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Reserving - how to reserve an Engineering portfolio with its specific characteristics

Prepared by:

Jürg Buff (Partner Re) Zürich (Chairman)
José Blanco (PartnerRe) Zürich
Pascal Bourquin (Partner Re) Zürich
Matia Cazzaniga (ZFS) Zürich
Brad Dalton (Vero) Sydney
Alain Favre (AXIS Re) Zürich
Andy Hottinger (AXIS Re) Zürich
Hari Radhakrishnan (HDFC Ergo) Mumbai
Jean-Marc Rossé (Nationale Suisse) Basel
Anne Sheehy (XL Insurance) Zürich
Marina Zyuganova (Renaissance) Moscow

Oscar Treceno (Nationale Suisse) Basel (Sponsor)

Table of Contents

1. Executive summary

This paper is intended to give underwriters insight into the actuarial world of how to reserve an engineering portfolio with its specific characteristics. Through the contribution made in this IMIA paper, it is not seen as the objective of the group to give recommendations to insurers how to reserve claims of engineering portfolios.

The paper describes some of the standard reserving concepts which are common to all lines of business, and emphasizes about accurately measuring earned premium for medium to long tail business considering the increasing exposure over time, and the consequences for loss reserving.

Claims reserves for claims that have not yet been paid can significantly impact the balance sheet and profit & loss account of insurance and reinsurance companies. Particularly in medium/long term business where identification and settlement of claims can take a long time claims reserves are of utmost importance.

Insurers are using several methods to determine reserves. No matter which method is chosen it must never be forgotten that reserving is as much an art as a science. There is no method that will deliver the “correct” estimate of ultimate losses in an automatic fashion. For all reserve analyses, multiple techniques are used to come to a sound opinion on the amount, and adequacy, of reserves needed.

A thorough understanding of the characteristics of the portfolio underlying the reported claims is critical. Reliability of claims development projections and estimates depends on the volume and accuracy of data which can be made available to actuaries. The difficulty here is to have a suitable IT system which captures this information for extraction.

2. Introduction

The most important stakeholders of insurance companies are the policyholders and the owners /shareholders of the insurance company. Because policyholders expect to have claims paid, insurers must set aside adequate reserves to guarantee the timely payment of these claims. Owners and shareholders benefit when reserves are accurate because under-reserving and over-reserving create volatility in profits. While under-reserving may lead to higher profits in the short-run, it often leads to reduced profits later. Supervisory authorities also have a keen interest in the reserving methods of insurers. By encouraging holding adequate reserves, supervisory bodies not only protect consumers, but also help insurers avoid insolvency. Moreover the interests of governmental tax authorities are also aligned with shareholders; though higher profits result in additional tax revenue, insurers are in some countries allowed to carry forward losses to reduce their tax burden.

Claims reserves are funds that are set aside and reflected on an insurer’s balance sheet for claims that have occurred and not yet been paid. The assets corresponding to the claims reserves are financed with premiums paid by policyholders. In case premiums are not sufficient, the difference has to be covered by shareholder’s equity. Increases in reserves are expenses, while reserves releases are producing income. The two main claims reserves categories of a non-life insurance company are for: 1) notified claims and 2) incurred but not reported claims (IBNR).

Because claims reserves are based on forecast of ultimate losses, reserve setting on long-tail business (project business) needs special attention. A property claim, such as a fire loss, is apparent to the customer within hours or days. The loss amount can be verified by the insurance company and the claim can usually be settled quickly. Therefore, claims reserves in short-tail lines are small. In contrast, significant claims reserves are necessary for all long-tail lines like liability and medium-tail lines like project business. The reason for the high reserves in long and medium tail business is the lag between the time premiums are collected and the time claims are paid; reserves need to be reflected on the insurer’s balance sheet until claims are settled.

Claims reserves are even more important and larger in reinsurance than in direct insurance. Reinsurers are usually informed about claims at a later stage because they are at least one level removed from the policyholder, with the direct company interacting as the interface sometimes through intermediaries. As the number of involved parties increases, so does the delay in notification.

The difficulty here (on top of having a suitable IT system) is to have a representative sample (in terms of volume, timing and characteristics), on which we can build solid conclusions

3. General accounting principles

Reserving is generally done based on a General Accepted Accounting Principle (GAAP).
The two most popular generally accepted accounting principles are the IFRS (International Financial Reporting Standards) and the US GAAP (Generally Accepted Accounting Principles of the United States). The convergence of IFRS and US GAAP is underway, but without a set conversion timeline yet.
In general both standards, IFRS and US GAAP, have the same purpose: to reflect a true and fair view of the business affairs of the organization and to make them comparable between different organizations. These standards stipulate that premiums should be earned over the period of cover in accordance with the pattern of the incidence of risk. Hence also the reserving has to be done in order to show a true and fair view. The loss experience of past years and the future expectations have to be taken into account to achieve a claims reserve that is as realistic as possible; in other words it has to reflect a so called “best estimate”.
IFRS is getting more and more important, in 2010 approximately 120 nations and reporting jurisdictions permit or require IFRS for domestic listed companies; approximately 90 countries have fully conformed to IFRS. Also the Securities and Exchange Commission (SEC) in the United States allowed in 2007 to private foreign issuers to report their financial statements under IFRS.

4. Definitions

This chapter shall give some guidelines to a common language between underwriting, claims, reserving and accounting

Since the definitions shall be valid for both insurance and reinsurance the term client is used for both clients of direct insurers and cedants (clients for reinsurers)

4.1 Reserving Terms (what are claims reserves?)

4.1.1. Outstanding loss reserves (OLR, notified claims, case reserves)

Reserves for specific incurred claims, which are not (yet) finally settled

4.1.2. Additional case reserves (ACR)

Amounts reserved for individual losses in excess of outstanding loss reserves. ACR's are usually applied if doubts exist that the claim can be settled within the reserve frame reported by the client. ACR's are particularly used in reinsurance.

4.1.3. Incurred but not reported (IBNR)

We are aware that there are different definitions in respect of IBNR's. For the purpose of this paper IBNR means the amount reserved for claims **i**ncurred **b**ut **n**ot yet **r**eported at the end of a financial reporting period. Therefore IBNR are always bulk reserves and are unrelated to specific claims. The concept of IBNR serves to "bridge the time gap" between a financial closing date and the moment until all incurred losses in the respective financial period are known.

Thus the scope of IBNR depends on the choice of the financial reporting period. On ultimate basis the IBNR are all future losses to incur until the last policy of the portfolio has expired and the last loss is settled. For a construction/erection policy book this might take many years.

4.1.4. Incurred but not enough reported (IBNER)

Reserves for claims **i**ncurred **b**ut **n**ot **e**nough **r**eported at the end of a financial reporting period. In many cases IBNER's are included in IBNR's.

4.1.5. Unallocated loss adjustment expense (ULAE reserves)

Reserves for general claims' adjustment cost. Not related to specific claims.

4.1.6. Allocated loss adjustment expense (ALAE reserves)

Reserves for claims' adjustment of specific claims; e.g. loss adjuster's fees, specific legal expenses, defence cost etc.

4.1.7. Ultimate loss

The final paid amount for all losses in the defined portfolio (can only be established after all policies have expired and all losses are settled)

4.1.8. Premium deficiency reserves

Negative difference between an actuarial estimation of the present value of future benefits and expected future expenses (claims cost, overhead, reinsurance) is recorded as premium deficiency reserve on a separate financial statement line.

Premium deficiency reserves are used in cases where the company suspects that the premium paid for a specific line of business is insufficient to cover its total cost.

