CHAPTER 1

Regulatory and Contractual Background

§1.01 OUTLINE

This chapter covers the factual, regulatory and contractual background of space activities. First, the main facts of space activities, satellite operation and application will be outlined, together with today's challenges and the risk and insurance perspective, in order to show the full aspects of space activities. Then space activities will be presented from international, European and national law perspectives, at each level presenting the regulatory and contractual framework. The author's objective is to focus on those issues within the scope of space law, which may be important from an insurance point of view. In other words, it is necessary to identify the scope of the activities that come under space law and are directly related to the risk of exploring outer space. The aim of identifying the space activities in this context is to distinguish space risks as a subject of insurance coverage in space insurance contracts, which will be looked at in the subsequent chapters.

[A] Facts

In order to understand the space activity based on launching a satellite into orbit, the features of the launch and its risky nature need to be explained. The facts are that, in order to make the launch operation successful, i.e. to place the spacecraft in the Earth's orbit, the launch vehicle (LV) has to lift off the ground and accelerate rapidly to a minimum speed of approximately 28,000 km/h. In order to reach the Moon or other celestial bodies, the velocity must reach about 40,000 km/h to minimise the time needed to pass through the stressful atmosphere, during which the engines must work on the edge of their performance limits. In those conditions, the rocket engines burn large quantities of propellant at a high rate, while at the same time the vehicle is controlled from the ground so that it follows its planned trajectory. The whole launch, from lift off until reaching the transit orbit, takes approximately ten minutes.[1] The above circumstances are of significant importance for the shape of the industry: it is costly, it is risky and until the 1960s there were no legal provisions regulating this area. At a national level, the legal framework is still in its formative stage.[2]

There is no doubt that launching a rocket into outer space is still an extraordinary endeavour, catching the eyes of the whole world each time. It is, however, only the first part of a very precise, though not so spectacular, process being the core of the satellite business and bringing the most revenues to the space industry. The launch operation is only a means of transport for the satellite in its travel to orbit, where starts the operational phase, enabling it to render various services to Earth. The operation of satellites stands behind many daily activities of all modern societies and makes outer space a necessary part of our lives on Earth. The operation of satellites has become, as many experts say, 'vital to our planet's operation' and 'provide us with one of the many keys to achieve the agreed sustainable development target', as 'it has transformative power to address our concerns'[3] Satellite operations are behind the various practical uses of satellite signals, such as 'traditional' communications, remote sensing, to which we can now add new techniques for satellite applications.[4] Broadening the scope of using space technology brings various benefits that cannot be undermined. It gives us knowledge about the Earth and its environment; it enables us to observe changes in climate and the ozone layer; it allows us to watch the environment and is a neutral resource for assessing the risk of natural disasters, or mitigating the effects; it provides vital assistance for making meteorological forecasts as well as facilitating communication and reducing information gaps around the world, including serving as a tele-education and tele-medicine tool. Many technologies that were designed for space are now used on Earth, and a great many innovations developed in the aerospace industry, such as microelectronics and modern computers, have implication and applications that should significantly impact medicine, education, transportation, agriculture, etc.[5]

It seems that space activities have grown into a whole space industry, which is now more than fifty years old. Its starting point was on 4 October 1957, when Russia

1. Logsdon J.M., 'Launch Vehicle'. *Encyclopaedia Britannica. Encyclopaedia Britannica Online.* Encyclopaedia Britannica Inc., 2015. Web, 23 August 2016, http://www.britannica.com/topic/launch-vehicle; Pelton J., *Satellite Communications*, Springer Science & Business Media, Arlington 2011, p. 76; Elbert B., *Introduction to Satellite Communication*, Artech House Inc. 2008, pp. 15–16.
2. Dempsey P.S., *National Laws Governing Commercial Space Activities: Legislation, Regulation, & Enforcement*, 36 Nw. J. Intl. L. & Bus. 2016, Marboe I., *National Space Law* in: Handbook of Space Law (Dunk F.G. von der, F. Tronchetti, eds), Edward Elgar Publishing Limited, 2015, pp. 127–204; Jakhu Ram S. (ed.), *National Regulation of Space Activities*, in Space Regulations Library Series, vol. 5, Springer, 2010; Hermida J., *Legal Basis for a National Space Legislation*, Space Regulations Library, vol. 3, Kluwer Academic Publishers, New York, Boston, Dordrecht, London, Moscow 2004.
3. Pelton J., *Satellite Communications*, Springer Science & Business Media, Arlington 2011, p. 1; United Nations, Office for Outer Space Affairs, 2015 Annual Report, p. iii.
4. *see* Wade D., *New Technology & Markets*, Atrium Space Insurance Consortium, WSRF, 2012 Dubai.
5. World Economic Forum, Bringing Space Down to Earth, March 2015, http://www3.weforum.org/docs/WEF_Bringing_Space_Down_to_Earth.pdf, accessed 27 August 2016.

launched the *first artificial satellite*, Sputnik, shortly followed after by United States (US) Explorer I in 1958. While they initially served military purposes, the rapid development of technology in a short time opened the door for various satellite applications that we know and use today. The commercialisation of the launch industry started in 1962, when the first *commercial communications satellite*, Telestar 1 owned by AT&T, *was launched by National Aeronautics and Space Administration (NASA)* by Delta Expendable Launch Vehicle (ELV) *and placed in geosynchronous orbit* (it took place on 10 July 1962). It was shortly followed by Telestar 2 in 1962[6] and others. The satellite insurance market saw its dawn on 6 April 1965, when the Intelsat 1 satellite 'Early Bird', insured by the London market, was launched by NASA.[7] Commercial pressure for the private use of outer space has been growing continuously ever since, and has now, finally, been reflected in legislation (first international, then national), the privatisation of international organisations (such as Intelsat, Inmarsat, Eutelsat and Intersputnik) and of course insurance, which has accompanied the commercial use of outer space from its early days.

Considering the present situation in the space industry, according to the Organisation for Economic Co-operation and Development (OECD) report, it should be noted that only eight countries and the European Space Agency (ESA) are able to organise launch operations. Since 1994, there have been approximately 1,300 successful launches in total, which comes to more than seventy launches worldwide a year, with over eighty launches in 2015 and approximately hundred launches in 2016, though many of them including several smallsats.[8] The numbers seem to be stabilising in relation to the early stages in the 1980s, but the industry is still subject to strong variations due to a low number of launches, a similar satellite life, the replacement cycle, etc. As regards commercial launches, there are six companies able to offer commercial launch services, with Geostationary Orbit (GEO) being the most demanded orbit, due to its profitability, as the home to large communication satellites. The demand for future launch services is expected to face stable or increasing demand from institutional and commercial clients.[9] Suffice it to say that the industry related to satellite services is worth approximately USD 122.9 billion, with revenues of USD 203

6. Mossinghoff G.J., Sloup G.P., *Legal Issues Inherent in Space Shuttle Operations*, 6 J. Space L. 47, 1978.
7. Though it covered only pre-launch property risks and third-party liability risk; Gimblett R., *Liability. Space Insurance into the Next Millennium* in: Outlook on Space Law Over the Next 30 Years, (Lafferranderie, G.), Brill 1997; Gaubert C., *Insurance in the Context of Space Activities* in: Handbook of Space Law (Dunk F.G. von der, F. Tronchetti, eds), Edward Elgar Publishing Limited, 2015, p. 910; Kayser V., *Launching Space Objects: Issues of Liability and Future Prospects*, in Space Regulations Library, vol. 1, Kluwer Academic Publishers, New York, Boston, Dordrecht, London, Moscow 2004, p. 12; Diederiks-Verschoor I.H.Ph., Kopal V., *An Introduction to Space Law*, Wolters Kluwer, 2008, p. 113; Manikowski P., *The Columbia Space Shuttle Tragedy: Third-Party Liability Implications for the Insurance of Space Losses*, 8(1) Risk Mgt. & Ins. Rev., 142, John Wiley & Sons, 2005.
8. OECD, *The Space Economy at a Glance 2014*, OECD Publishing, Paris 2014. DOI: http://dx.doi.org/10.1787/9789264217294-en; *See also* http://space.skyrocket.de/doc_chr/lau2016.htm; https://sites.google.com/a/slu.edu/swartwout/home/cubesat-database, accessed 23 August 2016.
9. OECD, *The Space Economy at a Glance 2014*, OECD Publishing, Paris 2014. DOI: http://dx.doi.org/10.1787/9789264217294-en, p. 76.

billion and only last year it grew by 4% (data from 2014) which is above the average global growth.[10] The facts are that, by the end of 2014, fifty-seven countries operated at least one satellite as launching states, and altogether there were 1,261 operating satellites in the Earth's orbit.[11]

The space activities are accompanied by a regulatory framework adopted at various levels and in various forms, including international and national legislation, both in the form of hard law and in the form of soft law. No regulatory framework existed, however, at the moment when the space industry was emerging. The first successes in space activities were followed by respective legal provisions, first at the international level, then flowing down to the domestic level at a much later stage. These were enacted not earlier than in the 1960s, initiated by the Outer Space Treaty (OST) and followed subsequently by four 'space treaties': the Liability Convention (LC), the Rescue Agreement, the Registration Convention (RC), and the Moon Agreement. The regulatory framework for commercial launches at a national level was introduced initially by Norway, but within a limited scope, and then, as the first comprehensive legislation, by the US in the Commercial Space Launch Act (CSLA) of 1984.[12] It was introduced at the sunset of the US monopoly in the field of launching operation[13] and reinforced by announcing a new trend in space politics of the US, aimed at encouraging US commercial satellite launches to be privatised, with the natural consequence of limiting NASA's involvement in commercial space operations.[14] By that moment, NASA, based upon the authority granted and authorisation given annually by the US Congress, had already made several dozen reimbursable launches, a growing percentage of which were commercial launches for the privately owned satellites.[15] Apart from that, it was also an era of undertaking private/commercial launches on a more regular basis and on a larger scale than ever before by governments.[16] The international regulations did not follow this trend, however, and still only involve states as addressees of international regulatory framework, though they set basis also for the commercial space activities. Thus, private commercial launch activity is regulated by national law, by soft law or by the

10. Satellite Industry Association, *2015 State of the Satellite Industry Report*, http://stakeholders.ofcom.org.uk/binaries/consultations/space-science-cfi/responses/State_of_the_Satellite_Industry_Report_2015.pdf, accessed 27 August 2016.
11. Of which 38% are communication satellites, 14% government communication, 14% earth observation, 11% R&D, 8% navigation, 8% military surveillance, 5% scientific, and 2% are meteorology satellites.
12. Though the first national legal act was enacted by Norway in 1969, it was very vague and general; *see also* Hermida J., *Legal Basis for a National Space Legislation*, Space Regulations Library, vol. 3, Kluwer Academic Publishers, New York, Boston, Dordrecht, London, Moscow 2004, p. 78.
13. Dunbar D.R., Schrerer L.R., *The U.S. Commercial Launch Services Industry and International Competition*, Paper Session II B, 1989, pp. 5-1.
14. Laisné M., *Space Entrepreneurs: Business Strategy, Risk, Law, and Policy in the Final Frontier*, 46 J. Marshall L. Rev. 1039, 1040, 2013.
15. Mossinghoff G.J., Sloup G.P., *Legal Issues Inherent in Space Shuttle Operations*, 6 J. Space L. 47, 51, 1978.
16. Greenberg J.S., *Considerations When Analyzing Investment in Space Transportation Business Ventures*, 47 Acta Astronautica, 2000.

contractual clauses of Launch Services Agreements (LSA) worked out by the space industry.

