

# The space risk and commercial space insurance

Ilias I. Kuskuvelis

**This article reviews the history of commercial space insurance and describes the relevant legal framework. It then describes the types of transactions that take place and analyses four categories of insurance: pre-launch, launch, in-orbit and re-entry. The recent difficulties of the space insurance industry are described, and the author offers several suggestions for the future.**

Ilias I. Kuskuvelis holds a Doctorat d'Etat is a lawyer and teaches air and space law at the Hellenic Air Force Academy. He can be reached at Pipinou 73, 11251 Athens, Greece.

<sup>1</sup>P.D. Nesgos, concluding his paper 'Recent developments in risk allocation of concern to the US commercial launch industry and the insurance community', presented at the Fifth International Conference on Space Insurance, Rome, 2-3 March 1989, comments: 'the Commercial Space Launch Act Amendments (1988) represent the successful efforts by US commercial launch companies to obtain the support of the Government for an emergent space industry' (p 23).

<sup>2</sup>M.G. Bourély, 'L'assurance des activités spatiales', *Annuaire de Droit Maritime et Aérien*, Vol VII, 1983, p 361.

<sup>3</sup>Comsat was the first in 1965 to buy pre-launch and launch insurance; Intelsat followed in 1968; in-orbit or satellite life insurance was not offered before 1975: *ibid*, p 360.

<sup>4</sup>*Ibid*, pp 360-361.

<sup>5</sup>See *Insurance Brokers Monthly*, 1 September 1969 (UK); *Versicherungs Wirtschaft*, 1 August 1969 (FRG); *L'Argus*, 1 August 1969 (France); *Canadian Insurance*, 1 July 1989; *Chicago Tribune*, 17 July 1969. This author holds a copy of the 'astropolicy'.

<sup>6</sup>E.R. Finch and A.L. Moore, *Astrobusiness*, Praeger, New York, 1984, p 46.

Although private enterprise has entered the space arena, states still bear the cost of space conquest and support their nationals' efforts in commercializing space. They offer them know-how at low or no cost, space facilities, low launch prices and even third-party liability coverage.<sup>1</sup> Thus states subsidize the private sector, reduce the capital the latter is risking, and, in a way, share the risk to which the private sector is exposed. But states are not willing to assume the whole risk and pay for everything.

The very high risk is one of the reasons why insurance has entered the field. The other is that space law holds states liable for damages due to the space activities of their nationals. Thus, beyond a certain level of assistance, states oblige them to buy insurance.

This article deals exclusively with commercial space insurance, leaving aside state subsidies. After a brief historical review, the international responsibility and liability provisions of space law influencing space insurance will be identified. The transactions taking place within the space insurance market will be described next, followed by an analysis of four different categories of commercial space insurance (pre-launch, launch, in orbit and re-entry) and the influence satellite rescue activities have on it. In conclusion, an assessment of the state of commercial space insurance and some proposals will be made.

## History

Commercial space insurance first appeared in Anglo-Saxon countries, with Lloyds of London pioneering the whole effort.<sup>2</sup> It has, however, mostly been developed in the USA,<sup>3</sup> and the main branch to enter space was aviation insurance. Although French, German and Italian insurers were quite early on interested in space risk evaluation and insurance in the context of the ELDO/ESRO effort, they entered the market later with the coverage of an Ariane launch, on 24 December 1979.<sup>4</sup>

Two space life insurance policies were also reported. The first 'astropolicy', made by a Greek insurance pool, insured the crew of the Apollo 11 mission.<sup>5</sup> The second, made by the National Space Institute, provided coverage for the crew of one of the Shuttle's missions.<sup>6</sup>

Today space insurance has become the business of a small number of insurance corporations. Given the limited need for space insurance and its heavy losses, this insurance business is grouped in pools and competition is therefore restricted.

### **Relevant legal framework**

The concept of third-party liability was introduced by Article VII of the 1967 Space Treaty and later elaborated by the 1972 Convention on International Liability for Damage Caused by Space Objects. According to the latter, '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' (Article II). '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, or the *fault* of persons for whom it is responsible' (Article III).<sup>7</sup>

If the damage occurs on the surface of the Earth or to an aircraft of a third state, as a result of other 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).

The Convention 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 possibly be 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 IV.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 to those present in the immediate vicinity of a planned launching or recovery area after an invitation by the launching state (Article VII). Victims excluded may claim compensation under their own national law or that of the launching state.

### **Transactions in the space insurance market**

#### *Risk and risk assessment*

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

Space insurance policy has to determine precisely the elements constituting the advent of space risk. Determining the risk to be insured, even though some categories of risk are excluded,<sup>8</sup> requires an analysis of the various phases from the construction to the operational stage of the satellite.