4.1.9. Graphic illustration of terms

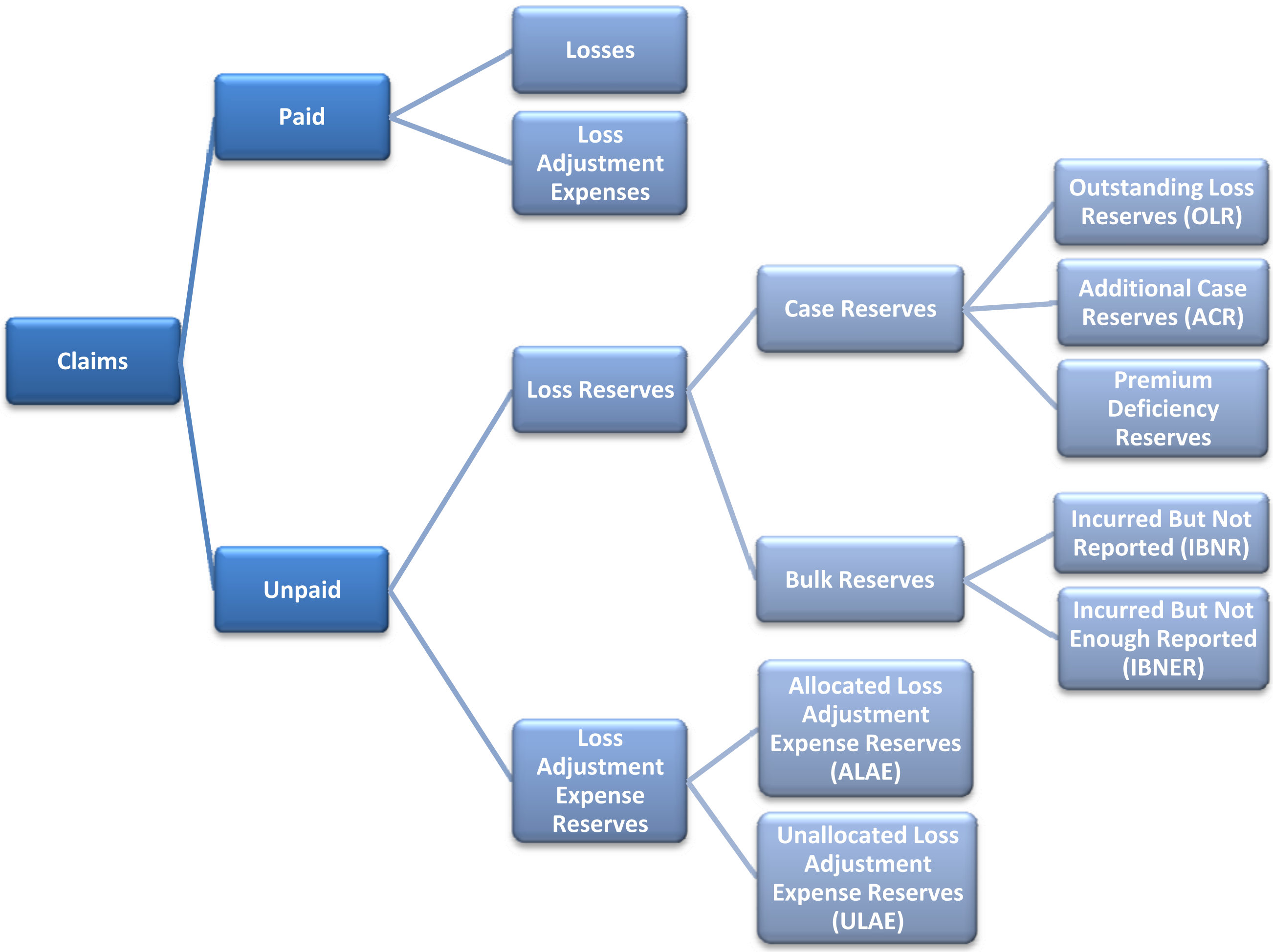


Figure 1: Loss Reserves Schematic

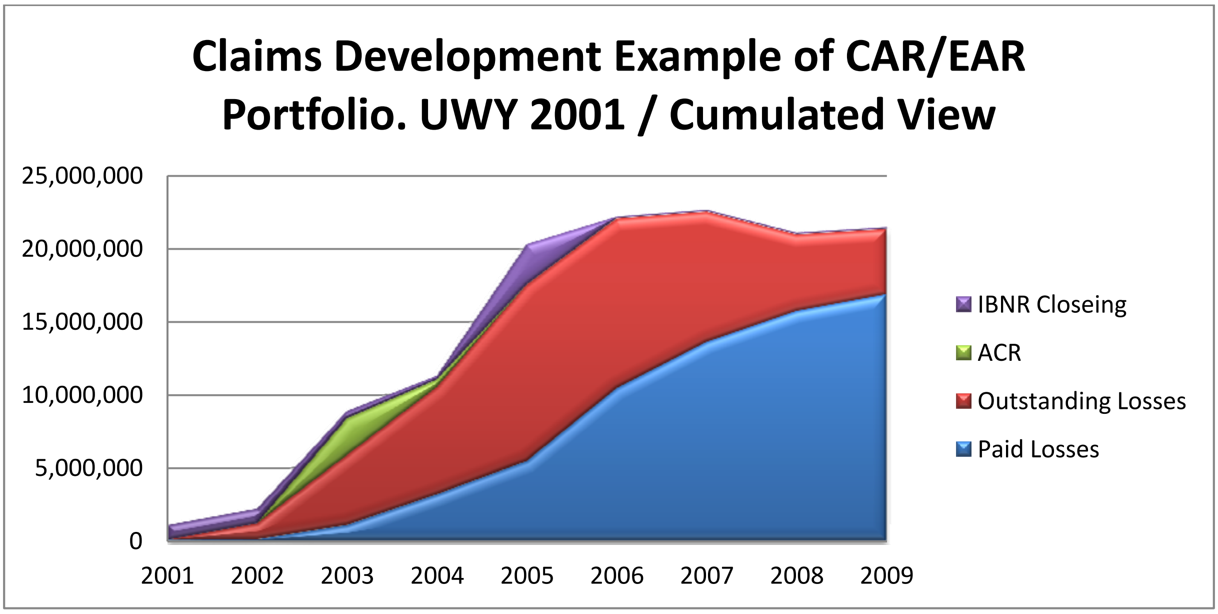


Figure 2: Claims Development Example of CAR/EAR Portfolio

The losses of this portfolio develop gradually and still after 8 years of development there is an important amount of outstanding losses. In the above example a loss event happened in 2005 (e.g. CAT event). No loss reports have been received at the time of closing but from the known exposure some losses must be expected, hence the increased IBNR setting at end of 2005.

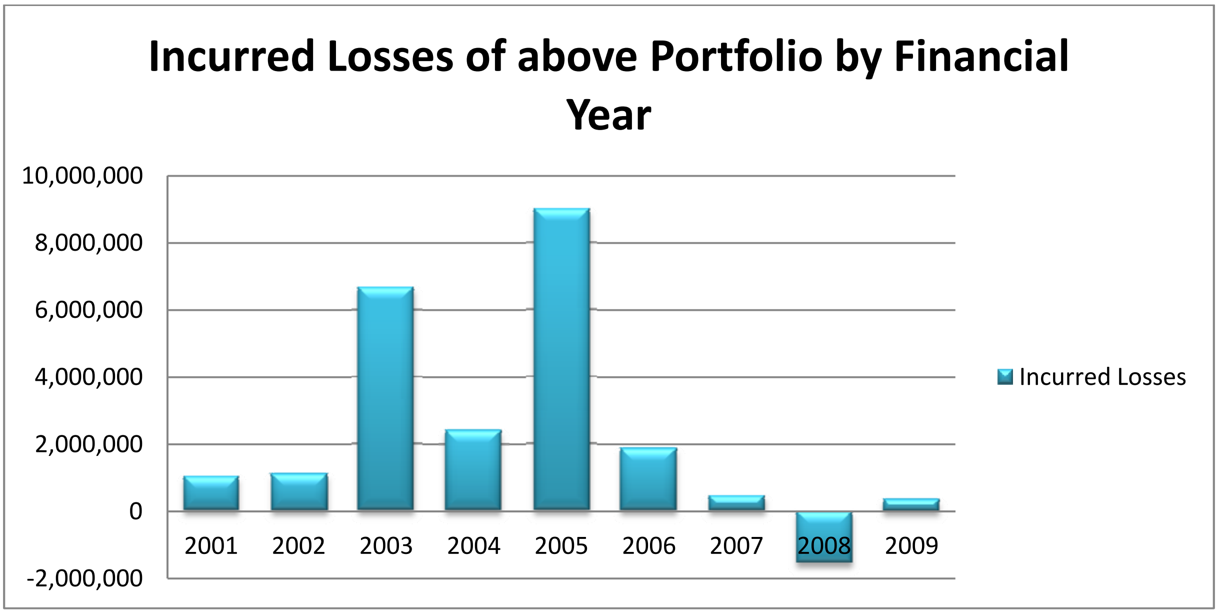


Figure 3: Incurred Loss breakdown per Financial Year

The spike in 2003 is to be expected in a portfolio with the bulk of policies having a duration of 2-4 years. The spike in 2005 is owed to the IBNR from an event. Due to prudent reserving there is a positive development with negative incurred numbers in 2008.

4.2. Premium terms definitions

4.2.1. Written Premium

Premiums for all policies sold during a specific underwriting period. This is the sum of all premium amounts stated on the policies written for one portfolio during a defined period (e.g. UWY).

4.2.2. Accounted Premium

Booked premiums during a specific accounting period.

4.2.3. Earned Premium

Premium that has been recorded as revenue during a specific accounting period. The earned premium is risk/exposure based. It represents the consumed part of the risk of a portfolio.

4.2.4. Unearned premium reserves (UPR)

Premium written for future financial periods and carried over to the next period's financial statements. This is essentially the difference between written but not yet earned premium.

4.2.5. Graphic illustration of terms

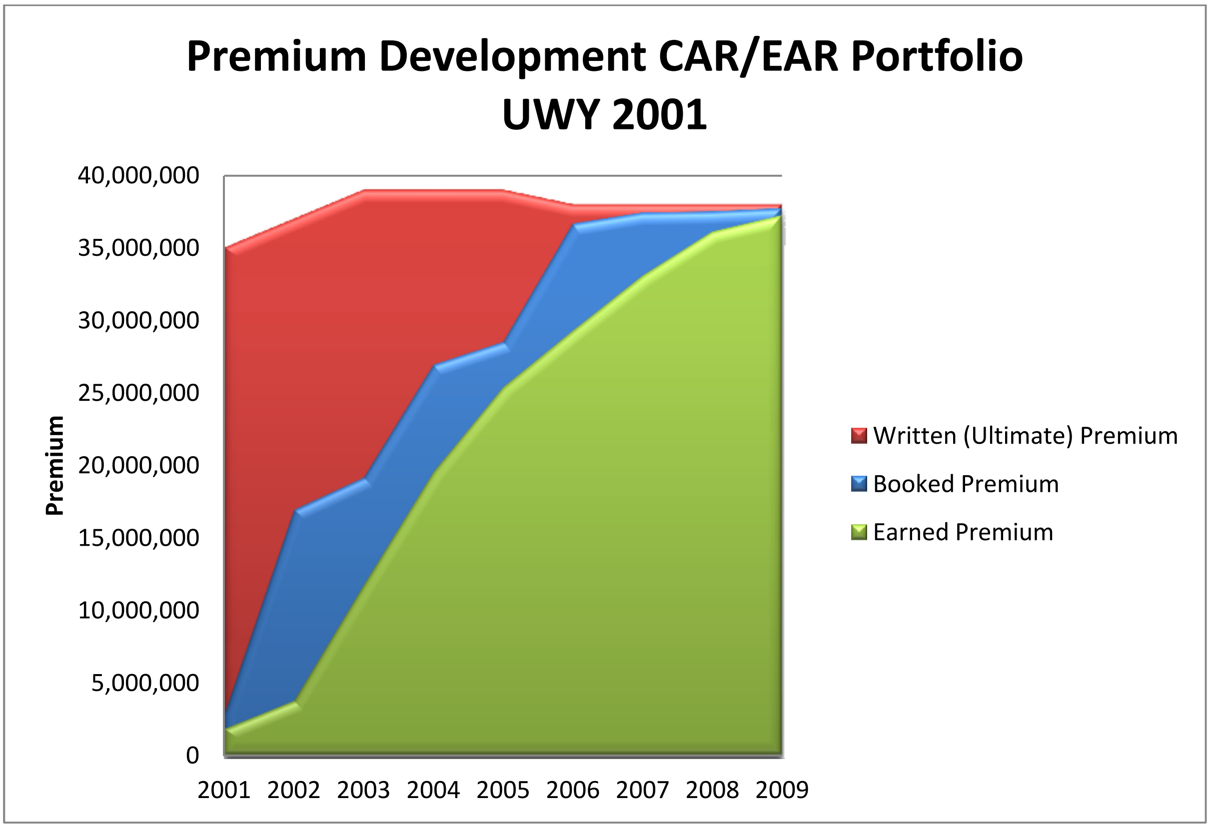


Figure 4: Premium Development of CAR/EAR Portfolio

It is usually the case that the earned premium lags behind the accounted premium. It can be nicely observed that on ultimate basis all three premiums converge.

