible parties (PRPs) for cleaning up waste sites. Superfund employs the following legal bases:

- Strict liability;
- Joint and several liability; and
- Retroactive liability.

The potential liabilities that arise from Superfund could be staggering for both insurance companies and PRPs. To put the potential cost in perspective, the Environmental Protection Agency (EPA) estimates that the clean-up costs for the approximately 1,300 sites currently on the national priorities list (NPL) may be $30 billion to $40 billion.

This figure is expected to increase significantly as more of the 37,000 potential sites are added to the NPL list[1]. Additionally, a University of Tennessee study estimates that environmental clean-up costs could exceed $1.0 trillion[2]. Attention from several forces such as the Securities Exchange Commission (SEC), regulators and rating agencies regarding the reporting of environmental liabilities has recently increased due to the magnitude of the potential liabilities.

In 1992 the General Accounting Office (GAO) recommended that the SEC require insurers to disclose in their annual reports the number and type of environmental claims they have received and an estimated range or minimum amount of associated claims and expenses.

The 10-K's of industrial companies in general state that their pollution liabilities are covered by insurance, and therefore, have no effect on their bottom lines. However stock insurers often state that environmental claims filed to date are not covered by the policies in question and are only posting modest amounts relative to the potential exposure. Therefore, there is a concern that neither companies nor insurers are recording environmental liabilities. In an attempt to improve this situation, the SEC issued Staff Accounting Bulletin No. 92 in July 1993 requiring companies to disclose liabilities both gross and net of anticipated insurance recoveries. The 1993 10-K's issued by industrial companies and insurers may shed some light on the insurance recoveries anticipated by insureds as compared to liabilities acknowledged by insurance companies.

In the remainder of this paper, we will:

- Describe methods which can be used by insurance companies to analyze their

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[1]David Foppert "Pressure Mounts for Clean-up Reserving" Best's Review, November 1993

[2]Hazardous Waste Remediation Project Study of the University of Tennessee, December 1991

environmental liabilities;

- Outline publicly available data that can help actuaries and claim administrators in the evaluation of environmental liabilities;

- Describe procedures that analysts are likely to apply based on public data as well as methods that management might want to include as part of its overall evaluation of a company's environmental liabilities; and

- Discuss insurance coverage issues (this legal analysis is attached as Appendix A).

Any reference to environmental liabilities in the following sections should be interpreted as liabilities arising out of inactive hazardous waste sites. We acknowledge that other liabilities may be classified as environmental liabilities (e.g. oil spills); however, these categories are outside the scope of our paper.

None of the procedures described in this paper provide "the method" to analyze environmental liability exposures. For financial reporting purposes, company management needs to evaluate the details of its own exposures and judge the ultimate cost based on current facts and financial reporting principles. Management should also consider the provisions under the Superfund Reform Act of 1994 which are likely to have a significant impact on these liabilities.

Evaluating Environmental Liabilities

Traditional actuarial reserve projection techniques are not directly applicable in evaluating environmental liability exposures for several reasons. First, it is difficult to assign losses to an accident or policy year. If a firm dumped at a particular site between 1950 and 1990, the assignment of damages to years is uncertain. Second, insurance companies and insureds are involved in extensive litigation with regard to coverage issues. Finally, we lack historical data and there may be changes in the state and federal laws under which these claims may be ultimately resolved.

We will discuss a number of methods to project environmental liabilities in this paper. Specifically we will discuss the following methods which we believe can be used to project environmental liabilities:

1. A curve fitted to calendar year emergence;
2. A calendar year loss development method;
3. An industry benchmark method;
4. A market share model; and
5. An exposure model.

The first two methods are loss development methods, the only difference between the two methods being how the development factors are derived. In method 1, we rely on a curvefit of the insurance company's internal data, while in method 2, we analyze this data and an external data source to select development factors.

Method 3 provides benchmarks an individual company may use to compare itself to peer companies and the industry. These benchmarks provide guidance on the relative level of the company's reserves and payments as compared to the industry and peer companies. The benchmarks that are used for comparison include: reserves as a multiple of annual payments or annual incurred and indicated market share based on payments and incurred losses to date.

Methods 4 and 5 are exposure-based methods. Method 4 requires an estimate of the liability for the U.S. insurance industry and assumes that an individual company's share is represented by its general liability premium market share. Method 5 provides a systematic process of estimating these liabilities using insurer and EPA data.

LOSS DEVELOPMENT METHODS

Methods 1 and 2 are loss development methods. These methods treat the losses arising out of inactive waste sites as if they were due to one accident year and measure the development of these losses in total. As we mentioned previously, it may be difficult or impossible to assign individual environmental claims to accident years. Also, underlying "causes" of development are calendar year events which have the same effect on all old accident years regardless of accident year age. For example, in the case of clean-up costs for inactive waste sites, the underlying cause of development is the passing of CERCLA in 1980.

The purpose of the two development approaches is to use a methodology which is generally used for actuarial projections, until such time as a company has sufficient data to utilize more refined approaches. The assumption underlying the projections is that there is a relationship between environmental losses reported and the ultimate losses. The approaches differ with respect to the source of the development factor, with one inferred from the patterns in the actual data, and the other derived from an external - and presumably sufficiently comparable - source.

CURVE FITTING TO CALENDAR YEAR EMERGENCE-METHOD 1

In explaining why we might want to rely on calendar year emergence, it may be useful to outline what we will call the life cycle of latent claims. This life cycle can be broken down into the following segments:

Event: Something happens to expose an individual/property to a hazardous agent (e.g. the initial dumping of waste into a site which does not immediately result in any property damage);

Exposure: Once the event occurs, the exposure to the hazardous agent takes place often over a long and undetermined period of time (e.g. chemicals from the site slowly enter the ground water system);

Emergence: The effects of the exposure are known (e.g., it becomes clear that the ground water system is polluted). In this stage claims are made or PRPs notified; and

Expenditure: Payments are made to clean up sites as well as legal fees incurred to determine coverage issues.

The attached Exhibit 1 displays a graph for a hypothetical life cycle for latent claims.

Much of the activity that led to waste site claims occurred between 1950 and 1980. This is the event stage. Stage two, the exposure stage, probably overlapped with the event stage but may have initially lagged the event stage by several years (as the chemicals dumped did not immediately leak from the site).

The next stage, the emergence stage, probably lagged the exposure stage by several years (especially the emergence of the clean-up costs of inactive waste sites, which is governed largely by Superfund legislation). Superfund did not become law until 1980. Therefore, we would expect the emergence curve to start low but increase dramatically after 1980.

We would expect the expenditure curve to lag the emergence curve by several years and to increase less dramatically than the emergence curve due to the fact that several coverage/liability issues are delaying actual payments. Additionally the expenditure curve will be extended after the site is cleaned up because annual maintenance costs are significant and may be expected to continue for 30 or more years. While the expenditure curve only reflects payments in Exhibit 1, the expenditure horizon could be separated into two steps: (1) Loss reserves established; and (2) Claim payments made.

The curve fitting to calendar year emergence method extrapolates the ultimate claim costs based on fitting an "S" curve to the cumulative calendar year incurred losses. Exhibit 2 displays cumulative incurred environmental losses by accident year and calendar year for a hypothetical insurance company, ABC Insurance Company, based on the insurance company's assignment of losses to accident year. As the exhibit shows, the accident year losses do not display a normal development pattern for a property/casualty coverage as no payments or case reserves were established prior to year end 1989 for accident years 1970 through 1977.

However, it appears that the calendar year cumulative losses, in total, may be extrapolated based on an "S" curve. Exhibit 3 displays the actual and fitted points and the estimated curve. The footnotes on Exhibit 3 elaborate on the mathematical form of the curve. (However, it should be noted that there is considerable uncertainty involved in estimating the shape of the curve at this time due to the fact that few of the waste sites have been cleaned up.) This method implies that currently reported incurred losses will increase from $128.8 million currently to $600.4 million.

A second version of the curve fitting to calendar year emergence which may be useful in the future is an extrapolation based on actual payments. At this point in the environmental claim cycle so few payments have been made that this procedure is not practical.

CALENDAR YEAR LOSS DEVELOPMENT-METHOD 2

For this method, ABC's reported losses to date are projected to ultimate using development factors from an external source that reasonably matched ABC's development to date.

This method is illustrated on Exhibit 4. The method relies on the incurred environmental losses, from Exhibit 2, by accident year and calendar year for ABC Insurance Company. The accident year losses do not display a normal pattern of development for a casualty coverage, however; it appears that the calendar year incurred loss totals at the bottom of the exhibit show a "development pattern".

We selected Reinsurance Association of America (RAA) 1993 data as the external source of data which might reasonably match ABC's loss development to date. Exhibit 4 compares the environmental calendar year period to period development factors from Exhibit 2 to the incremental RAA factors. The RAA data is provided on an accident year basis and the factors on Exhibit 4 display the incremental change in the RAA accident year losses from one year to the next.

By posting the calendar year development factors for ABC's environmental claims against the incremental (age to age) accident year RAA factors, we are attempting to match ABC's age-to-age factors against the RAA factors to estimate the equivalent maturity of ABC's environmental claims. Based on Exhibit 4, we would estimate that ABC's environmental claims (in total) are at a maturity equivalent to an accident year at 36 months of maturity. Therefore, one approach to develop ultimate environmental losses for ABC Insurance Company is to multiply the environmental losses to date by a 36 month to ultimate loss development factor from RAA data. The following chart displays the calculation.

ABC-Ultimate Environmental Losses ($000's)	
(1) ABC Incurred Losses - All Years	$128,790
(2) 36 Month to Ultimate Factor Based on RAA Data*	3.6
(3) Ultimate Environmental Losses (1)x(2)	463,644
(4) Environmental IBNR Reserves** (3)-(1)	334,854

* Based on our review of RAA GL data for combined treaty and facultative business excluding environmental and asbestos claims

** Including supplemental development on case reserves.

The results obtained using this method have to be monitored closely. The following discussion is helpful in understanding why we believe a factor of 3.6 may be too low for an insurance company with significant exposures and some of the limitations of this method.

1. The claim paying and reserving activity for environmental claims has just begun for many companies and it is likely to extend over a period in excess of 50 years. Using what has emerged in a horizon of less than 10 years to project what may be expected in the next 40 years is best characterized as the "tail wagging the dog."

   It is important to note that in using the RAA patterns we are not stating that the environmental loss development patterns are similar to excess reinsurance patterns. Those patterns were selected because they provided a reasonable match to ABC's development to date, and we believe that environmental patterns, like excess reinsurance patterns, have a long tail.

2. As is discussed later, our crude estimates of environmental losses for the U.S. insurance industry indicate a ratio of ultimate losses to recognized losses (payments to date + case reserves + IBNR) of 4.7, which is in excess of 3.6. If only reported losses were considered for the U.S. insurance industry, the ratio would have been higher than 4.7.

   The 4.7 ratio is based on an estimate of $70 billion for the U.S. insurance industry ultimate losses and recognized losses of $15 billion through 1993. (A special report by A.M. Best's entitled "Environmental/Asbestos Liability Exposure: A P/C Industry Black Hole" dated March 28, 1994 indicates that approximately $15 billion has been recognized by the U.S. insurance industry through 1993. The U.S. insurance industry estimate of $70 billion is based on our analysis outlined in Attachment A.)

INDUSTRY BENCHMARKS METHOD

There are multiple forces exerting pressure on an insurance company to recognize environmental liabilities, e.g.., rating agencies such as Best's, SEC and regulators. However, the standards for establishing appropriate environmental liability reserves are still developing. There is uncertainty associated with the estimation of ultimate liabilities because historically based actuarial approaches do not apply and exposure models, when applied, may produce significantly different results with small changes in assumptions. The Superfund Reform Act adds another dimension of uncertainty in the estimation of these liabilities. The Superfund Reauthorization Act, as proposed, has sweeping changes which could have a significant impact on these liabilities. A large portion of these liabilities may be addressed via a premium tax. Given these uncertainties, one approach to evaluating environmental liabilities may be to examine the reasonableness of the reserves from a number of perspectives including comparison to industry averages and consistency over time.

We have used actual data for Company A from its 1992 10-K, adjusted by an arbitrary scale factor to obscure its identity, to illustrate benchmarks an insurance company might consider in evaluating its environmental liabilities.

Environmental Reserve Analysis
(Dollar Amounts in Millions)

	Calendar Year		
	1992	1991	1990
Company A Net Losses:			
(1) Loss & ALAE Paid During Year	$108	$122	$62
(2) Loss & ALAE Incurred During Year	$184	$122	$83
(3) Loss & ALAE Reserve End of Year	$216	$140	$140
Industry Net Losses:			
(4) Loss & ALAE Paid During Year	$965	$887	$675
(5) Loss & ALAE Incurred During Year	$2,047	$1,674	$1,043
(6) Loss & ALAE Reserve	$5,854	$4,772	$3,985
(7) Loss & ALAE Reserve End of Year/Loss & ALAE Paid During Year:			
(a) Company	2.0	1.1	2.3
(b) Industry	6.1	5.4	5.9
(8) Losses & ALAE Reserve End of Year/Loss & ALAE Incurred During Year:			
(a) Company	1.2	1.1	1.7
(b) Industry	2.9	2.9	3.8
(9) Ratio of Company A Loss & ALAE Paid to that of Industry	11.2%	13.7%	9.2%
(10) Ratio of Company A Loss & ALAE Incurred to that of Industry	9.0%	7.3%	8.0%
(11) Ratio of Company A Loss & ALAE Reserves to that of Industry	3.7%	2.9%	3.5%
(12) Company A GL Written Premium Market Share (adjusted for Reinsurance)	4.5%	4.5%	4.5%

(4), (5) and (6) from A.M. Best's report entitled "Environmental/Asbestos Liability Exposure: A P/C Industry Black Hole."

The following observations can be made about Company A reserve levels:

(1) Company A's reserves appear to be less adequate than industry reserves. (Line 7a versus 7b and 8a versus 8b)

(2) Company A's share of losses paid has been 11.5% (line 9) and its share of losses incurred is approximately 8% (line 10). Its market share based on GL premium is 4.5%. The payment and incurred ratios to date indicate that Company A's share of ultimate losses might be higher than its 4.5% premium share. This suggests several possibilities, two of which are as follows:

(a) Company A's GL market share may not be representative of its share of industry losses because of higher than average exposure to insureds with environmental liability exposures.

(b) Company A's share is higher initially but will drop down to its GL written premium market share because most of Company A's exposure is in states where the environmental case law is more developed than for an average state, or its limits are lower.

(3) Company A's reserves can fund 2 years of payments, compared to industry reserve levels which provide for 6 years of payments. (Line 7a versus 7b for 1992)

(4) Company A's reserves provide for 1.2 years of IBNR losses compared to an industry level of 3 years (Line 8a versus 8b for 1992). IBNR provides for true unreported claims as well as adverse development on reported claims. Due to the uncertainty associated with coverage issues, initial case reserves may be low even for claims that settle for significant amounts.

While reviewing the environmental liability reserve levels for Company A it might be instructive to review them in the context of what might be needed if Company A selected a reserving approach based on analysis of the U.S. insurance industry data. The following table displays the estimated paid losses through year-end 1993 for the U.S. insurance industry and some critical observations that can be inferred from the U.S. insurance industry experience.

ESTIMATED PAYMENT PATTERN
U.S. INSURANCE INDUSTRY
ENVIRONMENTAL LOSSES

	Calendar Year	Estimated Insurance Industry Payments (in Millions)
1.	1985 and Prior	$500.0
2.	1986	237.8
3.	1987	255.3
4.	1988	360.8
5.	1989	468.1
6.	1990	674.8
7.	1991	886.5
8.	1992	964.4
9.	1993	1,060.8
10.	**Total**	**$5,408.5**
11.	Estimated Ultimate U.S. Insurance Industry Losses	$70,000
12.	Paid Loss Development Factor at December 31, 1993	13
13.	Expected percentage of Losses Paid at December 31, 1993	7.7%
14.	Reserve to Average Calendar Year Paid Factor at December 31, 1993 (Assuming Average Calendar Year Payment of $1 Billion)	65

(1):	Estimated based on subsequent payments
(2) - (5):	Estimated From Rand Study entitled "Superfund and Transaction Costs"
(6) - (9):	A special report entitled "Environmental Asbestos Liability Exposures: A P/C Industry Black Hole" by A.M. Best Company dated March 28, 1994.
(11):	See Attachment A.
(12):	(11)÷(10)
(13):	(10)÷(11)
(14):	(70,000 - 5408.5)/1,000

Some of the U.S. industry statistics that are helpful in the evaluation of Company A's reserve levels are outlined below:

- Percentage of losses expected to be paid through December 31, 1992
  [(10) - (9)] / (11) 6%

- Multiple of payments indicated as of December 31, 1992 for industry reserves to be fully funded assuming average calendar year payment of $1 billion
  [(11) - (10) + (9)] / 1,000 66

Assuming average annual payments of $100 million for Company A and a multiple of 66 as indicated above, Company A's ultimate losses could be $6.6 billion. Thus indicated reserves as of December 31, 1992 would be $6.2 billion ($6.6 billion - $0.4 billion estimated paid through December 31, 1992).

Assuming that 6% of ultimate losses are paid through December 31, 1992, the ultimate loss level for Company A is expected to be $6.7 billion ($0.4 billion / 0.06). Thus indicated reserves as of December 31, 1992 are $6.3 billion ($6.7 billion - $0.4 billion).

Using either one of the above approaches, Company A appears to be significantly underreserved with respect to what might be ultimately needed.

Another test that is helpful to Company A would be to compare itself to its peers. The following chart displays the reserves as of December 31, 1992 expressed as a multiple of average calendar year payments for three stock insurance companies using data from 12/31/92 10-K's.

