# THE AVIATION AND SPACE INSURANCE MARKET

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With special thanks to
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Richard Power


## SUMMARY


This is not a technical paper and so is easy to read. It should be useful both for those who work in the aviation and space field as well as providing information for those who have no practical involvement in the market.

The aim of this paper is to describe the types of insurance that make up the Aviation and Space Insurance Market, and to provide a degree of understanding as to how these complex and unique markets work. The main market sectors are considered in some detail; the main drivers and trends in these sectors have been described. The major issues affecting the market are looked at, as well as the possible responses from the Aviation Insurance Industry to these issues. Possible future changes have been suggested. The paper includes a brief section where market data obtained by the Working Party has been projected to its ultimate position. This illustrates the effect of the insurance cycle in this area, and the highly variable nature of the claims experience. This is particularly the case given the rapidly increasing exposure and equally fast moving changes to aviation safety.

# INTRODUCTION

The contents of this paper represent the personal views of the working party members and should not be considered as representing the views or policies of our employers or the Institute of Actuaries.

The Working Party would like to thank the Corporation of Lloyd's and British Aviation Insurance Group (BAIG); particularly Cameron Johnston and Richard Power for their help and assistance both with data and the more technical elements of this paper.

This paper has been written to provide a factual description of a little understood area of General Insurance. It describes the main sectors of the market, and the factors that are determining results in these areas. The Working Party also suggest changes that could be made by insurers, expected growth in the main sectors, and high profile factors that may materially impact on future experience. This paper is intended primarily as an educational paper for those unfamiliar with this esoteric but high profile area of the General Insurance Industry.

Where given, premium figures have generally been taken from brokers' statistics. As such, they are before brokerage (typically 10%) and assume that the entire market gets leader's terms. This is patently not the case, the difference in rates between lead and following slips is usually between 20% and 40% for Airlines, but less for Satellites and Products cover. More details on this are given in the section on vertical placing. These two factors make the actual experience considerably worse than that shown.

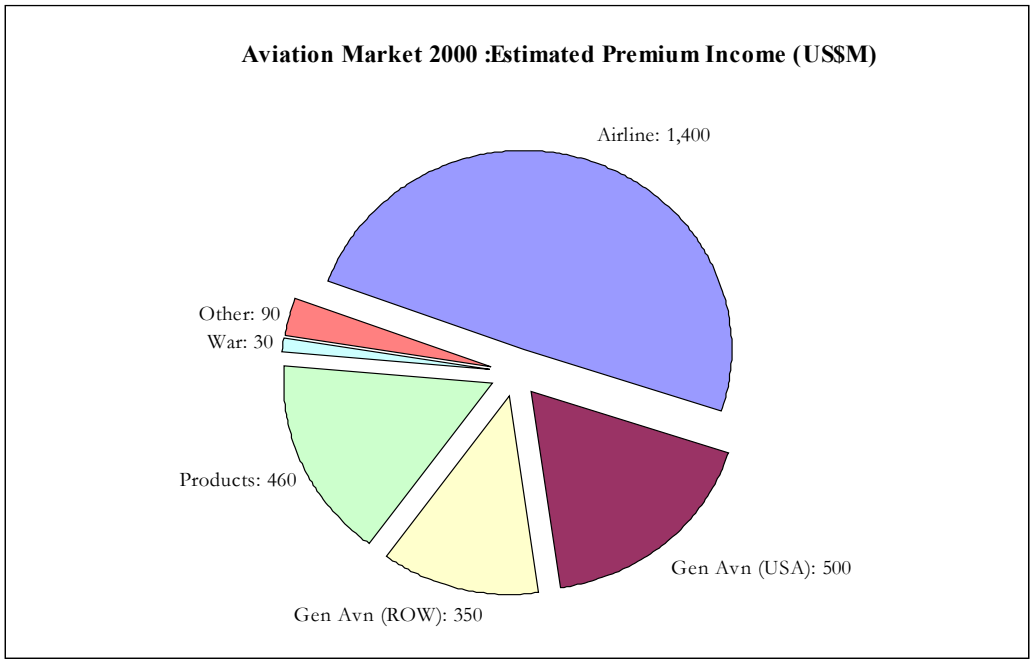
The paper has been split into the following sections:

# THE AVIATION MARKET

## Overall Summary

Air transport started from very humble beginnings; the first international daily air service was in 1919, connecting London and Paris. By 1994 the Air Transport Action Group estimated that air transport impacted the global economy to the tune of $1 trillion, and the industry provided 24 million jobs worldwide, (3.5 million working in the industry, 7.5 million in related industries, and 13 million in other industries). By 2010, this is projected to have grown to a $2 trillion contribution to the world economy, with employment for 30 million people.

The total aviation premium, in 2000, is projected to be around US$2,830m. The premium is before brokerage and on leaders terms. This is split between the following areas:




It should be noted that half of the premium comes from under 500 insureds; and of this total premium over 40% is reinsured.

There are huge potential exposures arising from an individual accident. Hull values can be up to $225m, and liability payments average $3m per person in the US (up to $10m in some cases). A collision between two 747's could cause a loss in excess of $3bn (assuming they were fully laden and the flights originated in the US), more than the total premium for the whole market.

# AIRLINE INSURANCE (HULL AND LIABILITY)

## Introduction

This sector traditionally covers aviation hull and liability, for western built aircraft that can carry 40 or more passengers. Small aircraft form part of General Aviation, the definition of which will vary depending on how an insurer wants to classify their book of business. The hulls of aircraft constructed in the eastern block are not generally insured. Cargo planes are often included when owned by major airline companies - although the loss or damage to cargo is usually covered separately. Ground property and liabilities arising from ground operations are covered separately as are war risks.

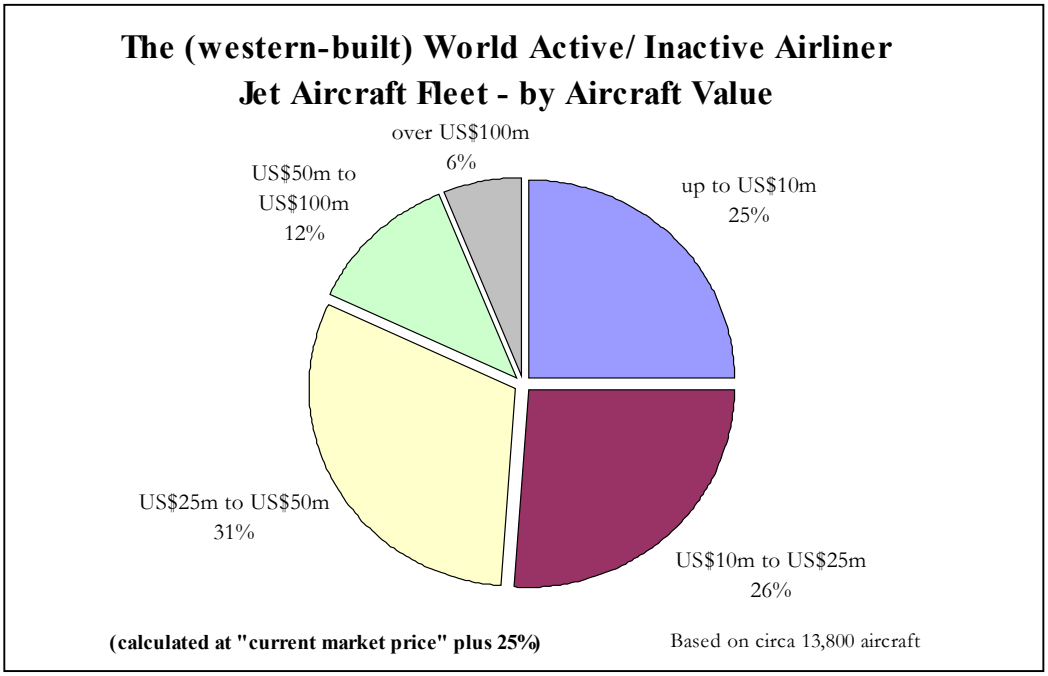
The world airline fleet is built up as follows:-

| | **In Service** | **Stored** |
|---|---|---|
| Western Built Jets | 13,250 | 554 |
| Eastern Built Jets | 2,070 | 545 |
| Western Build Turbo-Props | 4,998 | 365 |
| Eastern Build Turbo-Props | 1,965 | 850 |
| Executive Jets | 1,397 | 12 |

Of the active western jet fleet almost 90% are passenger aircraft, the rest being cargo planes.

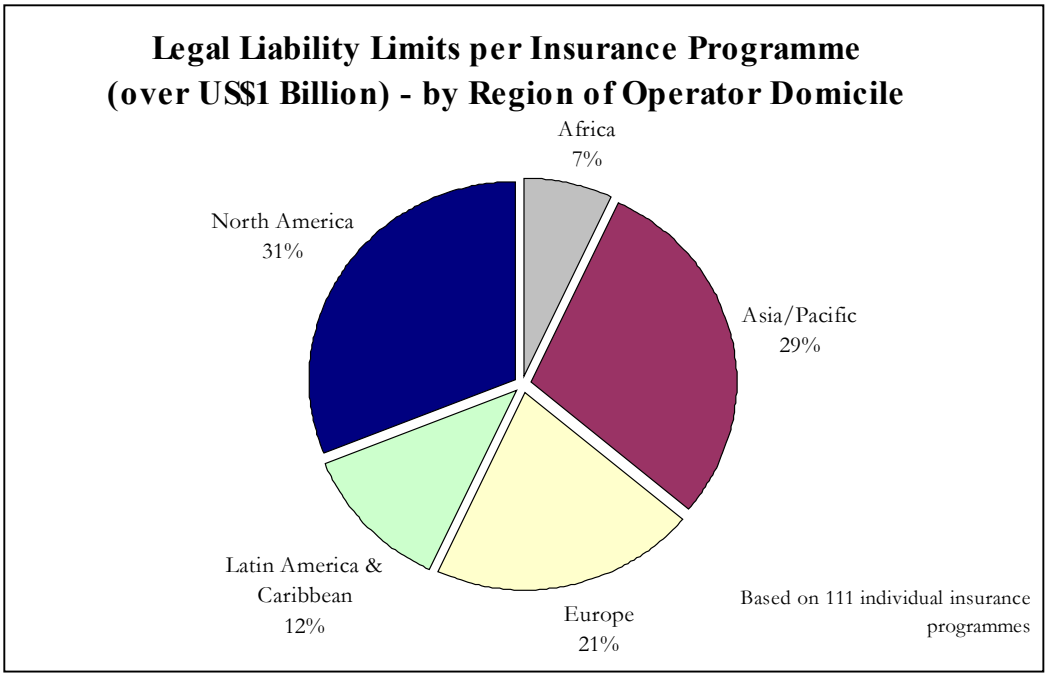
The hull policy covers loss and accidental damage (including emergency landings) to air and ground risks; the liability policy covers the airline against legal action from third parties or customers in respect of death, injury or physical damage to property. Most airlines have 'manuscript' wordings devised by the brokers, insurers and purchasers to reflect individual needs, circumstances and preferences.

Individual hull values can now attain $225m, and 20 programs include aircraft with values of $200m or more (source AON). Although there are few of these aircraft, numbers will rise as a new generation of planes enter service.




The chart above illustrates the approximate split of the world airline fleet by insurance value. This is defined as the current market value by type and variant, grossed up by 25% (to represent the average mark up between the two values). It is surprising to note that over 50% of the total fleet is worth less than $25m per aircraft; this is probably due to the high proportion of jet airliners that are over fifteen years old. This proportion is likely to decrease as more new, higher value planes are delivered by manafacturers over the next decade, and the new “super jumbos” come into service.

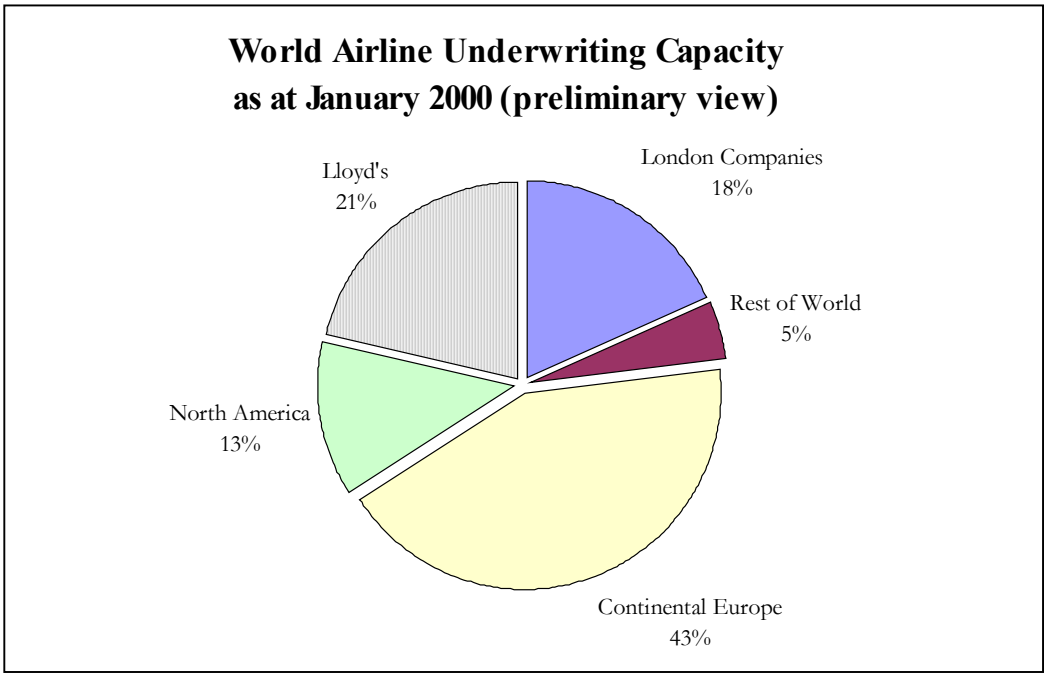
Whilst hull values can easily be quantified, the same cannot be said for liability limits. In 1999 111 insurance programs had a liability limit of $1bn or more (source AON). These can be analysed by region of operator domicile:




The amount of liability cover purchased will vary substantially by airline and area of operation. A small regional operator might buy cover for $500m per loss, whilst a major international airline with substantial US exposure may buy in excess of $2bn for each and every loss. Multiple losses in one year are possible eg Korean Airways in 1999.

A large proportion of these large limits are purchased by North American operators due to the large airline population. The maximum limit purchased by an American operator is $1.75bn (Northwest/Continental). This is less than that purchased by many European and Asian operators (eg BA, Air France, JAL). The average limit for US operators with over $1bn of liability cover is about $1.1bn whilst for European and Asian operators it is nearly $1.5bn.

The available capacity can be split as follows (source AON):




There is substantial capacity available for both hull and liability programs, and this is showing little sign of reducing between 1999 and 2000 (with the odd exception). Surprisingly little of the capacity is American, given the large proportion of business that is US domiciled.

