When the Wind Blows:
An Introduction to Catastrophe Excess of Loss Reinsurance
by D.E.A. Sanders

THE STORY OF A TILE

On 25th January 1990 a tile blew off my house - luckily I managed to get a handyman in who replaced it - for £75.00 This may be exorbitant but they were busy and, in any case, insurers were paying claims up to £ 1,000 without question.

I put in an insurance claim, and received £75.00. By this time the insurer - my own company - had breached their deductible. They themselves put in a claim totalling £67.50 (10% of the risk was retained). This cover was placed with over 100 reinsurance companies, including Munich Re, M & G Re and Syndicates with Lloyds. By this time these reinsurers had breached their limits and were passing their excess (£60.75) to their reinsurers. The trail is now more difficult to follow. This £60.75 was passed from Reinsurer to Reinsurer (including Eagle Star's own reinsurance operation) time and time again.

For convenience I will assume it went 10 times round the system, and generated some £500 in transaction. It then ended up at a Whole Account protection programme and went into the Marine market as an "incidental non-marine loss". This went round the system yet again - and is still moving. My tile has been involved in over 20 financial transactions, with total amounts in excess of £1,000.

If that storm happened today, the situation would be different - there would possibly be only two transactions since the secondary market has completely disappeared. The challenge for the Actuary is to estimate the total cost of this simple transaction and to assist in the pricing of the products. As the old age dies, and a new one arises, I hope it is useful to put down some of the methods used in the past to solve the problem of tracking the claim.

THE POLICY

Excess of Loss Policies are split into two distinct types - Risk XL's or working covers and CATXL or catastrophe covers.

A Risk XL covers the cost of individual losses above a certain specified sum up to a maximum amount. The lower level is the deductible and the difference between the lower level and the maximum amount is the cover or line. Cover is sometimes expressed as a number of lines which equals cover/deductible, but this is more appropriate to surplus treaties. The losses may be unlimited in amount or limited by aggregate amount. Generally today policies have limited aggregate amounts, i.e. a reinsurers exposure is limited.

CATXL's covers the cost of the aggregate claims (after deduction of other reinsurance recoveries) in excess of a specific amount, up to a maximum. The type of risk and cover is specified. For example the policy may cover losses in excess of £5 million up to £25 million. The cover is called into play, and the insured may receive up to £20 million. This may be achieved by one loss of £25 million or 20 losses of £6 million.

In the event of a loss, the cover is normally reinstated on a pro-rata basis by the payment of a reinstatement premium. (The calculation may also be pro-temp I.e. related to remaining exposure period). Thus, in our example, a loss of £10 million will mean a £5 million payout, less a reinstatement premium of 5/20 x initial premium.

In general in Non-Marine Insurance one reinstatement is given, and in Marine Insurance two reinstatements are given. In effect, the aggregate covers are two and three times the stated cover. The policy may be specific to the type of risk (e.g. UK windstorm) or general. (All losses world-wide).

Other specific considerations are two loss warranties (i.e. for the cover to come into force there must be two losses). Thus a single vessel sinking may be excluded.

Another important feature is the "hours clauses". Under this, in respect of most losses, an event is defined as a 72 hour period. Thus as a hurricane hits one part of the US causing damage, and then another part four days later, this is categorised as two catastrophe losses and hence two deductibles apply. However, if two separate events occur within a specific 72 hour period, each event is separate, despite the hours clause, and two deductibles apply.

The exception is winter freeze losses which apply over a 156 hour period. The art form in this case is to pick the 7 days which maximises the loss - and hence the reinsurance recoverable.

In 1990, it was difficult to differentiate the losses arising from two storms on 25th January and 27th January. The market took a pragmatic view of this.

THE PLACING OF CATASTROPHE REINSURANCE

Catastrophe Reinsurance is generally placed by Brokers in the National and International Reinsurance Market via a slip system. Under a slip system a specific percentage of the risk is underwritten. For example, if the risk is for £10 million in excess of £2 million (i.e. to cover losses above £2 million up to an aggregate of £ 10 million) an Underwriter may place a line of 10%. This gives him an initial exposure of £ 1 million (excluding reinstatement).

The Broker aims to try and place more than 100% of the risk. In the Non-Marine market, the insured normally retains 10% of the risk - but for the purpose of what follows this will be ignored. For Marine risks 100% can still sometimes be placed.

If a Broker writes so the total "signings" exceed 100%, then the slip is signed down. In the case of the Broker placing 125%, the 10% line is signed down to 8%, and the exposure is reduced to £800,000.

If the Broker places 75% of the risk, there is no increasing the line - the reinsurers' limits are set and the residual 25% is unplaced and hence retained by the insured. Brokers like continuity, in that they always aim to place more than 100% of the risk, and the renewal business is always given to the existing reinsurers as a first refusal. An example of a slip, with the stamps and lines is attached as Appendix 1.

Now consider a major UK insurer. The exposure to property is astronomical. The reinsurance it wishes to purchase is £175 million in excess of £25 million. It is extremely difficult - indeed impossible - to place such a risk in one tranche. The largest reinsurer would only want a small (2.5%) line, and the very smallest would be writing decimal point lines. Note in the real slip some individuals are writing only 0.15% of 95% of $25 million.

A Broker would spend an eternity trying to place the risk. What happens is that the reinsurance is structured into a placeable programme. The £175 million over £25 million could be structured into, say, four separate categories:-

(i)	£25	million	xs	£ 25 million
(ii)	£25	million	xs	£ 50 million
(iii)	£50	million	xs	£ 75 million
(iv)	£75	million	xs	£125 million

The consequences of this are three fold:-

a) The business has a greater possibility of being placed. The smaller company which only wants an exposure of £250,000 can write a 1% line on programme (i) or (ii).

b) Different reinsurers like different types of risk. Specialists can be identified for each contract.

c) The cost of the programme theoretically reduces.

A simple example will explain this last point (again reinstatements are ignored). Let us consider a company with the following loss:-

(i)	1 Loss of £60 million	(A)
(ii)	1 Loss of £40 million	(B)
(iii)	3 Losses of £ 30 million	(C), (D) and (E)

Under the one policy structure the insurer received £35 million from A, £ 15 million from B and £5 million each from C, D and E - a total of £65 million. Under the new structure he receives £35 million from A, (£25 million from the first policy and £ 10 million from the second) and nothing from B, C, D and E. If one reinstatement is allowed, he will also receive £ 15 million from B, £5 million from C and D and nothing from E! As the expected receipt is lower, so should the theoretical premium.

The consequences of the above restructuring lead to innovative products which increase the exposure of the actual programme. These include cascade programmes and top and drop, where unused parts of the vertical programme (i.e. the higher value programme) is used to cover a horizontal exposure (more losses of lower value). Under the example, an insurers cover (say £ 50 m xs £ 150 m) can be used to cover the losses in (iii).

The important issue to note is that the price for CATXL has changed radically in the last three years. This is due to recent major losses. Losses in the CATXL market are usually given a name (e.g. Hurricane Andrew) or a CAT code (e.g. 87J). This is the 'J'th event of year 1987. This storm is .the event of 15th October when Michael Fish, the Weatherman, got it all wrong! Illustrations of how, for example, Sevenoaks became one oak can be found in [6].

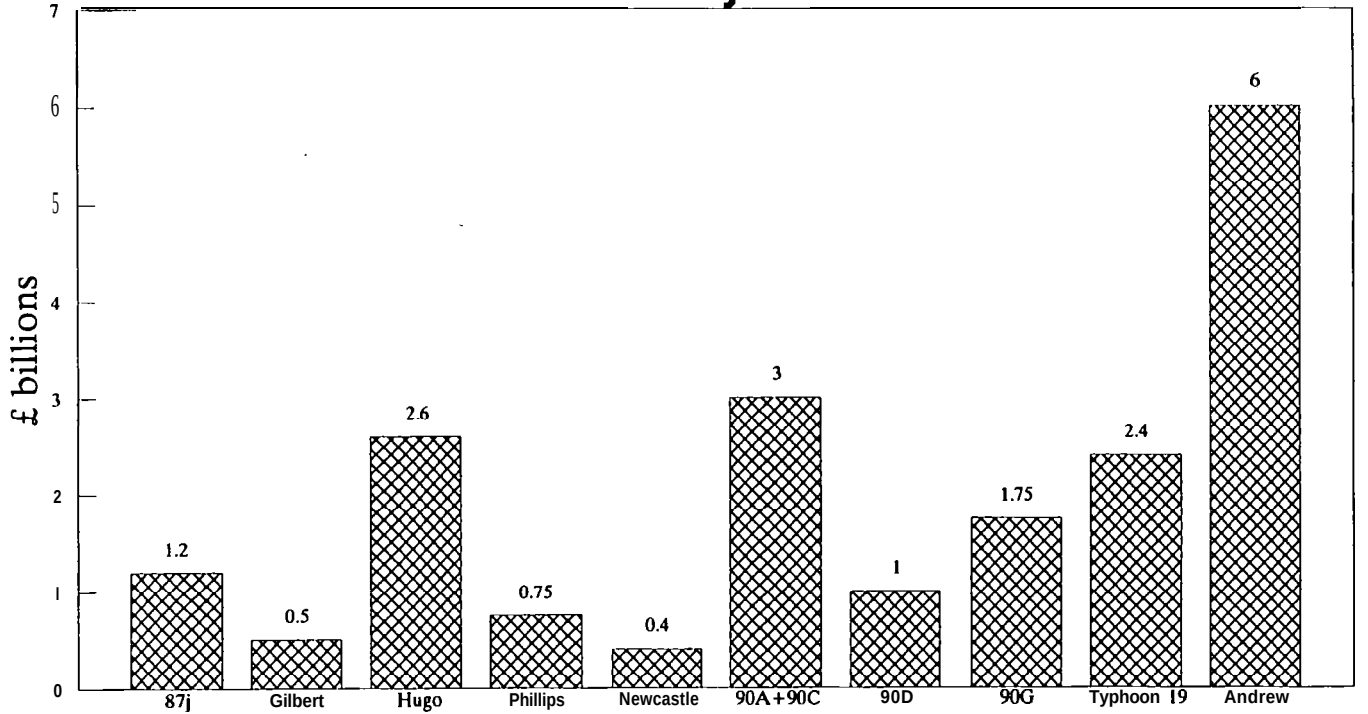
The storm of 1990 on 25 January is 90A. This is followed by 90D and 90G - 90B was an aviation loss. Recent losses are given in the graphs attached to this section. Catastrophe cover costs have jumped by a factor of nearly 4.

The policy is rated on Premium Income i.e. as a percentage of premium income of the cedant company. There is normally a Minimum and Deposit premium which relates to the expected premium income of the cedant. However, this premium is usually expressed as a Rate on Line, the Line being the exposure. The graphs following this section illustrate the point. In the rating section the issues will be explained in greater depth. The following graphs indicate the cost as a mid point in a spread of layers, and indicate how the cover, expressed as a percentage of premium income, has changed.

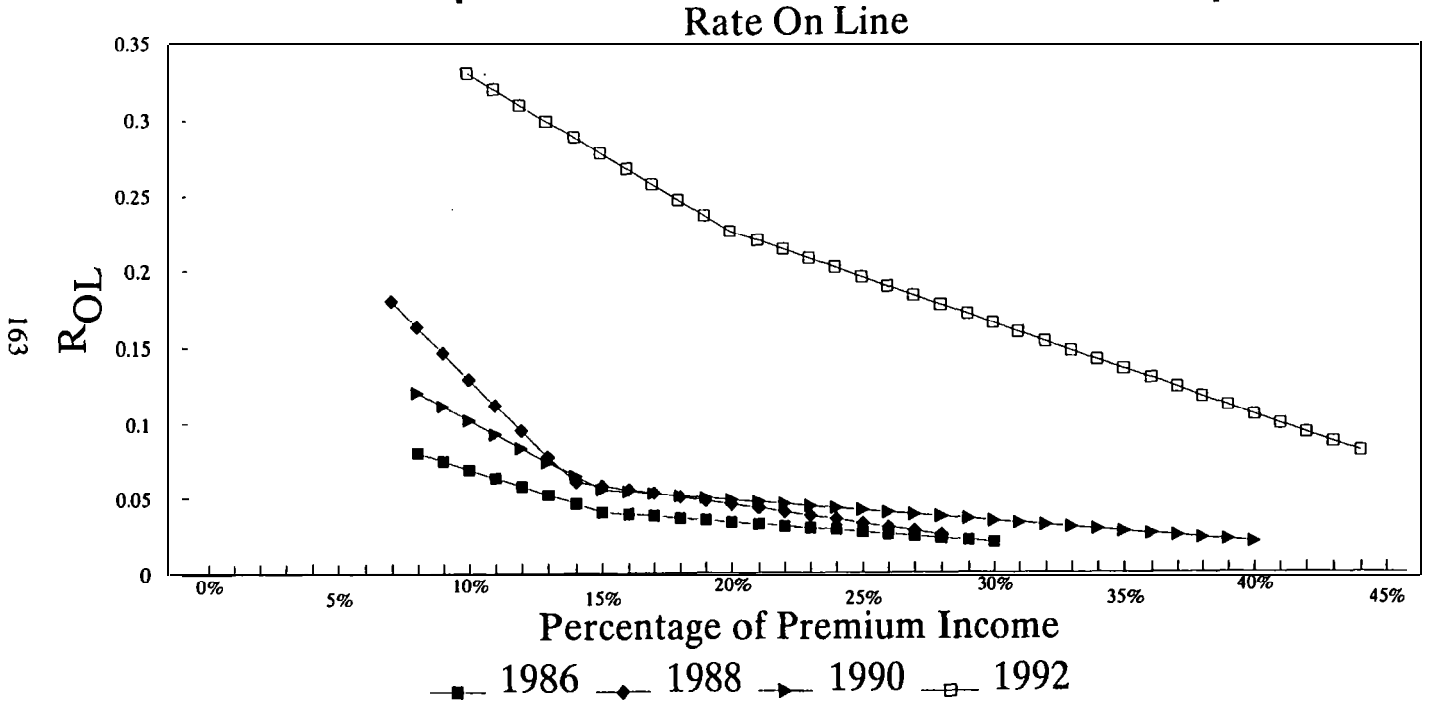
A company with a premium income of £ 100 million wanting cover from £10 million to £30 million would, therefore, expect to pay a price above the 20% of premium income on this graph. In 1990 this would have been about 5% (5% x £20 million line gives £ 1 million). In 1992 this would be 25% on £ 5 million.

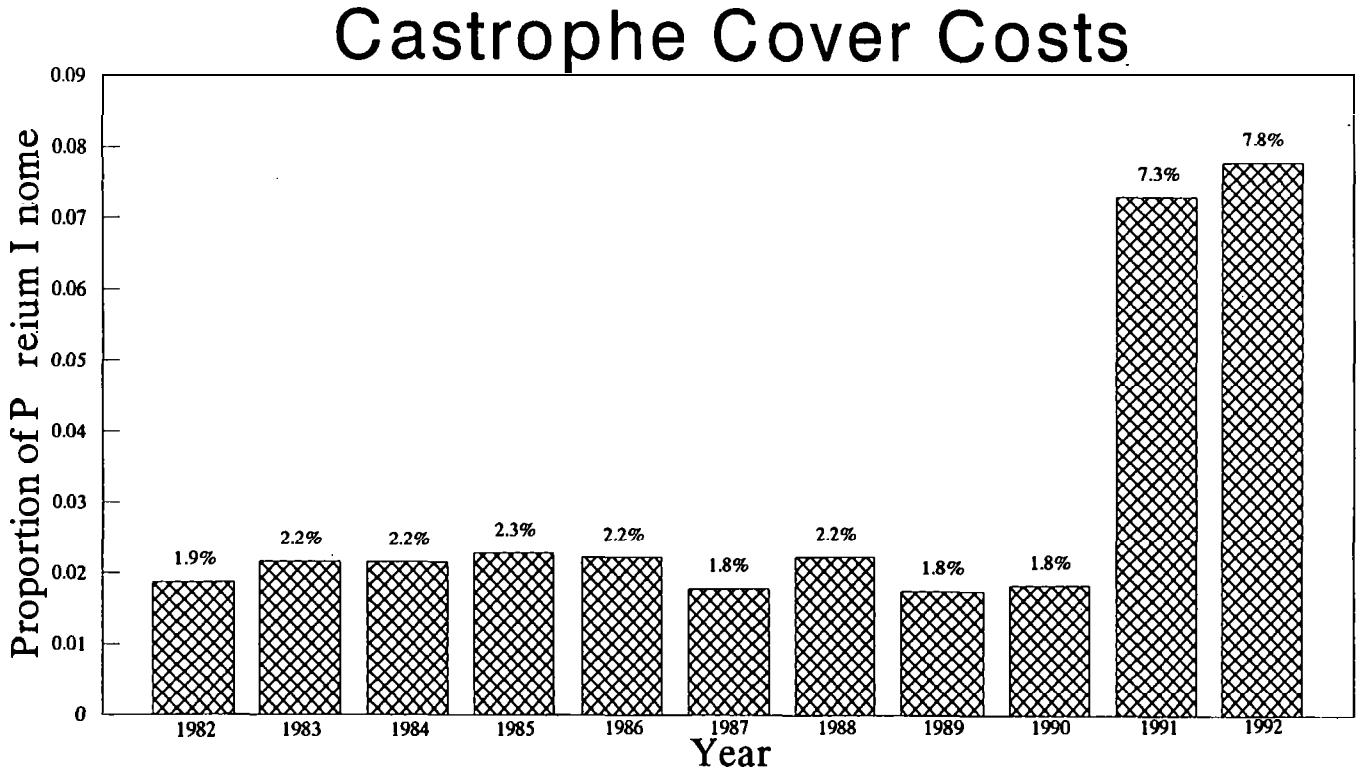
This massive increase in rates has created new problems for insurers. When rates were cheap the philosophy was to place as much as you can. Why have rates increased substantially?

Recent Major Losses



UK Composite Insurance Companies




Castrophe Cover Costs
Proportion of P reium I nome
0.09
0.08
0.07
0.06
0.05
0.04
0.03
0.02
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2.2%
2.3%
2.2%
1.8%
2.2%
1.8%
1.8%
7.3%
7.8%
1982
1983
1984
1985
1986
1987
1988
1989
1990
1991
1992
Year

THE **RETROCESSION** MARKET AND THE SPIRAL

Although pronounced dead, the spiral and retrocessionary (reinsurance of reinsurance) markets are just alive - prices have increased tenfold. The key phrase is LMX; which is Excess of Loss placed on London Market Excess of Loss business. The principles of writing this business are simple.

I have a series of risks for which I received a premium of (say) £ 100. If I can place these risks with someone for (say) £98, I will have a guaranteed profit of £2! Also, in direct reinsurance, the higher up the programme the cheaper per unit the risk. It was thought that the same applied to Retrocessionary market, this led to considerable mispricing. As long as I could sell my book of business cheaper than I bought it, the basic reinsurance product itself was being priced too cheaply.

Take two reinsurers. Let us assume both have £10 million of inwards reinsurance exposure. Insurer A reinsures its whole portfolio with B and vice versa. Both now, individually, have £20 million of gross exposure of which £ 10 million is reinsured. (The first program is £ 10 million xs £0 million). They then place this second level (£ 10 million xs £10 million) with each other.

Their individual total exposure is £30 million of which £20 million is reinsured. We continue this for, say 10 times, giving us a comfortable £ 110 million exposure of which £ 100 million is reinsured. Of course, the higher levels of reinsurance are more remote for the loss and accordingly are cheaper! The Broker takes 10% of each placing as brokerage.

A loss of £ 10 million occurs to each insurer. Insurer A passes £ 10 million to Insurer B. A has £ 10 million loss which he recovers. B has £ 20 million loss, which he recovers from A; A has £30 million loss, £ 10 million of which is recovered, so he asks B for £20 million and so on. An initial loss of £10 million for each company produces payments for A of £110 million - and a net loss of £ 10 million.

This example is simplified. In practice there were hundreds of companies and Lloyds syndicates playing the game.

The rules of the game were quite simple - understand the total aggregate exposure and make sure you had more reinsurance than your rival. For example, if A had written one more reinsurance its exposure would be £ 110 million with reinsurance of £ 110 million, and B would be £ 120 million with reinsurance of £ 100 million. In the case of no loss B would be the winner - the premium from A would be its profit. In the event of a claim, however A would be the winner. Several syndicates at Lloyds were the B players - reporting profit to names. Since the top layer was mispriced, when a catastrophe occurred the results for company B would be bankruptcy.

How would a prudent reinsurer have behaved in the Spiral market? I will assume the aggregate exposure is £100 million (i.e. the total of all reinsurance written). It would be inefficient/impossible to reinsure the total exposure. A prudent reinsurer should have purchased £60 million excess of £5 million. This would have cost a considerable amount of the incoming premium.

This gives a perceived retention of £ 5 million and a "hidden" retention of £35 million (£ 100-£60-£5). In practice what was happening was that either insurers were not aware of their aggregate exposure or were being imprudent. They were reinsuring f25 million excess of f2 million. The hidden retention was f73 million (i.e. an unreinsured exposure of f73

million). A series of losses would devastate the market - which turned out to be the case. A lot of the criticisms by Lloyds have been the lack of understanding of aggregate.

The turning events for the market were the following losses:-

(1) Piper Alpha

Press reports regarding major professional reinsurers indicate how they got their reserves and recoveries wrong.

(2) 1999 Losses

Hugo, Exxon Valdez, Phillips Petroleum and Arco Platform. Their losses are not yet fully developed.

1989 was also hit by smaller losses such the San Francisco Earthquake (17.10.89) and Newcastle (Australian) Earthquake (28.12.89).

(3) The European Storms of 1990

For further details of this topic see either the "C.A.S. Loss Reserving Talk" [3] or read Cathy Gunn's excellent book "Nightmare on Lime Street" [11].

RATING

There are three basic methods of assessing ratios for the risks:-

(1) Some form of simulation relating storms to a portfolio of risks. The risks are usually categorised by type (Household, Property, Shops, Offices etc.) by value and by postal code. Old storms or hypothetical new storms are then simulated on the portfolio.