SURVEY OF ENVIRONMENTAL LIABILITY RESERVES*
FOR A SELECTED GROUP OF COMPANIES
(All Dollar Amounts in Millions)

	(1)	(2)	(3)	(4)	(5)	(6) = (5)/(4)
	Calendar Year Payments					
	1990	1991	1992	Average Annual Payment	Reserve @ 12/31/92	Reserve To Annual Payment Ratio
Company 1	$55	$30	$55	$47	$734	15.6
Company 2	18	52	55	42	435	10.4
Company 3	72	102	131	102	340	3.3

Source: 1992 10-K's

*Includes Asbestos and Other Toxic Tort Claims

As in the case of Company A, these sample companies are posting reserves less than the 65 factor that our analysis for the U.S. insurance industry implied. However, Companies 1 and 2 show higher reserve ratios and are arguably more adequately reserved than Company A.

While some companies might be justified in using a factor less than 65, a factor higher than 65 may be appropriate for companies that are paying environmental claims at a rate significantly slower than industry levels. Given the long term nature of these liabilities, an argument could be made that a factor less than 65 is reasonable. For example, industry net payments of $1 billion per year in a perpetuity at 5% interest would be funded by $20 billion, implying a factor of 20.

The values described above could be altered by multiples (even orders of magnitude) based on court decisions on coverage terms, reinsurance treatment, etc.

MARKET SHARE MODEL

The market share model requires an estimate of the total cost to the insurance industry associated with inactive waste sites. Attachment A provides an illustration of how the total industry costs may be estimated. The cost for a specific insurance company is estimated based on the company's share of the total insurance industry cost.

The specific calculation is described below:

1. Total company and U.S. insurance industry general liability (GL) and Commercial Multi Peril (CMP) direct premiums written in the time period 1950-90 are compiled. We are only interested in GL and CMP premiums because these coverages are expected to generate the majority if not all of the insurance industry losses associated with inactive hazardous waste sites. We are interested in the years 1950-90 because those years are expected to generate the majority of the environmental losses.

2. Based on the information compiled in Step 1 above, individual insurance company direct premium as a percentage of total U.S. industry direct premium is calculated for the time periods 1950-55, 1955-60, 1960-65, 1965-70, 1970-75, 1975-80, 1980-85 and 1985-90.

3. Expected U. S. insurance industry environmental losses are then allocated to the five-year intervals described above using a basis such as the following:

   a. Years of operation of the sites[3]: This is a proxy for years of dumping and is expected to provide a measure of the liability due to hazardous waste sites under the exposure trigger; or

   b. Year of discovery of sites: This basis of allocation provides a measure of liability based on the discovery trigger.

4. Individual company losses are estimated as the product of the percentage estimated in Step 2 and US insurance industry environmental losses estimated in Step 3 for each applicable five-year interval. These estimates may need to be modified based on some additional factors. For example, if, an insurance company insured a high percentage of Fortune 500 companies or companies most often listed as PRPs, then, its exposure may exceed its market share as determined in Step 2.

5. The result of Step 4 is an estimate of direct ultimate losses. The net ultimate losses may be estimated based on individual insurance company's reinsurance programs. Some statistics that might be helpful in the estimation process include net to direct ratios exhibited by reported losses to date and written premiums.

The procedure described above applies to primary companies. For reinsurers, a similar approach may be used with one modification. The modification occurs in

[3] The attached Exhibit 5 displays an allocation of costs to 5 year interval for a select number of NPL sites based on data published by the EPA (this data is discussed in a later section of the paper).

Step 2 and involves analyzing a reinsurer's assumed premium as a percentage of total direct premium to determine its share of the market. Additionally, the reinsurer's market share may have to be modified downwards because it is expected that the reinsurer's share would be lower than what its market share would otherwise indicate. This is because losses due to waste sites are expected to be spread over many years and many insureds, and therefore, may not expose the reinsurer as much as the primary company. (Steps 4 and 5 above would require a primary company's market share to be increased based on the same logic.) Additionally, special adjustments may be necessary for companies which write a significant amount of excess and claims made coverage.

The following table displays an estimate of the total cost for Company A based on the method discussed above[4].

MARKET SHARE MODEL

($ Billions)

1) Selected Insurance Industry Total Costs Due to Inactive Waste Sites	$70
2) Percentage of Primary GL Market Written by Company A	6%
3) Adjustment for Company A's Relative Exposure (10% Greater Due to Concentration of Insureds Which are Chemical Companies)	110%
4) Estimate of Losses Ceded to Reinsurers	25%
5) Estimated Ultimate Cost - Company A (1)x(2)x(3)x[1-(4)]	$3.5

Therefore for Company A, the cost estimate associated with inactive waste sites is roughly $3.5 billion.

[4]For simplicity, the industry losses are not separated into 5 year periods.

EXPOSURE MODEL

The exposure model separately estimates the costs for reported claims and incurred but not reported (IBNR) claims. We first discuss the cost estimation procedure for reported claims. The cost estimation procedure for IBNR claims is discussed later in this section.

The costs due to inactive waste sites can be divided into the following categories:

- Clean up costs;
- Remedial Investigation / Feasibility Study costs (RI/FS);
- Third party claim costs;
- Allocated loss adjustment expense costs (ALAE);
- Declaratory judgment action costs (DJA); and
- Unallocated loss adjustment expense costs (ULAE).

The data required for the analysis includes the following information from insurer records:

- Reported claims and notifications per site and per PRP.
- Coverage terms-retention, limits, applicable exclusions, etc.
- Insurer estimates of costs (in total or in the categories listed above), likelihood of exposure, likely share of total clean-up costs for each insured, etc.
- Reinsurance attachment points, limits, and policy terms.

The insurer information can be supplemented by EPA data available in the following five databases.

- Comprehensive Environmental Response, Compensation and Liability Information System (CERCLIS);
- Site Enforcement Tracking System (SETS);
- Superfund Comprehensive Accomplishment Plan (SCAP);
- Record Of Decision (ROD); and

- State books.

CERCLIS

CERCLIS contains a significant amount of information on each site identified by the EPA (not just the NPL sites). The information is site specific and a few of the fields listed on the databases are:

- Name of the site;
- Location of the site;
- The physical classification of the site (e.g. ground water contamination, dioxin, housing area);
- Status (NPL, non-NPL); and
- Discovery date of the site.

While there are over 250 fields in CERCLIS, CERCLIS does not include a list of the parties who dumped at the site (PRPs), the expected future costs associated with cleaning up the site, the actual expenditures to date associated with the site, or information regarding the dates the site was used/closed. That information comes from other sources.

SETS

The SETS database contains a list of PRPs identified by site. These PRPs may or may not have yet filed claims with their insurance carriers. To the extent that this list agrees with the insurers' claim notifications, it represents reported claims. To the extent that policyholders are included in the SETS list but have not yet filed claims, these sites represent potential IBNR reports.

SCAP

The next database, SCAP, contains actual expenditures by site. The expenditures are divided into approximately 50 categories, which can be aggregated into two broad types of expenditures:

- Remedial Investigation/Feasibility study (RI/FS) expenditures; and

- Actual clean-up costs.

The RI/FS expenditures represent the costs associated with investigating the site and determining how to best clean up the site. These costs are often significant. Both RI/FS costs and actual clean-up costs are not available for all sites.

ROD

The next database, ROD, contains information on clean-up costs estimated by the EPA at individual sites. The record of decision (ROD) is a formal estimation procedure employed by the EPA.

The following information is available on ROD:

- The date the ROD was established;

- Estimated initial clean-up costs;

- Estimated cost to monitor the site once the initial clean-up is complete;

- Number of years of annual maintenance;

- Whether the estimated costs are undiscounted or discounted; and

- Owner of the site (sometimes).

The ROD database also contains information on the physical condition of the site. In many cases the EPA delineates cost summaries by technology employed to clean up a site.

Of the 1,300 sites on the NPL list, about 600 have RODs. Of the remaining non-NPL sites RODs have only been completed on a small percentage of the population of sites, but it is anticipated that approximately 60% of the 37,000 potential sites will not require a ROD as the site will not need to be cleaned up.

State Books

The last data source is the state books. The state books contain, among other things, the number of years the site was in operation, the year the site was closed, nature of ground water contamination if applicable and proximity of neighborhoods to the site.

Description of Exposure Model - Known PRPs/Sites

The model estimates ultimate losses associated with reported claims (situations where a PRP has notified the insurance company of its exposure at a site) for clean-up costs, RI/FS costs, third party claim costs and ALAE. Estimates of costs for ULAE, Declaratory Judgment Actions (DJA) and IBNR are prepared separately.

The key steps in the model are as follows:

1. Identify reported claims for each PRP and site combination

2. Estimate costs by site from EPA data, insurer data and other sources

3. Allocate the costs by year for each site

4. Apply the PRP share to the step 3 results

5. Apply policy limits and reinsurance retention by year/PRP/site

6. Adjust for the probability that insurance coverage applies

7. Repeat steps 1-6 for each PRP/site combination and aggregate to obtain the total insurer cost estimate for reported claims

This model can be envisioned in the following manner by site. First, PRPs are identified by site. Step 2 involves estimating the clean-up and RI/FS costs by site. If a ROD estimate from EPA is available this may be used, otherwise, clean-up and RI/FS costs can be estimated. (For example, we would expect similar sites in the same general area to have similar costs.) Next, costs are spread to year and PRP based on the assumed legal coverage theory and known or estimated PRP shares. These costs are then increased for deficiencies in EPA estimates, third party costs, legal expenses, ALAE, etc. Some costs (e.g., third party costs) may be estimated as a percentage of the clean-up costs on the assumption that these costs are likely to be correlated with clean-up costs.

Next, specific coverage items are considered (self insured retentions, aggregate limits and reinsurance). The result of the first four steps is the anticipated cost to the insurance company assuming that all inactive waste site exposures are covered (i.e. insurance company does not win on any coverage defense issues). Lastly, the probabilities of coverage responding are applied to certain cost items (to clean-up costs but not legal costs).

Site Identification and Cost Estimates

Based on insurance company records, known PRPs and exposure years can be identified. The sites on which PRPs are exposed can be identified from both insurer records and EPA databases.

For example, from EPA data sources, a record can be created to reflect :

- The insured (PRP);
- A cost estimate for the site (clean-up, etc.); and
- The number of years the site was in operation.

Cost Allocation by PRP and Year

Next, costs by site need to be spread to year and PRP.

There are several legal theories that can be used to spread the loss estimate to individual years. Potential triggers are:

- Exposure;
- Manifestation;
- Continuous; or
- Actual injury.

If the applicable trigger were the exposure trigger, the losses might be spread equally to the years the site was used (years of operation of the site may be used as a proxy if more detailed information is not available). Similarly, loss estimates under alternative triggers can be calculated.

Next, the PRP share by site/year may be estimated as (a) 1/n where n is the number of PRPs on the site or (b) 1/n adjusted to reflect the relative size or degree of responsibility for the PRP. A size adjustment would be based on the theory that a larger PRP is more likely to be able to pay and may have contributed more to the environmental impairment than a smaller PRP. One measure of degree of responsibility might be how often the PRP is on an EPA site list. Another measure of size is whether or not the PRP is a Fortune 500 company.

For example, if 20 PRPs are named at a site, one estimate of a specific PRP's share for the site would be 5%. However, a Fortune 500 chemical company should probably be assigned a share greater than 5%.

Policy Terms and Reinsurance

In the next phase, policy provisions and reinsurance are applied to estimate individual insurance company shares of these losses under the assumption that coverage applies. For example, if the above mentioned procedure resulted in $1,275,000 of losses per year for a specific PRP insured, and if the insurance company only wrote policy limits of $1,000,000 per year (in aggregate), then the insurance company's indemnity exposure would be capped at $1,000,000 per year.

Probability of Coverage

The last step would be to incorporate the probability that coverage applies to the estimates by site/PRP/year. This probability is based on the jurisdiction and the insurer's coverage defenses. The probability of coverage responding is a rather complex item which would most likely vary by:

- The coverage defenses postulated by the insurance company;
- The state; and
- The year (ISO introduced a pollution exclusion in 1973 and a second stronger exclusion in 1986, and many companies follow ISO forms.)

The probability of coverage responding may best be thought of as a matrix by year:

PROBABILITIES OF INSURANCE
COVERAGE RESPONDING

	State	
Coverage Defense	A	B
Clean-up Costs Not Damages as Defined in CGL Policy	XX%	XX%
Clean-Up Costs Excluded Due to Pollution Exclusion	XX%	XX%
Coverages only applies if Damage is not Expected or Intended	XX%	XX%
Owned Property Exclusion	XX%	XX%
Late Notice of Occurrence	XX%	XX%

Total Costs

The above procedure is performed by site/PRP/year combination and the results aggregated to determine the insurance company's potential reported exposure for a PRP. All insured PRPs can then be aggregated to estimate the insurance company's potential exposure.

DJA, ULAE and IBNR costs are described in the next sections.

Declaratory Judgment Action (DJA) Costs

DJA costs represent the costs associated with litigating coverage issues (e.g., whether a CGL policy responds to Superfund clean-up).

The DJA costs may be estimated based on:

- Average DJA expenditures per site and PRP;
- Expected number of future claims (PRP/site notifications);
- A factor reflecting the fact that over time as coverage issues become more well defined, costs may be reduced; and
- Inflation in legal expenditures.

The following table displays a sample calculation for a hypothetical insurance company:

	ABC Insurance Company	
(1)	Average Historical DJA Costs Per Site per PRP	$750,000
(2)	Estimated Future Site/PRP Combinations Involving DJA Litigation	100
(3)	Factor Reflecting More Clearly Defined Case Law	50%
(4)	Inflation Factor for Legal Fees	1.2
(5)	Estimated Future DJA Costs (1)x(2)x(3)x(4)	$45 Million

ULAE Costs

One method to estimate ULAE costs is to estimate:

- Average annual ULAE costs;
- The number of years in the future for which ULAE costs will be incurred; and
- Inflation in claims adjustment costs.

For example, many insurance companies have established a special work force of claims personnel dedicated to handling only environmental claims. If we assume:

(1) A unit generates annual salary and benefits of $350,000;

(2) Wage and benefit inflation of 5% per year; and

(3) Environmental claims take 30 more years to be settled,

then, the estimated ULAE reserve is equal to
$(350{,}000)(1.05)+(350{,}000)(1.05)^2+\ldots(350{,}000)(1.05)^{30}$ or approximately \$24.4 million.

IBNR Claims

IBNR claims may result from the following:

(1) Known PRPs being named at future sites; and

(2) Unknown PRPs being named at known and future sites.

The cost of IBNR claims can be calculated by PRP for known PRPs at future sites based on:

- Anticipated number of sites where an insured (PRP) will be named;
- Estimated cost of the sites (including clean-up; RI/FS costs, third party costs and ALAE costs);
- The PRP's share at IBNR sites (PRP shares at known sites may be used as a proxy);
- Insurance company coverage response probability (again information at known sites may be used as a proxy); and
- Coverage provisions and reinsurance.

To illustrate, assume that PRPs have been notified by the EPA on 600 sites and ultimately we expect PRPs to be notified by the EPA at 3,000 sites. Therefore our IBNR claim universe for PRPs is 2,400 sites (i.e. the maximum number of additional times that an insured could receive a PRP letter is 2,400). Based on the 600 sites for which the

EPA has identified a list of PRPs, a specific PRP is identified 60 times (10% of the time). Therefore, for the additional 2400 sites we might assume that the PRP would be named 240 times (2,400 times 10%).

Next, based on evaluating previous sites, we might estimate a clean-up cost of $33 million for each newly identified site.

Based on known sites, the PRP's average share is 5%. Based on the specific insurance company's success in arguing that coverage does not apply and on the insurer's coverage and limits, we estimate that the insurance company may be responsible for 40% of the total costs. Therefore, one estimate of the insurance company's liability for a specific PRP's IBNR exposure is:

	Insurance Company's Estimated Liability for Newly Identified Sites	
(1)	Estimated Number of Future Sites	2,400
(2)	Estimated PRP Exposure at Future Sites	10%
(3)	Estimated PRP IBNR Sites (1)x(2)	240
(4)	Average Cost of Newly Identified Sites	$33 Million
(5)	PRP Share	5%
(6)	Insurance Company Coverage Probability*	40%
(7)	Third Party and ALAE Costs Factor	1.70
(8)	Insurance Company Liability (3)x(4)x(5)x(6)x(7)	$269 Million

*Includes coverage provisions (e.g. limits, number of years insured)

This process can be repeated for all the insured PRPs to obtain a total estimate of IBNR cost for known PRPs at future sites. Unknown PRPs at current and future sites may be reflected using a judgmental factor. These costs can then be allocated to year based on EPA information (e.g., years of operation of the future site universe).

The IBNR estimates by year plus the estimates for reported claims equal the total costs.

If the estimates of total costs are summarized in five-year intervals, these values can be compared to the results of the market share model discussed previously.