The space industry as a whole, and particular activities within it, is backed up by the financial institutions, as, due to the enormous costs of a single space project, the support of external financing constitutes an inherent part of the whole endeavour. *Another important partner of the satellite operators are insurers, in accordance with the known statement that without insurance there is no financing, and without financing there is no space mission.* [17] Exceptions from the above principle may only concern public space missions, financed by governments, though in this case the insurance scenario of the space project is also seriously taken into consideration. The space insurance coverage at the beginning was offered by aviation insurance, as the branch the most capable to assess the risk related to the flight. It was clear that the principal issues that space insurance had to face in the beginning were somehow similar to those relating to aviation insurance in its early stage, i.e. the potential of catastrophic consequences of hazards that could not be precisely measured.[18] It has been stressed by the experts that the space industry faced in its infancy the same problems as other ultra-hazardous activities with respect to the insurability of the relevant risks.[19] Quickly, however, it appeared that the specific nature of the space industry required such a specialised approach that a separate branch of insurance needed to be developed for insuring space risks.[20] At the moment, the scope of space insurance competition is still small, as there are about forty insurers worldwide able to offer space coverage.[21]

The first space insurance contract was concluded in 1965 for COMSAT's Early Bird satellite with coverage of pre-launch insurance and third-party liability (TPL)

17. *See* for example, Coopersmith J., *The Cost of Reaching Orbit: Ground-Based Launch Systems*, 27 Space Policy 77–80, 2011; Dembling P. G., *Assessing the Space Insurance Field*, 34 Proc. on L. Outer Space, 387 1991.
18. International Space Brokers Ltd Memorandum – Risk and Legal Liability in Commercial Space Launches, 2000, http://www.publications.parliament.uk/pa/cm199900/cmselect/cmtrdind/335/335ap04.htm; accessed 14 January 2017.
19. Ross S., *Risk Management and Insurance Industry Perspective on Cosmic Hazards* in: Handbook of Cosmic Hazards and Planetary Defense (J. Pelton, F. Allahdadi, eds), Springer International Publishing, Switzerland, 2015, p. 1100.
20. Kuskuvelis I.I., *The Space Risk and Commercial Space Insurance*, Space Policy, May 1993; Horl K.U., *Legal Aspects of Risks Involved in Commercial Space Activities*, Montreal 2003. It is however worth mentioning that the space TPL insurance still is underwritten by the aviation insurers Gaubert, C., *Insurance in the Context of National Authorisation* in: National Space Legislation in Europe: Issues of Authorisation of Private Space Activities in the Light of Developments in European Space Cooperation (Dunk F.G. von der, ed.), Martinus Nijhoff Publishers, Leiden/Boston, 2011, p. 170; Gaubert C., *Insurance in the Context of Space Activities* in: Handbook of Space Law (Dunk F.G. von der, F. Tronchetti, eds), Edward Elgar Publishing, 2015, p. 911.
21. International Space Brokers Ltd, *Memorandum – Risk and Legal Liability in Commercial Space Launches*, 2000, http://www.publications.parliament.uk/pa/cm199900/cmselect/cmtrdind/335/335ap04.htm; accessed 14 January 2017 http://www.publications.parliament.uk/pa/cm199900/cmselect/cmtrdind/335/335ap04.htm, accessed 29 August 2016.

insurance, written by marine insurers.[22] It is stressed that launch insurance was not possible at that time, due to a lack of data as to the probability of the hazard related to the space endeavour.[23] The coverage of launch and in-orbit risks began in 1968 with insuring an Intelsat fleet of satellites, providing for a franchise for the first launch. The first insurance contract without a franchise was concluded in 1975 for the launch of a Marisat satellite. It was also the year of concluding the first in-orbit insurance.[24] The history of space insurance is indicated by years of losses, followed by an increase in premiums, and then by the years of revenues with no substantial damages suffered by the industry.[25] The numbers of the current space insurance sector, however, do not seem to present an effective landscape: at the moment, there are only about 250 satellites covered by insurance, with an exposure of USD 26.5 billion. The insurance premiums collected in 2014 amount to USD 700 million, while the space industry revenue for that period is approximately USD 203 billion.[26] The total insurers' actual capacity for launch coverage amounts to approximately USD 750 million, and in-orbit coverage to approximately USD 550 million,[27] where the largest share belongs to the

22. Reeth van G., *Space and Insurance*, 12 Intl. Bus. L., 127, 1984; Pagnanelli B., *Tracking Take-off of Space Insurance*, 2007, www.pagnanellirs.com/downloads/id281107.pdf, accessed 27 August 2016; Kuskuvelis I.I., *The Space Risk and Commercial Space Insurance*, Space Policy, May 1993 – different (stated that it covered also launch insurance).
23. Horl K.U., *Legal Aspects of Risks Involved in Commercial Space Activities*, Montreal 2003.
24. Harrington A.J., *Legal and Regulatory Challenges to leveraging Insurance for Commercial Space*, 31st Space Symposium, Technical Track, Colorado Springs, Colorado, United States of America Presented on 13–14 April 2015; Reeth van G., *Space and Insurance*, 12 Intl. Bus. L., 127, 1984; In -orbit insurance needed more time to take-off and it appeared only in the 1980s; Pagnanelli B., *Tracking Take-off of Space Insurance*, 26 November 2007; Daouphars P., *L'assurance des risques spatiaux* in: L'exploitation commerciale de l'espace (P. Kahn, ed.), Bourgogne 1992, p. 254.
25. The first claims appeared in 1977 and they resulted from the launch failure of OTS-1 satellite being a total loss, and then in 1979, when the Indonesian Satcom III satellite launch appeared to be a failure and caused a claim for USD 77 million (constituting 200% of the loss ratio). The situation repeated in 1984, when the total amount of claims reached a level of USD 280 million, and in 1985 – for the amount of USD 351 million; in 1986 – USD 81 million. The above resulted in using all the reserves accumulated by the insurers and caused marine insurers to withdraw from underwriting the space risks; Koops-Jubitana S.C, *Commercial Launch Activities: Launch Contracts and Launch Insurance - Liability Aspects*, Leiden University, 2006, p. 55; Traa-Engelman van H.L., *Commercial Utilization of Outer Space – Legal Aspects*, Rotterdam, Drukderij Haveka 1993, p. 232; More in: Meredith P.L., Robinson G.S., *Space Law: A Case Study for the Practitioner. Implementing a Telecommunications Satellites Business Concept*, Martinus Nijhoff Publishers, 1992, pp. 318, 339.
26. Wade D., *Insurance for Spaceflight, Spaceport*, UK, Royal Aeronautical Society, 2016; Data provided by Kunstander C., *Space Insurance Market Overview*, 2013 say about 205 satellites insured totally (GEO – 185 for the value of USD 22.5 billion; LEO – 20 for the value of USD 1.5 billion), where the annual premium ranges from USD 750 million to USD 1 billion and claims from USD 100 million to 1.8 billion; the average insured value per satellite amounts to USD 100–300 million, up to USD 400 million (up to 750 million for dual launches). As regards the space insurance figures, in 2013 it collected USD 775 million premium, but incurred losses in total value of USD 806 million (one single claim of Intelsat in the amount of USD 406,200 million coming from failed Sea Launch launch) Kunstadter C., *Space Insurance Market Overview*, AIAA Workshop, 2013; so far, annual claims varied from USD 100 million to USD 1.8 billion; while annual premium ranges from USD 750 million to USD 1 billion. For seventy to eighty launches annually for a worldwide scale, the insured is approx. 50%.
27. Capacity means an amount available to cover one risk and in terms of the market capacity it means an aggregate of all capacities that underwriters individually allocate to the given risk, *see*

Lloyd's market. As regards TPL insurance, the world capacity is approximately USD 500 million. The space insurance market is a volatile one and cyclical (Axciom),[28] it goes through cycles of soft and hard markets. It is claimed that for a few years now, the market has been growing softer, after the last increase of premium rates in 2008. Apart from that, the volatility is also attributed to the relatively small number of insurers (approximately forty[29]) and insurance contracts (twenty to thirty annually), as well as the possibility of the whole premium collected being consumed in a single event,[30] constant technology changes, generic nature of failures and the unique nature of each space project.[31] The response of the space insurance market to losses is usually relatively short and results in an increase of rates and reduced capacity,[32] though nevertheless a shift of claim trend in relation to the level of premiums and capacity is inevitable.[33]

What is interesting is that, in spite of the volatility, the space insurance line was not hit so much by the financial crisis as other lines of insurance business. This was due, among other things, to the fact that space risks are subject to underwriting and contracting a long time before the space programme actually begins. The risk is insured at the manufacturing stage at the latest, which is approximately two to three years before the launch and further space operations. Of course, the decline in the risk written could depend on the shrinking financing of subsequent projects.[34] The current situation of the space market has been described by experts as stable, but with 'underlying fragility'; 'profitable' but with increasingly thin margins. The space insurance market also faces many challenges these days and this concerns mostly environmental factors and the increasing amount of space debris, commercial human spaceflight and smallsats insurance.[35]

Space Insurance Market, Report by Timofeev Aleksander MSM 09 ISU, Strasbourg; Timofeev A., *Space Insurance Market* – Report, Strasbourg 2009, p. 10.
28. Manikowski P., Weiss M., *The Satellite Insurance Market and Underwriting Cycles*, 38(2) Geneva Risk & Ins. Rev., 148–182, 2013.
29. As has been mentioned, the space insurance market is a sophisticated one and it gathers only the most specialised insurers, i.e. Swiss Re, Munich Re, AIG, Partner Re, Global Aerospace, Inter Hannover, XL Catlin, Lloyd's syndicates such as Atrium, Beazley and some others. Morgan G., *The Space Insurance Market*, The 6th Annual International Conference 'Aviation and Space Insurance in Russia', Moscow 26 February 2015.
30. It should also be pointed out that the volatility is not expressed only in the amount of premium, but also may consist of higher deductibles, shorter coverage periods and satellite health related exclusions (DTV report of 27 February 2009). Efimova Y., Butchers M., *Space Insurance Report*, Knowledge Transfer Network, 2014, p. 10.
31. Kunstadter, C., *Space Insurance Overview*, Proceedings from 14th International Space Insurance Conference 2005, 2007; Gould A., Linden O., *Estimating Satellite Insurance Liability*, Papers on Fall CASAC Conference, 2000.
32. Timofeev A., *Space Insurance Market – Report*, Strasbourg 2009.
33. Stevens N., *Lecture at London Institute of Space Policy and Law*, October 2016 (not published, copy with the author).
34. Bradford M., *Space Market Pricing Steady Despite Ailing Economy, But Risks on the Rise*, Business Insurance, 13 April 2009.
35. Kunstadter, C., *View from the Leading Edge*, Proceedings from 2nd World Space Risk Forum 2012, WSRF; Morgan G., *The Space Insurance Market*, The 6th Annual International Conference 'Aviation and Space Insurance in Russia', Moscow 26 February 2015.