Examples of this type of estimation may be found in the GISG paper "Storm Rating in the Nineties" (8). This type of method is often revealing about the area by area exposure, but the estimation of losses is extremely subjective. A windstorm loss may vary between 0.5% to 2% of Sum Insured and the uncertainty is enormous. Key factors are often excluded from the databases, for example, construction type. On ordinary household policies, no account is taken of the square footage and number of stories. We rate policies by Sum Insured (a linear type rating), yet Danish experience indicates storm exposure increases with increased square footage (square footage is a rating factor in Danish household policies).

The information given by such simulations should not, however, be discounted.

(2) Burning Cost Rating

Under Burning Cost Rating actual losses incurred are used to determine the cost. The keys to assessing these rates are:-

(a) Loss Frequency

A burning cost method is only suitable if there are a sufficient number of losses to obtain a suitable loss frequency.

(b) Indexation

Losses should be revalued into current terms. This involves both inflation and the increase in number of policies. A suitable index could be premium income adjusted for any rate changes.

(c) Changes in Policy Conditions

(d) Changes in Retentions

(3) Exposure Rating

Simulation is one form of Exposure Rating. Normally, exposure rating is intended to provide a comparison with the burning cost rate - particularly if changes to the portfolio have taken place.

Exposure rating is used to rate areas and covers with little or no loss experience. There are three stages:-

(1) Establish a Catastrophe Estimated Maximum Loss (E.M.L.).

(2) Establish a Catastrophe Premium - this is normally From The Ground Up - (F.G.U.).

(3) Establish a suitable Loss Distribution Curve. In the example I will use a Pareto type distribution.

As an alternative to this type of approach, formula could be used. In my ASTIN paper, I use formulae from Financial Mathematics and Option Pricing (Black-Scholes) to derive consistent price rating for certain classes of loss. This involves the estimation of three parameters, the return period if an event being one of them and implied volatility is another. A similar approach is made by using Pareto formulae. These methods involve difficult mathematics and are beyond the scope of this paper.

Set out below is an example of a calculation for a UK direct writer requiring a quote of £25 million excess of £50 million. Reinstatements and brokerage are ignored.

The estimated Gross Premium income for 1992 is £ 230 million and the data is as follows:-

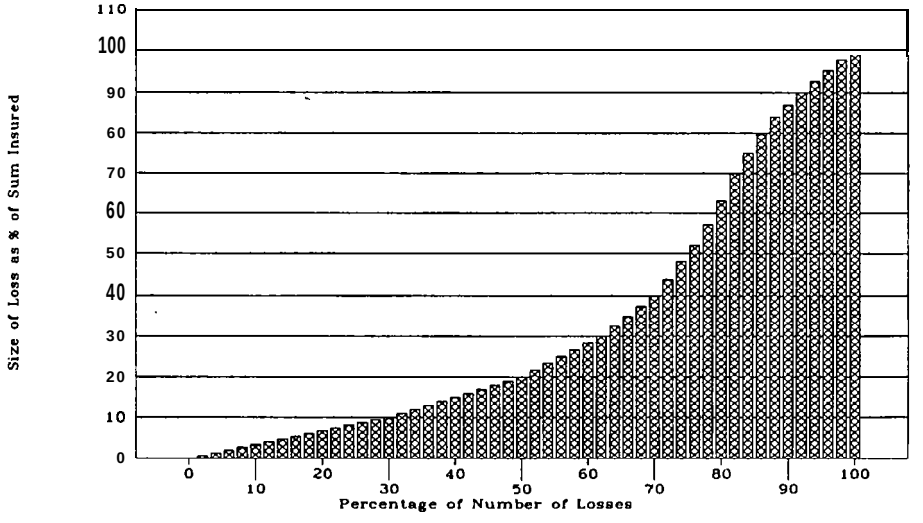
	Premium	Losses F.G.U.		Indexed
1991	220,000,000	Nil		Nil
1990	200,000,000	95,000,000 22,000,000	(90A) (90G)	109,250,000 25,300,000
1989	180,000,000	Nil		Nil
1988	170,000,000	Nil		Nil
1987	160,000,000	65,000,000	(87J)	96,451,612
1986	155,000,000	Nil		Nil
1985	150,000,000	Nil		Nil
1984	145,000,000	6,500,000		10,310,344
1983	120,000,000	Nil		Nil
1982	100,000,000	Nil		Nil

We first calculate the Maximum Possible loss. This is taken as twice the 90A Loss Indexed i.e. £220 million (2 x 109.250). This is the current market practice.

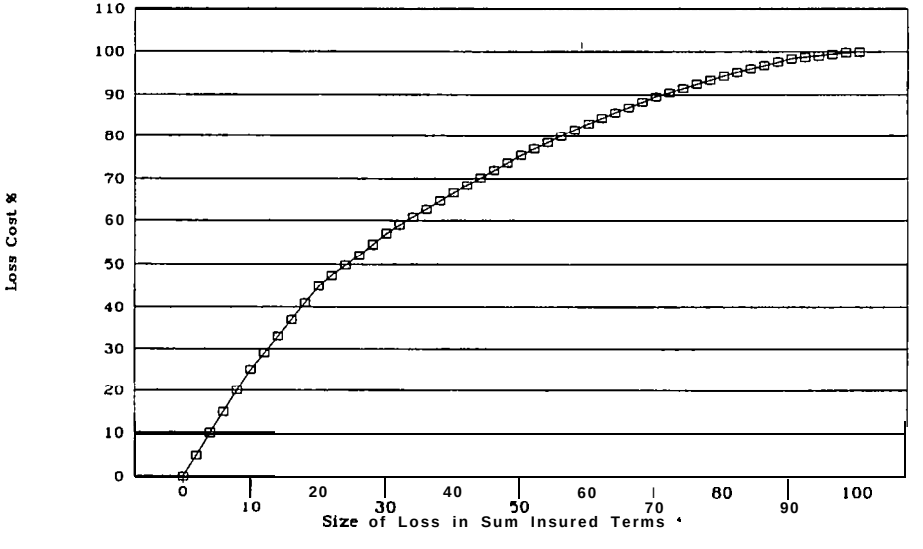
Next, we calculate a loss for a specific layer. I use 90% xs of 10% of the largest loss (109,250,000) say £ 90 million xs £ 10 million.

The losses are larger and in this treaty today would be £90 million + £15.3 million + £86.451 million + £0.310 million = £ 192.151 million. (This is similar to the burning cost). The average cost is £19.215 million per annum.

Loss Distribution Pattern



Loss Distribution Pattern



This cost, from the Pareto curve, represents about 50% of the total cost. This is taken from the size of loss curve looking at the size of loss of 10 (giving 20%) and 50 giving 70%). Therefore, the total catastrophe programme should cost £38.42 million.

The £50 million point represents about 22.5% of the E.M.L. of £220,000,000 and £75 million (i.e. £25 million xs of £50 million) is about 34% of E.M.L. Using the lower graph 22.5% is about 45% of loss cost, 34% is 60% of loss cost and so the premium is 15% of the total cost of £38.42 million or £5.73 million (before expense, commission and safety loading).

The basic problem is that the market is not applying this type of rating, and reinsurance costs are substantially higher than those derived by the above calculations or any pure exposure basis. They are trying to recover the rest of the early losses to re-establish capital.

The Capacity of Reinsurance has been devastated. Lloyds names have ceased to be members of syndicates and Reinsurers have ceased to trade. Accordingly, premium rates are substantially above the theoretical calculated rate, due to demand exceeding supply and the absence of any real retrocession or spiral market.

Let us consider the need. I will relate everything to 90A as this is the market norm (remember PML is 2x Indexed 90A loss).

I will consider nine companies, A-I. These are all UK composite insurers. In the first graph 90A losses are expressed as a proportion of Premium Income. Thus for Company A, 90A loss F.G.U. represents 40% of its total property premium income.

The next graph represents the deductible as a proportion of premium. The average deductible is about 10% of property premium, although there is wide fluctuation.

Finally, I give the cover purchased From The Ground Up. Thus Company A purchased reinsurance between about 12.5% and 87.5% of its premium income, 90A accounted for about 40% of its premium income, so in an event which is twice as damaging it should still have protection. Company B, however is only purchasing up to its 90A cover and it is, therefore, more exposed to possibly higher losses. The rate on Line, as a Proportion of 90A, is given for 1992 reinsurance costs.

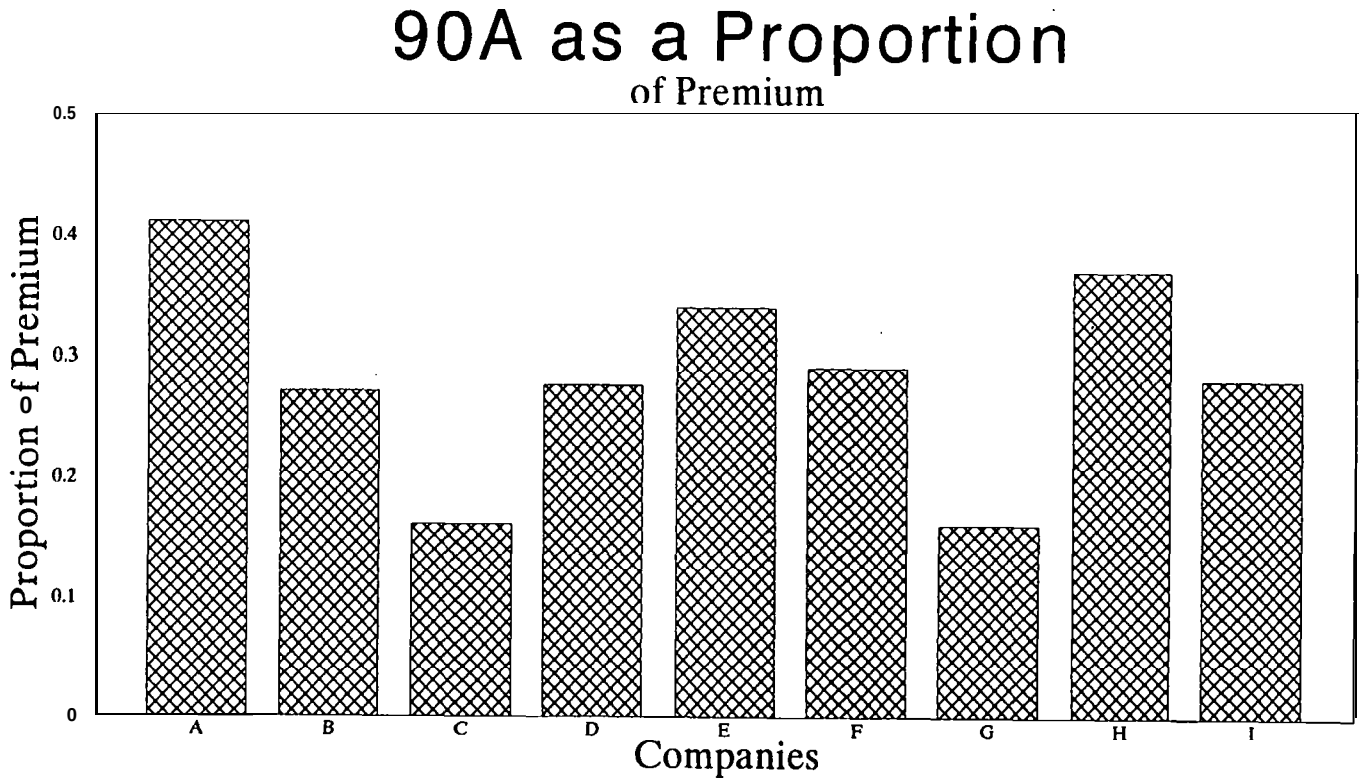
In the example I calculate a premium for £25 million xs £50 million at £5.73 million or about 23% rate on line.

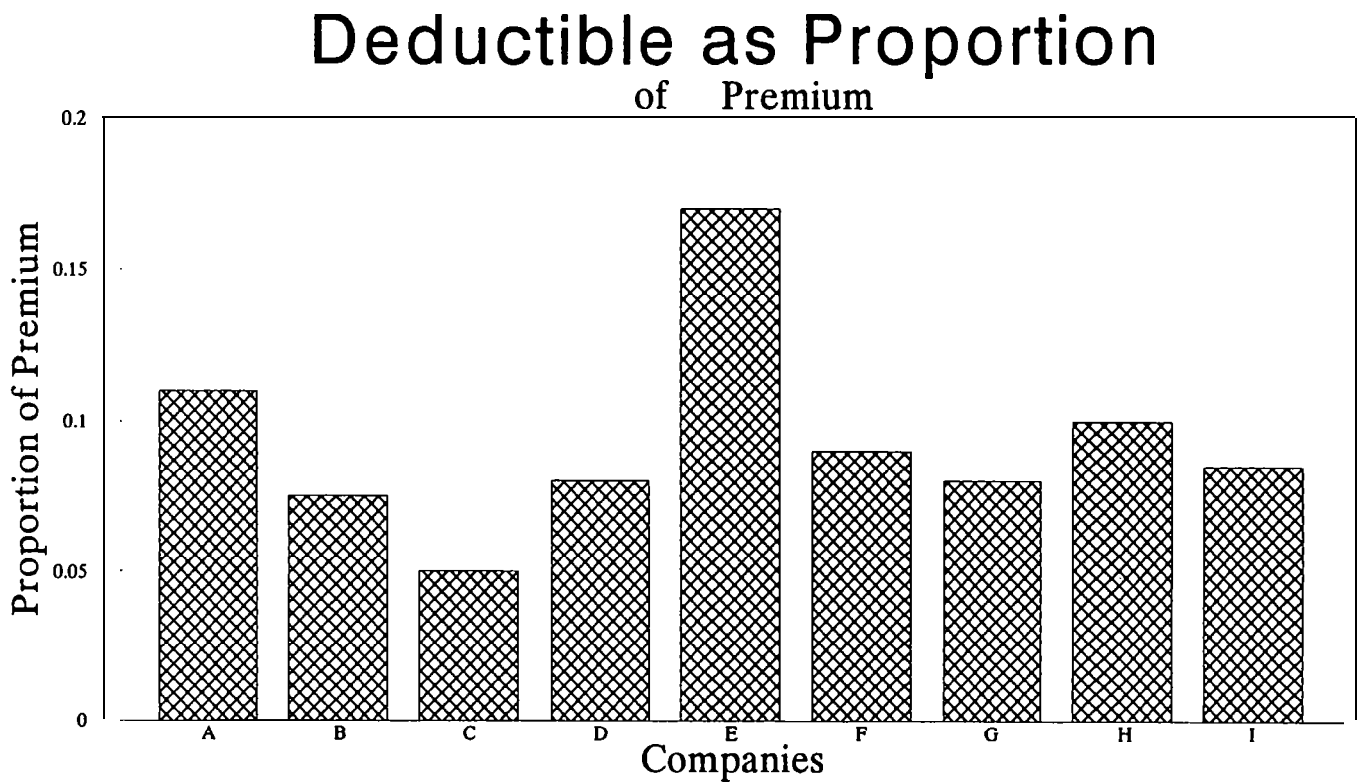
Based on this, we have exposure from 45.5% (50/109.25) to 68.6% (75/109.25). This has an average of 57.2. From the graph for 1992, the Market would be charging a rate on Line of slightly more than 30% or £7.5 million.

There are clearly many considerations that need to be taken into account:-

(a) If the actual price is loaded by 25% to 40% over expected values should the cover be bought? The answer to this depends on the shareholders resources and/or future employment prospects for the Managers. Should an event occur what would be the impact on the P & L account.

(b) What should be done about the retention? If only 75% of the business is placed, how should the reinsurance of the 25% be planned for. Losses need to be financed. Should the "loaded" or "real" premium be transferred to the Internal


90A as a Proportion
of Premium
Proportion of Premium
0.5
0.4
0.3
0.2
0.1
0
A
B
C
D
E
F
G
H
I
Companies


Deductible as Proportion
of Premium
Proportion of Premium
0.2
0.15
0.1
0.05
0
A
B
C
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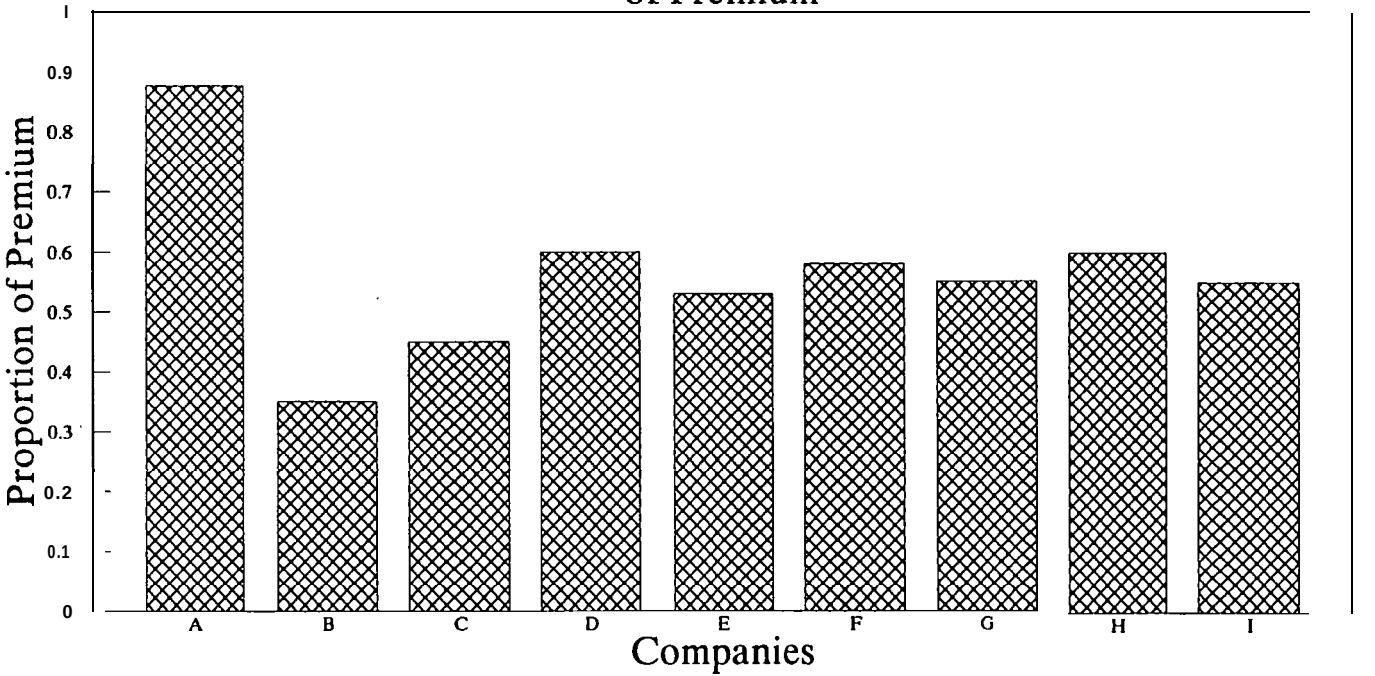
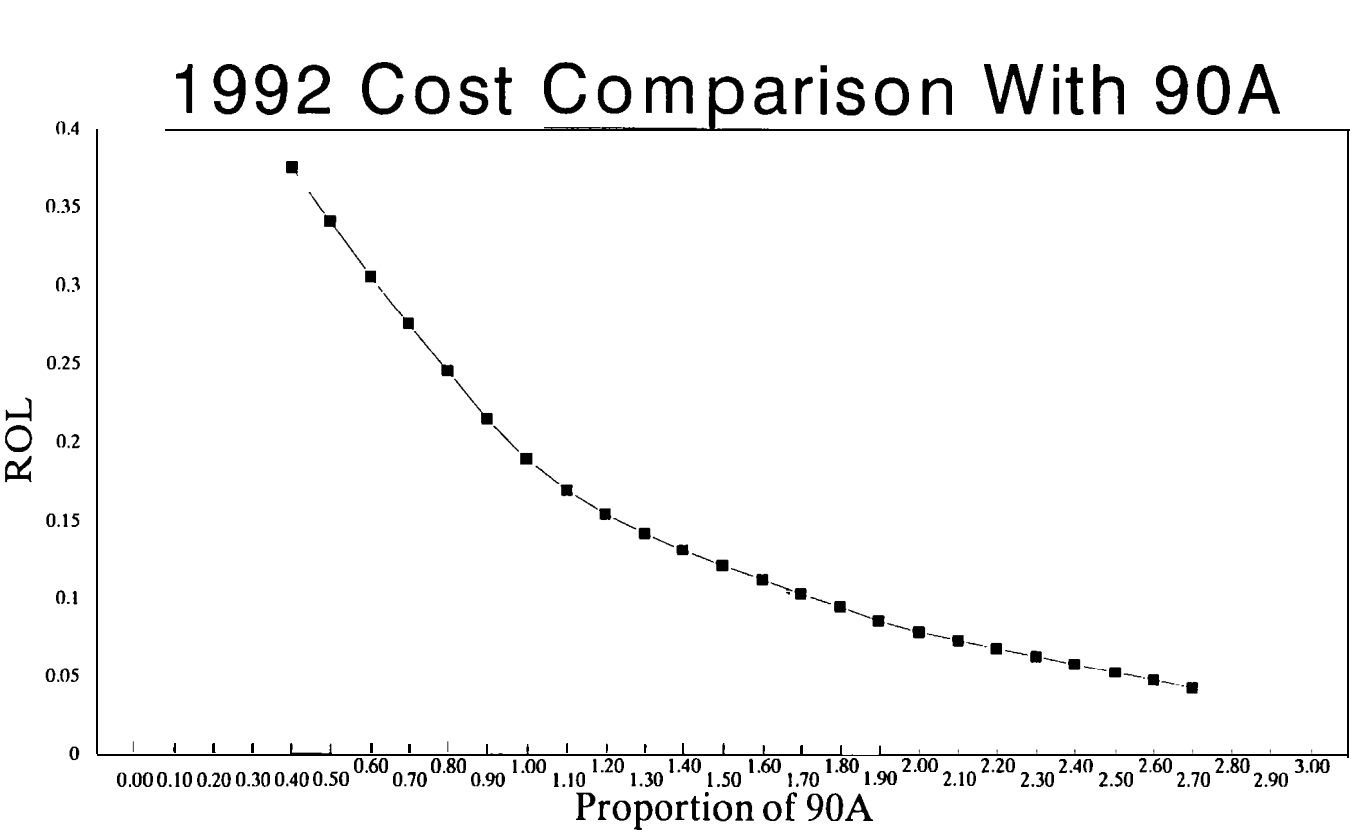
E
F
G
H
I
Companies

Cover FGU as Proportion of Premium




1992 Cost Comparison With 90A
ROL
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0.00 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00 1.10 1.20 1.30 1.40 1.50 1.60 1.70 1.80 1.90 2.00 2.10 2.20 2.30 2.40 2.50 2.60 2.70 2.80 2.90 3.00
Proportion of 90A

Funding mechanism, if that route is chosen. The loading represents brokerage (10%) and safety margins (15%).

