

Legal Aspects of Space Commercialization

Edited by
K. Tatsuzawa



SECTION II

SPACE INSURANCE

Ilias I. Kuskouvelis

Docteur d'Etat en Droit, M.A., D.E.A.; Member I.I.S.L.

Introduction

In 1982, ESA insured the Marecs-A and B satellites for \$90 million,¹⁾ for a premium of \$6.7 million (7.5% of the insured capital). Insurance would cover only a second failure, meaning that payment would occur if both satellites malfunctioned or were destroyed during launching. Thus, having successfully launched Marecs-A, the second satellite was not covered. ESA decided to insure Marecs-B and obtained a coverage of \$20 million for a premium of 6.5% of the insured capital (at the moment Ariane had 3 successful out of 4 launchings). The launching of Marecs-B having failed, ESA was compensated and, thus, financed partially the construction and launching of a replacement, Marecs-B2.²⁾

A \$150 million Japanese satellite, built by Ford Aerosystems and launched by Ariane June 6, 1989, has failed in geosynchronous orbit because most of its attitude control propellant leaked overboard. Japan's Space Communications Corp. (SCC) was forced to shut down its Superbird-A which has been used by 20 companies and was providing TV for a 100,000 homes in Japan, in December 23, 1990, and is filing a \$150 million insurance claim for the vehicle and additional insurance filings are likely by users of the satellite. The inability to provide communications services could cost the SCC millions of dollars in revenue. A substitute spacecraft cannot be launched before November 1991. SCC is working a plan to transfer some SCC customers to the two satellites JC-Sat-1 and 2.³⁾

These two cases are just an illustration of the variety of risks space activities incur, the costs, and

the possible solutions space insurance provides in order to compensate the damage or economic losses. This section, however, covers most aspects of space insurance. The following subjects are examined: the nature of space activities; the actors of the space insurance market; the relevant space law rules; the transactions in the space insurance market; the four different types of market space insurance, and finally, governmental insurance subsidies.

1. Nature of Insured Activities

A. Recent

Space activities are recent and relatively unknown to the insurance industry. Up to 1965 all American satellites were governmental and, thus, the government assumed the risk. Until the mid-70s, commercial applications developed slowly, and then at a rather faster pace. In comparison, however, to maritime and aviation activities, there were few cases to be insured and, it was therefore, difficult for the insurance industry to evaluate the space risk, calculate premia, and, at best, create a pool of capital to be used in case of losses.

B. Evolving

Telecommunications, meteorology, and remote sensing were at first entrusted to profit and non-profit public international and regional entities, such as INTELSAT and INMARSAT, EUTELSAT, and INTERSPUTNIK. Private enterprise became interested in the commercial aspects of these activities. Naturally, commercial applications need insurance coverage, and, thus, private enterprise became the client of space insurance.

An important evolution also occurred in space

launch services. Today, besides the USA and the USSR, Arianspace, China, and soon Japan,⁴⁾ provide these services with Expendable Launch Vehicles (ELVs). The USSR and China have even created profit organizations in order to commercialize their launch capabilities, and the American government has allowed private enterprise to enter the sector of launch services.

Launch agencies have used different vehicles. Arianspace is currently using the Ariane IV launcher and is preparing the Ariane V model. Soviets advertise their Proton, and Chinese the "Long March" launch vehicle. The most important diversification in space launch services was brought, however, by the introduction of the American Space Shuttle, a reusable vehicle. The above vehicles have a different ratio of success and, therefore, expose their clients to a varying risk of failure.

2. Risky and Expensive

An important number of satellites were destroyed during launching and others did not function or failed very early in orbit. Annex I is an indication of satellites lost and the reason for their failure.

Destruction during launching or failure in orbit means losing the initial investment for the satellite's building.⁵⁾ Its total cost, however, is related to its expected function. The loss of a scientific satellite brings cancellation of a research program, and that of military satellite may cause important problems to national security systems.

Failure of a commercial satellite involves loss of profits. The cost is greater when the commercial satellite system is operational, different services allotted, and the operator has already assumed obligations towards users. As in the above example of the Japanese Superbird-A, Space Communications Corp. has to accommodate its users on other satellites; but even if it wanted to replace its satellite, it would have to wait for a new launch.

Finally, loss of satellites means compensation paid to the insurance industry. Again Annex I offers an example of compensations paid for failed satellites.

The Space Insurance Market

Clients

As military and scientific satellites are insured by governments, the number of space insurance clients

is very limited.⁶⁾ Clients are basically corporations (i.e., RCA, ASTRA, SCC, UWC) and international organizations (i.e., INTELSAT, EUTELSAT, ARABSAT, etc.) wanting to exploit a satellite service and be insured against the space risk.

The first client to take an insurance policy was a telecommunications satellite — COMSAT's Early Bird in 1965. COMSAT had taken a third-party liability, for damages during the satellite's launching and its orbital life, and a pre-launch insurance for damage before launching, while the satellite was still on the ground.⁷⁾

B. Insurers

Given that the first satellites were governmental, and States are held liable by the Space Treaty and the 1972 Liability Convention for damages arising from their space activities, the first space insurers were States, covering governmental and private satellites.⁸⁾

Market space insurance appeared in anglo-saxon countries with Lloyds of London, as in maritime insurance, pioneering the whole effort.⁹⁾ It has been, however, mostly developed in the U.S.,¹⁰⁾ and the main branch to enter space was aviation insurance.¹¹⁾

The first proper insurance contract covering all risks during launching (launch insurance) of two series of INTELSAT satellites, was signed in 1968. It was not before 1975, however, that the insurance business was ready to insure damages intervening during the exploitation phase (in-orbit or satellite life insurance).¹²⁾

French, German, and Italian insurers have been quite early interested in space insurance and in evaluating the space risk in the context of the European space effort (ELDO and ESRO, fused now into the ESA).¹³⁾ But they entered the space insurance market later than Anglosaxons, with Ariane, in December 24, 1979.¹⁴⁾

For the sake of history, it should be mentioned that there has even been a life space insurance policy, insuring the crew of the Apollo 11 mission. This "astropolicy", made by a Greek insurance pool was hailed by the insurance industry for its inventiveness and innovation.¹⁵⁾ A copy of this "astropolicy" has been obtained and is presented in Annex 2.

Today, space insurance has become the business of a small number of insurance corporations. Given the limited needs for insurance and important losses, insurance business is grouped and competition is

therefore restricted.¹⁶⁾ Today, insurance companies usually insure the space risk and then reinsure themselves through insurance pools.¹⁷⁾

C. The State of the Space Insurance Market

Space insurance has been in a state of crisis since the early 1980s. For the first time in 1982, the total of payments surpassed the total of all premia paid to insurance companies.¹⁸⁾ The continued very high incidence of claims, especially in 1984, 1985 and 1986,¹⁹⁾ brought a big drop in capacity, that is in the volume of insurance on offer, and an escalation of premia to a level which the clients could not bear.²⁰⁾ In 1985, insurance capacity has been reduced from \$180/200 down to \$120 million. Premia went up to around 16-18% of the insured value and even higher according to some experts.²¹⁾

As a reaction, a multitude of analytical studies have been undertaken by space insurers in 1987 and 1988;²²⁾ but the limited number of commercial space launchings carried out in the West from mid-1986 up to 1988 did not allow space insurance business to win back the volume of premia which would have helped it to recover from its state of lethargy. Despite this, according to Dahbi and other observers, the market was back again in 1988, because it has shown improved capacity — about 15 to 20% above that of early 1987 — and a greater willingness by insurers to commit themselves well in advance.²³⁾

On the one hand, the development of capacity was mainly the effect of the situation in the insurance business in general which, from the beginning of 1987, showed signs of increasing capacity in all classes of insurance. On the other hand, the insurers' greater willingness to insure was due to the very low level of demand, resulting from both the small number of insurable launches and the more limited capacity required by clients.²⁴⁾

According to Dahbi, satellite life insurance showed less strain in 1988; the market capacity could amply meet the requirements of clients, and rates remained within acceptable limits, even if they had risen considerably since 1984. The only problem in this type of space insurance arose from the shrinking demand, because a good number of American satellite operators, in particular, preferred to be self-insured against the risk of incidents in orbit.²⁵⁾

Independently of the crisis, insurance business provides an important variety of space insurance

contracts, perhaps because of the expected profits.²⁶⁾ In 1991, however, space insurance rates may go up. International Technology Underwriters announced that space insurers have lost \$200 million on recent failures of orbiting satellites. Intec President Frederick H. Hank said that his company may pull out of the market if rates do not increase. "Clients should anticipate more restrictive terms and coverage at higher premium rates," Hank said.²⁷⁾

3. Relevant Space Law Framework

Space law provisions influence space insurance. The 1967 Space Treaty introduced international responsibility for governmental or non-governmental space activities of States Parties to it (Article VI). The concept of third-party liability was introduced by Article VII of the Space Treaty, and it was later elaborated by the 1972 "Convention on International Liability for Damage Caused by Space Objects." According to Article II, "a launching State shall be *absolutely* liable to pay compensation for damage caused by its space object on the surface of the earth or to aircraft in flight." "In the event of damage being caused elsewhere than on the surface of the earth to a space object of one launching State or to persons or property on board such a space object by a space object of another launching State, the latter shall be liable only if the damage is due to its *fault* of persons for whom it is responsible" (Article III).