The difference between written premium (essentially = booked premium in direct insurance) and earned premium needs to be booked as Unearned Premium Reserve (UPR).

5. Reserving methods

This text uses as a principal reference the text *"ESTIMATING UNPAID CLAIMS USING BASIC TECHNIQUES"* by Jacqueline Friedland, FCAS, FCIA, MAAA, FCA © Casualty Actuarial Society, 2010.

5.1. Development triangles

In the following discussion we will use as our example, data on reported claims. Similar analyses can be performed on paid claims, case outstanding, reported claim counts, etc. For most reserve analyses, at the very least, triangles for both paid claims, and reported claims will be examined.

5.1.1. Example

Consider the triangle of values shown in the table below:

Exhibit 1

	Development Period in Months									
Accident Year	12	24	36	48	60	72	84	96	108	120
2001	4,286	7,063	7,753	7,452	7,343	6,948	6,958	7,589	7,650	7,913
2002	4,140	7,388	6,862	7,955	8,186	8,049	8,167	7,788	7,789	
2003	4,298	5,420	5,125	7,207	7,333	5,667	5,827	5,776		
2004	5,058	4,741	6,460	6,246	6,168	5,892	5,959			
2005	4,305	6,777	7,941	9,506	8,398	8,243				
2006	11,388	22,317	25,312	23,929	23,159					
2007	15,001	22,745	23,268	22,540						
2008	30,457	44,130	43,055							
2009	20,708	31,178								
2010	19,366									

These values represent reported claim amounts (paid plus case reserves on reported claims), in thousands, from a segment of a construction portfolio. So, for example, we see that for this portfolio,

- At the end of 2001 there was a total reported amount of 4,286,000 for claims having accident year 2001.
- At the end of 2002 there was a total reported amount of 7,063,000 for claims having accident year 2001.
- At the end of 2010 there was a total reported amount of 7,913,000 for claims having accident year 2001.

We ask the following two questions:

Question 1: Can we use this data to estimate ultimate values for reported claims for each of the accident years 2001 to 2010?

Question 2: If the answer to Question 1 is yes, how can we best use this data to make such an estimate?

The answer to Question 1 depends on the validity of the assumption that for each Accident Year (AY), claims will « develop » in a similar manner. This is a strong assumption and while it does not require that the triangle is built from values pertaining to claims arising from similar risks, it does require that the mix of risks (at least in terms of how claim amounts develop over time) should remain stable. If, for example, the portfolio was exposed for the most part to builders' risk for homebuilders in 2001, but now in 2010 is mostly exposed to risks arising from the construction of bridges and tunnels, one would expect claims to develop very differently in 2010 than they did in 2001, and that 2001 AY data have probably little to tell us about AY 2010. In summary, we need to be able to assume throughout the experience period:

- consistent claim processing,
- a stable mix of types of claims,
- stable policy limits,
- and when working with net values, stable reinsurance (or excess insurance) retention limits.

We will assume for the remainder of the discussion in this section that we are satisfied that the data represented in our triangle satisfies the assumption needed to answer Question 1 in the affirmative. That is, that claims recorded to date will continue to develop in a similar manner in the future.

Triangles can also be constructed on an underwriting year, or reporting year basis, and development periods can be quarterly, or even monthly, depending on the volume of data.

5.1.2. The Chain Ladder Technique

A quick look at the triangle shown in section 5.1.1 above shows (not at all surprisingly) that for each Accident Year (AY), the reported claim amounts increase over the first few development periods (DP). (The DP is the time in months from onset of the AY). After a DP of about 48 months, it looks like the reported amount for that AY has leveled off and doesn't change much in successive DP's. In order to estimate the change in reported amounts from one period to the next, we calculate age-to-age factors. An age-to-age factor for a given Accident Year is the ratio of total reported amount in one DP divided by the previous one. So, for example, the 12 to 24 month age-to-age factor for the 2001 AY is 7,063/4,286 = 1.65, and the 36 to 48 month age-to-age factor for the 2003 AY is 7,207/5,125 = 1.41.

Exhibit 2

	Age-to-age factors								
Accident Year	12 to 24	24 to 36	36 to 48	48 to 60	60 to 72	72 to 84	84 to 96	96 to 108	108 to 120
2001	1.65	1.10	0.96	0.99	0.95	1.00	1.09	1.01	1.03
2002	1.78	0.93	1.16	1.03	0.98	1.01	0.95	1.00	
2003	1.26	0.95	1.41	1.02	0.77	1.03	0.99		
2004	0.94	1.36	0.97	0.99	0.96	1.01			
2005	1.57	1.17	1.20	0.88	0.98				
2006	1.96	1.13	0.95	0.97					
2007	1.52	1.02	0.97						
2008	1.45	0.98							
2009	1.51								
2010									

If our fundamental assumption is correct:

***Fundamental Assumption**: claims recorded to date will continue to develop in a similar manner in the future*

then for each AY, age-to-age factors for the same periods are all estimating the same development, and our best estimate of the development in reported claims from, for example, DP 12 to 24, will just be the average, over all AY's, of the respective 12 to 24 age-to-age factors. Different weighting systems can be used to calculate these averages and frequently more than one is used, the reason being that we never fully believe our fundamental assumption, and differences in averages will highlight aspects of the data which may indicate ways in which the actual development pattern differs from our assumptions. Moreover, if results derived from different weighting systems lead to very different ultimate values, we will need to invest some effort in understanding discrepancies in order to feel confident that our final reserves are really best estimates. These averages will be discussed in more detail in the next section.

Before proceeding to the calculation of averages of age-to-age factors (referred to as Loss Development Factors), we want to take a closer look at the individual factors. Note that, diagonals in the triangles of reported amounts, as well as age-to-age factors, refer to the same calendar years. Patterns seen in these diagonals may indicate deviations from our fundamental assumption and for this reason deserve some study. For example, in the triangle of age-to-age factors shown above, the diagonal of values AY 2003 age-to-age factor 12 to 24, AY 2002 age-to-age factor 24 to 36, and AY 2001 age-to-age factor 36 to 48 are all small relative to the average age-to-age factor for the respective DP's. This sort of pattern is suggestive of a change in the setting of case reserves by claims handlers and is probably worth looking into. If this were indeed the case and not just a statistical aberration, we might decide to omit these particular age-to-age factors from any averages we would calculate.

5.1.2.1. Selecting Loss Development Factors

5.1.2.1.1. Volume weighted average

The volume-weighted average is the weighted average using the amounts of reported claims as weights. The formula for this type of average uses the sum of the claims for a specific number of years divided by the sum of the claims for the same years at the previous age. For example, the 36-48 month volume-weighted average of the latest three years is equal to the sum of the reported claims for AY's 2005 through 2007 as of 48 months (9,506 + 23,929 + 22,540 = 55,975) divided by the sum of the reported claims for AY's 2005 through 2007 as of 36 months (7,941 + 25,312 + 23,268 = 56,522), or 0.990.

5.1.2.1.2. Average excluding high and low values

Average of age-age factors for the relevant DP's where the highest and lowest values are omitted from the average. For example, the average 48 to 60 month age-age-factor, excluding high and low is just (0.99 + 1.02 + 0.99 +0.97)/4. In the table below the highs for any DP are shaded red, the lows are shaded yellow.

5.1.2.1.3. Simple (or arithmetic) average

This is just the usual arithmetic average of all age-to-age factors corresponding to the same period.

Exhibit 3

	Age-to-age factors						
Accident Year	12 to 24	24 to 36	36 to 48	48 to 60	60 to 72	72 to 84	84 to 96
2001	1.65	1.10	0.96	0.99	0.95	1.00	1.09
2002	1.78	0.93	1.16	1.03	0.98	1.01	0.95
2003	1.26	0.95	1.41	1.02	0.77	1.03	0.99
2004	0.94	1.36	0.97	0.99	0.96	1.01	
2005	1.57	1.17	1.20	0.88	0.98		
2006	1.96	1.13	0.95	0.97			
2007	1.52	1.02	0.97				
2008	1.45	0.98					
2009	1.51						
2010							
36-48 month volume-weighted average of the latest three years	1.482	1.027	0.990	0.951	0.904	1.018	1.010
36-48 month volume-weighted average of the latest five years	1.553	1.053	1.019	0.971	0.930		
Average excluding high and low values	1.534	1.058	1.051	0.990	0.961	1.013	0.991
Average	1.515	1.080	1.086	0.978	0.928	1.014	1.012
Selected	1.482	1.027	0.990	0.98	0.904	1.013	1.010

The resulting averages are referred to as Loss Development Factors (LDF) because it is these factors that will be used to develop reported claim amounts at a given DP to ultimate amounts. You see from the table above that depending on which average you use, you get a very different result for the LDF. Various considerations lead to the choice of a *selected* LDF, and this selection process demands a thorough understanding of the business underlying the claims experience as well as specifics of claims handling processes.