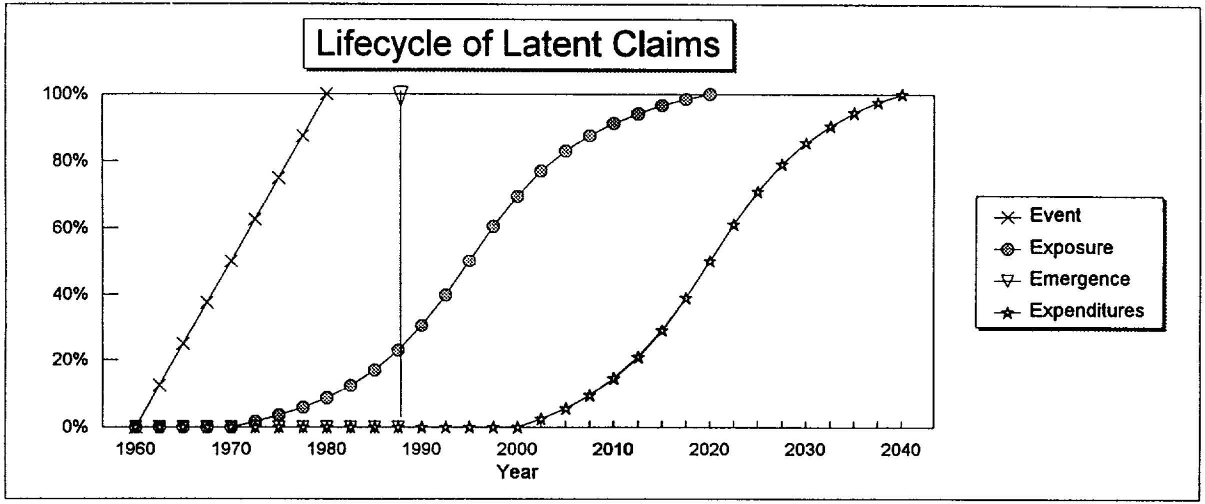
SUMMARY

This paper has outlined several methods that can be used to estimate insurance company (as well as PRP) liabilities associated with inactive hazardous waste sites. Additionally we have outlined several publicly available data elements which can assist in evaluating environmental liabilities along with summarizing the current legal issues involved in coverage disputes between insureds and insurance companies (Appendix A).

The potential liability associated with inactive hazardous waste sites is significant. Insurance companies and PRPs need to introduce procedures to attempt to monitor and quantify the potential liability.

None of the procedures described in this paper provide "the method" to analyze environmental liability exposures. For financial reporting purposes, company management needs to evaluate the details of its own exposures and judge the ultimate cost based on current facts and financial reporting principles. Management should also consider the provisions under the Superfund Reform Act of 1994 which are likely to have a significant impact on these liabilities.

Exhibit 1



<u>Notes</u>

Event -- Assumes the event stage occurs between 1960 and 1980. Company A uniformly dumps at a particular site between 1960 and 1980.

Exposure -- The chemicals start leaking in 1970 and are still leaking. Therefore the exposure stage starts in 1970 and is still occurring.

Emergence -- The effects of the exposure are known. For one particular site, this may be a point in time. However, it will be a curve for all sites.

Expenditures -- Company A makes payments to clean up the site. Cleanup at the site begins in the year 2000 with ongoing maintenance continuing until 2040.

Exhibit 2

ABC Insurance Company

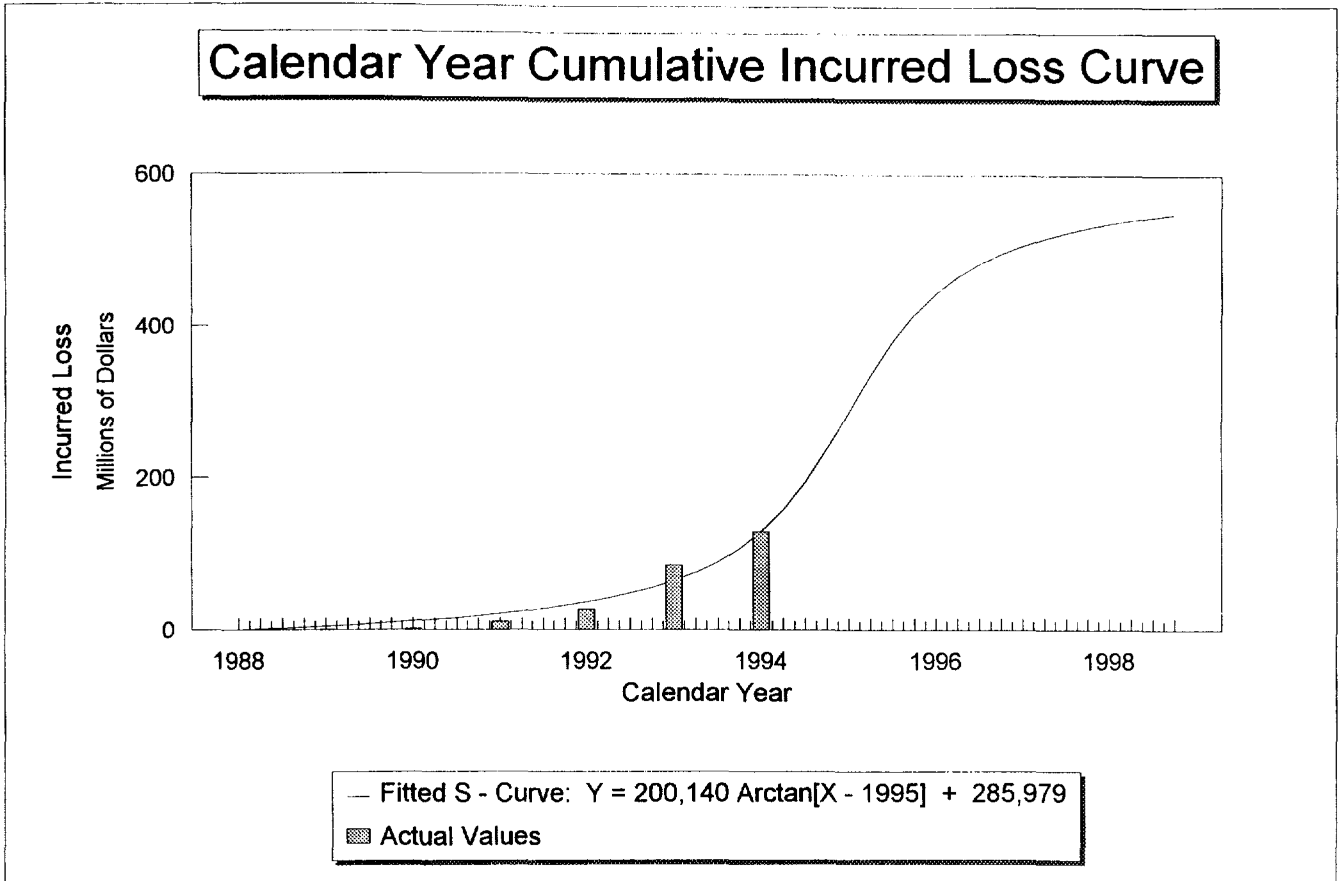
Environmental Claims

Incurred Losses

($000's)

Accident Year	At 12/88	At 12/89	At 12/90	At 12/91	At 12/92	At 12/93	At 12/94
1970	0	40	290	1,300	3,350	13,350	13,350
1971	0	150	600	600	600	800	1,200
1972	0	3	300	5,230	11,400	11,400	27,700
1973	0	50	50	600	800	5,000	7,200
1974	0	50	250	250	290	4,876	14,500
1975	0	50	40	600	620	1,690	11,800
1976	0	0	0	800	2,400	19,000	23,740
1977	0	0	0	1,000	7,300	29,300	29,300
1978 & Subsequent	0	0	0	0	0	0	0
Calendar Year Total	0	343	1,530	10,380	26,760	85,416	128,790
Calendar Year LDF	NA	NA	4.46	6.78	2.58	3.19	1.51

Exhibit 3



According to Makridakis and Wheelwright, "An S curve implies a slow start, a steep growth, and then a plateau."

Forecasting Methods for Management, Page 322.

Exhibit 4

Comparison of Development Factors

ABC Insurance Company

Environmental Claims

RAA Data For General Liability

Calendar Year	ABC Insurance Company	RAA Age to Age	RAA Accident Year Age to Age Factors
12/89-12/90	4.46		
12/90-12/91	6.78		
12/91-12/92	2.58		
12/92-12/93	3.19	12-24	3.00
12/93-12/94	1.51	24-36	1.60

An Estimate of the Allocation of NPL Clean-Up Costs to 5-year Periods

For Select NPL Sites

Period		Percentage of Total
Prior to	1901	0.64%
1901	1905	0.22%
1906	1910	0.29%
1911	1915	0.37%
1916	1920	0.41%
1921	1925	2.58%
1926	1930	2.19%
1931	1935	0.59%
1936	1940	0.81%
1941	1945	1.75%
1946	1950	2.76%
1951	1955	6.32%
1956	1960	9.99%
1961	1965	12.99%
1966	1970	15.84%
1971	1975	18.04%
1976	1980	16.88%
1981	1985	5.25%
1986	&Subsequent	2.10%

Note: In allocating costs to 5-year period, we assumed an exposure trigger and used the years of operation of the site as a proxy for years of dumping. The exposure is based on an allocation of ROD clean-up cost estimates to year for those NPL sites with available ROD cost estimates.

The approaches for estimating insurance industry liabilities due to inactive hazardous waste sites are illustrated on sheets 2 through 7 of this attachment. We have used an estimate of $70 billion throughout this paper as an estimate of the total liabilities for the U.S. insurance industry. It is important to recognize that these ultimate loss estimates are highly uncertain. For example, a special report entitled "Environmental/Asbestos Liability Exposure: A P/C Industry Black Hole" dated March 28, 1994 indicates expected environmental liabilities of $255 billion. The best and worst case estimates in that report are $60 billion and $608 billion respectively, showing the uncertainty associated with estimating these liabilities. This uncertainty stems from the fact that many of these cases have not been resolved in court yet. In addition, average clean-up costs, third party costs, PRP shares, insurer litigation costs and success of insurer coverage defenses are critical assumptions in the estimation process and are best guesses at this point.

The approach described in sheet 2 explicitly considers the various elements such as clean up costs, ALAE costs, etc. for which the insurance industry would be responsible with respect to inactive hazardous waste sites. The only item that is not considered is the payment associated with natural resource damages. The PRPs, and hence, the insurance industry, may be required to share in the cost of restoring natural resources damaged by pollutants to their original form. The cost for this element is not considered because there is very little information available on this issue. Sheet 2 provides the ultimate loss estimate for the insurance industry using a set of what might be considered reasonable assumptions. The notes on sheets 3 and 4 explain some of the thought process that underlies our assumptions.

It is important to understand that there is uncertainty associated with each of those assumptions and more than one set of assumptions may be considered reasonable. To illustrate this uncertainty, we have included results based on a variation of the critical assumptions. Sheet 5 provides results based on these alternate assumptions.

Sheet 6 outlines an alternate method where the insurance industry ultimate loss payments are estimated as a percentage of total national expenditures related to clean-up activity.

Sheet 7 summarizes the results of various estimates of ultimate environmental liabilities.

Based on review of results in sheets 2, 5, 6 and 7 we selected $70 billion as the ultimate loss estimate for the U.S. insurance industry for the illustrations in the paper.

Estimated Ultimate Insurance Industry Liability Due to Inactive Hazardous Waste Sites

Dollar Amounts in Millions

Attachment A
Sheet 2

		Scenario A
(1)	Expected number of ultimate NPL sites	**3,000**
(2)	Estimated clean up cost per site	**$33**
(3)	Estimated RI / FS cost per site	$2
(4)	Estimated total clean up and RI / FS cost for NPL sites [(1)×{(2)+(3)}]	$105,000
(5)	Estimated expected number of non-NPL sites	**15,000**
(6)	Estimated clean up and RI / FS cost per non-NPL site	**$5.0**
(7)	Estimated total clean up and RI / FS cost for non-NPL sites [(5)×(6)]	$75,000
(8)	Total clean up cost at NPL and non-NPL sites [(4)+(7)]	$180,000
(9)	PRP share of (8)	**50%**
(10)	Total PRP clean up cost responsibility [(8)×(9)]	$90,000
(11)	Third party costs [25% of (10)]	$22,500
(12)	Insurance Industry portion of PRP share if coverage were to apply 100% of the time	60%
(13)	Insurance Industry cost if coverage were to apply 100% of the time [((10)+(11))×(12)]	$67,500
(14)	Probability that coverage applies	**50%**
(15)	Insurance Industry Indemnity cost [(13)×(14)]	$33,750
(16)	ALAE / ULAE / DJA costs as a percentage of total indemnity costs	60%
(17)	ALAE / ULAE / DJA costs [(15)×(16)]	$20,250
(18)	Total cost to the industry for Indemnity, ALAE, ULAE, DJA costs [(15)+(17)]	$54,000

Notes	Source
(1) (a) EPA estimates that the number of NPL sites by the year 2000 would be 2,100. (Currently there are approximately 1,200 NPL sites and 37,000 CERCLIS sites.)	Coming Clean: Superfund Problems Can Be Solved Prepared by Office of Technology and Assessment (OTA) (October 1989)
(b) OTA estimates that the number of NPL sites by the year 2000 would be 10,000.	Coming Clean: Superfund Problems Can Be Solved Prepared by Office of Technology and Assessment (OTA) (October 1989)
(c) Hazardous Waste Remediation Project (HWRP) of the University of Tennessee estimates that based on current policies for adding sites on CERCLIS and designating sites to the NPL, the number of sites in CERCLIS would grow to over 75,000 producing approximately 3,000 NPL sites. HWRP estimates a plausible upper bound of 6,000 NPL sites.	Cleaning Up Hazardous Waste: Is There a Better Way Prepared by Orin Kramer & Prof. R. Briffault (January, 1993)
(2) (a) EPA estimates average cost of completed cleanup excluding non-federal transaction costs at $30 million per site.	Cleaning Up Hazardous Waste: Is There a Better Way Prepared by Orin Kramer & Prof. R. Briffault (January, 1993)
(b) In 1990, EPA estimated that construction costs would approximate $25 million per site.	A Management Review of the Superfund Program prepared by EPA (June, 1989)
(c) The 1992 RAND study estimates the average cost to cleanup existing NPL sites at $25 to $33 million per site.	Superfund and Transaction Costs Prepared by RAND (ICJ) (1992)
(d) HWRP estimates that the average cost of remediation per site would ultimately rise to approximately $50 million per site.	Cleaning Up Hazardous Waste: Is There a Better Way Prepared by Orin Kramer & Prof. R. Briffault (January, 1993)
The cleanup cost estimates cited in (2)(a)-(d) do not consider increases expected if guidelines established by SARA are strictly followed.	Cleaning Up Hazardous Waste: Is There a Better Way Prepared by Orin Kramer & Prof. R. Briffault (January, 1993)
(3) We assumed an average of $2 million per site or 5% of average clean up costs for RI/FS costs.	
(5)(6) There are 37,000 sites in the Nation's inventory. More than half of these sites would need no action beyond initial investigation. We assumed that approximately 15,000 sites will need some action on a non-NPL basis. We estimated that the clean-up and RI/FS cost at non-NPL sites would approxiamte 15% (or $5 million) of the cost per NPL site.	
HWRP study cites that most cleanup activity at non-NPL sites is removal of waste rather than remediation. They used clean-up cost estimates of $1 million to $3 million for non-NPL sites in their study.	

Notes		Source
(9) (a)	PRP's are estimated to pay 50% of the total cost for the cleanup of current NPL sites.	A Management Review of the Superfund Program Prepared by EPA (June, 1989)
(b)	PRP's are estimated to pay 45% of the total cost for the cleanup of current NPL sites. It is likely that PRP's may be responsible for a larger share at non-NPL sites because of more PRP initiated actions at non-NPL sites.	Report to the Congress of the United States - An Overview of Superfund Reauthorization Issues Dated March 29, 1985.
(11)	The RAND study estimated BI/PD claims accounted for 21% of the indemnity expenditures for the insurers in 1989. We selected 25%.	Superfund and Transaction Costs Prepared by RAND (ICJ) (1992)
(12)	This percentage was judgmentally selected based on our experience. The Insurance Industry will ultimately pay only a portion of the PRP cleanup costs due to self-insured retentions and policy limits.	Judgment
(14)	**Based on discussions with attorneys for PRP's and insurance companies, we selected a ratio of 50%. Also, SEC Commission member, Richard Y. Roberts, is quoted in Business Week as saying that insurers are losing 70% of the time.**	**The Hurricane Called Superfund Business Week article, August 2, 1993**
(16) (a)	The RAND study estimated that transaction costs accounted for 88% of the total expenditures for the insurers in 1989.	Superfund and Transaction Costs Prepared by RAND (ICJ) (1992)
(b)	The RAND study estimated that transaction costs accounted for 69% of the total expenditures for closed claims for the insurers in 1989.	Superfund and Transaction Costs Prepared by RAND (ICJ) (1992)
(c)	Paul Portney of Resources for the Future has cited that transaction costs are running anywhere from 30% to 70%.	Cleaning Up hazardous Waste: Is There a Better Way Prepared by Orin Kramer & Prof. R. Briffault (January, 1993)
(d)	We selected transaction costs as representing 60% of total insurer costs. This selection is based on items (a) - (c) discussed above and the expectation that as the coverage defenses get played out in court, transaction costs will go down as a % of total costs.	Judgment

Estimated Ultimate Insurance Industry Liability
Due to Inactive Hazardous Waste Sites
Dollar Amounts in Millions