In article I, the Convention offers a series of definitions. "Damage" means "loss of life, personal injury or other impairment of health; or loss of or damage to property of States or of persons or juridical or property of international intergovernmental organizations." "Launching" includes "attempted launching," and a "launching State" is the one "which launches or procures the launching" or the one from "whose territory or facility a space object is launched." Finally, "space object" includes its component parts as well as the launch vehicle and its component parts.

If the damage occurs on the surface of the earth or to an aircraft of a third State, as a result of another damage taking place elsewhere than on the surface of the earth between two different "launching" States, then the last two will be held "jointly and severally liable to the third State" in terms of *absolute* liability; if on the other hand this damage occurs elsewhere

than on the surface of the earth, then their liability is based on the *fault* (Article IV).

Although the definition of damage is quite broad, it does not provide anything for lost investments or profits due to a satellite's destruction during launching or in-orbit. The only case in which investment and profit could be possibly claimed on the basis of the Convention, is when the damage occurs to a satellite in orbit as a consequence of a fault of one (Article III) or more "launching" State(s)' satellite(s) (Article V.1.b).

Finally, the Convention does not apply to nationals of the launching State and foreigners participating in the launching or the recovery of the space object, or those present, in the immediate vicinity of a planned launching or recovery area, after an invitation by the launching State (art. VII). Victims excluded may claim compensation under their own national law or that of the launching State.

Transactions in the Space Insurance Market

A. Risk

Risk in insurance law means the possibility of incurring an economic need, which is to be determined by the policy. Possibility means: a. uncertainty whether the economic need will appear; b. although it is expected to appear, it is uncertain when; and c. uncertainty on the amount of the economic need.

Space insurance policy has to determine precisely the elements constituting the advent of the space risk.²⁸⁾ Determining the risk to be insured requires an analysis of the various phases from the construction of the satellite to the operational stage.

During the pre-launch and launching phases, it is uncertain that the launch is not going to be delayed, that the satellite is not going to be lost (destruction or wrong positioning) or cause damage. For the cases of delay and, especially, of destruction, the cost of the satellite and the lost expected profits can be approximately calculated in advance; what cannot be calculated in advance is the extent of damages to third parties.

Once the satellite is in the right orbital position, it is known that its lifetime has a limit. What is not known is whether this is going to happen earlier than expected, and to what degree its operational capabilities are going to be reduced. Finally, many satellites, unless pushed to a higher safety orbit, are

expected to return to Earth. It is uncertain when this may happen, uncertain that the satellite is not going to disintegrate, and uncertain if it will cause damage and of what amount on our planet.

Space insurance has to determine the possibility of the advent of the risk. First of all, both the insured and the underwriter need to know whether it is a simple or joint launch,²⁹⁾ and have a good technical knowledge of the launch vehicle and the satellite. This appears necessary for the insurer who often reinsures himself by other insurance branches not having a good knowledge of space activities.³⁰⁾

Based on this technical information, the insurer needs to know the statistical appearance of the risk during the different phases of a satellite's life. Space insurers collect information and analyze statistically the launch vehicle's and the satellite's reliability. Calculation of the risk influences the level of premia, and a low premium means increased reliability and low risk. On the other hand, an increased premium in the market means a low reliability of the launch vehicle, reducing thus its competitiveness.³¹⁾ As an example, in the late 70s, insurers have, on the basis of 150 launchings, calculated the statistical reliability of the launcher Thor Delta to 93% and asked for a simple launch premium of 7.8%, lowered soon to 6.1%. The Ariane launcher's reliability in the very beginning of the program, given its two failures during the development and one operational launchings, was estimated at 60%.³²⁾

The statistical occurrence of the risk is difficult to determine given the limited number of launchings; calculation of probabilities and the law of great numbers do not apply in space insurance as in maritime or aviation insurance,³³⁾ where there are thousands of ships and planes undertaking millions of trips. Calculation becomes harder in the case of States which do not allow a great amount of information concerning their launch vehicles.

Finally, it should be pointed out that some categories of risk are excluded. According to Diederiks, insurance policies exclude: nuclear risk, the risk of war, technical deficiencies inherent to the project, and worn out equipment.³⁴⁾

B. Capital to be Insured

The aim of any insurance is to provide insurance coverage, meaning the economic means in order to face the occurrence of the insured economic risk

(need). Insurance coverage takes often the form of damage compensation, but also the form of down-paying a prefixed amount, without even examining if the insured risk provoked a damage as in the case of life insurance. In the first case, it is necessary to determine financially the economic need that the risk's occurrence will create. If the cost of damages cannot be calculated, because limits cannot be traced, then the insurer together with the insured may set a ceiling of the insurance coverage. Based on this ceiling, and in relation with the chance of the risk's occurrence, the insurer is going to calculate the premium for the insurance policy. On the other hand, the "launching" State, the satellite's owner³⁵⁾ and/or operator³⁶⁾ may also calculate, on the basis of the risk and the premium they want to pay, the amount they want to be covered for.³⁷⁾

The owner has to insure the cost of the satellite and the price he paid for its launch. He has to negotiate with the satellite's constructor and the launching organization in order to obtain the best price possible and consequently reduce the amount to be insured and the premium he will have to pay.³⁸⁾ This insurance coverage may be used for financing partially or totally the relaunching of another satellite.

The owner has to determine the profit he expects from the satellite's renting, and the guarantee he pays to the operator for the expenses the latter has undertaken, i.e. for the construction of earth stations.³⁹⁾ The operator may take an insurance to cover expected profits, the amount he has advanced for the creation of the exploitation system, i.e. advertizing of the satellite services he will provide, guarantees to other secondary commercial operators. In relation to profits of the owner and/or operator, the insurance coverage is influenced by the calculation of the risk — the end of the satellite's orbital lifetime. The earlier the satellite ceases functioning in relation to his expected life in orbit, the higher is the compensation to be advanced by the insurer.⁴⁰⁾

In determining the insurance coverage, both the owner and the operator have to take under consideration launching delays, which may cause important financial losses and fines. If this delay is due to the launching authority, then no indemnities are foreseen. If, however, the delay is due to the client and the schedule of flights has to be modified, then the client has to pay delay compensations. In practice, Ariane-space, with the idea that the later the delay is an-

nounced the greater is the resulting inconvenience, asks for higher compensation for delays the closer to the launching date the announcement is made.⁴¹⁾

C. The type of the insurance contract

The insurance contract is the conclusion of negotiations between the satellite owner or operator and insurers. The former will try to obtain the largest insurance coverage possible for the lowest premium; the latter, taking under consideration the existing technical and statistical data, will seek and eventually invent a formula to leave some of the risks to his client.⁴²⁾

In order that both sides reach the desired aim, many innovations have been introduced. We may thus see that instead of insuring one satellite, insurance covers a series of satellites or a specific number of failures over the entire series. It can be provided that coverage may be reduced proportionally either to the limitation of the satellite's performance or to the satellite's remaining expected lifetime. Finally, the premium could be broken in to several payments,⁴³⁾ or, if no insured risk has occurred, a part of the paid premium could be returned, according to a clause launch insurance policies contain, known as "no loss, return premium."⁴⁴⁾ This clause requires that the insured pays a higher premium at the conclusion of the contract. At the end of the insurance coverage, the refunded part of the premium will reduce its cost in relation to the regular market premia.⁴⁵⁾

Authors examining space insurance have distinguished the methodological distinction of contracts in to those covering third-party liability and those covering economic loss.⁴⁶⁾ Here another existing categorization is chosen, distinguishing three categories of space insurance on the basis of distinct phases of the satellites' life: pre-launch, and in-orbit insurance.⁴⁷⁾ The second and third categories include insurance coverage for economic losses by the insured and for damages to third parties. We have to add a fourth category which is the Liability re-entry insurance.