The odds of occurrence of the risk need to be assessed as well. Insurers need to know whether it is a simple or joint launching, and must have a good technical knowledge of the launch vehicle and the

<sup>7</sup>'Damage', 'launching' and 'space object' are defined in Art I.

<sup>8</sup>According to I.H. Diederiks-Verschoor, insurance policies exclude: the nuclear risk, the risk of war, technical deficiencies inherent to the project, and wornout equipment; see *L'assurance – satellite*, *Annals of Air and Space Law*, Vol X, 1985, p 322.

satellite. They further want to know the statistical appearance of the risk during the different phases of a satellite's life. This is why, in practice, insurers collect information and analyse statistically the launch vehicle's and the satellite's reliability.

The statistical occurrence of risk is difficult to assess 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, where thousands of ships and planes undertake millions of trips. Calculation was (is?) even harder in the case of states not allowing a great amount of information on their launch vehicles, as in the case of the former USSR.

Calculation also faces the problem of the launchers' diversity. Launch agencies have used different vehicles. Ariespace is presently using the Ariane IV launcher and is preparing the Ariane V model. An important diversification in space launch services was brought about by the introduction of the US Space Shuttle, a reusable vehicle, and the entry of private enterprise into this business. Finally, the USSR advertised their Proton Expendable Launch Vehicle (ELV), the Chinese their Long March ELV, and the Japanese decided to gain their independence by creating a powerful vehicle similar to Ariane V, capable of placing 2 tons in geostationary orbit. The above vehicles have different success rates and therefore expose their clients to varying risks of failure.

Calculation of the risk influences the level of premia: a low premium in the market means increased reliability and low risk; conversely, an increased premium means low reliability of the launch vehicle, thus reducing its competitiveness. As an example, in the late 1970s, on the basis of 150 launchings, insurers calculated the statistical reliability of the Thor Delta launcher at 93% and asked for a simple launching a premium of 7.8%, lowered soon to 6.1%. The Ariane launcher's reliability very early in the programme, given two development and one operational failures, was estimated at 60%.<sup>9</sup>

#### *Capital and insurance coverage*

The aim of any insurance is to provide insurance coverage for the capital invested, meaning the funds required to face the occurrence of the insured economic risk/need (proportional to the capital invested). Insurance coverage usually takes the form of damage compensation,<sup>10</sup> and it is necessary to determine the economic need that the risk's occurrence may create. If the cost of damage cannot be calculated, because limits cannot be established, then the insurer together with the insured may set a ceiling on the insurance coverage. Based on this ceiling, and in relation to the chance of the risk's occurrence, the insurer will calculate the premium for the insurance policy. Moreover, the 'launching' state, the satellite's owner and/or operator may also calculate, on the basis of the risk and the premium they want to pay, the amount they want to be covered for.

In determining the amount of the insurance coverage, the owner, the operator and the insurer have to consider several variables. The owner has to insure the cost of the satellite<sup>11</sup> and the price of launching. He also has to determine the expected profit from the satellite's rental, and the guarantee he pays to the operator for the expenses the latter has undertaken, ie for the construction of Earth stations.

The operator may take out insurance in order to cover expected profits, expenses incurred in the creation of the exploitation systems<sup>12</sup>

<sup>9</sup>Bourély, *op cit*, Ref 2, p 362.

<sup>10</sup>It may also take the form of downpaying a prearranged amount, without even examining if the insured risk caused damage as, eg, in the case of life insurance.

<sup>11</sup>The average price for a regular communications satellite in 1990 was \$150–200 million.

<sup>12</sup>Ie, for advertising the satellite's services or giving guarantees to other secondary commercial operators, etc.

and also his losses.<sup>13</sup> Insurance coverage of profits is basically determined in relation to one risk: the end of the satellite's orbital lifetime. The earlier the satellite ceases functioning in relation to its expected life in orbit, the higher the compensation to be paid by the insurer.

Finally, both the owner and the operator have to consider launch delays, which often incur heavy financial losses and fines. If the 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 compensation.<sup>14</sup>

#### *The type of insurance contract*

The insurance contract is the outcome of negotiations between the satellite owner or operator and the insurers. The former will try to obtain the largest insurance coverage possible for the lowest premium; the latter, taking into consideration the existing technical and statistical data, will seek and eventually come up with a formula which leaves some of the risks to his client.

In order that both sides reach the desired aim, many innovations have been introduced. Thus, instead of insuring one satellite, insurance sometimes covers a series of satellites or a specific number of failures over the entire series. The coverage may be reduced proportionally either to the limitation of the satellite's performance or to the satellite's remaining expected lifetime. Also, the premium may be broken down into several payments, or, if no insured risk has occurred, part of the paid premium may be returned, according to a clause launch insurance policies sometimes contain, known as 'no loss return premium'. 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 the cost in relation to regular market premia.<sup>15</sup>

Authors examining space insurance have emphasized the methodological distinction between contracts covering third-party liability and those covering economic losses.<sup>16</sup> Here another categorization is chosen that distinguishes three categories of space insurance on the basis of distinct phases of the satellites' life: pre-launch, launch, and in-orbit insurance,<sup>17</sup> the last two including insurance coverage for economic losses by the insured and for damage to third parties. A fourth category will be also examined, the re-entry liability insurance.