Attachment A
Sheet 5

		Scenario B	Scenario C
(1)	Expected number of ultimate NPL sites	5,000	2,100
(2)	Estimated clean up cost per site	$50	$33
(3)	Estimated RI / FS cost per site	$3	$2
(4)	Estimated total clean up and RI / FS cost for NPL sites [(1)×{(2)+(3)}]	$265,000	$73,500
(5)	Estimated expected number of non-NPL sites	25,000	15,000
(6)	Estimated clean up and RI / FS cost per non-NPL site	$7.5	$5.0
(7)	Estimated total clean up and RI / FS cost for non-NPL sites [(5)×(6)]	$187,500	$75,000
(8)	Total clean up cost at NPL and non-NPL sites [(4)+(7)]	$452,500	$148,500
(9)	PRP share of (8)	75%	50%
(10)	Total PRP clean up cost responsibility [(8)×(9)]	$339,375	$74,250
(11)	Third party costs [25% of (10)]	$84,844	$18,563
(12)	Insurance Industry portion of PRP share if coverage were to apply 100% of the time	60%	60%
(13)	Insurance Industry cost if coverage were to apply 100% of the time [((10)+(11))×(12)]	$254,531	$55,688
(14)	Probability that coverage applies	70%	50%
(15)	Insurance Industry Indemnity cost [(13)×(14)]	$178,172	$27,844
(16)	ALAE / ULAE / DJA costs as a percentage of total indemnity costs	60%	60%
(17)	ALAE / ULAE / DJA costs [(15)×(16)]	$106,903	$16,706
(18)	Total cost to the industry for Indemnity, ALAE, ULAE, DJA costs [(15)+(17)]	$285,075	$44,550

ULTIMATE U.S. INSURANCE INDUSTRY LOSSES FOR INACTIVE HAZARDOUS WASTE SITES DOLLAR AMOUNTS IN BILLIONS

			COMMENTS
(1)	OTA estimate of spending by all parties on cleanup related costs	$500.00	Note 1
(2)	Estimate of national spending by all parties on cleanup related costs from inception through 1993	$30.00	Note 2
(3)	Insurance company expenditures from inception through 1993	$5.40	Note 3
(4)	Insurance company expenditures as a % of total national annual spending	18.00%	(3) / (2)
(5)	Insurance company ultimate expenditures	$90.00	(4) * (1)

NOTES:

Note 1

We have assumed that the Office of Technology and Assessments (OTA) estimate of $500 billion represents total expenditures of the nation as they relate to inactive hazardous waste sites. We have seen other reports where OTA's estimate was interpreted as being just clean-up costs without any provision for transaction costs. (Coming clean: Superfund problems can be solved, Chapter 1, prepared by OTA October, 1989)

Note 2

News report from Superfund Improvement Project (Release date February 3, 1994)

Note 3

From Chart B of our paper

Attachment A
Sheet 6

Estimates of Ultimate Liabilities for the U.S. Insurance Industry
Due to Inactive Hazardous Waste Sites

Method	Estimate (Billions)
Scenario A*	$54.0
Scenario B*	285.1
Scenario C*	44.6
Projected Based on OTA data	90.0
Estimated	**70.0** **

* These scenarios project ultimate losses based on differing assumptions regarding the ultimate number of NPL sites, the cost to clean up the sites, the number of non-NPL sites, and various other assumptions as delineated on sheets 2 and 5 of this attachment. These estimates are for the U.S. and non-U.S. insurers and reinsurers. To estimate the liabilities for the U.S. insurance industry a reduction has to be made for cessions to non-U.S. reinsurers and losses due to non-U.S. primary insurers. In making our selection for the U.S. insurance industry we judgmentally reduced the indications under scenarios A, B, and C for the non-U.S. component.

** Selection for U.S. Insurance Industry.

COMPREHENSIVE GENERAL LIABILITY INSURANCE COVERAGE OF ENVIRONMENTAL LIABILITIES

INTRODUCTION

For decades, most corporations have purchased general liability insurance policies to provide coverage for the risk of bodily injury or property damage arising out of their business operations. Members of the insurance industry, collaborating through the Insurance Services Office and its predecessor organizations, drafted the standard comprehensive general liability ("CGL") policy form in 1966, which form was subsequently revised in 1973 and 1985. As its name indicates, the CGL policy was intended to provide coverage for a broad range of liabilities, subject to its specific terms, provisions and exclusions. Most CGL policies issued during the past four decades either utilize the standard form or incorporate the key policy language from that form.

When the standard CGL policy form was initially drafted in 1966, the legal framework for environmental obligations and liabilities of industrial operations was not well-developed. Disposal of waste materials, discharge of wastewaters and emissions of exhaust gases were largely unregulated. Just as importantly, the impact of these activities upon the environment was poorly understood and generally not the subject of liability claims, whether by governmental agencies or private parties. The environmental impacts of such industrial operations came into sharper focus in the 1970's and laws were developed to prevent or respond to those impacts. Congress passed the Air Quality Act of 1967 and strongly revised it with the Clean Air

Amendments of 1970 and 1977. The Federal Water Pollution Control Act Amendments were enacted in 1972 and amended in 1977 by the Clean Water Act Amendments. Congress began to regulate waste management practices by enacting the Resource Conservation and Recovery Act of 1976 and the Hazardous and Solid Waste Amendments of 1984. Most importantly, in terms of impact on liability insurance coverage, the Comprehensive Environmental Response, Compensation and Liability Act of 1980, or "Superfund" legislation was enacted to create a system of liability for the environmental consequences of literally decades of unregulated waste disposal.

As a result of the foregoing statutes, the regulations promulgated thereunder, and similar developments in both the statutory and common law of the fifty states, industrial companies faced substantial liabilities in the 1980's that could not have been imagined just a short time before. Significantly, much of this liability was retroactive, being imposed upon these companies as a result of their actions (or those of their predecessors or others) years or even decades earlier. The most dramatic example of such liability is Superfund, under which an individual company can be held liable for 100% of the cost of remediating the environmental damages arising from a waste disposal site, simply because some portion of the waste at that site (no matter how small) is determined to have been generated by that company, regardless of how it came to be disposed at the site in question. The cost of such environmental remediation projects undertaken pursuant to Superfund have in some cases exceeded $100 million. Given the prospect of such staggering liability, potentially responsible parties ("PRPs") have become embroiled in an ever-increasing storm of litigation with governmental regulators, other PRPs and, of course, liability insurers.

Pursuant to the insuring agreement of the standard CGL policy form, liability insurers have two separate duties to their insureds: (1) to indemnify the insured for all liabilities covered by the policy, and (2) to defend any suit against the insured which, if successful, would subject the insured to a liability covered by the policy. Insurers and insureds have come to disagree strongly regarding the interpretation and application of the language of that insuring agreement, as well as certain key exclusions in the policy, so that the state and federal judicial systems have become swollen with declaratory judgment litigation seeking to resolve these disagreements.

The indemnity portion of the insuring agreement typically obligates the insurer to "pay on behalf of the insured all sums which the insured shall become legally obligated to pay as damages because of bodily injury or property damage to which this insurance applies, caused by an occurrence." The policy defines an "occurrence" to mean "an accident, including injurious exposure to conditions, which results, during the policy period, in bodily injury or property damage neither expected nor intended from the standpoint of the insured." The primary battle lines between insurers and insureds (as well as among various insurers) are initially drawn at the underlined portions of the foregoing insuring agreement and definition.

- Insurers argue that the phrase "as damages" limits the policy coverage to the insured's liability to pay monetary damages to a third-party claimant, and excludes coverage for an insured's obligation to incur the expense of performing an environmental remediation pursuant to Superfund or other legal requirement. Insureds maintain that the distinction between payment of money to environmental contractors to perform a remediation and payment of money to the government or some other third party as reimbursement for the cost of such a remediation is irrelevant for purposes of policy coverage.

- Because of the long-term and largely unseen nature of environmental contamination, insurers generally challenge any contention that bodily injury or property damage occurred during the relevant policy period. Indeed, most environmental insurance coverage disputes involve a continuing process of environmental contamination over a long period of time and a multitude of policy periods. The issue of when bodily injury or property damage occurred and which policy or policies should provide coverage is a quagmire from which few insurance coverage disputes have yet to emerge.

- Depending upon the circumstances, insurers frequently contend that insureds either expected or intended the bodily injury or property damage for which they subsequently seek coverage. Even where insureds undeniably engage in intentional acts of waste disposal, however, they contend that they did not intend and could not anticipate the property damage which ultimately arose therefrom.

In addition to the foregoing provisions of the insuring agreement, insurers and insureds litigate the meaning and application of two key policy exclusions known as the "pollution exclusion" and the "owned property" exclusion. The pollution exclusion was generally introduced to the standard CGL policy form as an endorsement in approximately 1970. It basically states that the insurance does not apply to bodily injury or property damage arising out of the discharge or release of waste materials or contaminants into the environment. In turn, however, the exclusion itself does not apply "if such discharge, dispersal, release or escape is <u>sudden and accidental</u>." Insurers contend that this exclusion significantly reduces coverage by introducing a temporal qualification which requires pollution to be abrupt or instantaneous (e.g., the result of an explosion or traffic accident) in order to be covered. Insureds respond that "sudden and accidental" means nothing more than "unexpected and unintended" and is simply an application of the basic occurrence definition to events of pollution.

The owned property exclusion generally states that the insurance does not apply to property damage to any property owned or occupied by the insured or in the care, custody or control of the insured. Regarding most Superfund liabilities, the insured has never had any interest in or control of the contaminated waste site property. Not infrequently, however, insureds become subject to liability for contamination arising from the historic discharge or disposal of waste at their own facilities. Insurers contend that such on-site property damage is excluded by the owned property provision. Insureds generally respond that, while some or all of the environmental remediation activity might take place on the property of the insured, it is legally obligated to do so in order to remediate or prevent damage to adjacent, off-site property, or the underlying groundwater which is owned or controlled by the State and not the insured.

In addition to the duty to indemnify, the insuring agreement of CGL policy form obligates the insurer "to defend any suit against the insured seeking damages on account of such bodily injury or property damage, even if any of the allegations of the suit are groundless, false or fraudulent." Insurers have argued that this defense obligation is triggered only by a judicial action brought against the insured in a court of law and does not apply to notices of potential responsibility under the Superfund statute or other administrative proceedings initiated by governmental agencies. Insureds argue that the initiation of any action which can ultimately lead to the imposition of legal obligations on the insured constitutes a "suit" which the insurer must defend. Of course, the insurers and insureds also regularly dispute whether the allegations of any such suit, if true, seek damages on account of bodily injury or property damage that is covered by the policy.

Each of the foregoing legal issues have been variously decided by the courts of different states, or by federal courts attempting to apply or anticipate the law of those states. Many states have yet to address some or all of those issues. In states where there have been judicial decisions regarding these coverage questions, the matter may not yet have come before the court of highest authority in such states. Accordingly, there remains a high degree of uncertainty regarding questions of environmental insurance coverage throughout the country. This uncertainty is the source of significant difficulty for insurers and insureds alike, as well as their outside litigation counsel and the entire judicial system.

GENERAL ISSUES OF JUDICIAL INTERPRETATION

Before it can even begin to consider the foregoing policy language in the context of an environmental coverage dispute, a court must first address certain preliminary issues that are critical to any interpretation of the policy. The most important of these is probably the choice of which state's law the court will apply in order to interpret the policy language in the case at issue. Because of the contrary positions that have been taken by the various state courts regarding the major coverage issues, such a choice of law can be dispositive of the substantive issues in a coverage dispute.

The courts of each state have developed principles for determining which state's law should control any particular lawsuit, and even these choice-of-law principles are not consistent among the various states. Traditionally, disputes regarding contracts, including contracts of insurance, are governed by the law of the state in which the contract was made. Because of the nature of the insurance underwriting process and its reliance upon local commercial insurance brokers, contracts of insurance are generally deemed to have been made in the state in which the insured's principal place of business is located. In recent years, however, courts have begun to move away from this relatively simple place-of-contract approach and to apply instead the law of the state which has the "most significant contacts" with the dispute between the parties. In contract actions generally, and environmental coverage lawsuits in particular, the state with the most significant contacts often turns out to be the same state in which the contract was made. Some litigants have argued (and courts have decided), however, that the location of the environmental contamination which is the subject of the underlying claim against the insured is the most significant contact and that the law of the state in which the contamination took place should govern the subsequent insurance coverage dispute. Of course, because the same insured may operate facilities in many different states, or may be identified as a PRP at waste disposal sites located throughout the country, that insured may be seeking coverage for environmental contamination located in more than one state. If the place of contamination is deemed to be the most significant contact which controls the choice of law, the same CGL policy can be subjected to different and conflicting interpretations pursuant to the judicial precedent in different states.

The foregoing choice of law argument between the place of contract and the place of contamination does not find either insurers or insureds consistently on one side or the other. Litigants generally argue for the application of that state law which has already been decided favorably to their own coverage position. Indeed, the same insurance companies have argued for the law of the place of contract in one coverage dispute while requesting application of the law of the place of contamination in another. As the highest courts of more and more states continue to decide the substantive coverage questions discussed herein, choice of law will increasingly become the primary dispositive issue in any environmental coverage litigation.

After choosing the applicable law, courts also apply a number of important rules of construction for interpreting any policy provisions at issue in an insurance coverage dispute. The most important such rule is contra proferentum, a judicial principal which holds that any ambiguity in an insurance contract will be strictly construed against the insurer as the drafter of the policy. In applying this rule of construction, insuring agreements are generally interpreted broadly so as to afford the greatest possible coverage to the insured, while exclusionary clauses are interpreted narrowly against the insurer.

In recognition of the fact that insurance policy forms are generally prepared by the insurer (or, as in the case of the standard CGL form, the insurance industry acting in a collaborative effort), courts require that insurance policies be construed in order to give effect to the reasonable expectations of the insured. Accordingly, where such reasonable expectations are in conflict with the intentions of the insurers expressed in technical policy language, the purported limitations of such language often will not be allowed to defeat the coverage expectations of the insured. These rules of construction apply in any case involving standard form policy language regardless of whether the insured is a small company or a large corporation with significant bargaining power and sophistication concerning insurance. Where the insurance policy in question is not a standard form policy, however, insurers argue that the insurance contract is an arms length transaction (particularly where the insured is a major corporation) and that the rule of contra proferentum should not be applied.

While most environmental insurance coverage disputes focus primarily upon the language of the policy provisions identified above, historical documentation regarding the drafting and interpretation of that language and other similar extrinsic evidence has played an important part in many judicial decisions. Insurers usually argue that the language of the CGL policy form is unambiguous and that courts should not allow the discovery or admission of extraneous materials into evidence but limit themselves to the "four corners" of the insurance contract. Some courts have so held and have denied insureds the right to obtain discovery of policy drafting history or other extrinsic documents. Insureds have consistently sought to discover and make use of such documents, and many courts have ordered insurers to produce documents regarding the drafting history of the standard form CGL policy, the representations made by insurers to state insurance regulators, internal interpretive documents of the insurers, and communications with other policy holders regarding environmental coverage claims. Many courts that have ruled in favor of insureds on the substantive environmental coverage issues have done so, at least in part, in reliance upon such extrinsic documents or evidence. As a result, the fight over the discovery and admissibility of such documents has become a significant preliminary battle in the environmental insurance coverage wars.

DUTY TO DEFEND

The duty of an insurer to defend its insured is independent of and broader than the duty to indemnify. An insurer must defend its insured against a claim if there is any possibility that the claim is covered by the policy, based solely upon the allegations against the insured. An insurer must provide a defense regardless of whether it believes an exclusion may ultimately defeat coverage, unless it is clear from the complaint that the allegations fall entirely within the scope of a policy exclusion. In an action with multiple claims against the insured, if any one of those claims gives rise to a duty to defend, the insurer must defend against the entire action.

In a typical CGL policy, the duty to defend is independent of the limits of liability which govern the duty to indemnify. In other words, the insurer must pay the cost of defense in addition to the amount of any indemnity. This is important in Superfund litigation where the defense expenses can be very significant and often continue for long periods of time before there is any determination regarding the liability of the insured. Indeed, even in cases where the insured is not ultimately held liable to pay for the alleged environmental contamination, the insurer may be required to pay substantial amounts in order to defend against the claim.

The typical duty to defend provision in the CGL policy form requires the insurer "to defend any suit against the insured seeking damages on account of such bodily injury or property damage, even if any of the allegations of the suit are groundless, false or fraudulent . . .". Insurers have argued that the word "suit" only refers to the institution of civil judicial proceedings against the insured. In contrast, the procedure for determining liability for environmental response costs under Superfund is typically initiated by a notice letter from the USEPA informing the insured that it is potentially responsible for environmental remediation at a given Superfund site. The liability for many Superfund cleanups is often resolved with little or no judicial proceedings whatsoever. Insureds maintain that any administrative or other legal proceeding, including the typical PRP notice letter issued by USEPA, constitutes a "suit" pursuant to the CGL policy which triggers the duty of an insurer to defend against that claim of liability. Although a few courts have ruled that the term "suit" is limited to civil judicial proceedings, the clear majority of courts have concluded that a PRP letter pursuant to Superfund (or other similar notice or remedial order from a regulatory agency) is a "suit" which gives rise to a duty to defend the insured.

MAJOR COVERAGE ISSUES

As "Damages"

The typical insuring agreement provides for indemnity of "all sums which the insured shall become legally obligated to pay as damages because of bodily injury or property damage . . ." Insurers have argued that the term "damages" incorporates the historical distinction in both English and American common law between an award of legal damages (i.e., a requirement to pay a sum of money to the plaintiff) and the issuance of an injunction or other form of equitable relief (i.e., the requirement to perform or refrain from a certain action which may result in certain costs to the defendant). This distinction is potentially very significant when applied to the modern context of Superfund liability. Typically, USEPA orders a group of PRPs to perform a specified environmental remedy and the PRPs allocate the cost of that remedy among themselves through a process of negotiation or litigation. In the alternative, if some or all of the PRPs fail to perform the remedy, either USEPA or a group of the PRPs will do so and then seek to recover the cost of that remedy from the non-participating PRPs. Superfund negotiations with USEPA typically result in the entry of an injunctive consent order to perform a remedy. In contrast, a successful cost recovery action by USEPA or private parties results in the entry of a damage award. Insurers contend that, while the latter might come within the scope of the insuring agreement as an obligation to pay "as damages," the former is outside the scope of that agreement and not covered by the standard CGL policy.