5. Pre-Launch Insurance

This insurance covers both the launch vehicle, the satellite development, their transport to the launching center and their testing, up to the moment of their

integration on the launching pad or the launch vehicle's ignition.⁴⁸⁾ Most probably two liabilities may be incurred:

Property damage and consequential loss resulting from it, caused by the launching agency or the satellite owner and their agents, contractors and subcontractors during the launch campaign to facilities and equipment used for, or in connection with the launching (the launching pad, satellite preparation hall, the launcher and satellite, their ground support equipment) respectively.⁴⁹⁾

Bodily injury caused by the same launching agency, satellite owner or their respective agents, contractors or subcontractors, to representatives or employees of any party engaged in carrying out the launch, during the launch campaign.⁵⁰⁾

These damages cannot be insured under third-party launch liability insurance, even if such damage is attributable to the other party involved in the launching. Although, from a technical point of view, liability insurance can be designed to apply in the same way as property or bodily injury insurance, insurers exclude in general from the provisions of liability policies bodily injury⁵¹⁾ and damage to property in the care, custody or control of the insured. Instead, they prefer to cover liability for injury or damage to such property under a regular bodily injury or property damage policy, based on the indemnity principle.⁵²⁾ According to Bourély, as these activities are not proper space activities, they could be covered by common industrial insurance policies.⁵³⁾

Consequently, the launching agency and the satellite owner come to a "hold harmless" pact under which each party agrees not to bring any claim against the other party for bodily injury⁵⁴⁾ or damage caused to his property. The scope of the "hold harmless" pact must include property belonging to the agents, contractors and subcontractors of both parties.⁵⁵⁾

According to Dahbi, there is a third liability possibly to incur: damage to property and/or bodily injury, which may be caused from the start of the launch campaign to any third party on the earth's surface by the launch vehicle, the satellite or any part of them.⁵⁶⁾ The chances of its occurrence, however, are limited. Transport of the different space components is effected very carefully. Once they arrive at the launching base, then the danger of damage to

third parties due to pre-launch operations is very limited due to the remoteness and the important size of space centers. On the contrary, the chances of causing damage to any third party are increased during the launching phase, which is examined below.

6. Launch Insurance

A. Satellite(s)' Loss or Damage

This is the type of insurance the market has paid the largest amount of compensation for in comparison to third-party liability insurance whose risk is estimated higher and the coverage is more important.⁵⁷⁾ It provides coverage for damage to or loss of a satellite during the launching,⁵⁸⁾ including the apogee manoeuvre if any, and commissioning tests. This insurance expires when the satellite becomes operational in its final position on orbit.⁵⁹⁾

The risk of the satellite's destruction during launching is left by both NASA and ESA to the client. Launching agreements exclude any possibility of action against the launching authority for damage or loss of the satellite.⁶⁰⁾ If damage occurs, insurers compensate, i.e., the owner of the satellite, but they have no right to claim against the launching State.⁶¹⁾

Action is as well precluded between clients, if there is more than one satellite on board. This innovation was introduced by the American Space Transportation System (STS), the Space Shuttle, able to carry more than one satellite. Some of them are scientific and, consequently, costs less than commercial satellites. In order that NASA does not lose small clients, it adopted since November 1, 1982 an "inter-party waiver of liability," a policy according to which clients are obliged to abandon systematically their claims against NASA or its contractors or against other passengers aboard the Space Shuttle and their contractors.⁶²⁾

The inter-party liability waiver is based on the "NASA Shared Launch Agreement on Payloads Launch and Associated Services," issued by the NASA office of space transportation operation on March 8, 1979. It stipulates that the Shuttle's "user" should agree to its provisions. Article V.3 of this "Cargo Launch Agreement" on the allocation of certain risks, states:

"NASA and the user agree that, with respect to damage to persons or property involved in a Space Transportation System (STS) operation,

neither NASA or the user, nor any person who has contracted with NASA or the user of STS services or who owns property or employs a person to be flown on the Shuttle, shall make any claim with respect to injury to or death of its contractor's property or personnel caused by NASA, the user or any other persons involved in STS operations during such operation, whether such injury, death or damage arises through negligence or otherwise."⁶³

Consequently, each party has to insure its own property in order to cover possible damage during the operation.

B. Third-party Launch Liability Insurance

Compensation for damage caused to third parties during the launching of a satellite, by the launch vehicle, the satellite or their component parts, is governed by the Liability Convention.⁶⁴ Thus, the Liability Convention drives States and persons or corporate bodies, involved in launching operations, to take an insurance policy.

The policy's coverage starts either with the satellite's integration on the launcher and the launching pad or at the moment of the intentional ignition of the launch vehicle. It ends either with the complete destruction of the launch vehicle, or with the expiration of a certain delay after which the satellite is considered as destroyed⁶⁵ or as functioning in its right orbital position.

Third-party liability policies do not cover: a. property damage to facilities and launching equipment, and bodily injury to people participating in the launching operations; b. financial loss, that is loss of expected profits; and, c. noise, pollution and other nuisances, not resulting from an unforeseen occurrence, during launching or when the satellite is in service in orbit.⁶⁶

When there is only one "launching State."⁶⁷ then operations are undertaken with the State's own responsibility. When the launching State provides its launch services to another State or a foreign private entity, then we have according to the Liability Convention two launching States bearing responsibility, and the former asks the latter to take a third-party liability policy.

(1) NASA

This was the case when NASA offered its launch-

ing services to other States, like Canada, the U.K., France, Japan, or to international organizations like ESA, INTELSAT, etc. NASA obliged its clients to take an insurance policy covering the U.S. liability obligations in case of damage. Initially, the insurance coverage was of \$100 million, and around the end of the 1970s it rose to more than \$300 million. Given the rare damages to third parties and the important preventive measures taken by NASA, the premium required for a \$100 million coverage was of \$25.000 per launching.⁶⁸

In practice, however, launching organizations take an insurance policy either for a series of launchings of the same vehicle or for a determined period of time.⁶⁹ In the case of the Shuttle, the risk of spacecraft liability during launching is covered by a joint insurance policy taken by NASA and every satellite-client. The 1979 amendment of section 308 of the 1958 NASA Act imposes NASA to contract a global insurance policy in order to cover third-party liability; NASA does this and the user pays the part of the premium corresponding to its satellite.⁷⁰

This in practice meant that, at the conclusion of a launching agreement, NASA obliged its clients to take an insurance policy for third-party liability of \$500 million per flight (or proportionally to their satellites).⁷¹ As liability is unlimited, the launching States should pay the rest of the amount, if compensations surpassed the amount of \$500 million.⁷² There is, thus, an insurance coverage shared between the market and launching States.

