



Insuring Space Activities A risky business

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Abstract

Satellites sometimes are lost in the process of launching them or due to technical failures when they are in orbit. These losses have enormous financial consequences for owners and operators. It could be material damage, third-party liability or loss of revenue; damage on Earth or in space. Insuring the risk is an option. This paper describes space insurance market characteristics, s.a. risk assessment, types of insurance, premiums and (forms of) cover, involved parties, etc.

Keywords: space, insurance, market, risks.

Introduction

Almost fifty years into the Space Age, launches and satellites, advanced technologies notwithstanding, still go bust. When space faring became commercial, emerging space technologies together with high financial investments created a need for specialized (space) insurance. The insurance of space activities and the accompanying risks, matured over the years and a highly specialized insurance market evolved. This is a changing and volatile market in a global setting and consists of different insurance types and different players. It is dictated by insurance cycles, global economic conditions, launch and satellite losses and (technological) changes in the space industry. Moreover, it only involves a small number of mostly American and European underwriters and the coverage is very high per insured risk. The insurance community has a vital interest in the performance of launchers and satellites on the one side and in the interaction between all the players on the other side; where launch providers tend to believe that they perform optimally while the satellite owners and operators assert that it is often less than nominally and for a too high a price.

History

The first satellite (Sputnik 1) was launched on 4 October 1957 and the first man (Yuri Gagarin) to orbit the Earth was on 12 April 1961, but commercialized space flights only begun in the mid sixties when private operators started putting communication satellites into orbit.¹ The satellite Early Bird (Intelsat I), launched in 1965, is recorded to be the earliest commercial satellite to be insured with a cover of 5 m\$US for pre-launch own damage for the satellite and the launch vehicle, and 25 m\$US for third-party liability for damage occurring during the launch. At the time, insurers did not want to include own-damage launch risks, since they lacked the experience to assess the risks involved. It took another ten years for the first in-orbit life risk insurance policy to be written (Satcom series for RCA). Over the years, space insurance evolved continuously to meet the demands of emerging commercial space technologies and the widening utilisation of space.

In November 1982 commercial driven insurance was combined with NASA controlled manned space with the insurance of satellites to be launched by space shuttle mission STS-5. The ANIK C3 satellite was deployed for TELESAT Canada and the SBS C satellite was deployed for Satellite Business Systems. In November 1984 a space shuttle mission was used to retrieve the Westar VI and the Palapa B2 satellites. This mission was partly funded by Lloyd's of London. When the astronauts had completed their recovery, they held up a "For Sale" sign, a joking reference to the fact that the satellites' owners hoped to refurbish and sell the satellites to recoup their investment in the rescue mission (Figure 1). However, the Challenger accident removed the commercial satellites from the space shuttle manifest.

Experience increased over the years. The space insurance market became highly specialised and detached itself from the aviation industry insurance market in which it first was embedded. Technology was regarded as more and more reliable and the perception took place that the associated risks decreased over time.



On the other hand, the low launch frequency and the consequent lack of representative figures — insurance for the most part is based on statistics — meant that applying statistics was a major problem.

Space flight was thought to be relatively low-risk and space insurance was reputed to be highly profitable. The number of insurers increased, resulting in lower prices while the insurance cover (capacity) soared. In 1977 the OTS 1 communication satellite was destroyed when the Thor Delta space launch vehicle experienced a launch failure. The loss was estimated at some 27 m\$US, reportedly about the total premium income from the previous 12 years. In 1979 losses rose worldwide to about 121 m\$US while premium income stopped at a mere 60 m\$US. This was an unprecedented loss ratio of about 200%. Insurance capacity decreased rapidly while premiums reached unknown heights. The economic law of supply and demand also applied to space insurance. The largest insured loss beyond question is the case of six Boeing 702 communication satellites that were launched between December 1999 and May 2001. After the sixth launch it was discovered that the solar arrays were deteriorating more rapidly than they were designed for. The expected 15 years of economic lifespan will therefore not be possible and the claim is reportedly about 875 m\$US.²

The Underwriting Process

The process of insuring a satellite is not an easy one.³ Typically for a given launch project, either the satellite owner or manufacturer begins by choosing an insurance broker. This broker becomes the primary agent responsible for transmitting information between the insured party and the underwriters. The underwriting process for a project begins when the broker presents technical reports and contractual and financial information to a number of international underwriters. In order to decide what kind of coverage they can offer, the various underwriters conduct in-depth technical analyses of the satellite and the launch vehicle. The respective reliabilities of the launch vehicle variant, satellite model, and the satellite's intended orbit are evaluated. Details such as launch site location, contract specifics, and satellite finance and value are also taken into account. When the various evaluations are complete, potential underwriters present the broker with bids containing information regarding capacity, premiums, and terms and conditions that they feel that they can offer the insurance client.