[B] Satellite Operation and Application

The tasks performed by the satellites are the only 'visible' part of their operation, but they could not perform any services without being backed by manoeuvring, commanding and tracking the satellite, all of which is necessary in order to keep the satellite properly functioning in a dedicated position in the Earth's orbit. For purposes of this chapter, these activities will be referred to as the 'operation of the satellite'. The operation of satellites, from both the regulatory and risk point of view, should be distinguished from the application thereof on Earth. In this respect, the space segment and ground segment should be distinguished (upstream and downstream activities). The oldest, best-known and most profitable part of the space industry,[36] related also to the most complex and developed regulations, is satellite communications. The distinctive feature of this sector is also that it is subject to legal regulation, even in countries that have not developed domestic comprehensible space law (such as Canada), or the European Union (EU), the harmonisation power of which, though it excludes space matters, is still extended to particular sectors of space applications. It must be remembered that this is only one of the many possible applications, of which remote sensing (earth observation) and satellite navigation are gaining in importance and present potential for commercialisation, as well as becoming a subject of regulatory endeavours on international, European and national levels.[37]

The communication satellite sector is a worldwide net in various orbits, including serving telephone communications, internet and television broadcasting.[38] Communication satellites are operated mostly by private operators, such as Intelsat, Iridium, Global Star, SES. It clearly exceeds the frames of the space sector in the strict meaning, which is very visible in the role played by the International Telecommunication Union (ITU) in the technical coordination of frequencies to be used by telecommunications satellites, due to the assignment of frequencies, which is a necessary condition of undertaking space activities in this field.[39] The potential of communication satellites[40] was visible ever since the first communication satellite was launched in-orbit by Intelsat in 1965. It was able to provide 240 telegraph circuits simultaneously, or one TV

36. Annual global sales in communication satellites sector amount to EUR 110 billion as for 2012, Densing R., Reinke N., *The Need for European Independence in Space Applications*, European Autonomy in Space, Springer, 2015, p. 132.
37. Traa-Engelman, van, H.L., *Commercialization of Space Activities: Legal Requirements Constituting a Basic Incentive for Private Enterprise Involvement*, SP O5/1996, pp. 122 et seq.
38. Specific categories of communication satellites are usually distinguished by type or by the purposes they serve and services they render. Most communication satellites services are defined as fixed satellites services (FSS), broadcasting services (BSS) and mobile satellite services (MSS) – and are also called the 'big three' satellite communication services. Definition applied by ITU, Pelton J., *Satellite Communications*, Springer Science & Business Media, Arlington 2011, pp. 13–14.
39. It seems to be a challenge for the future, due to the limited number of free slots in-orbit; Hobe S., *Current And Future Development Of International Space Law*, Proceedings United Nations/Brazil Workshop on Space Law Disseminating and Developing International and National Space Law: The Latin America and Caribbean Perspective, United Nations, New York, 2005, pp. 10–11.
40. The communication satellite industry has the largest (2010 – revenues at the level of USD 170 billion – including associated branches such as manufacturing and launch services).

channel, which was more efficient than transatlantic cables. This shows that it is the technology that remains behind the success, as it is directly related not only with the technical possibilities, but also affects the cost factors. The success has also been connected with allocating new, higher frequency bands.[41]

The second sector of significantly growing importance, *satellite navigation*, serves the global positioning of ships, spacecraft, aircraft and automobiles. It has spread from military and commercial purposes to consumer usage. The increase in satellite navigation applications is due to the growth in the population and infrastructure. In this respect, the issue of liability is more and more a concern of operators and their customers, rendering services to the public, and also poses questions with respect to the application of space law to that branch of space services. Navigation services initially served military purposes and were operated by governments,[42] but with opening up GPS to the public, a huge market appeared for hardware and software.[43] It was realised that navigation is 'an essential critical infrastructure,' which was the reason behind the EU developing Galileo, composed of thirty satellites.[44] Navigation satellite systems are on the increase in various countries, such as in China (Compass/Beidou), Japan (QZSS) and India.

A third sector, *remote sensing*,[45] consists of measuring data about the atmosphere and the surface of the Earth with high temporal and spatial resolution It is a key technology for monitoring the environment (weather, flooding landslides and agriculture) and providing info from the sensors measuring the surface, processing and converting it.[46] The main significance of the remote sensing is perceived in protection of the mankind from natural disasters[47] (e.g., the Copernicus project in the EU). The majority of remote sensing satellites operate at an altitude of around 800 km. Meteorological missions fly even higher – to GEO, from where the entire Earth can be viewed. In remote sensing also we can see a clear change in application, from espionage in early days to the modern, environmental services. Radar technology used

41. From C-band communication satellites have been switched to Ku-band (10–14 GHz) and Ka-band (20/30 GHz); though the higher a frequency is, the more the weather affects the signal quality, though the new technologies are able to make it resistant to that factor Koudelka O., *The Technical Dimension of Space*, Outer Space in Society, Politics and Law, Springer Wien New York, 2011, pp. 46–47.
42. US GPS – twenty-four satellites; Russian Glonass – twenty-four satellites.
43. Koudelka O., *The Technical Dimension of Space in Outer Space*, Society, Politics and Law, Springer Wien New York, 2011, p. 49.
44. *Supra*, p. 50.
45. Soucek A., *Earth Observation*, Outer Space in: Society, Politics and Law, Springer Wien New York, 2011, p. 122, Gabrynowicz J.I., *The UN Principles Relating to Remote Sensing of the Earth*, in: Soft Law in Outer Space: The Function on Non-binding Norms in International Space Law (I. Marboe, ed.), Boehlau 2012.
46. Koudelka O., *The Technical Dimension of Space*, Outer Space in Society, Politics and Law, Springer Wien New York, 2011, pp. 50–52; Soucek A., *Earth Observation*, Outer Space in Society, Politics and Law, Springer Wien New York, 2011, p. 111.
47. Hobe S., *Current and Future Development of International Space Law*, Proceedings United Nations/Brazil Workshop on Space Law Disseminating and Developing International and National Space Law: The Latin America And Caribbean Perspective, United Nations, New York, 2005, p. 11.

to the contract), insurable interest (though with some exceptions) principle of indemnity, the basic features of the insurable risk (reflected in the condition of fortuity of the event insured, etc.) and the principle of reasonableness (reflected in the obligation of reasonable behaviour or obligation to fulfil reasonable expectations). There is no doubt that the law of insurance contract fluctuates, and the way it fluctuates makes it more coherent and less divergent among the civil and common law systems. This trend, however, concerns mostly B2C relations, where a strong impact is put on the protection of the weaker party to the contract. While extensive protection, going even further than general consumer protection, is granted to the insurance contract concerning 'mass risks', the insurance contracts of 'large risks' enjoy substantive contractual freedom. That is visible in all aspects of insurance contracts, such as pre-contractual information, the consequences of a breach thereof and other contractual duties, as well as in the rules governing the conflict of laws. Against this background, the space insurance contract must be clearly distinguished from among other types of insurance contracts.

CHAPTER 3
Content of Space Insurance Contract

§3.01 OUTLINE

The aim of this chapter is to identify the risks related to the exploration of outer space. This is necessary for an analysis of the content of space insurance contracts, in view of the fact that it is risk that is the subject of the insurance contract. Consequently, various aspects of the risk in space activities and insurance have been analysed. First, the sources of hazards are distinguished, then the hazards (perils) deriving from the identified sources, and finally the risk understood as a combination of hazards and their consequences are analysed. The above has been put in the context of the insurability of space risks, the types of risks that are covered by space insurance and those risks that are typically excluded. An indispensable factor of the space insurance contract is also the period of insurance cover, which has been analysed in the context of the risk period related to space activities. Lastly, the legal aspects of measuring risk for the purpose of insurance are presented, such as the insurable value, the sum insured and the maximum probable loss.

§3.02 RISK IN SPACE ACTIVITIES

[A] General

Columbia Accident Investigation Board Findings: 'Building and launching rockets is still a very dangerous business, and will continue to be so for the foreseeable future *while we gain experience at it. It is unlikely that launching a space vehicle will ever be as routine an undertaking as commercial air travel.'*[1] This statement, though expressed in

1. Wilde, P., *Public Risk Criteria and Rationale for Commercial Launch and Reentry*. Presented to UNCOPUOS Scientific and Technical Subcommittee (Federal Aviation Administration Office of Commercial Space Transportation February), 2014.