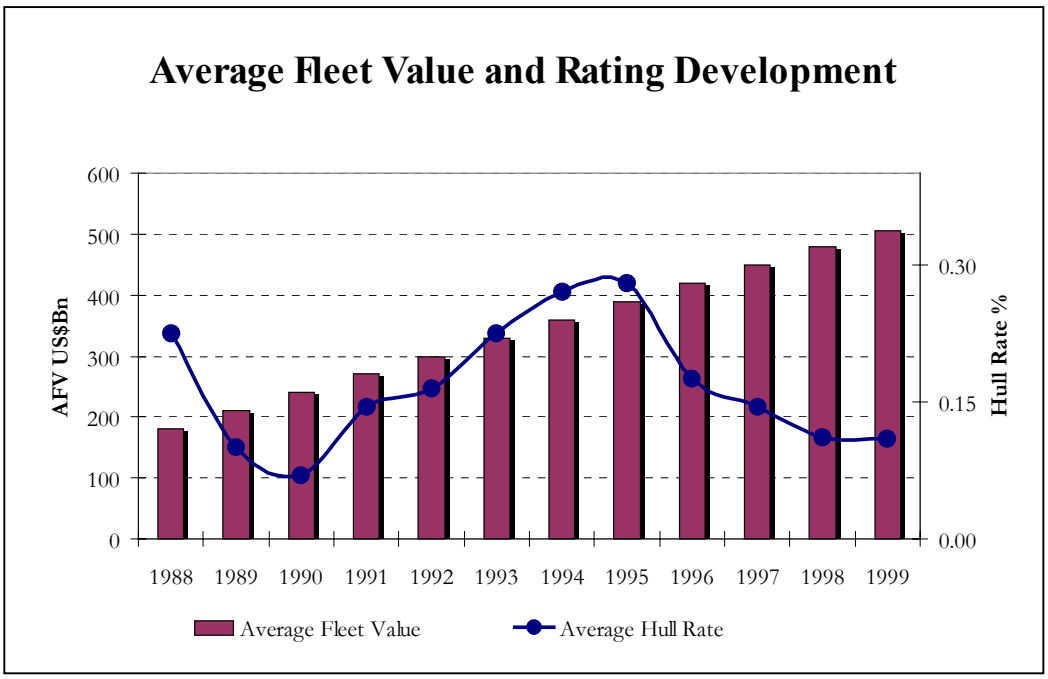
**Rating**

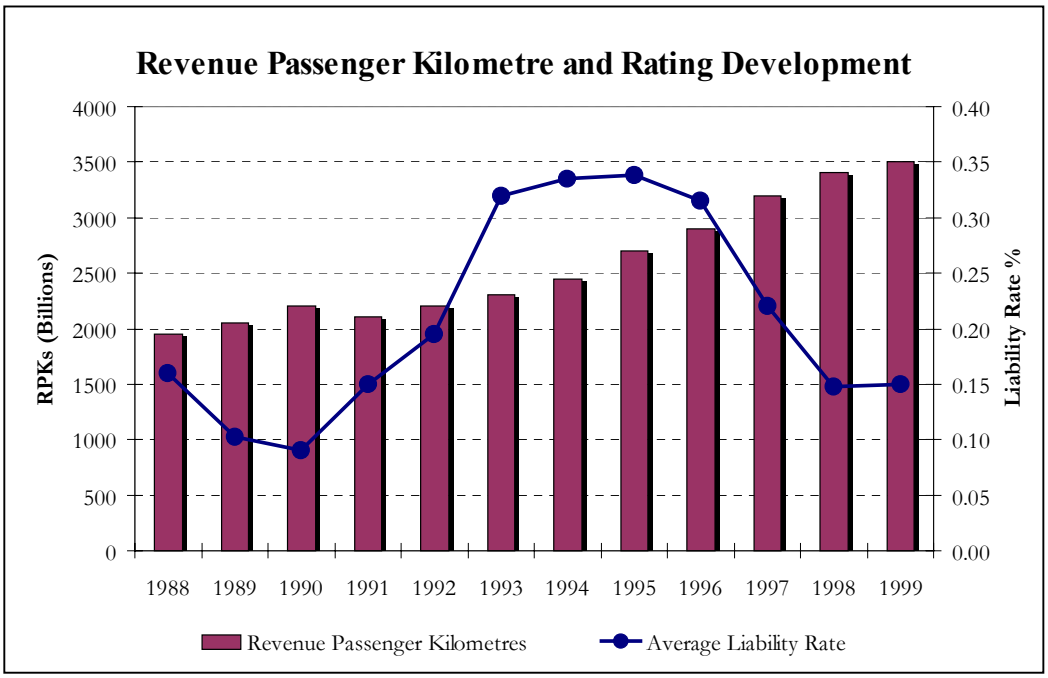
The rates charged will depend on:

| Hull | Liability |
|---|---|
| Experience of fleet | Experience of fleet |
| Type & value of aircraft | Past details of RPKs flown |
| Experience of pilots & crew | Passenger make up |
| Routes flown | Routes flown, conditions of carriage operated and underlying legal situation. |
| Excess used | Capacity of aircraft |

Revenue Passenger Kilometres (RPKs) is defined as the number of passengers multiplied by the distance flown.

The main global factors that will also be taken into account include the worldwide level of aviation rates, changes to legal situations governing liability, the overall global claims experience, the availability and cost of reinsurance, and the spare capacity from other markets. The value of the aircraft will affect the Hull rate - low valuations increase the rate as insurers will tend to pay all partial claims if a single pro-rata rate is applied to a low valuation.



The graphs above illustrate the effect of the cycle on rating levels, and the increasing exposure arising from both hull and liability business. The effect of the cycle on rates can clearly be seen; it is obvious that the only factor keeping premiums up is the increasing exposure, which in turn will lead to more claims, all other things being equal. Rating levels are at almost historically low levels, particularly allowing for the changes in the rules governing liability payments, and this situation is clearly unsustainable.

In 1996, a previous GIRO working party reviewed a rating model produced by Swiss Re in their Sigma publication (see Aviation Underwriting Working Party report). This indicated that, by comparison with rating levels pertaining in 1995, they would expect rates to move in line with the figures in the following table:

| Year | Liability Rates % change from 1995 | Hull Rates % change from 1995 |
|---|---|---|
| 1996 | -25 | -50 |
| 1997 | -40 | -33 |
| 1998 | -28 | -35 |
| 1999 | -30 | -37 |
| 2000 | -32 | -39 |

These figures were, of course, subject to a significant margin of uncertainty which increased with the period of time from 1995.

With the benefit of hindsight, we can now compare these figures with the "actual" movements, which are shown in the following table.

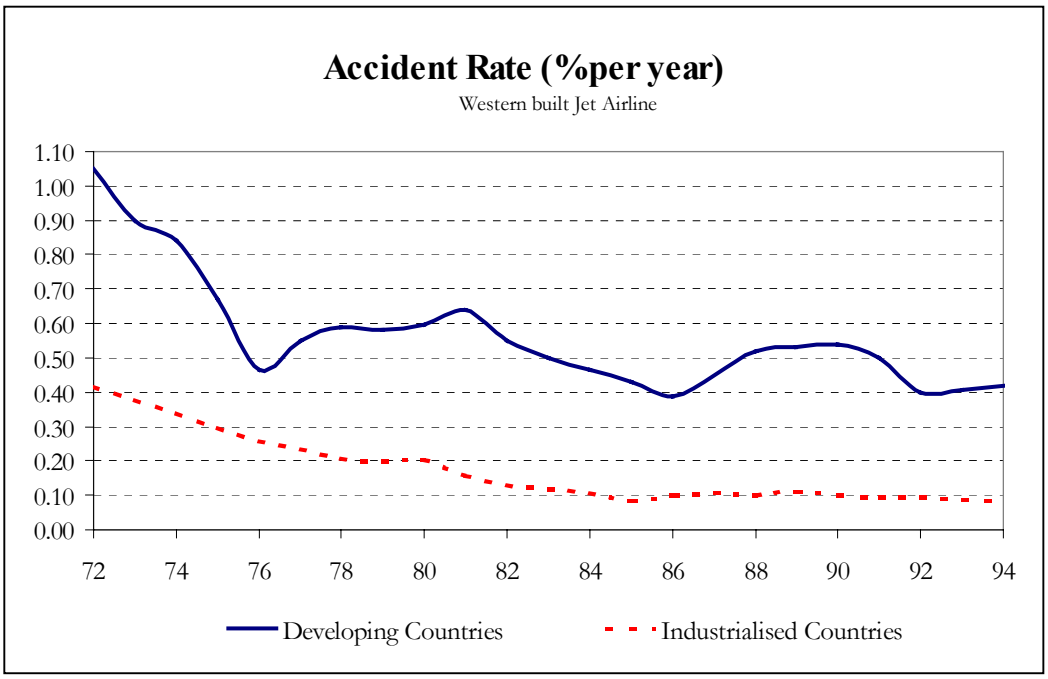
| Year | Liability Rates % change from 1995 | Hull Rates % change from 1995 |
|---|---|---|
| 1996 | -9 | -19 |
| 1997 | -38 | -45 |
| 1998 | -57 | -68 |
| 1999 | -56 | -67 |

Clearly, whilst the Sigma model predicted a significant fall in rates over the 5-year period, neither the "shape" of the reduction nor the extent to which the rates would fall was foreseen. In particular, the 1998/1999 rates were subject to almost twice as serious a deterioration as forecast. On the positive side, and possibly arising as a consequence of the magnitude of this particular cycle, the upturn has been somewhat earlier than predicted, coming in 1999/2000, whereas the model did not anticipate an improvement before 2001.

**Claims**

Hull claims are quickly determined and settled. The number of total losses has been fairly steady at around 20 each year, despite the large increases in traffic. In 1985 there were 15, 1990 19, 1995 21, and 24 in 1998. Projections indicate that this will be around 25 by 2003, rising to around 28 by 2015 (source Airclaims). Significant partial losses are occurring, the size of which can often exceed many of the total losses. There seems to be a trend for the severity and frequency of significant partial losses to rise, with the recent Australian Qantas loss (23/09/99) exceeding $80m. This is as a result of the rise in hull values. Appendix A contains brief details of large losses mentioned in the paper.

From the graph below (source AON) it can been seen that improvements have occurred in accident rates (number of accidents/number of planes used) for both developing and industrialised countries. Industrialised countries (US, Europe and Australasia) have an average loss rate of a quarter of that of developing countries, leading to very different premium rates. This is increased where older, less valuable aircraft are operated. It should be noted that although the trend in both has been downwards, the fall in accident rates in industrialised countries was initially higher, and has been proportionately larger until recently when the safety plateau has been approached (see later).




Liability losses are usually complex, as accidents often result from a combination of factors. Often liability will be split with other parties, such as airports and, particularly, manufacturers.

Investigation of an accident is the responsibility of the state in which it occurs, although other interested states (eg those from where the passengers originate) will also have representation. Thus the jurisdiction of the claim will be complex; the liability claims will be limited by the conditions of carriage operated by the airline on international (but not domestic) flights. The situation can easily arise where one passenger is on a domestic flight but the same flight for another passenger is part of an international journey. Consequently different local laws and international agreements may be applicable at the same time for the same accident. Around 70% of all scheduled airline passengers travel on domestic flights (ICAO), of which a significant proportion are within the US.

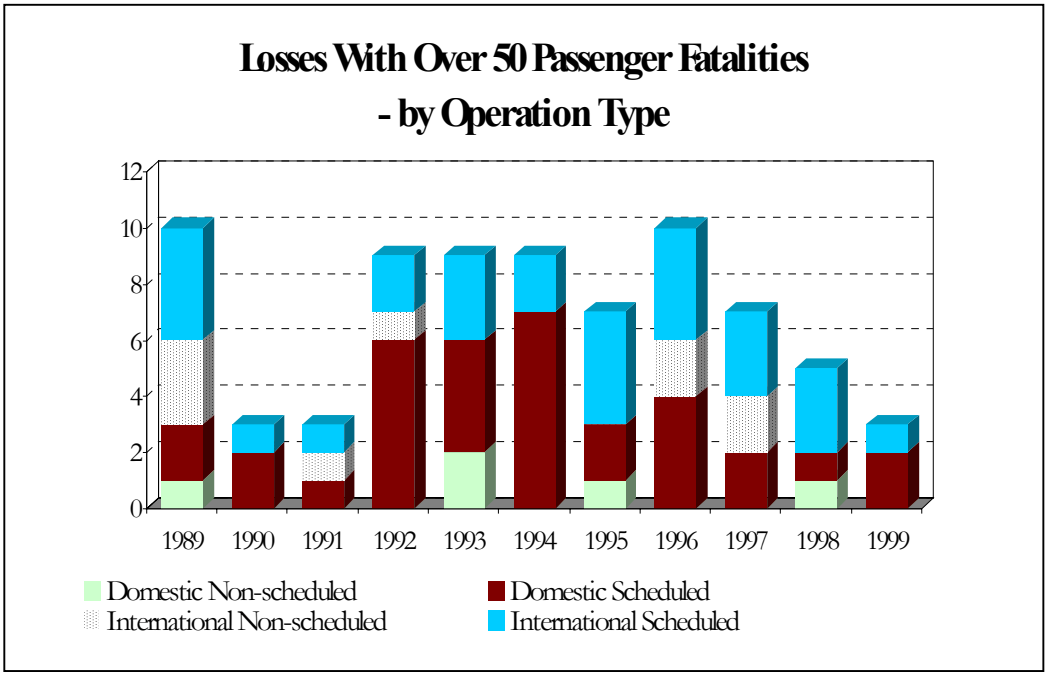
The major changes in the compensation regimes operated are as follows:

- Warsaw Convention (1929) – the airline's liability on death of a passenger was limited to $10,000 for flights between member states except for wilful misconduct and set exclusions. 126 parties signed this.
- Hague Protocol (1955) – doubled the limits, 112 parties adopted this.
- Montreal Agreement (1966) - limits set at $75,000. It applies only to flights involving the US and it waived some of convention's defences.
- Montreal Protocol (1975) - set liability for airline passengers death or injury to $100,000 special drawing rights – but this has not been ratified by the US.

In the last decade there have been a number of moves towards unlimited airline liability. These moves were begun by Japanese carriers waiving the convention's limits for passenger liability during 1992. This was followed up by:

- IATA Intercarrier Agreement on Passenger Liability (1995) waived the current contractual limits, reserved all convention defences and reserved all rights of recourse against third parties. It also gave airlines the option for damages to be set according to the law in the passengers domicile. This was only intended to be an interim arrangement.
- EU Proposals (Dec 1995) suggested the abolition of all statutory and contractual limits on passenger death/injury for all flights. All defences would be scrapped except for contributory negligence for damages of up to ECU 100,000 and a non-refundable payment of 50% of this amount to be made within 10 days. Any passengers not covered by this agreement would be notified in advance.
- The Montreal Convention (1999) was designed to bring together the different regimes that existed into a single unified instrument. It appears that it will be ratified at least by the US and by EU states. It effectively abandons limits of liability and it seems sensible to conclude that this will lead to increased claim payments in the future.