After negotiating a space insurance policy, many underwriters also seek additional financial backing. Reinsurers and financial institutions can buy participation in any insurance package from an underwriter. Generally, reinsurers and financiers take on the same risks as underwriters and are similarly affected by mission successes and losses. The participation of these additional financial backers allows underwriters to spread risk throughout many layers of the insurance industry. Reinsurers do not analyze any technical information, but instead depend on underwriters' evaluations of risk to determine their level of involvement.

Insurance Coverage

There are generally four types of space insurance in which are covered risks to the rocket, the satellite and related equipment, and third-party liability. Factors that influence the policies that are written are market conditions, type of rocket, orbital deployment and satellite attributes. The scope and design of the coverage have kept pace with the development of technology, the demands of policyholders and the constantly improving expertise of insurers. Although all underwriters use similar terms and conditions, policies for commercial satellites are individually made up based on the satellite and the launch vehicle which will put it into orbit. Terms and conditions s.a. premium rates and period of coverage are negotiated between the client and the underwriters. The risks and associated coverage are described below.⁴

The risk of material damage is covered by all-risks policies whose scope goes far beyond what is customary in normal property insurance. Apart from the usual war, terrorism, wilful acts and nuclear peril exclusions, there are virtually no exclusions what so ever. Insurers grant the broadest coverage imaginable. This is mainly due to the 'one-way-mission' of launching a satellite. It is generally impossible to rectify malfunctions once a satellite is in orbit and it is for these malfunctions that insurance is required. Without this extensive scope of cover the insurance protection would be of very limited value. Space risks can be projected on a time-line and are related to a sequence of events. Material damage insurance therefore is divided in pre-launch insurance, launch insurance and in-orbit insurance. There are some more risks that can be insured separately s.a. assembly of satellite and launch vehicle, functional testing on the launch pad of the launch vehicle and satellite, testing of individual components and procedures etc. These risks are usually (re)insured outside the space insurance market. Furthermore there is mandatory third-party liability insurance.

Pre-launch Insurance

Pre-launch insurance provides all-risks coverage for material damage to the launch vehicle and / or the satellite during the period of time between the departure from the integration facility and the intentional ignition of the first stage of the launch vehicle. It may also cover termination fees, launch delay penalty fees, lost revenues and other consequential or incidental damages that can be attributed to a physical occurrence. The party that bears



the risk of loss purchases this cover. Before the satellite leaves the factory, it falls under normal entrepreneur's risks and can be insured (or not) accordingly. The transportation from the factory to the launch site is often covered under a marine policy. The pre-launch insurance starts mostly when the satellite arrives at the launch site. There it is transformed into its launch configuration (taken out of protective packaging, assembling) and integrated with the launch vehicle while all the preparations for the launch are being made (fuelling, arming, etc.). The coverage generally ends when the ownership passes from the manufacturer to the purchaser. This point in time is at the latest when the launch can no longer be aborted. This transfer of title is contained in the satellite procurement contract and precisely described in the policy and varies per launch vehicle (e.g. intentional ignition, launch, retaining clamps released, lift-off, etc.). Pre-launch insurance is available for the launch vehicle also. If both the launch vehicle and the satellite have pre-launch insurance, the moment they are integrated, the insurances start to accumulate with each other. If the launch is aborted after the pre-launch cover has terminated, mostly a so called reattach coverage applies (post-abort coverage).

It can be argued that pre-launch insurance should be an engineering insurance in stead of a space insurance. However, there are some very particular risks in pre-launch insurance which can only be assessed using the kind of comprehensive specialized knowledge that is almost only available in the space insurance market.

Launch Insurance

The launch risk phase starts at lift-off (or alternatively when the first stage engines are intentionally ignited, in which case an aborted launch is also covered) and ends when the satellites are totally separated from the launch vehicle and in-orbit testing has been completed. Nowadays a longer period of cover, usually up to 365 days after launch, is often possible. The holder of a launch insurance policy is generally the satellite operator. If the satellite operator chooses the option of in-orbit delivery of a turn-key satellite, the manufacturer carries the launch risks and will be the policy holder.

