Insuring Space Activities

A risky business

by

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Introduction

Despite the fact that we are almost fifty years into the Space Age, launch vehicles and satellites - advanced technologies notwithstanding - still fail prematurely. When space faring became commercial, emerging space technologies together with high financial investments created a need for specialized (space) insurance. The business of insurance of space activities has matured over the years and a highly specialized insurance market has evolved. This is a changing and volatile market in a global setting and consists of different types of insurance cover and different players. It is dictated by insurance cycles, global economic conditions, launch and satellite loss statistics and trends, and technological changes in the space industry. Moreover, it only involves a small number of underwriters, mostly American and European, and the premiums are very high per insured risk. The insurance community has a vital interest in the performance of launchers and satellites, on one hand, and in the interaction between all the players on the other. Launch providers tend to believe that their equipment performs optimally, while satellite owners and operators believe that this is often not the case and also believe that launch costs are too high.

History

The first satellite (Sputnik 1) was launched on 4 October 1957 and the first man (Yuri Gagarin) orbited the Earth on 12 April 1961. Commercialized space flights, however, only began 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 mUSD for pre-launch damage to the satellite or the launch vehicle, and 25 mUSD 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 the RCA company). 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 activities 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. However, the Challenger accident resulted in the removal of commercial satellites from the space shuttle manifest.

Astronaut Dale Gardner holds up a "For Sale" sign after two satellites were retrieved. [NASA]

Space insurance market experience has increased over the years. It has become highly specialised and has detached itself from the aviation industry insurance market in which it was first embedded. Technological

advances have, in general, resulted in more reliable equipment and consequently the perception evolved that the associated risks have decreased over time. However, insurance for the most part is based on statistics and the low launch frequency and consequent lack of representative figures has meant that applying a statistical process to space insurance was a major problem.

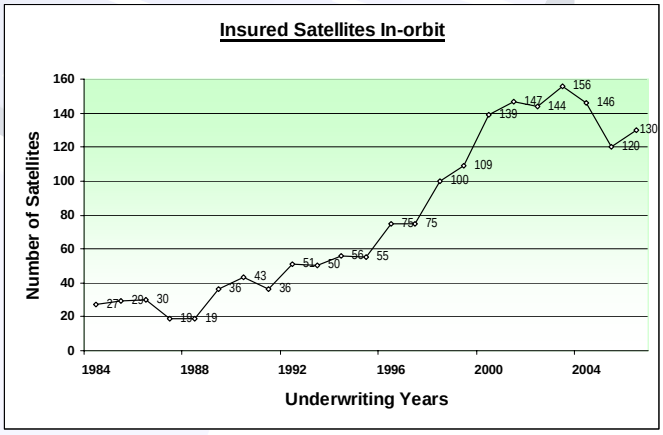
In the early days, space flight was thought to be a relatively low-risk activity and space insurance was reputed to be highly profitable. The number of insurers increased, resulting in lower prices while the insurance cover (capacity) soared. Then in 1977, the OTS 1 communication satellite was destroyed when the Thor Delta space launch vehicle experienced a launch failure.

OTS 1 fragment, recovered from the Ocean after the Delta rocket failed to put the satellite in orbit. [Skynet.be]

The loss was estimated at some 27 mUSD, reportedly about the total premium income from the previous 12 years. In 1979 losses rose worldwide to about 121 mUSD while premium income peaked at a mere 60 mUSD. This was an unprecedented loss ratio of about 200%. Insurance capacity decreased rapidly while premiums reached unprecedented levels. 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 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 mUSD.[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 (people of an insurance company who assess risks and determine the premiums). 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 cover 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 are also taken into account. When the various evaluations are complete, potential underwriters present the broker with bids containing information regarding level of cover, premiums, and terms and conditions that they feel that they can offer the insurance client.



Number of insured satellites in orbit from 1984 to 2006. [*ribs* SC&I/DB&C

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 un-

derwriters' evaluations of risk to help them decide on their level of involvement.