A minority of courts have agreed with the insurers and held that environmental response costs incurred by PRPs in order to perform a cleanup pursuant to Superfund are a form of equitable or injunctive relief (and not legal "damages") which is not covered by the CGL policy. In contrast, a large majority of courts have ruled that such a technical reading of the policy is contrary to the reasonable expectations of the insureds and have construed this language of the insuring agreement broadly in favor of coverage.

Trigger of Coverage

The standard form CGL policy provides coverage for bodily injury or property damage "caused by an occurrence" which is defined to mean an accident which results in bodily injury or property damage "during the policy period." In other words, in order to determine whether one or more CGL policies provides coverage for a given claim, a court must decide whether the alleged injury or damage occurred during the relevant policy period. This "trigger of coverage" issue is often very complex because of the continuous long-term development of the alleged damage or injury in most environmental cases and the delayed manifestation of such damage or injury. In order to resolve this issue, courts have generally resorted to one of four approaches or "triggers": exposure, manifestation, continuous or actual injury.

Some courts have held that environmental damage occurs at the time of exposure of the contaminant to the environment, regardless of when the property damage was discovered. Depending upon the circumstances, such "exposure" can consist of either a single event of waste disposal, discharge or emission, or a number of such events. Obviously, exposure through a series of discharge events over multiple policy periods could trigger coverage under more than one policy.

A number of courts have held that property damage is not deemed to exist until it becomes manifest or is discovered, regardless of when the initial exposure to contamination occurred. This manifestation trigger theory is favored and promoted by insurers for two reasons. First, it generally results in the triggering of only one policy period and precludes the stacking of policy limits for multiple policies even where the contamination or events of waste disposal took place during more than one period. Second, although the disposal or discharge events and environmental exposure may have occurred in the 1960's, the resulting property damage may not have become manifest or discovered until the mid-1970's (after the introduction of the sudden and accidental pollution exclusion), or even the mid-1980's (after the introduction of the absolute pollution exclusion). Consequently, the application of the manifestation trigger can provide a substantial benefit or even complete victory to insurers in many environmental coverage disputes.

An emerging rule in environmental coverage cases is that environmental contamination can be progressive and cumulative, and that coverage is continuously triggered during all policy periods in which the property was damaged. Under this continuous trigger theory, all policies in effect after the time of the initial release or discharge of contaminants into the environment potentially provide coverage for the resulting environmental damages.

Finally, a few courts have refused to adopt the exposure, manifestation or continuous trigger theories and instead have held that there must be "actual injury" during the policy period in order to trigger coverage. This approach requires an analysis of the particular facts of each case and often precludes summary judgment on the basis of more readily identifiable events such as the time of discharge or discovery. In actual application, this actual injury trigger may well result in coverage under multiple policy periods for environmental liabilities.

Expected or Intended Damage

Pursuant to the definition of "occurrence," the insuring agreement of the standard CGL policy only provides coverage for bodily injury or property damage "neither expected nor intended from the standpoint of the insured." The issue is whether the insured expected or intended to cause the alleged injury or damage, not whether it intended to dispose of waste materials or perform some other act which ultimately caused the damage. Accordingly, environmental property damage at a waste disposal site to which an insured intentionally and regularly shipped waste materials is not deemed to be "expected or intended" from the standpoint of the insured. In contrast, depending upon the nature and circumstances of the insured's actions, a discharge of contaminants by the insured directly to the environment can be the basis for an inference that the insured intended the alleged injury or damage.

Most courts focus upon the subject of intent or expectation of the insured in the circumstances of the case at issue, not some objective standard as to what the insured should have known or expected. Recognizing that "expected or intended" means more than just reasonably foreseeable (i.e., simple negligence on the part of the insured), some courts interpret this provision to exclude only those damages which the insured knew would flow directly and immediately from its intentional act. On the other hand, other courts have held that coverage will be excluded if there was a "substantial probability" that the damage would occur.

Pollution Exclusion

Prior to 1970, the standard CGL policies generally did not contain any policy language specifically addressing pollution or excluding liability arising from pollution events. In about 1970, the Insurance Services Office drafted a standard form pollution exclusion which was adopted by its member companies and incorporated into most CGL policies as either an endorsement or an exclusion within the policy form. The standard form exclusion provides as follows:

> This insurance does not apply . . . to bodily injury or property damage arising out the discharge, dispersal, release or escape of smoke, vapors, soot, fumes, acids, alkalis, toxic chemicals, liquids or gases, waste materials or other irritants, contaminants or pollutants into or upon land, the atmosphere or any watercourse or body of water; but this exclusion does not apply if such discharge, dispersal, release or escape is sudden and accidental.

The meaning and application of the foregoing sudden and accidental pollution exclusion has been perhaps the principal issue in the long-playing environmental insurance coverage debate between insurers and their insureds. The controversy concerns the exception to the exclusion and particularly the meaning of the phrase "sudden and accidental." Insurers contend that the word "sudden" in this exclusion has a temporal meaning and that a discharge or release of contaminants must occur abruptly or instantaneously in order to be covered by the CGL policy. Environmental damages resulting from a gradual release of contaminants over a long period of time are subject to the exclusion and not covered by the policy. A substantial number of courts have agreed with this argument and excluded coverage for "gradual" pollution.

In contrast, insureds argue that the word "sudden" means nothing more than unexpected or unanticipated, a surprise. Accordingly, the phrase "sudden and accidental" should be interpreted as "unexpected and unintended," which is the basic concept of the "occurrence" definition and a fundamental character of the risk inherent in the insuring agreement. An equally substantial number of courts have agreed with this argument of the insureds and have construed the "sudden and accidental" language so as not to exclude coverage for gradual pollution so long as that pollution was not expected or intended by the insured.

For those courts which construe "sudden and accidental" to mean "unexpected and unintended," the question then becomes what must be unintended and unexpected? The initial disposal, discharge or release of contaminants? Or the consequent damage to groundwater or some other environmental resource? For example, if an insured deliberately places waste materials into a landfill, surface impoundment or other waste management unit, and contaminants from that waste material subsequently migrate from the waste management unit to the underlying groundwater, does the pollution exclusion apply? Many cases have focused upon the consequent environmental damage and have held such unexpected and unintended damage to be covered regardless of the intentional nature of the initial act of waste disposal. Other courts have focused more closely on the actions of the insured and have held that coverage exists only where the discharge, dispersal, release or escape of contaminants was not expected or intended. In these cases, the particular facts and circumstances of the underlying contamination, including the nature of the waste or contaminants, the type and character of the waste disposal unit and the purpose of the required remediation, are critical factors in the ultimate coverage decision.

In general, extrinsic evidence from historical documents (in addition to the policy language itself) has played a significant role in many of the judicial rulings that "sudden and accidental" means nothing more than "unexpected and unintended." Those courts which have found such extrinsic materials to be both discoverable and admissible have frequently ruled in favor of the insureds regarding the application of the pollution exclusion. In contrast, those courts which have rejected extrinsic evidence and limited their consideration to the policy language are also more inclined to opt for a restrictive interpretation which excludes coverage for gradual pollution. Numerous drafting history documents and other historical materials have become exhibits for judicial consideration in a host of environmental coverage lawsuits. Perhaps the most important of these documents are the representations made by the Insurance Services Office on behalf of its member companies in connection with the submission of the pollution exclusion form for approval by the insurance regulatory authorities of the various states. Insureds contend, and many courts have agreed, that these statements on behalf of the insurers constitute evidence that the proposed exclusionary language was intended to be nothing more than a restatement of the "unexpected and unintended" requirement of the basic insuring agreement. Recently, a New Jersey court has gone even further in ruling that, on the basis of these representations to state insurance authorities, the insurers are estopped from contending that "sudden" has a temporal meaning or that the exclusion should be construed narrowly. Insureds are likely to present this same estoppel argument to other courts in the near future.

In or about 1985, the Insurance Services Office developed the "absolute" pollution exclusion which most insurers have included in general liability policies issued since that time. In rather elaborate language, this new exclusion precludes coverage for (a) bodily injury or property damage arising out of the release of pollutants and (b) costs of any environmental clean-up pursuant to governmental direction or request. Courts confronting this absolute pollution exclusion in recent litigation generally have concluded that it is unambiguous and excludes coverage for all claims alleging damage caused by pollutants. The exclusion has been held inapplicable in several cases, however, where there was a material issue of fact as to whether the substance in question was a "pollutant" within the meaning of the exclusion. Significantly, the Supreme Court of Louisiana recently found the absolute pollution exclusion to be ambiguous as a matter of law because a literal application could preclude coverage of many routine business accidents which an insured would reasonably expect to remain covered. While the court held that coverage for soil and groundwater remediation expenses arising from an underground storage tank leak were excluded, "nonenvironmental" property damage to underground telephone cables were covered. Undoubtedly, the parameters and application of the absolute pollution exclusion will continue to be tested on a case-by-case basis.

Owned Property Exclusion

The majority of environmental coverage claims involve underlying liabilities in which the insured is identified as a PRP at a Superfund site because waste generated by that insured was ultimately disposed of at the site in question. In these circumstances, the PRP typically had no ownership interest in or operational control over the waste disposal site. Indeed, the insured may have had no knowledge whatsoever regarding the ultimate destination of its waste. In a significant number of cases, however, insureds have been subjected to liability for environmental damages at facilities which they have owned or operated. Typically, such on-site environmental liabilities arise in connection with governmental enforcement actions under the hazardous waste regulations, private litigation by adjacent property owners, or environmental cost recovery claims by subsequent purchasers of the facilities in question. In such cases, the owned property exclusion of the CGL policy may limit or preclude coverage for certain damages arising from on-site environmental contamination.

Typically, the owned property exclusion provides that "this insurance does not apply . . . to property damage to (1) property owned or occupied by or rented to the insured, (2) property used by the insured, or (3) property in the case, custody or control of the insured or as to which the insured is for any purpose exercising physical control. . ." The basic principle underlying this exclusion is that liability insurance covers damage to the property of third parties, whereas damage to the insured's own property is typically covered by first-party property insurance. In general, courts have applied this exclusion to reject coverage claims where the alleged property damages are solely confined to the property of the insured and there is no contamination of underlying groundwater or adjacent, third-party property. Frequently, however, the application of this exclusion has proven to be rather complicated. Typically, contamination which may have originated on the property of the insured has either migrated to off-site property or is threatening to do so. Most courts have held that the exclusion does not apply where there has been actual off-site contamination. Some courts have even held that, where environmental remediation is required in order to prevent threatened off-site contamination, the owned property exclusion is inapplicable. Where environmental response actions are undertaken in part to remediate on-site contamination and also to prevent or remediate off-site migration of contaminants, the court must determine whether the on-site remediation costs are subject to the exclusion, or whether the exclusion is completely inapplicable and all response costs are covered by the policy.

The treatment of groundwater is perhaps the most important issue regarding the owned property exclusion. Insurers maintain that groundwater underlying owned property should be considered no different from structures upon that property, or the property itself. In other words, underlying groundwater is property owned or controlled by the insured and any damage to such property is excluded from coverage. The insureds respond that they do not own or control the groundwater which is the property of the state, so that groundwater contamination is not damage to owned property. In general, most courts which have addressed this issue have agreed with the insureds and have refused to apply the owned property exclusion to groundwater contamination. Indeed, one court recently held that the costly remediation of groundwater contamination is driven by the interest of the state in such groundwater, not by the property interests of the insured.

CONCLUSION

As of this writing, most (if not all) of the foregoing issues of policy interpretation are pending before courts in jurisdictions with no binding, determinative precedent. Many of those cases involve factual circumstances concerning the nature of the contaminating release, the environmental damages or the governmental response which may serve to distinguish them from prior judicial decisions. As a result of this ongoing judicial process, the interpretation of the CGL policy and its application to events of environmental contamination will continue to evolve and be refined.

Readers interested in any citations to judicial decisions regarding the issues discussed in this article are encouraged to contact the author.

Recognition, Measurement and Disclosure of Environmental Liabilities

by Paul Kazenski

Recognition, Measurement, and Disclosure of Environmental Liabilities

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Recognition, Measurement, and Disclosure of Environmental Liabilities

Paul M. Kazenski

During the past fifteen years, environmental legislation has proliferated at the federal, state and local levels. Businesses operating in the United States are now faced with the challenge of achieving and maintaining compliance with over 30,000 pages of federal regulations alone. Estimates of the potential costs to remediate past environmental damage run into the hundreds of billions of dollars. By the year 2000, businesses are expected to expend billions of additional dollars to assure that current and future operating activities achieve and maintain environmental compliance.

There is evidence that corporate executive and director attitudes have begun to reflect a greater awareness of, and increasing sensitivity to environmental issues (United Nations, 1991a, 1991b; Nash, 1990; Coopers et al, 1990). However, much of this same evidence shows a disparity between the perceived importance of environmental issues, and the quality of environmental disclosure in publicly available financial statements. In part, the existence of this disparity has been tentatively attributed to a lack of detailed accounting standards relating to environmental issues, and to a reluctance on the part of corporate management to fully apply existing standards that would facilitate more complete disclosure (United Nations, 1992).

To deal with the demands for improved financial reporting, the accounting profession must confront fundamental questions relating to *timing* (i.e., determining when a loss become sufficiently probable to require accrual and recognition in the financial statements), *recognition*, (i.e., formally recording or incorporating an item into the financial statements), *recognition*, (i.e., formally recording or incorporating an item into the financial statements), *measurement* (i.e., determining the value at which to record a probable loss), and *disclosure* (i.e., given the uncertainties surrounding the loss, determining where (and how) in the financial statements the facts should be communicated). These questions are closely interrelated, and will almost certainly require reliance on outside expertise to provide the information necessary to make informed professional judgments.

This paper undertakes to review current standards and practices with regard to the recognition, measurement, and disclosure of environmental related liabilities in corporate financial statements. Its purpose is twofold: to establish the nature and extent of current requirements and practices; and to identify emerging trends likely to result in demands for still more detailed disclosure.

Overview

Policy makers, advisory groups, and professionals worldwide have begun to address the issues related to establishing standards for improved financial reporting of environmental costs and liabilities. In the United States, the American Institute of Certified Public Accountants (AICPA) has issued an exposure draft on a proposed Statement of Position which would call for more complete disclosure of certain significant risks and uncertainties, including those relating to environmental matters. The Securities and Exchange Commission (SEC) recently revised regulation S-K to require additional disclosures of material effects of regulatory compliance on capital expenditures, earnings, and competitive position. Although no environmentally related reporting issues have yet been added to the Financial Accounting

Standards Board's (FASB) agenda, the likelihood that the Board will be called upon to do so is increasing (Johnson, 1993).

In 1992 and 1993, the Canadian Institute of Chartered Accountants (CICA) issued research reports directed towards resolving fundamental issues involved in the financial reporting of environmental costs (CICA 1993), and accounting's role in environmental auditing (CICA 1992). The United Nations, European Community, International Accounting Standards Committee (IASC) and the Federation des Experts Comptables Europeens (FEE) are all actively seeking solutions to the problems underlying the financial statement recognition and disclosure of environmental liabilities.

Motivating these activities is increasing apprehension over the disparity between the estimated costs to remediate already known environmental damage, and the amounts being reflected in corporate balance sheets. In the U.S., specific concerns have been raised with respect to the apparent lack of symmetry between the anticipated insurance recoveries being used to offset all or part of these liabilities, and the failure of insurers to disclose a corresponding liability in their own financial statements (GAO, 1993).

In turn, insurers and non-insurers alike cite the complexity of existing environmental regulations as a major impediment to making cost estimates required for financial reporting. Further, insurers point to inconsistent judicial decisions regarding the existence of insurance coverage for environmental losses as a confounding factor in determining whether they have any obligation at all to satisfy environmental claims.

Presently, there are five major U.S. statutes that can impose substantial costs on business enterprises relating to past, current and future activities. Of these the Clean Air Act

(CAA: 42 USC 7401 et seq.), Clean Water Act (CWA: 33 U.S.C. 1251 et seq.), Toxic Substances Control Act (TSCA: 15 USC 2601 et seq.), and the Resource Conservation and Recovery Act (RCRA: 42 U.S.C. 6901 et seq.) are primarily directed at the control of present releases into the environment, and the prevention of future releases of hazardous substances. The financial costs imposed by these statutes are generally considered to be operating expenses of the enterprise, and as such present no particular difficulties for insurers.

The most far reaching of the statutes is the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA: 42 U.S.C. 9601 et seq.) and its companion Superfund Amendment and Reauthorization Act (SARA) of 1986. CERCLA addresses the uncontrolled release of hazardous materials into the environment caused by past activities, and requires remediation at sites where the release of hazardous substances is likely to occur. Two facets of the act are of most most immediate relevance here. The first is its imposition of strict, joint, and several liability for the costs of cleanup on potentially responsible parties (PRP's) that can include almost anyone that has come into possession of hazardous waste, including subsequent purchasers of property even though there was no connection between the purchaser and the pollution activities occurring prior to acquisition (N.Y. v Shore Realty 759 F2d 1032, 2d Cir 1985). The second, and perhaps most ominous, is that "it has no regard for time" (Becker, 1992). Liability is imposed retroactively and without any statute of limitations; it is based upon current standards and does not exempt prior activities that were in compliance with standards existing at the time they occurred.

Financial accounting and reporting concerns extend to all environmental costs, whether associated with past, current, and future activities. In light of their more immediate significance to insurers, however, the remainder of this paper emphasizes issues raised by the retroactive liabilities imposed by CERCLA.