#### **Pre-launch insurance**

This insurance covers both the launch vehicle and the satellite's development, their transport to the launching centre and their testing, up to the moment of their integration on the launching pad or the launch vehicle's ignition.<sup>18</sup> Two liabilities may incur: property damage and bodily injury, including consequential losses, 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 (launching pad, satellite preparation hall, the launcher and satellite, and their ground support equipment), and to representatives or employees of any party engaged in carrying out the launch.<sup>19</sup>

These damages cannot be insured under third-party launch liability insurance, even if such damage is attributable to the other party

<sup>13</sup>Losses are going to be greater when the satellite system is operational, services are allocated and the operator has already assumed obligations towards users. In the case of the Japanese Superbird-A satellite, Space Communications Corp, the owner and operator, had to accommodate its users on other satellites; see *Aviation Week and Space Technology*, 7 January 1991, p 34. For a replacement launching SCC was expected to wait until December 1992; see *Space News*, 9–15 December 1991.

<sup>14</sup>In practice Arianespace, considering the resulting inconvenience greater, charges higher compensation the closer to the launch date the delay announcement is made; see J. Chappez, 'Les systèmes de transport', in Dutheil de la Rochère, ed, *Droit de l'Espace*, Pédone, Paris, 1988, p 122.

<sup>15</sup>P.M. Sterns and L.I. Tennen, 'Doing business in space: operating strategies for a changing market', in *Proceedings of the 29th Colloquium on the Law of Outer Space*, AIAA, New York, 1987, p 192.

<sup>16</sup>See Bourély, *op cit*, Ref 2.

<sup>17</sup>See K. Tatsuzawa, 'Japanese space policy and the regulation of commercial launches', *San Francisco State University Journal*, Vol 2, 1990, p 62.

<sup>18</sup>For a detailed description of pre-launch services involving payload processing and handling, see Table I of S.E. Doyle, 'Legal aspects of international competition in provision of launch services', in *Proceedings of the 30th Colloquium on the Law of Outer Space*, AIAA, New York, 1988, p 204.

<sup>19</sup>See M. Dahbi, '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 February 1988, Gordon & Breach, New York, 1989, p 424–425.

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 in general exclude from the provisions of liability policies bodily injury 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.<sup>20</sup> As these activities are not proper space activities, Bourély suggests that they could be covered by the common industrial insurance branch and policies.<sup>21</sup>

The launching agency and the satellite owners usually come to a 'hold harmless' pact: each party agrees not to bring any claim against the other party for bodily injury 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.<sup>22</sup>

The chances of a third-party liability due to damage to property and/or bodily injury to any third party, caused during the launch campaign by the launch vehicle, the satellite or any part of them, are limited. The transport of space components is effected very carefully, and once they have arrived at the space centre the danger practically disappears because of its usual remoteness and its size. However, the chances of causing damage to a third party are increased during the launching phase.

## **Launch insurance**

### *Satellite(s)' loss or damage*

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

In practice, both NASA and ESA leave the risk of the satellite's destruction during launching to the client. Launching agreements exclude any possibility of action against the launching authority for satellite damage or loss.<sup>23</sup> Consequently if damage occurred, insurers would compensate the owner of the satellite but they would have no right to return against the launching state.

Action is also precluded between clients if there is more than one satellite on board, as in the case of the US Space Transportation System (STS), the Space Shuttle. On 8 March 1979 the NASA office of space transportation operation introduced an inter-party liability waiver<sup>24</sup> in the Shared Launch Agreement on Payloads Launch and Associated Services.<sup>25</sup> Article V.3 stipulates:

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.<sup>26</sup>

<sup>20</sup>*Ibid.*, pp 425–426.

<sup>21</sup>Bourély, *op cit*, Ref 2, pp 364–365.

<sup>22</sup>Dahbi, *op cit*, Ref 19, p 425.

<sup>23</sup>Bourély, *op cit*, Ref 2, p 367.

<sup>24</sup>One of the reasons for this waiver is that some of the satellites are scientific and cost less than commercial ones, and NASA did not want to discourage this type of clientele.

<sup>25</sup>Known as the 'Launch Services Agreement' or LSA.

<sup>26</sup>Quoted in I.B.R. Supancana, 'The contribution of developing countries to the legal formulation of future space law', in T.M. Zwaan, W. De Vries, P. Tuinder and I. Kuskavelis, eds, *Space Law: Views of the Future*, Kluwer, Deventer, the Netherlands, 1988, p 123.