(2) ESA — ARIANESPACE

The same principles of liability apply to the ESA/Arianespace launch vehicle Ariane, creating liability obligations to the French government, not only because the latter is an ESA member, but also because Ariane is launched from French territory. Ariane's development launchings have been effected under ESA's supervision, which had contracted an insurance policy for these launchings.⁷³ If ESA had to indemnify more than the insurance coverage, then, according to the Liability Convention, the surplus amount had to be covered by the ESA members. But, according to Article 4.1 of the ESA members' Declaration of January 14, 1980,⁷⁴ it is France which is going to bear the amount over 400 million French Francs of compensations.⁷⁵

Since the 11th launching (November 9, 1984), re-

sponsibilities have been transferred to a private agency of French nationality, Ariespace, providing commercial launching services. This agency either provides insurance coverage by its own insurance system or it makes obligatory to its users to subscribe an insurance policy. If a victim sues the French government, Ariespace has to pay up to FF400 million and the rest is paid by the French government, which according to the Liability Convention's Article I is a "launching" State held liable.⁷⁶⁾

Ariespace organized space insurance by covering a series of launchings and not by each launch. The principle used is that of self-financing, by compensating losses with the successful launchings' gains of premia. For this purpose, Ariespace created an insurance company, the "Societe de Reassurance de risques relatifs aux applications spatiales" (S3R), providing only launch insurance.⁷⁷⁾ Starting in 1986, S3R proposed to Ariane clients a system of reinsurance covering a series of 15 non consecutive launchings, estimating one failure out of the 15.⁷⁸⁾ This first series was covered with a preferential percentage premium — 11 to 13% — depending on whether the client was relaunching with Ariane.⁷⁹⁾

A second series is now open covering a group of 30 launchings with a slightly higher premium, of 12.9 to 14.5%.⁸⁰⁾ Until mid 1988, S3R had made 19 insurance policies.⁸¹⁾ The capital insured is of a 100 million European Currency Units. Insurance has to cover 5 failures out of 30 launchings. The 4th and 5th failure are reinsured by the Caisse Centrale de Reassurance, with a premium calculated over the thirty flights.⁸²⁾

(3) The space industry

Third-party liability insurance was boosted since the 1984 U.S. Commercial Space Launch Act⁸³⁾ gave corporations the right to commercialize launch services and use in this respect certain Federal ground facilities. Section 16 of the Act requires every private entity engaging in space launching to take an insurance policy for third-party liability in such amount as the Secretary of Transportation deems necessary, considering U.S. international obligations.⁸⁴⁾

In 1988, the U.S. government, under pressure from the industry, amended Section 16. Accordingly, the U.S. government assumes liability risks up to \$1,5 billion for claims in excess of the amount of \$500 million, amount of the private launching agency's

demonstrated responsibility or of the insurance obtained by it.⁸⁵⁾

Several American corporations propose their launch vehicles: General Dynamics, the Atlas and Centaur; McDonnell Douglas, the Delta and Delta II/MLV; Martin Marietta, the Titan, Titan 34D, and Titan 3 Commercial;⁸⁶⁾ American Rocket, provides "small industrial vehicles" from Vandenberg A.F. Base; Conatec, the Terrier-Blanc Brant vehicles, from White Sands New Mexico; E'Prime offers services from Cape Canaveral and Cape York, Australia; and Space Services, Inc., the Conestoga vehicle, from Wallops Island, Virginia.⁸⁷⁾

These corporations, and European groups of satellite constructors, like Aerospatiale/MBB or Matra/British Aerospace, had to solve problems similar to those Ariespace encountered since the first commercial flight of Ariane in May 1984.⁸⁸⁾ Martin Marietta, General Dynamics, McDonnell Douglas provide similar insurance coverage as S3R.⁸⁹⁾ Martin Marietta is said to ask lower premia than those of S3R for its Titan-3 Commercial (10 to 12%).⁹⁰⁾ Aerospatiale has created Aeroassurance, its own insurance company.

They use as well indirect insurance mechanisms, such as the turn-key agreements. According to such an agreement the constructor has to deliver the satellite to its client functioning in the right orbital position. Therefore it is the constructor of the satellite who assumes the pre-launch and launch phase risk. The practice was initiated in the U.S. and has been recently introduced in Europe, by Aerospatiale and MBB.⁹¹⁾

(4) State of the third-party (launch) liability insurance

Up to 1988, third-party liability insurance has not encountered the same difficulties as the satellite's loss insurance and satellite life insurance. From time to time there was some difficulty in finding all the capacity needed to cover multiple launchings, particularly with multiple payloads on board the Space Shuttle, before the tragic accident of January 28, 1986.⁹²⁾

Its cost has remained marginal: about \$150,000 per launch, for coverage during launching (and first year in orbit) of a half-ARIANE-3 class satellite, and for a single combined property damage and bodily injury limit of some \$100 million. In Dahbi's opinion, in 1988, it was possible to obtain a limit of

500 to \$700 million per occurrence, if the corresponding premium was seen as sufficiently attractive by the underwriters and if standard coverage only was required.⁹³⁾ Is this amount adequate? Many observers think it adequate, taking under consideration the locations of the launch sites and the measures taken to prevent loss of the life and property, while the launch is carried out.⁹⁴⁾

The characteristic of third-party liability insurance is that nobody can assess the amount of loss beforehand. In cases such as the launch of commercial satellites, anyone who wants to work out a projection, combining any number of claims or aggravating circumstances, can reach a much higher figure than \$750 million or even \$1 billion. Everyone is aware of this problem, but no solution can be found on the insurance market, whatever the amount of premium the client is prepared to pay.⁹⁵⁾ As will be shown, the problem seems to be solved with the help of States.

7. In-Orbit Insurance

A. Satellite's Damage or Loss Insurance

This insurance is purchased by satellite owners or operators, in conjunction with launch insurance, in order to cover themselves against the partial or total loss of its operational capability or any shortening of its life or any consequent financial loss they might suffer.⁹⁶⁾

Orbital lifetime may be divided into several periods and thus insurance can be expanded each time in order to cover a new period of the satellite's life. For a geostationary satellite, whose expected lifetime is seven to ten years, insurance will cover the first three years. Then the state of the satellite will be assessed and eventually the coverage will be expanded for another three years.⁹⁷⁾

If the lifetime is shorter than expected, then the insurer will have to pay for lost profits. Obviously the clauses of the insurance policy in relation to lost profits will be very restrictive so that only the real and justified losses can be compensated.⁹⁸⁾

Besides orbital lifetime, the satellite's performance can be divided as well, from a limitation of its functions to total failure. This avoids an "all or nothing" formula and to compensate proportionally a partial deficiency.⁹⁹⁾

B. Third-party orbital liability insurance

Chances of a collision in orbit are limited, yet they have increased due to space debris.¹⁰⁰⁾ Some damages have been attributed to parts of other satellites. It has been suggested that Cosmos 1275 has been completely destroyed by space debris. It was even found that during the 7th Space Shuttle mission, in 1983, a paint flake had just missed destroying its window in space.¹⁰¹⁾ In cases such as these, it is difficult to find out the origin of such debris and determine liability.

The insurance market does not issue policies exceeding 12 to 18 months.¹⁰²⁾ This has not been seen as a problem by clients, given that the greatest exposure to risk is during launching. Once the satellite is in orbit then the risk of a faulty collision becomes very remote, if indeed it still exists.

Yet, the risk of collision between two jointly launched payloads is higher than usual at the moment they are set free by the carrier. NASA has taken precautions against such an eventuality. According to art. V.2 of the "NASA Shared launch Agreement on Payloads Launch and Associated Services," "the user shall obtain, at no cost to NASA, insurance protecting the U.S. government and its contractors from any third party for any damage resulting from a free-flying payload after separation of the payload from the shuttle."¹⁰³⁾

8. Re-entry Liability Insurance

Authors neither specify whether damages, in case of a space object's re-entry, are covered by third-party launch liability insurance, nor leave any hint for such an eventuality.

The re-entry of a space object may cause damage and gives rise to economic claims. Some dangerous re-entries have been registered. By 1972, 34 cases of crashed satellites or rocket stages were reported. In 1969 a Japanese ship was hit by pieces of space debris and 5 sailors were injured. The most wellknown are those of the Soviet nuclear powered Cosmos 954, which in January 24, 1978, fell in Canada, and of the American Skylab, which in 1979 fell over Australia with pieces up to 500 kg hitting the ground. Worries have been expressed during the re-entry of another Cosmos (1402), in October 1982.

Re-entry Liability is purely a third-party liability. On the one hand, the 1972 Liability Convention holds liable the "launching" State for any damage caused

by a space object on the earth or to aircraft in flight. On the other hand, the satellite, when it re-enters, is considered as having already lost its commercial value in orbit.