Fundamental Accounting and Reporting Issues

Financial reporting is "directed toward the common interest of various potential users in the ability of an enterprise to generate favorable cash flows" (Statement of Financial Accounting Concepts (SFAC) No. 1). To serve this common interest, both accurate and complete disclosure are necessary to assure that the financial statements are not misleading to investors, creditors and other users.

Environmental liabilities present some particularly difficult financial reporting challenges because of the uncertainties to which they may be subject, many in the nature of contingencies. Consequently, accounting guidance is taken primarily from Statement of Financial Accounting Standards No. 5, "Accounting for Contingencies" (FAS 5) which requires that a contingent loss be accrued (recognized) when it is "probable that an asset had been impaired or a liability had been incurred" and "(b) the amount of loss can be reasonably estimated." If a loss is not required to be recognized because either of these criteria are not met, disclosure of the contingency may still be necessary if there is "at least a reasonable possibility" that a loss may have been incurred.

The language in FAS 5, though not specifically stated, also applies to insurance company accruals of liabilities relating to litigation and claims, whether asserted or unasserted. Where a suit has been filed or a claim has been made, recognition is necessary if it is determined that a loss is both probable and estimable. In the case of unasserted claims, an insurer must "determine the degree of probability that a suit may be filed or a claim ... may be asserted and the possibility of an unfavorable outcome."

Neither U.S., Canadian, nor International standards establish quantifiable thresholds for either of the terms "probable" or "reasonably estimable." Rather, these determinations are left as matters of professional judgement (CICA 3290.12; IAS 10, par. 8). Consequently, both financial statement preparers and auditors have substantial latitude in judging whether the underlying uncertainties have been sufficiently resolved so that financial statement recognition is necessary, or that sufficient uncertainties remain so that disclosure alone is appropriate.

Although both recognition and disclosure convey potentially useful information to the users of financial statements, the FASB has repeatedly emphasized that disclosure is neither a substitute for, nor an alternative to recognition. Statement of Financial Accounting Concepts No. 5 states: "Disclosure of information ... that may be provided by notes or parenthetically on the face of financial statements, by supplementary information, or by other means of financial reporting is not a substitute for recognition in financial statements for items that meet recognition criteria" (par. 9). In a recent exposure draft of a proposed standard, the FASB reiterated the distinction between recognition and disclosure, and explicitly rejected the notion that improved disclosures may be equally useful as recognition.

Substantial professional judgment is required in determining whether financial statement recognition is required. An affirmative decision presumes (1) a factual determination that an obligation exists; (2) an identification of the costs incurred or to be incurred, or the amount of loss sustained; and (3) the selection of a measurement basis from which to assess the amount of the costs or losses involved.

Timing of Recognition

Recognition concerns do not arise spontaneously; some event, either internal or external to the enterprise, must first raise at least a suspicion that such a liability exists. Other events must then follow which indicate the probability of existence is more than remote, and reduce to some acceptable level the uncertainty regarding the amounts involved. Only after both existence and measurement uncertainties have been adequately resolved will recognition occur.

Presently, there is no hard data about what events first give rise to suspicions that an environmental liability may exist. As a result, data are also lacking with respect to the process by which uncertainties concerning the existence of potential liabilities are actually resolved in practice. There have, however, been some efforts to identify those points in time at which environmental liabilities are first recorded by non-insurance enterprises, several of which are discussed below. Unfortunately, there is no corresponding data with respect to the timing of initial recognition by insurers.

Recognition Triggers

Commencement of operations. In certain industries, e.g. mining, commencement of operations may be sufficient to trigger recognition. Where environmental damage is a direct consequence of the enterprise's operating activities, and it is the responsibility the enterprise to incur site restoration and related costs, accounting standards require that these costs be accrued and charged to income currently (FAS 19). Specific accounting guidelines exist for the recognition of nuclear power plant decommissioning costs (FAS 71). Landfills that have an obligation to make future expenditures to comply with RCRA post closure monitoring requirements are required to accrue the liability currently, with municipal landfills being subject to Statement of Governmental Accounting Standards (GASB) No. 18. These costs are considered to be current operating expenses of the enterprise, and generally do not result in potential claims against insurers.

Internal discovery of an existing problem, including reports of current events with the potential for consequent environmental damage may initiate investigation into the existence and possible recognition of a liability. The effectiveness of internal reporting in alerting management to potential environmental problems would be expected to depend upon the level of environmental awareness, technical competence in recognizing potentially hazardous situations, and whether or not there are processes in place to monitor ongoing activities.

There are indications that the frequency of financial statement recognition upon internal discovery is increasing. Responses to the Price Waterhouse (1991 and 1992) studies indicate that the percentage of respondents accruing clean-up costs upon internal discovery of a problem rose from two percent in 1990 to 56 percent in 1992.

Commencement of litigation against an enterprise could also be expected to trigger recognition in the financial statements. Presently, there is no definitive evidence on how prevalent recognition at this point is. Generally, disclosure (as opposed to recognition) is provided either in Management's Discussion and Analysis or in the notes to the financial statements along with other unrelated litigation matters.[1]

Initial notification by a regulatory agency. The existence of a potential liability is called into question whenever notice has been served that a violation of environmental regulations has or may have occurred, or that the entity has been named a potentially responsible party (PRP) in connection with a hazardous waste disposal and storage site subject to CERCLA or equivalent state law. Notification alone does not conclusively establish the existence of a legal obligation, nor does it necessarily indicate an amount or range of amounts for which the enterprise may be ultimately held liable. There is, however, some minimum cost associated with responding to the regulatory action, suggesting the recognition of at least these direct costs.

In actual practice, a decision to delay recognition appears to predominate. Price Waterhouse reports that only 12 per cent of the respondents to the 1990 survey recognized a liability upon initial notification; in its 1992 survey, this number increased to 22 percent.

In connection with the performance of a Remediation Investigation/Feasibility Study (RI/FS). Subsequent to being named a PRP, it may be necessary to direct efforts towards assessing the nature and extent of the problem, the agent or agents responsible for actual or impending damage, and identify strategies for remediation, if necessary. At the point the RI/FS is initiated, the obligation to incur the cost has been established, and there is at least a minimum estimate of the costs to be incurred in connection with the study. As the RI/FS

[1]Specific guidance for disclosure outside the financial statements can be found in items 101 (Description of Business), 103 (Legal Proceedings), and 303 (Management's Discussion and Analysis) of SEC Regulations S-K and S-B.

progresses, information will likely become available that will narrow the range of ultimate cost estimates, further supporting the need for recognition. At completion of the RI/FS, additional narrowing of the range of cost estimates is to be expected, adding further support for the need to recognize the corresponding liability.

Recognition at the initiation of a RI/FS appears to be limited, with only 16 per cent of the Price Waterhouse (1992) respondents indicating recognition at this point. This is, however, a substantial increase from the five percent of respondents that reported recognizing a liability at the initiation of a RI/FS in 1990. One possible reason for these relatively low numbers is that management views the results of the RI/FS to be necessary to reduce uncertainties regarding the ultimate costs to a tolerable level. Indeed, this appears to be the case. A majority of the respondents to the 1992 Price Waterhouse survey (52 percent) recognized a liability during the conduct of a RI/FS. An additional 20 percent reported recording cleanup liabilities on completion of a RI/FS (down from 28 percent in 1990).

Upon an offer of settlement. Normally, the amount of the settlement offer represents the responsible party's best estimate of its minimum cost to obtain a release from its obligation. Of course, some uncertainty will remain up to the point that the offer is accepted, and there is agreement with respect to any conditions imposed on the acceptance. Despite this remaining uncertainty, the recognition criteria of FAS 5 will generally have been met, and accrual of a liability of least the amount of the settlement offer is appropriate. Price Waterhouse reports 20 percent of the respondents to its 1992 survey (up from 15 percent in 1990) indicated that recognition occurred at this point. There is no currently available information regarding the influence of settlement offers to third party claimants on the timing of recognition.

Upon contemplation of a purchase or sale transaction. Given the extension of liability for cleanup costs to owners and operators of property, including subsequent purchasers, recognition may be triggered at the point an enterprise contemplates either the disposition or acquisition of assets, including indirect asset purchases (merger and acquisition activities), discontinuance of operations, or divestitures of ownership interests. Recognition at this point in time is likely to increase as commercial real estate transactions now generally require some form of environmental audit be performed prior to consummation of a contract of sale. If the audit uncovers existing hazards, additional investigation is normally required to establish the extent of the problem and the probable costs of clean-up or containment, information which would support the seller's recognition of an environmental liability. Some 20 percent of the respondents to the 1992 Price Waterhouse study reported recognizing a liability in connection with a sale, disposal or abandonment of a facility.

Pay-as-you-go. Finally, recognition for environmental costs may be delayed until the related expenditures are actually made. Given the requirements of FAS 5, this method of accounting would be acceptable only in extreme cases where the future expenditures are so uncertain as to preclude estimation, or the amounts are sufficiently small as to be deemed immaterial. Despite the lack of accounting support for this method, some 18 percent of respondents to the PW 1992 survey (up from 15 percent in 1990) admitted to using a pay-as-you-go method to account for the costs of clean-up.

Although the Price Waterhouse survey results cited above provide some valuable insight into the timing of recognition in practice, certain limitations on these data should be noted. First, the sample is limited to respondents with known significant environmental liabilities. Second, the percentages cited above apply only to the recognition of clean-up costs associated with hazardous wastes generated in prior periods. Finally, the survey intentionally excluded financial services companies, so no inferences can be drawn concerning the timing of recognition in that sector.

Recognition by Insurers

The insurance contract requires that insurers be given prompt notice of claims or impending claims. Information supporting the recognition of environmental liabilities by a policyholder may also support a claim against its insurer. Barring questions of coverage (a matter discussed below), one would expect there to be a correlation between the time insureds make an affirmative recognition determination, and the time by which their insurers have at least initiated an assessment of the probability that an obligation to its insured exists. Consequently, notification to an insurer at the point in time a policyholder becomes aware of the existence of a potential liability—upon internal discovery, commencement of litigation, or notification by a regulatory agency, e.g.— might also serve to trigger recognition of a corresponding liability, or begin the process of assessing the need for recognition. Similarly, as new information is gathered, e.g., during the conduct of a RI/FS, the incidence of recognition on the part of insurers should increase as uncertainties are resolved. Again, barring coverage disputes, an insurer will normally have been sufficiently involved with the claim that recognition at the time a settlement offer is made would be appropriate.

In reality, the question of whether or not insurance coverage extends in a particular circumstance is often disputed, and is presently the subject of a substantial amount of litigation. In its 1993 report to stockholders, Aetna reported that eight percent of its open claims "represented coverage disputes between the company and its policyholders that has reached the litigation stage." The outcome of such litigation is far from certain, as courts have reached inconsistent conclusions with respect to the existence of insurance coverage for environmental claims. Consequently, although the FAS 5 recognition criteria may have been met from the perspective of the polichyholder, it is by no means certain that recognition is required, or even appropriate, by the insurer.

Limited recognition and disclosure, on the part of both insurers and insureds, can at least partially be attributed to difficulty in establishing the existence of a potential liability, and to additional difficulties with respect to quantifying the amounts involved. The latter involves issues related to measurement, discussed below.

Measurement Uncertainty

Given the existence of a present obligation, recognition is required when its amount is reasonably estimable, with the accrual being equal to the best available estimate. When only a range of estimates is available, and no amount within the range can be considered a better than any other amount, accrual of at least the minimum of the range is required (FASB Interpretation (FIN) No. 14; CICA 3290; IAS 10).

The process of measurement involves a number of factual determinations and qualitative judgements. At issue are the costs to be included or excluded from the estimate, the measurement basis to be applied, the precision with which the estimates can be made, and the materiality of the estimated amount to the financial statements as a whole. Although an item may appear to meet the tests of both relevance and materiality, technological, legal and other uncertainties may still support a conclusion that the estimation process is not sufficiently reliable to support financial statement recognition.

A number of surveys have indicated that difficulties in measurement dominate the probability of existence in determining whether to recognize a liability. Of the 500 largest U.S. companies, 23 per cent disclosed information on superfund status in 1989, with few providing detailed disclosure. Others "broadly admitted" their potential liabilities in unstated amounts (Biersach, 1991). Similarly, Price Waterhouse (1992) reported that "62 percent of respondents indicate that known environmental exposures exist at their companies which have not been accrued because the FAS 5 criteria remain unmet."

The SEC has taken some action to limit the opportunities for non-recognition on the basis of estimation uncertainty. Staff Accounting Bulletin 92 (SAB 92) states "management may not delay recognition of a contingent liability until only a single amount can be reasonably estimated," reminding preparers that once the existence of a liability is established, its amount is unlikely to be zero. Consequently, recognition of an amount at least "equal to the lower limit of the range is necessary even if the upper limit of the range is uncertain" (SAB 92).

In estimating the amount of the liability, SAB 92 requires consideration be given to all available facts and circumstances at the financial statement date. This includes information gained from prior experience with environmental matters, existing technology, presently enacted laws and regulations, and consideration of the likely effects of inflation, societal and other economic factors in making the necessary estimates.

Certain characteristics have been identified as having a significant practical influence on the process of estimation. These involve the nature of the source of environmental damage—chemical composition, site characteristics, the degree of or potential for migration off site, etc.; the number of regulatory agencies that have asserted or may assert authority with respect to a specific site; the number and financial viability of other parties that may be held liable to bear a portion of the costs; and the potential for recovery from insurance companies. These variables identify a number of separable issues, but in considering their influence on the process of measurement, the potential for interaction among them is clear.

Assessing the degree of site complexity requires the application of scientific analysis and judgement. The extent of the problem depends, in part, upon the number, types and concentration levels of specific compounds present. Response costs, in turn, depend upon the availability of existing technology and its effectiveness in reducing or eliminating the identified hazardous substance or substances. Where alternative technologies exist, there is a question as to which should be employed: the Best Practical; Best Conventional, or Best Available technology for treatment (Clean Water Act (CWA): 33 U.S.C. 1251 et seq.).

Selection of an appropriate technology depends, in turn, on the standards imposed at a particular site. This issue is, however, contentious in that specific standards may not have been set for a given chemical compound, leaving doubt as to the extent of cleanup to be undertaken. Language in the Clean Water Act is illustrative: "Where no standards are established, EPA or state agencies apply 'best professional judgment' to set standards for a site based on available data on known pollutants in the discharge" (CWA: 33 U.S.C. 1251 et seq.) Further, the number of regulatory agencies that may assert jurisdiction can complicate the selection of an appropriate response strategy. Again, language in the CWA is illustrative: "[E]ven if an operation meets effluent discharge limitations, more stringent requirements may be imposed if it is determined that the discharge may violate state water quality standards or federal water quality criteria for receiving waters" (US CFR V40 part 122 (1988)).

The SEC specifically notes that a RI/FS is intended to determine the "extent of contamination, evaluate remediation alternatives for removal, treatment, destruction and monitoring the hazardous materials and recommend a remediation action plan, including a cost estimate" (SAB 92). A major conclusion is that: "As a result of the RI/FS, two major variables of the clean-up process, remediation method and related costs, are reasonably determinable." It appears that, barring compelling circumstances, delaying recognition beyond the point at which a RI/FS is completed may no longer be acceptable to the SEC.

While completion of the RI/FS may be the latest point at which recognition should occur, comments made elsewhere in SAB 92 clearly indicate the Commission's position favoring earlier recognition. Specifically, SAB 92 states that:

> Information necessary to support a reasonable estimate or range of loss may be available prior to the performance of any detailed remediation study. Even in situations in which the registrant has not determined the specific strategy for remediation, estimates of the costs associated with the various alternative remediation strategies considered for a site may be available or reasonably estimable.

A further complicating factor in measuring the amount of loss is the imposition of strict, joint, and several liability under CERCLA. Where more than one party has contributed to damage at a site, each is responsible for at least a proportionate share of the total costs. The potential does exist, however, for a single PRP to be held liable for amounts far in excess of its proportionate contribution to the problem. Consequently, measurement of the liability must consider the total costs of clean-up, the entity's likely proportionate share of the total, and the probability that "excess" costs may be assigned as a result of financial incapacity of one or more named PRP's or the inability to identify all PRP's contributing to the environmental damage. For the purpose of financial statement presentation, this raises a serious question regarding the amount to be reported, i.e., with or without consideration being given to amounts that would otherwise be assignable to other PRP's. On this question, the SEC has adopted the position that

> If it is probable that other responsible parties will not fully pay costs apportioned to them, the liability that is recognized by the registrant should include the registrant's best estimate, before consideration of potential recoveries from other parties, of the additional costs that the registrant expects to pay. Discussion of uncertainties affecting the registrant's ultimate obligation may be necessary if, for example, the solvency of one or more parties is in doubt or responsibility for the site is disputed by a party. A note to the financial statements should describe any additional loss that is reasonably possible [SAB 92].

Having been named a potentially responsible party (PRP) by the EPA does not conclusively establish legal responsibility with respect to a given site. Rather, it raises a rebuttable presumption that such liability exists. The quality and comprehensiveness of records maintained by an entity concerning the generation, transport and disposal of hazardous substances may be critical in reducing the uncertainties, particularly if these records can establish a *de minimis* contribution to the overall environmental damage.

A similar question arises when potential recoveries from insurers are considered. This point is explored further in the section following.

Measurement Bases:

Three main questions arise in connection with the selection of an appropriate basis for measuring the amount of environmental costs to be reported in the financial statements. First, should these amounts reflect consideration of possible recoveries from other responsible parties or from insurers? Second, if the costs of an environmental response are to be borne over a number of years, should the reported amounts reflect the time value of money? Third, when an environmental cost results from an impairment of asset value, what reference point(s) should be used in measuring the loss of value?