2003, is still valid today.[2] The level of risk has not much changed in recent years in spite of the amazing progress in technology.[3] Still, the technology of the launch phase shows several types of hazards of technological or environmental nature able to cause failure of the entire space mission. With this in mind, there can be no doubt that all activities undertaken in outer space are ultra-hazardous, inherently very risky and random activity, which is potentially so harmful that ordinary person would not regularly take on such an activity.[4] This is due to the technology, that must be used in order to carry out the space mission. For example, in order to reach the orbit, intense energy must be built up during the launch, and the high velocity of a space object leads to enormous friction with the atmosphere to be traversed transforming kinetic energy into heat.[5] Moments such as the launch involve numerous perils and although the launch is perceived as the most risky, the risk is also connected with the early stage operation of the satellite, when the deployment of antennae and solar arrays takes place. Not only does the risk not diminish in spite of the technological progress, but in some cases it may even be increased by technology, which now allows much larger satellites than before (up to 20 m) as well as much smaller satellites to be built and launched.[6] All the measures adopted for the launch and operation phase still give no guarantee of success, as even a single malfunctioning component may cause a total loss of the satellite, and no servicing in-orbit is practicable.[7] Though the risk of a catastrophic failure permanently disabling a satellite after it has been placed in proper orbit is relatively low, it is clear that in space projects, one may only mitigate risk but not avoid it.[8]

Risk in space activities is a mixture of technological, human and nature related perils. There are various risks and various criteria of risk division. While the types of hazards and risks seem to be common for any type of activity (including technological, natural, market, political, operational and legal hazards, including the worst scenario which is always a loss of human life), their meaning is quite unique for space

2. The risk related to launch in relation to the whole space project risk (as a ratio to the whole operation risk) is assessed by the insurers at the level of 30–40%; Catalano Sgrosso G., *International Space Law*, LeGisma Editore, 2011, pp. 479, 487; *see also* Gould A., Linden O., *Estimating Satellite Insurance Liability*, Papers on Fall CASAC Conference, 2000, pp. 53, 67.
3. It is said that though changes in satellite technology may be clearly seen over time, the engineers of the 1970s would still recognise today's satellites as such, as they still take the form of a box in shape with solar arrays deployed off the satellite and antennas on the Earth-facing surface. Hofer C.F., Kim D., J., *The Continued Evolution of Communication Satellites*, 47 (2-9) Acta Astronautica, 68–70, 2000; Koudelka O, *Outer Space a 'Real' Issue*, Outer Space in Society, Politics and Law, Springer Wien New York, 2011, pp. 48–49.
4. The notion of the ultra-hazardous activity has been outlined by the Prof C.W. Jenks in 'Liability for Ultra-Hazardous Activities in International Law', 1966 cited by Brodecki Z., *Liability in InternationalLlaw*, Studia Europejskie, Instytut Stdiów Europejskich, Gdynia 2000, p. 179; Parquet C_A, *Allocation of Potential Liabilities and Risks in Launch Services Agreements*, Project 2001 Plus workshop, 29–30 January 2004; also Soucek A., *International Law* in: Outer Space in Society, Politics and Law (A. Soucek, Ch. Brunner), Springer Wien New York 2011, p. 342.
5. Soucek, A., *International Law* in: Outer Space in Society, Politics and Law (A. Soucek, Ch. Brunner, eds), Springer Wien New York 2011, p. 338.
6. Pelton J., *Satellite Communications*, Springer Science & Business Media, Arlington 2012, p. 56.
7. *Ibid.*
8. Elbert B. (ed.), *The Satellite Communication Applications Handbook*, Artech House, Inc., 2004, p. 487. Soucek A., *International Law* in: Outer Space in Society, Politics and Law (A. Soucek, Ch. Brunner, eds), Springer Wien New York 2011, p. 340.

activities.[9] The well-known rule is that the first thing in proper risk management is to identify the risk. This fully applies to risks in space.[10] Though it seems that space risks are associated primarily with 'anything outside Earth's atmosphere that can cause harm to people or property',[11] it is obvious that the risk related to space operations is not limited to cosmic risks, but also includes substantial risks that can occur on Earth. It may sometimes be confusing, in view of the fact that the space insurance coverage starts basically only upon lift off. However, the risks related to space operations include a variety of risks related to both the Earth and space natural environment, as well as those that derive inherently from the technology of the LV or satellite and its manufacturing process. The specifics of space risks constitute a combination of all of these factors.

Thus, identifying the risks relating to space activities requires a comprehensive approach, including all legal and technology hazards as well as natural threats that may affect the mission. In this respect, insurance underwriting is not left alone with the task of identifying the risk. The advanced authorisation requirements introduced to the national legal systems, as well as elevated industry standards, have also introduced the mission assurance[12] and other risk management measures, such as system safety process, quantitative risk analysis (QRA), operational restrictions (OR) into highly developed, technical regulations.[13] All of these measures constitute part of the space

9. Horl K.U., *Legal Aspects of Risks Involved in Commercial Space Activities*, Institute of Air and Space Law, McGill University, Montreal 2003, p. 18.
10. For example, Hermida J., *Risk Management in Arianespace Space Launch Agreements*, XXV Annuals of Air & Space L., 2000.
11. Ross S., *Risk Management and Insurance Industry Perspective on Cosmic Hazards* in: Handbook of Cosmic Hazards and Planetary Defense (J. Pelton, F. Allahdadi, eds), Springer International Publishing, Switzerland, 2015, p. 2.
12. Mission assurance is considered to be equivalent to launch insurance; it is a tool of risk management in government missions and consists of all activities performed to manage flight risk and to minimise the probability of failure; it is composed of two basic parts, i.e. the design validation (for inherent and generic reliability) and the readiness validation (reliability of the process for a particular launch) Johnson R., *Managing Launch Risk in new space Era*, WSRF 2014, Dubai; http://worldspaceriskforum.com/2014/wp-content/uploads/2014/05/7_KEYNOTE_JOHNSON.pdf, accessed 15 October 2016; To this aim, new requirements are imposed by national law, such as draft of French law requiring French launch providers to direct the upper stages of the launch vehicles on the course that would cause them to drop into open waters or disintegrate immediately after launch in Earth atmosphere; *see* Al-Ekabi C. (ed.), *European Space Activities in the Global Context* in: European Autonomy in Space, Springer 2015, p. 36.
13. *See*, for example, the Launch Collision Avoidance (Launch COLA) analysis, performed not only for commercial, but also for civilian and military launches; the Launch COLA safety requirements aim to protect the launch against collision with orbiting assets (that are occupied or may be occupied by humans); Schultz E.D., Wilde P.D., *Mitigation of the Collision Hazard for the International Space Station (ISS) from Globally Launched Objects*, 6th IAASS Conference: Safety is Not an Option: 21–23 May 2013, Montreal, Canada; *See also* Wilde, P., *Public Risk Criteria and Rationale for Commercial Launch and Reentry*, Presented to UNCOPUOS Scientific and Technical Subcommittee (Federal Aviation Administration Office of Commercial Space Transportation February) 2014; Bjorndahl W.D., *Mission Assurance Programme Framework*, 2010, http://www.aerospace.org/wp-content/uploads/2015/04/TOR-20108591-18-Mission-Assurance-Program-Framework.pdf, accessed 27 August 2016. The French Technical regulations issued as a part of the system of the licensing deal with the technical issues of launch; they include quality system, launcher reliability, stage fall- back, hazard analysis, collision avoidance, environmental impact

traffic management.[14] The role of the national legislation in this respect includes proper management of the risks related to space operations in such a way that they are manageable for all the participants thereof, by limiting the burden of the risk, assuming and potentially insuring another part of the risk.[15] Although not harmonised all over the world, do seem to be similar, and this similarity is encouraged by the launching authorities in the licensing process and affects the level of regulated TPL insurance.[16] It is also under a 'harmonisation' process via soft law instruments worked out by several international organisations. These patterns are often followed by national agencies and authorising authorities while introducing the safety standards and requirements.[17] The technical standardisation of the space operations seems to be an important factor for insurers when assessing the risk concerning space activities.

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analysis; Fsoa And Associated Regulations Applied To Future European Launchers A5 Es Galileo, A5ME, A6, Sixth IAASS-Session 2 Regulations and standards for safety, Cahuzac F., Biard A., Date: 21 May 2013; also Lazare B., *Technical Regulations for Space Operations, a Tool Box to Protect People, Goods, Public Health and Environment*, 2014, http://www.unoosa.org/pdf/pres/stsc2014/tech-10E.pdf, accessed 27 August 2016; Wilde P, *Public Risk Criteria and Rationale for Commercial Launch and Reentry*, Presentation to UNCOPUOS Scientific and Technical Subcommittee, February 2014; Jakhu R.S., Sgobba T., Dempsey P.S. (eds), *The Need for an Integrated Regulatory Regime for Aviation and Space ICAO for Space?*, Springer, 2011, p. 77.

14. It is explained for example as '*the set of technical and regulatory provisions for promoting safe access into outer space, operations in outer space and the return from outer space to Earth free from physical or radio-frequency interference.*' Contant-Jorgenson C., Lala P., Schrogl K.U, *The IAA Cosmic Study on Space Traffic Management*, Vienna, 2006, https://iaaweb.org/iaa/Studies/spacetraffic.pdf, accessed 27 August 2016; necessary measures within the STM include the following: the introduction of safety certificates, the clarification of the terms 'space object' and 'launching state', the delimitation of outer space, the introduction of pre-launch notification system as well as the notifications on damages. *See also* Lazare B., *Technical Regulations for Space Operations, a Tool Box to Protect People, Goods, Public Health and Environment*, 2014, http://www.unoosa.org/pdf/pres/stsc2014/tech-10E.pdf, accessed 27 August 2016 and an explanation of the launch safety objectives. Also Crowther R., *Space Security*, *Lecture at London Institute of Space Policy and Law*, October 2016 (not published, with the author).

15. Johnson Ch.D., *Legal and Regulatory Considerations of Small Satellite Projects* in: Small Satellite Program Guide, 1st edn. (M. Victoria Alonsoperez, Ran Qedar, eds), CEI Publications, 2014.

16. Kayser V., *Launching Space Objects: Issues of Liability and Future Prospects*, Space Regulations Library, vol. 1, Kluwer Academic Publishers, New York, Boston, Dordrecht, London, Moscow 2001, pp. 10–11; For example *see*: Lazare B., *Technical Regulations for Space Operations, a Tool Box to Protect People, Goods, Public Health and Environment*, 2014 http://www.unoosa.org/pdf/pres/stsc2014/tech-10E.pdf, accessed 27 August 2016, The regulations include a prohibition on generating debris during nominal operations, minimising the probability of accidental break-up, preventing collisions with satellite of known orbital parameters, as well as removing space vehicles and orbital stages from protected regions after the end of the mission; the regulations provide separate obligations for the launch systems (Art. 21) and orbital systems (Art. 40) Decree on Technical Regulation dated 31 March 2011, issued pursuant to Act No. 2008-518 of 3 June 2008.