Looking at losses involving 50 or more fatalities it is difficult to spot any trend between domestic and international scheduled or non-scheduled (source AON):




A probable total loss for each aircraft type can be worked out based on the price of the aircraft plus across the board compensation levels for passengers, assuming that on average an aircraft is 70% full (a reasonable load factor based on recent experience). At $2.5m per passenger, the loss of a 747 would cause a claim of almost $1.2bn (and there are about 800 747's in service), whilst the loss of a Boeing 777, Airbus 340 or Airbus 440 would all cause claims of around $950m. If liabilities averaged $1m per passenger the loss of a 747 would be $575m whilst the others would amount to around $400m.

Both the Swiss Air loss (2/9/98) and Egyptair 767 loss (31/10/99) were flights originating in the US (so will involve US legal practitioners); both were operating with a 64% load factor but have very different liability reserves. Swissair is reserved at $700m ($3.2m per person), whilst Egyptair is reserved at $300m ($1.5m per person). At present $115m has been offered to the families of those who died in the Egyptair loss. Swissair are not disputing liability - although attempts are being made to reduce the liability by assessing non-US residents' claims in courts in their own countries and setting US compensation at levels governed by the 'Death on the High Seas Act'.

This law states that where the death of a person is caused by wrongful act, neglect, or default occurring on the high seas more than 1 marine league (3 miles) from U.S. shores, a personal representative of a victim can only sue for any actual pecuniary loss sustained by the victim's wife, child, husband, parent, or dependent relative. The act does not allow families of the victims of aviation incidents to obtain any other type of damages, such as recovery for loss of society or punitive damages, no matter how great the wrongful act or neglect by an airline or aircraft manufacturer.

The ability to seek redress in court is thus hampered by this 1920 shipping law, which was originally intended to cover the widows of seafarers, not the relatives of jumbo-jet passengers embarking on international air travel. The settlements from the TWA 800, Swissair 111 and EgyptAir disasters could potentially be reduced by this act. There are currently efforts to prevent the 'Death on the High Seas Act' from being used in cases surrounding international air travel, but it is not yet clear which way these appeals will go.

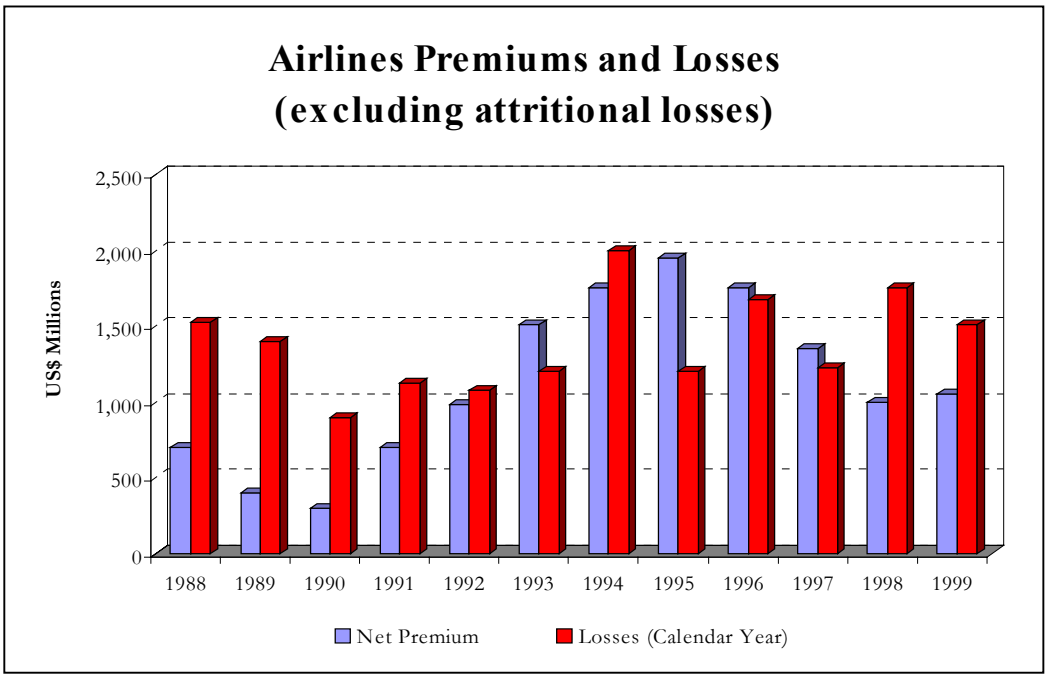
Whilst there is a degree of consistency in the number of accidents, the liabilities generated can vary substantially; the number of losses that are survivable by some or all of the passengers and crew seems to be increasing.

1985 produced the highest ever number of passenger fatalities at 1,489. In general, fatalities have been over 1300 per annum. However, 1999 produced the lowest number of fatalities in the 1990's, due in part to an increasing number of accidents that are survivable by some or all of the passengers. The 1999 fatalities can be analysed as follows:

| | **Total Losses** | | **Passenger Fatalities** | **Crew Fatalities** | **Third Party** |
|---|---|---|---|---|---|
| | **Western** | **Eastern** | | | |
| Jet Airliners | 20 | 2 | 356 | 73 | 10 |
| Turbo Prop Airlines | 21 | 2 | 190 | 37 | |

**Overall Airline Results**

The airline premiums and claims for the last twelve years are shown below. These figures take no account of vertical placement (see later), which will cause significant variations in the premium levels for different participants. Over the last two years premiums have amounted to approximately $2bn, with claims of around $3.3bn (or $3.5bn including attritional losses). This is clearly unsustainable. The graph below very clearly indicates the cyclical nature of the premium rates.




There is little correlation between premium rates and claims for either hull or liability.

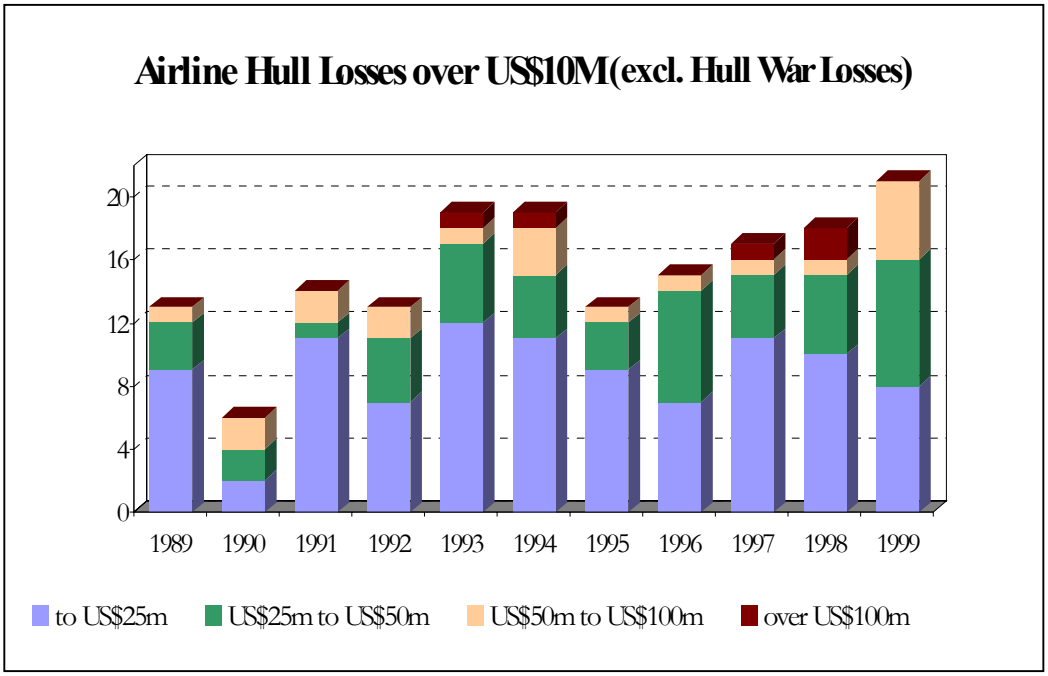
The largest 1998 loss was the MD11 Swissair claim (over $800m), whilst the largest 1998 hull loss was the Korean Airways 747-400 at $147m. The largest 1999 loss was Egyptair ($350m) with the Federal Express MD11 (18/10/99) at $91m being the highest hull loss.

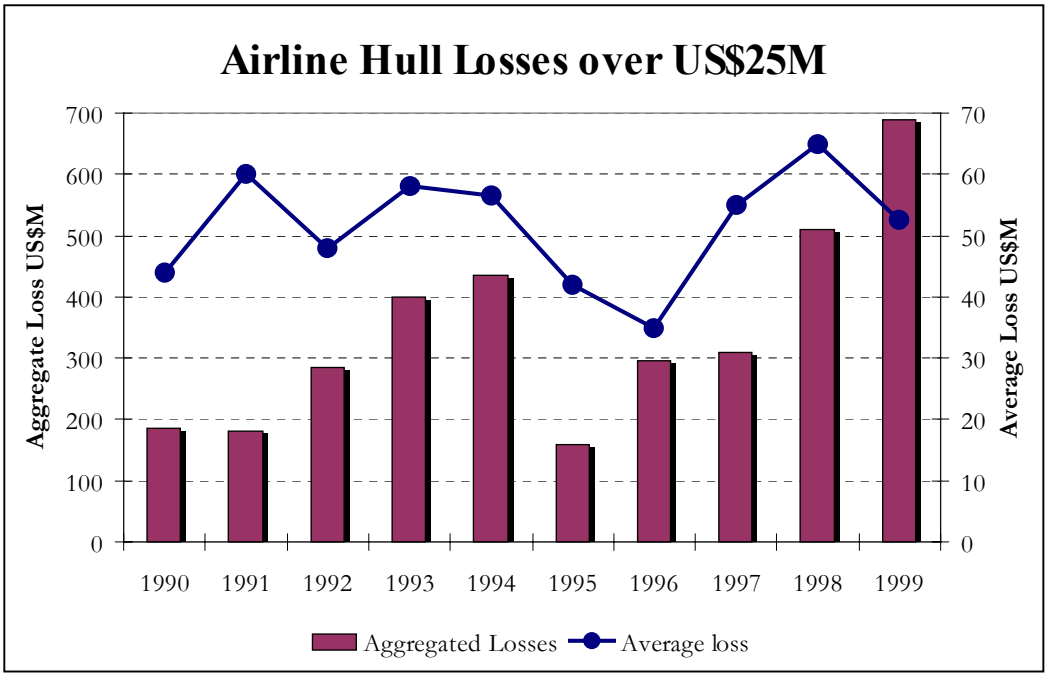
The position for 1998 and 1999 known and non-attritional losses is as follows:

| | Hull | Liability | Total |
|---|---|---|---|
| **1999** | $1,017 | $483 | $1,500 |
| **1998** | $892 | $895 | $1,787 |

21 individual hull losses exceeded $10m in 1999, compared to an average of 15 per annum 1989-1998. Of these, 18 were total losses with 3 partial losses.

The number of high value aircraft is rising, but there does not seem to be an obvious trend for increasing loss size over recent years.



If hull losses exceeding $25m are considered (source AON), it can be seen that 1999 is above average. This may represent a trend to higher valued losses, particularly as the number of wide-bodied aircraft is increasing. Losses of wide-bodied aircraft have previously been below 20% of the total, but in 1999 they represented 28%.

The worst single loss in terms of the number of casualties was the 1985 Japanese Airlines 747, causing 505 passenger and 15 crew fatalities; the worst incident was the Pan American/KLM collision at Tenerife (two 747s) in 1977 resulting in 560 passenger and 23 crew fatalities. The cost of either of these incidents if they occurred today could exceed $2bn.

Since 1990 airline net premiums have averaged $1.2bn, with claims averaging $1.7bn. Writing for gross profit seems impossible, so most insurers are depending on cash flow and reinsurance (see later sections) to achieve profitability. However, most insurers have had negative cash flows since mid-1999. With aircraft values and passenger legal liability compensation awards rising it is unlikely that losses will fall below $1.7bn per annum and, as seen earlier, rating levels are at historically low which are clearly unsustainable even allowing for safety improvements.

Underwriters need to regain control of the situation, and act both to reduce the potential claims and increase premium rates. Improvements that could be made by underwriters include:

- Increasing deductibles
- Imposing aggregate deductibles
- Imposing exclusions.

At the very least this would remove the constant drain of small hull claims, baggage losses etc that are paid in full by underwriters. They would also reduce the values of the larger non-attritional losses.

However, although rates seem to be rising in 2000, it is unlikely that substantial progress will be made during 2000 for a number of reasons. Insurers are currently writing inwards business supported by reinsurance programs that were two-year deals priced in 1999 to cover the millennium. Reinsurance costs will rise when these programs are renewed, which will put more upward pressure on the direct rates in 2001. However, many airlines' programs are tied into long-term deals so are unlikely to yield substantial rises. Insurers are trying to maintain market share even on unprofitable rates because there is an expectation in the market that rates will rise. Also total capacity in the airlines market remains very high at 170% of that required for an individual hull loss (110% for US domiciled risks). For legal liability, based on a cost of $1.5bn, there is also plenty of capacity, again with 170% for non-US risks and 110% for US risks.

# AIRLINE INSURANCE (HULL WAR)

## Introduction

These policies provide cover to airlines for loss of, or damage to, their property (aircraft and spares). The risks covered are excluded from hull all risks policies, and arise from war or war related activities including:

- War, invasion, hostilities, civil war, rebellion, attempted coups etc.
- Strikes, riots, civil commotion or labour disturbances
- Sabotage
- Hijacking (attempted or actual) or seizure of control (including pilot suicide)
- Acts for political or terrorist purposes
- Confiscation, naturalisation, detention etc for the use of any government or public authority.

Exclusions include war between any of the UK, US, CIS, France or China, loss from atomic or nuclear fusion; repossessions resulting from airline contracts or confiscation by the government of the country in which the aircraft is registered. A number of areas are subject to special rating - flights are usually permitted but may be subject to surcharge. Most are in Africa (15 out of 25 countries) including Algeria, Rwanda, Uganda, Congo; but all the parts of the old Yugoslavia and most of the old CIS, excluding Russia, are also on this list; along with Afghanistan, Iran and Cambodia.