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

#### *Third-party launch liability insurance*

This type of insurance covers for damages caused to third parties during launching by the launch vehicle, the satellite or their component parts, and is governed by the Liability Convention.<sup>27</sup> The characteristic of third-party liability insurance is that nobody can assess the amount of loss beforehand. Anyone wanting 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. As the insurance market is unable to finance such a coverage whatever the amount of a premium the client is prepared to pay, the problem has been solved by states limiting the amount up to which insurance coverage has to be purchased.

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

Third-party liability policies do not cover: property damage to facilities and launching equipment, and bodily injury to cover people participating in the launching operations; financial loss, that is the loss of expected profits; and noise, pollution and other nuisances, not resulting from an unforeseen occurrence, during launching or when the satellite is in service in orbit.<sup>28</sup>

Where there is only one 'launching state',<sup>29</sup> operations are undertaken with the state's own responsibility. When the launching state provides its services to another state or a (foreign) private entity, then the former asks the latter to take out a third-party liability policy.

*USA (NASA).* This was the case when NASA offered its ELV services to other states (Canada, the UK, France, Japan) or to international organizations (ESA, Intelsat). Clients were obliged to buy insurance covering possible US liability obligations. Initially the required coverage was of \$100 million for a premium of \$25 000 per launch; at the end of the 1970s it went up to more than \$300 million.<sup>30</sup>

In the case of the Shuttle, the 1979 amendment of section 308 of the 1958 NASA Act gave NASA the authority to specify third-party liability insurance for its customers. If commercial insurance was not available at a reasonable cost, then NASA would sell it to them.<sup>31</sup> For this reason, through overall agreements NASA would take out an insurance policy either for a series of launches of the same vehicle or for a determined period of time, and each client would pay proportionally.<sup>32</sup>

NASA has incorporated these terms into its Launch Services Agreement (LSA) with customers. At the conclusion of an agreement clients have to buy a maximum third-party liability insurance of no more than \$500 million for a single payload.<sup>33</sup> If there are two or more payloads, the maximum insurance required is of \$1 billion. As liability is unlimited, NASA has to provide for unlimited government indemnification to its customer for the rest of the amount, if compensations exceed the amount of the coverage. Naturally, insurance coverage and government indemnification are valid only during the 'risk period', which under the LSA begins at the start of the physical attachment of the payload to the

<sup>27</sup>If the claimant state is not a member of this Convention, then compensation is settled by public or private international law; see Dahbi, *op cit*, Ref 19, p 426.

<sup>28</sup>*Ibid*, p 430.

<sup>29</sup>When the launching facility, the vehicle and the satellite are owned by one government, ie the USA or the USSR.

<sup>30</sup>Bourély, *op cit*, Ref 2, p 366.

<sup>31</sup>D.E. Cassidy, 'Allocation of liabilities between government and private sector and implications on insurance for space commercialization', *Proceedings of the 30th Colloquium on the Law of Outer Space*, AIAA, New York, 1991, p 25.

<sup>32</sup>Bourély, *op cit*, Ref 2, p 367.

<sup>33</sup>For a coverage of \$500 million obtained for a payload on the flight of Columbia 3, the premium was of \$90 million; see *ibid*, p 368.

STS and nominally ends when it lands after launch of the payload.<sup>34</sup>

The customers' contractors and subcontractors are excluded under the LSA from government indemnification. Under the LSA they do not have to be insured, but the customer can include them in its third-party launch liability policy. As far as concerns NASA's contractors and subcontractors liability, NASA's Procurement Regulations and the Federal Acquisition Regulations form the basis for NASA's supplier contracts and cover the allocation of risks and liabilities between the government and its contractors and subcontractors.<sup>35</sup>

Thus the 1979 amendment provides for an insurance coverage shared between the market and the launching state (USA). However, this mixed system has been less frequently used since 1986, when National Security Decision Directive 254 stated 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'.<sup>36</sup>

*ESA (Arianespace)*. ESA at first contracted an insurance policy for Ariane's development launchings effected under its responsibility. If ESA had to indemnify more than the insurance coverage, then the surplus amount had to be covered by ESA members. But according to Article 4.1 of the ESA members' Declaration<sup>37</sup> it is France that has to bear any amount over FF400 million of compensation.<sup>38</sup>

Since the eleventh launching (9 November 1984) the relevant responsibilities have been transferred to a private French agency, Arianespace. This agency either sells insurance through its own insurance system or obliges its users to subscribe to an insurance policy. If a victim sues the French government, Arianespace has to pay up to FF400 million and the rest is paid by the French government.<sup>39</sup>

Arianespace has organized space insurance by covering a series of launches through its Société de Reassurance de Risques Relatifs aux Applications Spatiales (S3R).<sup>40</sup> The principle is that of self-financing: compensate losses with successful launches' gains of premia. 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.<sup>41</sup> This first series was covered with a preferential percentage premium (11–13%) depending on whether the client was relaunching with Ariane.<sup>42</sup>