(c) What about losses below the retention? In previous years retentions were set as low as 2%-3% of premium income. Freeze and other losses were reinsured as part of the overall programme. How should they be financed or planned?

In simulations made for the ASTIN paper it is not unusual to find the catastrophe attrition losses (i.e. those below the deductible) to be, on average, a factor of between 100% and 150% of the deductible. The reasons for this are as follows:-

(i) We have a considerable number of small losses (e.g. floods, freeze etc.) below the catastrophe. The recent 1993 January storms and floods have cost many insurers £ 10 million or more.

(ii) When the big catastrophe hits, a prior charge of the deductible is made before any reinsurance can be recovered.

These issues need careful planning.

Finally, pre 1990, the cost of reinsurance for the UK property account was small compared with the premium income and deductibles were considerably lower. Premiums were based on gross experience, and profit made on reinsurance. Nowadays, the cost of catastrophe claims via catastrophe premium, deductible, retained percentage of programme and so on is considerably higher.

The basis for premium rates should be the larger of:-

(i) Gross premium.

(ii) Net premium plus catastrophe costs.

I believe the rating basis has switched i.e. (ii) is larger than (i); yet the insurance market has not reacted. I also believe that the UK property account could be suffering because the market has not addressed this problem. The reinsurance or catastrophe costs are not yet fully costed in the premium basis.

RESERVING FOR CATASTROPHES

It is normal to review a book of Excess of Loss Reinsurance Business in two parts:-

1. The attrition losses arising from working covers.

2. The individual (main) catastrophes separately.

For the catastrophe, the losses can be reviewed either in aggregate or the cover to which they relate (Reinsurance, Retrocession business, Spiral business, Specific, International, Whole Account).

The purpose of reserving is two-fold:-

1. To ensure adequate reserves are placed, and the account is not under or over reserved.

2. To provide management information at specific points of time.

   This management information may be used to purchase additional reinsurance cover.

The method I use is curve fitting a three parameter curve to the paid and incurred claims:-

$$Y = A\,(1-EXP\,(-t/B)^{C})$$

This is a monatonic increasing curve.

The parameters are:-

A	=	Anticipated ultimate loss.
B	=	Parameter for slope of the curve.
C	=	Parameter for the shape of the curve.
t	=	Period (in days).

For pre 1992 catastrophes B was in general about 600 and C = 2. For modern catastrophes (Typhoon 19 and Hurricane Andrew) B is much lower.

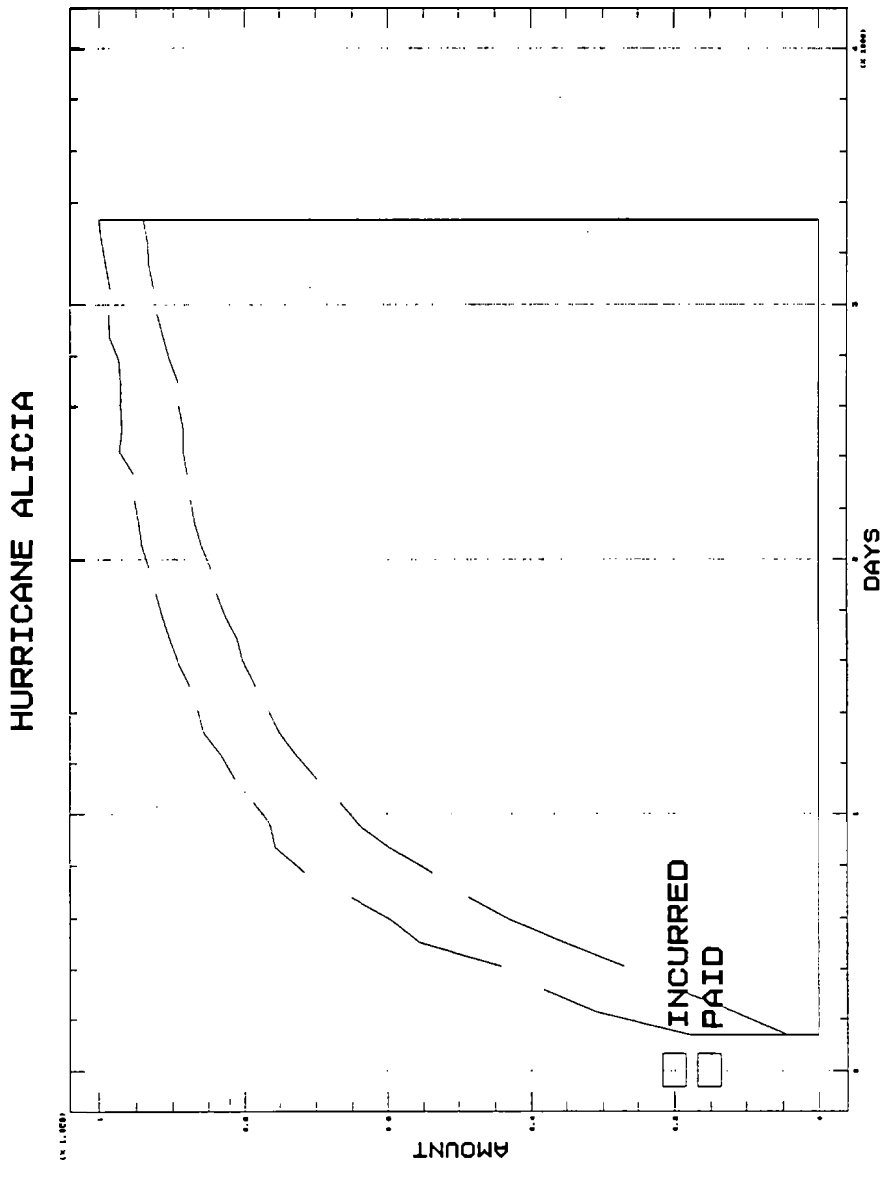
Reserving is not just curve fitting. Several other factors need to be taken into account

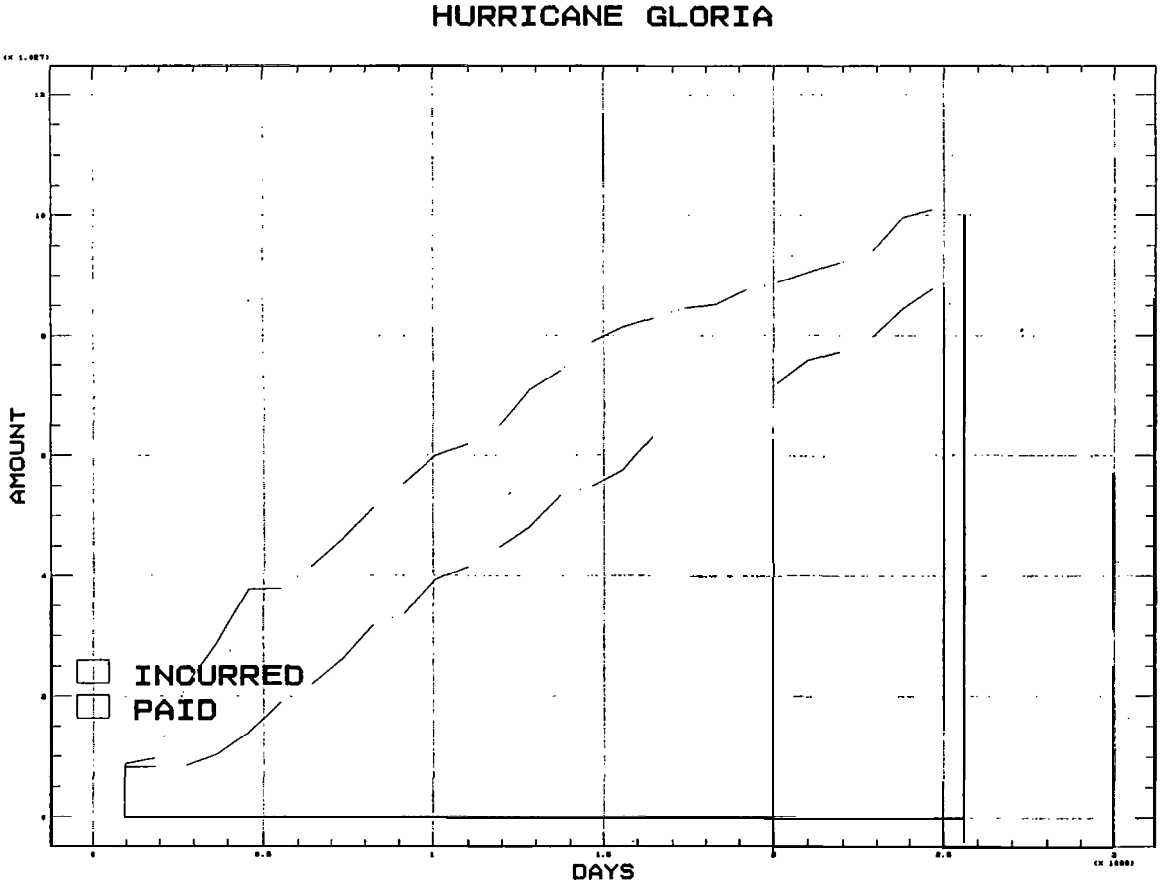
(i) Estimation is based on Paid Claims and Incurred (i.e. Paid plus Reported Outstanding Claims).

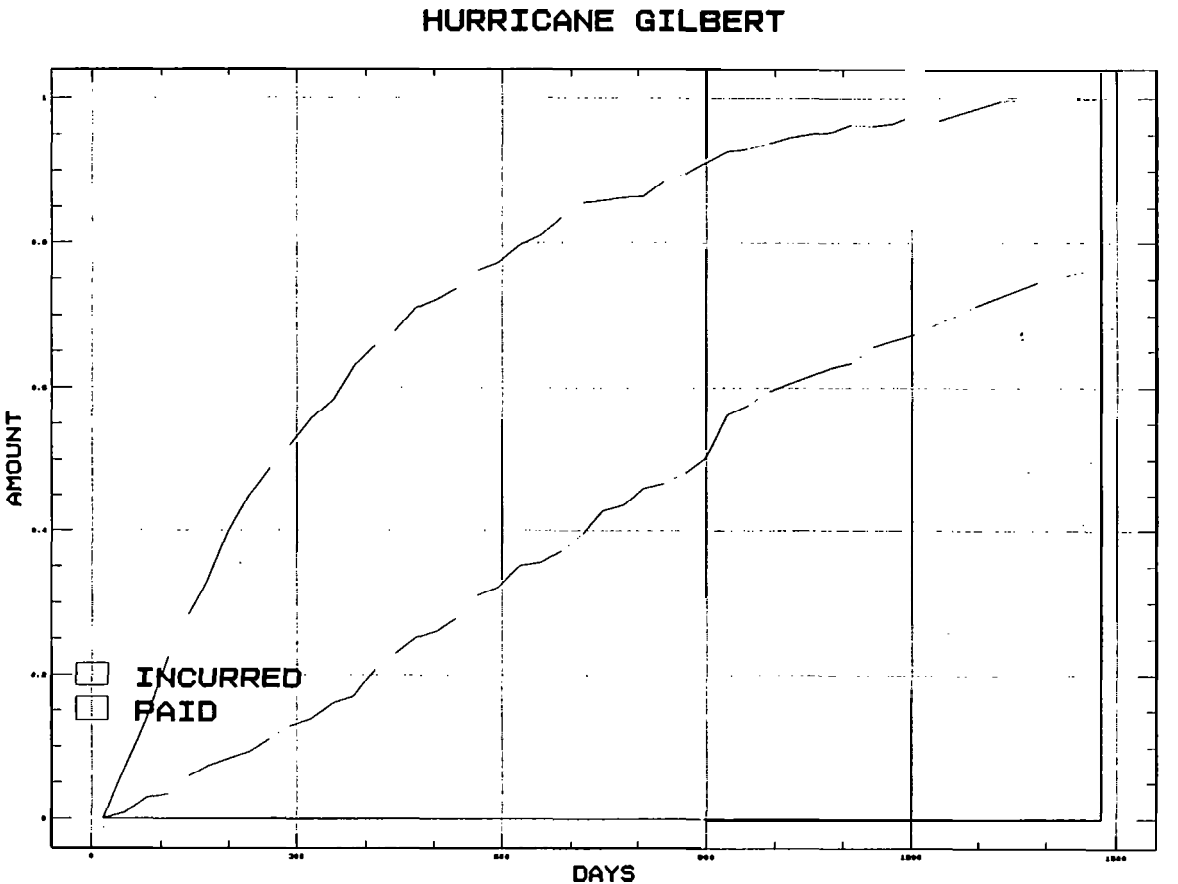
   In most catastrophes there is a gap between these paid and incurred. The first three graphs attached to this section show the gaps for Hurricanes ALICIA, GLORIA and GILBERT. The amounts have been normalised so that today's incurred claims are £100,000,000.

   The most developed is ALICIA when a gap of about £10,000,000 has been apparent for a number of years. The possible explanation is that there are a residual amount of outstanding losses reported by Brokers, which have not been released as the catastrophe claims are made. These are possibly redundant.

When reserving, one needs to be aware of this 5%-10% gap. The incurred position should unwind as these reserves are released. ALICIA occurred in 1983; GLORIA in 1985 and GILBERT in 1987. Gilbert is primarily a Jamaican loss and reporting standards for Caribbean countries may reflect the wider gap. All the losses are expressed in one currency.


HURRICANE ALICIA
AMOUNT
DAYS
INCURRED
PAID


HURRICANE GLORIA
AMOUNT
DAYS
INCURRED
PAID


HURRICANE GILBERT
AMOUNT
DAYS
INCURRED
PAID

(ii) Curve fitting is statistical by nature, and one should be aware of standard errors. The best fit curve may give an Ultimate below the current paid or incurred. This feature should be taken into account when undertaking the reserves Whereas incurred unwinds, paid claims increase.

(iii) The use of a single curve may not be appropriate. Certain loss payments come in two distinct surges. The first is normally the physical damage (Loss of Rig - Piper Alpha; Loss of Aircraft - Japanese 747; Earthquake - San Francisco - Plant Destruction - Phillips).

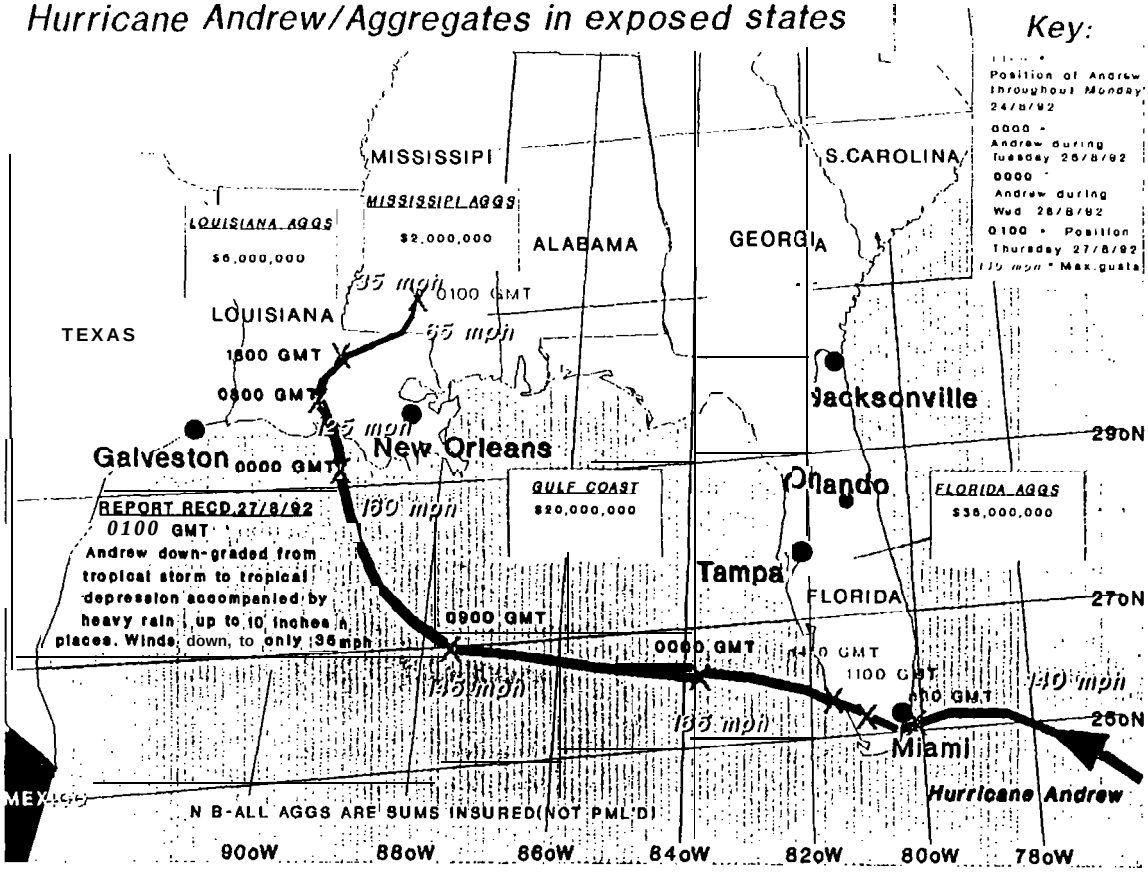
This is followed by liability or business interruption losses:-

Employers	Liability	-	Piper Alpha
Passengers	Liability	-	Japanese 747
Architects Liability			San Francisco Earthquake
Business	Interruption	-	Phillips

It may be appropriate to superimpose a second (later) curve for this final surge. Examples are clearer in the development curves at the end of this section.

(iii) Underwriters judgement and exposures should be taken into account. although based on crude estimates, the exposure multiplied by a probable maximum loss (80% say) may be the only guidelines available.

Attached is a typical exposure for Hurricane Andrew. (Amounts are artificial).


Hurricane Andrew/Aggregates in exposed states
Key:
Position of Andrew throughout Monday 24/8/92
0000 - Andrew during Tuesday 25/8/92
0000 - Andrew during Wed 26/8/92
0100 - Position Thursday 27/8/92
135 mph - Max.gusts
MISSISSIPI
S.CAROLINA
MISSISSIPI AGGS
$2,000,000
LOUISIANA AGGS
$6,000,000
ALABAMA
GEORGIA
TEXAS
LOUISIANA
135 mph
0100 GMT
1500 GMT
0600 GMT
125 mph
Galveston
0000 GMT
New Orleans
Jacksonville
29oN
GULF COAST
$20,000,000
Orlando
FLORIDA AGGS
$36,000,000
REPORT RECD 27/8/92
0100 GMT
Andrew down-graded from tropical storm to tropical depression accompanied by heavy rain, up to 10 inches in places. Winds down, to only 35 mph
100 mph
Tampa
FLORIDA
27oN
0900 GMT
0000 GMT
1100 GMT
110 mph
145mph
135 mph
Miami
26oN
Hurricane Andrew
MEXICO
N B-ALL AGGS ARE SUMS INSURED(NOT PML'D)
90oW
88oW
86oW
84oW
82oW
80oW
78oW

(iv) **The difference between Marine and Non-Marine Losses**

In general a Non-Marine loss such as Hurricane Hugo will rise rather rapidly in the Non-Marine account. As the Non-Marine Specific reinsurance is absorbed the Whole Account protections (with associated spiral) come into play. Non-Marine losses are normally settled first and the CAT developments reach a stable position fairly early. Marine Excess of Loss and Whole Account claims then take up.

My estimation for parameter B for Hugo is 232 days Non-Marine and 744 days Marine.

Marine Gross Losses also tend to be substantially higher than Non-Marine Gross Losses. This is due to the more effective spiral (no 10% retention). A 30 times spiral (i.e. gross to net) is not unusual.

(v) **The Special Impact of 1989**

In 1989 there were a number of losses which have had a substantial impact on the CATXL market - particularly the Marine market. There are only three large losses allowed for on most treaties - yet we have four major losses - Hurricane Hugo, Exxon Valdez, Phillips Petroleum (an explosion) and Arco Platform (a drilling rig). For a large number of reinsurers one of these three is redundant - and the smallest is Arco Platform.

To put these figures into perspective the Marine Market losses: Hurricane Hugo (total $4 billion of which about $2.4 million is non Marine and the Marine losses are likely to be $1.6 billion) $1 billion Exxon Valdez, $1 billion Phillips and $0.4 billion Arco Platform. A consequence of this is that in the book of incurred claims there is likely to be some double counting (i.e. the sum of all the notified losses per cedant is likely to exceed the aggregate exposure). The paid losses are controlled by physical checks on amounts recovered under treaties, but aggregate exposures are not. As a result the smallest losses are likely to have higher than average redundancy as the incurred position unwinds.

Secondly, Phillips Petroleum is a very confusing loss in that it is one of the few losses which the model fails to fit. The reason is that it is , in reality, three different types of loss which behave differently - namely a material damage loss, a business interruption loss and a US liability loss. It is, in practice slower to develop than its peer losses.