## Rating

The main rating factors are:

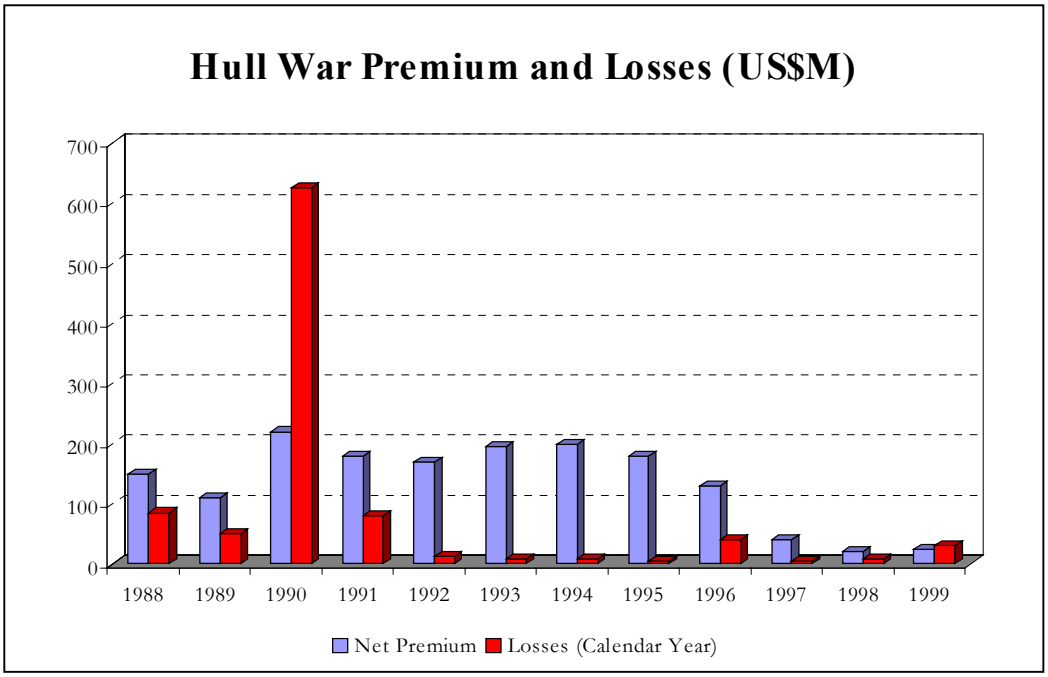
- Fleet size
- Country or origin
- Destinations flown
- Airline security measures
- Claims record
- Coverage required.

Rates are quoted as a percentage of total fleet value and are generally lowest for North America and highest for Africa (followed by the Middle East). There are rarely deductibles for this type of business; but limits are imposed on both the value of spares in any one location (typically $150m) and on the value of any individual aircraft (up to $225m). Additionally there are annual aggregates based on a multiple of the hull maximum value covered.

The business has proved very volatile with rating levels over the last few years dropping to an all time low. The business is very short tail and responsive to claims which are extremely variable. There is potential for very large claims eg the Kuwait Airways (1990) claim for hulls and spares is estimated to have cost $450m before interest. It took about five years for that loss to be recouped, after which rating levels collapsed. Typically, over the period 1990 to 1995, rates for North American risks averaged about 0.03% of the fleet value, for Europe and the Far East 0.045%, the Middle East 0.075% and Africa 0.11%. This gave an average rate of between 0.04% to 0.05%. Current rating levels are somewhere below 0.015% on average.

In recent years rates have been very low by comparison with exposure. This is unlikely to change in the short term for a number of reasons. The loss experience has been very favourable, so there has been little in the way of claims to be paid. Capacity is high at about $470m per aircraft (compared to maximum hull values about $225m). Nearly all this business is written through Lloyd's and there are still 8 recognised leaders with a total of 35 players active in the market, so there are plenty of alternatives for the brokers.

**Results**




The number of hijacking incidents seems to be decreasing from an average of around 25 per annum in the early 1990's to between 12 and 15 per annum now. The majority of these are settled without bloodshed; during 1999 only 2 people were killed by hijackers (the pilot of an All Nippon Airways 747 flying between Tokyo and Sapporo, and a passenger on the Indian Airlines Airbus 300 flown to Pakistan).

However, there is currently some debate as to whether air rage claims (which are dealt with in a later section) are covered under Hull War policies.

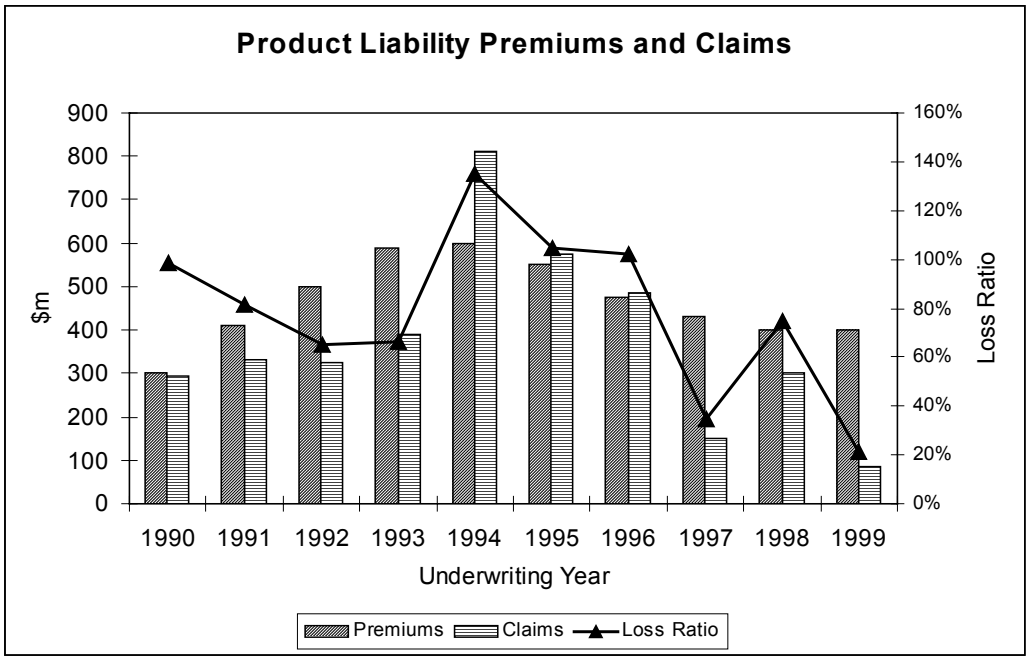
The total premium for this class of business was around $33m for 1999. The main losses were Trans Afrik ($8m), Uni Air ($15m being a 50% contribution towards the loss, the rest was picked up by the hull underwriters), and Air Botswana ($21m where a disgruntled pilot committed suicide by crashing into 2 parked planes). On top of this there were twelve hijackings, of which the longest and highest profile was the Air India A300 hijacked by Islamic militants.

Despite inadequate rating, this class has a large credit balance during the 1990's even after the Kuwait Airlines loss. However, one large loss would easily result in a large overall loss for the year in question.

# PRODUCT LIABILITY

Product liability covers an insured's legal liability to third parties for injury and loss or damage arising out of the defective design or manufacture of an aircraft product. It encompasses all types of aircraft products, for example airframes, engines, seats and minor components.

The graph below shows estimates of the premiums and claims for the market as a whole. It is not possible to get details of individual claims because of the sensitive nature of such information especially with regard to disclosure in the US. Many of the losses are attritional in nature, however seven claims exceeding $100m in the 1990's have had at least a partial contribution from product liability insurers.




The majority of programs, in terms of numbers, provide coverage up to $500m, but there are a few with coverage in excess of $2bn per loss, with Airbus Industrie and Boeing arranging cover up to $2.5bn. The total annual premium for this cover was around $450m in 1999. This has reduced from a peak of nearly $600m in 1994. Currently around 50% of it covers airframe manufacturers and 20% engine manufacturers.

The claims for 1994 and prior should be reasonably mature but the figures for later years can only be taken as a guide to the ultimate run-off due to the discoverability of reserves being held for particular incidents and the early stage of development. This said, a rough estimate of the average annual claims cost, in today's terms, would be over US$500m. A premium of this level is unlikely to be achieved in 2000.

Four programs (Aerospatiale, Airbus Industrie, Boeing and UTC) account for roughly 50% of the annual premium income. Consequently the market suffers from the problem of concentration of risk. Further consolidation in the market is highly likely and this will make the situation worse. 65% of the total premium arises from US manufacturers, and nearly all of the rest is from Europe. Of the 13,250 or so active western built jet airliners around 73% were manufactured by Boeing and 15% by Airbus Industrie.

Aircraft manufacturers try to limit their liability using disclaimers and warranty limitations in the purchase/sales agreements when selling the aircraft. However this does not limit their liability to third parties such as passengers.

In the event of an aircraft accident, liability may be apportioned between an airline, manufacturer or other party. Airlines and aircraft manufacturers often put in place a sharing agreement. This is an agreement among all defendants to voluntarily allocate percentages of the claim amongst themselves. These deals have a number of advantages:

- It prevents cross claims among defendants thereby saving legal expenses
- It means that a united effort can be made to defend the claim thereby improving the chances of success
- It will help to keep the costs of investigating, defending and settling the claim to a minimum.

Claim sharing agreements mean that many aviation claims will have at least some element of a product liability claim.

The abolition of limits of liability for airlines may have a beneficial effect on manufacturers. Claimants will no longer need to seek damages from a third party (such as the manufacturer) as they will be able to seek all their damages from the airline concerned. This may make it more difficult for those concerned to negotiate a sharing agreement.

If the large increase in air travel, which has been predicted, occurs it will undoubtedly put more stresses and strains on aircraft as utilisation rises even further. This may lead to higher accident rates and more claims. As a balance to this, production techniques and technology are constantly improving.

## GENERAL AVIATION

Very little reference has been made to the general aviation sector of the aviation insurance industry in previous GIRO papers. This may reflect the fact that it is a quite disparate and ill-defined sector. The best definition discovered is that general aviation is the insurance of "all aircraft other than commercial and military aircraft, and commercial aircraft capable of carrying less than 40 passengers". Different insurers use different definitions. Often planes that can carry between 40 and 60 passengers may be included in either this book or the airline book, depending on the insurer's reinsurance program. On this basis, the general aviation fleet worldwide is, at around 300,000, over 12 times the size of the commercial (airline) fleet. It has been estimated that these aircraft operate 120 million flights totalling 45 million hours per annum.

As mentioned above, there are a considerable number of different uses of general aviation aircraft, the principal of which are:

- Personal (35%) - transportation and/or pleasure
- Business (11%) - private business or service
- Corporate (10%) - transportation of business employees or cargo
- Air taxi (7%) - shuttle service for passengers
- Aerial application (6%) - crop spraying or other aerial dispersion
- Instructional (18%) - flying with an experienced pilot for learning.

The estimated proportions of the overall US general aviation fleet are given in brackets above. The remaining 12% include such activities as aerial observation and public use. As nearly two-thirds of the world fleet are estimated to be based in US, this probably gives a reasonable impression of the make-up of the overall world fleet. Overall North America and Europe make up an estimated 86% of the total, reflecting the strong correlation with the wealth in these areas.

The vast majority of the fleet is piston-engined, with very small elements being propelled by turbojet, turboprop, rotors or other means. The average age of general aviation planes is estimated as approximately 28 years, reflecting the reduced number of new planes being manufactured in US. This, in itself, has had a fairly major impact on the number of manufacturers, which reduced from nearly 30 in 1980 to under 10 in 1994, but has now increased to 12. The earlier reduction is understood to be largely the result of legal actions against manufacturers in the product liability area.

The coverage provided for general aviation aircraft is very similar to that for airlines, consisting principally of hull and liability insurance. In light of the lower sums insured and greater diversity of risks, however, there is a greater tendency for general aviation risks to be insured in the local markets, although the major aviation markets, as used for airline insurance, still have a significant involvement in the insurance and reinsurance of general aviation business. It is, however, known that significant proportions of the general aviation business are insured in national pools, which then obtain a greater spread of risk by reciprocity between them.
As a consequence of the greater spread of insurance, it is difficult to quantify the size of this market with any precision. The best estimate is that the overall worldwide general aviation premium is of the order of $0.9bn. It is, likewise, difficult to obtain a clear idea of the profitability of this market, although it is believed that there is a greater variety in loss ratio between the different markets than is the case in the airline market. Competition tends to be quite fierce, especially in US, so the overall results may be worse than break-even; and may even be worse than those of airlines.

One factor, which is apparent, is that given the greater number of similar general aviation risks, it is possible to use a more technical approach to rating such risks. It is understood that some underwriters do, indeed, base their rates at least partly on the past experience for the particular model of aircraft being rated.

Very little data is available on recent loss experience but US general aviation statistics indicate that the overall accident and fatality rates have reduced over the last 5 years. Accident rates have reduced from approximately 9 per 100,000 hours flown to 7 per 100,000 hours flown. Perhaps surprisingly, fatalities result from only about 20% of accidents, and have followed a similar trend, possibly falling slightly more sharply. With the increasing number of hours flown, accidents and fatalities may be increasing in absolute terms. One feature of interest is that this data also shows the number of accidents being heavily weighted towards the summer months and weekends, presumably reflecting the preponderance of personal usage. As an example, there are more than twice as many accidents in each of June, July and August as there are in each of November, December and January.

As to the future, the increased number of manufacturers since 1994 is expected to result in a rise in the number of new planes, particularly business jets, and this is likely to result in further increases in the exposure. With regard to the insurance of general aviation aircraft, there has been one relatively recent change, which is likely to speed up the finalisation of claims. This is the enactment in US of the General Aviation Revitalisation Act which limits the scope for actions to be brought against manufacturers. As a consequence, manufacturers cannot be liable for accidents which occur to planes which are over 20 years old. This was a relevant factor in the accident resulting in the death of the US golfer Payne Stewart.

# MISCELLANEOUS COVERS

There are a number of other types of aviation cover available. Long term policies (of up to 3 years) are common for each of these types of covers.

**Airport legal liability**

On the one hand this provides cover for minor claims such as passengers slipping or falling in the terminal but at the other extreme there is potential exposure to a catastrophic loss. For example an aircraft could crash on take off after birds are sucked into an engine. The airport could be held responsible for the crash if it did not have a comprehensive and successful wildlife control program in place. The failure of the cleaning of the runway at Charles De Gaulle Airport, which led to a strip of metal puncturing a tyre as Concorde took off, may become a claim against either the airport or any subcontractor. Given the potential exposures it is somewhat surprising that some airport authorities have fairly low levels of cover (eg US$500m). Most claims arise from passenger injuries such as slips and falls.

**Air Traffic Control legal liability**

A number of airport legal liability programs include cover for air traffic control. Separate cover has become more common over recent years mainly as a result of privatisation of the air traffic control industry. There is the potential for a huge claim in this area if, for example, two aircraft were to collide.

This cover is likely to become increasingly important over the coming years as the skies become ever more crowded and the stresses on air traffic control increase.

**Refueller's legal liability**

There have been a number of significant claims in recent years following the supply of contaminated fuel. Most recently, at the end of 1999, thousands of light aircraft in Australia were grounded after Mobil supplied contaminated aircraft fuel. However no known accidents have resulted from the incident. This often forms part of the product liability class of business.

# CURRENT ISSUES IN THE AVIATION MARKET

## Airline Alliances and Code Sharing Arrangements

We live in an age of globalisation where customers expect a service to be provided worldwide. Airlines are no exception to this. Consumers expect an airline to offer a truly global range of destinations from their home base. In the past, even the biggest airlines were only able to provide a service on a limited number of routes and to a limited number of destinations. This meant a customer would potentially have to purchase a number of different tickets with different airlines to make one journey.

The response by airlines has been to form large strategic alliances and code sharing agreements. A code sharing agreement is a simple marketing and ticketing agreement between airlines enabling passengers to seamlessly use more than one carrier to reach their destination on a ticket issued by one airline. The revenue generated will be split between the airlines. An alliance is similar, but also tends to include the sharing of other elements of the operation eg crew and maintenance.