17. For example, IAASS drafted some recommendations concerning the public risks related to the launch and re-entry, including the '[t]he publication by any country involved in launch and re-entry operations of their practices for the identification, evaluation, and management of quantitative risk criteria, [t]he development of voluntary international guidelines based on best practices for identification and management of quantitative public safety risk criteria related to launch and re-entry operations, [T]he development of voluntary international guidelines and benchmarks for the computation of public risks to ensure consistency of risk estimates by operators'; Wilde, P., *Public Risk Criteria and Rationale for Commercial Launch and Reentry Presented to UNCOPUOS Scientific and Technical Subcommittee* by Wilde P., (Federal Aviation

The structure of the hazards types associated with space activities may be divided as per the phase of the space mission, such as the launch, orbital and re-entry. This concept seems useful also for insurance purposes and the most common structure of the space insurance coverage. It is possible to identify generic types of hazards related to each of the space mission phases.[18] This does not mean the risk stays the same, as each space project is different and should be addressed separately in terms of the risk assessment.[19] Modern failures analyses identify potential failures that might occur during the mission, their probability and effects on the LV's trajectory and integrity. In particular, vehicle probability of failures and debris casualty areas are unique for each launcher, launch conditions and each operator,[20] and that is why, the data for such an analysis must be based on some assumptions by reference to comparable systems.[21]

For the purposes of a proper assessment of the risk related to the launch, it should be stressed what is meant by launch. LSA usually refers to the technology in defining it, and though finally the definition depends on the type of the LV, its common feature is the moment when the launch becomes irreversible[22] and it:

> 'begins when the launch vehicle is no longer in physical contact with equipment and ground installations that made its preparation and ignition possible (or when the launch vehicle is dropped from the carrier-aircraft, if any), and continues up to the end of the mission assigned to the launch vehicle'.[23]

Administration Office of Commercial Space Transportation February) 2014; Also ESA developed 'European Space Standards, as a single set of technical standards for use in European space activities (ECSS standards), *see also* ISO standards Jakhu R S., Sgobba T., Dempsey P.S. (eds), *The Need for an Integrated Regulatory Regime for Aviation and Space ICAO for Space?*, Springer, 2011, pp. 33–36; Howard D., *Safety as a Synergetic Principle in Space Activities*, 10(2) FIU L. Rev., 722–725, 2015.

18. Hazard Analysis Of Commercial Space Transportation, DOT Office of Commercial Space Transportation 1995, https://www.faa.gov/about/office_org/headquarters_offices/ast/licenses_permits/media/hazard.pdf, accessed 27 August 2016, pp. 1–5.

19. Wilson S. (et al.), *Space Launch and Re-Entry Risk Hazard Analysis – a New Capability, Space Launch and Re-entry Risk Hazard Analysis – a New Capability*, 60th International Astronautical Congress, Korea 2009, p. 9.

20. In this respect, such factors as the experience of a given operator in relation to a given type of the launch vehicle are taken into account.

21. An important factor for making a failure analysis is the concept of 'failure response mode', which categorises certain types of failure resulting in one type of behaviour of the launch system. Among many failure response modes, the following are recognised as most common: loss of tracking, pitch attitude error, motor explosion, abnormal ignition, premature thrust termination, asymmetric thrust, loss of control surface, separation failure, structural failure, low thrust, abnormal thrust, loss of attitude reference, thrust vector control failure, Wilson S. (et al.), *Space Launch and Re-entry Risk Hazard Analysis – a New Capability, Space Launch and Re-Entry Risk Hazard Analysis – a New Capability*, 60th International Astronautical Congress, Korea 2009, p. 3.

22. In other words when the automatic lift off sequences starts, the moment of the intentional ignition or the moment of opening the clams holding the launch vehicle, i.e. when the launch operation cannot be stopped by human intervention (apart from the possibility of destroying the launch vehicle); Fabre H, *Insurance Strategies for Covering Risks in Outer Space: A French Perspective*, 18 Space Policy, 283, 2002; Parquet C_A, *Allocation of Potential Liabilities and Risks in Launch Services Agreements*, Project 2001 Plus workshop, 29–30 January 2004.

23. http://www.iadc-online.org/Documents/IADC-2002-01,%20IADC%20Space%20Debris%20Guidelines,%20Revision%201.pdf.

The launch phase itself, which for the purposes of hazards analysis is distinguished as a flight stage of the launch operation,[24] is also not a homogenous action, as it can be divided into two or three parts.[25] Such a division may also be helpful in identifying and assessing the risk specific for each phase of the space flight.[26] The launch operation ends at the moment of satellite separation and upon reaching the correct final orbit, after which the in-orbit phase starts. The latter can also be divided into some subsections with significance from an insurance risk point of view, such as commissioning and testing phase (early in-orbit, including also the pre-operational tests and initial operation[27]) and standard in-orbit. The first of these is nowadays very often combined in one contract with the launch insurance, due to many similarities as regards the high level of risk.[28]

The next step necessary for the successful operation of the satellite after its launching and separation from the LV is deploying it in the proper orbit. Satellites are initially launched to an elliptical orbit with an apogee (the highest point) or perigee (the lowest point), also called the transfer orbit (when the satellite is designed for GEO with an apogee of 35,780 km), to be placed thereafter in the final orbit[29] (this phase is known

24. Flight – that period of time beginning with engine ignition and continuing until earth impact for suborbital or orbital trajectories, or indefinitely for deep space trajectories, Hazard Analysis Of Commercial Space Transportation, DOT Office of Commercial Space Transportation 1995, p. 4-1. https://www.faa.gov/about/office_org/headquarters_offices/ast/licenses_permits/media/hazard.pdf, accessed 27 August 2016.
25. The first stage of the launch begins on a point indicated as t = 0, which consists of the lift off and the injection of the spacecraft and ends with the separation of the satellite from the last and upper stage of the launch vehicle. The second phase of the launch operation begins with the separation of the satellite (the end moment of the first phase) and includes the positioning of the satellite on its own (with the help of its own engine) to the right orbit. In this phase, the satellite is transported into its designated orbit. Depending on the type of vehicle used and the purpose for which the satellite is intended, this may already be the final orbit or – as is usually the case with geostationary satellites – a transfer orbit, from which the satellite then moves into its final orbit under its own power. There is also a third period distinguished, namely the commissioning period, which starts with the satellite reaching its designated orbit.
26. Schöffski O., Wegener A.G., *Risk Management and Insurance Solutions for Space and Satellites Projects*, 24 The Geneva Papers on Risk and Insurance 205, 1999.
27. Aviation underwriting (1996), *General Insurance Convention, Working Party Members;* https://www.actuaries.org.uk/documents/aviation-underwriting, accessed 17 January 2017.
28. An important contribution to defining the launch operation comes from the documents including risk assessments, such as the QRA (quantitative risk assessment) which explain the concept of launch mission for purpose of the public risk assessments during the launch. 'Launch Mission' is defined for the purposes of the public QRA, (consistent with RCC) as beginning with lift off and ending at orbital insertion. It includes impacts from all planned debris released prior to orbital insertion. In this respect, the lift off has been defined as occurring 'during a launch countdown with any motion of the launch vehicle with respect to the launch platform (which includes a carrier aircraft), including any intentional or unintentional separation from the launch platform'. In turn, 'orbital insertion occurs when the vehicle achieves a minimum 70 nm (130 km) perigee based on a computation that accounts for drag.'; Wilde, P., Public Risk Criteria and Rationale for Commercial Launch and Reentry Presented to UNCOPUOS Scientific and Technical Subcommittee (Federal Aviation Administration Office of Commercial Space Transportation February) 2014.
29. Hofer C.F., Kim D., J., *The Continued Evolution of Communication Satellites*, 47 (2-9) Acta Astronautica, 77, 2000.

as the 'in-orbit commissioning phase' and it includes full-scale tests).[30] This may last for several days – in the case of conventional propulsion systems – or even for 200–400 days in the case of 'all-electric propulsion satellites', due to the differences in the operational features of chemical propellants when compared to electric ones. The satellite must be positioned continuously in order to keep a precise position in relation to the Earth. This is the purpose of the telemetry and tracking systems.[31] Physically, it can be done by the satellite's thrusters, supporting the initial positioning, orbital positioning corrections and de-orbiting[32] and including highly explosive and poisonous fuel, or bi-propellant systems in larger satellites, as well as the electric propulsion recently, giving the satellite longer lifespan.[33] A failure to deploy or keep a satellite in a precise position (slot) can make the satellite worthless.[34]

Though technological progress in that field is obvious, quite surprisingly given that the space industry emerged through a 'technological revolution', there is not much push to use new technologies (at least in a rapid way). This is due to the fact that both operators and their insurers prefer spacecraft that are proven and reliable.[35] New technologies, however, tend also to search for solutions that, for example, enable signal restoration and on-board processing, so new technology is not only inevitable, but is also necessary to mitigate the risk of the satellite malfunction once in-orbit. *The main technology issues are insurance related.* This is also the case with propellants. The development of this sector of space activity attracts great interest and it is becoming obvious that changes in propellant technology may change the entire satellite business,

30. This phase is conducted, depending on the contractual relations by the operator, or by the manufacturer, in case of in-orbit delivery contracts; to that aim however, the tracking stations and operations have to be arranged. Elbert B. (ed.), *The Satellite Communication Applications Handbook*, Artech House, Inc., 2004, p. 109. *Recette en vol* information on the CNES website: http://spot4.cnes.fr/spot4_fr/recette.htm, accessed 15 October 2016.
31. Satellite operations are based upon two segments: a space segment and a ground segment. The ground segment includes infrastructure (fixed or mobile) enabling communications with the satellite by transmitting and receiving signals. The ground infrastructure consists mostly of the antennas system, apart from the distribution and network control facilities. In turn, the space segment consists of satellites (one or a constellation) receiving signals from the Earth containing some data (tv, telephone, etc.), transferring it through transponders and sending back to Earth. Rendering services with help of the satellite is made upon two types of links between satellite and ground system. This is the TT&C, which exchanges commands and sends information between the control station and the satellite, as well as datalinks (uplinks and downlinks) that enable communication, navigation and imaging data to be sent to the Earth; Hermida J., *Transponders Agreements*, 24(1) J. Space L., 36, 1996. Elbert B. (ed.), *The Satellite Communication Applications Handbook*, Artech House, Inc., 2004, Pelton J., *Satellite Communications*, Springer Science & Business Media, Arlington 2012.
32. As, from the moment of separation, the satellite must rely on its own thrusters to reach the proper orbit. In the case of electric propulsion, the thrust is continuous but low; Horne R.B., Pitchford D., *Space Weather Concerns for All-Electric Propulsion Satellites*, 13 Space Weather, 430–433, 2015.
33. Pelton J., *Satellite Communications*, Springer Science & Business Media, Arlington 2012, pp. 6, 32.
34. For example, W3B satellite launched on an Ariane 5 in November 2010 by Eutelsat, which proved to be a failure due to the leakage of fuel from the satellite thrusters); Pelton J., *Satellite Communications*, Springer Science & Business Media, Arlington 2012, p. 31.
35. Pelton J., *Satellite Communications*, Springer Science & Business Media, Arlington 2012, p. 53.

its profitability, the time frames of projects, etc. These are much improved, but the reliability is still not absolute, mostly in terms of the propulsion system, the conventional forms of which are not much different from that invented for launching fifty years ago.[36] However, that change is possible and its dramatic effects have already been proven with respect to the 'all-electric propulsion'[37] and the same may be the case with 'green space propulsion'. The endeavours (e.g., GRASP project founded by EU) to limit the use of hazardous (chemical) and costly propellants are still underway (mostly to replace the toxic and carcinogenic hydrazine), which would not only make the launch and satellite operation safer, but also limit the environmental risks on the ground, in transportation to the launch site, etc. Another technical issue that is insurance related is the impracticability of OOS of spacecraft[38] and remedying any anomalies only by tele-commanding.[39] This is an obvious obstacle through mitigating the losses, preventing them, and inspecting the causes of failures and anomalies. Due to this fact, electronics inside the satellite, powered by solar energy and batteries, must respond to the hazards of the space environment 'on their own'.[40] Finding solutions for on-orbit anomalies and a shortage of propellants would be in the interest of insurers, who would have to change the terms of insurance coverage or make finally vivid some of its clauses (such as salvage clause).[41] With this in mind, it is noted however that OOS