A total loss of the satellite is declared when the satellite is physically destroyed or cannot fulfil its planned operations because it failed to attain its intended orbit. The amount of compensation payable in the event of a total loss is specified in advance. It usually covers the cost of a new satellite, the costs of launching it and the cost of the launch insurance.

A partial loss is assumed when the satellite can only partially fulfil its planned operations or when its operational life is shortened. The sum insured will be paid out only in ratio to the decrease in value, depending on the scale of the impairment. The policy will contain formulae to calculate various malfunctions and the resulting decreases in value. Reasons for a decreasing value could be a reduction in fuel supply because of excessive fuel consumption in the positioning phase, an insufficient power supply, transponder failures etc. However, a decrease in value is only granted if the satellite's operational capacity is assuredly impaired. If the impairment caused by a partial loss exceeds a certain limit specified in the policy, a "constructive total loss" is assumed. In general, to be declared a constructive total loss, the impairment of the satellite must be so severe that it does not meet the insured's operating requirements and has to be replaced.

Launch insurance is the most expensive type of coverage and it is not uncommon for launch service providers to offer a 'launch risk guarantee' as an alternative to launch insurance.⁵ This may also be provided as a supplement to the traditional launch insurance policy. These guarantees are designed to cover the expense of a replacement launch service and usually take the form of a cash payment or an option of a repeat launch free of charge. Since these guarantees usually cover only part of the launch risk, in both financial and technical terms, the operator will require supplementary launch insurance for the remaining portion of the risks. The danger exists that there are gaps in the coverage which could and probably will jeopardize the claims for compensation.

In-orbit Insurance

In-orbit commissioning insurance. Once the satellite is separated from the launch vehicle, it often has to autonomously manoeuvre in-orbit so as to reach its final orbit. Within typically no more than six months (time period allowing for one of the two yearly eclipse seasons in geostationary orbit), the satellite is fully deployed and all its systems are tested.⁶ In-orbit commissioning insurance covers failures or damage caused to the satellite during such period.

In-orbit insurance covers all risks of partial or total loss of a satellite while it is functional in its commercial life period. Such cover may begin as soon as in-orbit commissioning is confirmed. The insured value is an agreed value, based on replacement value at the beginning of the service life of the satellite. The sum insured covers the total cost of manufacturing and launching a replacement satellite, but is reduced over time to avoid over-insurance. Total loss, partial loss and constructive total loss are the same as in the launch insurance and the same formulae are used. Insurers will benefit from any salvage value that the satellite may have or revenues derived from the damaged satellite. Usually in-orbit insurance policies are written for twelve month at a



time and could be renewed depending on the technical condition of the satellite, or completely rewritten if the satellite's condition or its performance warrants this. After the satellite has performed for some time and there is confidence that the equipment will be working for the duration of the commercial life period, the in-orbit insurance might be stopped or the operator turns to self-insurance or under-insurance.

Coverage of incentive schemes. The manufacturer and its client usually agree that the price of a satellite splits into a fixed part and a variable part which will depend on the satellite's functions, performance and service life. The variable part, often called satellite performance incentive scheme, may be insured by the manufacturer with the satellite operator's agreement. Coverage of these risks, which is like insuring performance guarantees, is problematic because it is difficult to distinguish it from the general business risks, which are uninsurable.

Transponder insurance. This insurance provides protection against the loss of one or more (communication) transponders. This type of insurance is bought by operators that do not own a satellite (system) but purchase, lease or rent (spare capacity) satellite transponders or on an existing satellite that is operated specifically for that purpose. There is quite a market for this type of transponders. Insurance of this type needs assessments of the condition of the satellite and the question of service protection which relates to whether and under what conditions the policy holder is entitled to a replacement transponder.

Loss of Revenue Insurance

Coverage of loss of revenue generated by a satellite, operates on an indemnity basis and is due following the partial or total failure of the insured commercial payload. The financial loss caused by the failure may be far greater than the material damage itself if the reduced serviceability results in a loss of revenue. There is no standard form of cover for these insurances, but in general indemnification only takes place when it can be proven that the revenue really would have been earned if the failure had not taken place.