Over half the world's scheduled capacity is provided by the 4 major alliances. These are:

- One World Alliance – includes British Airways, American Airlines, Cathay Pacific and Qantas
- Star Alliance – includes Air Canada, Air New Zealand, Lufthansa, Singapore Airways, Thai Airlines, United Airlines and SAS
- The Qualiflyer Group – this includes Swissair and Sabena
- KLM/Northwest alliance.

Alliances can buy group insurance cover. The motivation for this is the greater purchasing power the group would have, and the ability to absorb more of the insurance costs via a captive avoiding ceding profits. However, there are a number of potential problems:

- The legal and regulatory requirements of the different airlines, particularly if an American airline is involved.
- Some underwriters do not write American business and therefore would be unwilling to provide cover for a group containing a US airline unless they changed their reinsurance protection.
- In a group of airlines some will have better loss records than others. It is unlikely that those with the better past performance will be prepared to pay the higher premiums associated with those with poorer loss records.

The latter point is illustrated by what happened to the KSSAF group after the 1998 Swissair Flight 111 disaster. The group of 40, mainly European, airlines had existed for 28 years for the purpose of buying insurance. As a result of the Swissair loss their premium at renewal attracted rate increases of 75% to 100% at a time when the rest of the market were achieving reductions in premiums. As a result of this KLM and SAS voted Swissair out of the partnership and it broke up. The issue of who would pay the additional premium in cases like this is a difficult one to resolve, as it would be hard to isolate the cost arising from the accident from that due to market factors.

Code sharing and alliances raise other insurance issues. The main one concerns which airline is liable in the event of an accident. Passengers on a flight may have booked tickets with any of the airlines in the alliance. Therefore they might have a case for claiming compensation from either the airline they booked with or the airline they were flying with at the time of the accident.

There are a couple of dangers in this situation, and a way forward is urgently needed. Claims may be pursued with more than one airline thereby increasing the cost of a claim to the airline industry as a whole. This could be in terms of defence costs and other costs of handling claims, and maybe even claims payments. It may lead to claimants pursuing the claim in the most favourable jurisdiction or the airline with the deepest pocket (eg if one of the parties involved is an American airline). Again this would increase the overall cost of a claim, and could lead to the duplication of reserves by insurers if the parties have different insurance cover.

The airline and insurance industries need to agree a way forward on these issues, and write them into code sharing agreements, before they begin to impact on costs. The most obvious solution would be for airlines and insurers to agree that the operating carrier should be liable for, handle and pay any claims (the concept of "Your paint, your problem"). This could potentially lead to large increases in the liability limits purchased by many airlines to cope with the greater potential exposure.

**Airline Liability**

As mentioned earlier the Montreal Convention (1999) effectively abandons limits of liability. Another significant issue arising from the Convention comes from the fact that it is a whole new convention rather than an amendment to the old one. This means that it will be possible to reopen discussion as to the definition of terms even where these terms were contained in the old convention. For instance, the definition of bodily injury in the original conventions and amendments is not thought to include mental injuries. This issue can now be reviewed afresh and it is only likely to lead to more and higher compensation payments.

**Safety Improvements**

The effect of improvements in safety can be seen in the reductions in the accident rates shown on the graph in the claims part of the Airline section. For industrial countries this has fallen by 80% between the early 70's and early 90's (from 0·4% to 0·08%) whilst for developing countries this has improved by 60% (from 1.05% to 0.4%). For developed countries this rate has been fairly steady since 1984 implying that given the current composition of the fleet and standards of safety and maintenance, a safety plateau is being approached (where technical advances will not lead to further reductions in the accident rate). This would enable the theoretical reduction in the number of accidents to be calculated assuming all airlines achieved the same safety standards, and a theoretical number of losses per annum for a given fleet size assuming the new airliners do not contain additional safety features.

Planes have become more reliable as there is now considerable experience available for all the major types of planes flown by airlines, so teething problems have been ironed out. Every time a possible problem is identified, the UK, US and other Aviation Authorities issue bulletins advising of the potential problem, or requiring remedial work to be undertaken within a given timescale.

A Ground Proximity Warning System (GPWS) has been introduced to reduce the number of accidents where planes hit the ground. However, in some countries this cannot be properly calibrated due to differences in the way height is measured. Most countries use height above sea level (QNH), but some countries notably in the former Soviet Union use height above the airfield (QFE). This can cause problems when utilising this system.

Another recent introduction has been a traffic collision avoidance system (TCAS) to reduce the number of mid-air collisions. For this to work it needs to be fitted in both aircraft; currently it is only compulsory for planes operating in North American airspace, although there are plans by the EU to introduce this within Europe. Unfortunately this only provides height related information, the lateral positions of planes is often inaccurate. This almost caused a mid air collision recently when a pilot based their avoiding action on both the lateral and vertical information, and as a result flew into the path of the other aircraft.

Other recent safety issues include the use of automatically updating route maps, which can lull pilots into a false sense of security. If they fail, the pilot may find that if they have been using these that their situational awareness is diminished.

There is talk of introducing cameras to cover the cockpit and parts of the exterior of the plane. Pictures would be recorded in the black box, and erased at the end of each flight.

Concerns have been raised about the publication of these pictures in the event of an accident, and also that pictures of the outside of the aircraft could interfere with possible hostage rescue operations. It is likely that cameras will soon be introduced both in the cockpit and either mounted on the tail or underside of the plane (to monitor the engines and undercarriage).

One other issue that is becoming increasingly common is interference in the communication between the pilots and the air traffic controllers. Often this is accidental eg pirate radio stations or taxi radios, but there have been an increasing number of attempts to direct planes into hills or the paths of other planes. Often this is inaudible to the air traffic controllers, so it is up to the pilot to realise what is occurring. No accidents have resulted from this sort of interference – yet!

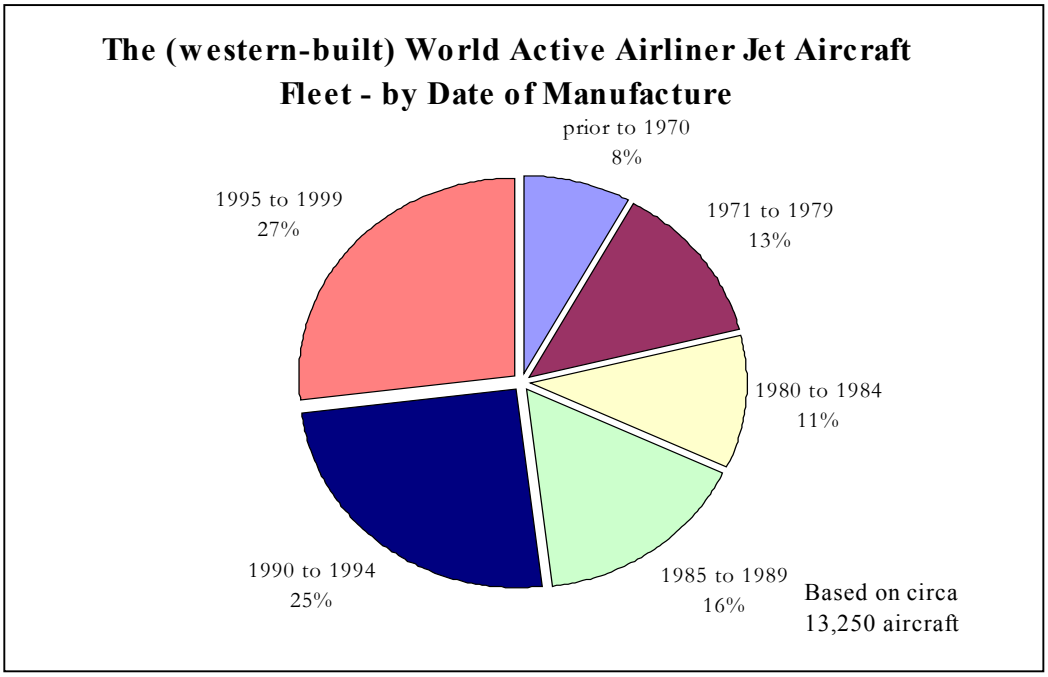
Pilot training has been improved with the use of Digital Flight Data Recorders (DFDR) which record over 100 parameters per second. These are then played back through a Special Event Search and Monitor Analysis program to identify if any flight exceeds pre-set parameters. If this happens, further investigations will be performed; if necessary the results will be discussed with the Pilots' Association and the individual pilot. Confidential incident reporting has also been introduced, where malfunctions and incorrect actions are recorded and passed around airlines and on to individual pilots.

As important as attention to man/made/system interface is, it is also important to have an overall approach to a safe flying organisation. This is known as the 4Ps concept:

- Philosophy - organisational, structure & strategy to secure a safe operation.
- Policy - senior management committed to safety targets and how these are achieved.
- Procedures - define systems that secure safe operation
- Practice - encourage, supervise and monitor safe performance

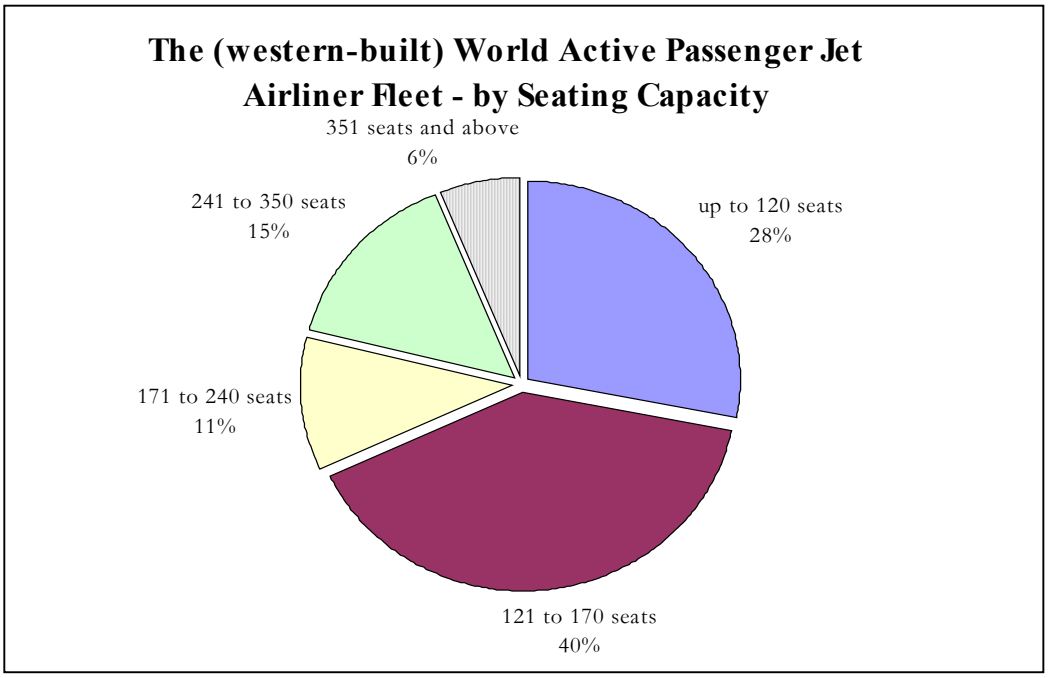
**Industry Growth**

Boeing and Airbus delivered about 900 aircraft in 1999 alone, although deliveries in 2000 are expected to be lower. Over the next ten years it is expected that 9,000 new jet airliners will be required at a cost of $585bn (source Boeing), implying an average cost of $65-70m per new plane. This should significantly reduce the average age of fleets. The current age banding is shown below, many of the older planes are in operation in North America.




Currently over 20% of the jet airliner fleet is over 20 years old; the total value of all jet airliners is around $328bn; this is expected to rise to close to $900bn within ten years, and $1,380bn within the next 20 years. In general the turbo-prop fleet shows similar age banding except that the proportion of the fleet under 5 years old is about 10% lower, and the 10-15 years old proportion is about 10% higher.

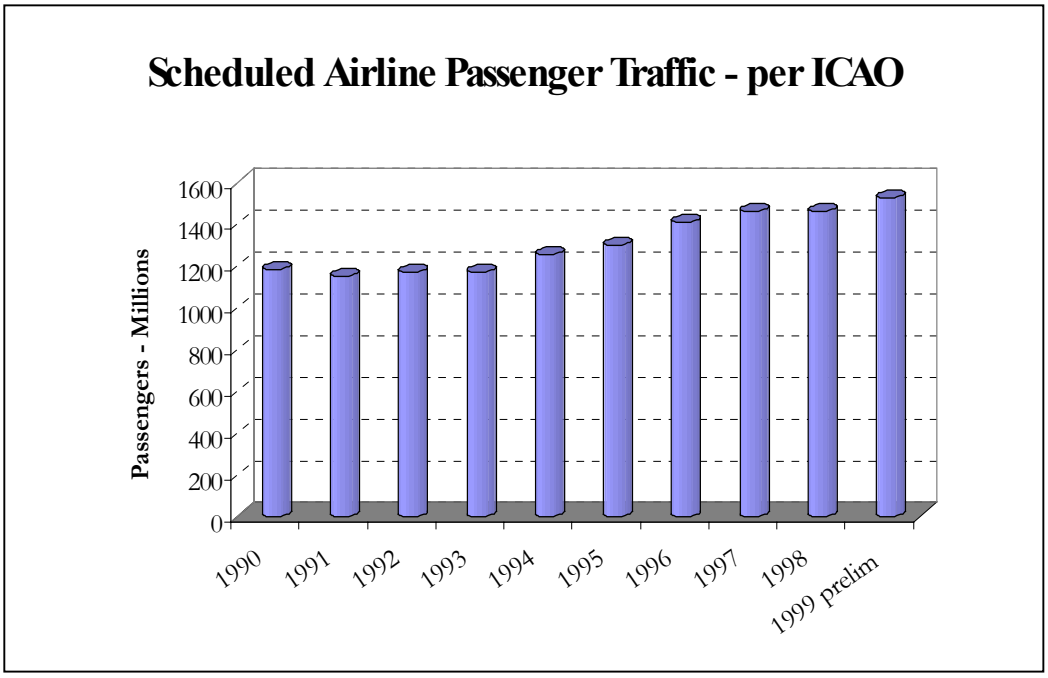
The number of wide-bodied aircraft is gradually increasing - representing 21% of the total fleet. Types include Airbus 300, 310, 330 and 340, Boeing 747, 767 and 777, DC10, MD11 and the L1011. The differing seating capacities of the current passenger airline fleet (about 11,750 aircraft) are shown following.