The range of damage caused by the re-entry of the Skylab is not known. Claims due to Cosmos 954 damages were settled through negotiations between Canada and the USSR. On April 2, 1981, Canadians and Soviets signed a Protocol, under which Canadians accepted a payment of C\$3 million "in full and final settlement of all matters connected with the disintegration of the Soviet satellite 'Cosmos 954' in January 1978." As Hurwitz points out, Canadians agreed to accept C\$3,041,174.70 less than the compensation originally demanded, and C\$10,979,143.66 less than their actual expenses.¹⁰⁴⁾

It is not clear what damages the Soviets paid for. Implicitly, however, it was recognized that "the definition of damage in the Convention included 'damage to property of States' caused by nuclear contamination," precautionary steps to limit damage, and psychological harm.¹⁰⁵⁾ Thus, for a damage which did not include any bodily injury or other tangible property damage, actual expenses were of C\$11 million. What could the amount to be claimed have been if such injuries had unfortunately occurred? And what if the satellite was owned by a private entity not having taken any third-party liability insurance for re-entry?

Of course the launching organizations or the launching organization would have paid. But, wouldn't it be safer for them if the satellite's owner had to take an insurance policy for third-party re-entry liability? If up to now, only self-insurance is practiced for the re-entry risk, then this is not a wise path to follow.

9. State Subsidies/Insurance

"In addition to financial protection against space mishaps through private insurance contracts, protective practices have been used by governments for subsidizing either directly or indirectly commercial space endeavors, including launches, conducted under the authorization and supervision of those governments."¹⁰⁶⁾ Since the price of launching influences directly the insurance coverage and the premium paid, every governmental intervention permitting the launch price to be lower could be considered as a form of indirect insurance.

(1) USA

The private sector in the U.S. benefits from indirect subsidies. American launch corporations did not pay back the important research and development cost of the launch vehicles.¹⁰⁷⁾ Instead, the Department of Transportation explicitly received the order to encourage them.¹⁰⁸⁾ According to section 15 of the Commercial Space Launch Act,¹⁰⁹⁾ the private sector could acquire certain governmental facilities and equipment at a "fair market value" or on a cost basis, determined by the governmental agency possessing the facility in consultation with the Department of Transportation. Although section 15 recommends not to provide direct governmental subsidies, American launch corporations, such as Transpace Carriers Inc., have paid very interesting prices for obtaining launch installations.¹¹⁰⁾ Research will continue on ELVs, corporations will continue to benefit from it, and they could soon be using the Cape Canaveral and Vandenberg facilities. Moreover protectionist groups in the 96th U.S. Congress proposed the creation of a "Space Industrialization Corporation" in order to promote, encourage, and assist the development of the space industry.¹¹¹⁾

Direct subsidizing is obvious in the difference, on the one hand, between nominal and practiced prices, and, on the other, between practiced prices and the total cost of a Space Shuttle mission. In 1977, a decision was made for prices to remain stable for the first three years of the Shuttle's operation. They were going to be increased in the following nine years in order to cover the expenses of all twelve years.¹¹²⁾ Clients could pay in advance as high as \$100,000 and as low as \$1,000 1975 dollars for "small self-contained payloads."¹¹³⁾

These nominal prices were similar to those practiced by ESA/Arianespace and without discrimination to American or foreign clients. The price for a satellite of the half-Ariane-3 class was \$18 million; for an Atlas Centaur class satellite, occupying half of the Shuttle's bay, \$24 million, plus \$6 million for the Payload Assist Module (PAM-A), the satellite's booster to the geostationary orbit. But pricing was flexible and could be revised according to the size and weight of the satellite, the type and time the flight was scheduled, and the number of clients on the same flight.¹¹⁴⁾

Thus, until the fall of 1985, NASA was effectively charging, according to the 1977 pricing system, \$38

million 1982 dollars for the full use of the Shuttle's cargo bay.¹¹⁵) In addition, NASA has for a long time offered the promotional price of \$10 million, of which Canada took great advantage. As a result, practiced prices varied a lot from the announced nominal prices.¹¹⁶)

Corporations entering the space launch services protested, however, against these low prices (and those of Ariespace), which compromised their commercial chances.¹¹⁷) NASA decided, starting in the fall of 1985, to set a new price of \$71 million, and, after 1988, a minimum of \$87 million. This put NASA in conflict with the Department of Transportation which suggested a price as high as \$150 million.

In 1985 President Reagan settled the issue with National Security Decision Directive 181.¹¹⁸) The Shuttle's 1989-91 commercial flights should be auctioned, starting at the bottom price of 74 million 1982 dollars for the full Shuttle bay.¹¹⁹)

Now let's compare the announced or practiced prices with the total cost of a Shuttle' mission. According to estimates, the total cost exceeds \$200 million.¹²⁰) Of this cost, the commercial part of the Shuttle's mission represents the 2/3 or the 3/4; yet, the price paid by clients was far from covering even the commercial part.¹²¹)

All this has been, however, changed after the Challenger accident. NASA announced, in August 1986, that the Space Shuttle will be limited to launching payloads that require the unique characteristics of the Shuttle or those that otherwise directly serve U.S. national security or foreign policy issues.¹²²) This policy has been codified in the National Security Decision Directive 254, stating that "the STS will be phased out from providing launch services for commercial and foreign payloads that do not require a manned presence or the unique capabilities of the STS. If there is a need for additional NASA capacity for government launches, then NASA is authorized to contract for necessary ELV launch services (U)."¹²³)

Obviously, NSDD 254 does not prevent NASA from undertaking commercial launchings. Consequently, given the present situation of the market, the Shuttle price would remain closer to the bottom (\$74 million), and, thus, the U.S. government's subsidization will persist at the same levels.¹²⁴)

(2) Europe/ESA/Ariespace

The Ariane vehicle was developed in the context of ESA and commercialized by Ariespace.¹²⁵) As in the US, Ariespace benefits from indirect subsidies to a different degree and with different modalities. The most important form of subsidy is that ESA does not recover the research and development cost of the launch vehicle. ESA members have made available to Ariespace the production facilities of the Ariane ELV, France, against payment, the use of the Kourou base, and CNES made available some of its personnel. Ariespace benefited as well from the commercial promotion of the launch vehicle made by ESA and the preference ESA members have to show to the Ariane launch vehicle.¹²⁶)

ESA members paid 175 million 1975 French Francs (F.F.) for a simple, full, 1.7 tons capacity. Ariane I launch; 150 million FF for a simple demi-Ariane or Thor-Delta (1.1 tons) launch, and 95 million FF (per satellite) for a joint launch of Thor-Delta class satellites.¹²⁷) But, according to the Declaration of January 14, 1980, and the agreement between ESA and Ariespace, the latter could offer lower prices to non European clients, who usually obtained a 20% reduction.¹²⁸) Under this "two tier pricing policy," ESA members had to pay, until the 1st of July 1986, higher prices in order to subsidize the Ariane vehicle.¹²⁹)

The "two tier pricing policy" was aimed at promoting Ariane and permitting it to compete with the Shuttle which was already heavily subsidized. But U.S. corporations (in particular Transpace Carriers Inc.) complained about this two tier pricing, and, in May 25, 1984, filed a petition before the U.S. Trade Representative.¹³⁰) Ariespace declared in a communiqué of May 29, 1984, that, after 1987, the "two tier pricing" would be suppressed. Then negotiations between ESA and the U.S. authorities started at the end of 1984; ESA exercised pressure by wanting to expand discussion on subsidies and pricing of all space transport systems, including the Shuttle and future means.

Presidential NSDD 181 and 254 were answers to the ESA initiative and pressures. The TCI petition was dismissed by NSDD 181; Ariespace practices, said the decision, "are not unreasonable and a burden or restriction on U.S. commerce."¹³¹) Finally, NSDD 254 limited the Shuttle's commercial missions.