36. Coopersmith J., *The Cost of Reaching Orbit: Ground-Based Launch Systems*, 27 Space Policy, 2011; It is claimed that most of the satellite failures are due to the bus rather than payload deficiencies, Report of Frost & Sullivan, *Commercial Communications Satellite Bus Reliability Analysis*, 2004, http://lr.tudelft.nl/index.php?id=29218&L=1. Accessed 15 January 2017.
37. In March 2012, Boeing announced of its first order for XIPS thruster as an exclusive power supply, both for station keeping and orbit raising; while a start of the idea of using 'all-electric' propulsion took place in the 1990s. *See* more Wade D., Gubby R., Hoffer D., *All-Electric Satellites – Insurance Implications*, 65th International Astronautical Congress, Toronto, Canada. Copyright ©2014 by the International Astronautical Federation. Also on XIP propulsion Hofer C.F., Kim D., J., *The Continued Evolution of Communication Satellites*, 47 (2-9) Acta Astronautica, 77, 2000. Morozova E., *All-electric Satellite Seek Equal Right in Space*, 41(3) Air & Space L.194, 2016.
38. The term 'on-orbit servicing' (OOS) refers to operations conducted on spacecraft in-orbit intended to accomplish some value-added task. While most may think that this implies the use of robotics to mechanically assist a satellite in need, it also refers to activities such as providing 'life extension' or performing visual inspections; Benedict B.L., *Rationale for Need of In-Orbit Servicing Capabilities for GEO Spacecraft*, AIAA SPACE 2013 Conference and Exposition, SPACE Conferences and Exposition, (AIAA 2013-5444). http://dx.doi.org/10.2514/6.2013-5444.
39. Horl K.U., *Legal Aspects of Risks Involved in Commercial Space Activities*, Institute of Air and Space Law, McGill University, Montreal 2003, p. 24.
40. Which includes the systems of keeping a balanced temperature in spite of the heat and cold to which the satellite is exposed during its orbiting activities, Pelton J., *Satellite Communications*, Springer Science & Business Media, Arlington 2011, p. 30. Trials of on-orbit servicing are continuously being repeated in LEO (*see* DARPAs Orbital Express in 2007) and new projects are being researched that would help prolong the life of satellites (*see* MDA projects for refuelling satellites) or even only enabling non-functioning satellites to de-orbit. The main obstacle to progress effectively with these projects is unproven reliability, which causes a lack of willing investors. (Intelsatgeneral).
41. On-orbit servicing, as it is stressed, could mainly support solving the BOL (beginning of life) problems or unexpected end of life (EOL). EOL is usually caused by a shortfall of propellants. It is interesting to note that approximately 10% of satellites suffer today from unexpected EOL, but 1/3 after the expected EOL are still in service and are usually only de-commissioned due to the lack of propellants. Old satellites prove to be quite stable. Intelsat calculated one anomaly per seven years).

is not certain for its effectiveness and cost-saving feature, with an added note that OOS would probably be uninsurable at the present state of insurance knowledge of this risk.[42] OOS may have also legal implications, such as licensing, liability and insurance. This is an obvious impediment of the above.[43]

The sections below outline the risk and its sources. It should therefore be emphasised that the concept of risk must be distinguished from the notion of peril or hazard, which mean the cause of the possible loss and factors contributing to the occurrence of the loss and increase the severity of the loss or conditions affecting the perils.[44] For the purposes of the considerations below, risk in the meaning used in the US CFR will be used, which describes risk as 'a measure that accounts for both the probability of the occurrence of a hazardous event and the consequence of that event to persons or property'. Identifying the hazards, hazardous events risk factors and subject matter of the risk is the first step towards effective risk management and insurance.[45]

[B] Sources of Hazards

A risk assessment for a given space operation must take into account the probability of failure at any instant of time, what is the probability of the failure mode, as well as the type of consequences it may have on Earth or in outer space, at the given moment of the failure.[46] That is why it is important to distinguish hazards and the risks they produce, as well as the types of losses resulting therefrom and the entities and goods that may be potentially affected. With respect to the sources of risks related with space operations, the complexity of the space technological systems must be stressed, and in particular the fact of using high technology in the absence of large scale statistics, as well as the uniqueness of technological solutions (prototype approach). Another category of factors is the specific environment of space operation (outer space), as well as other sources common for other types of commercial activity, such as human failure and industrial risk (design failures, etc.).[47]

42. Some of the projects include the ISS as a platform for satellite servicing missions, especially for LEO services. New propulsion technologies make such projects more realistic; Open for business: a new approach to the commercialization of the International Space Station, SP 16 (2000), pp. 71–75.
43. Belcher D, Freese S., Laygo K., Osborn D, *United States Legal and Policy Impediments to On-Orbit Satellite Servicing Activities, with Recommended Policies and Legal Implementations, https://cistp.elliott.gwu.edu/sites/cistp.elliott.gwu.edu/files/Belcher%202014.pdf*.
44. Sethi J., Bhatia N., *Elements of Banking and Insurance*, PHI Learning Pvt. Ltd., 2011, pp. 139–145.
45. Gołębiewski D., *Ubezpieczenia zakładów przemysłowych dużego ryzyka*, in: *Ubezpieczenia w zarządzaniu ryzykiem przedsiębiorstwa*, vol. 2 Zastosowania, J. Monkiewicz, L. Gąsiorkiewicz, Poltext, 2010, p. 42.
46. Millard S., *Overflight Risk Considerations for the Launch of an ELV Rocket to an ISS Inclination*, 2010, AIAA Atmospheric and Space Environment Conference, 2–5 August 2010, Toronto, Ontario, Canada.
47. Kayser V., *Launching Space Objects: Issues of Liability and Future Prospects*, Space Regulations Library, vol. 1, Kluwer Academic Publishers, New York, Boston, Dordrecht, London, Moscow 2001, pp. 5–6; Within this approach, there may be indicated several categories of hazards may

In relation to launching a space object, when analysing the hazards that may contribute to the failure of the launch, it should be explained what, in fact, is perceived as a *failure*. It is worth noting that a failure occurs, from a risk management point of view, when the LV does not complete any of the phases of its intended flight, or when the anomalies show the potential for the LV or its debris to impact the Earth or re-enter the atmosphere during the mission. Launch failures usually exclude any accidents before lift off, but it depends on the criteria adopted.[48] Some practitioners also distinguish the space mission failure from flight failure, in this context, the flight itself may be successful, but the mission can still be a failure. This happens in the case, where the LV successfully places a satellite in transfer orbit, but the satellite isnot deployed properly or its life is shorter than expected.[49] It is generally the case that a launch failure causes the failure of the whole space mission. The notion of the *failure of the satellite* during its operational stage is used in association with an anomaly, which means any deviation from the nominal operation as designed, and which may result in a failure in the meaning of permanent dysfunction of the satellite or other premature loss of the satellite and disrupting of the services rendered by it.[50] This is referred to the parameters of the satellite included in its technical specification.

The most common root causes of space accidents are presented briefly below, as experience shows these are the most often causes of launch failures.

[1] Technology

Technology *is one of the* main sources of risk in space activities. This is related to the type of assets involved in the space activities, namely, the launch systems and satellites. These are related to the mechanical aspects of the launch operation, i.e. mostly related to the reliability of the LV and satellite, as well as the operator's

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be indicated related in relation to the space operations. In particular, still there can still be distinguished separate phases of the launch for this purpose, and there are hazards to the involving on —pad failures, low altitude failures (those two mostly being explosions) as well as failures of the 1st and 2nd or upper stages, or failures of guidance and/or destruct systems. In satellite operations, the stage early in-orbit and the remaining period is distinguished, as the statistics say that most of the failures occur during the first year of operation. This is reflected in the insurance underwriting process; Robertson B, Stoneking E., *Satellite GN&C Anomaly Trends*, 26th ANNUAL AAS Guidance And Control Conference, 2003.

48. FAA, *Handbook of Flight Safety*, 2011, p. 41. The failure, however, is not a homogenous notion and it can be defined by taking into account several different criteria; one of the criteria is categorising failure with respect to the launch stage; and distinguishes the (1) infancy stage failures occurring at ignition and causing that the launch does not commence, (2) a random failure that can occur during any stage of flight, and include control failure, structural failure, engine explosion, SRM, case rupture, guidance failure, and (3) sunset failures (duration failure), including the failure of separating the payload; FAA, *Risk sharing liability regime*, Study and Analysis, 2002, p. 83.
49. Eleazer R.W., *Paper Session I-C – An Analysis of Worldwide Space Launch Failures*, 1980–2002, Space Congress Proceedings, 2003; The definition of failure may also be found in the launch agreements: Sample launch contract; The Space Congress® Proceedings.Paper 28.http://commons.erau.edu/space-congress-proceedings/proceedings-2003-40th/april-30-2003/28, accessed 14 January 2017.
50. Robertson B., Stoneking E., *Satellite GN&C Anomaly Trends*, NASA Goddard Space Flight Center 2003.

experience in that field, which is also due to the fact that space operations in spite of some standardisation are still based on prototypes, subject only to intensive testing.[51] The source of the hazard lies in this respect often in the design and manufacturing process.[52] That is why, although manufacturing is not space activity in a strict meaning, it is inherently related thereto. Consideration of the hazards related to the space technology is not possible without realising how complicated satellites and LVs are. *From the technical point of view, satellites are defined in literature as 'any object that has been placed in orbit by human activity (...), an unmanned spacecraft that performs a practical function in orbit with respect to an activity on Earth'*.[53] A satellite – technologically – is a type of a relay station that is able to transmit voice, video and data in a much better and more precise way than ground-based infrastructure.[54] A satellite consists of the bus (spacecraft structure), which includes the thruster, propulsion and thermal control,[55] attitude control as well as payload, attached to the bus,[56] which is the core of the satellite and contains instruments that perform the primary mission, such as cameras for remote sensing, transponders for communication, scientific experiments or other equipment. Though this description applies to large and small satellites, one major difference exists, related to the lack of propulsion systems or other typical subsystems in order to reduce mission complexity[57] *New technological trends in satellites dominating many discussions and analyses concern the small satellites,*[58] *with the most popular -cubesats among them.*[59] This segment is