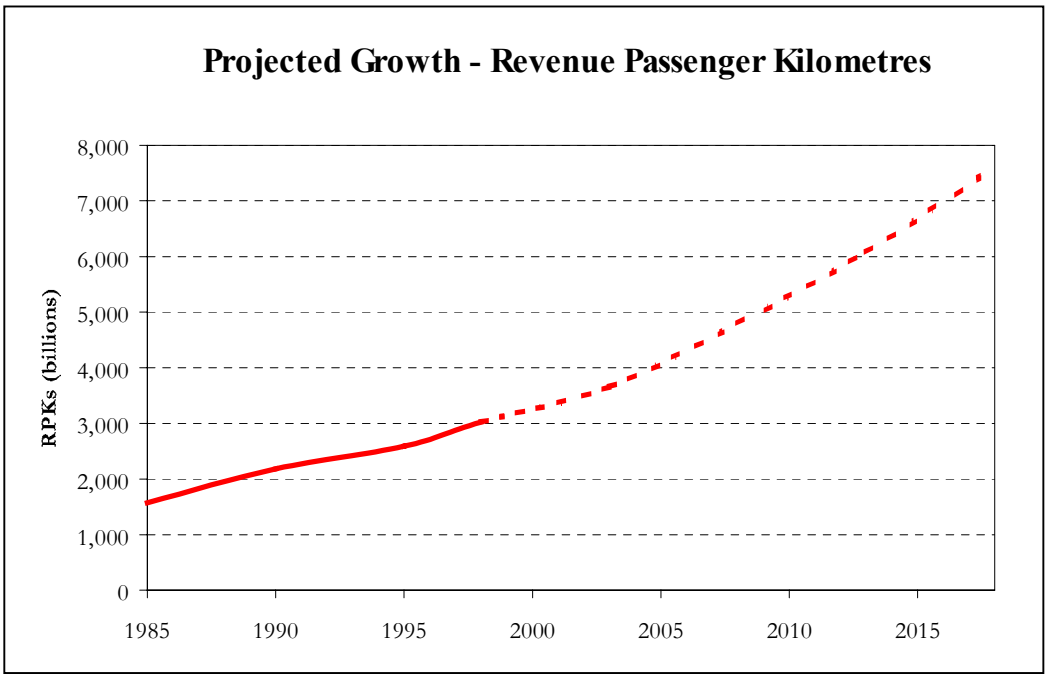

The number of smaller aircraft is forecast to grow more rapidly than the overall fleet due to the demand for greater frequency on domestic and short haul international flights. At the same time, both Airbus and Boeing are developing larger aircraft capable of carrying up to 1,000 passengers - the Airbus A3XX is expected to enter service in 2005. Emirates and Air France have placed firm orders, with another four or five airlines interested. These planes may require substantial airport modifications, and will certainly increase the maximum liability cover required by the airlines.

Of the overall active jet airliner fleet (13,250 aircraft) about 73% were manufactured by Boeing (and McDonnell Douglas), 15% by Airbus and the rest by small manufacturers (Canadair, Embraer etc). However, when aircraft delivered in the last five years are considered (3,550 planes), the Boeing share was only 55% with Airbus Industries accounting for 26% of the total. Of the current firm orders (3,150 aircraft), Boeing have only a 39% share, Airbus a 34% share, with the rest being split between Canadair (11%), Embraer (10%) and Fairchild/Dornier (6%). This in part reflects the move towards providing a more frequent service to the shorter destinations, which will require generally smaller aircraft.

It is expected the growth in RPKs will continue at around 5% per annum for the next 20 years, (Boeing and Airbus market forecasts). Cargo is expected to grow slightly faster, averaging 6.5% increase per annum over the next 20 years. The number of passengers carried on scheduled passenger flights exceeded 1.5 billion for the first time in 1999 (ICAO press release). This ignores the charter and other airline activities; the total number of passengers carried during 1999 was around 2.2 billion.




The growth of revenue passenger kilometres has been rapid and this is expected to continue (source Boeing).

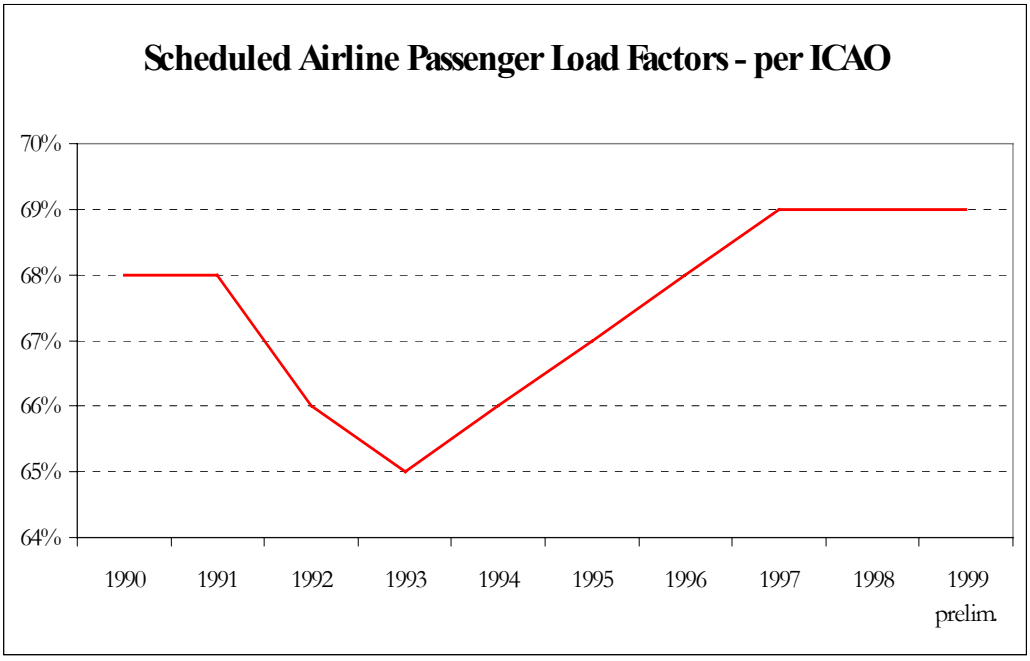



Cargo traffic has shown similarly rapid growth - from 18.4 million tonnes in 1990 to 27 million tonnes in 1999.

Such levels of growth raise obvious concerns with regard to the environmental impact, how such additional traffic will be accommodated in the increasingly crowded skies, and the availability of additional facilities at airports. All these issues will have to be addressed in the near future.

Currently the US accounts for over 38% of the total RPKs, with Europe accounting for 27%. Larger bases of established travel in Europe and North America mean that even with lower projected growth rates, the demand for many of the new airlines will come from these regions. It is expected that Latin America and Asia will grow much faster than average, despite their current economic problems.

It is worth noting that seat occupancy levels have hardly changed over the last decade, so that there is still plenty of potential for increased exposure to liability claims from the current levels of flight and airliners (ICAO figures for Scheduled Passenger Load Factors).




**Air rage**

A recent "hot topic" in the airline industry has been the increasing incidence of air rage. Violent and rowdy behaviour on aircraft has become much more common, and there are substantial costs involved for an airline in the event that they have to make an emergency landing as a result.

As an example of the extent to which air rage has grown, British Airways reported more than 200 incidents in the 12 months ending March 1999, and it is believed that the number of events world-wide for all airlines has grown by up to 400% over the past 5 years. Causes include domestic disputes, over indulgence in alcohol, smoking bans, delays and the continuing reduction in space available to passengers. In the UK alone, we have seen such headline grabbing incidents as the "Lewisham twelve", and the passenger who refused to comply with cabin crew requests to turn off his mobile phone. Foreign carriers have seen instances as extreme as smashing the interior windows and starting fires.

It is difficult to predict whether these incidents will become more or less commonplace over the coming years. To attempt to combat this problem, airlines are trying to recover costs from the passengers concerned, and governments are announcing new measures to crack down on unruly passengers. For example the UK government has defined specific new crimes and set limits of up to 2 years in prison or a £2,000 fine for a range of offences.

**ATC deregulation**

Another high-profile concern of recent months has been the UK Government's proposed part-privatisation of the UK air traffic control services (NATS). Reports have suggested that safety could be jeopardised by cost cutting and job losses and such a development, if it were to occur, would obviously have an impact on the insurance industry. Whilst the working party does not wish to enter the political arena over this issue, there are a number of comments that we feel we could make here.

Firstly, this would not be the first such project – the Canadian government privatised its air traffic control services in 1996. We have not analysed the experience of the Canadian project to determine whether there has been any impact on safety.

Secondly, if the part-sale were to be made to an interested party, for example one of the alleged potential buyers is a consortium of airlines, it may be considered far less likely that any new owners would sacrifice safety for a quick profit. Such a course of action would have dire consequences for the reputation of the interested parties if it were to become public knowledge.

As such, the proposals are at far too early a stage to pass comment on whether such a policy in the UK would change airline safety levels. In any event a change in the UK would probably only have a small impact on the international market as a whole. It is unlikely, in our opinion, that this issue will have a major impact on aviation insurance rating.

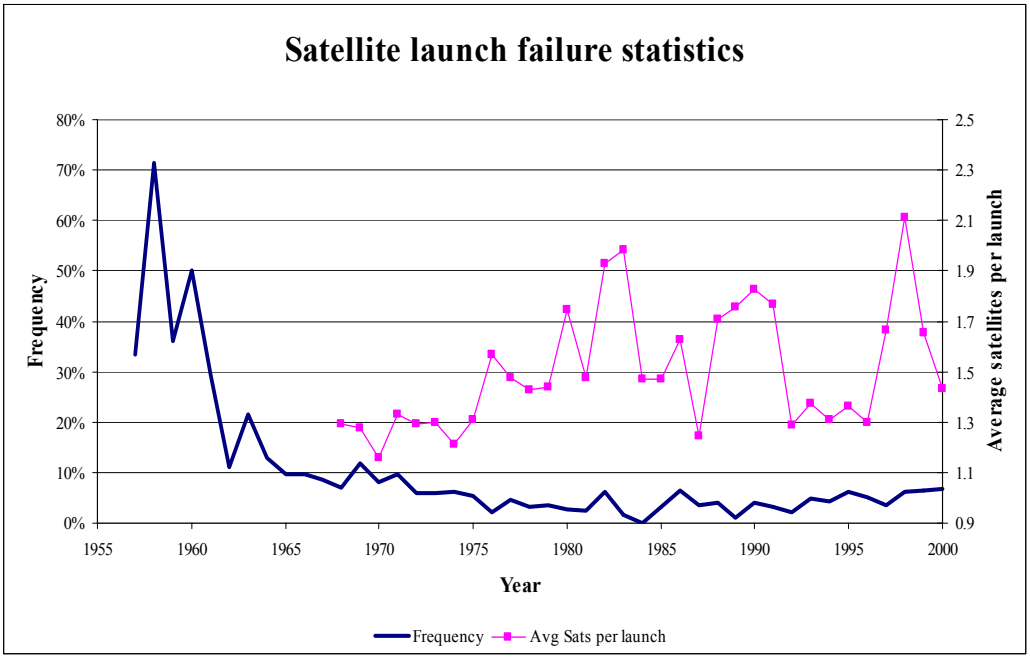
# SPACE INSURANCE

## The market

The space market covers satellites and other space vehicles. Coverage tends to be split between launch risk and "in orbit" risk. To date the vast majority of losses have been launch risks, partly because of the relative youth of the in orbit satellites. Covers are sold separately and as combined packages – for instance recent renewals have tended to be for launch plus three years in orbit.

In the analysis which follows we have obtained information on all satellite launches up to 24 May 2000, whether insured or not. Satellite insurance was not available until the technology had been tried out a good number of times, some years after the first launch. The loss frequencies calculated may well therefore not match up with market loss frequencies, depending on whether a greater or lesser proportion of uninsured launches failed.

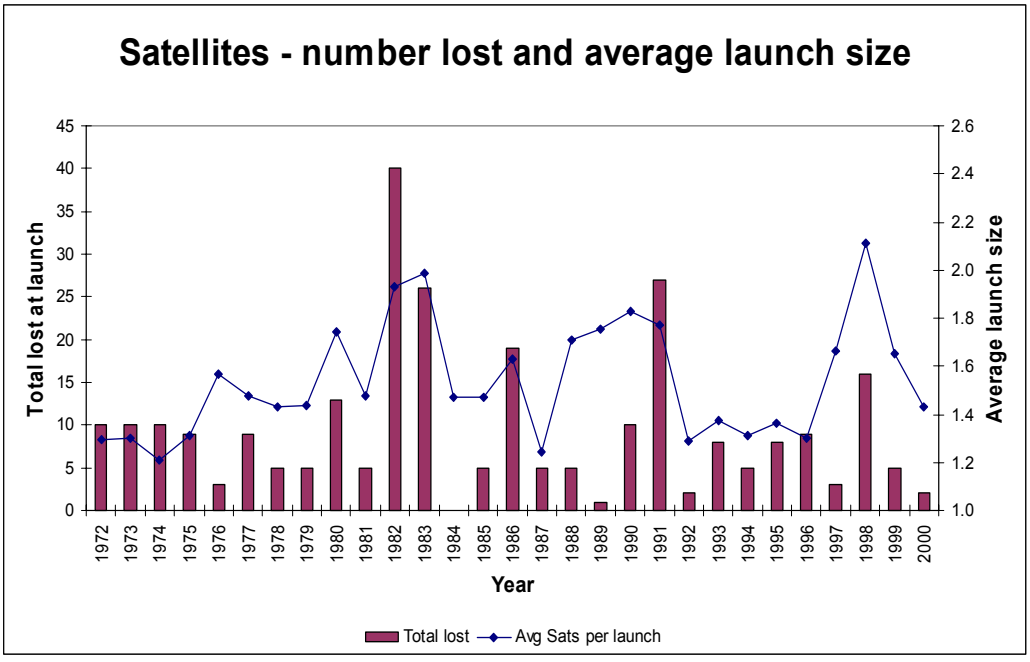
Between 1965 and 1990 the number of launches was relatively constant – between 110 and 130 individual launches per year. Since 1990 this figure has ranged between 80 and 100. These launches often release more than one satellite at once.



In the early years of satellite launches, failure rates were unsurprisingly high. In 1958 there were 28 launch attempts, of which 20 failed. Since 1972, launch failure frequencies have remained below 7%, with an average of 4.0%. The 1998 underwriting year has generally been regarded as a bad one for space insurance risks with many market practitioners reporting large losses. However launch failure frequency was only 6.1% - certainly not the highest over the period. Although this frequency is a little higher than in the preceding few years, it is not sufficient to explain the shockingly bad results that the market experienced in 1998.

Launch failure frequency is not the key factor here. In fact the stability over the last 25 years or so of this frequency shows that the biggest driver of the losses is severity. On September 9 1998 a launch of 12 GlobalStar satellites failed and all were lost. This loss in itself is around $200m. It would appear that given the stability of frequency of these losses it is relatively easy to estimate how many launch failures there will be – the variability of loss experience for a given underwriting year depends critically on which of the launches fail. An individual insurer may or may not be exposed to the launch failures that actually occur and so their results may differ widely from the results for the market as a whole.

Given the sheer power required to get a satellite into orbit, it is probably a good starting assumption that if a launch fails at any point after take-off then the loss will be total, and that salvage possibilities will be small. So for launch risks one would expect the risk premium to be some margin over 4% of the sum insured in a given launch.



Not all satellite launches are insured. The frequency calculated is for all launches, and so the market could be lucky or unlucky in any one year by having the uninsured or insured launches failing respectively.