Third-Party Liability Insurance

Third-party losses caused by the launching and operating of launch vehicles and satellites constitute special risks that are excluded from the scope of cover granted under general liability insurance policies and therefore a special form of liability insurance for satellites have been developed. The purpose of this insurance is to cover all third-party legal liability claims arising from damage caused by a satellite, its launch vehicle, or any part thereof, regardless of the party against whom such claims were made. The policy includes as co-insured all those parties that might conceivably be liable, in particular the manufacturer, the operator, the Launching State, and all organisations rendering services in the launch and operating phases. The cover becomes effective with the scheduled ignition of the launch vehicle and ceases when the policy expires or if the satellite and its launch vehicle are completely destroyed. Damage to the launch facilities is not covered. Damage to the payload(s) is not covered either since the underlying contracts usually contain a cross-waver of liability by all parties.

For states that have ratified "The Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies, 1967" and/or "The Convention on the International Liability for Damage Caused by Space Objects, 1972", third-party liability insurance is usually a requirement pursuant to the grant of license for a space launch.

Insuring Commercial Human Spaceflight

In October 2004, space tourism is said to have begun in reality when SpaceShipOne became the first commercially built spacecraft that carried humans into space. In this new era of space tourism, not only the companies that design and operate new spacecraft, but space flight participants as well, want to buy insurance to mitigate the risks associated with spaceflight. Apart from the obligatory purchase of third-party liability insurance, operators may also choose to buy insurance to mitigate financial risks. Actually, the first so called space tourists Dennis Tito and Mark Shuttleworth both bought insurance policies to cover their financial risks. As space tourism will evolve, so will the underlying insurance market.

World Wide Space Insurance Market

The World wide space insurance market consists of relatively few players. E.g. insured amounts in 2005 were as in figure 2. The first commercial launchers were American launch vehicles. Until the early 1980's Delta and Atlas shared the market, but the space shuttle and Ariane 4 later changed this status. Until 1986 and the Challenger disaster, and the subsequent removal of commercial satellites from the space shuttle manifest, competition between Ariane and the space shuttle was intense. The Ariane launch vehicle is now only competing with Atlas, Proton and Zenit SL. Space insurance had a difficult start and the loss ratio was almost permanently in excess of 100% until the early 1990s. Thereafter, a globally generated profit for space insurers was realized mostly because of the reliability of the Ariane 4 family of launch vehicles and of in-orbit satellites. However, since 1998 rates decreased and because of the claims development, the global loss ratio has returned to levels



just exceeding 100%. Nowadays the global results of space insurance are just balanced. Figure 3 presents the cumulative results of the world space insurance market since 1984.

The insurance market cycle and market capacity. The short history of the space insurance market shows a fluctuation between soft and hard conditions. In the very early beginnings, insurance policies were written sporadically. The space insurance industry started in earnest in the 1980s with the growth of the private satellite industry. Due to a series of dramatic losses the market started off volatile, but by the end of the 1980s and the early 1990s the insurance industry became profitable. Premiums for policies for launch plus one year in-orbit (L+1) levelled around 18-20%. This profitability attracted more underwriter capital, increasing the insurance capacity. In response, the average premium rates lowered. This resulted, among others, in binding launch coverage to two to three years prior to the scheduled launch date, loosening of policy terms and offers of multi year policies for in-orbit operation. In the early 2000s the launch insurance market moved from a 'soft market' (increasing underwriting capacity and declining premium rates) to a 'hard market' where the underwriting capacity was shrinking, the premium rates rose and the policy terms were curtailed. One of the main reasons for this market shift was the business failures of non-geostationary communications networks that caused a dramatic decrease in the launch rate. Large insurance pay-outs (lower underwriter profits) also contributed to the shrinking of the market capacity. Between 2000 and 2005 this market capacity per launch decreased from 900 m\$US to about 400 m\$US.⁷ In response to the significant improvement in the sector's profit/loss ratio over the last three years some 26 insurers world wide, but mainly in Europe and the US, have now (2006) an aggregated launch coverage capacity of about 475 m\$US per launch. The in-orbit coverage capacity in 2006 is estimated to be about 300 m\$US. The market capacity evolution is as in figure 4.