Insurance Cover

There are generally four types of space insurance: insurance covering risks to the rocket, risks to the satellite, risks to related equipment, and third-party liability. Factors that influence the policies that are written are market conditions, type of rocket, orbital deployment and satellite specification. The scope and detail of the cover 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, such as premiums and period of cover required, are negotiated between the client and the underwriters. The risks and associated cover are described below.[4]

Envisat/Ariane 5 on the launchpad
[ESA/CNES/Arianespace/S.Corvaja]

The risk of material damage is covered by all-risks policies whose scope goes far beyond that customary in normal property insurance. Apart from the usual war, terrorism, wilful acts and nuclear peril exclusions, there are virtually no exclusions whatsoever. Insurers grant the broadest cover imaginable. This is mainly due to the 'one-way-mission' aspects of launching a satellite. It is generally impossible, or at best extremely difficult, 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, 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 into pre-launch, launch and in-orbit insurance. There are other risks that can be insured separately such as 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 cover for material damage to the launch vehicle and / or the satellite during the period of time between 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 will bear the risk of pre-launch loss purchases this cover. Prior to the satellite leaving 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 usually starts when the satellite has arrived at the launch site. At the launch site 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 made (fuelling, arming, etc.). Pre-launch cover generally ends when ownership passes from the manufacturer to the purchaser. This 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, normally mostly a 'so called' reattach cover policy applies (post-abort cover).

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

Launch Insurance

The launch risk phase generally starts at lift-off but can, alternatively start when the first stage engines are intentionally ignited. In the latter 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 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 satellite, the manufacturer carries the launch risks and will be the policy holder.

Total loss of a satellite is declared when the satellite has been physically destroyed or cannot fulfil its planned operations due to failure to reach 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 declared 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 relation to the decrease in value which will be dependent upon the scale of the failure. The policy will contain formulae to calculate the resultant decreases in value associated with the various potential malfunctions. Reasons for decrease in value could be reduction in fuel supply caused by excessive fuel consumption in the positioning phase, insufficient power supply, transponder failures etc. However, a decrease in value is only granted if the satellite's operational capacity is agreed to be 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 any aspect of the insured's operating requirements and has to be replaced.

CBERS-2 launch on 21 October 2003 with a Long March 4B from the Taiyuan Satellite Launch Centre in China. [INPE]

Launch insurance is the most expensive type of cover. It is not uncommon for launch service providers to offer a 'launch risk guarantee' as an alternative to launch insurance.[5] This could also be provided as a supplement to the traditional launch insurance policy. These guarantees are designed to cover the expense of a replacement launch and usually take the form of a cash payment, or, option of a repeat launch free of charge. Since these guarantees usually cover only part of the launch risk, the operator will require supplementary launch insurance for the remaining portion of the risks. If this supplementary insurance is not taken out, the danger is that these gaps in cover could, and probably would, jeopardize any claims for compensation.

In-orbit Insurance

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

In-orbit insurance covers all risks of partial, or total, loss of a satellite during its commercial operational life period. Such cover may begin as soon as in-orbit commissioning is confirmed. The insured value is an agreed figure, based on replacement value at the beginning of the service life of the satellite. The sum insured covers the total cost of manufacture and launch of a replacement satellite, but the figure 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 a period of twelve months at a time and could be renewed depending on the technical condition of the satellite. Alternatively, these policies are completely rewritten if the satellite's condition or performance warrants this action. If the satellite has been fully operational for some time and there is confidence that the equipment will work for the duration of the commercial life period, in-orbit insurance may be stopped or the operator may turn to self-insurance or under-insurance.

Cover of incentive schemes. The manufacturer and client usually agree that the price of a satellite splits into a fixed and variable part dependent upon 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. Cover of these risks, which is like insuring performance guarantees, is problematic because it is difficult to distinguish it from 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 who do not own a satellite but purchase, lease or rent spare capacity on satellite transponders on an existing satellite. There is a considerable market for this type of activity. Insurance of this type needs assessments on the condition of the satellite and on service protection relating to the specific conditions when the policy holder would be entitled to a replacement transponder.