(3) USSR

In 1985 the Soviets created the Glavcosmos organization in order to provide the means for international cooperation, and also to commercialize the Proton launch vehicle.¹³²⁾ In July 1986, the foreign trade Litsenzingtorg agency created the group Cosmos, with the mission to take orders for foreign satellite launches.¹³³⁾

The Soviets proposed quite interesting financial terms for launches. A 2 ton geosynchronous satellite launch would cost \$30 million instead of 40.¹³⁴⁾ Moreover, in case of a failure, Soviets offer a free new launch.¹³⁵⁾

Besides this indirect insurance coverage, Ingosttrakh, the Soviet insurance agency, announced some insurance coverage systems.¹³⁶⁾ In addition, in order to increase their credibility, Soviets have as well contacted, in 1988, some Western insurance companies, whom they wanted to associate with covering space risk.¹³⁷⁾

(4) China

The Chinese are trying to commercialize their "Long March" 3 and 4 vehicles through the Great Wall Agency (CGWIC). They claim practicing prices, terms and conditions compatible with those other services provided in the market, without missing to advertise that prices for "end users" are more competitive than those of others.¹³⁸⁾

Their terms are close to those offered by the Soviets. For a geostationary launch of a 1.5 ton satellite, they ask a price of \$30 million. And like the Soviets, they offer as well a new free launch in case of failure.¹³⁹⁾

As Jiao Yong states, the People's Insurance Company of China (PICC) insures launch services with rates and conditions similar to those of the world market. Customers "can select all kinds of launch insurances" and PICC may "provide reasonable gross insurance"; "if the required gross insurance of customers is over the insurance offered by PICC, the latter can be in charge of reinsurance to the international reinsurance market."¹⁴⁰⁾

10. Satellite Rescue and Insurance

In November 1984, Space Shuttle Discovery has captured and brought back to earth the Western Union Corporation's Westar VI and the Indonesian

Palapa B 2, whose loss was compensated by \$105 and \$75 million respectively. Moreover, in 1984, Challenger repaired the satellite Solar Max in orbit.¹⁴¹⁾ James Beggs, the NASA Administrator, said then that rescue missions permitting maintenance and provisioning of satellites in orbit could extend their lifetime from an expected 7 to 10 years up to 40 to 50 years.¹⁴²⁾

Such an extension of lifetime or the recovery of satellites could have important consequences for the insurance business. In fact, Lloyds, who had paid \$180 million in compensations, took possession of the satellite and wanted, after repairing them for a cost of \$5 million each, to sell them again for a total of \$60 million.¹⁴³⁾ Westar-6, sold and renamed Galaxy 6, was expected to be launched by Ariane in 1990.¹⁴⁴⁾

Although such operations are limited to low earth orbit, after these successes, the space insurance community thought that rescue missions could better the insurance's financial condition and allow clients to pay lower premia; also, that future policies had to contain clauses on the property and the rights on rescued satellites.¹⁴⁵⁾ But, according to others, rescue missions were difficult,¹⁴⁶⁾ and not very interesting financially, given the cost of rescue¹⁴⁷⁾ and the cost of repairing the satellite.

II. Future (New Space Activities)

More than 90% of space activities are military and scientific, with governments assuming the space risk. States will continue financing military space applications and will always provide them with insurance coverage. But States have also initiated commercial space activities, and then subsidized the entry of private enterprise, either by offering their know-how, space facilities, and low launch prices, or by providing, as they were obliged to by the Liability Convention, third-party liability coverage.

Governments, however, with the sole exception of the Cosmos 954 case, have neither paid any compensation for third-party liability, nor are they going to compensate satellite losses during launching (given the inter-party liability waiver) or in-orbit (given the difficulty of demonstrating fault in space). If one puts aside governmental third-party liability coverage, which has never occurred, the burden of commercial applications coverage has been carried solely

by market space insurance, which has paid important compensations, and, as a result, has been in a state of crisis for many years now. Thus, the role of space insurance in the development of commercial space activities has been very important.

Currently, in the western world, governments tend to gradually limit their involvement and entrust the future of commercial applications to private enterprise. It is only natural that the latter needs coverage against space risk, and market space insurance companies are going to provide it. Thus, in the future, as in the past, the space industry or commercial space activities depend on market space insurance.

The state market space insurance and its ability to insure with low premia, however, depends on governmental policies and on the space industry. What could States and the space industry do in order to facilitate the space insurance business?

First of all, States and launching agencies should increase the reliability of their launch vehicles and stop practicing inter-party liability waivers. It is unreasonable that the destruction of a satellite during launching is not compensated by the one who might have originated this damage.

States should also make efforts to limit orbital debris. Not only for environmental reasons, but also because of the increasing risk of damage due to collisions in space, which, in case they occur, are going to be compensated by the insurance business. As the problem of space debris is not going to be resolved in one day. States should set rules and accept procedures determining or clarifying fault in orbit. In conjunction, they should consider the problem of orbital debris re-entry and the related procedures for advanced notification and cooperation in limiting damage, something that has not happened in the case of Cosmos 954.

States, particularly those not practicing free information, and launching agencies should also cooperate in providing statistics and data on their

launchers. Insurance companies could thus determine more accurately the degree of reliability of the offered space services.

Finally, technological developments are expected to increase the number of space activities, reduce the cost of delivering a pound in orbit, and increase the reliability of future space transportation systems. This will mean a greater need of insurance, lower premia and less compensations. Nevertheless, States should pay attention in establishing the rules of liability for future space activities. Problems of interpretation, such as those already pointed out in the Intergovernmental Agreement on the use of the Space Station,¹⁴⁸⁾ should be avoided.

In establishing new rules, States should also show creativity. Many of them are today working on Aerospace Plane (ASP) projects. Is, for example, compensation for collisions with aircraft going to be based on the principle of absolute liability characterizing space objects, or is this going to change because ASPs are expected to have the (double) nature of an aero-space object and move in the aerospace medium as aircraft?¹⁴⁹⁾

Finally, Doyle's comments on space risk could be the concluding suggestion:

“(Space) risks arise in a variety of categories and are being dealt with today in several ways. There are no simple or final solutions to the problems raised. A great deal more attention is required. It may prove fruitful for an international conference among the space launching and using nations to explore the problems and implications of risks involved in spaceflight and to consider whether or not international limits on liability should be established and agreed upon among States. The risks are real and their management is essential. The fear of assumption of risk should not be allowed to become a major impediment to the peaceful uses of outer space.¹⁵⁰⁾

ANNEX 1.

Satellite	Launching Agency	Date of launching	Owner	Failure	Insurance Compensation
Satcom 2	NASA	26/3/1976	RCA		\$9 million U.S.
O.T.S.-1	NASA	13/9/1977	European	Thor Delta	\$29 million U.S.
E.R.S. 1			Japanese		\$40 million U.S.
Satcom 3		6/12/1979	RCA		\$77 million U.S.
	ESA	23/5/1980		Ariane 1	
Insat-1A		10/4/1982	India		\$65 million U.S.
Marecs-B	ESA	10/9/1982	European	Ariane	\$20 million U.S.
Sirio-2	ESA	10/9/1982	European	Ariane	
TDRS-1	NASA/STS	1983		in orbit	
Westar-6	NASA/STS	1984	W.U.Co.	in orbit	\$105 (112) million U.S.
Palapa B-2	NASA/STS	1984	Indonesia	in orbit	\$75 million U.S.
Intelsat V		9/6/1984	Intelsat		\$102 million U.S.
	ESA	11/9/1985		A3, V15	
(Intelsat)	ESA	31/5/1986		A2, V18	
Leasat-3	NASA/STS	1985			
Syncom				failed GSO	\$85 million U.S.
Geostar (package)	ESA	1986		in orbit	
TV-SAT I	ESA	9/8/1989		in orbit	
Hipparchos	ESA	9/8/1989		Ariane	
Superbird-B	ESA	22/2/1990		Ariane	

ANNEX 2.
ASTROPOLICYASPIS-PRONIA
GREEK INSURANCE COMPANY INC.

THE FIRST ASTROPOLICY IN THE WORLD

MOON SERIES No. 1

ASPIS-PRONIA, acting jointly with their Exclusive Agent INTERAMERICAN underwrite the first life astropolicy in the world covering the unique space risks of the insured astronauts N. ARMSTRONG, E. ALDRIN and M. COLLINS during their flight to and back from the Moon on board spacecraft APOLLO 11 as well as during landing and stay on lunar ground of N. ARMSTRONG and E. ALDRIN.

INSURED ASTRONAUTS

NEIL ARMSTRONG, aged 38, born 5 August 1930. Chief of the Expedition.