Premium rating. Premiums in the space insurance market are mainly generated by policies for in-orbit insurances and they consist of about two thirds of the total premium income. (Figure 5) Premium rates increased from the late 1990s on as a result of poor loss experiences, but further rate increases could not be sustained. Some insurers even began adopting alternative risk management strategies to counter the rate increases. As a result of improved sector performance and overcapacity, rates are now reducing for launch as well as for in-orbit coverage. In 2005 premium income significantly exceeded the paid claims and in 2006 the aggregated premium income could be as high as 875 m\$US. (Figure 6).

Coverage conditions and premium rates. Currently the policies are still written for twelve month periods, but some insurers are considering 18 – 24 month policy periods. The constructive total loss point seems to be firm at 75%. However, in exchange for premium savings, higher constructive total losses are being offered while there is a potential to buy back the cover for constructive total losses less than 75%. There is a market tendency to impose exclusions for specific and generic anomalies. For standard geostationary communications satellites the premium rates for L+1 insurance are lowering and rates of about 15% or better seem to be attainable for attractive risks. By the end of 2006 rates could reduce further for L+1 for reliable satellites and launch vehicles. Figure 7 gives an overview of the average L+1 premium rates.

There is a tendency to more differentiate in in-orbit premium rates between satellites that have or have not a proven heritage and reliability record. Rates could differ from as low as 1.35% for proven standard spin stabilized satellites to as high as about 5% for unfamiliar or unproven satellites, s.a. imagery satellites. Here also there is a potential for premium savings through the adoption of increased constructive total loss points. Now, widespread premium reductions are being seen depending on factors s.a. the sum that is insured, the condition of the satellite and not in the least because of the loss-experience of the satellite platform and / or the operator. Figure 8 gives an overview of the average 12 month in-orbit insurance premium rates.

Concluding Remarks

From 2002 on, increased premiums and few pay-outs produced a launch insurance net profit. Data from 2005 and 2006 indicate that the insurance market is softening again as industry profits broke through the ever declining insurance capacity and attracted new underwriter investments. Further increases in insurance capacity is anticipated, but will probably be modest. The net profits since 2002 are seen as a result of high premiums and only few pay-outs and this trend may continue in the near future, but the space insurance market still has no broad base to fall back to. A couple of major failures and subsequent high pay-outs could easily consume the profits that have been built up by underwriters. Therefore, high premium rates will continue to attract more underwriter investments and so increase the market capacity further into the green zone.

Acknowledgments

My thanks go to Willis Inspace (UK), La Réunion Spatiale (France) and Münchener Rückversicherungs-Gesellschaft (Germany) for their worthwhile contributions, especially for their updated facts and figures.



Figure 1 – Astronaut Dale Gardner holds up a “For Sale” sign after two satellites were retrieved. [NASA]

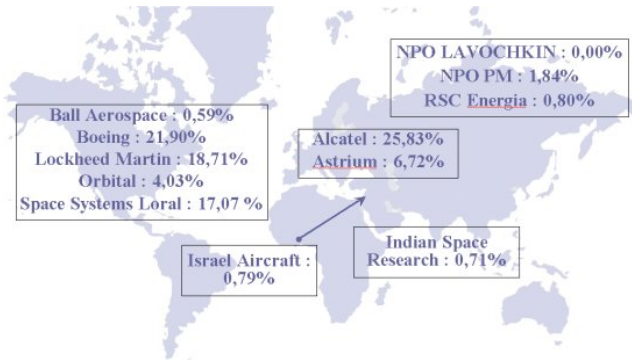


Figure 2 - Insured amounts (%) per manufacturer in 2005. [La Réunion Spatiale]