Loss of Revenue Insurance

Loss of revenue cover operates on an indemnity basis and is due following the partial or total failure of the insured commercial payload. Financial loss caused by the failure could be far greater than the material damage itself. There is no standard form of cover for these insurances, but in general indemnification only takes place when it can be definitively proven that the revenue 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. Consequently, a special form of liability insurance for satellites has 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 on the scheduled ignition of the launch vehicle and ceases when the policy expires or if the satellite and it launch vehicle are completely destroyed. Damage to launch facilities is not covered. Damage to payload(s) is also not covered since the underlying contracts usually contain a cross-waver of liability by all parties.

For States who 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-part liability insurance is usually a requirement prior to the granting of a license for a space launch.

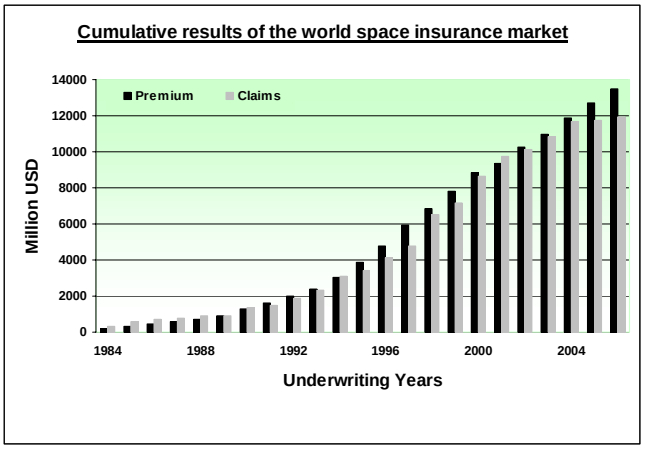
Insuring Commercial Human Spaceflight

In October 2004, space tourism began in reality when SpaceShipOne became the first commercially built spacecraft to carry humans into space. In this new era, 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. In fact, the first so called space tourists Dennis Tito and Mark Shuttleworth both bought insurance policies to cover their financial risks. As space tourism evolves, so will the associated insurance market.

World Wide Space Insurance Market

The World wide space insurance market consists of relatively few players. The first commercial launchers were American launch vehicles. Until the early 1980's Delta and Atlas alone shared the market, but the Space Shuttle and Ariane 4 later changed this dominance. 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 in-orbit satellites. However, since 1998 premium rates decreased and because of the increase in claims, the global loss ratio has returned to levels just exceeding 100%. Nowadays the global results of space insurance in terms of premiums versus claims are finely balanced. The figure to the right presents the cumulative results of the world space insurance market since 1984.

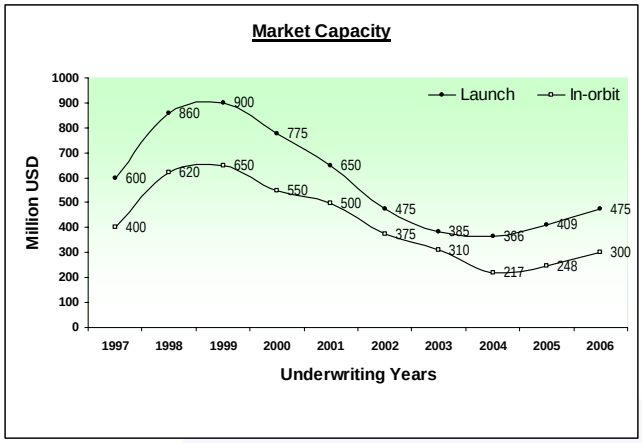
The insurance market cycle and market capacity. The short history of the space insurance market shows a fluctuation between soft and hard conditions.