It has been common practice to report many liabilities net of anticipated recoveries. Under GAAP, for example, loss and loss adjustment reserves are reported net of anticipated salvage and subrogation. Doing so requires that the criteria for recognition be met with respect to both the liability and the related asset (receivable). Recently, however, concerns have been raised that the practice of netting may have been too aggressively applied, i.e. offsetting probable losses with (only) likely recoveries. In SAB 92, the SEC has made it clear it believes "separate presentation of the gross liability and related claim for recovery in the balance sheet most fairly presents the potential consequences of the contingent claim on the company's resources and is the preferable method of display." This position is supported by the consensus opinion reached by the FASB's Emerging Issues Task Force (EITF) in Issue 93-5, that "an environmental liability should be evaluated independently from any potential claim for recovery," and that "any loss arising from the recognition of an environmental liability should be reduced by a potential claim for recovery only when that claim is probable of realization."

The practice of reporting environmental losses net of insurance recoveries has recently received explicit attention. Of particular concern is the apparent disappearance of a significant amount of liability as insureds implicitly recognize insurance recoveries in the process of netting, while insurers have not recognized an equivalent amount on the basis that either coverage does not extend to these losses (the potential liability fails to meet the existence test) or that "there are too many uncertainties to estimate their potential liabilities for environmental losses within any accepted degree of accuracy" (Foppert, 1993).

In response, the SEC has adopted a position intended to limit this practice, declaring that "risks and uncertainties associated with a registrant's contingent liability are separate and distinct from those associated with its claim for recovery from third parties" (SAB 92). A consequence of this position may be the restoration of some symmetry in the disclosure of environmental liabilities by insurers and insureds.

Existing accounting standards generally support the position taken by the SEC. Accounting Principles Board Opinion No. 10 proscribes offsetting liabilities and related receivables except in those cases where a right of set-off exists. Financial Accounting Standards Board Interpretation No. 39, "Offsetting of Amounts Relating to Certain Contracts," further supports the position favoring a more comprehensive application of the prohibition against setoff. For SEC registrants, "the presentation of liabilities net of claims for recovery will not be appropriate after the provisions of FIN 39 are required to be applied in financial statements."[2]

[2]The provisions of the Interpretation are effective for financial statements prepared for fiscal years beginning after December 15, 1993.

While these restrictions are, at present, unique to the United States, there are indications that similar prohibitions will be more universally applied. Although Canadian accounting standards do not advocate offsetting expected recoveries against the related liability, CICA section 3290.11 states: "A likely loss to an enterprise may be reduced or avoided by a counter-claim or a claim against a third party. In such a case, the amount of the likely recovery is an element of the likely loss and would, therefore, be taken into account in determining the amount to be accrued."[3] There is, however, an outstanding exposure draft, "Contingent Gains and Losses" (CICA 1993) that would treat the claim or counter-claim as a contingent gain. Under the proposed standard, the contingent gain would only be recognized if its realizability were virtually certain. If adopted, this standard would bring U.S. and Canadian GAAP into closer accord on this issue.

Where an environmental liability may require cash outlays to occur over a number of years, serious consideration may be given to valuing the liability at its present value. Although not common in practice, EITF 93-5 addressed the issue, stating a conclusion that "discounting an environmental liability for a specific clean-up site to reflect the time value of money is appropriate only if the aggregate amount of the obligation and the amount and timing of the cash payments are fixed or reliably determinable for that site." If the requirements for discounting are met, the SEC maintains the position that the appropriate rate is either that which would produce an amount for which liability "could be settled in an

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[3]IAS 10 (par. 11) contains similar wording: "A potential loss to an enterprise may be reduced or avoided because a contingent liability is matched by a related counter-claim or claim against a third party. In such cases the amount of any accrual may be determined after taking into account the probable recovery under the claim."

arm's-length transaction with a third party," or, if that rate is not readily determinable, a risk-free rate on securities with comparable maturities in accordance with paragraph 4(a) of FAS 76, "Extinguishment of Debt." Where a liability is presented on a discounted basis, any related claims for recoveries should also be discounted.

Environmental losses related to declines in asset value present another troublesome set of challenges. In the general case, any decline in asset value that is considered to be "other than temporary" requires the immediate recognition of a loss. With respect to declines in the value of owned assets, it is necessary to establish a reference point from which the amount of the loss is to be measured. Where the loss results from an event that is "sudden," there is no conceptual problem in measuring the loss from a point just prior to its occurrence. Alternatively, where the loss in value has occurred gradually over a period of time, it may be difficult, if not impossible, to establish a reference point just prior to the "occurrence." The issue is not simply one of timing, as the choice also has a bearing on whether the costs of remediating the damage will be properly categorized as repairs, betterments, or losses. How these costs are ultimately categorized may be affect whether or not insurance coverage extends to the specific costs, and may also affect the treatment of these costs for tax purposes.

A consensus was reached by the EITF (Issue No. 90-8) that capitalization of environmental costs is appropriate only if the costs are recoverable (through future operation or subsequent sale of the asset) provided that one of the following criteria is met:

1. The costs extend the life, increase the capacity, or improve the safety or efficiency of property owned by the company. For purposes of this criterion, the condition of that property after the costs are incurred must be improved as compared with the condition of that property when originally constructed or acquired, if later.

2. The costs mitigate or prevent environmental contamination that has yet to occur and that otherwise may result from future operations or activities. In addition, the costs improve the property compared with its condition when constructed or acquired, if later.

3. The costs are incurred in preparing for sale that property currently held for sale.

The EITF noted that where contaminated soil is processed to remove existing contaminants, the activity neither extends the useful life of the property, nor does it improve its efficiency relative to its unimpaired condition at acquisition. In addition, while the activity addresses an existing problem, it does not mitigate or prevent future contamination. Consequently, the costs may not be capitalized for financial reporting purposes.

Required Financial Statement Disclosures

Both accurate and complete disclosure are necessary to assure that the financial statements are not misleading to investors, creditors and other users. Efforts to accelerate the recognition of environmental liabilities are primarily motivated by this need. In addition, certain disclosures may serve as early warnings to financial statement users of economic events and circumstances that may adversely affect an entity's ability to generate favorable cash flows.

Contingent losses whose existence is not sufficiently probable, or its measurement is not sufficiently reliable to require accrual and recognition in the body of the financial statements may still require disclosure in either the footnotes to the financial statements, Management's Discussion and Analysis, or both if its probability of existence is more than remote. Under both U.S. and international accounting standards, the nature of the contingency and an estimate of the possible loss or range of loss, or a statement that such an estimate cannot be made is required in the notes to the financial statements (FAS 5; IAS 10). Under Canadian GAAP, the disclosures extend to losses that are "unlikely" provided that, if confirmed, "would have a significant adverse effect on the financial position of an enterprise" (CICA 3290.17).

Staff Accounting Bulletin 92 provides additional detailed guidance to SEC registrants. The basic premise underlying this SAB is that

> product and environmental liabilities typically are of such significance that detailed disclosures regarding the judgments and assumptions underlying the recognition and measurement of the liabilities are necessary to prevent the financial statements from being misleading and to inform readers fully regarding the range of reasonably possible outcomes that could have a material effect on the registrant's financial condition, results of operations, or liquidity.

This SAB provides detailed guidance for the disclosure of environmental loss contingencies that is far more comprehensive than that provided in FAS 5. Specific examples of disclosures that may be necessary include:

- Circumstances affecting the reliability and precision of loss estimates.
- The extent to which unasserted claims are reflected in any accrual or may affect the magnitude of the contingency.
- Uncertainties with respect to joint and several liability that may affect the magnitude of the contingency, including disclosure of the aggregate expected cost to remediate particular sites that are individually material if the likelihood of contribution by the other significant parties has not been established.
- Disclosure of the nature and terms of cost-sharing arrangements with other potentially responsible parties.

- The extent to which disclosed but unrecognized contingent losses are expected to be recoverable through insurance, indemnification arrangements, or other sources, with disclosure of any material limitations of that recovery.

- Uncertainties regarding the legal sufficiency of insurance claims or solvency of insurance carriers. (Where registrants can rebut the presumption that no asset be recognized for contested claims for recovery) registrants should disclose the amount of recorded recoveries that are being contested and discuss the reasons for concluding that the amounts are probable of recovery.

- The time frame over which the accrued or presently unrecognized amounts may be paid out.

- Material components of the accruals and significant assumptions underlying estimates.

Further, registrants are cautioned that

> a statement that the contingency is not expected to be material is not sufficient ... if there is at least a reasonable possibility that a loss exceeding amounts already recognized may have been incurred and the amount of that additional loss would be material to a decision to buy or sell the registrant's securities. In that case, the registrant must either (a) disclose the estimated additional loss, or range of loss, that is reasonably possible, or (b) state that such estimate cannot be made.

These requirements are in addition to those disclosures that must be made outside the financial statements. Items 101 (Description of Business), 103 (Legal Proceedings), and 303 (Management's Discussion and Analysis) of Regulations S-K and S-B govern such disclosures. Securities Act Release No. 6130 (September 27, 1979) and Financial Reporting Release (FRR) No. 36 (May 18, 1989) are two interpretive releases that provide additional guidance with respect to environmental matters.

Disclosures made in light of this guidance "should be sufficiently specific to enable a reader to understand the scope of the contingencies affecting the registrant." This would include discussion of past and anticipated expenditures, with separate descriptions of

(a) recurring costs associated with managing hazardous substances and pollution in on-going operations,

(b) capital expenditures to limit or monitor hazardous substances or pollutants,

(c) mandated expenditures to remediate previously contaminated sites, and

(d) other infrequent or non-recurring clean-up expenditures that can be anticipated but which are not required in the present circumstances.

Disaggregated disclosure describing accrued and reasonably likely losses with respect to specific environmental sites may be necessary if their amounts are individually material. In addition, "if management's investigation of potential liability and remediation cost is at different stages with respect to individual sites, the consequences of this with respect to amounts accrued and disclosed should be discussed."

Disincentives to Disclosure

Earnings pressures and tax considerations have been identified as two of the most important disincentives to the recognition and disclosure of environmental costs (U.N., 1991c). In general, insurers and non-insurers alike are subject to their influence.

Both earnings pressures and tax considerations can combine to create strong disincentives to recognition. The consensus reached in EITF 90-8 (discussed previously) generally favors the recognition of environmental costs as current period expenses rather than as assets. Specifically, the EITF argues against the capitalization of costs associated with the removal, treatment, and replacement of contaminated soil. Consequently, the full income statement effect of these costs would be reflected in the year in which they are recognized.

The U.S. Internal Revenue Service reached a different conclusion in Private Ruling 9315004 issued in December 1992. In that ruling IRS argued that the costs of soil removal and replacement necessitated by PCB contamination is not deductible under section 162(a) of the Internal Revenue Code. This section allows a deduction for ordinary and necessary expenses paid or incurred during a taxable year. In arguing against deductibility, IRS noted that

> Pursuant to section 161 of the Code, the deductibility of expenses under section 162 is subject to the provisions in section 263. Section 263(a) of the Code provides that no deduction shall be allowed for any amount paid out for permanent improvements or betterments made to increase the value of any property or estate, or for any amounts expended in restoring property. Deductions are exceptions to the norm of capitalization.

Further, the IRS relied upon section 1.162-4 of the Income Tax Regulations which allows a deduction for a *repair cost* only if all of the following conditions are met: the repair is incidental; the cost of the repair does not materially add to the value of the property; the repair does not appreciably prolong the useful life of the property; and the purpose of the expenditure is to keep the property in ordinarily efficient operating condition.

In the specific case under discussion, IRS argued that soil removal and replacement failed the test for deductibility on several points. The scale of the activity precluded characterizing the activity as incidental; the costs expended could be expected to increase the value of the property relative to its value as contaminated property just prior to the commencement of remediation activities; and the removal of a known hazard increased the safety of operations carried out at the site. Further, the IRS placed significant weight on the fact that remediation activities were undertaken as a part of a comprehensive plan of rehabilitation. In summary, the IRS argued a position that would categorize such activities as betterments, rather than repairs—a position clearly at odds with financial accounting treatment of the same costs. Should this position be pursued and subsequently upheld by the courts, it would create an additional financial disincentive for business enterprises to undertake prompt and comprehensive responses to environmental problems.[4]

Insurers are faced with specific disincentives with regard to recognizing and disclosing environmental loss reserves. First, earnings pressures work against accelerated recognition. The recognition of additional liabilities, whether to establish a reserve or strengthen an existing reserve, reduces both earnings and surplus. Though the effects would not be felt equally across insurers, there is the potential for such adjustments to affect rating agency perceptions of insurer strength and performance, and may, at the margin, limit the capacity of an insurer to write new business.

Second, there is concern that detailed disclosure may compromise an insurer's chances of successful litigation "both in terms of appearing to admit liability and of having the deep pockets to cover it" (A.M. Best, 1994). Third, measurement uncertainties include not only the uncertainties involved in estimating the underlying liabilities of claimants, but also the uncertainties associated with the outcome of litigation involving coverage disputes. Together, these uncertainties may make it difficult to defend the tax deductibility of reserves against an IRS challenge on the basis that reserve amounts appear excessive (A.M. Best, 1994).

The Future

The current state of financial reporting for environmental costs might best be described as unsettled. Standard setters have yet to give environmental reporting issues high

[4]A revenue ruling has since been issued that may substantially modify this position. Details were not available in sufficient time to be incorporated into this paper.

priority. While the accounting profession recognizes the financial significance of environmental costs, the majority appears to hold that the accounting for these costs involves no new theoretical issues, and the accounting guidance in FAS 5 is sufficient. Consequently, the likelihood that FASB involvement with environmental issues at the standard-setting level is, at least in the near term, relatively low. Situation specific accounting questions will continue to be delegated to its Emerging Issues Task Force. To date, no specific requirements have been imposed on insurers with respect to the preparation of statutory accounting statements.

In contrast, the SEC has taken a leadership role in attempting to close the gap between the quality of disclosure demanded by financial statement users, and that being provided by financial statement preparers. It has made clear its intentions to actively monitor registrants' disclosures, and question registrants when it believes that disclosure is incomplete. Although there has yet been no action, the U.S. General Accounting Office has recommended that the SEC revise its guidance "to specifically address insurance companies' disclosure of environmental liabilities," including the disclosure of the number of reported claims and "an estimated range or minimum amount of associated claims costs and expenses" (GAO, 1993).

There is some evidence that financial statement preparers have begun to respond to demands for a more complete accounting of environmental costs. The Price Waterhouse surveys results discussed previously suggest that non-insurance enterprises are accelerating the recognition of environmental liabilities. Corresponding action by insurance companies is, however, not in evidence. Of the 16 largest publicly held property-liability companies, only three separately disclosed the costs associated with environmental liability claims in their original 1991 SEC filings (GAO, 1993).

Litigation costs are likely to take on increasing importance to insurers. Despite the insurance industry's vigorous denial of environmental claims, more companies are reporting that they consider potential insurance recoveries in estimating their environmental liabilities. From 1990 to 1992, the percentage of companies considering insurance recoveries rose from 21 to 69 percent; fully 88 percent indicate they believed recovery to be probable (Price Waterhouse, 1992). The potential for increased litigation activity is apparent, as is the potential for the associated costs to be substantial. Aetna, for example, reported in 1993 that two-thirds of its $231 million reserve for environmental claims "represents a bulk reserve for legal fees." Insurers will no doubt be under increasing pressure to recognize and disclose at least this component of their potential environmental liability.

Continued improvements in financial reporting will depend, in large part, on the development of more detailed data. Environmental auditing activities are increasingly being viewed as an appropriate response to environmental concerns. The Canadian Institute of Chartered Accountants has formally taken up the issue of accountants' role in such activities. Specialized environmental consulting services are now available from a number of national accounting firms. In Europe, environmental auditing activities are becoming more formalized. On June 29, 1993 the EC Council formally adopted a Regulation (1836/93) for the introduction of a voluntary Eco-Management and Audit Scheme. Movement is clearly toward the provision of more detailed, and more focused environmental information.

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Geographical Techniques to Review and Track Environmental Liabilities

by Philip Miller and Beth Mabee

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"We already have the statistics for the future: the growth percentages of pollution, population, desertification. The future is already in place."

Gunther Grass

Abstract

The identification and quantification of environmental liability exposures is becoming increasingly more important to U.S. property/casualty insurers. This article discusses new tools available to assist in the evaluation of Environmental Impairment Liability (EIL) exposures, and how EIL reserving might be handled in "the Perfect World of the Future."

The opinions expressed in this paper are those of the authors, and do not represent the official views of Insurance Services Office, Inc.

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Gunther Grass

Introduction

Hazardous waste cleanup costs in the United States continue to escalate. A 1991 University of Tennessee study estimated they may reach $750 billion over the next 30 years.[1] More recently the A. M. Best Company reported "[t]he ultimate cost of environmental and asbestos damages and remediation in the United States could run well over $2 trillion...."[2] Potential liability for these environmental cleanup costs is of

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The opinions expressed in this paper are those of the authors, and do not represent the official views of Insurance Services Office, Inc.

[1]Milton Russell, et.al., Hazardous Waste Remediation: The Task Ahead, University of Tennessee, Waste Management Research and Education Institute (Dec. 1991), quoted in Environmental Liability: Property and Casualty Insurer Disclosure of Environmental Liabilities (GAO/RCED-93-108, June 2, 1993), p.4.

[2]John H. Snyder and W. Dolson Smith, "Environmental/Asbestos Liability Exposures: A P/C Industry Black Hole," BestWeek Property/Casualty Edition (March 28, 1994), p. P/C 1.

particular concern to property/casualty insurers, even if they haven't knowingly written environmental impairment coverage.