When selecting LDF, actuaries review the claim development experience for the following characteristics:

- Smooth progression of individual age-to-age factors and average factors across *development periods*. Ideally, the pattern should demonstrate steadily decreasing incremental development from valuation to valuation (i.e., as we move further away from the accident period), especially in the later valuations. In the triangle above, it would appear that in the period 60 to 72 there is some increase in the magnitude of increments (sharp decrease in reported claims). This needs to be further investigated.

- Stability of age-to-age factors for the same development period. Ideally, there should be a relatively small range of factors (small variance) within each development interval (i.e. down the columns). We look for stability of age-to-age factors and within the various averages for the same development period. Because of the relatively small number of claims reflected in the triangle shown above, there is quite some variance in the individual age-to-age factors within the same development period. We would be wise to proceed cautiously here and dive a bit deeper before setting ultimate reserves.

- Credibility of the experience. Actuaries generally determine credibility based on the volume and the homogeneity of the experience for a given accident year and age. If the claim development experience of the insurer has limited credibility because of the limited volume of claims, organizational changes, or other factors, it may be necessary to use benchmark development factors from the insurance industry. An examination of the triangle in

Section 5.1.1 shows clearly that there has been a sharp increase in reported claims from 2006 and onwards. It would be important to understand here what the origin of this growth is, and, if it is a result of a fast growing book of business, to understand the specifics of differences between this new book of business and earlier business, and any changes in the insurance operation that may have accompanied this growth.

- Changes in patterns*.* Actuaries review the age-to-age factors to identify systematic patterns that may suggest changes in the internal operations or external environment.
- Applicability of the historical experience. Actuaries determine the appropriateness of historical age-to-age factors for projecting future claim development based on qualitative information regarding changes in the book of business and insurer operations over time. Actuaries also consider the effect of changes in external factors that have not yet manifested themselves in the reported claims experience.

5.1.2.2. Tail factor

When the data is not sufficient to analyze development until the point where the losses are fully mature (LDF = 1.000), we need to estimate a tail factor which is used to estimate ultimate losses from reported loss amounts at a given period of maturity. There are a number of ways to do this including using industry benchmark development factors, and/or using curves fit to the selected LDF pattern to estimate the tail factor. A detailed discussion of this topic is beyond the scope of this paper.

The triangle above would suggest that reported losses are not fully developed for this portfolio even after 7 years. Fortunately we have more than 7 years of data at our disposal, and for the sake of this example we will assume that LDF's are equal to 1 after the eighth DP!

5.1.2.3. Cumulative claim development factors

Cumulative claim development factors (CDF) (also known as age-to-ultimate factors) are used to project total growth over the remaining development periods.

Reported CDF at 96 months

= selected tail (96-ultimate) factor

= 1.000

Reported CDF at 84 months

= (selected tail factor) x (selected LDF 84-96 months)

= 1.000 x 1.010

= 1.010

Reported CDF at 72 months

= (selected tail factor) x (selected LDF 84-96 months) x (selected LDF 72-84 months)

= 1.000 x 1.010 x 1.013

= 1.023

Reported CDF at 12 months

= 1.363

5.1.2.4. Ultimate claims

The projected ultimate claims for a given AY, at a given valuation date, is equal to the reported claims for that year multiplied by the selected reported CDF for that year. The IBNR estimate for that AY, at a given valuation date, is equal to the projected ultimate claims minus the reported claims at the valuation date. For our example then, the projected ultimate claims for the AY 2010 is 19,366 x 1.363 = 26,402.
The IBNR estimate for that year is 26,402 – 19,366 = 7,036.

5.1.2.5. When the Chain-Ladder technique works

The following is an excerpt from the paper by Friedland and provides a succinct summary of where the Chain-Ladder Technique works best:

"When used with reported claims, there is an implicit assumption that there have been no significant changes in the adequacy of case outstanding during the experience period; when used with paid claims, there is an implicit assumption that there have been no significant changes during the experience period in the speed of claims closure and payment. Thus, the development method is appropriate for insurers in a relatively stable environment. When there are no major organizational changes for the insurer and when there are no major external environmental changes, the development technique is an appropriate method to use in combination with other techniques for estimating unpaid claims…...The development technique requires a large volume of historical claims experience. It works best when the presence or absence of large claims does not greatly distort the data. If the volume of data is not sufficient, large claims could greatly distort the age-to-age factors, the projection of ultimate claims, and finally the estimate of unpaid claims using a development method."

5.2. Expected claims technique

The expected claims technique uses an actuarial estimate of the total amount of unpaid claims, which does not rely on any observed claims experience. This method is often used when:

- An insurer enters a new line of business or a new territory
- Operational or environmental changes make recent historical data irrelevant for projecting future claims activity for that cohort of claims
- The claim development method is not appropriate for less mature periods since the development factors to ultimate are too highly leveraged
- Data is unavailable for other methods.

The underlying actuarial estimate is frequently just the product of the earned premium for the period of interest multiplied by the expected loss ratio (plan loss ratio) for that period.

5.3. Bornhuetter-Ferguson method

The Bornheutter-Ferguson method combines the methods of the Chain-Ladder technique, with the estimated claims technique. It is a weighted combination of the actual claims experience, and the expected claim amount. The weight given to the actual claims experience is derived from the Chain-Ladder technique, and is equal to 1/CDF. Recall, that in the Chain-Ladder technique, we estimate the ultimate claims for a given experience period, at a given maturity date, to be equal to reported claims x CDF. Therefore 1/CDF is an estimate of the proportion of ultimate claims which have been reported at a given maturity date. The greater the maturity date, the more weight that is given to the experience and the less weight that is given to the (à priori) expected claims estimate. Note that we can also apply this technique to triangles of paid claims.

5.3.1. Example

We refer to the example in section 5.1.1 above. For the AY 2010, the CDF is 1.363 (see 5.1.2.3). From this we infer that at 12 months 1/1.363 = 73% of the ultimate claims for the AY 2010 have been reported at this time. Suppose that our (à priori) expected claims for the AY 2010 is equal to 30,000. At 12 months we have reported claims of 19,366.

AY 2010		
Expected Claims	Claims Reported at 12 months	% Claims Reported (from Chain-Ladder technique)
30,000	19,366	73%

From this we calculate:

Ultimate Claims = Actual Reported Claims + Expected Unreported Claims
= 19,366 + (1 - 0.73) x 30,000
= 0.73 x Ulimate from Chain-Ladder Technique + (1 - 0.73) x Ulimate from Expected Claims Technique

Notice that when we use the Bornheutter-Fergusson method, the IBNR is estimated by the expected unreported claims.

5.3.2. When the Bornheutter-Ferguson method works

The Bornheutter-Ferguson method is generally used when the AY is not yet mature. At this time, random fluctuations in reported, or paid, amounts can significantly distort projections. The fundamental assumption underlying this method is that unreported (respectively unpaid) claims will emerge in accordance with expected claims, and that the estimate of percentage claims unreported is appropriate. The ease with which we can make this assumption will depend heavily on our knowledge of the line of business. Note that the estimate of the CDF typically is derived from an analysis of claims triangles and so shares this input with the Chain Ladder method.

5.4. Other methods

There are a number of other methods that are commonly used in reserving. Some, like the Benktander method are weighted averages of the Bornheutter -Fergusson method, and the Chain-Ladder, with the weight for the Chain-Ladder estimate increasing with increasing development year. Others, like the Cape Cod method, provide an estimate of the expected claims based on premium and loss data from all years, which can then be used as input to the Bornheutter -Fergusson method.

5.5. Summary

It must never be forgotten that reserving is as much an “art” as a science. There is no method that will deliver the “correct” estimate of ultimate losses in an automatic fashion. For all reserve analyses, multiple techniques are used to come to a sound opinion on the amount, and adequacy, of IBNR needed for a line of business. The methods described above are some of the more common methods used and the issues associated with these are typical of those relating to all techniques, the most critical being the relevance of historical reporting and/or paid patterns to the period of interest. A thorough understanding of the characteristics of the portfolio underlying the reported claims is critical and increases the confidence in the results produced by the projection methods.

5.6. Pitfalls of traditional reserving methods applied to an engineering portfolio

Analogous to our discussion on earning methods, the various lines of Engineering business should, ideally, be reserved separately, with the reserving profiles being determined by the relevant product or type of cover.

5.6.1. Renewal business

For renewal business, typically MB (machine breakdown) and EEI (electronic equipment insurance) policies, the underlying exposure remains approximately uniform throughout the policy period both in terms of value at risk and operational matters.

Reserving techniques like Chain-Ladder, expected claims, Bornhuetter-Ferguson, Cape Cod or a combination of them are suitable methods for Engineering Lines renewal in the same way as they are for Property annual business.

However, the accuracy of reserve estimates depends on the validity of general assumptions as extensively illustrated in earlier sections of this chapter.

In particular, when applying the Chain-Ladder technique, diagonal patterns in the triangles of reported amounts have to be carefully monitored and any evidence of deviations from general assumptions has to be investigated to the extent of tracking any inconsistency in claims processing or changes in internal operations and external environment.

Furthermore, the assumption about a stable mix of types of claims throughout the experience period is also critical and needs to be considered in light of the fact that claims coding for Engineering Lines business remains extremely basic. In general, all claims covered under MB and the ones covered under EEI although the complexity of insured risks would require a much more accurate coding by loss causes in order to allow an effective analysis of MB and EEI portfolio.

In addition, it is a cause of concern when MB and/or EEI coverage is provided as part of a combined Property/Engineering lines policy and treated (recorded) as Property business only.

Reliability of claims development projections and estimates depends critically on the volume of data which can be made available to actuaries especially for niche products.

5.6.2. Project business

Project business or so called one-off CAR/EAR (construction/erection all risks) policies are a unique feature of Engineering lines business as:

a) underlying exposure increases over the policy period as value at risk is not constant and some operations - testing and commissioning - just take place when the project is completed and almost ready for hand over e.g. the policy is close to expiry date,

b) some optional policy extensions like ALoP/DSU or Maintenance have most of the exposure approaching or after the expiry date.