A second series is still open covering a group of 30 launches with a slightly higher premium of 12.9–14.5%.<sup>43</sup> Up to mid-1988, S3R had made 19 insurance policies.<sup>44</sup> The capital insured is 100 million ECUs. Insurance has to cover five failures out of 30 launchings. The fourth and fifth failures are reinsured by the Caisse Centrale de Reassurance, with a premium calculated over all 30 flights.<sup>45</sup>

*The space industry*. Third-party liability insurance was boosted when the 1984 US Commercial Space Launch Act<sup>46</sup> 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 out an insurance policy for third-party liability in such amount as the Secretary of Transportation deems necessary, considering US international obligations.<sup>47</sup>

In 1988 the US government, under pressure from the industry, amended Section 16. Accordingly the private launching agency (licen-

<sup>34</sup>Cassidy, *op cit*, Ref 31.

<sup>35</sup>*Ibid*.

<sup>36</sup>NSDD 254, United States Launch Strategy (U), 27 December 1986.

<sup>37</sup>14 January 1980; it entered into force on 14 April 1980. The countries are the Federal Republic of Germany, Belgium, Denmark, Spain, France, Ireland, Italy, the Netherlands, the UK, Sweden and Switzerland.

<sup>38</sup>M. Bourély, 'National space legislation in Europe', in *Proceedings of the 30th Colloquium on the Law of Outer Space*, AIAA, New York, 1988, pp 199–200.

<sup>39</sup>Bourély, *op cit*, Ref 2, p 367.

<sup>40</sup>Chappez, *op cit*, Ref 14, p 139.

<sup>41</sup>*Les Echos*, 20 July 1988, p 7.

<sup>42</sup>Chappez, *op cit*, Ref 14, p 139.

<sup>43</sup>*Ibid*, p 139.

<sup>44</sup>*Les Echos*, 20 July 1988, p 7; 8 December 1988, p 10.

<sup>45</sup>A. Simon, 'L'importance économique de l'espace – situation internationale', *Etudes Internationales*, Vol XIX, No 3, September 1988, p 440.

<sup>46</sup>49 USC 2601 *et seq*; PL 98-575, 30 October 1984.

<sup>47</sup>E.J. Steptoe, 'Regulation of private commercial space transportation by the US Department of Transportation', in *Proceedings of the 29th Colloquium on the Law of Outer Space*, AIAA, New York, 1986, p 244.

see) has to take out insurance or demonstrate financial responsibility sufficient to cover the maximum probable loss (MPL) – to be determined by the Department of Transportation – from claims by a third party resulting from the activities carried out under the licence.<sup>48</sup> The maximum amount of insurance that has to be purchased is \$500 million or the maximum amount available on the world insurance market at a reasonable cost in any case.<sup>49</sup> The US government assumes liability risks up to \$1.5 billion for claims in excess of the amount of \$500 million.<sup>50</sup> Also, the 1988 amendments provide for reciprocal waivers between, on the one hand, each private party launch participant and, on the other, each government launch participant.<sup>51</sup>

Moreover, the amendments require the licensee to obtain liability insurance or to demonstrate financial responsibility sufficient to compensate the MPL 'from claims against any person by the United States for loss of or damage to property of the United States resulting from activities carried out under the license'. The maximum amount required is \$100 million or the maximum liability insurance available on the world market.<sup>52</sup>

Several US corporations promoting their launch vehicles<sup>53</sup> and European groups of satellite constructors such as Aerospatiale/MBB or Matra/British Aerospace solved their problems in a similar way to Arianespace.<sup>54</sup> Thus Martin Marietta, General Dynamics and McDonnell Douglas provide similar insurance coverage as S3R;<sup>55</sup> Martin Marietta is said to ask even lower premia than those of S3R for its Titan-3 Commercial (10–12%).<sup>56</sup> Aerospatiale has created Aeroassurance, its own insurance company.

Moreover, the space industry has created indirect insurance mechanisms such as the 'turnkey' agreement. According to this, the constructor has to deliver the satellite to its client functioning in the correct orbital position, thus assuming the pre-launch and launch phase risks. The practice was initiated in the USA and has recently been introduced in Europe by Aerospatiale and MBB.<sup>57</sup>

Finally, it should be mentioned that government agencies using private launch services buy pre-launch and third-party launch insurance. The cost of insurance is included in the price. This was the case for launches of SDIO payloads.