EDWIN ALDRIN, aged 39, born 20 January 1930. Lunar module pilot.

MICHAEL COLLINS, aged 38, born 31 October 1930. Command pilot.

EXTENT OF COVERAGE

Loss of life or disappearance in space and Permanent total disability of the insured astronauts.

INSURED AMOUNTS

The drachmae equivalent-at date of issue of this life astropolicy-of-thirty thousand U.S. dollars (\$30,000.-), or drachmae nine hundred thousand, (Dr. 900,000.-) divided equally among the three insured astronauts, as follows:

NEIL ARMSTRONG: The drachmae equivalent of ten thousand U.S. dollars (\$10,000.-) or three hundred thousand drachmae (Dr. 300,000.-).

EDWIN ALDRIN: The drachmae equivalent of ten thousand U.S. dollars (\$10,000.-) or three hundred thousand drachmae (Dr. 300,000.-).

MICHAEL COLLINS: The drachmae equivalent of ten thousand U.S. dollars (\$10,000.-) or three hundred thousand drachmae (Dr. 300,000.-).

The insured amount per astronaut has been fixed at the drachmae equivalent of U.S. ten thousand dollars (\$10,000.-) since this amount represents the average size of life policies issued in the United States of America.

BENEFICIARIES

The proceeds shall be paid to the beneficiaries designated herebelow in the event of loss of life or disappearance in space of:

- a. Astronaut NEIL ARMSTRONG: to his wife Janet and children: Eric (born 30 June 1957) and Mark (born 8 April 1963), in equal shares or to the survivor.
- b. Astronaut EDWIN ALDRIN: to his wife Joan and children: Michael (born 2 September 1955), Janice (born 16 August 1957) and Andrew (born 17 June 1958), in equal shares or to the survivor.
- c. Astronaut MICHAEL COLLINS: to his wife Patricia and his children: Kathleen (born 6 May 1959) Ann (born 31 October 1961) and Michael (born 23 February 1963), in equal shares or to the survivor.

In the event of permanent total disability, the proceeds are payable to the insured astronauts.

INCEPTION OF ASTROPOLICY

On boarding spacecraft APOLLO 11 on the set date of 16 July 1969, or any other launching date within the year 1969.

EXPIRY OF ASTROPOLICY

On completion of the quarantine of the insured astronauts following return of spacecraft APOLLO 11 to Earth.

NOTES

- 1) All sums, unless otherwise specified, are U.S. dollars.
- 2) Bourély M.G.: "L'Assurance des Activités Spatiales," *Annuaire de Droit Maritime et Aérien*. Tome VII, 1983, p.371.
- 3) *Aviation Week & Space Technology* (AW&ST), Jan. 7, 1991, p.34.
- 4) Japan built its first vehicles N1 and N2 with American technology under license. In 1986, the HI vehicle placed 3 satellites in orbit. Japan decided to gain its independence and create a powerful vehicle similar to Ariane 5, capable of placing 2 tons on geostationary orbit. See Chappex J.: "Les systèmes de transport" in Dutheil de la Rochère (ed): *Droit de l'Espace*, Paris, Pédone, 1988, p.108.
- 5) The average price for a regular communications satellite in 1990 is between \$150 to \$200 million.
- 6) *Supra* No.2, p.362.
- 7) *Ibid.*, p.360.
- 8) *Ibid.*, p.366.
- 9) *Ibid.*, p.361.
- 10) *Ibid.*, p.360.
- 11) Chappex J.: "Les systèmes de transport," in Dutheil de la Rochère (ed): *Droit de l'Espace*, Paris, Pédone, 1988, p.126.
- 12) *Supra* No.2, p.360.
- 13) *Ibid.*, p.361.
- 14) *Ibid.*, p.360.
- 15) See *Insurance Brokers Monthly*, 1/9/1969 (U.K.); *Versicherungs Wirtschaft*, 1/8/1969 (F.R.G.); *L'Argus*, 1/8/1969 (France); *Canadian Insurance*, 1/7/1969; *The Chicago Tribune*, 17/7/1969.
- 16) *Supra* No.2, p.364.
- 17) *Ibid.*, p.363; *Supra* No.11, p.127.
- 18) *Supra* No.2, p.361.
- 19) Dahbi M.: "Considerations on Satellite Liability Insurance," in *Space Commerce*, Proceedings of the 2nd International Conference and Exhibition on the Commercial and Industrial Uses of Outer Space, Montreux, 21-25/2/1988, Gordon & Breach Science Publishers, N. York, 1989, p.422.
- 20) *Ibid.*, p.423.
- 21) *Supra* No.11, p.139.
- 22) *Supra* No.19, p.423.
- 23) *Ibid.*
- 24) *Ibid.*
- 25) *Ibid.*
- 26) *Supra* No.2, p.364.
- 27) *AW&ST*, 28/2/1991, p.17.
- 28) *Supra* No.2, p.369.
- 29) Satellites are often launched in groups, which means that they face a risk because of the other "passengers"; see *Supra* No.2, p.363.
- 30) *Supra* No.2, p.370.
- 31) See *supra* No.11, p.138.
- 32) *Supra* No.2, p.362.
- 33) *Supra* No.11, p.127.
- 34) Diederiks-Verschoor I.H.Ph.: "L'assurance-satellites," *Annals of Air & Space Law*, Vol. X, 1985, p.322.
- 35) The public or private institution or person who decides to create and launch a satellite.
- 36) The operator may be different than the developer.
- 37) *Supra* No.2, p.369.
- 38) *Ibid.*
- 39) *Ibid.*, p.369; *supra* No.11, p.127.
- 40) *Supra* No.2, p.370.
- 41) *Supra* No.11, p.122.
- 42) *Supra* No.2, p.370.
- 43) *Ibid.*
- 44) *Supra* No.34, p.322.
- 45) Sterns P.M. & Tennen L.I.: "Doing Business in Space: Operating Strategies for a Changing Market," *Proceedings of the 29th Colloquium on the Law of Outer Space*, AIAA, N.Y., 1987, p.192.
- 46) See Bourély, *supra* No.2.