The above peculiarities undermine most of the fundamental assumptions in reserving methods regarding the stability of policy limits and future claims development patterns.

Whereas the policy limit is considered to be up to the total sum insured (or total contract value) without any restriction depending on the different phases of a project – the most common situation for CAR/EAR portfolio – the theoretical limit or actual exposure is continuously changing in relation to the value at risk and this should be considered in age-to-age factors with some direct relation to the premium earning pattern used for the specific product and class of business/industry.

In addition, claims recorded to a certain date are not expected to develop in a similar manner in the future as portfolio exposure and claim amounts change according to the maturity and the development pattern of each account.

Different classes of business covered under the same product can have different exposure depending not only on construction/erection stages but also on intrinsic engineering factors (a bridge is on average more exposed during its construction phase than during testing in comparison with a power plant) and external environment (natural catastrophes exposure).

While standard reserving methodologies represent a reasonable approach to estimate reserves for renewal business, the same is not true for project business. Some key aspects of this class of products, such as maturity of the policies and portfolio stability, are not adequately reflected in the reserve estimate. It is possible to have two portfolios, each with the same number of policies, overall premium amount and loss amounts but because of different maturity of the policies composing each portfolio they need to be assessed and adjusted manually.

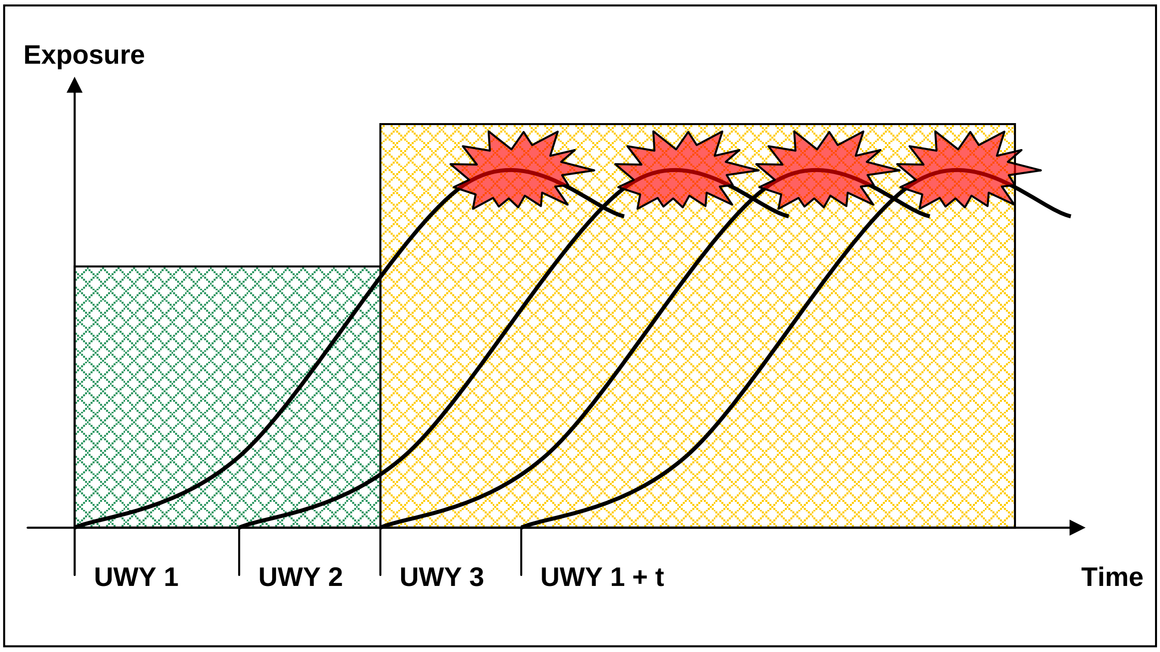
It stands to reason that the first step in improving the reliability of the estimate of Engineering lines reserves consists in a separate analysis of renewal and project accounts.

5.6.3. Potential ultimate loss ratio understatement with reserving methods

In the case of a newly created Engineering lines portfolio, supported by a limited amount of statistical data, the correct interpretation of results coming from traditional reserving methods is of utmost importance.

In particular, when one-off project business represents the majority of the book of business, the fact that the exposure of each single risk is assumed increasing as works progress needs to be taken properly into account.

Consider the graphical display shown below. The y-axis indicates the average exposure of accounts in the portfolio written in a given underwriting year, while the x-axis indicates time.



If the number of risks – and premium volume – written between UWY 1 and UWY (1 + t) is continuously increasing the traditional reserving methods could mislead reserving actuaries. By traditional reserving methods, we mean the assumption, traditionally made, that premium is earned uniformly over time, but is it right to assume that this is the case for all Engineering lines?

There is also the danger that the experience of earlier years will be used to predict the loss ratio for later years resulting in an underestimation for those later years.

A further analysis of how the premium should be earned is necessary to face these issues.

6. Appropriate earning methodology for an engineering portfolio

6.1 Importance of an appropriate earning methodology

As unearned premium is the portion of the premium applicable to the unexpired period of the policy, Unearned Premium Reserve (UEPR) in its turn is the sum of all premiums representing the unexpired portions of the policies which the insurer or reinsurer has on its books as of a certain date. Apart from other functions, which are essential for all insurance reserves the size of UEPR should:

a) reflect the risk exposure during the policy period,

b) be sufficient to consider the interests and concerns of insurer and insured in case of cancellation of the policy.

According to the survey made by WGP members the pro rata temporis method (proportionally to time) is used in almost all markets for all the engineering lines. The peculiarity of this method is that the premium is earned equally day by day during the period of the policy.

It is assumed that the insurance protection and exposure is evenly spread over the policy term.

But analyzing the different classes of Engineering lines we can clearly see that their exposure development is different for them (see table below), and moreover there are some classes for which the insurance protection overlaps the policy period (e.g. IDI insurance, maintenance guarantee).

Class of Business	Type of Business	Duration of Coverage	Underwriting Year	Value at Risk	Exposure
MB/EEI	Renewable	Annual (usually 12 months)	As per coverage inception	Constant	Equally distributed over coverage period
CAR/EAR	One-off project	Construction period + Maintenance period (if any)	As per coverage inception	Increasing during construction period	Variable according to value at risk and risk intrinsic characteristics Basically increasing getting closer to coverage expiry
IDI	One-off project	10 years after works completion	Usually at works inception OR at coverage inception	Constant	Equally distributed over coverage period
ALOP/DSU	One-off project	Construction period + Indemnity period (usually up to 24 months)	As per coverage inception	Constant	Variable according to value at risk and risk intrinsic characteristics Basically increasing getting closer to coverage expiry

So, taking the above into consideration are we earning the premium correctly for all classes of business?

For annual renewable policies pro rata method seems quite appropriate, as exposure can be assumed to be spread during the policy period and in case of early cancellation premium may be returned to the insured proportionally to the policy actual duration. Here we can't see any difference from reserving property portfolio.

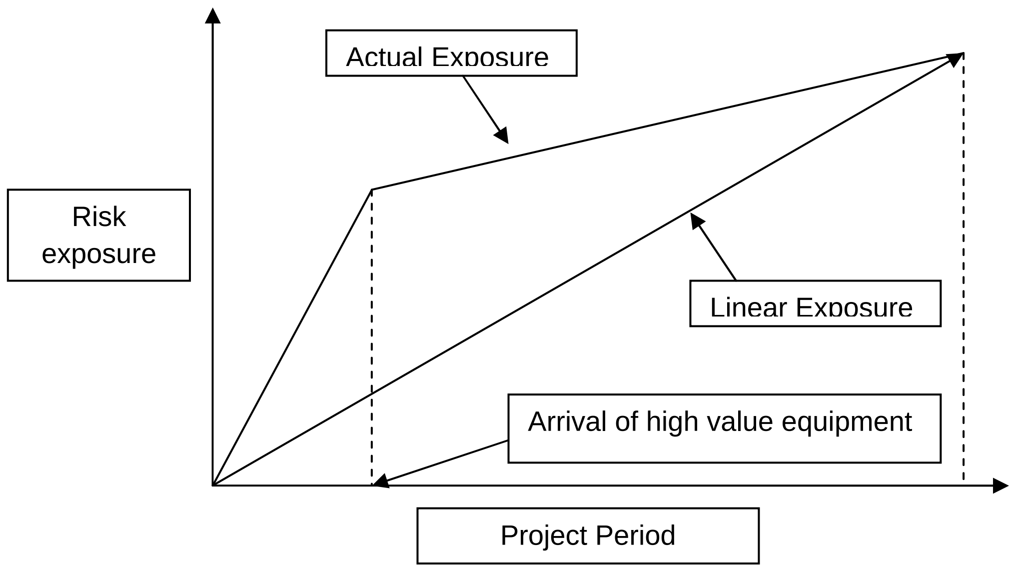
For such policies where the insurance risk is not evenly spread throughout the policy period, it would be more appropriate to apply a "non-pro rata" earning pattern (see 6.3).