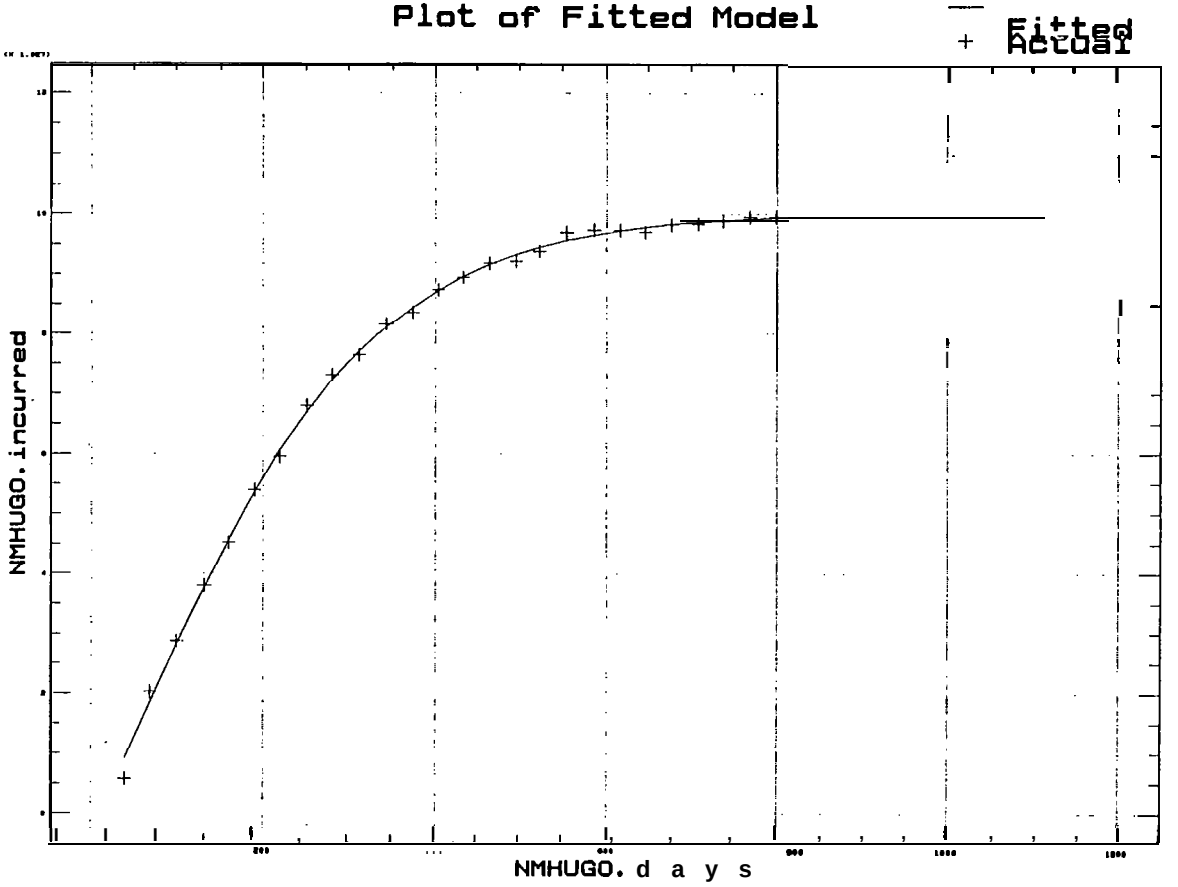
On the attached sheets I calculate the factors for these losses. I have normalised the losses so that today's incurred losses are £100 million.

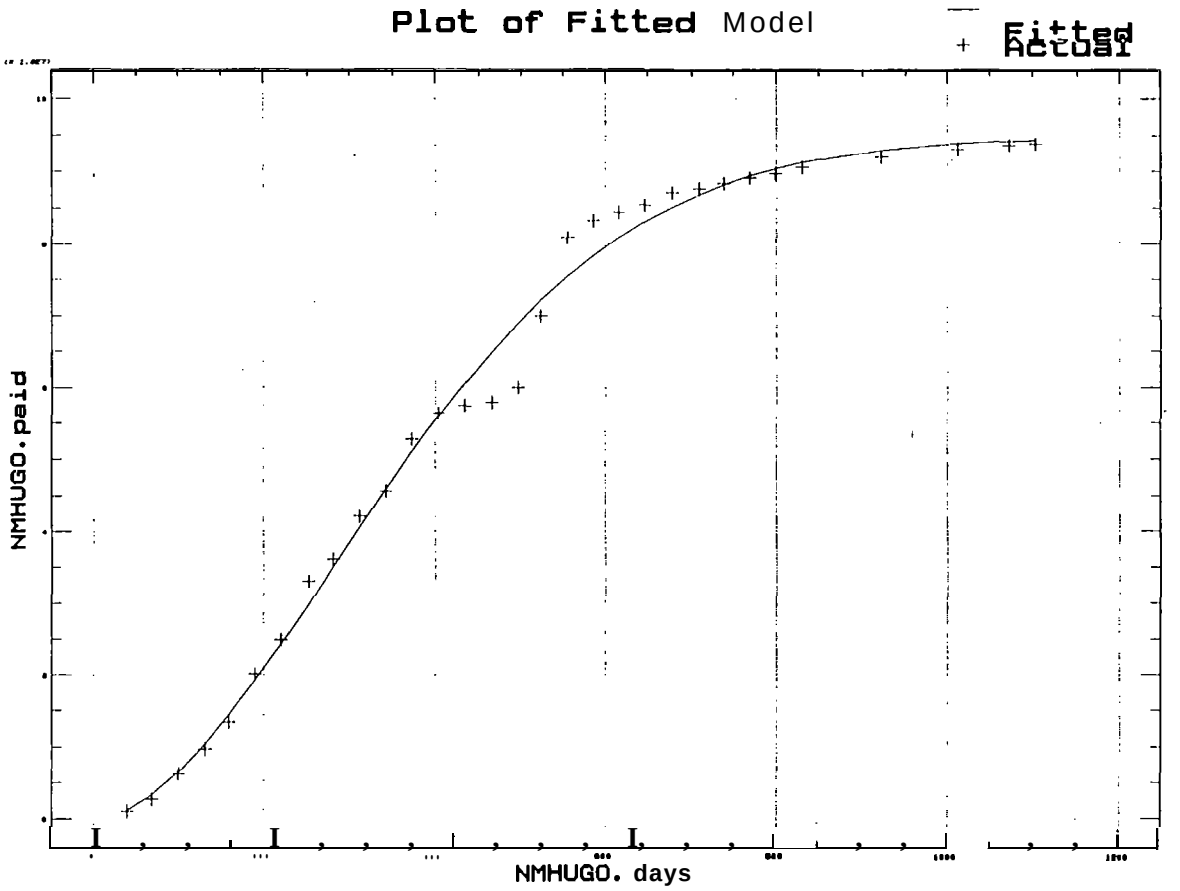
Note that Non-Marine Hugo has stopped and Marine Hugo has nearly completed its development, and Arco and Exxon are near complete development. Considerable uncertainty surrounds Phillips so an alternative method may be required.

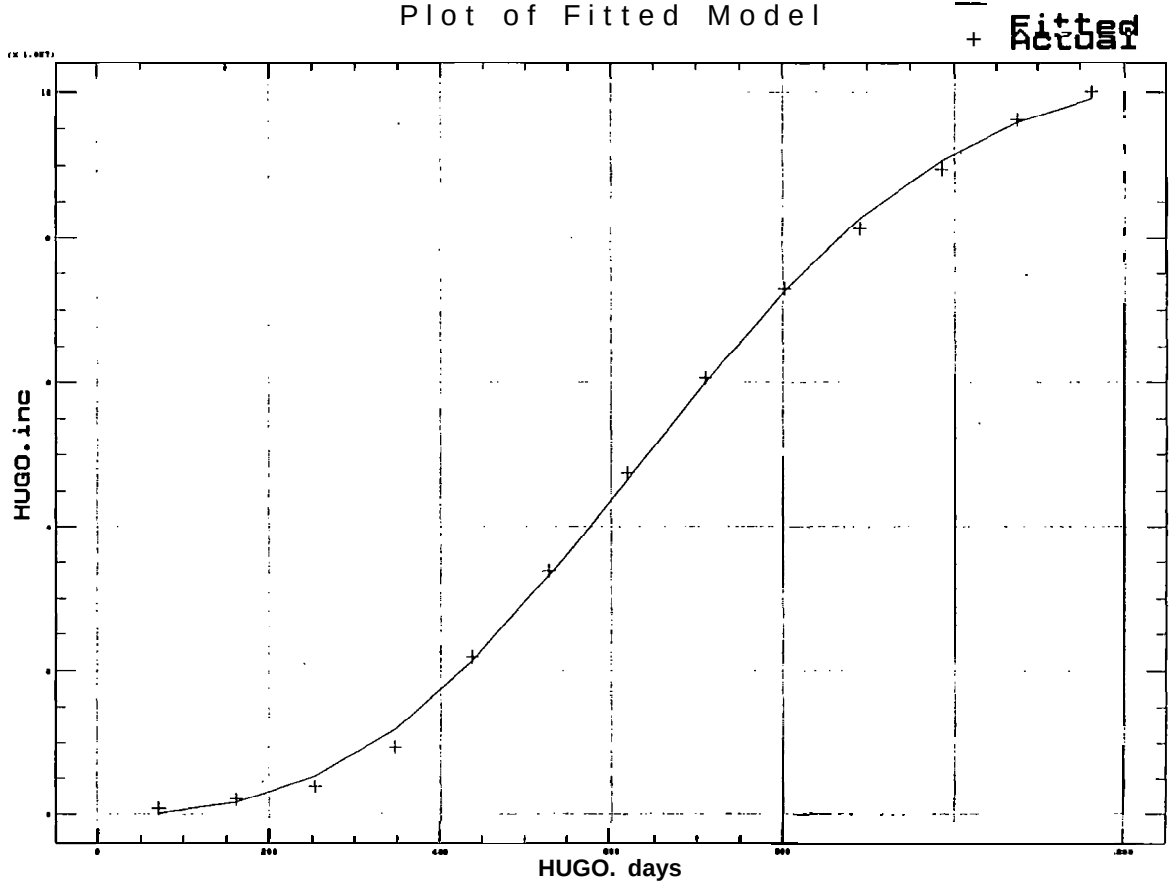
The figure in brackets is the standard error.

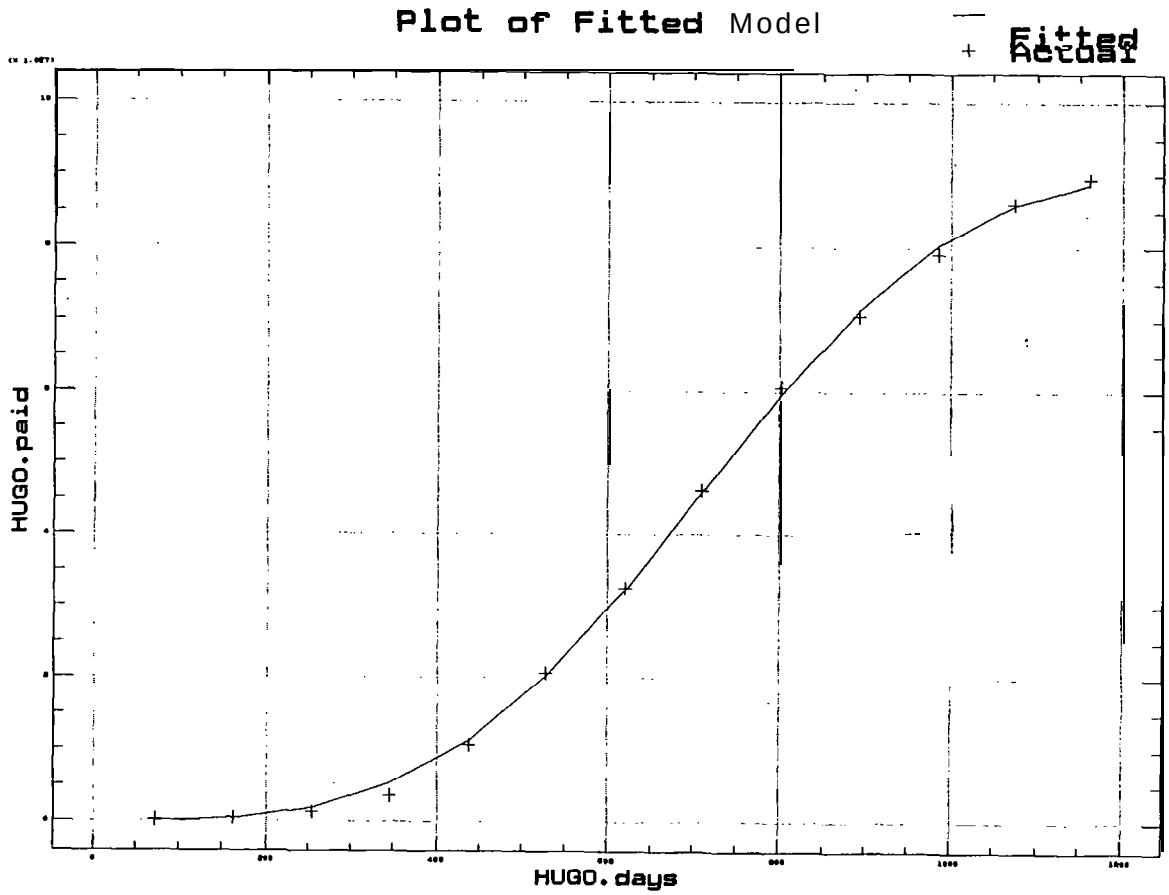
CATS OF 1989

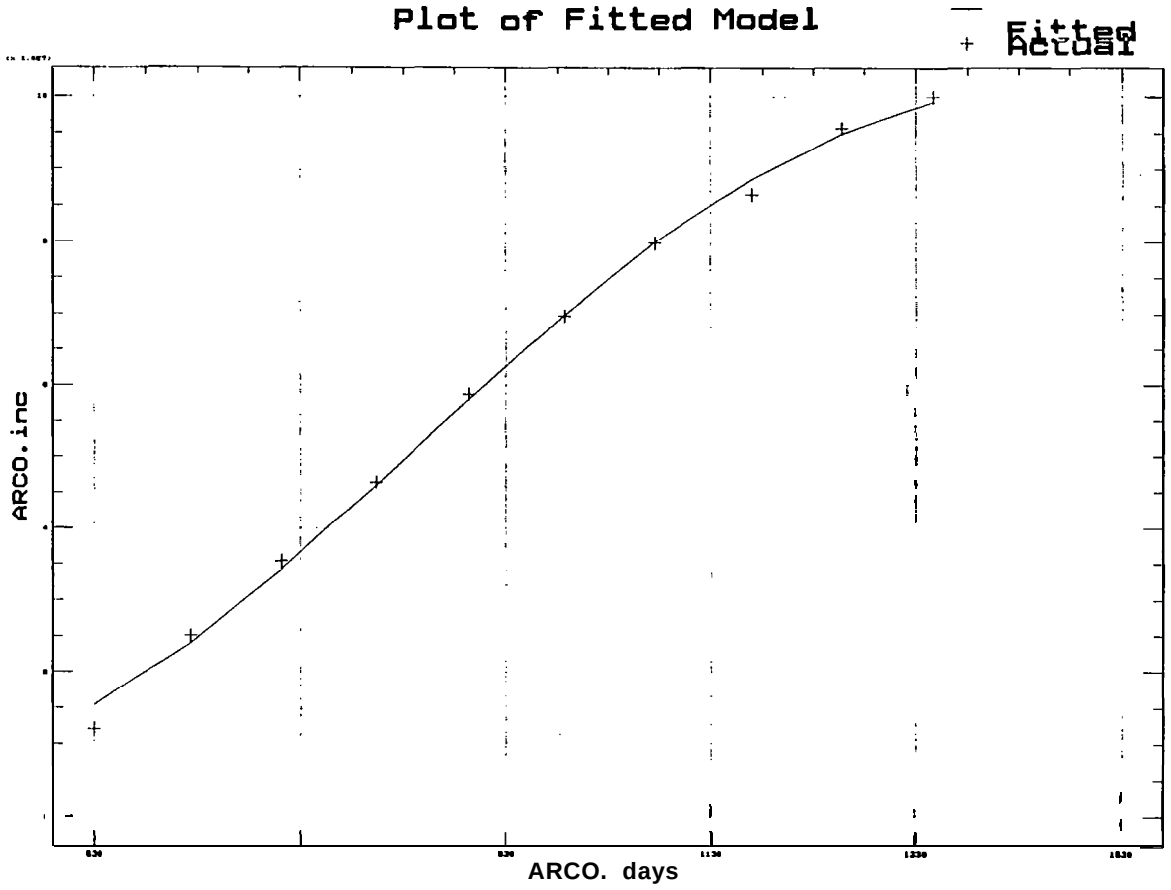
CATASTROPHE			BASIS	A		B		C	
HUGO	NON-MARINE	(NMHUGO)	INCURRED	100.050	(0.323)	232	(2.03)	1	(0.19)
HUGO	NON-MARINE	(NMHUGO)	PAID	94.763	(1.532)	429	(10.58)	1.8	(0.08)
HUGO	MARINE	(HUGO)	INCURRED	102.508	(1.721)	744	(11.08)	3	(0.08)
HUGO	MARINE	(HUGO)	PAID	90.833	(1.055)	786	(6.81)	3.4	(0.08)
ARCO	MARINE	(ARCO)	INCURRED	105.419	(3.259)	960	(21.44)	3.0	(0.14)
ARCO	MARINE	(ARCO)	PAID	80.514	(1.887)	933	(15.5)	3.4	(0.15)
EXXON	MARINE	(EXXON)	INCURRED	108.97	(5.628)	897	(43.19)	2.0	(0.15)
EXXON	MARINE	(EXXON)	PAID	83.93	(7.284)	988	(62.21)	2.9	(0.30)
PHILLIPS	MARINE	(PHIL)	INCURRED	211.421	(9.678)	1,341	(404.80)	2.0	(0.2)
PHILLIPS	MARINE	(PHIL)	PAID	95.57	(3.610)	995	(22.73)	3.0	(0.7)