Cumulative results of the world space insurance market since 1984. [*ribs* SC&I/DB&C]

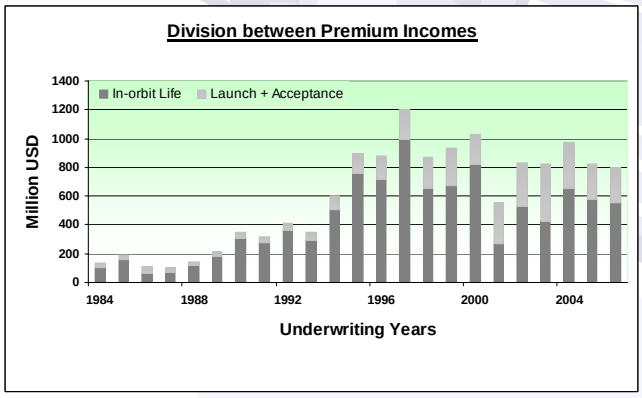
In the very early beginnings, insurance policies were written sporadically. The space insurance industry started in earnest in the 1980s with the growth of the private satellite industry. Due to a series of dramatic losses, the market began in a volatile state, but by the end of the 1980s/early 1990s, the insurance industry became profitable. Premiums for policies for launch plus one year in-orbit (L+1) levelled at around 18-20% of the insured sum. This profitability attracted more underwriter capital thereby increasing insurance capacity. In this new competitive environment, average premium rates lowered. This resulted in, amongst other things, binding launch cover to two to three years prior to the scheduled launch date, a loosening of policy terms and conditions 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, premium rates rising and the policy terms more restrictive. One of the main reasons for this market shift was the business failures in non-geostationary communications networks which caused a dramatic decrease in the launch rate. Large insurance pay-outs - therefore lower underwriter profits - also contributed to a shrinking of market capacity. Between 2000 and 2005, market capacity per launch decreased from 900 mUSD to about 400 mUSD.[6] However, in response to a significant improvement in the sector's profit/loss ratio over the last three years, some 26 insurers have now generated in 2006 an aggregated launch cover capacity of about 475 mUSD per launch. These insurers are world wide, but mainly in Europe and the US. The in-orbit cover capacity in 2006 is estimated to be about 300 mUSD. The

market capacity evolution is shown in the figure below.



The market capacity for launch cover and in-orbit cover evolution. [*ribs* SC&I/DB&C]

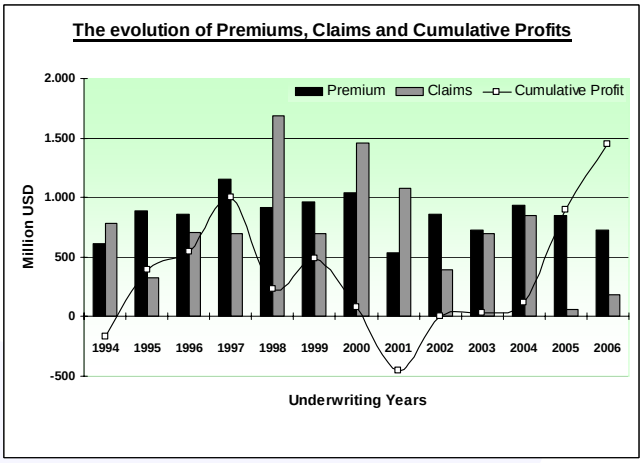
Premium rating. Premiums in the space insurance market are mainly generated by policies for in-orbit insurances and represent about two thirds of the total premium income as shown in the figure below.



Division between premium incomes from Launch and in-orbit acceptance insurance, and from in-orbit insurance. [*ribs* SC&I/DB&C]