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51. Horl K.U., *Legal Aspects of Risks Involved in Commercial Space Activities*, Institute of Air and Space Law, McGill University, Montreal 2003, p. 23; the importance of testing is more taken into account after the Apollo 1 mission which due to the lack of training concerning testing resulted in explosion at the launch pad during the pre-launch testing; Jakhu R S., Sgobba T., Dempsey P.S. (eds), *The Need for an Integrated Regulatory Regime for Aviation and Space ICAO for Space?*, Springer 2011, p. 73.
52. One of the most famous accidents involving a faulty design was the Challenger disaster, where, after the investigation of its causes, the Commission stated that the main cause of the disaster was the failure of the pressure seal in the aft field joint of the right solid rocket motor and the failure's essence was faulty design of the O-ring, causing it to be too sensitive to a number of factors, such as the effects of temperature.
53. Kleiman J., Lamie J.K., Carminati M-V., *The Law of Spaceflight, A Guidebook for New Space Lawyers*, pp. 17, 24–25, ABA Book Publishing, 2012. It should be noted that no legal definition of the satellite is present in the international law, so the most common definitions have technical roots, *see also* Myszona – Kostrzewa K., *Nawigacja Satelitarna w świetle prawa międzynarodowego*, Stowarzyszenie Absolwentów Wydziału Prawa i Administracji Uniwersytetu Warszawskiego, Warszawa 2011, pp. 32–33.
54. There are a few steps for satellite communication: (1) getting the signal transmitted from the uplink ground station, (2) amplifying the incoming signal and changing frequency, (3) transmitting the signal to the ground equipment on Earth.
55. There are many examples of failures related to the use of propellants; *see* an example described in the Report of 11 July 2003 of SEC concerning the failure of XIP (xenon propulsion system) shut down in Panamsat Galaxy satellite IIR.
56. Soucek A., *International Law* in: Outer Space in Society, Politics and Law (A. Soucek, Ch. Brunner, eds), Springer Wien New York 2011, p. 120.
57. Trautinger M., *The Impact of Technology and Export Controls on Small Satellite Missions*, in: Small Satellites: Regulatory Challenges and Chances (I. Marboe, ed.), Brill Academic Publishing, 2016, p. 290.
58. There is no standard definition of the small satellite', and they are grouped into various categories based on their mass; Various types of small satellites divided according to their mass include Mini Satellites ('Minisats' mass less than 1000 kg), Micro Satellites ('Microsats' – a mass

attracting growing interest for use by governments, scientific missions and increasingly also commercial uses.[60] Suffice to say that in 2014, there were 130 cubesats sent into orbit, 84 cubesats were sent into orbit by ISS, and 28 cubesats were lost in the recent Antares 2014 failure. The coming years will see approximately 500 small satellites being launched by 2020. Small satellites can be transported in a dedicated launch of several small satellites, or released from the ISS dispenser, or by piggybacking on a launch, i.e. as a secondary payload.[61] These different methods of launch affect the risk assessment scenarios, the last of the launch methods being considered as the most risky.[62] From a legal point of view, satellites and LVs are one of the main types of space objects, as defined in the national laws; therefore, the activities with the use of the satellites are qualified as space activities.

Communication satellites provide their serviceswith help of transponders, and so the capacity offered by transponders is the core of the contracts in the satellite industry, as well as subject of coverage by in-orbit insurance. The transponder is the device in a satellite that accepts communication signals relayed to it from the satellite's receiver antenna,[63] amplifies it, converts the signal into another frequency and relays the signal to the satellite's transmitting antenna for transmission to the receiving station on Earth.

less than 100 kg), Nano Satellites ('Nanosats' – mass up to 10 kg), Pico Satellites ('Picosats' – mass of 10g to 1 kg), Femto Satellites ('Femtosats' – mass less than 10 g) and Spires – the size of a postage stamp and they contain all the essentials for a satellite such as a radio, aerials a solar cell and instruments. Apart from CubeSat, a newer design should be mentioned, known as a Tube Satellite ('TubeSat') is emerging to compete with the CubeSat design. A TubeSat is a low cost alternative to a CubeSat; The simplified division of small satellites had been proposed in 2005 by the International Academy of Astronautics (IAA) Study Group on 'Cost-Effective Earth Observation Missions'; while The International Telecommunication Union (ITU) and industry consider satellites with mass of less than 500 kg as 'minisatellites', while taking up the other subcategories. Which has a maximum mass of 0.75 kg; Long G.A., *Small Satellites and Liability Associated With Space Traffic Situational Awareness*, 6 November 2014, *Space Traffic Management Conference*. Paper 17, http://commons.erau.edu/stm/2014/thursday/17.

59. The concept of CubeSats had been introduced by Bob Twiggs, professor at Stanford University, and Jordi Puig-Suari, professor at California Polytechnic State University and co-founder of Tyvak Nano-Satellite Systems in 1999; Koudelka O., *Micro/Nano/Picosatellite-Activities:Challenges towards Space Education and Utilisation*, in: Small Satellites: Regulatory Challenges and Chances (I. Marboe, ed.), Brill Academic Publishing, 2016, pp. 7–8 and Balogh W., *Capacity Building in Space Technology Development: The Role of the United Nations*, in: Small Satellites: Regulatory Challenges and Chances (I. Marboe, ed.), Brill Academic Publishing, 2016, p. 32; *see also* Small is the new big. White paper (2014) Technology Strategy Board UK.

60. Though, it should be noted that small satellites had been built also in the beginnings of the space industry, as Sputnik satellites belonged also to the category of small satellites with their weigh under 100 kg, Koudelka O., *Micro/Nano/Picosatellite-Activities: Challenges towards Space Education and Utilisation*, in: Small Satellites: Regulatory Challenges and Chances (I. Marboe, ed.), Brill Academic Publishing, 2016, pp. 7–8.

61. Trautinger M., *The Impact of Technology and Export Controls on Small Satellite Missions*, in: Small Satellites: Regulatory Challenges and Chances (I. Marboe, ed.), Brill Academic Publishing, 2016, p. 288. *See* more Shaw A., Rosher P., *Micro Satellites: The Smaller the Satellites, the Bigger the Challenges* ? 41(4&5) Air & Space L.312, 2016.

62. Crowther R., *Space Security, Lecture at London Institute of Space Policy and Law*, October 2016 (not published, with the author).

63. Kleiman J., Lamie J.K., Carminati M-V., *The Law of Spaceflight, A Guidebook for New Space Lawyers*, ABA Book Publishing, 2012, pp. 24–25.

A single satellite may contain several transponders.[64] During the operational stage, the satellite is powered mainly by solar power, and as soon as the satellite becomes operational, the transponders operate automatically. In addition, the satellite is monitored by rocket engines, which help to keep its position. Apart from transponders, there are electronic devices enabling the position and operations of the satellite to be controlled.[65] *Components of remote sensing satellites*, rather than transponders include passive and active sensors, enabling the Earth to be pictured and for images to be sent to the ground system consisting of data reception facilities, antennas and stations processing the data, data storage, distribution means, etc.[66]

Launch vehicles are transportation systems carrying satellite into outer space.[67] They need a thrust sufficient to achieve velocity in order to get through the Earth atmosphere and reach the orbit.[68] In the case of the LVs, ensuring redundancy of the main parts, i.e. the engines, is more difficult, which influences the hazard ratio.[69] Though it is stressed that each launch is different due to the different ratio of components, the propulsion system, engine, it seems that the propellants system and attitude control are the major causes of failures.[70] It is also worth noting that this ratio

64. Each transponder accepts only signals on the frequency for which it has been programmed; Kleiman J., Lamie J.K., Carminati M-V., *The Law of Spaceflight, A Guidebook for New Space Lawyers*, ABA Book Publishing, 2012, pp. 12–64.

65. Domsat Transponder sale, 90 FCC 2d 1238; Settlements guidelines for transponders, US Taxation Department.

66. Soucek A., *Earth Observation* in: Outer Space in Society, Politics and Law (A. Soucek, Ch. Brunner, eds), Springer Wien New York, 2011, p. 121; Pelton J., *Satellite Communications*, Springer Science & Business Media, Arlington 2012, p. 19.

67. While mentioning hazards related to technology, we also have to take into account the differences in the construction of the expendable launch vehicles and reusable launch vehicles. The common elements, such as the similar propellants, make the risks similar, though several differences were also stressed. In the past, RLV were considered more hazardous due to the more complex construction needed for the re-entry phase. The risks related to RLV were considered to be fairly similar as concerning aircraft, though of course taking into account substantial differences. However, since the times of Challenger, ELV have mostly been in use, with the new endeavours of SpaceX making it probably necessary to have a new assessment of risk for these kinds of launch vehicles. Concerning the present technology of RLV offered by SpaceX and possible other producers, the task of assessment has to be undertaken again. Parkinson R.C., *The Hidden Costs Reliability and Failure in Launch Systems*, 44 Acta Astronautica, 423, 1999; Peyrefitte L, *Droit de l'espace*, Dalloz, 1993, p. 97; Risk sharing liability regime for US, FAA, US DOT (2002).

68. Trautinger M., *The Impact of Technology and Export Controls on Small Satellite Missions*, in: Small Satellites: Regulatory Challenges and Chances (I. Marboe, ed.), Brill Academic Publishing, 2016, p. 288.

69. Though redundancy of other sub-systems of the launch vehicle is usually ensured Horl K.U., *Legal Aspects of Risks Involved in Commercial Space Activities*, Institute of Air and Space Law, McGill University, Montreal 2003, p. 27.

70. Falcon 9 Launch Vehicle Payload User's Guide http://www.spacex.com/sites/spacex/files/falcon_9_users_guide_rev_2.0.pdf, accessed 27 August 2016, p. 5; Statement Garret Reisman Director of Crew operations Space Exploration Technologies Corp (SpaceX) before the Subcommittee on Space Committee on science, space and technology US House of Representatives, February 2015; *see also* Parkinson R.C., *The Hidden Costs Reliability and Failure in Launch Systems*, 44 Acta Astronautica, 421, 1999; it is repeatedly noted by various experts that even launch vehicles of similar design show different failure rates; though some common features may be distinguished; e.g. in solid rocket motors, the failures are often due to manufacturing

has not much changed in at least twenty years.[71] It should also be remembered that propellants constitute most of the weight of the LV. These are the fuel and oxidiser necessary to burn the fuel.[72] The propulsion system is the major cause of rocket break-up, though the type thereof may give different effects – depending whether it is solid or liquid. No spacecraft has yet been observed to have broken up as a result of liquid propulsion failure, and no rocket body as a result of battery failure.[73] Although occurring during the flight, the root cause of failures is usually on the ground, for example resulting from a misuse of the ground support equipment.[74]

Technological hazards during the operation of the satellite are related to several other factors. Satellites are, as a rule, designed to survive the worst scenarios and harsh space environment. Still, they face many unavoidable risk factors. Among many types of failures of a technical nature, there are particularly distinguished battery failures, solar array mechanical failures, attitude control failures, failures due to plasma-discharge events, cell failures, other array failures, darkening of glass or solar reflectors, and cell interconnect failure.[75] The various types of possible power system failure seem to be the most common cause of satellite failures, even causing explosions.[76] A separate analysis of satellites failures should concern small satellites, which in spite of their similar construction, are still partially subject to other perils from a technological point of view. It relates to the quite low reliability causing high 'infant mortality' among the smallsats, the highest ratio of which is among the new designs. Also typical is the

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faults, while liquid engines' reliability is dependent on the numbers of start-stop cycles; avionic failures, in turn, were caused mainly by mechanical failures related to manufacturing faults.