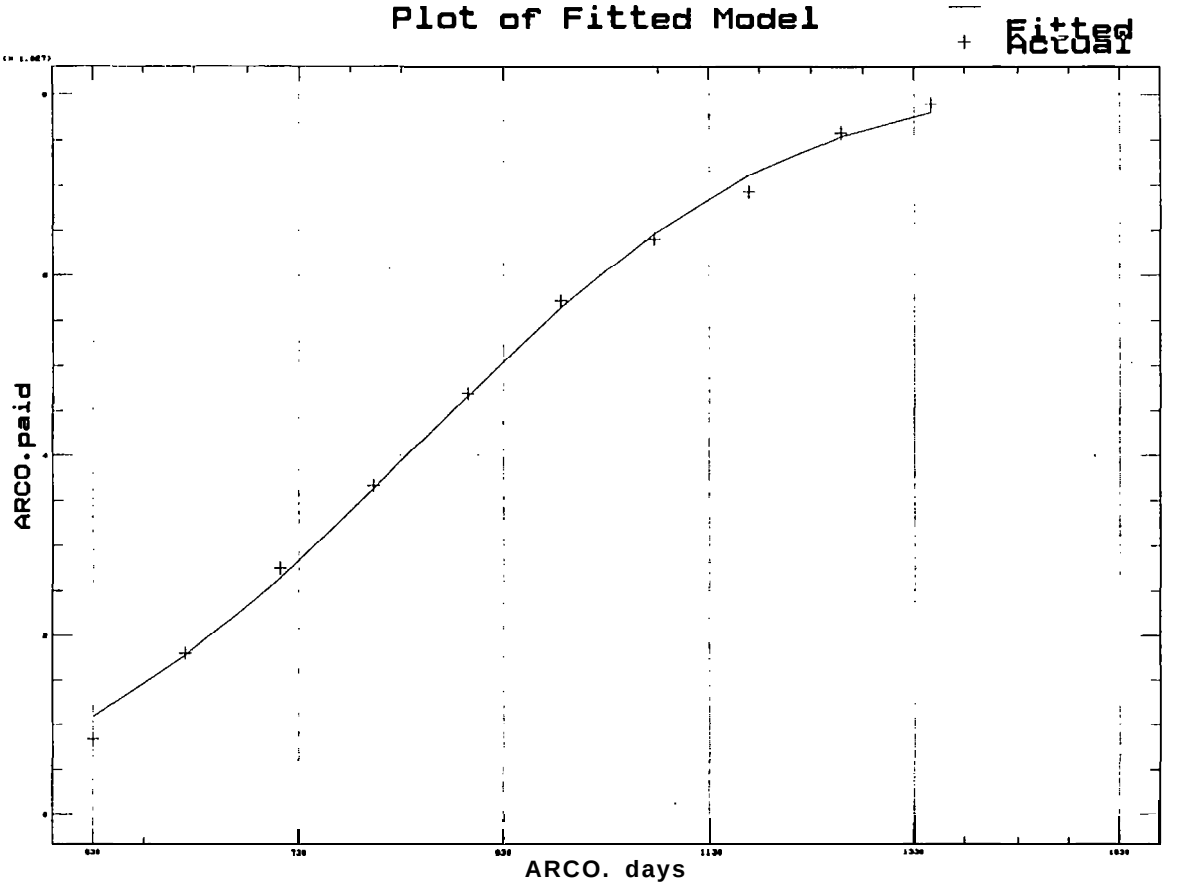

Plot of Fitted Model
Fitted
Actual
NMHUGO.incurred
NMHUGO.days

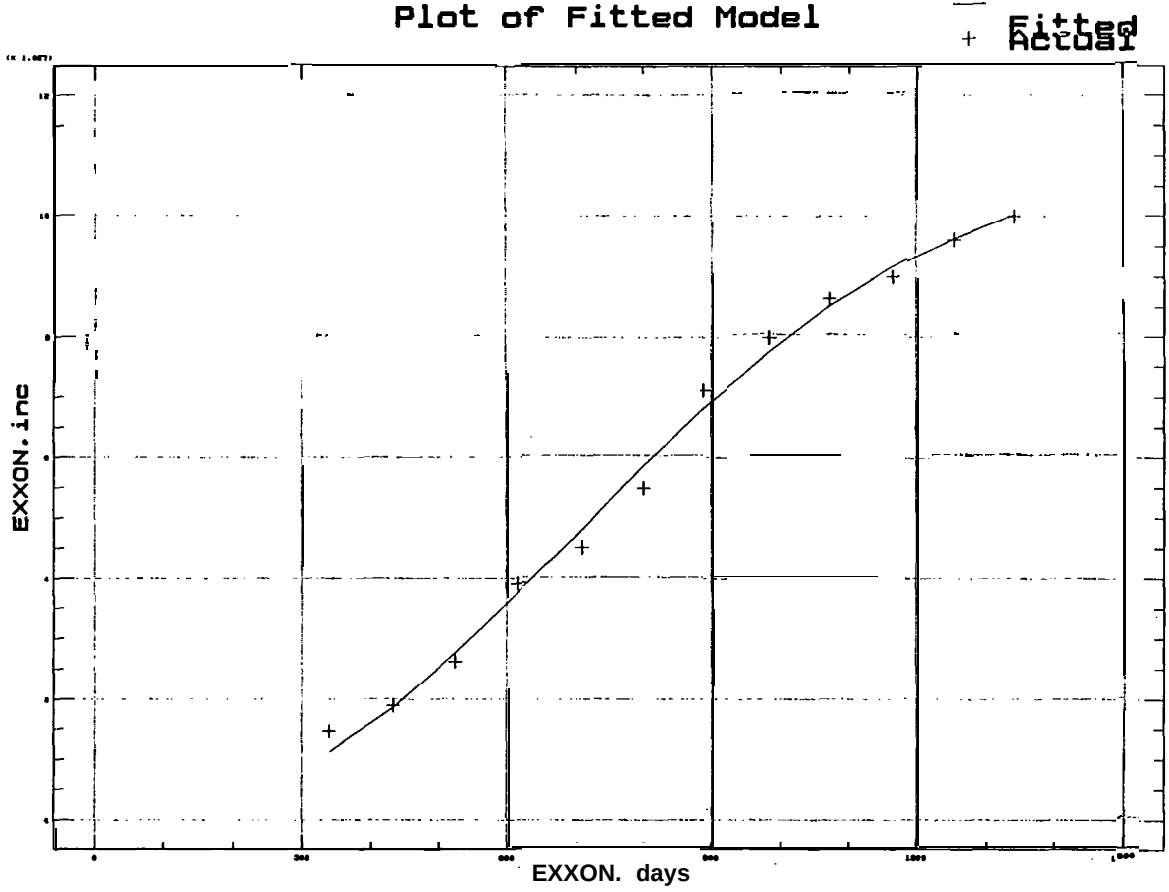

Plot of Fitted Model
Fitted
Actual
NMHUGO.paid
NMHUGO. days

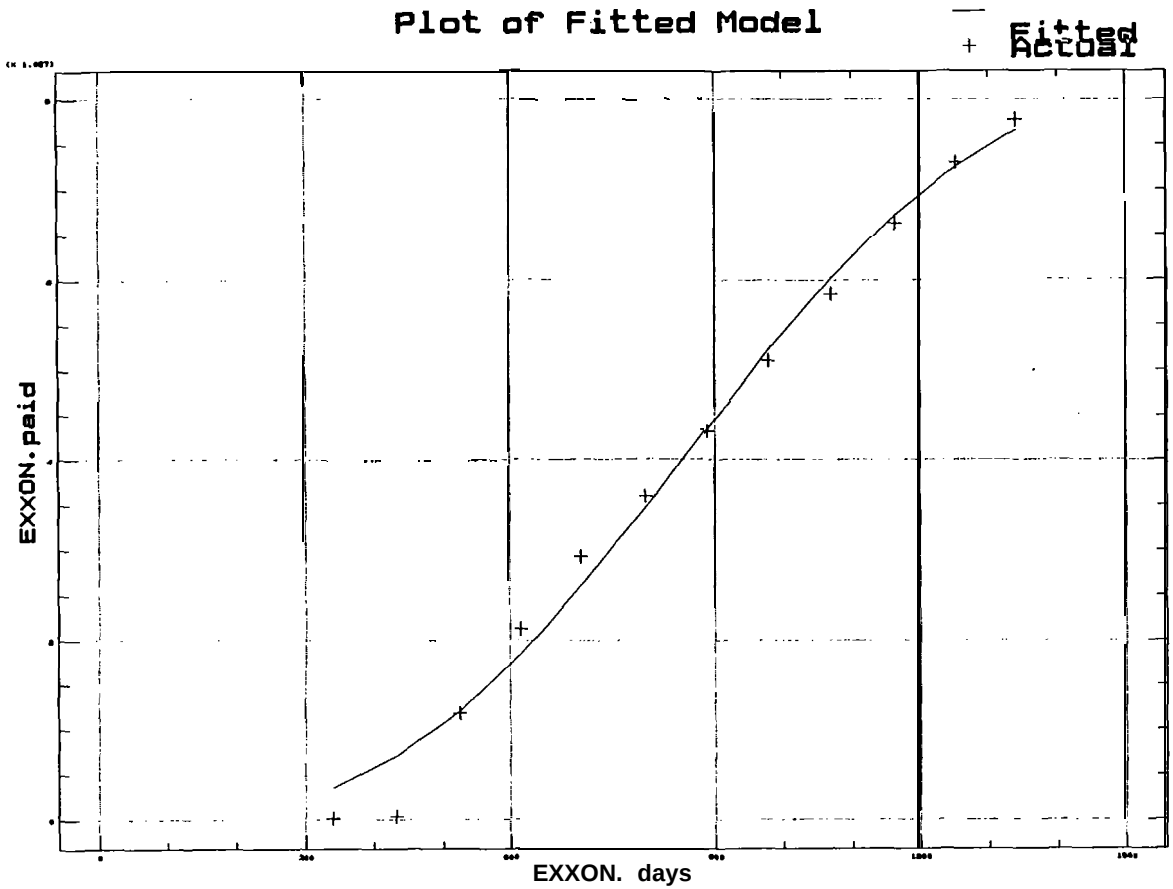

Plot of Fitted Model
Fitted
Actual
HUGO.inc
HUGO. days

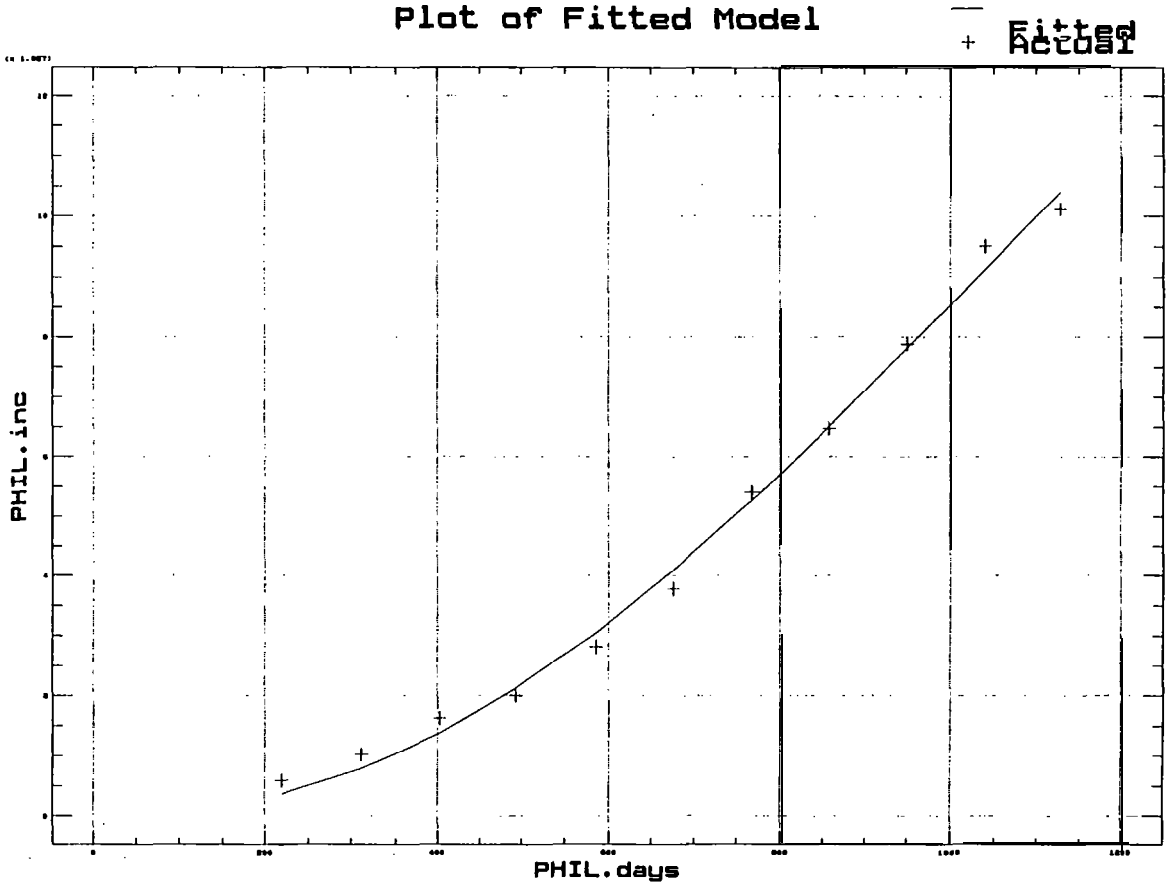

Plot of Fitted Model
Fitted
Actual
HUGO.paid
HUGO.days

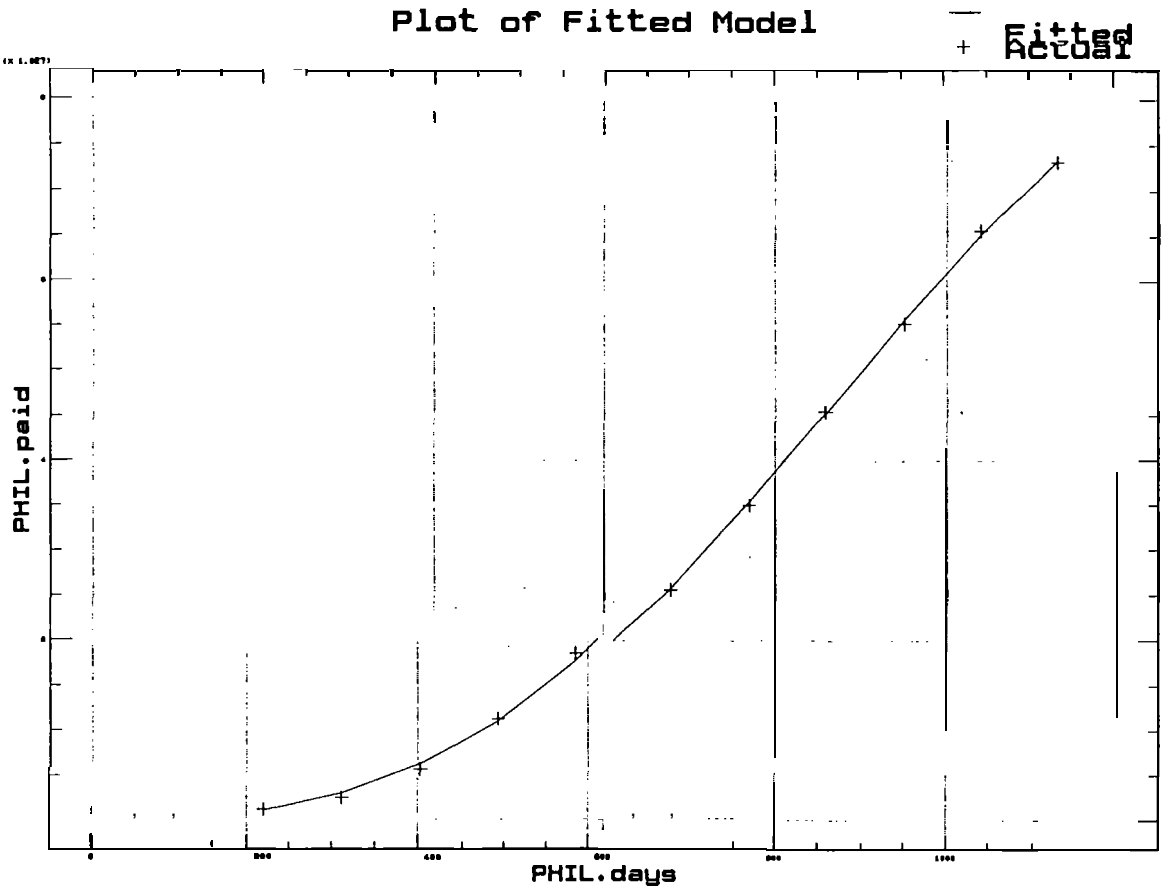

Plot of Fitted Model
Fitted
Actual
ARCO.inc
ARCO. days


Plot of Fitted Model
Fitted
Actual
ARCO.paid
ARCO. days


Plot of Fitted Model
Fitted
Actual
EXXON.inc
EXXON. days


Plot of Fitted Model
Fitted
Actual
EXXON. paid
EXXON. days


Plot of Fitted Model
Fitted
Actual
PHIL.inc
PHIL.days


Plot of Fitted Model
Fitted
Actual
PHIL.paid
PHIL.days

Finally, I set out some further examples of Windstorm Losses. Note how different the Development of Typhoon 19 (Merielle) is when compared with the other losses.

Hurricane Andrew also has the same features. The amounts in the brackets are standard errors to the parameter estimation.

Several points need to be noted:-

(i) In Lloyds and many London Market Companies Reserves are only reviewed annually. This leads to a lack of on-going data. Furthermore, accounts are not finalised until three years' losses have occurred. The lower the number of data points, the less information is available. This leads to a large error potential in the parameter estimations. Frequent data points are needed for better estimations.

(ii) The estimation process is only the first stage of establishing the reserves. The estimate may exceed the aggregate exposure and special features may need to be brought into consideration.

(iii) The reserves are gross reserves. Net reserves are calculated by super-imposing the reinsurance programme on anticipated ultimate loss to obtain the net reserves.

(iv) There is no need to fit the curve over the whole period. Recent developments can also be fitted to highlight any local short term variation in the data. Errors may occur due to information not being put in the database in a uniform manner which can distort the picture.

LOSSES

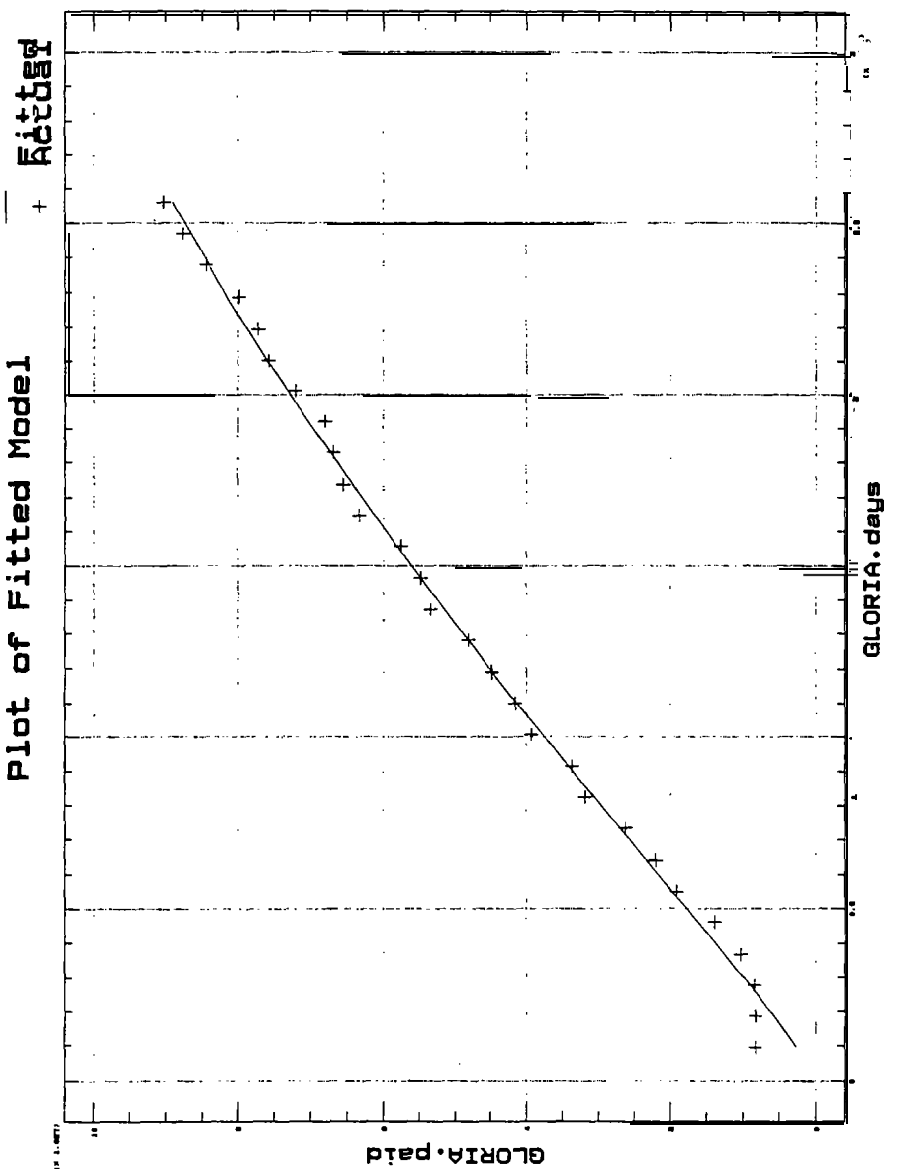
CATASTROPHE		MARINE/ NON MARINE	BASIS	A		B		C	
GILBERT	(1987)	(NM)	INCURRED	101.363	(0.781)	405	(7.08)	1	(0.019)
GILBERT	(1992)	(NM)	PAID	96.537	(4.110)	1063.2	(53.04)	1.5	(0.04)
GLORIA	(1988)	(NM)	INCURRED	124.837	(7.822)	1555	(184.6)	1	(0.05)
GLORIA	(1989)	(NM)	PAID	161.726	(31.326)	3091	(777.6)	1	(0.1)
MERIELLE	(1991)	(NM)	INCURRED	97.204	(1.359)	762	(2.59)	3.1	(0.40)
MERIELLE	(1991)	(NM)	PAID	93.717	(1.059)	81.2	(1.90)	3.7	(0.39)
STORM	90A	(M)	INCURRED (ST90M)	106.823	(6.163)	810	(26.78)	4.0	(0.28)
STORM	90A	(M)	PAID (ST90A)	91.079	(2.217)	841.7	(9.79)	4.7	(0.15)
STORM	90D	(M)	INCURRED (ST90D)	113.690	(6.156)	464	(46.42)	1.0	(0.07)
STORM	90D	(M)	PAID (ST90D)	69.796	(1.092)	521.8	8.21	2.8	(0.12)
STORM	90G	(M)	INCURRED (ST90G)	110.001	(4.456)	567	(29.0)	2.0	(0.07)

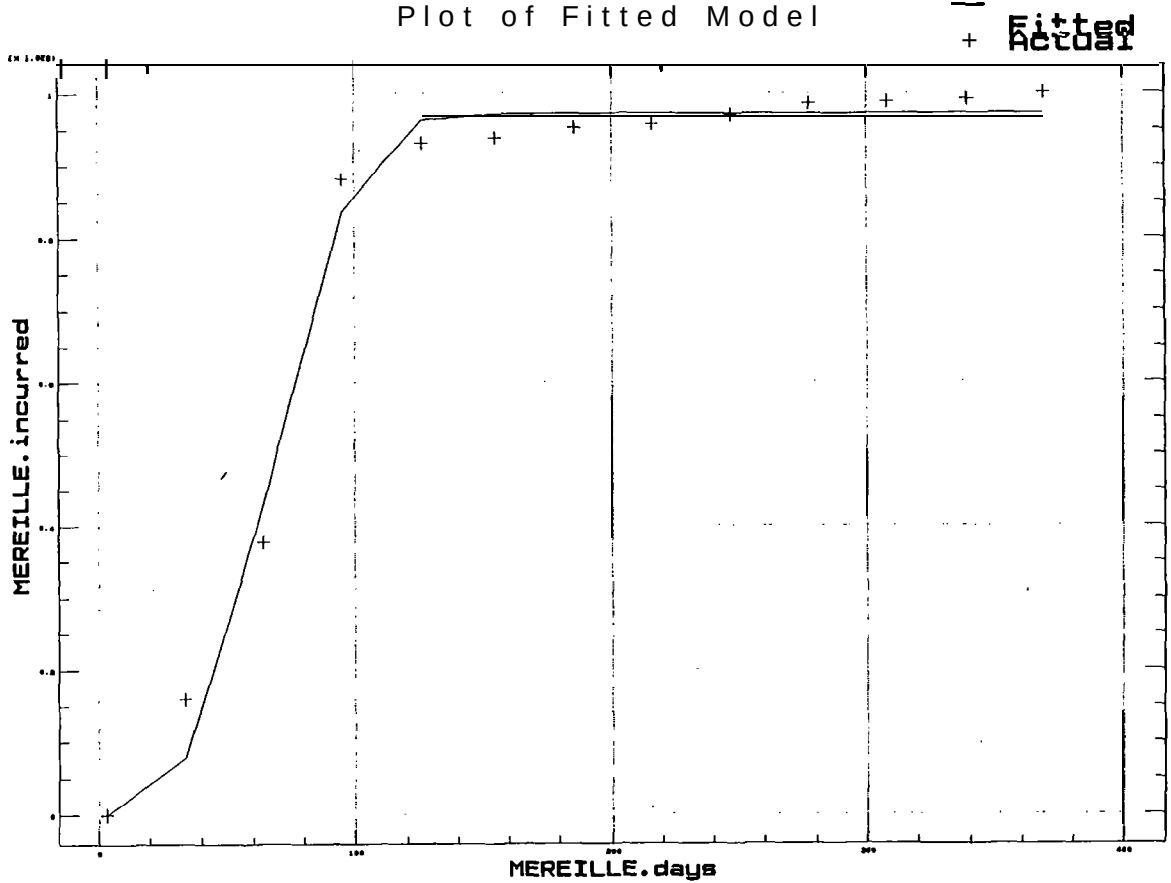
STORM	90G	(M)	PAID (ST90G)	85.566	(9.231)	798.9	(66.39)	2.3	(0.13)
STORM	87J	(NM)	INCURRED	96.516	(0.422)	320.1	(4.39)	1.4	(0.04)
STORM	87J	(NM)	PAID	89.377	(0.045)	512.1	(11.15)	1.6	(0.06)
STORM	90A	(NM)	INCURRED	100.163	(0.815)	331	(4.44)	2.0	(0.06)
STORM	90A	(NM)	PAID	89.267	(1.721)	439	(8.92)	3.3	(0.02)
STORM	90D	(NM)	INCURRED	100.163	(3.211)	402	(22.64)	1	(0.08)
STORM	90D	(NM)	PAID	68.593	(1.055)	529	(8.43)	2.8	(0.12)
STORM	90G	(NM)	INCURRED	110.513	(4.317)	589	(29.42)	2	(0.06)
STORM	90G	(NM)	PAID	83.248	(6.994)	799	(52.83)	2.3	(0.11)