## In-orbit insurance

### *Satellite's damage or loss insurance*

This is purchased by satellite owners or operators, in conjunction with launch insurance, in order to cover themselves against the partial or total loss of operational capability or any shortening of its life or any consequent financial loss they might suffer.<sup>58</sup>

Orbital lifetime may be fractioned in periods and insurance can be extended each time in order to cover a new period of the satellite's life. For a geostationary satellite, with an expected average lifetime today of 10 years, insurance will cover the first three years. Then the state of the satellite will be assessed and eventually the coverage will be extended for another three years.<sup>59</sup>

If the orbital 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 real and justified losses can be compensated. Similarly, the satellite's perform-

<sup>48</sup>Cassidy, *op cit*, Ref 31, p 26.

<sup>49</sup>Amendments, Section 16(a)(1)(A).

<sup>50</sup>Amendments, Section 16(b)(1). See also P.L. Meredith, 'A comparative analysis of United States domestic licensing regimes for private commercial space activities', in *Proceedings of the 32nd Colloquium on the Law of Outer Space*, AIAA, New York, 1990, p 377.

<sup>51</sup>Cassidy, *op cit*, Ref 31, p 27; Nesgos, *op cit*, Ref 1, p 15.

<sup>52</sup>Amendments, Section 16(a)(1)(B); see also Nesgos, *op cit*, Ref 1, pp 10–11; and Cassidy, *op cit*, Ref 31, pp 26–27.

<sup>53</sup>In 1988 General Dynamics marketed the Atlas and Centaur; McDonnell Douglas, the Delta II/MLV; Martin Marietta, seven versions of the Titan; American Rocket provided 'small industrial vehicles' from Vandenberg Air Force Base; Conatec, the Terrier-Blanc Brant vehicles from White Sands, NM; E'Prime offer services from Cape Canaveral and Cape York, Australia; and Space Services, Inc, the Conestoga vehicle, from Wallops Island, VA. For current launch services see *Aviation Week and Space Technology*, 16 March 1992, p 131.

<sup>54</sup>Dahbi, *op cit*, Ref 19, p 424.

<sup>55</sup>*Les Echos*, 20 July 1988, p 7.

<sup>56</sup>Chappez, *op cit*, Ref 14, p 139.

<sup>57</sup>*Les Echos*, 8 December 1988, p 7.

<sup>58</sup>Dahbi, *op cit*, Ref 19, p 422.

<sup>59</sup>Diederiks-Verschoor, *op cit*, Ref 8, p 321.

ance can be fractioned, from a limitation of its functions (ie the number of transponders) to total failure. This avoids an 'all or nothing' formula and compensates proportionally for a partial deficiency.<sup>60</sup>

#### *Third-party orbital liability insurance*

The insurance market does not issue orbital liability policies exceeding 12–18 months.<sup>61</sup> Clients do not see a problem in this as they consider that the greatest exposure risk is during launching and that the chances of a collision in orbit are limited. The risk has, however, increased because of space debris and damages have already been attributed to parts of other satellites: Cosmos 1275 was completely destroyed by space debris and it was proved that the Shuttle's window was almost destroyed by a paint flake during its seventh mission, in 1983.<sup>62</sup>

In cases of collision in orbit it is difficult to determine fault and liability. This is why when the risk is higher than usual, as when two jointly launched payloads are set free by the carrier, launching organizations take precautions. According to Art V.2 of the NASA Shared Launch Agreement, 'the user shall obtain, at no cost to NASA, insurance protecting the US 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'.<sup>63</sup>

#### **Re-entry liability insurance**

Given the 1972 Liability Convention, re-entry liability is purely a third-party liability. Authors on the subject, however, neither specify whether damages resulting from a space object's re-entry are covered by third-party launch liability insurance, nor hint at any such possibility.

The re-entry of a space object may cause damage and give rise to economic claims. 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 five sailors were injured. On 24 January 1978 the Soviet nuclear-powered Cosmos 954 fell on Canada. In 1979 the US Skylab fell over Australia with pieces of up to 500 kg hitting the ground; the range of damage caused by its re-entry is not known. Worries were expressed during the re-entry of another Cosmos (1402) in October 1982.

Claims due to Cosmos 954 damages were settled through negotiations between Canada and the USSR. On 2 April 1981 Canada and the USSR signed a protocol under which Canada 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'.<sup>64</sup>

It is not clear what damages the USSR 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.<sup>65</sup> Thus for a damage which did not include any bodily injury or other tangible property damage, actual expenses were of C\$11 million. Which would have been the amount claimed 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?

Obviously, according to the 1972 Liability Convention, the launching organization(s) would have been responsible to pay for damages. But would it not be wiser, for both the launching organization and the

<sup>60</sup>Bourély, *op cit*, Ref 2, pp 369–370.

<sup>61</sup>Dahbi, *op cit*, Ref 19, p 430.

<sup>62</sup>R. DeMeis, 'Cleaning up our space act', *Aerospace America*, February 1987, p 10.

<sup>63</sup>Supancana, *op cit*, Ref 26, p 123. Also NASA does not provide indemnification if a claim arises after the designated risk period: Cassidy, *op cit*, Ref 31, p 25.