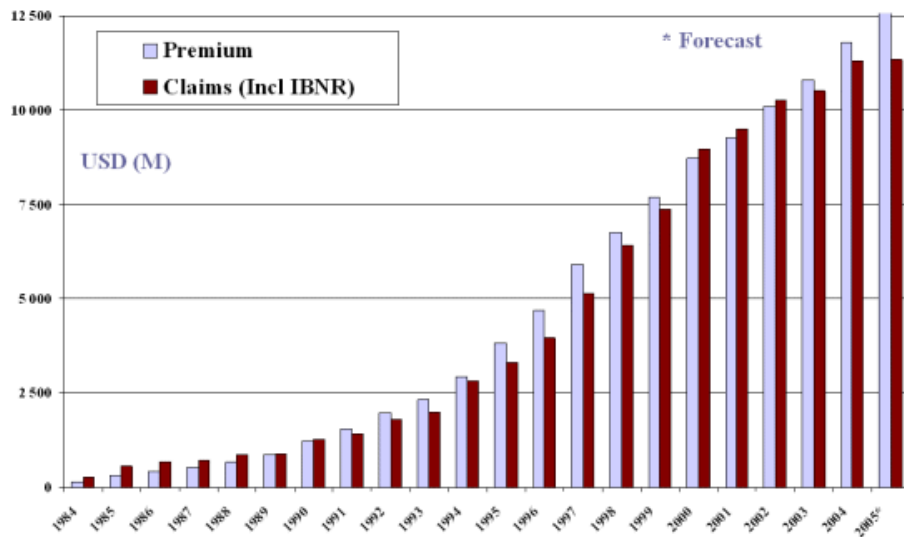


Figure 3 - Cumulative results of the world space insurance market since 1984. [La Réunion Spatiale]

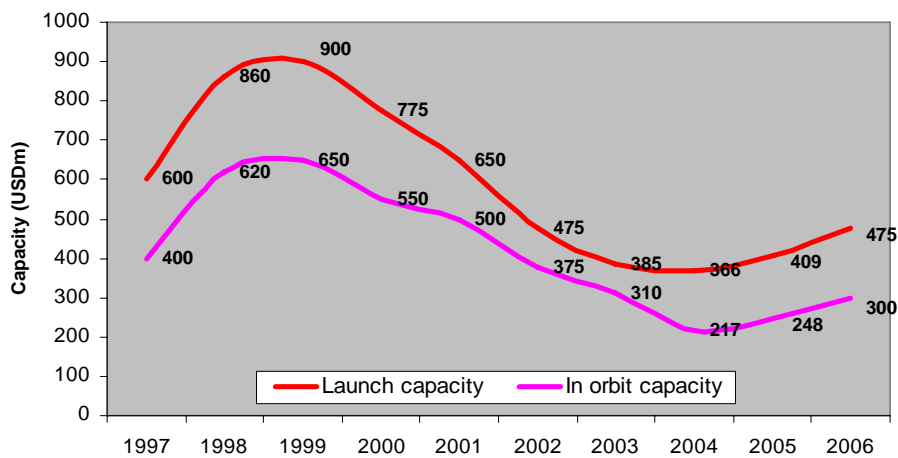


Figure 4 – The market capacity for launch coverage and in-orbit coverage evolution. [Inspace Willis Ltd.]

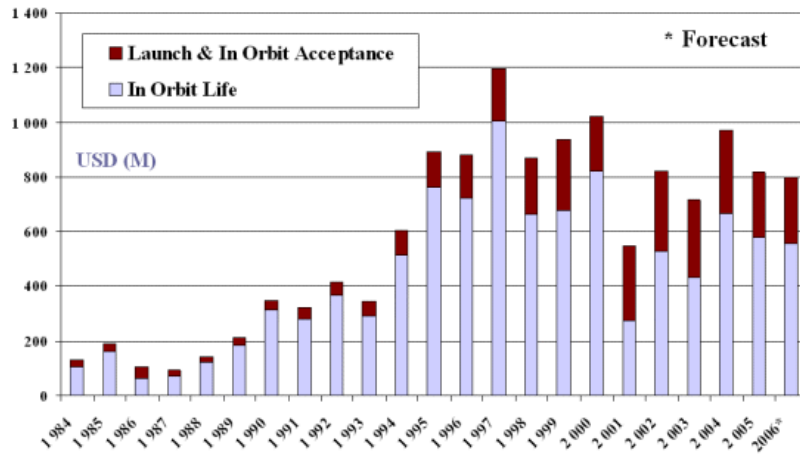


Figure 5 – Division between premium incomes from Lunch and in-orbit acceptance insurance and from in-orbit insurance. [La Réunion Spatiale]