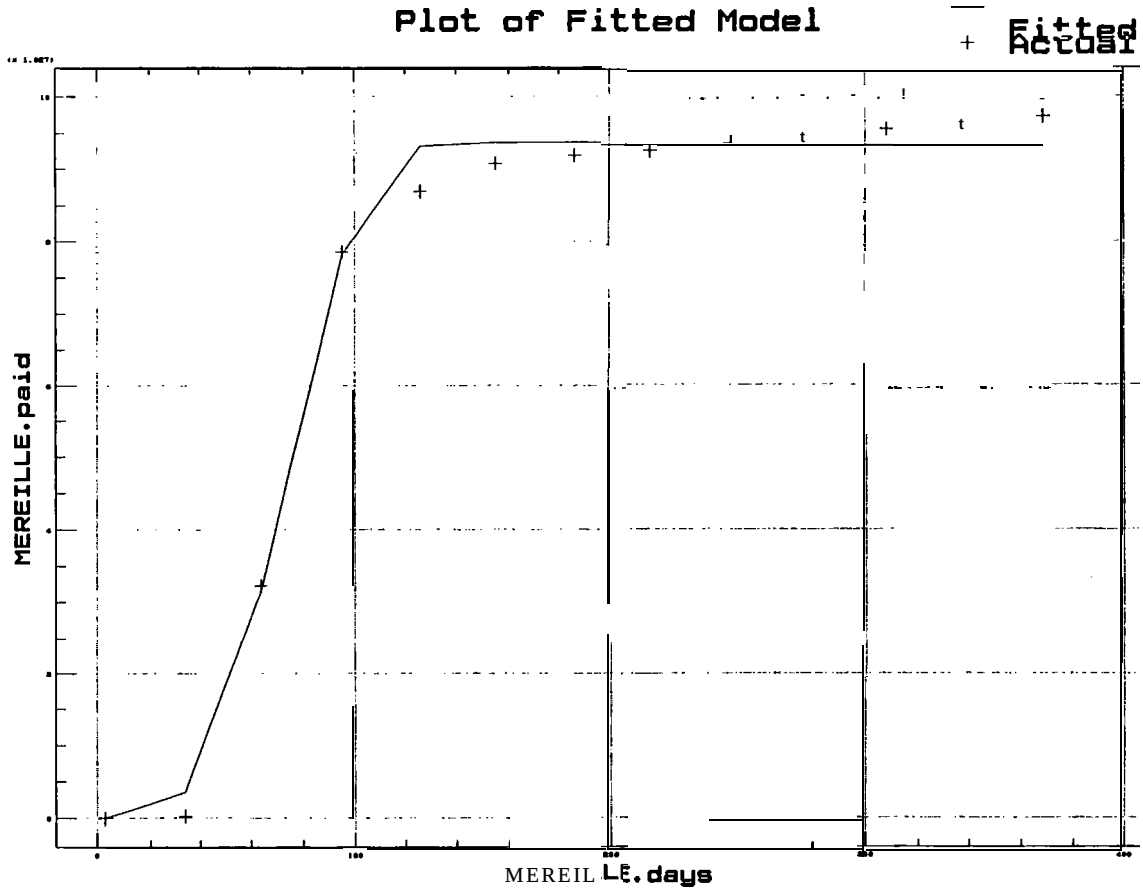
Plot of Fitted Model
Fitted
Actual
GILBERT.incurred
GILBERT.days

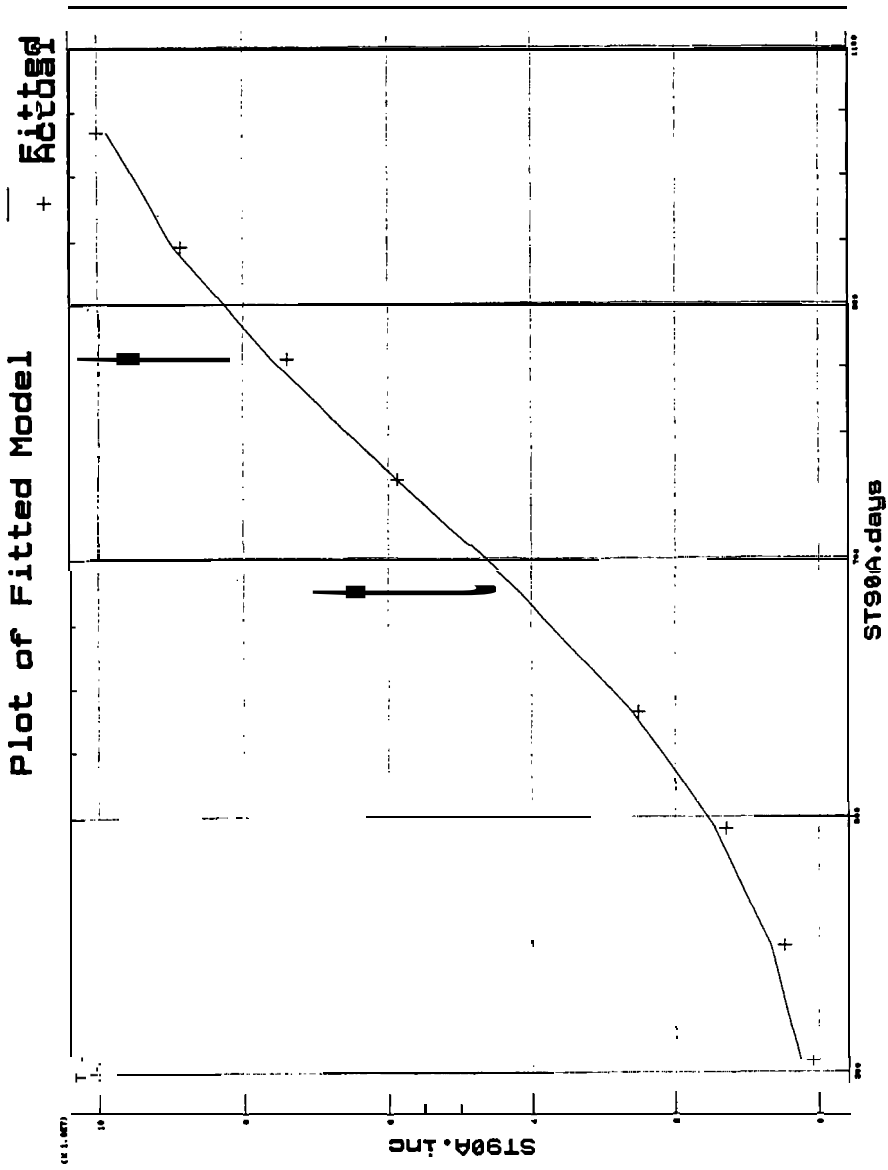
Plot of Fitted Model
Fitted
Actual
GILBERT.paid
GILBERT.days

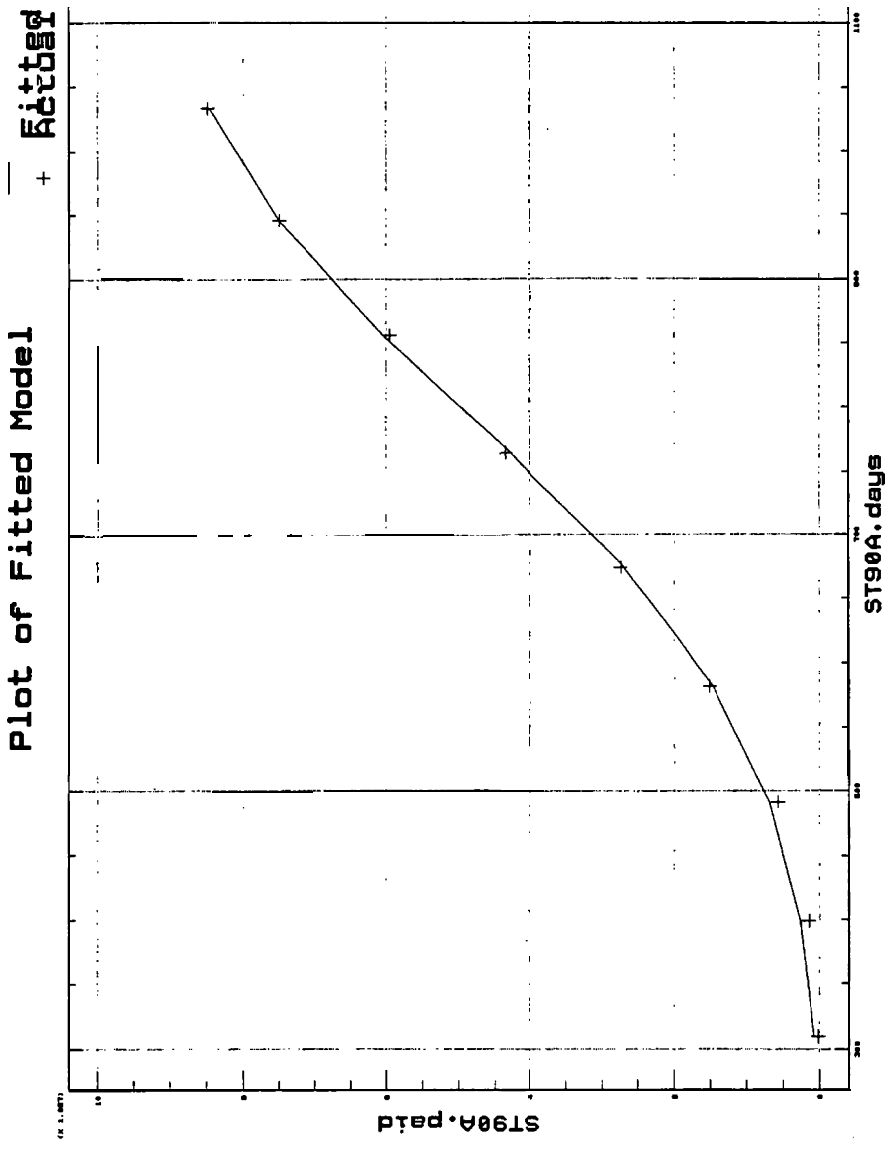
Plot of Fitted Model
Fitted
Actual
GLORIA.incurred
GLORIA.days


Plot of Fitted Model
Fitted
GLORIA.paid
GLORIA.days

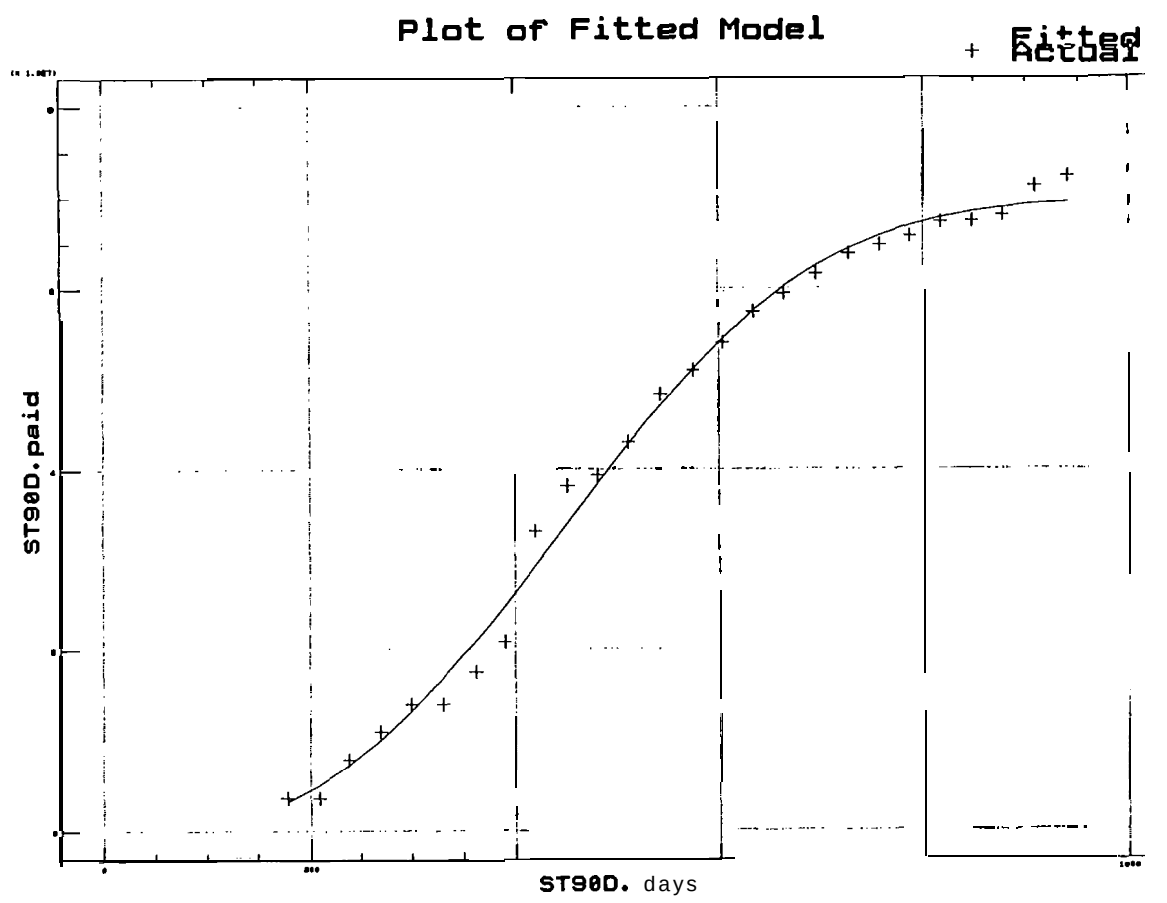

Plot of Fitted Model
Fitted
Actual
MEREILLE.incurred
MEREILLE.days


Plot of Fitted Model
Fitted
Actual
MEREILLE.paid
MEREILLE.days

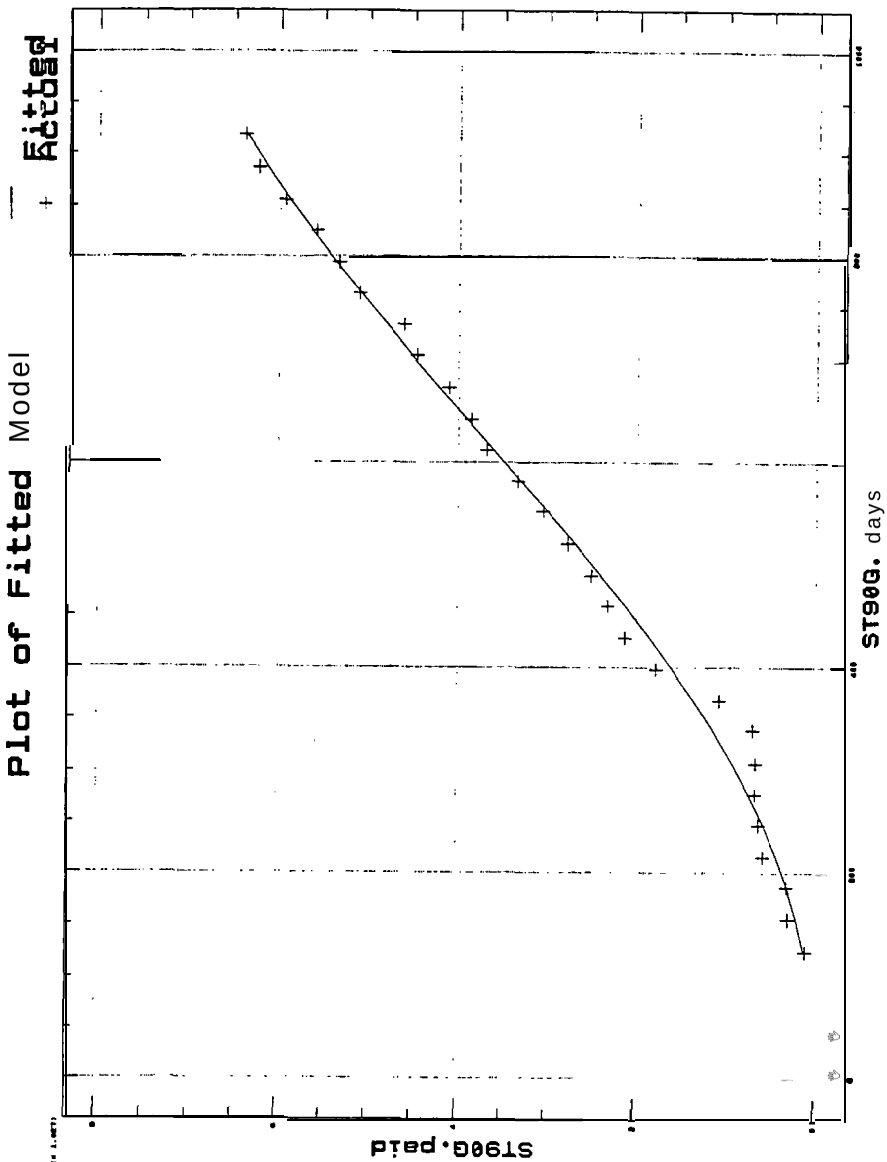

Plot of Fitted Model
Fitted
Actual
ST90A.inc
ST90A.days

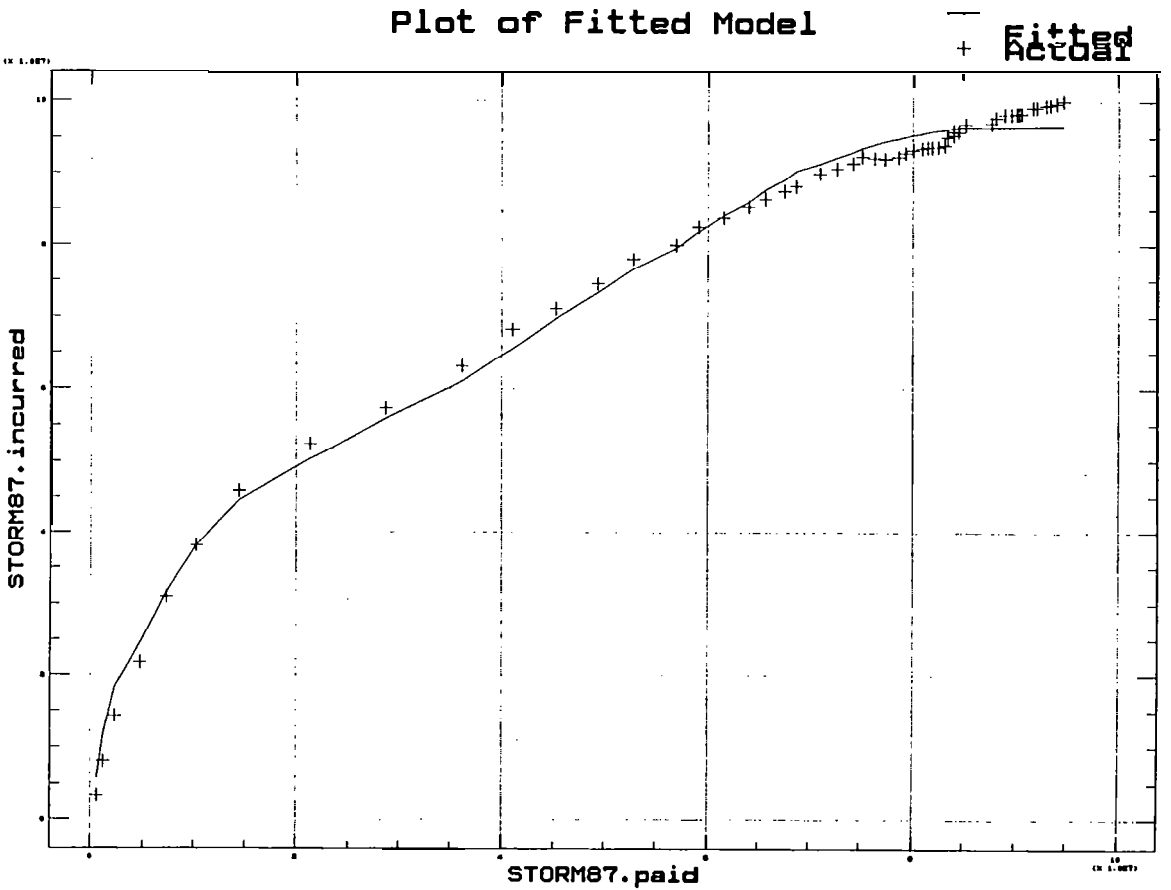

Plot of Fitted Model
— Fitted
+ Actual
ST90A.paid
ST90A.days

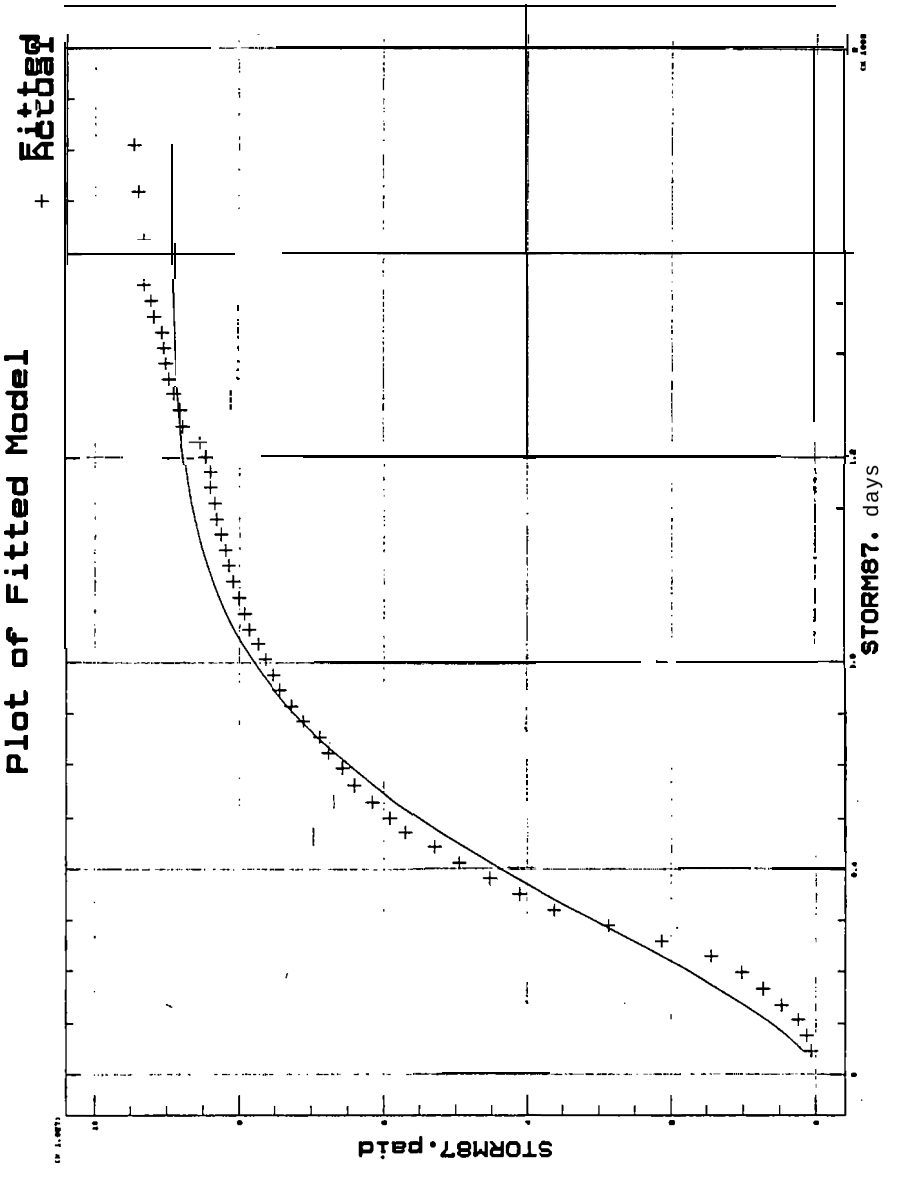
ST90D.dags
Plot of Fitted Model
Fitted
Actual
ST90D.inc