<sup>64</sup>As Hurwitz points out, Canada 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: see B.A. Hurwitz, 'Reflections on the Cosmos 954 incident', in *Proceedings of the 32nd Colloquium on the Law of Outer Space*, AIAA, New York, 1990, p 352.

<sup>65</sup>J. Reiskind, 'Towards a responsible use of nuclear power in outer space – the Canadian initiative in the United Nations', *Annals of Air and Space Law*, Vol 16, 1981, p 463, cited in Hurwitz, *ibid*, p 353.

satellite owner, if the latter had to buy insurance for third-party re-entry liability?

### **Satellite rescue and insurance**

In November 1984 the Shuttle captured and brought back to Earth the Western Union Corporation's Westar-6 and the Indonesian Palapa B-2, whose loss had been compensated to the tune of \$105 million and \$75 million respectively. Moreover, in 1984 *Challenger* succeeded in repairing in orbit the satellite Solar Max. 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 7–10 years up to 40–50 years.<sup>66</sup>

Such an extension of lifetime or recovery of satellites could have important consequences for the insurance business. In fact Lloyds, having paid \$180 million in compensation, took possession of the satellites and intended, after spending \$5 million on each for repairs, to sell them again for a total of \$60 million.<sup>67</sup> Westar-6, sold and renamed Galaxy 6, was relaunched by Ariane in 1990.

Although such operations are limited to low-Earth orbit, these successes made the insurance community think that rescue missions could improve the market's financial state and allow clients to pay lower premia; also, that future policies had to contain clauses on the property and the rights to rescued satellites.<sup>68</sup> Others, however, argued that rescue missions were difficult,<sup>69</sup> and, given the cost of rescuing and repairing a satellite, not very interesting financially.

### **Present and future of the market**

#### *The state of insurance*

More than 90% of space activities are military and scientific. States will continue financing and assuming the risk for them. With the sole exception of the Cosmos 954 case, however, governments have neither paid compensation for third-party liability, nor will they compensate for satellite losses during launching (given the inter-party liability waiver) or in orbit (given the difficulty of demonstrating fault in space).

Up to 1988, although it was difficult to find all the capacity needed to cover multiple launchings, as on board the Shuttle, third-party liability insurance had not encountered the same difficulties as satellite loss or damage insurance.<sup>70</sup>

The cost of third-party liability insurance has remained marginal: about \$150 000 per launch for coverage during launching (and first year in orbit) of half an Ariane-3 class satellite, and for a 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 \$500–700 million per occurrence if the corresponding premium was seen as sufficiently attractive by the underwriters and if standard coverage only was required. Is this amount adequate? Many observers think so, taking into consideration the locations of the launch sites and the steps taken to prevent loss of life and property while the launch is carried out.<sup>71</sup>

However, the burden of commercial space applications coverage has been carried solely by commercial space insurance, which has paid significant compensation, and as a result has been in a state of crisis for many years now. For the first time in 1982, the total of payments

<sup>66</sup>Diederiks-Verschoor, *op cit*, Ref 8, pp 323–324.

<sup>67</sup>*Ibid*, p 323.

<sup>68</sup>'The Shearson Report', in *Space Business News*, November 1984.

<sup>69</sup>On the problems of rescue missions, see J.-P. Croisé, 'Les pannes de l'espace', *Le Figaro*, 18 August 1989, p 30.

<sup>70</sup>Dahbi, *op cit*, Ref 19, p 424.

<sup>71</sup>*Ibid*, p 430.

surpassed the total of all premia paid to insurance companies.<sup>72</sup> The continued very high incidence of claims, especially in 1984, 1985 and 1986, and the 'unrealistically low premia' 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 just could not bear.<sup>73</sup> By 1985 insurance capacity has been reduced from \$180–200 million down to \$120 million. Premia went up to around 16–18% of the insured value, and even higher according to some experts.<sup>74</sup>

As a reaction, a multitude of analytical studies were undertaken by space insurers in 1987 and 1988; but the limited number of commercial space launches carried out in the West from mid-1986 up to 1988 did not allow the space insurance business to win back the volume of premia which would have helped it recover from its state of lethargy. In addition, there was a shrinking demand for insurance because a good number of US satellite operators, in particular, preferred to be self-insured against the risk of incidents in orbit.<sup>75</sup>

Despite this, the market was reportedly back again in 1988; it has shown improved capacity – about 15–20% above that of early 1987 – and a greater willingness by insurers to commit themselves well in advance. 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, 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.<sup>76</sup>