Related strongly to sum insured is the number of satellites on any one launch. Since the first satellite was launched the average number of satellites per launch has tended to increase, though individual years may show upwards or downwards movements in this average. Perhaps unsurprisingly there appears to be some negative correlation between the total number of satellites lost in the preceding year and the change in the average this year – if many satellites are destroyed at launch in one year, satellite operators tend to put fewer eggs in one basket in the next year. Given that the frequency is relatively stable, as is the number of launches, a high number of losses implies that the driving factor was the average number of satellites in each launch – hence the reaction.

The other major factor that made the 1998 underwriting year a bad one for satellite business was the number of in-orbit losses. Since satellites are not cheap to get up into the sky one would perhaps expect them to have quite a long working life. The earth's atmosphere, though doubtless cluttered with some space debris, is hardly full to the point that in-orbit collisions are likely, and the chances of satellites being hit by small asteroids must similarly be tiny. The major risk in-orbit ought to be component failure rendering the satellite inoperable, and if they are designed for long service it is not clear whether we yet have enough satellites that have been in orbit long enough to see many losses coming through.

Supposition aside there were a number of in-orbit failures in 1998 and 1999. Probably the most widely reported was the high-profile failure of the Iridium satellite network and the company's decision to abandon their other satellites currently in orbit.

An increasing number of launches, and losses are being made to low-earth orbits rather than other higher orbital paths. Such launches are cheaper and have only been commonplace over the last few years. We have not been able to assess whether the loss frequency for such launches is significantly different to that for other launches, but it may be that the emphasis on lower-cost launches leads to a reduction in the quality of the launch vehicles used too. Trends over the next few years will be interesting to watch.

**Rating factors for launch insurance**

Launch insurance has some obvious risk factors, though it is questionable whether accurate rating differentials could be derived for practical use.

One potential rating factor is launch site (which will allow for differences in ground support, weather etc).

Another factor is launch vehicle. There are a number of rockets (and the space shuttle) that can be used to launch satellites, and some have better success records than others do. Unfortunately the technology is constantly developing and there appears to be no guarantee that Ariane 5, say, will be more or less successful than Ariane 4. Any rate differentials applied between launch vehicles are necessarily subjective, especially since many makes of rocket do not carry out enough launches to assess their performance record to any level of significance.

**Length of tail**

Given the nature of the losses for this type of insurance it should come as no surprise that satellite insurance is generally short-tailed. An insurer will know fairly quickly after a launch loss that they have a claim to pay, and there will be little argument over the total loss amount. There are a number of features of the satellite insurance market that affect the length of the tail for this business.

- Variable exposure periods
  As mentioned above satellite launch insurance is usually sold on a "launch plus x years in-orbit" basis. As the current soft market developed 'x' has grown from 3 to around 5 years. This trend has begun to reverse as the market hardens again. At its hardest the market tends to offer "launch plus one year in orbit" cover.
- Delayed launches
  Launch cover is bought to cover one or more launches. If these launches are delayed for some reason (eg weather, fault on prior launch) then the exposure to risk is also delayed. This is often dealt with by portfolio transferring premium between accounting years, but obviously this is not compulsory.
- Redundant launches
  When companies rely on a large number of satellites to carry out their business they tend to factor a number of launch and in-orbit failures into their plans. In this case they can buy insurance excess of a predetermined number of losses. If they buy insurance excess of a number of failures (especially when some are in-orbit failures) then the length of the tail for the program increases. In the case of the ill-fated Iridium program, 72 satellites were launched, and the company needed 66 working to keep its communications network functional. Sadly 7 failed fairly early into the program, and the whole project was closed down. This could have been such a case of a longer-tailed loss.
- Redundant components
  In the same way that redundant satellites are occasionally launched, back-up components can be installed. Many contracts are written "excess of one transformer" for example. A failure at launch of some of the internal components may hence make an in-orbit claim more likely. Had there not been a component deductible these would have been immediately notified as launch losses. These component failures within the deductible are often notified to insurers as "anomalies" until it is known whether or not they become claims.

# FEATURES OF THE AVIATION AND SPACE MARKET

## Vertical Placing

One of the main problems with Aviation Insurance is the way in which risks are placed. This arises from the power of the brokers and the fact that most of the premium is generated from a small number of assureds. Although a slip system is used, this is placed in a very different way from other London Market business. The system is called vertical placement, and is unique to the aviation market. It is a relatively new phenomenon, having only really emerged over the last five years.

Traditionally the market was split into three layers, leaders and other large capacity writers, a middle market which primarily followed known leaders, and the other participants who would write some aviation business for diversification purposes (for example many of the Lloyd's composite and marine syndicates). As the rating levels have fallen, the middle market has been substantially reduced. Risks are placed with the following market first, conditional on certain leader(s) taking the risk. The differential between lead and follow markets is of the order of 20% to 40% for Airline insurance. The differential is smaller for Products and Satellite cover, but the practice is still widespread. No member of the following market will know what price the lead is getting for the risk so each participant has to set a price for their own share. It is quite common for a different price to be offered to the leader using different slips for the various different deals on offer. This may take the form of a better rate, or a flat fee paid up front. None of the other participants on the slip would be aware of this, so often leaders will agree large reductions in the headline rate which the rest of the market will be offered, and then take an additional fee on top to compensate for some or all of this reduction. The additional fee is justified because the leader will provide capacity, claims handling and legal services, as well as the expertise when underwriting the risk.

## Consolidation

There has been considerable consolidation within the major US airlines as code sharing arrangements lead on to alliances which evolve into full mergers. The following summarises this. Delta have taken over North East, Western & Pacific Northern; American have taken over Trans Caribbean and Air California; Continental have taken over 6 regional airlines including Eastern; Northwest have taken over 6 airlines; and US Airways have been formed from Pacific Southwest, Braniff, Piedmont, Pan Am, Lake Central, Mohawk and Allegheny. This trend seems to be spreading to other areas of the market eg the proposed BA/KLM merger.

This trend is also very obvious when considering the other major group of insurance customers – the aviation manufacturers; particularly in the US. Lockheed Martin now comprises 8 former distinct companies. Northrop Grunman is formed from Northrop, Grunman, Vought, Hexcel EMT & Westinghouse. Raytheon GM Hughes is formed from 8 companies including GM Hughes, Texas Instruments, Raytheon and Magnavox. Boeing have taken over Rockwell and McDonnell Douglas.

This consolidation means that effectively, fewer risk managers will be responsible for managing enormous pools of risks. This will increase the requirements from insurers, needing stronger capital bases and more sophisticated global capabilities, particularly if an insurer wishes to remain a leader in this sector.

The smaller number of clients will further increase the power of the brokers, who have themselves been consolidating. The small size of the industry, large premium size, and large amounts of reinsurance premium generated (which often has to go through the placing broker as part of the original deal, generating two lots of commission) all increase the power of the broker. There are only three major brokers left; AON (comprising AON, Minets, Bain Hogg, Alexander & Alexander and five others), Marsh (Marsh & McLennan, Barings, Sedgwicks and six others) and Willis Corroon (formed from Willis Faber, Corroon & Black and Stewart Wrightson).

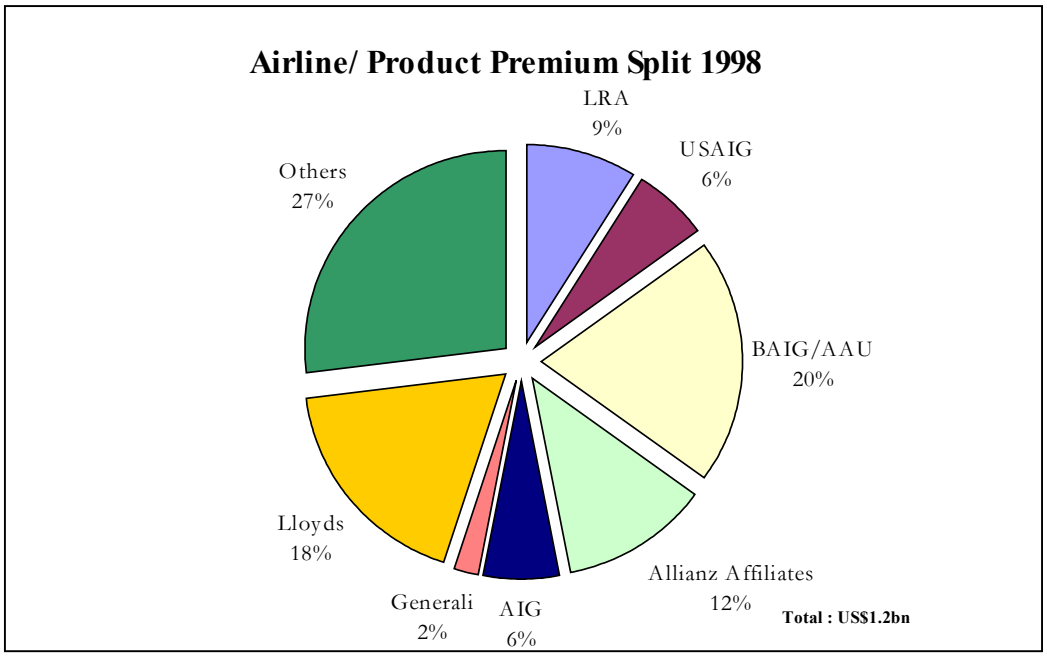
There has also been consolidation in both the insurance and reinsurance markets, leading to the emergence of fewer but more wide ranging global players; in total there are less than 70 organisations accepting aviation business directly.

Traditionally Lloyd's and a few London Market companies provided the key leads in the world aviation market. However, between 1992 and 1996 Lloyd's Aviation insurers lost this position (with one or two exceptions). This was due to a number of reasons:

- The loss of key underwriters leading to a weakening of relationships
- The restructuring of Lloyd's US regulatory status required substantial letters of credit to enable business to be written with appropriate reinsurance protection (hastening corporate partnerships eg Tilling with St. Paul)
- The consolidation of Lloyd's syndicates replicating the rest of the aviation market (There were 35 aviation specialist syndicates in 1991 which has reduced to 9 in 1999).

Even in the US, the number of companies in the market has fallen drastically. USAIG and AAU still dominate (despite problems), with AIG and Cigna both involved. There are many underwriters in the US who write only General Aviation; the main players are Phoenix Aviation Managers, SafeCo and National. The main European players throughout the market remain Generali, AXA, Allianz and LRA.

Generally across the whole industry fewer stronger players have replaced a weaker more fragmented market. This should mean competition will be stronger and better capitalised but more professional - with fewer insurers the ability of brokers to play them off against each other should be reduced. The graph below shows the split of the market in 1998:




Although the total premium shown is $1.2bn this is before brokerage and is based on leaders terms. This would net down to closer to $800m after these factors have been taken into account. The consolidation of the brokers has probably had the greatest impact on the market, creating the phenomenon of vertical placing. To improve the market a more balanced approach is needed, and the power of the broker needs to be reduced. This will only happen if the market works together and rebuilds long term relationships, as well as developing other sources of business. To obtain a supply of US business many insurers are trying to source business locally and directly eg ACE write North American business directly through Cigna outlets. A logical extension of this will be further consolidation in the insurers across the Atlantic, to enable a more effective answer to the problems of client need and geographic diversity - the first step in this direction can be seen in BAIG's recent merger with AAU, the specialist US aviation and satellite syndicate manager.

**Underwriting Cycle**

As for all insurance classes the aviation market is cyclical and, as with many, is currently soft. Historically the market has turned when underwriters start to experience a net cash outflow – cash flow underwriting, though actuarially displeasing, is common practice. Because the aviation insurance market is small compared to many classes of business all of the constituent parts tend to cycle together. Hull specialists for instance notice their premium income dropping rapidly as the cycle takes hold and start to look at other areas of aviation insurance. Products cover and general aviation may be targeted for example, putting pressure on rates in these classes too.

A comparison of the premiums expected to be generated over the market during 2000, with the comparable figures for 1994 is shown below to give some illustration of the extent of the cycle. For most classes 1994 is close to the top of the cycle and 2000 is close to the bottom of the cycle. Figures are in $m.

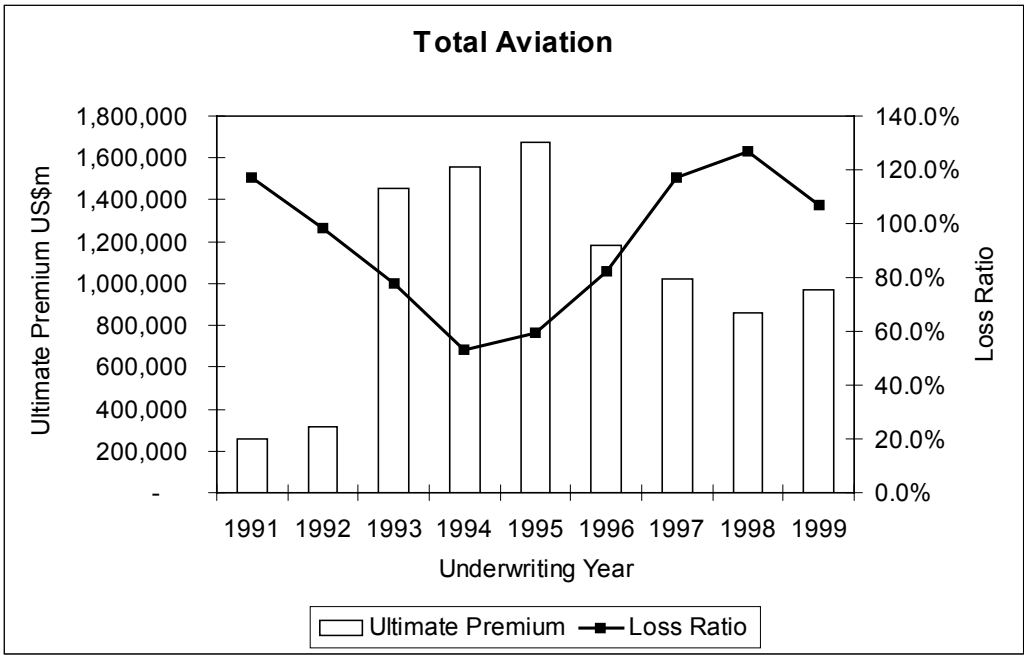
| Segment | 2000 Year | 1994 Year |
|---|---|---|
| Airline | 1,400 | 1,750 |
| General Aviation (US) | 500 | 1,250 |
| General Aviation (Other) | 350 | 700 |
| Satellite | 700 | 525 |
| Products | 460 | 500 |
| War | 33 | 180 |
| Other | 90 | 175 |