6.2. Considerations on construction engineering policies in respect of exposure evolution

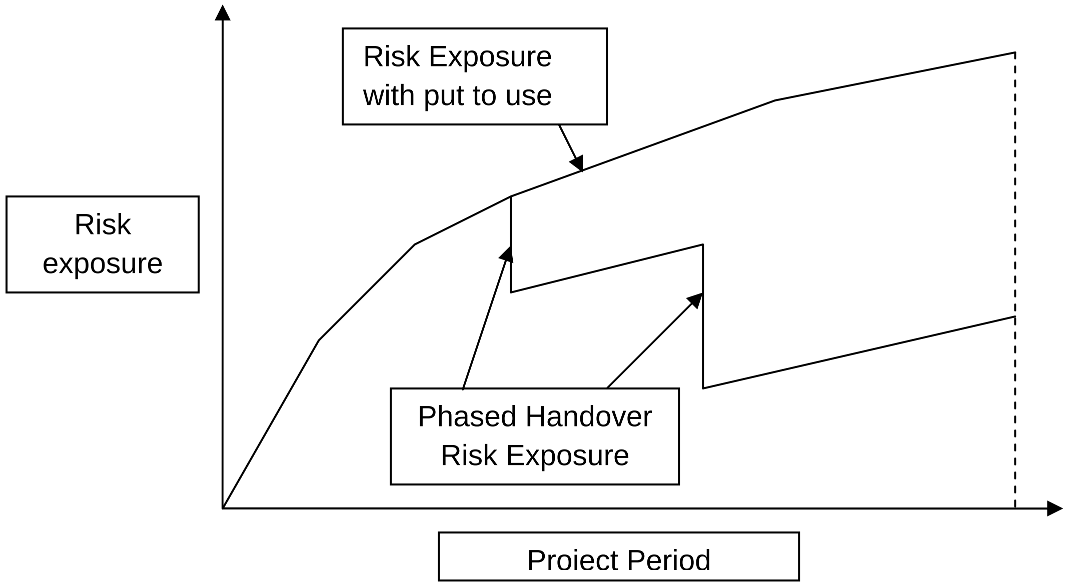
In case of construction insurances, it is difficult to predict how the actual risk exposure varies during the period of insurance. The covers can last from a few months to many years. The build-up of values and risk exposure is time dependent. In some cases, the exposure can also be season dependent, i.e., risk exposure may be higher during rainy seasons for civil construction as compared to dry season. Not all considerations can be captured within a "perfect" earning pattern (this is also true for other classes of business), but one should be aware about the specificities of the business for which we want to estimate an earned premium as much in line as possible with the exposure and consequently determine an appropriate level of loss reserves, to illustrate this consider the following points:

- In case of simple civil structures such as construction of an apartment building not exceeding four to five floors, the value build-up can be uniform. The values build up uniformly over time.

- In case of complex civil structures such as high risk buildings or metro railway works, there is a possibility that considerable amount of time could be spent in the initial phase in heavy piling or tunnelling works, where accretion in terms of value could be lesser in the initial phase than towards the end. Hence the risk distribution may not be uniform.
- In case of erection of plant and machinery, there are different dimensions to be taken care of. The risk exposure depends on various factors such as length of erection, testing and maintenance periods, arrival of material at site, storage exposure etc. For instance if the testing period is longer, say more than three months there is a prolonged risk exposure towards the tail end of the project, thereby requiring an adjustment in the earned premium calculations.
- Since the project policies cover also storage of plant and machinery at site awaiting erection, this also can change the actual risk exposure. For instance, in case of a thermal power plant, the critical equipments such as Boiler, Turbine and Generator (BTG) could constitute close to 65% of the total project value. In the event that the project takes 36 months to complete and the BTG arrives in the third month, then there could be a spike in the risk exposure early into the project than another case where such equipment arrives later on. In such cases, a linear basis of earned premium working would not be appropriate.



- Another aspect to be examined is the impact of ‘phased handover’ or ‘put to use’ clause in respect of construction risk policies. In respect of the former, portions of the project which gets commissioned are knocked off from the coverage and ones that are yet to be commissioned remain within the scope of cover. In such an event, the risk exposure changes with each handover. Contrary to this, if there is a put to use provision in the policy, whereby the completed units remain within the scope of cover till all the units are tested and commissioned, the risk exposure will not abate, but instead there will be an upward progression of risk exposure. The two situations are explained in the following graphs



- In respect of ALOP/DSU, it can be generally stated that the risk exposure is at its highest during the testing and commissioning phase when there is little time available for repairing or reordering damaged equipment. However, there can be variations in respect of this risk for different type of projects.

- In case of batch plants where there are cluster of different units without interdependency between them, the testing of individual units could be carried out independently. In case of loss or damage, the ALOP could be limited to only the unit affected and not the entire plant. Hence while the premium collected could be on total SI, the risk exposure would be spread over individual units. However situation changes for continuous process plants where there is interdependency between units whereby the risk exposure is towards the end of the project where all units are put to integrated testing.

- There is no uniformity of view among markets as to whether maintenance period needs to be considered along with policy period or not while arriving at earned premiums. In some markets, the policy is deemed to expire after the property is tested and commissioned. Maintenance period is not considered as part of the policy period itself. In some other markets, policy is considered as expired only after maintenance period is also over. In view of the above differing perceptions, the earned premium computations can also vary widely. Nevertheless from a risk perspective, during the maintenance period, many of the construction related risks are absent and only risks related to the performance of any maintenance obligation are normally covered. Hence the exposure is different (lower) from that during the construction period. This needs to be reflected in the earning patterns being assumed.

This non-exhaustive list of considerations shows how complex the evolution of the exposure of the object insured by a construction engineering policy can be. This evolution depends mainly on the nature of the project, the duration of the policy, the arrival of consignments, the mix of civil works vs. engineering works, the presence of ALOP cover along with EAR and/or the maintenance period (if any).

A general curve for all types of projects would lead to an over generalization missing some important specific characteristics and would not be suitable on a project by project basis, but to have different curves for each kind of project would lead to too much complexity, which for practicality reasons would also not be suitable.

The best course would be to group projects into different distinct categories, so that earning curves can then be developed for application for each group, the difficulty is to define the major aspects to be considered to do the groupings.

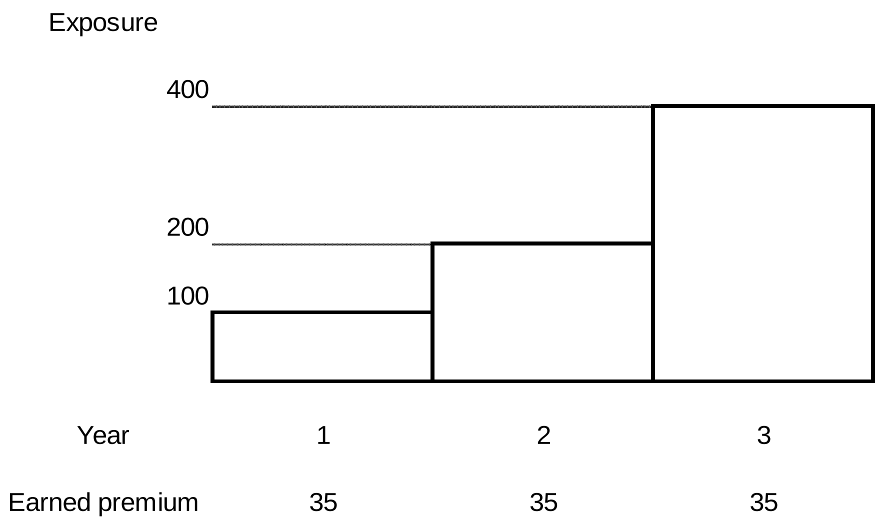
6.3. From the exposure to an earning pattern

We have seen that the exposure for a construction engineering policy evolves over time, generally speaking it increases, to illustrate how this is translated into the way the premium should be earned, we have put together the following example.

Let's assume we have a 3 years construction policy and that the exposure during the first year is always equal to 100, in the second year 200 and in the third year 400. Let's also assume that the premium generated by this policy is equal to 105.

We have two cases, in case 1 we apply a prorata temporis pattern, this gives us an earned premium for the first year equal to 35, for the second year also 35 and the same for the third year; each year one third. This case is illustrated in the following graph.

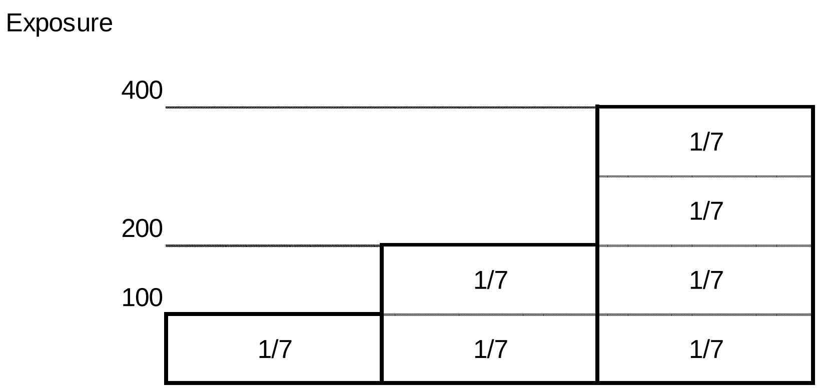
Case 1: pro rata temporis earning



In case 1 we take into consideration the time to earn the premium but not the fact that the exposure is increasing year by year.

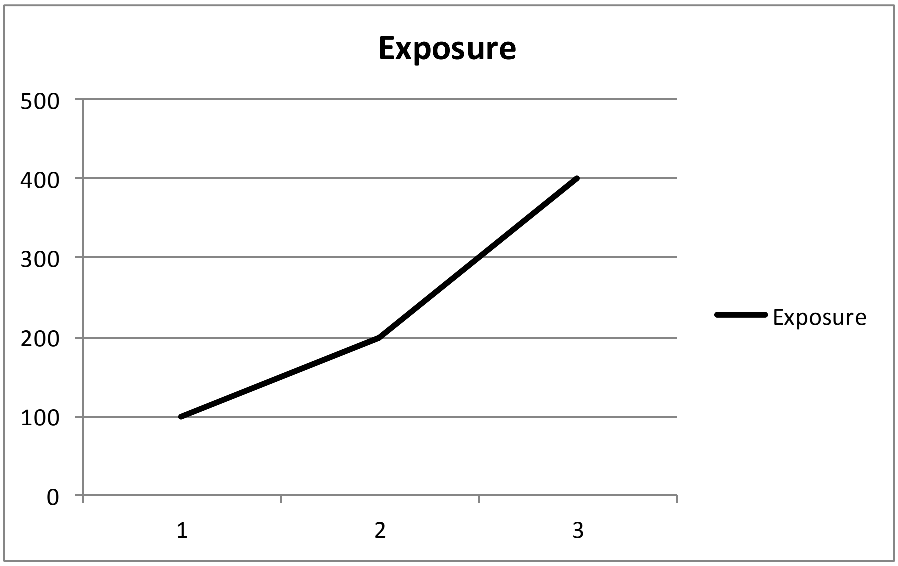
In case 2, we intuitively calculate what should be the earned premium taking into account the specific exposure by year. For the first year we should earn $1/7^{th}$ of the 105, which is equal to 15, in the second year $2/7^{th}$ of the 105, which is equal to 30 and in the last year $4/7^{th}$ of the 105, which is equal to 60. Case 2 is illustrated in the graph below.