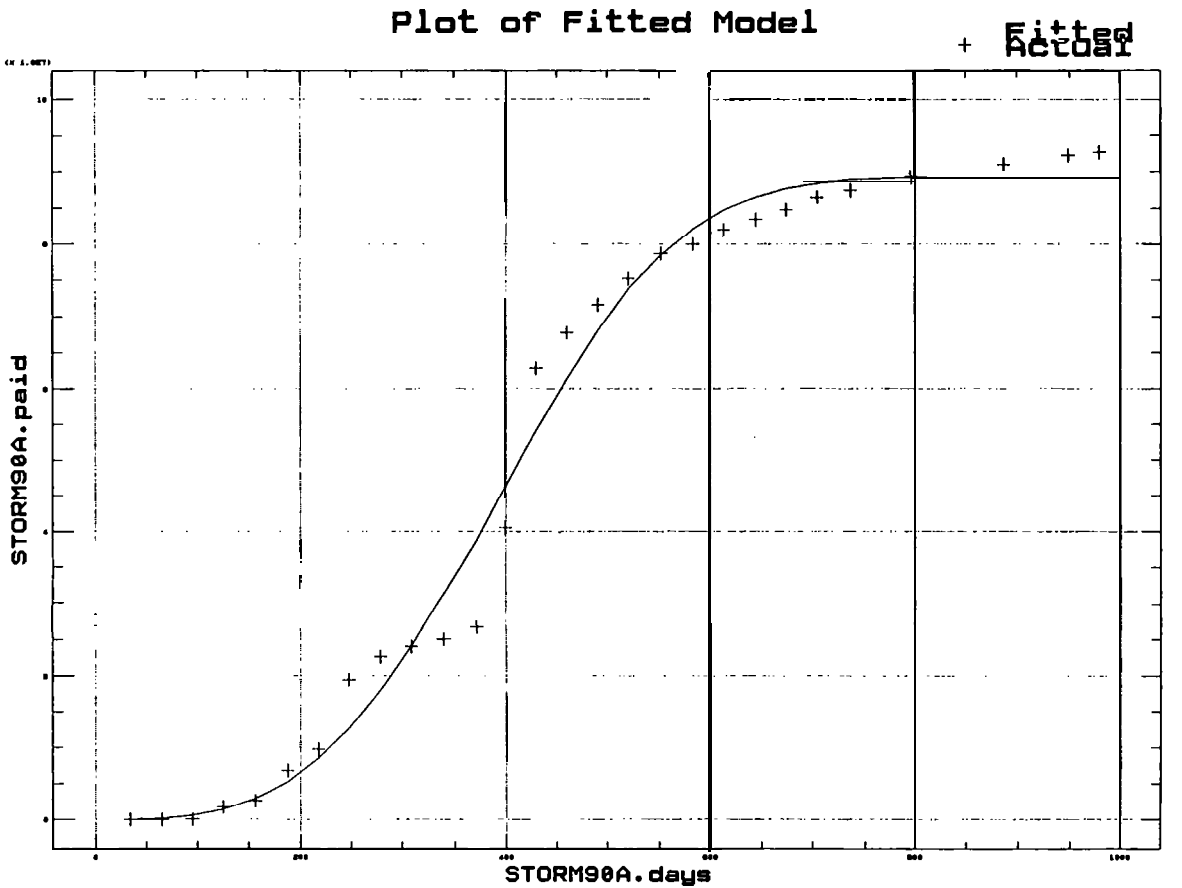

Plot of Fitted Model
+ Fitted
+ Actual
ST90D.paid
ST90D. days

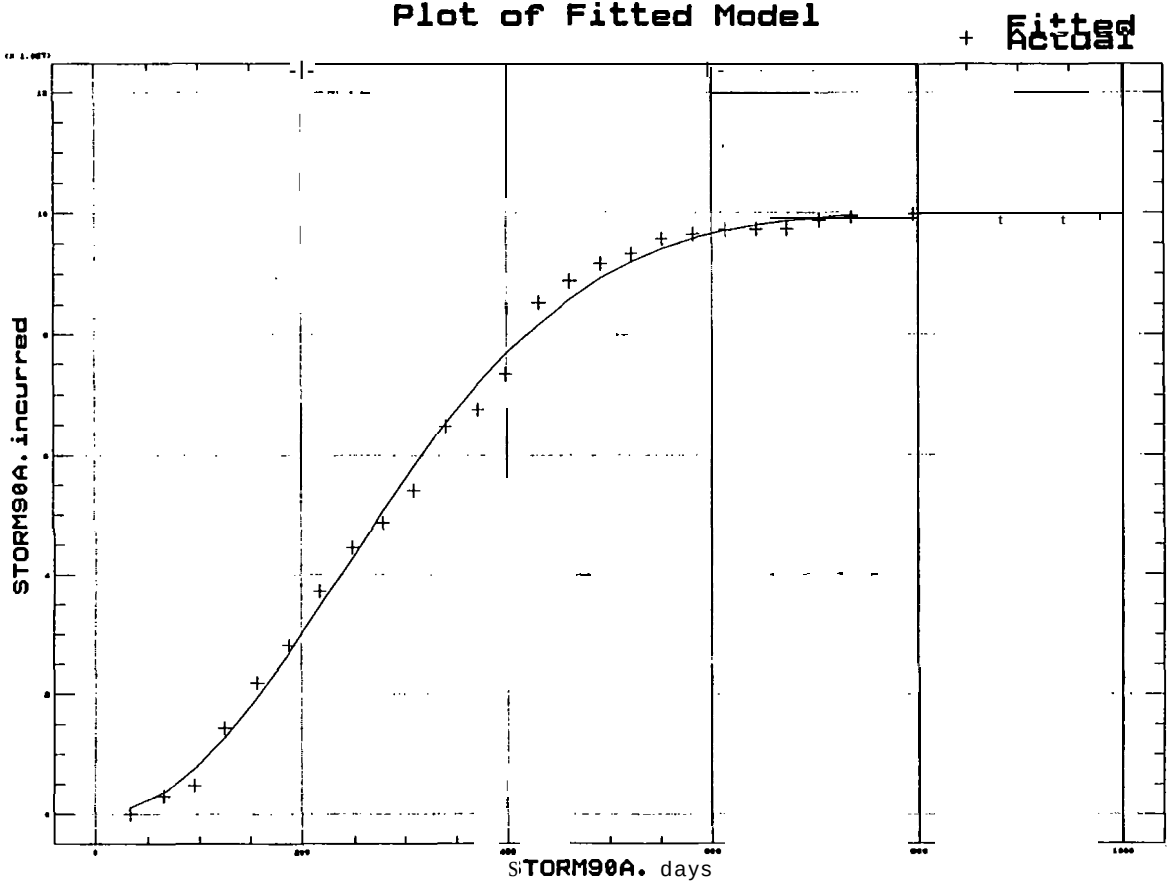
Plot of Fitted Model
Fitted
Actual
ST90G.inc
ST90G.days

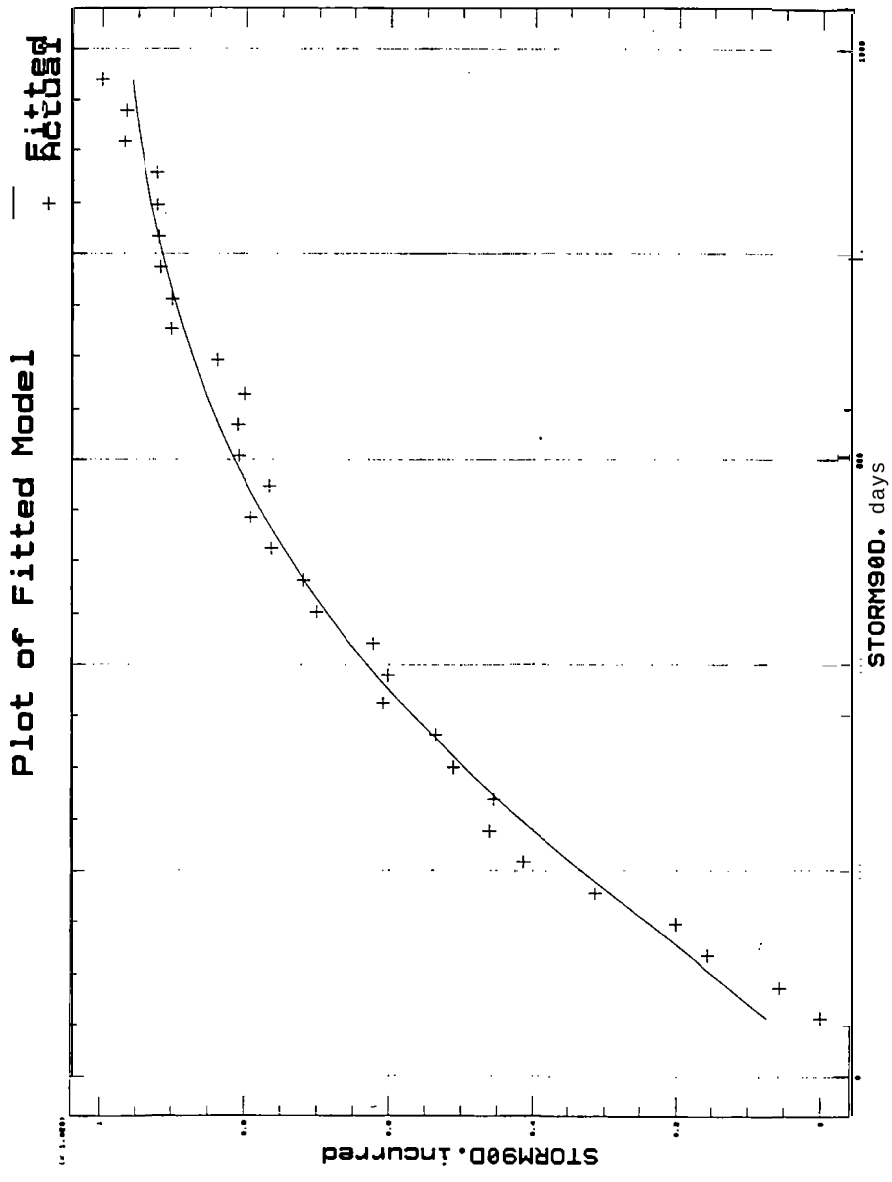

Plot of Fitted Model
Fitted
Actual
ST90G.paid
ST90G. days

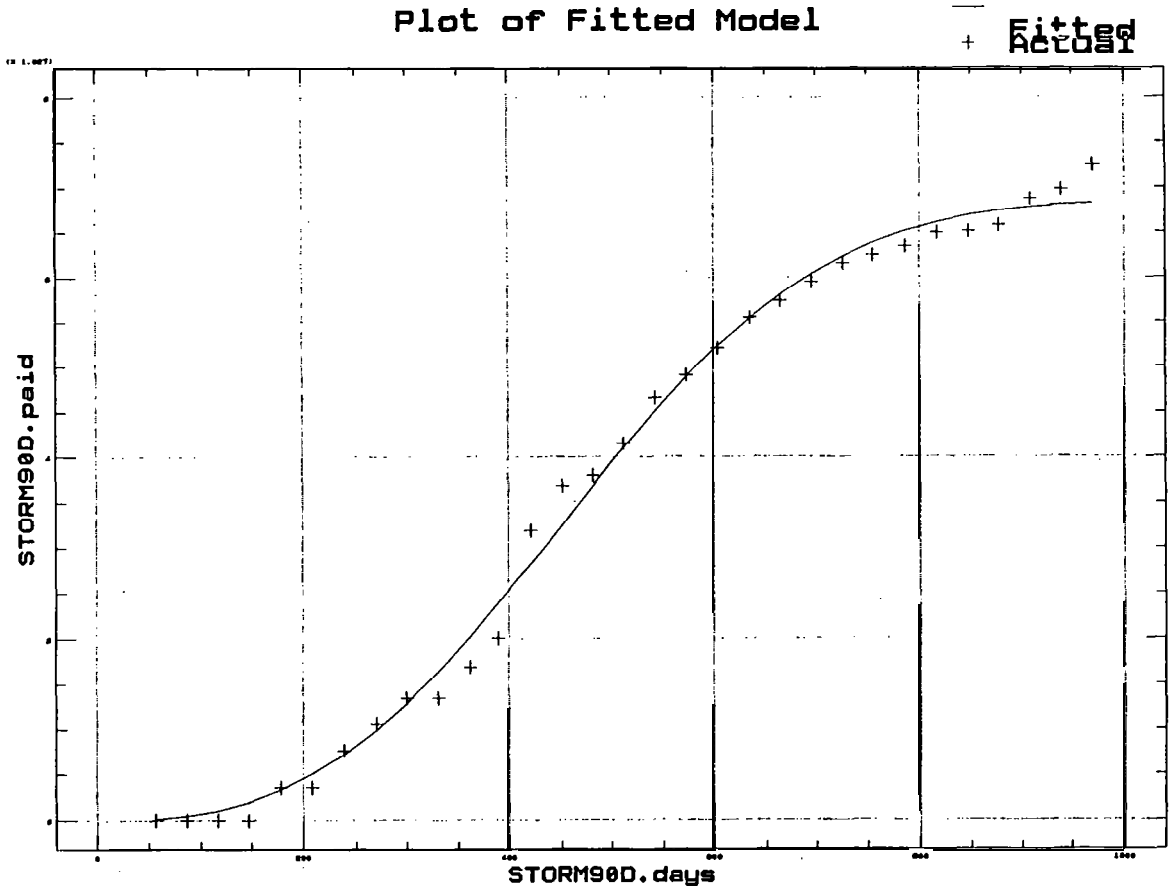

Plot of Fitted Model
Fitted
Actual
STORM87.incurred
STORM87.paid

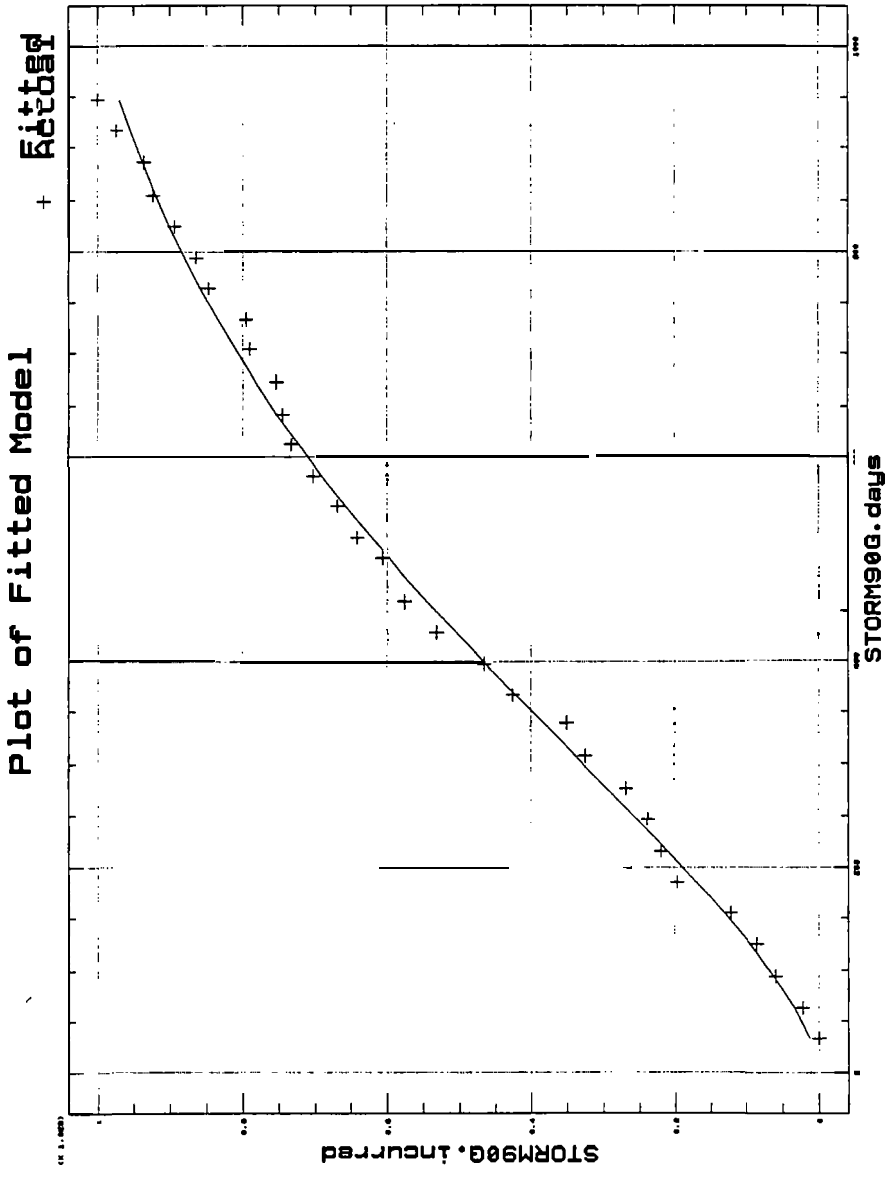

Plot of Fitted Model
+ Actual
+ Fitted
STORM87.paid
STORM87. days

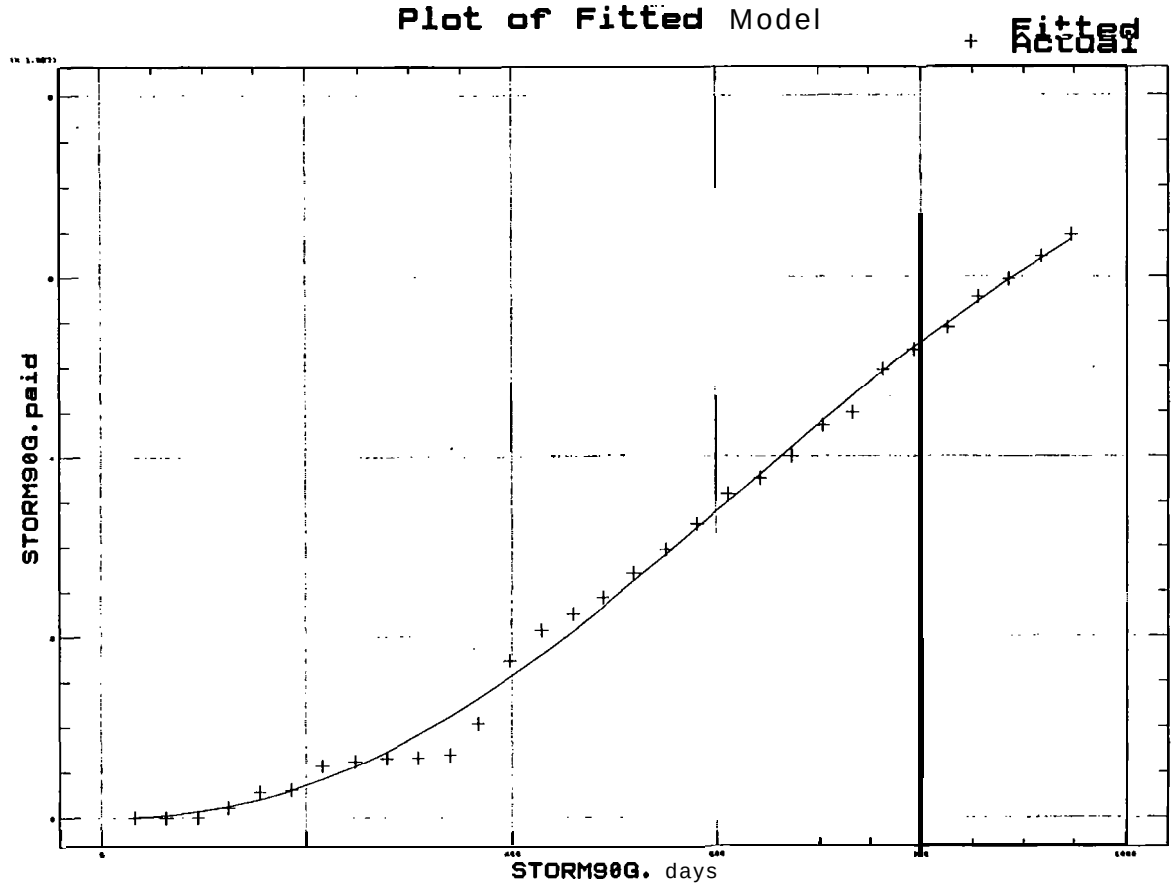

Plot of Fitted Model
Fitted
Actual
STORM90A.paid
STORM90A.days


Plot of Fitted Model
+ Fitted
Actual
STORM90A.incurred
STORM90A. days


Plot of Fitted Model
— Fitted
+ Actual
STORM90D. incurred
STORM90D. days


Plot of Fitted Model
Fitted
Actual
STORM90D.paid
STORM90D.days


Plot of Fitted Model
+ Fitted
STORM90G.incurred
STORM90G.days


Plot of Fitted Model
+ Fitted
Actual
STORM90G.paid
STORM90G. days

SOME THOUGHTS ON THE FUTURE:

What type of losses should we look for in the future? There is a time bomb of potential losses out there, and I will try and give an indication of the magnitude:-

a) Meteorite Hit

These events are not rare. It is possible that once every 65 million years a meteorite large enough hits the earth and causes mass extinctions. A large meteor, big enough to devastate a substantial part of Europe is expected once every million years. We have no recent experience of such events. An underwriter said that they gave the cover for free!

b) Earthquake

The potential for "big ones" are:-

Tokyo - due any time.
Los Angeles
San Francisco/Hayward Fault
Central Europe - about one every 10,000 years

The Market has not had a significant earthquake in recent times. The Loma Prieta (San Francisco) earthquake insurance was largely retained in the US and very little found its way to London. A Tokyo earthquake on the scale of the one in 1923 is anticipated to cost $400 billion and reduce world GNP. The Japanese have insured for this event by buying assets outside Japan (e.g. Manhattan) and the realisation of these assets and the impact on the Yen are difficult to assess [see 12].