- 47) See Tatsuzawa K.: "Japanese Space Policy and the Regulation of Commercial Launches," *San Francisco State University Journal*, 1990, V.II, p.62; Chappex, *supra* No.11, p.127; Dahbi, *supra* No.19, p.422.
- 48) For a detailed description of pre-launch services involving payload processing and handling, see Table I of Doyle St. E.: "Legal Aspects of International Competition in Provision of Launch Services," *Proceedings of the 30th Colloquium on the Law of Outer Space*, AIAA, Washington, D.C., 1988, p.204.
- 49) *Supra* No.19, p.424.
- 50) *Ibid.*, p.425.
- 51) *Ibid.*, p.426.
- 52) *Ibid.*, p.425.
- 53) *Supra* No.2, pp.364-5.
- 54) *Supra* No.19, p.426.
- 55) *Ibid.*, p.425.
- 56) *Ibid.*
- 57) *Supra* No.11, p.126.
- 58) For a list of space launch services involving vehicle and flight cooperations see Table II of Doyle St. E., *irrsupra* No.48.
- 59) *Supra* No.19, p.422.
- 60) *Supra* No.2, p.367.
- 61) *Supra* No.11, p.138.
- 62) *Supra* No.2, p.368.
- 63) Quoted in Supancana I.B.R.: "The Contribution of Developing Countries to the Legal Formulation of Future Space Law" in Zwaan, De Vries, Tuinder & Kuskuvelis (eds): *Space Law: Views of the Future*, Kluwer, Deventer, 1988, p.123.
- 64) If the claimant State is not a member to this Convention, then compensation is settled by public or private international law; see *supra* No.19, p.426.
- 65) *Supra* No.2, p.367.
- 66) *Supra* No.19, p.430.
- 67) When the launching facility, the vehicle, and the satellite are owned by one government; i.e., the USA or the USSR.
- 68) *Supra* No.2, p.366.
- 69) *Ibid.*, p.367.
- 70) *Ibid.*, p.368; *supra* No.11, p.137.
- 71) For a coverage of \$500 million obtained for the flight of Columbia 3, the premium was of \$90 million; see *supra* No.2, p.368.
- 72) NASA obtained a global insurance coverage of \$1 billion; see *ibid.*, p.368.
- 73) *Ibid.*, p.367.
- 74) It entered into force on April 14, 1980. The countries are Federal Republic of Germany, Belgium, Denmark, Spain, France, Ireland, Italy, Netherlands, United Kingdom, Sweden, and Switzerland.
- 75) Bourély M.: "National Space Legislation in Europe," *Proceedings of the 30th Colloquium on the Law of Outer Space*, AIAA, Washington, D.C., 1988, pp.199-200.
- 76) *Supra* No.2, p.367; *supra* No.11, p.128.
- 77) *Supra* No.11, p.139.
- 78) *Les Echos*, 20/7/1988, p.7.
- 79) *Supra* No.11, p.139.
- 80) *Ibid.*, p.139.
- 81) *Les Echos*, 20/7/1988, p.7; 8/12/1988, p.10.
- 82) Simon A.: "L'importance économique de l'espace — situation internationale" in *Etudes Internationales*, vol. XIX, No.3, Septembre 1988, p.440.
- 83) 49 U.S.C. 2061 *et seq.*; P.L. 98-575. October 30, 1984.
- 84) Steptoe E.J.: "Regulation of Private Commercial Space Transportation by the U.S. Department of Transportation," *Proceedings of the 28th Colloquium on the Law of Outer Space*, AIAA, N.Y., 1986, p.244.
- 85) Meredith P.L.: "A Comparative Analysis of United States Domestic Licensing Regimes for Private Commercial Space Activities," *Proceedings of the 32nd Colloquium on the Law of Outer Space*, AIAA, Washington, D.C., 1990, p.377.
- 86) *Supra* No.11, p.108.
- 87) Mussara G.: "Commercial Space Transportation: Regulatory Activities of the United States Department of Transportation," *Proceedings 30th Colloquium on the Law of Outer Space*, AIAA, Washington, D.C., 1988, p.224.
- 88) *Supra* No.19, p.424.
- 89) *Les Echos*, 20/7/1988, p.7.
- 90) *Supra* No.11, p.139.
- 91) *Les Echos*, 8/9/1988, p.7.
- 92) *Supra* No.19, p.424.
- 93) *Ibid.*
- 94) *Ibid.*, p.430.
- 95) *Ibid.*, p.431.
- 96) *Ibid.*, p.422.
- 97) *Supra* No.34, p.321.
- 98) *Supra* No.2, p.370.
- 99) *Ibid.*, p.369.
- 100) See on this rising danger the 1987 and 1989 IISL sessions on the "Legal Aspects of the Outer Space Environmental Problems," *Proceedings of the 30th and 32nd Colloquia on the Law of Outer Space*, AIAA, Washington, D.C., 1988 and 1990.
- 101) DeMeis R.: "Cleaning up Our Space Act," *Aerospace America*, February 1987, p.10.
- 102) *Supra* No.19, p.430.
- 103) *Supra* No.63, p.123.
- 104) Hurwitz B.A.: "Reflections on the Cosmos 954 Incident," *Proceedings of the 32nd Colloquium on the Law of Outer Space*, AIAA, Washington, DC, 1990, p.352.
- 105) Reiskind J.: "Towards a Responsible Use of Nuclear Power in Outer Space — the Canadian Initiative in the United Nations," 6 *Ann. Air & Sp. L.*, 1981, p.463, in Hurwitz, *ibid.*, p.353.
- 106) Tatsuzawa K.: "Japanese Space Policy and the Regulation of Commercial Launches," *San Francisco State University Journal*, 1990, V.II, p.62.
- 107) *Supra* No.11, p.118.

- 108) Executive Order 12465, February 24, 1984, and Commercial Space Launch Act, 49 U.S.C. 2061 *et seq.*
- 109) 49 U.S.C. 2614 (b).
- 110) *Supra* No.11, p.119.
- 111) See Tatsuzawa K.: "The Regulation of Commercial Space Activities by the Non-Governmental Entities in Space Law," in *Proceedings of the 31st Colloquium on the Law of Outer Space*, AIAA, Washington, D.C., 1988, p.346.
- 112) *Supra* No.11, p.135.
- 113) These "get-away specials" were available for payloads weighing less than 200 pounds, \$50 per pound, and occupying less than five cubic feet of volume.
- 114) *Supra* No.11, p.135.
- 115) *The New York Times*, 14/5/1985, p.C6.
- 116) *Supra* No.11, p.135.
- 117) Even Martin Marietta's promotional Titan 34D launchings, at a discount price of 50 to 55 million \$U.S., were higher than the Shuttle's; see *Air et Cosmos*, No.1136, p.32; in *supra* No.11, p.125.
- 118) NSDD 181, Shuttle Pricing for Foreign and Commercial Users, July 30, 1985; this decision was later codified and given the force of law: P.L. 99-170, December 5, 1985, 42 U.S.C. 2466, 66a-66c.
- 119) *Supra* No.11, p.136.
- 120) *The New York Times*, 14/5/1985, p.C6.
- 121) *Supra* No.11, p.136.
- 122) Frankle E.A.: "Commercial ELV Services and the National Aeronautics and Space Administration: Concord or Discord?," in *Proceedings of the 30th Colloquium on the Law of Outer Space*, AIAA, Washington, D.C., 1988, p.216.
- 123) NSDD 254, United States Launch Strategy (U), December 27, 1986.
- 124) *Supra* No.11, p.136.
- 125) *Ibid.*, p.109.
- 126) *Ibid.*, p.118.
- 127) *Ibid.*, p.123.
- 128) *Ibid.*, pp.119-123
- 129) *Supra* No.106, Tatsuzawa, p.62.
- 130) Hung Jiefang: "Toward a Regulatory Regime for Competition in Space Transport, in Zwaan — Kuskuvelis et al.: *Space law: Views of the Future*, Kluwer, Deventer, 1988, p.63; also *supra* No.11, pp.119-123.
- 131) *Ibid.*, p.63.
- 132) Soviets continues with the development of a medium class vehicle SLX 16, equivalent to Titan 3C, and with a giant vehicle Energia capable of placing 100 tons in low earth orbit. Energia undertook its first test flight in May 15, 1987. Energia could also launch the Soviet Space Shuttle. See *supra* No.11, p.106.
- 133) *Ibid.*, p.125.
- 134) *Air et Cosmos*, No.1147, p.181, in *supra* No.11, p.125.
- 135) *Supra* No.11, p.123.
- 136) *Ibid.*, p.139.
- 137) The managers of the following compagnies were invited at the Soviet space center: Italian Generali, German Munich Re, British Crawley Warren, and American Intec; see *La Tribune de l'Expansion*, 22/7/88, p.9
- 138) Jiao Yong: "Chinese Policy and Legal Garantees in the Provision of Launch Services for Foreign Countries" in *Proceedings of the 32nd Colloquium on the Law of Outer Space*, AIAA, Washington, D.C., 1990, p.442.
- 139) *Supra* No.11, pp.121-123.
- 140) *Supra* No.138, p.443.
- 141) *Supra* No.34, p.323.
- 142) *Ibid.*, p.324.
- 143) *Ibid.*, p.323.
- 144) *Le Figaro*, 20/7/1989, p.4.
- 145) "The Shearson Report," in *Space Business News*, November 1984, in *supra* No.34, p.323.
- 146) On the problems of rescue missions, see J.-P. Croisé: "Les Pannes de l'Espace," *Le Figaro*, 18/8/1989, p.30.
- 147) After the Westar and Palapa rescue, NASA announced that future rescue missions will be priced at higher prices. See *supra* No.11, p.144.
- 148) See Zwaan — De Vries: "Liability Aspects of the International Space Station Agreement of 29 September 1988." *Proceedings of the 32nd Colloquium on the Law of Outer Space*, AIAA, Washington, D.C., 1990, p.448.
- 149) Kuskuvelis I.I.: "The Aerospace Plane: In the Direction of an Aerospace Law," in *Proceedings of the 29th Colloquium on the Law of Outer Space*, AIAA, New York, 1987, p.177.
- 150) *Supra* No.48, p.213.