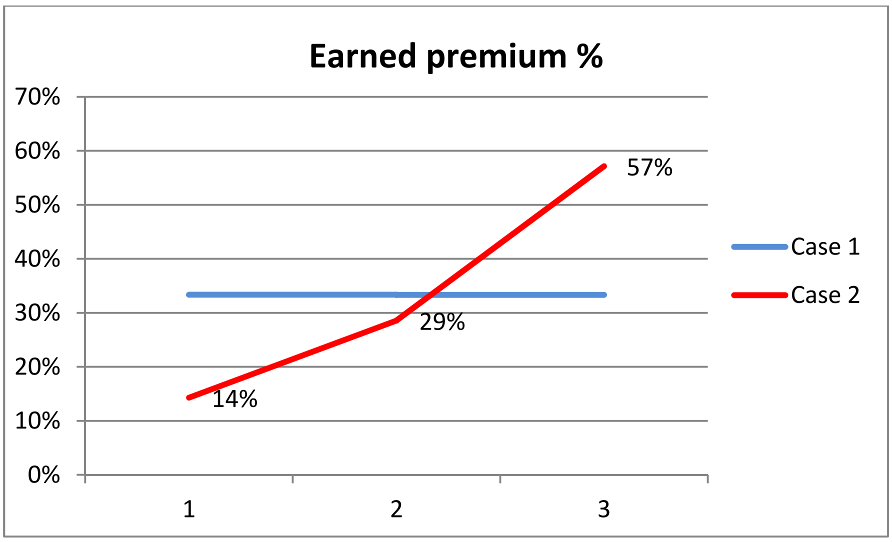
Case 2: earning according to exposure by year



Year	1	2	3
Earned premium	15	30	60

The following graphs show the evolution of the exposure and the earning patterns in case 1 and 2.





The shape of the earning pattern in case 2 follows the one of the exposure (both are convex), intuitively case 2 is more appropriate than case 1, because it takes into consideration the fact that the exposure increases over time.

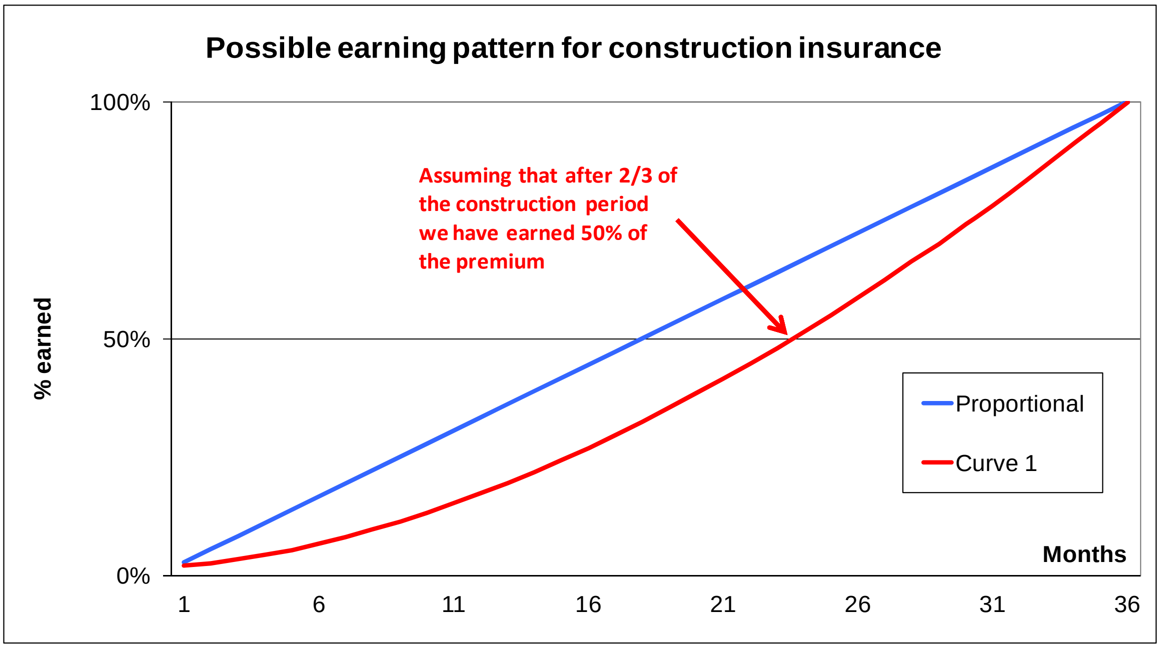
The calculation of "non-pro rata" earning patterns where the insurance risk is not evenly spread throughout the policy period depends highly on the evolution of the exposure; therefore the starting point in building earning patterns should be the estimation of the exposure evolution along the duration of the project. The first way to do that, which is also the most appropriate from a theoretical point of view, needs a significant amount of data: the evolution of the exposure at any point of time during a project.

A project bar chart giving milestones could be a starting point for developing risk exposure curves so that earning patterns can be ascertained. This is often available with project promoters and can be obtained in many cases as part of the underwriting submission. However, in many projects, the milestones initially set are often subject to changes and the initial bar chart could vary substantially during the duration of the policy from the actual risk exposure development. To mitigate this issue it would be important to get periodic updates from insured's regarding project milestones achieved as against original bar chart. However, in many markets compliance of this requirement can be an issue.

Another possibility would be to have project status monitoring surveys, where an engineer visits the site periodically and files reports on project progress. However this can be impractical or quite expensive in case of smaller projects.

The second way to estimate properly the evolution of the exposure for a kind of projects could be based on losses information. This would require an important amount of information; we would need a representative sample of total losses distributed along the duration of the projects. The difficulty here (on top of having a suited IT system) is to have a representative sample (in terms of volume, timing and characteristics), on which we can build solid conclusions.

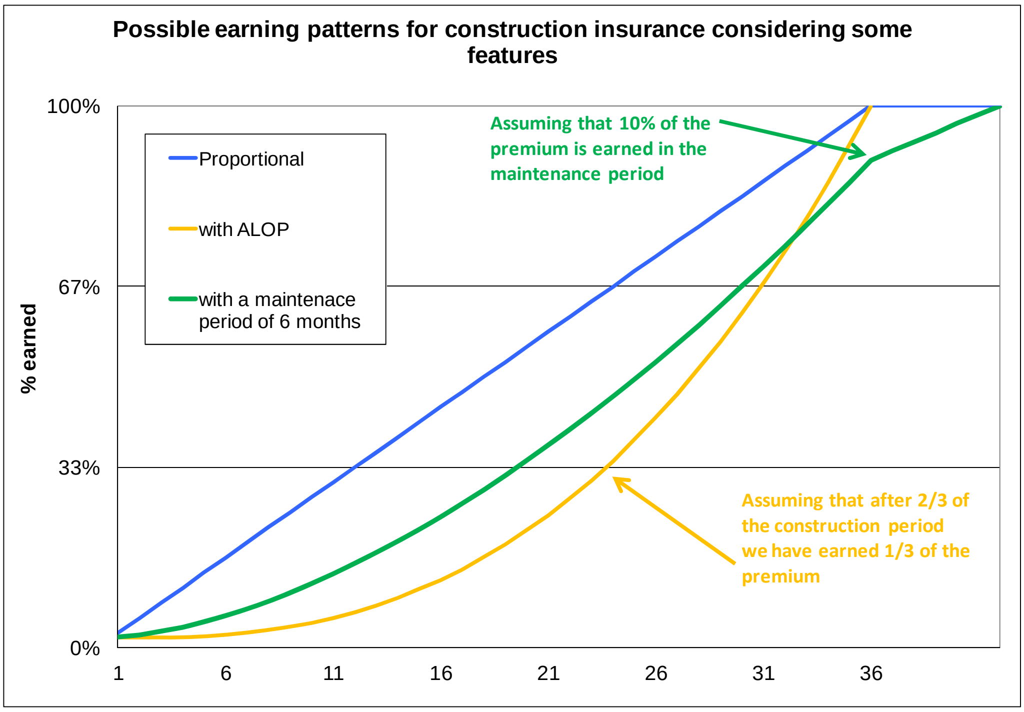
Both ways have their constraints and limits, to avoid these practical issues and come closer to a more suitable approach, pragmatically we could make some assumptions directly on the earning pattern instead of trying to estimate first the exposure. As everyone agrees on the fact that in almost all the cases the exposure increases continuously during the duration of the project, we can then assume that the earning curve should be convex and that a certain % of the premium generated by a project is earned after a certain stage of the construction period, and from there determine the rest of the earning pattern. This is illustrated in the following graph, where we are comparing a pro rata temporis earning pattern applied to a 36 months construction policy and the earning pattern we would apply assuming that after for example 2/3 of the duration (24 months in this case) we have earned 50% of the premium and the rest will be earned in the last third of the duration.