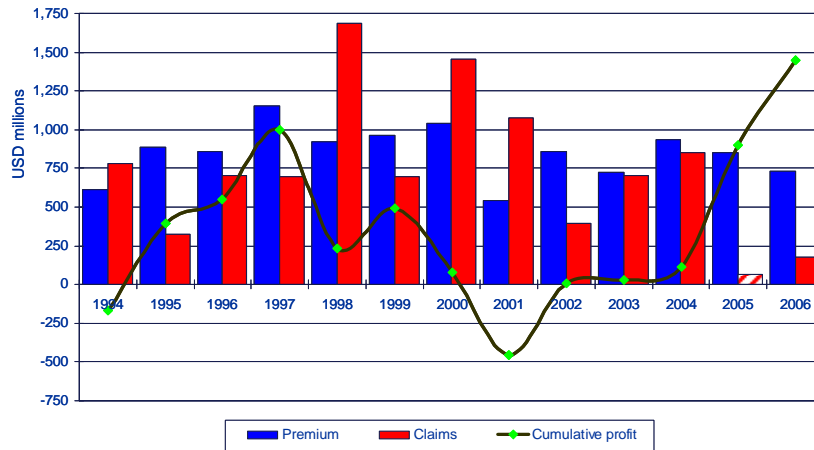


Figure 6 – The evolution of premium, claims and cumulative profit since 1994. [Inspace Willis Ltd.]

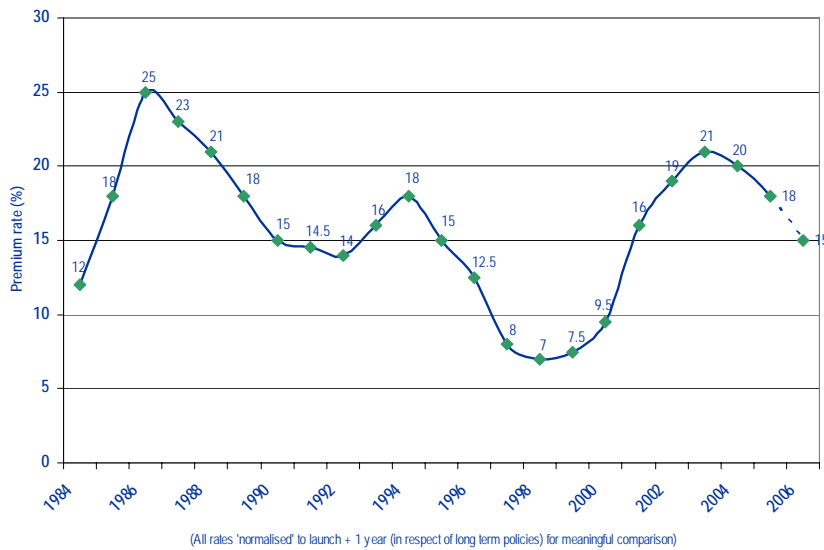


Figure 7 – Average Launch + 1 year in-orbit (L+1) premium rates. [Inspace Willis Ltd.]

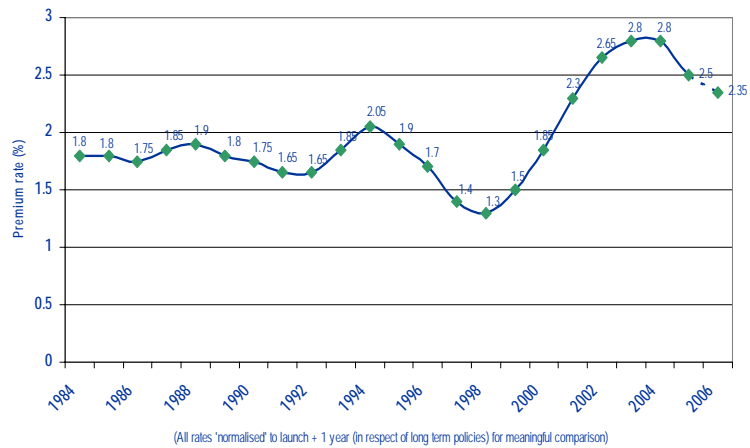


Figure 8 – Average 12 month in-orbit premium rates. [Inspace Willis Ltd.]

References

- ¹ ribs Space Consultancy & Insurance / Data Banking & Control, Databases, 1984 – 2006.
- ² http://www.space.com/spaceneWS/archive04/insurearch_091004.html
- ³ Office of Commercial Space Transportation, Quarterly Launch Reports, 1996 – 2006.
- ⁴ Münchener Rückversicherungs-Gesellschaft. Space Flight and Insurance. Third edition. 2006.
- ⁵ Risk and legal liability in commercial space launches: <http://www.parliament.the-stationery-office.co.uk/pa/cm199900/cmselect/cmtrdind/335/335ap04.htm>
- ⁶ <http://www.la-reunion-spatiale.com/>
- ⁷ Willis Space Insurance Market Overview, October 2006.