More precisely, in 1988 the market capacity (\$300 million) for satellite life insurance could amply meet the requirements of clients, and rates remained within acceptable limits, even if they had gone up considerably since 1984. By December 1991, however, the state of the market remained critical. The total insurance capacity available worldwide has not increased,<sup>77</sup> and satellite insurance because of recent losses<sup>78</sup> was operating at a break-even point for the first time since 1984–85.<sup>79</sup> Finally, in 1991 launch insurance premia were in the range of 17–20%, while those for in-orbit coverage were 1–2%.<sup>80</sup>

### *The future*

The state of the commercial space insurance business and its ability to insure with low premia depends on the space community (clients, insurers and industry) itself and on governmental policies. According to Nesgos, 'contractual arrangements to restrict claims will be mandatory', and 'great care will be required to structure reciprocal waivers of claims among the multiple participants in launch activities'. Moreover, 'experts in contract drafting will be needed to design comprehensive launch liability insurance policies and claims waiver provisions and advise on the implementation of the reciprocal waiver scheme'.<sup>81</sup>

Insurers also need to understand better the real risks involved in space ventures. Especially in relation to in-orbit insurance, 'this requires technology-based analysis because there will be no data for statistical analysis. The difference in the typical analytic approach of the insurance industry (statistical analysis of a historical data base) and the approach needed in addressing space ventures (a technology-based engineering analysis) was responsible for some part of the extensive insurance industry losses in the early 1980s'.<sup>82</sup>

<sup>72</sup>Bourély, *op cit*, Ref 2, p 361.

<sup>73</sup>Dahbi, *op cit*, Ref 19, pp 423–424.

<sup>74</sup>Chappez, *op cit*, Ref 14, p 139.

<sup>75</sup>Dahbi, *op cit*, Ref 19, p 423.

<sup>76</sup>*Ibid.*

<sup>77</sup>Estimated at \$310 million distributed as follows: USA, 31.3% (\$100 million); France, 18.8% (\$60 million); UK, 15.6% (\$50 million); Germany, 12.5% (\$40 million); Italy, 12.5% (\$40 million); others, including Japan, Sweden, Norway and Australia, 9.4% (\$30 million): courtesy of J. Masson and Gras Savoye.

<sup>78</sup>Intec Underwriters Co announced that space insurers have lost \$200 million on recent failures of orbiting satellites: *Aviation Week and Space Technology*, 28 January 1991, p 17.

<sup>79</sup>See *Aviation Week and Space Technology*, 13 April 1992, p 11.

<sup>80</sup>*Aerospace America*, May 1992, p 35.

<sup>81</sup>Nesgos, *op cit*, Ref 1, p 23.

<sup>82</sup>*Ibid.*, pp 15–16.

What could states and the space industry do to help the space insurance business? First of all, states and launching agencies should increase the reliability of their launching vehicles and stop imposing some of the inter-party liability waivers that are beneficial to themselves. It is unreasonable that the destruction of a satellite during launching is not compensated (at least in cases of gross negligence) by the party (ie the launching agency) that might have originated this damage or is responsible for the launcher's malfunction. Some in the USA have also suggested that the government should stop insuring itself: the base of insured launches would thus become larger, capacity would grow and premia would decrease.<sup>83</sup>

The risk of damage due to collisions in space with orbital debris is increasing and, obviously, any damage is going to be compensated by the insurance business. As the problem of space debris is not going to be resolved in a day, states should at least establish rules and accept procedures determining or clarifying fault in orbit. In conjunction with this, they should consider the problem of orbital debris re-entries (mostly from satellites in low-Earth orbit) and the related procedures for advanced notification and cooperation in limiting damage, something that did not happen in the case of Cosmos 954.

States, particularly those which have not in the past provided information, and launching agencies should cooperate in providing statistics and data on their launchers. Insurance companies could thus determine more accurately the reliability of their space services.

Technological developments are expected to increase the number of space activities, reduce the cost per pound of delivering a load into orbit, and increase the reliability of future space transportation systems. This will mean a greater need for insurance, lower premia and less compensation. Nevertheless, states should pay attention to establishing the rules of liability for future space activities. Problems of interpretation, such as those already observed in the Intergovernmental Agreement on the Use of the Space Station,<sup>84</sup> should be avoided.

Technological developments such as the Aerospace Plane (ASP) project will require new rules and states will have to show creativity in resolving the new regulatory dilemmas they will be faced with. For example, is 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 (dual) nature of an aerospace object and move in the aerospace medium as aircraft?<sup>85</sup>

Finally, Doyle's comments on space risks are offered as a 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.<sup>86</sup>

<sup>83</sup>See *Aerospace America*, May 1992, p 35.

<sup>84</sup>See T. Zwaan and W. De Vries, 'Liability aspects of the International Space Station Agreement of 29 December 1988', in *Proceedings of the 32nd Colloquium on the Law of Outer Space*, AIAA, New York, 1990, p 448.

<sup>85</sup>I.I. Kuskovelis, '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.

<sup>86</sup>Doyle, *op cit*, Ref 18, p 213.