As discussed above, construction policies may have other features on top of the longer duration and the increasing exposure that could be taken into consideration when it comes to determine an appropriate earning curve, for example this may be the case of a maintenance period or the inclusion of an ALOP clause. In the graph below we illustrate how these two characteristics could impact an earning curve taking some assumptions:

- In the case of a maintenance period, we could for example assume that a certain % of the premium should be earned on pro rata temporis basis during the maintenance (assuming that during this period the exposure is fixed), but keeping the assumption that after 2/3 of the construction period we have earned 50% of the premium

- In the case of an ALOP, we assume that this feature intensifies the premium to be earned at the end of the construction period (if a loss happens at the end of the construction, it gets harder to catch up and the ALOP claim will be higher), for illustrative purposes let's assume that after 2/3 of the construction period we have earned 1/3 of the premium



6.4. Application to a master policy / reinsurance treaty (portfolio of policies)

Consideration has to be given also for those cases where the policy is issued on a master basis i.e. declaration policies issued on annual basis which is seen in some markets. Under this concept, several projects are covered under a single master policy with a pre-determined coverage matrix and projects are covered on a risk attaching basis with individual declarations of projects being made. In such cases, the earning is dependent on attachment of individual projects over a shorter period, i.e., one year. Often there can be run offs, where projects incepting in one year need not get completed during the year and get carried over to subsequent year. This also can create complexities in risk exposure curves and consequently in earning patterns. Similar issues are faced by reinsurers when it comes to determine the exposure patterns (and consequently the earning patterns) of a given reinsurance treaty.

In reinsurance the "1/24 method" (also known as "parabolic" curve) is often used to earn the premium of treaties which are on a risk-attaching basis, because usually the reinsurer doesn't have all the details of the underlying policies (premium, inception and expiring date). This "simplified" method is based on the following assumptions concerning the underlying policies:

- All policies attach evenly over the year
- Frequency (probability of having a claim) is the same at each time during the policy period
- All policies have the same exposure over their exposition period, which is one year

For renewable business (MB, EEI) the 1/24 method could be used, but as the one-off (CAR, EAR) business doesn't fulfil the assumptions of the 1/24 method (duration is generally longer than one year and exposure increase over time), the curve 1/24 is somehow inappropriate. In the case of a portfolio made out of renewable and one-off business the appropriate approach would be to build a combined curve, to achieve it we could make some assumptions on the composition of the underlying portfolio and aggregate the different curves weighting the specific curves with the respective premium, this curve could for example consider:

- % of the portfolio which is made out of renewable business
- % of the portfolio made out of project/construction policies:

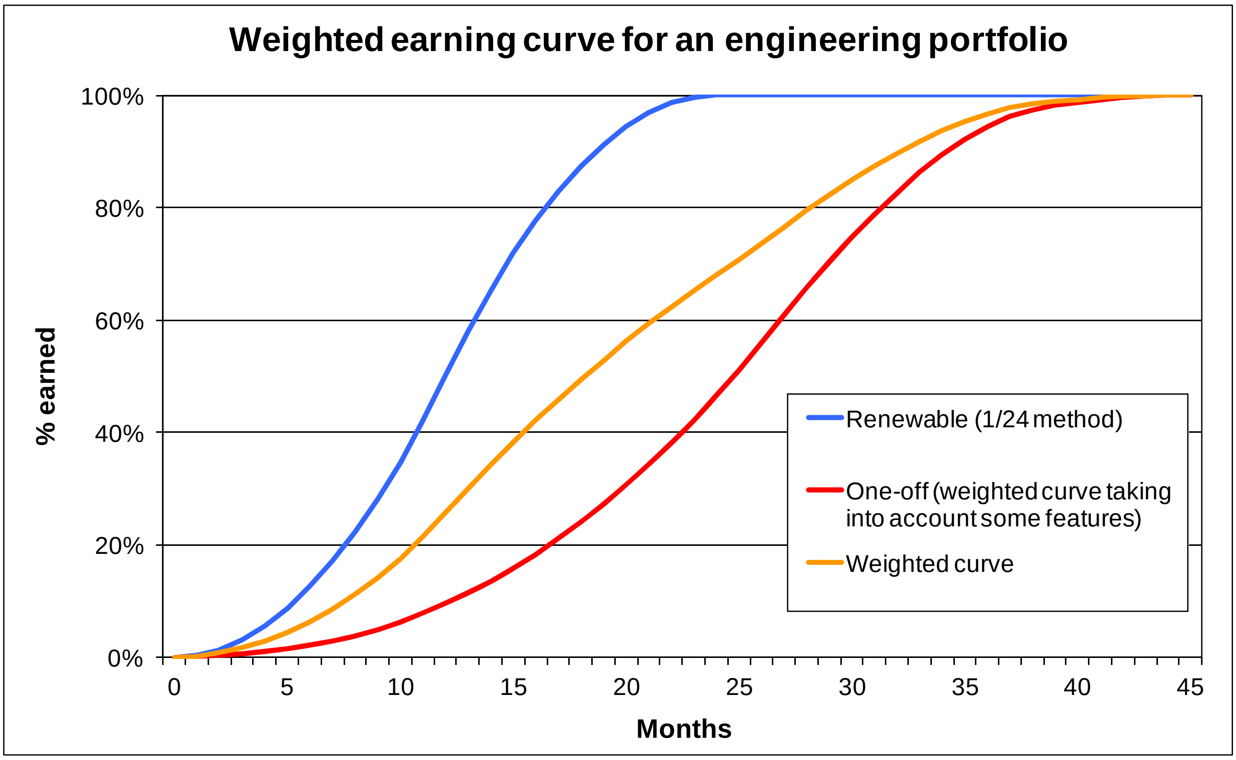
a) average duration of the construction period of the underlying policies

b) average duration of the maintenance period of the underlying policies

c) % of the underlying policies have an ALOP cover

d) Other features.

In the following graph, we illustrated a possible weighted earning curve:


Weighted earning curve for an engineering portfolio
100%
80%
60%
40%
20%
0%
% earned
0
5
10
15
20
25
30
35
40
45
Months
Renewable (1/24 method)
One-off (weighted curve taking into account some features)
Weighted curve

7. Glossary

Accident year (AY): For any analysis of claims, it is necessary to classify them in some way. Here, claims are grouped according to the year in which they occurred (cf notification year, underwriting year).

Accounted premium: Booked premiums during a specific accounting period.

Additional case reserves (ACR): Amounts reserved for individual losses in excess of outstanding loss reserves. ACR's are usually applied if doubts exist that the claim can be settled within the reserve frame reported by the client. ACR's are particularly used in reinsurance.

Allocated loss adjustment expenses (ALAE): Reserves for claims' adjustment of specific claims. E.g. loss adjuster's fees, specific legal expenses, defence cost etc

Bornhuetter-Ferguson: Claims projection technique that uses a claims triangle information about premiums and initial loss ratio assumptions.

Cape Cod: Claims projection technique that uses a claims triangle and information about premiums.

Chain Ladder: Simple projection technique that can be applied to a data.

Claims expenses: Internal and external costs incurred by the insurer in administering claims.

Claims incurred: In relation to a set of risks, this is the sum of claims paid to date plus the claims reserves held in respect of those risks.

Claims reserves: A term that covers provisions in respect of claims arising from risks that have already occurred. It includes the notified claims reserves and the IBNR provisions.

Earned premium: Premium that has been recorded as revenue during a specific accounting period. The earned premium is risk/exposure based. It represents the consumed part of the risk of a portfolio.

IBNER: Reserves for claims Incurred But Not Enough Reported at the end of a financial reporting period. In many cases IBNER's are included in IBNR's.

IBNR: We are aware that there are different definitions in respect of IBNR's. For the purpose of this paper IBNR means the amount reserved for claims **i**ncurred **b**ut **n**ot yet **r**eported at the end of a financial reporting period. Therefore IBNR are always bulk reserves and are unrelated to specific claims. The concept of IBNR serves to "bridge the time gap" between a financial closing date and the moment until all incurred losses in the respective financial period are known.

Thus the scope of IBNR depends on the choice of the financial reporting period. On ultimate basis the IBNR are all future losses to incur until the last policy of the portfolio has expired and the last loss is settled. For a construction/erection policy book this might take many years.

Loss ratio: The ratio of claims incurred to premium. The latter will be taken as written premium for business on an underwriting year basis and earned premium for business written on an accident year basis.

Outstanding loss reserves (OLR): Reserves for specific incurred claims, which are not (yet) finally settled.

Premium deficiency reserves: Negative difference between an actuarial estimation of the present value of future benefits and expected future expenses (claims cost, overhead, reinsurance) is recorded as premium deficiency reserve on a separate financial statement line.

Premium deficiency reserves are used in cases where the company suspects that the premium paid for a specific line of business is insufficient to cover its total cost.

Notification year: For any analysis of claims, it is necessary to classify them in some way. Here, claims are grouped according to the year in which they were notified (cf accident year, underwriting year).

Notified claims reserves: Provisions to cover the entire remaining costs of settling all claims that have been notified to the insurer, including ALAE.

Reserves: In insurance accounting, this term is often used interchangeably with provisions.

Triangle: Common arrangement of aggregated claims data for reserving purposes. Claim movements (this term includes notifications, payments, changes in estimates and settlements) are aggregated in rows according to their origin grouping (eg accident year, underwriting year) and in columns according to how long it took from the beginning of the origin period before the movement was recorded.

Ultimate loss: The final paid amount for all losses in the defined portfolio (can only be established after all policies have expired and all losses are settled)

Unallocated loss adjustment expenses (ULAE): Reserves for general claims' adjustment cost. Not related to specific claims.

Underwriting year: For any analysis of claims, it is necessary to classify them in some way. Here, claims are grouped according to the year when the period of insurance in which they occurred began (cf accident year, notification year).

Unearned premium reserves (UPR): Premium written for future financial periods and carried over to the next period's financial statements. This is essentially the difference between written but not yet earned premium.

Written premium: Premiums for all policies sold during a specific underwriting period. This is the sum of all premium amounts stated on the policies written for one portfolio during a defined period (e.g. UWY).

8. References

ESTIMATING UNPAID CLAIMS USING BASIC TECHNIQUES
Jacqueline Friedland, FCAS, FCIA, MAAA, FCA © Casualty Actuarial Society, 2010

Non-life claims reserving;
Swiss Reinsurance Company, Zürich – sigma No 2/2008