# MARKET PROFITABILITY

## Market Ultimate Loss Projections

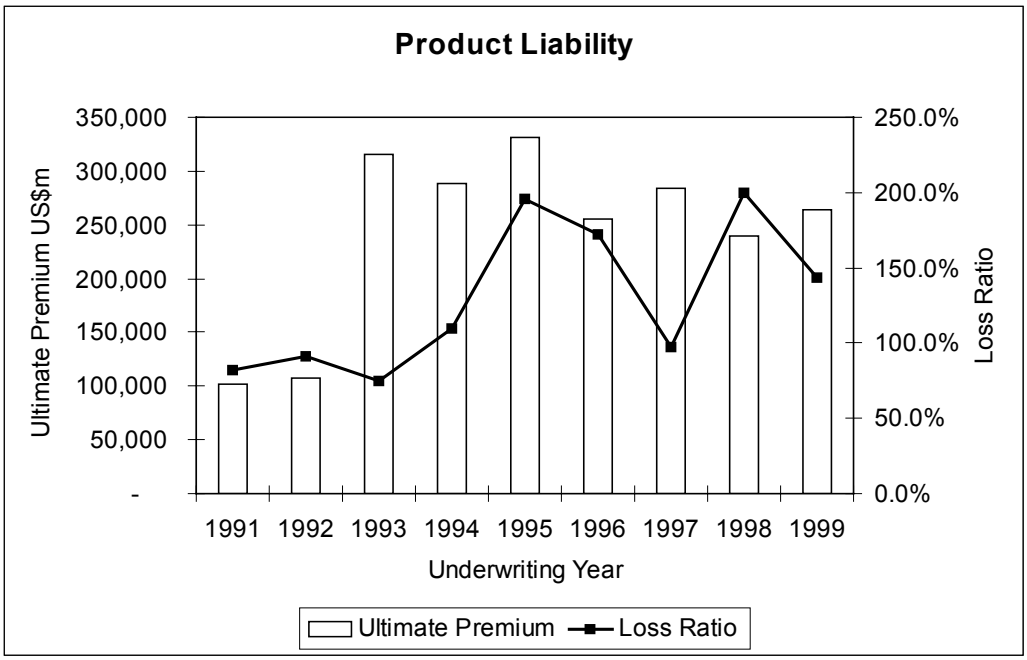
The working party obtained run-off data for premiums and claims from two different sources. Paid premiums and incurred claims were projected to ultimate using standard actuarial methods. Some of the data was only available back to 1993. Premiums are net of brokerage. Due to the different subdivisions in the data it was impossible to split General Aviation figures from the Airline data. The results can therefore only be analysed as follows:

Hull and Liability (Airlines and General Aviation combined)




For 1993 onwards the data represents up to 50% of the market. The insurance cycle is very clear in this data. Looking at this graph and the data used by the 1996 working party suggests that the cycle has a length or 9 or 10 years.

Product Liability

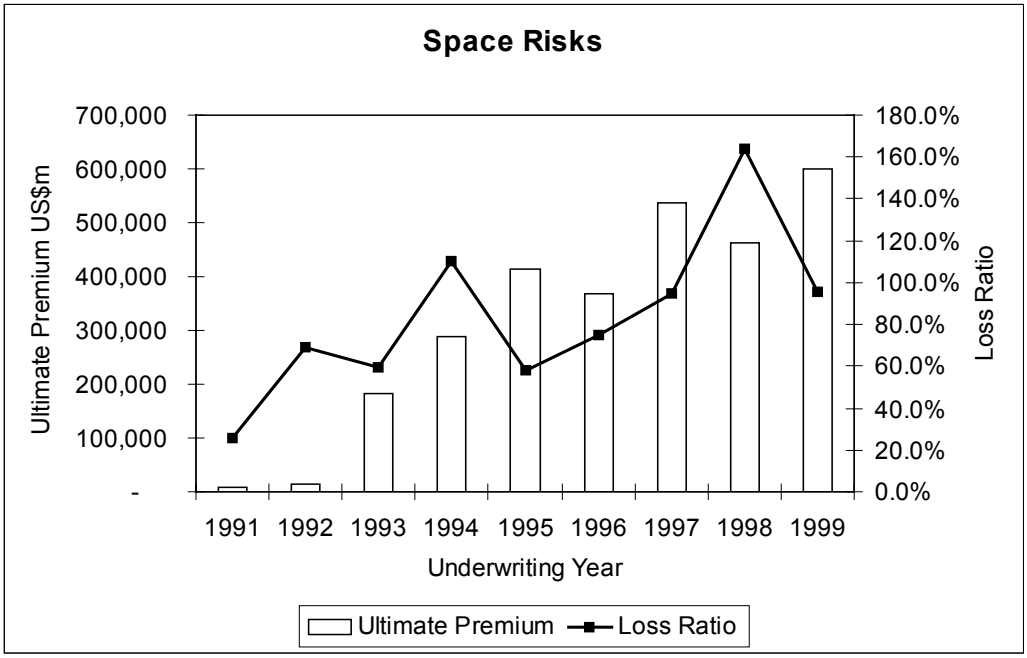



For 1993 onwards this graph represents between 50% and 65% of the global market. This class does not appear to be following the insurance cycle. This may be due to the fact that four major programs dominate the class and so it is more prone to single large claims. This feature, coupled with the claim sharing agreements, make the results very uncertain.

The loss ratios are much higher than expected from consideration of other market statistics. This is especially true of the more recent years and demonstrates the long tail of this class.

Product Liability would appear to be running at very unprofitable premium levels. The loss ratio has averaged about 150% since 1994 and even with investment income over the long tail of the business this is unsustainable.

Space Risks




For 1993 onwards this graph represents between 50% and 65% of the global market. The nature of the class means that losses experienced by the market vary greatly on the relative proportion of uninsured and insured satellites amongst the population that are actually lost in a given year. The total losses for the market are a small number of large losses, and as a result it is inappropriate to comment on how cyclical the market is based on loss ratios. An estimate of total sum insured and total premium would be required for each year in order to make such an assessment. Poor results in recent years would suggest that rates are set to increase, or terms to tighten over the next couple of years.

## Cash Flow

It has been suggested that, in spite of the adverse underwriting results, aviation insurers are willing to continue because they are able to produce a bottom line profit across the underwriting cycle. It is useful to estimate the level of investment income which may arise from the overall aviation insurance market.

Based on the market data, which was projected to ultimate (see Market Ultimate Loss Projections section), it is estimated that there is potential for investment income of approximately 14% of the net premium income over the run-off of a particular year's business. This assumes a return of 6% p.a. This seems unlikely to be adequate to compensate for the underwriting losses experienced over recent years, and certainly cannot be considered to provide an adequate bottom line return on capital employed.

It should, however, be pointed out that there are a vast variety of different underwriting strategies and portfolios written by different insurers, together with differing reinsurance protections. Each of these is likely to have different potential for earning investment income, as well as different net underwriting results.

## Reinsurance

One of the features of the aviation market is its large reliance on reinsurance. Even in years of poor experience, some direct writers can make money on the back of extremely cheap reinsurance deals. This leads many players to underwrite on the strength (and hopefully security) of the reinsurance program that they have managed to buy.

As the current down cycle has deepened, the direct market has seen an increasing number of multi-year deals being offered to the major airlines in particular. Many of the 1998 and 1999 renewals were for two or three years, as airlines tried to lock into the low rates on offer. This in itself has encouraged further deepening of the cycle, as underwriters who were unable to sign up for these large premium deals had to squabble over the business remaining in the interim year to maintain their market share.

As the reinsurance markets have now started to strengthen, the direct writers may suffer more. Any risks on multi-year deals will be priced at rates set at the lowest point in the cycle, but as reinsurance programs expire the reinsurance being purchased to protect the insurers will be more expensive than was previously the case. Some insurers bought two-year reinsurance deals to cover the millennium; whenever the insurer is forced to renew their cover the reinsurance will be more expensive, putting further strain on results. This should lead to the direct markets continuing to harden next year, but this year's results may not be good.

# CONCLUSIONS

## Future Trends

Despite the apparent year-on-year increases in the number of planes that are lost each year, frequency of loss has tended to fall or at least remain relatively stable. Growth in air traffic has been enormous over the past 20 or 30 years and is likely to continue at around 5% per year for the next 20 years or so. On the face of it we would expect to see the number of hull losses increasing at a similar rate over this time, and hence also the insurance cost.

However, things are not so simple, and there are factors which could push this number up or down.

On the positive side, safety features in aircraft are improving all the time. These both help to keep stricken aircraft in the sky and to minimise the number of casualties in the event of a crash. As a result we would expect both the frequency of losses and the severity of a given loss to decrease as these improvements are made, all other things being equal.

Unfortunately they are not! There will always be unavoidable problems (hence the very existence of the insurance industry) and the frequency will always be greater than zero. It is widely believed in the market that aircraft flying in the US are close to the "safety plateau", as efficient safety features, high quality pilot training and advanced air traffic control systems help to avoid problems. In the rest of the world western-built airlines have noticeably higher loss frequencies, and it is felt that improvements to air traffic infrastructure and emergency procedures on the ground could go a long way towards improving safety in some countries. Given that aviation insurance is a truly international industry, it is very likely that reductions in real losses could be made as safety improves.

Equally though, the world does become more litigious every day, and liability costs will be likely to rise in line with court award inflation and personal wealth. In the case of the Air France Concorde disaster, appeals have been made to hold a class action for damages in a US court on the grounds that one passenger was a US citizen, all those flying held one-way tickets to the US, and the ill-fated tyres were made by an American company. Previously a crash involving a French carrier flying a French plane in French airspace would probably have been handled in the far less financially punitive French courts. As the skies become more open there are likely to be more such requests, especially as Boeing, one of the two major aircraft manufacturers, is a US company.

The other problem is that of air congestion. If passenger traffic is set to increase at around 5% per annum then we are likely to see more aircraft in the skies to meet this demand. With many major airports already operating at close to maximum capacity, and with environmental objections to new international airports being built, more pressure is likely to be put on the air traffic control system. This will be offset somewhat by the advent of larger aircraft capable of carrying more and more passengers. However, if the desire to be able to fly to more and more destinations continues then the frequency of shorter flights using smaller aircraft will increase. How airports cope with these changes will probably depend greatly on how individual governments regulate their air traffic control services, and any minimum standards developed by the international community.

This paper has identified a number of current factors which could lead to higher future claims costs:

- Moves to unlimited liability
- The introduction of bigger aircraft
- Moves to try more cases in the US courts
- More air traffic
- Smaller reductions in accident rates as the safety plateau is reached
- Code sharing deals giving claimants more opportunity to pursue the deepest pocket
- Increased court awards in the US.

On the other hand we have identified relatively few factors which will lead to lower claims costs:

- Improved technology
- Improved safety record.

How these factors combine together is obviously not certain and there are many factors listed above the impact of which can only be guessed at this stage. However, the working party would like to hazard that over the next 15 years, airline insurance will see a gradual improvement in loss frequency offset by increases in claim severity which lead to an inflating risk premium. Future working parties are welcome to test these claims and report back!

**Market Profitability**

The aviation insurance market as a whole has without a doubt lost money over the last few years. There are a number of peculiarities of the market which have exacerbated this situation.

Firstly broker power has grown extraordinarily since the mass merger activity of recent years, and brought with it the phenomenon of vertical placing. To some extent this feature of the market will be acting to hide the true profitability of the business. This especially applies to the following market, who must become better educated with respect to the huge differential in prices that they are being offered in comparison with those offered to the leader(s). It will take serious action by underwriters to rein in some of the terms and conditions on policies (such as imposing aggregate deductibles) as well as to improve premium rates. Further consolidation of the aviation insurance market and/or a reduction in capacity is needed to reduce some of this imbalance. It is too easy at present for brokers to play underwriters off against each other.

The second peculiarity is equally difficult to get around. There seems an unhealthy fascination in Hollywood for airline disaster movies, and an equally unhealthy fascination for non-aviation specialists to throw their money at aeroplane crashes. In recent years both GIO and ReAC have suffered extremely large losses from their involvement in the aviation reinsurance market, and in previous years the marine XL specialists were also guilty parties. These and other players who get burnt may change every year, but for as long as people are wont to join the market, the reinsurance will remain cheap, the specialists will arbitrage at a cost to the reinsurers and the market as a whole will remain soft. Persuading "naive" capital that the aviation reinsurance market is not the place they want to be is going to be a very tough task indeed.

One of the interesting conclusions that comes out of the 1996 Sigma study is the extent to which it underestimated the sheer magnitude of the cycle this time around. The working party believes that it is unlikely that future cycles will be as intense, if measures are taken to ensure that capacity is managed more effectively as this cycle turns.

One thing which is clear from our research is that there is little or no involvement of actuaries or, indeed, use of any other scientific approach to rating airline business in particular. This is driven, at least in part by the continuing overcapacity in the market and the very powerful position held by the small number of aviation brokers and also the powerful negotiating position of the major airlines and airline groups. We believe there is scope for a more statistical approach to the rating issue, but that this unlikely to come to pass until capacity levels reduce to something more closely in line with demand for such insurance.

## APPENDIX A – LARGE LOSS DETAILS

The table below contains brief details of large losses mentioned in the paper:

| Date | Airline | Plane Type | Fatalities | Estimated Total Cost | Brief Description of Circumstances |
|---|---|---|---|---|---|
| 1977 | KLM/PanAm | 2 Boeing 747's | 583 | Not Known | Collision between the two planes at Tenerife Airport, Canary Islands |
| 12/08 1985 | Japan Air | Boeing 747 | 520 | US$213m? | Plane crashed in Japan shortly after take-off |
| 02/08 1990 | Kuwait | 15 planes | 0 | US$300m | 15 planes of Kuwait airlines seized by Iraq |
| 05/08 1998 | Korean | Boeing 747-400 | 0 | US$147m | Plane ran off runway at Kimpo Airport, South Korea |
| 02/09 1998 | Swiss Air | MD-11 | 229 | US$800m | Plane on route from New York to Zurich crashed in the sea off Nova Scotia, Canada after smoke in cockpit |
| 15/03 1999 | Korean | MD-83 | 0 | US$30m | Plane overshot runway on landing at Pohang City, South Korea |
| 15/04 1999 | Korean | MD-11 | 9 | US$80m | Cargo plane crashed in residential suburb of Shanghai, China after take-off |
| 24/08 1999 | Uni Air | MD-90 | 0 | US$30m | Plane caught fire after landing at Hualien, Taiwan. 50% contribution from war underwriters |
| 23/09 1999 | QANTAS | Boeing 747-400 | 0 | US$80m | Plane overshot the runway at Bangkok airport, Thailand whilst landing in thunderstorm |

| Date | Airline | Plane Type | Fatalities | Estimated Total Cost | Brief Description of Circumstances |
|---|---|---|---|---|---|
| 18/10 1999 | Fed-Ex | MD-11 | 0 | US$91m | Plane overshot the runway at Subic Bay Naval Base, Phillipines whilst landing and crashed into water |
| 31/10 1999 | Egyptair | Boeing 767-300 | 217 | US$350m | Plane on route from New York crashed off Nantucket Island, US |
| 22/12 1999 | Korean | Boeing 747-2B5F | 4 | US$38m | Cargo plane crashed at Stansted airport, UK during take-off in poor weather |
| 25/07 2000 | Air France | Concorde | 113 | US$300m | Plane crashed into hotel on take-off from Paris on route for New York, following tyre burst leading to debris in engine and fire |