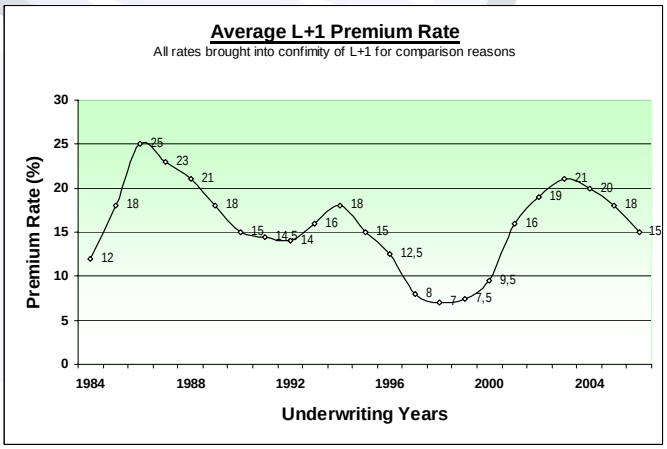
Premium rates increased from the late 1990s due to losses experienced, but further rate increases could not be sustained. Some insurers even began adopting alternative risk management strategies to counter rate increases. As a result of improved sector performance and overcapacity, rates are now reducing for launch as well as for in-orbit cover. In 2005, premium income significantly exceeded paid claims and in 2006 aggregated premium income could be as high as 875 mUSD as illustrated in the figure top right.

Cover conditions and premium rates. Currently, 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%.



The evolution of premium, claims and cumulative profit since 1994. [*ribs* SC&I/DB&C]

Additionally, there is currently 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. The figure below gives an overview of the average L+1 premium rates.



Average Launch + 1 year in-orbit (L+1) premium rates. [*ribs* SC&I/DB&C]

For in-orbit premium rates, there is a tendency to differentiate between satellites which have, or have not, a proven heritage and reliability record. Rates can differ from as low as 1.35% for proven standard spin stabilized satellites to as high as about 5% for unfamiliar or unproven satellites, such as imagery satellites. Here also there is a potential for premium savings through the adoption of increased constructive total loss points. Now,

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Increasingly, space-based assets are used in the pursuit of down-to-earth endeavours. A world without satellite-based communications, navigation and Earth observation is unthinkable. Today, commercial and environmental enterprises as well as civil and military security processes would be unable to operate effectively without space services.

Half of the world's space product expenditure comes from direct government investments through space agencies and organisations. The other half comes from private investment. In this market, companies are forced to make business decisions without a clear understanding of the priorities, intentions and reliability of other involved parties.

To identify accurately tomorrow's space-related opportunities, today's corporate planners face a great challenge. Adequate intelligence on the political, technological and commercial aspects of the space industry is essential for both strategic and tactical decision making.

In this market, success depends on spotting early trends, keeping the initiative and controlling the agenda. Effective and competitive use of exclusive SSI can be decisive in the pursuit of success.

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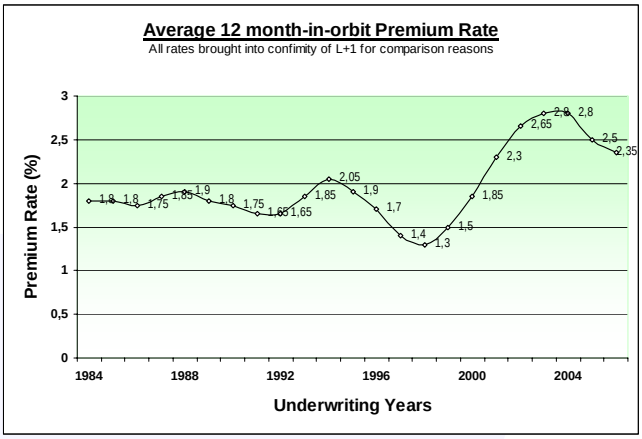
widespread premium reductions are being seen depending on factors such as the sum insured, satellite condition and, not least, loss-experience of the satellite platform and/or the operator. The figure below gives an overview of the average 12 month in-orbit insurance premium rates.



Average 12 month in-orbit premium rates. [*ribs* SC&I/DB&C]

Concluding Remarks

From 2002 on, increased premiums and few claims resulted in a launch insurance net profit. Data from 2005 and 2006 indicates 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 are anticipated, but these will probably be modest. It is assessed that the net profit trend experienced since 2002 may continue in the near future. Consequently, high premium rates will continue to attract more underwriter investments and so increase the market capacity further into the green zone. However, the space insurance market still has no broad base to fall back on. One or two major failures and subsequent high pay-outs could easily consume the profits that have been built up by underwriters.

[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] Willis Space Insurance Market Overview, October 2006.