The retroactive joint and several liability provisions of the current Superfund law may result in huge judgments against insureds or former insureds decades after a hazardous activity has been discontinued. When a Potentially Responsible Party (PRP) is notified of an impending cleanup and its associated costs, that PRP is likely to turn immediately to its insurer for defense and, if necessary, liability payments. Sources of pollution ranging from leaking underground fuel tanks to improper waste disposal may affect both commercial and personal lines policies long after the policies themselves have been shredded or sent to long-term storage.

When many activities that have retroactively saddled insurers with huge liabilities took place, they were legal, possibly even common, business practices. The responsible parties may not have understood the concept of environmental pollution, let alone realized they could later be held responsible not only for the cleanup of their own pollutants but for the liabilities of co-polluters who disappeared or declared bankruptcy. Similarly, their insurers included nothing in their Incurred But Not Reported (IBNR) reserves to cover liabilities that were not yet perceived as such--polluting activities that changes in the social climate caused to become retroactive liabilities.

As the September 30 expiration of Superfund nears, the debate over the continuation of its retroactive nature and joint and several liability provisions has intensified. Regardless of the outcome, however, insurers need better methods of quantifying their current and future environmental liabilities--those resulting from past court decisions, and those yet to be incurred.

The Ostrich Approach to Environmental Impairment Liability (EIL) Has Dangerous Consequences

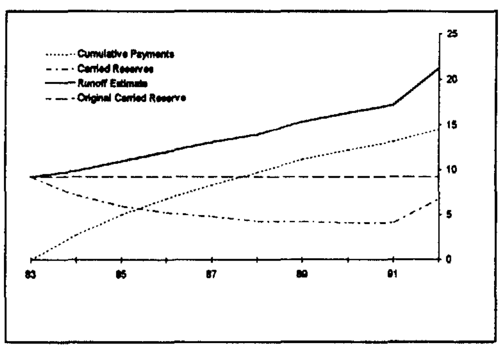
Until recently, insurers have not reserved for many potential environmental losses. Identification of environmental exposures has been difficult and accounting standards have not demanded revelation of tenuous liabilities. The Financial Accounting Standards Board has required that a potential liability appear on a company's balance sheets only when it is reasonably probable that a liability has been incurred and the amount of the loss can be reasonably estimated--difficult if not impossible in a world of long-tail hidden hazards and rapidly changing environmental contamination detection and cleanup technology.

Historical information has been of little use in quantifying losses. Past claims have been inconsistently reported, and changes in technology and liability standards have altered the costs of cleanup and the identification of responsible parties.

To complicate matters, many environmental liability suits have involved the interpretation of policy language that insurers believe shields them from responsibility for loss payment. Insurers have been understandably reluctant to reserve for these losses, feeling that such reserves would not reflect "reasonably probable" liabilities, and could even be interpreted as admissions of responsibility for payment (self-fulfilling prophecies). Then too, regulators have tended to pursue "deep pocket" PRPs, leaving the pursuit of smaller or "vanished" parties to the large PRPs and their insurers. The possibility of eventual recovery of cleanup costs from these other parties or their insurers has also limited the appearance of liabilities related to cleanup on insurer balance sheets. This situation has changed during the last year.

A June 1993 Government Accounting Office (GAO) report pointed out that of the nation's 16 largest property/casualty insurers, only 2 in 1990 and 3 in 1991 disclosed dollar amounts related to environmental claims in their annual reports. An additional 5 insurers in 1990 and 8 in 1991 stated they were involved in litigation over environmental claims without mentioning figures. At the same time, insurance executives claim environmental liabilities could significantly affect the financial condition of the PC industry .[3] Industry studies bear this out.

ISO's analysis of the runoff on year-end 1983 loss and loss adjustment reserves for general liability (excluding products) shows a disturbing trend. For eight of the nine calendar years ending December 1992, payments on accident years prior to 1983 have been more than 25% of the prior year's carried reserves. However, as shown in the chart below, the reserves themselves, instead of decreasing after the loss payments, have been flat--or worse yet, grew 65% in 1992! Through 1992 year-end, the $9.2 billion reserve established at year-end 1983 has run off $12 billion deficient.[4] Late emergence of environmental losses is the chief suspect in this adverse development.



A recent analysis by A.M. Best Company showed a 64% increase in industry environmental reserves from 1989 to 1992 (from $3.6 billion to $5.9 billion) compared to a 22% rise in total industry reserves over the same period. The authors of the analysis predicted that

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[3]Environmental Liability: Property and Casualty Insurer Disclosure of Environmental Liabilities (GAO/RCED-93-108, June 2, 1993).

[4]"Loss and Loss Adjustment Expense Reserves at Year-End 1992: Technical Analysis," Insurance Services Office, Inc., October 1993

environmental liability "represents the single largest threat to the property/casualty insurance industry's financial health for the next several decades."[5]

New Reporting Requirements Seek Uniformity in Reserve Handling

In response to the contradictory handling of these claims by different companies, the SEC has promulgated new rules for disclosure of liabilities. *Staff Accounting Bulletin No. 92*, issued June of 1993, directs companies to evaluate environmental liabilities "independently from any potential claim or recovery." Since insurer recovery from others for payment on behalf of their insureds is uncertain as to timing and achievement, the Securities Exchange Commission (SEC) no longer feels that the amount of potential liability should be offset by the amount of potential subrogation recovery. The SEC has also taken the position that "[n]ot withstanding significant uncertainties, management may not delay recognition of a contingent liability until only a single amount can be reasonably estimated." Regardless of how difficult estimating potential liabilities may be, insurers must reflect at least minimum estimates on their GAAP balance sheets now.[6] As a result, they are scrambling for better ways to identify and quantify environmental hazards and their associated loss exposures.

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[5]Snyder and Dolson, Op. Cit., p. P/C 3.

[6]"If management is able to determine that the amount of the liability is likely to fall within a range and no amount within that range can be determined to be the better estimate, the registrant should recognize the minimum amount of the range pursuant to Financial Accounting Standards Board Interpretation No. 14, 'Reasonable Estimation of the Amount of a Loss' ('FIN 14')."

New Geographic Mapping Technology Can Help

Insurers can more easily respond to this challenge of estimating loss reserves by using new technologies such as geographic information systems (GIS). GIS, as the name implies, can geographically locate addresses and relate them to a wealth of data that is geographically based. These systems identify point, line or polygon-specific data--in GIS terminology, these are "features." Each of these features can be pinpointed on the face of the earth utilizing a principle called "geocoding," the assigning of latitude and longitude based on an address or zip code. Data can be attached to these features and manipulated in a manner similar to spreadsheet or database programs. This can lead to the generation of maps, or the extraction of geographic information without the need for the user to view a map. GIS can be used to calculate the distance from one geographic feature to another or to measure how many features are located within a given area. Examples of these applications are the calculation of the distance an insured drives from his home to his office and the identification of how many insured residences are located within a given county.

The property/casualty insurance industry is a "natural" for the application of GIS technology, because so much of the coverage provided by property/casualty insurance policies is location-specific. These locations are in or near other features, such as counties, states, fire districts, census tracts, water bodies, or rating territories. The relationships between these features can be used in a variety of ways.

GIS technology is most widely used in the property/casualty industry for risk-by-risk underwriting. Using GIS tools and products, underwriters can screen new applications for a wealth of risk-related information that was previously unavailable or available only through time-consuming reference to maps and rating manuals. Inputting the risk address gives the underwriter access to essential information, including rating territories for various coverages, Public Protection Classifications, distances to water bodies, drive-distance-to- work calculations, and demographically based estimates of an area's crime potential. The addition of construction information for a given building may also allow the system to estimate maximum losses from insured events of varying magnitudes.

In addition to screening new applications, the information supplied by GIS systems is used by insurers for portfolio analysis. GIS can enable an insurer to estimate how many risks it writes within 1500 feet of a major water body, or along a given earthquake fault. Combined with modeling software, it may also be used to predict potential losses resulting from a hurricane or major hail storm. This information may assist the insurer in spreading its own risks and, as a side benefit, in obtaining reasonably priced catastrophe reinsurance. Combined with demographic information, GIS portfolio concentration analysis can also assist insurers in planning for future expansion.

From predicting the path of a storm and the concentration of risks in that area to predicting post-disaster adjuster deployment is a small step. The Federal Emergency Management Agency used aerial and satellite photographs and GIS to plan relief efforts after 1993's massive flooding in the Mississippi valley.[7] Combining information on where the risk addresses in an insurer's inforce policy files are with a storm's path, speed, and related factors can provide early estimates of the probable number of properties damaged and the number of claims adjusters that should be deployed. This technology can allow insurers to refine their contingency planning and respond more quickly to natural disasters--an important step in an era when speed is a major criterion used by customers to

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[7]Gary H. Anthes, "Fed Agency Tailors GIS to Locate Flooded Areas," Computerworld (Aug. 2, 1993).

judge the quality of service, and when speed can serve to minimize the ultimate loss payment.

EIL Uses for GIS

Specific uses of GIS involving Environmental Impairment Liability (EIL) exposures are also possible. Federal, state, and local governments have been storing information on actual and potential pollution sites for years in over 800 electronic databases. These databases can help identify environmental contamination risks. Geographic information systems can locate the addresses in an insurer's book of business, and quickly and accurately search the relevant databases for reports of pollution at each insured site and in the surrounding area. Several products now available or under development will allow insurers to access over 2.5 million governmental records on locations with actual and potential contamination. Types of hazards identified will include:

- Sites on the National Priorities List and its state equivalents;
- Other Superfund (CERCLIS)[8] sites;
- RCRA[9] transportation, storage and disposal sites;
- Properties used as solid waste landfills; and
- Leaking underground storage tanks.

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[8]CERCLIS is the information system containing records related to possible violations of the Comprehensive Environmental Response, Compensation and Liability Act of 1980 (CERCLA).

[9]RCRA is the acronym for the Resource Conservation and Recovery Act of 1976.

Underwriters will be able to use these systems as application-screening tools to gather data on recorded potential hazards at the risk location or in the surrounding areas--for example, within 1/2 mile for underground tanks or 1 mile for Superfund sites.

These database/GIS combinations and others like them can also be used in portfolio analysis to review and track exposures to other hazards. Both underwriting and portfolio analysis can help insurers with disaster planning. The insurer's exposure to potential environmental liabilities is intensified if pollution hazards are located in flood-prone or earthquake-prone areas. Identifying combinations of hazards can help insurers further refine their Probable Maximum Loss (PML) estimates for these areas and make more adequate provision for the deployment of adjusters and equipment should a disaster strike.

Although very little has been done with GIS to date in the area of reserving, the potential for increasing future use is there, particularly with regard to environmental impairment losses.

Geographic Information Technology Can Help Create a Better System

In the "Perfect World of the Future," geographic information databases would be available for all properties, residential and commercial. These databases would describe the physical and commercial characteristics of the properties--information such as previous site uses and the site uses for adjoining properties in addition to the construction, current occupancy, protection and exposure information available today from sources such as ISO Commercial Risk Services, Inc.'s Specific Property Information database. Historical information would be particularly valuable in identifying contaminated sites and leaking tanks where no structures remain. In addition, these databases would include information about soil type, terrain, elevation, ground water, aquifers, and other factors that would promote or impede the spread of environmental contamination. The current databases of government information on actual and potential contamination sites would also have been greatly improved by the adoption of uniform reporting standards and the inclusion of more historical information on both cleanup costs and the loss of property values resulting from reported contamination.

GIS could play a role by creating an "expert system." For example, once a relationship between geology or soil structure and the direction or velocity of a pollutant's spread is established, a map of an area's geology or soil structure could aid in determining the flow of contaminants and thus in estimating the area impacted by toxic levels of hazardous materials.

EIL claims adjusters would have instant access to this information upon entering the property address or some other geographic identifier (such as latitude and longitude) into the computer network. Underwriters would also have access to this information, improving application screening, portfolio management, and the pricing of EIL coverages.[10]

Toward More Accurate Reserving for EIL

In the Perfect World of the Future, such expert systems would be used to determine a damageability index. This index would measure the relative risk of contamination spreading, uncontrolled, should some event at the site cause a leak or other discharge of contaminants.

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[10]In his Insurability and the Regulation of Catastrophic Environmental Risks, p. 18, Martin Katzman finds little evidence to support the idea that EIL premiums are proportional to risks, even as crudely measured as those risks are at present.

This index would require an improved understanding of the area likely to be impacted by the spread of a contaminant. Some current models assume that the area affected by a contaminated site is a circle with a given radius from the source of contamination. Inversely, insurers concerned with particular risk locations have drawn circles around them and attempted to determine what sources of actual or potential contamination, if any, might adversely affect those risks.

The affected area, however, may not be circular nor of some more-or-less arbitrarily selected size.

The relative hazard of the pollutant could play a role in setting the boundaries. It is possible that the more toxic the substance, the further harmful levels of the substance will spread. For this reason the American Society for Testing and Materials standards, which the banking industry uses to search for historical pollutants in the vicinity of collateral properties, specifies record searches for leaking tanks or CERCLIS sites within a 1/2 mile radius of the subject property and for National Priorities List sites within a one mile radius.

The size of the affected area may also change with the risk tolerance of the insurer. Choosing a larger affected area then would be analogous to including a larger margin for adverse deviation.

In addition, factors such as geology and soil type/structure are important. The geology can affect the movement of subsurface flows of water or contaminants. Soil type is also important since (1) the contamination sites are located in the layer of the earth's crust above the permanent ground water level where the soil is and (2) its structure affects the direction and speed of movement.

GIS could help establish the effects of geology and soil structure on the flow of contaminants. By combining maps of the geology, soil structure, and sources of contamination, simulations could be run to test the expected spread of toxic elements against actual conditions.

In a similar way, a restoration index could be established to measure the relative cost of cleaning up after contamination occurs. The history of past site uses would also be important in using such indices, since past usage indicates the types of contamination that may have occurred historically but have yet to surface. With a GIS containing site-specific information such as that described above, actuaries and engineers could also develop parameters for expected costs of restoration and indemnification. These parameters might vary with the characteristics of the site.

Finally, the damageability and restoration indices can be combined with a frequency parameter. This parameter, at least for past contamination, might be estimated from historical land use maps, which can provide a basis for suspected unreported contamination. The parameters could be applied to each risk in a portfolio; the sum of such estimates would be an expected loss estimate for the EIL exposure of the portfolio. Obviously, such an inventory approach requires sufficient computer resources to be feasible.

As loss experience accumulates, the parameters will be updated, leading to new estimates of expected losses. Loss emergence models will be similarly updated, much as current development methods use the latest loss emergence to estimate future emergence.

This will require the development of new actuarial models. Traditional actuarial models of property/casualty loss development are based on the accident year or policy year model, where the event giving rise to the loss is discrete in time and place. In the past two decades, however, we have had to deal with such complexities as triple trigger theories of liability and latency periods from exposure to illness that span decades rather than weeks. Reserving for environmental impairment liabilities will require that actuaries develop models to deal with exposures that are not necessarily independent by year.

The Best Solution--Research, Research, and More Research

For past losses, perhaps the best hope is meaningful Superfund reform that would shift the burden of payment for retroactive losses to one of the proposed "no-fault" trust funds. Whether financed by taxes on industry or insurers, such a fund would immediately decrease insurers' exposure to unexpected, unreserved-for EIL losses.

For more recent losses we must work toward attaining the Perfect World of the Future.

Except for those carriers actively writing EIL business, we can only make heroic assumptions about loss potential and loss emergence. These estimates must be tested constantly against emerging loss data. Then new parameters will be used until they are refined by later data. Uniform EIL data collection standards, such as those under development by the American Society for Testing and Materials, may assist in this effort.

We must also be vigilant in our review of case law and technical journals. Reserve estimates must reflect, to the degree possible, changes in theories of liability and improvements in the technology for dealing with contamination. Technological breakthroughs in detection and remediation techniques can raise costs or lower them--either way we must be aware of them.

We can begin now to develop databases for GIS on two fronts.

First, we can work with existing GIS to look for systems most compatible with the industry's other underwriting needs. Then we can work with these systems to add elements that will increase the systems' utility to the insurance industry. As with any new industry, the GIS field is teeming with start-up companies, each with its own specialty.

Various government agencies, too, offer information such as flood zones, aerial and satellite photographs, and USGS maps that could provide valuable data if fed into GIS. By picking and choosing among the "best of the best," GIS could be enhanced to include important information on water, soil, and topography.

Second, we can use existing underwriting, loss control and claim files to begin compiling the information necessary to make the parameter estimates that will be needed for the reserving techniques. Information from these files, in conjunction with on-site inspections, should allow at least rudimentary correlation of cleanup costs/damages paid with distance of the site from the pollutant. On-site inspections may also increase our understanding of the relationships between topography, hazard types, and speed and path of pollutant migration. Insurer files and inspections are not the only potential sources of this information. Information on site use and existing pollutants has been collected by real estate lenders and securities firms. Environmental engineers can contribute estimates of average remediation costs. A diligent search will undoubtedly uncover further sources of historical information.

Conclusion

The ultimate costs to clean up environmental contamination in this country will be staggering. If the property/casualty insurance industry remains potentially liable for unanticipated and unfunded retroactive environmental impairment liabilities, it must aggressively search for the means to identify and quantify those exposures. Future actuarial research should center on how to accomplish this task.

The expansion of current environmental databases and the development of models and simulation routines needed to estimate parameters for EIL reserving pose considerable challenges for the members of the Casualty Actuarial Society over the next several years.

We urge the talented minds of the CAS to work on combining new reserving techniques with GIS technology to ensure that balance sheets can be adjusted realistically to reflect possible liabilities for policies written with pollution coverage or without pollution exclusions.