A Californian earthquake will not be as expensive, the main factor of loss being the wind speed and direction at the time and its effect on the fires. The maximum cost is of the order of $60 billion. California has tried to create an earthquake fund to finance this cost, but realised that the cost of payments would break the State if any event should occur.

A Central/North European earthquake would be devastating because construction standards do not take into account earthquake exposures.

c) Hurricanes

Saffir - Simpson Hurricane **Scale:-**

Index 0	Winds	less than 74 m.p.h.
Index 1	Winds	74-95 m.p.h.
Index 2	Winds	96-110 m.p.h.
Index 3	Winds	111-130 m.p.h.
Index 4	Winds	131-155 m.p.h.
Index 5	Winds	over 155 m.p.h.

All measurements are standard anemometer elevations.

Whilst the number of storms seems to be fairly consistent, the number of powerful Hurricanes and Windstorms has increased. On the graphs appended to this section I set out details on an annual basis, of the number of Storm and Hurricanes per annum over period of 120 and 105 years respectively. Details are found in [9]. These indicate a steady number of storms, but a cyclic frequency (80 year cycle) in Hurricanes. Local fluctuation could possibly be attributed to E1 Nino events.

We are seeing an increase in storm intensity. Hurricanes Hugo and Andrew were given Index 5 (although the Andrew damage seemed to indicate it was about Index 3.5). Index 5 storms are due to occur only once in 100 years. In the UK we have seen our once in 300 year storm twice in the past few years. The actual number of storms appear to be constant (see [8]). Is this the impact of Global Warming? Has the new volcanic dust from Mount Pinatoba affected weather for a short period - particularly as it came with an E1 Nino event. Have we been lucky? Certainly if Andrew had struck Florida 10 miles further North, the cost of the loss is estimated to have been $40 billion as opposed to the current estimate of $12 billion (and rising!).

The cost of such storm damage has been increased by two factors:-

(i) The inflationary value of property.

(ii) The population wishing to live in more exposed areas (e.g. sea fronts).

Buildings have been constructed to inadequate standards for the newer weather patterns' energy.

For more details see [7], [8] and [10].

Flood

If the Thames barrier fails, what would be the consequence?

If the Thames barrier doesn't fail, what happens to Essex?!

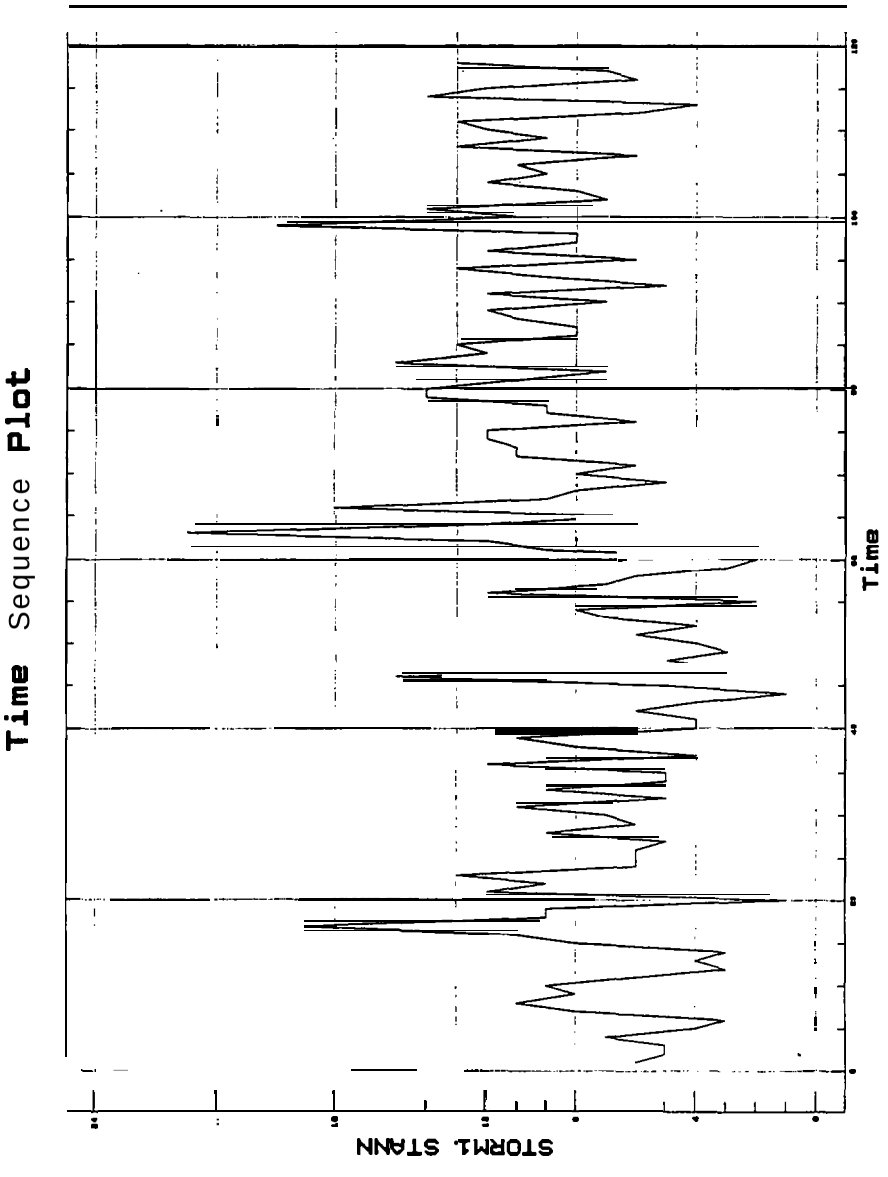
The Future

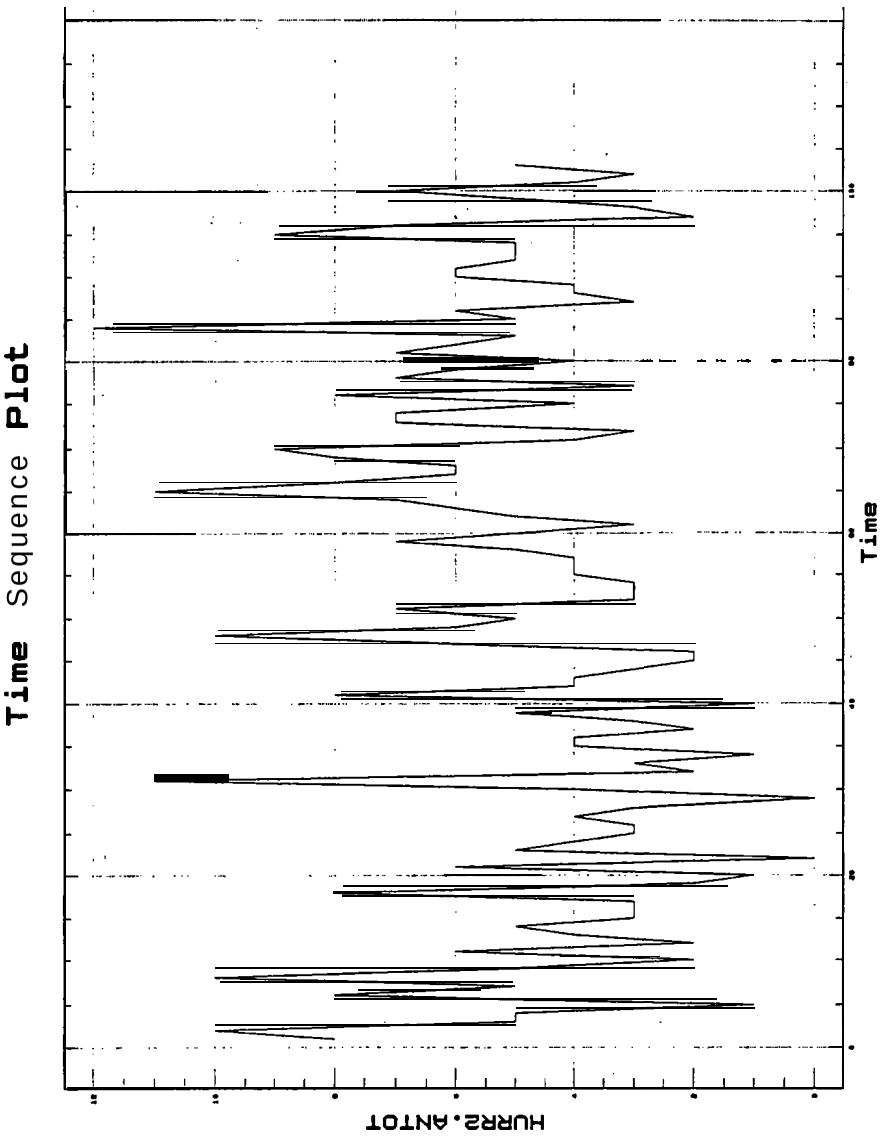
It is clear from the above that reserves need to be built out of current income to provide for the cost of these events. The Revenue puts the UK Market at a potential disadvantage to its European competitors by taxing such reserves.

CATXL is accordingly becoming more and more difficult to purchase. Alternative forms of insurance are being introduced to meet the shortfall. These fall into the stable of Financial (or Finite) Reinsurance. A classic example is a "spread loss" contact when losses from one event are spread forward over many years. Actuaries are becoming more involved with such contracts because of the need to get future cash flows correct to minimise loss. How long will it be before such contracts are traded and a "spread loss" spiral is created?

Other insurers are using quota share as a form of catastrophe cover. The Proportional Treaty Reinsurer is waking up to this.

Actuaries will become more involved with Catastrophe Reinsurance as a result of the new alternative.


Time Sequence Plot
STORM1 STANN
Time


Time Sequence Plot
HURR2.ANTOT
Time

CONCLUSIONS

The Catastrophe XL Market is one of the most interesting and stimulating markets open to Actuaries. This paper briefly touches the surface of many of the issues involved. The greater challenge is to find methods of managing the uncertainty and profitability of a market where demand exceeds supply, and where profits, though great, can be just as easily blown away with the wind.

I have kept this paper brief for two reasons. The first is a personal one in that I have no intention of giving all my secrets away. The second is to stimulate interest in the expanding role of the Actuary in Non-life Insurance.

Next time a major catastrophe event occurs, many UK insurers may be exposed to considerable loss. The challenge is to find methods of managing and funding for these potential losses. If the tile should fall today, the claim paid by the direct insurer is going to impact more substantially on the Profit and Loss Account. In addition, the cost to the individual can only increase as the impact of storm damage is felt by UK. insurers.

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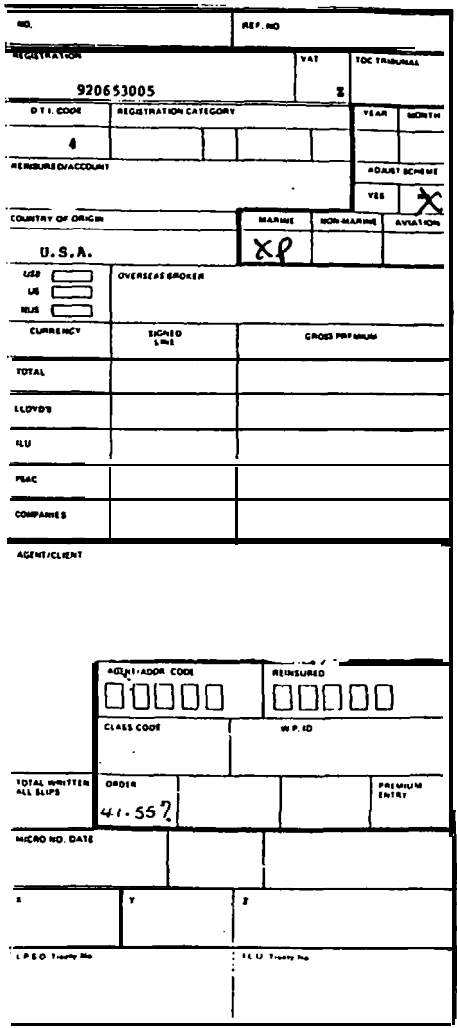
P HADFIELD

APPENDIX 1

A Slip



REINSURED : XYZ Insurance Company

PERIOD : 12 months at 1st January, 1992
Losses occurring during basis.

TYPE : SECOND PROPERTY CATASTROPHE EXCESS OF LOSS REINSURANCE.

CLASS : All Property insurance and reinsurance, classified by the Reinsured as Fire, Allied Lines, Inland Marine, Homeowners, Automobile Physical Damage (excluding Collision) Multiple Peril and Casualty (with respect to Glass business only).

TERRITORIAL SCOPE : U.S.A. and/or Canada and/or . . original.

LIMIT : 95% of $25,000,000 each and every loss occurrence

IN EXCESS OF AN ULTIMATE NET LOSS OF

$27,500,000 each and every loss occurrence.

CO-REINSURANCE : 5% retained net by the Reinsured.

REINSTATEMENT : One reinstatement for all perils at ~~pro rata~~ 100% additional premium as to time pro rata as to limit

PREMIUM : Deposit Premium $2.612.000
payable in four equal instalments in advance and adjustable at 0.825 % of the Reinsured's subject matter Gross Net Earned Premium Income.
Minimum Premium $ 2.089.000.

DEDUCTIONS : Federal Excise Tax as required under applicable law or regulation and 15% Brokerage (Nil for Reinstatement).

LOSS RESERVE : Non-admitted Reinsurers hereon agree Letters of Credit (Citibank N.A. &/or Chase Scheme) In respect of known and reported losses only but Cash O.C.As. for Canadian Dollars, as required by the Reinsured (Excluding I.B.N.R.).

REC'D	SETT DUE DATE	
1	31/3/92	30

1/20 adj

REASON

WRITTEN LINES PERCENTAGES OF $25.000.000

SIGNED LINES PERCENTAGES / PART OF

Underwriters agree to authorise L.P.S.O., P.S.A.C. and I.L.U. to sign book slips and to take down premium A.P.I. and R.P.I. and to settle claims and returns on a balance of account basis irrespective of discrepancies in the accounts subject to these being reconciled in the next account.
Ctl slips and signing slips I.D.s (if required) by L/UR only.
I.L.U. authorised to sign and deal in early wording as agreed by leading I.L.U. Coy

Subject otherwise to the terms of the C.C.S.A. 1980. Companies hereon agree that authorisation forms in respect of this policy shall not be required, it being understood that Closing Instructions or addenda will be sent to Companies together with a form for return (if necessary) within 7 days of receipt showing any objection or change of administrative details, any amended reference to be quoted thereafter.

By signing this slip signatories to the C.C.S.A. 1980 authorise the Leading C.C.S.A. 1980 Company to arrange for P.S.A.C. to sign the Policy on its behalf and accept that such signing will be a valid signing for all the purposes of the C.C.S.A. 1980.

GENERAL CONDITIONS : Intermediary Clause.
Net Loss Clause.
Net Retained Lines Clause.
Excess of Loss Reinsurance Clause.
Loss Settlement and Notice Of Loss Clause.
Hours Clauses as per NMA 2244.
Service of Suit Clause (NMA 1998).
Arbitration Clause.
Access to Records Claude.
Insolvency Funds Exclusion.
Insolvency Clause as per wording.
Nuclear Incident Exclusion Clause(s) as per wording.
Pools, Associations and Syndicates Exclusion Clause.
War Exclusion.
Seepage and Pollution Exclusion as per wording.

WORDING : As expiring as far as applicable, to be agreed L/U only.

INFORMATION : As per submission of 22 pages dated 9.10.91.

INTERNAL ARRANGEMENTS

Reinsurers hereon agree to accept all special agreements and acceptance8 relating to this contract made prior to the inception of this slip.

Loss Reserve - Admitted Reinsurers hereon will provide Letters of Credit (Citibank N.A. Scheme) In respect of known and reported losses only but cash O.C.A.'s for Canadian Dollars, where they consider circumstances warrant It.

Lloyd's Underwriters hereon agree that claims are to be agreed by, leading Lloyd's Underwriter and LUNCO only, including LOCs as applicable.

Reinsurers hereon authorise LPSO/LIRMA to take down adjustments/reinstatements without sight of client account subject to checking prior to submission and rectifying any errors as soon as possible after discovery.

Loss advices: Where the reserve from the ground up on an individual loss is 50% of the retention or less, claim advices will not be shown to the market.

31.10.91.

NWRe

3% G0104SH92

0.15% C0369D492

03% D0797DN92

CAA82XA0133B

0.30%

RCB 512

0 0 0 6 6 E 9 A X E X

DIM 606

0 9 M 0 1 2 4 6 6 1 0

0.25% ROS 227

8 0 0 S 7 J C A A H 2 X

WLM 807

A 8 5 5 9 2 8 3 3 1 5 D

THE TOA-RE (UK)

92 X 00 40

EXCLUDING LOC/OCA/IBNR

0.5%

0.25% CJ 4 5 6 9 9 2 A 4 8 0

0.50%

15/11/91

DPM 435

0 0 3 2 3 2 0 0

SVT 1007

1.5%

P 0 6 2 5 9 0 B

PER H.G.S. 15/11/91

C4009 LIPMA

Excluding LOC/OCA IBNR

0.75 FB 7 B B J 9 9 A 4 8 0

C. W. SPRECKLEY

NVB 1114

0.2% 0 3 4 1 0 0 9 2 A A N N

BURTON

10.12.90

EVERNDEN

PAR 1177

A 0 3 9 C 9 2 A 1 5 4

0.40% 4.12.91

A1

ZURICH RE (UK)

Z	6	2	0	0	3	9	0	3	7	9	2
Z4508			LIRMA					NCAD			
EXCL. LOC'S/OCA'S/IBNR I.B.N.R.											

R. E. BROWN & ORS

REB 702

0.70% P 6 0 C C 9 2 X C 2 X C

0.7% 0.50%

JHV 376

8 0 0 N 0 0 1 8 0 A LA

Terra Nova

0	9	2	B	P	0	7	1	6	7 T A
1	4	P	1	1	A	7			3
T3902			LIRMA						

Ex LOC IBNR

1½%

3/4%

Caudle

BFC 780

B 0 1 1 8 3 H B A 5 1 1 X

0.35% O/A

LLOYD-ROBERTS

GLR 55

B A 1 9 0 J 9 2 A A C 1

5.25

227

3

2/8 7/92
S.
1[illegible]
7113FH82601 0

BSH 72 AFB
0.4 T00311N 92 ANCC

ENC
SH
[illegible]
9/1/92

EPT
$ 316,555,000

0.3 % EAGLE STAR
3892955 0200
USAUS1SF1FX
E1102 LIRMA
MH

228

NO. 920653005

REINSURED

TYPE

SECOND PROP. CAT. X/L REINSURANCE

RENEWING		CLIENTS REF
~~910653005~~	BABCLM	
RELATED SLIPS	LESS 10%	
	ORDER 41.55 %	TOTAL WRITTEN HEREON
		NO. of SLIPS 1
BROKER DS/FGS	C/N DATED	PHOTOGRAPH
REPORTS XPS/NO		

FOR LPSO USE

FOR ILU USE

FOR PSAC USE