71. This is also due to the fact that, for a long time, the structure of the launch vehicle has remained fairly similar, i.e. consisting of stages, of which the first stage is the most dangerous, being the heaviest part of the launch vehicle, equipped with the largest engines, with the largest fuel and thrust potential ('its task is to impart the initial thrust needed to overcome Earth's gravity, and thus to lift the total weight of the vehicle and its payload off of Earth'); the second and third part (which is often the upper part of the LV) are lighter as they need less thrust to achieve orbital velocity; all of them, after having been used, fall back to the Earth and, depending on the stage, they fall back in pieces (as it is in case of the first stage) or are burnt while entering the atmosphere (as it is in case of upper stages); *see* Encyclopaedia Britannica 2015 available at: www:britannica.com/topic/launch-vehicle. *See also* for comparing: IAF (2012), Highlights in space technology and applications 2011, where the causes of the launch failures were described, p. 26.
72. *See also*, MacLaren A.J., Trudeau H.D., *Solid Rocket Motor Space Launch Vehicles*, 30 Acta Astronautica, 1993; Logsdon J.M., 'Launch Vehicle'. *Encyclopædia Britannica. Encyclopædia Britannica Online.* Encyclopædia Britannica Inc., 2015. Web, 15 November 2015, http://www.britannica.com/topic/launch-vehicle. Kleiman J., Lamie J.K., Carminati M-V., *The Law of Spaceflight, A Guidebook for New Space Lawyers*, ABA Book Publishing, 2012, p. 13.
73. Support to the IADC Space Debris Mitigation Guidelines Working Group 4 Action Item 26.2, IADC -04-06, Rev 5.5 May 2014, http://www.iadc-online.org/Documents/IADC-04-06%20Support%20to%20IADC%20Guidelines%20rev5.5.pdf, accessed 27 August 2016, p. 18.
74. For example mission Apollo 13 problems resulting in oxygen tank explosion were caused during the ground processing; Jakhu R S., Sgobba T., Dempsey P.S. (eds), *The Need for an Integrated Regulatory Regime for Aviation and Space ICAO for Space?*, Springer 2011, p. 71-71.
75. Most of the anomalies during in-orbit phase are due to guidance, navigation and control subsystems, Robertson B, Stoneking E., *Satellite GN&C Anomaly Trends*, 26th ANNUAL AAS Guidance And Control Conference, 2003.
76. http://spaceflightnow.com/2015/03/04/power-system-failure-likely-cause-of-military-satellite-explosion/.

low quality of components, low budget, insufficient testing or an absence of testing.[77] Any shortening of the satellite's design lifetime is perceived as a failure, so the risk is quite a long-term one. However, as has been mentioned before, the majority of anomalies occur just after launching, during the deployment phase and after reaching 10% of a satellite's design life, the anomaly failure rate declines precipitously and continues to decline thereafter.[78]

[2] *Debris*

The issue of space debris as a space hazard is subject to substantial concern and interest. Though it is more relevant to the satellite operation stage, the launch operation is also not free from risk related to debris impact, in particular in the case of a non-trackable item in conjunction with the launcher, which may have a disaster impact on a space mission. These may be space debris located at the Earth's orbit or even debris created at the launch phase as a result of jettisoning subsequent stages of an LV (e.g., the root cause of Columbia disaster).[79] While the problem is seemingly important in terms of the overall environmental protection, for business, the debris issue is rather related with continuity of providing the services.[80]

Space debris is not the subject of any obligatory binding regulation on the international level. In particular, there is no specific regulation on debris in the OST or other space treaties, though the obligations of the state may be derived from the general rules of acting in the interest of all and, in general, be compliant with international law.[81] However, there is a strong trend present in the national practice to follow the

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77. Antoni N., Bergamasco F., *To Orbit and Beyond: The Risks and Liability Issues From the Launching of Small Satellites at 2*, the 65th IAC in Toronto Canada on October 2014, 57 Proc. Colloquium on the Law of Outer Space, Intl. Inst. Space L., 79, 2014; the other causes of the higher ratio of smallsats failures is other than technical and it concerns for example worse resistance to radiation.
78. Robertson B., Stoneking E., *Satellite GN&C Anomaly Trends*, 26th ANNUAL AAS Guidance And Control Conference, 2003.
79. More Klinkrad H., *The Space Debris Environment and Its Environment*, (ESA), 6th IAASS Conference, 21 May 2013 and Ross S., *Risk Management and Insurance Industry Perspective on Cosmic Hazards* in: Handbook of Cosmic Hazards and Planetary Defense (J. Pelton, F. Allahdadi, eds), Springer International Publishing Switzerland, 2015; it is also claimed that the Columbia disaster was caused by debris impact at the launch, Manikowski P., *The Columbia Space Shuttle Tragedy: Third-Party Liability Implications for the Insurance of Space Losses*, 8(1) Risk Mgt. & Ins. Rev., 2005.
80. *See* more Tremayne- Smith R., *Environmental Protection and Space Debris Issues in the Context of Authorisation*, National Space Legislation in Europe: Issues of Authorisation of Private Space Activities in the Light of Developments in European Space Cooperation (Dunk F.G. von der, ed.), Martinus Nijhoff Publishers, Leiden/Boston 2011, Pp. 180–181.
81. The problem of debris became however a subject of intensive works of various bodies, such IADC, COPUOS; also debris mitigation guidelines are regulated as one of ISO standards (ISO 24113 Space Systems) Space Debris Mitigation Requirements published in 2010 revised in 2011. Also several national measures have been introduced as well as on European level – European Code of Conduct for Space Debris Mitigation was adopted in 2004, Steinkogler C., *Small Satellites and Space Debris Mitigation* in: Small Satellites: Regulatory Challenges and Chances (I. Marboe, ed.), Brill Academic Publishing, 2016, pp. 222–227; Horl K.U., *Legal Aspects of Risks Involved in Commercial Space Activities*, Institute of Air and Space Law, McGill University,

CHAPTER 4

Performance of the Space Insurance Contract

§4.01 OUTLINE

The last chapter deals with the legal aspects of performing insurance contracts. These legal aspects include all the parties' rights and duties that come into force after concluding the insurance contract. It also concerns the premium that, though usually paid at the contracting stage, from a legal point of view is more related to the performance stage than the contracting one. This is also visible in space insurance contracts, where payment of the premium is strictly related with the attachment of risk. The aim of this chapter is to analyse the performance stage of space insurance in the context of the principles of insurance, mainly the indemnity principle, in order to state whether, taking into account the specific nature of space risks, the indemnity principle may be applied to space insurance, and to what extent, as well as what impact it may have on the theory of insurance and the development of new, technology-related risks. It seems that, at the stage of performing the insurance contract, space insurance shows several features deriving from marine insurance. A central position seems to belong to the concept of loss, the occurrence of which imposes on the insurer the duty to settle the claim and leads to the obligation to prove the manifestation of the risk and the amount of the loss. All these aspects have many features, making space insurance a very specific vehicle for managing space risks.

§4.02 PREMIUM

[A] General

For entities in the space industry, the costs of insurance premiums are usually the third biggest expense after the cost of the satellite and launch services. *The premium rates* *basically mirror the risk ratio*, the peak of which is at the launch and deployment of the satellite and then significantly decreases after the first year in-orbit. The launch stage is also from where the majority of the premiums collected by the space insurers come from.[1] The premium rates in space insurance are dependent on several factors analysed during the underwriting process, such as the type of the LV and the satellite, the redundancy level, the value insured, the loss formula, the type of coverage and the history of losses suffered by the insured.[2] *The premiums for space risks are not, however, dependant solely on the risk assessment*, as the market is subject to volatility, cyclicity and competition factors, where, in overcapacity periods, the insurers are forced to cut the rates and make less difference between the reliable and less-reliable LV and satellites, which is even in the case of losses suffered.[3] Over time, the premiums in space insurance have varied from 5% to even 20%–30% after the Challenger disaster, even though Challenger did not lead to insurance claims.[4] More stable are the

1. The rates for property space insurance amount to approximately 7% for the 'launch plus one year' coverage, (where 3.5% concerns launch phase, 2.5% testing phase and 1% the remaining period). The TPL coverage for launch and a year after amounts to approximately 0.1% up to 0.25%. There are voices concerning the US thresholds of liability, which since their enactment are of a temporary character, which suggest that a premium increase may be expected once they are removed. There is, however, also another point of view (presented by the insurance circles) that, in reality, such changes in the US liability regime will not have a major impact on insurance, due to the low probability of damage caused to third persons; Stevens N., *Space Insurance*, Lecture at IALS, London, October 2016 (not published, with the author); Gaubert C., *Insurance in the Context of National Authorisation* in: National Space Legislation in Europe: Issues of Authorisation of Private Space Activities in the Light of Developments in European Space Cooperation (Dunk F.G. von der, ed.), Martinus Nijhoff Publishers, Leiden/Boston, 2011, p. 170; it has been noted by the author that there is a high volatility of the premium within space TPL insurance, as it is combined with the aviation liability insurance market and depends on the capacity and premium rates in this market. Harrington A.J., *Legal and Regulatory Challenges to Leveraging Insurance for Commercial Space*, 31st Space Symposium, Technical Track, Colorado Springs, Colorado, United States of America Presented on 13–14 April 2015; the author indicates that the ITAR regime has much more practical impact on space risks insurance.
2. JLT Training materials: 15–18 June 2015, p. 58; Whearty R., *Satellite Launch and In-orbit Insurance (Intro to Space Insurance. First party)* Presentation at International Conference and Exhibition on Satellite, Huston, USA, August 2015, http://satellite.conferenceseries.com/speaker-pdfs/2015/robert-p-whearty-marsh-space-projectsusa.pdf; it can be seen when comparing the ratio of the sum insured by Arianespace versus the premiums paid globally (31%–27%) – which shows that the rates applied to Arianespace are lower than the average on the market; *see* for example in Agren D., *Did Mexico Overpay for Satellite Insurance*, 2015 – pointing out that, while the average market price that could be reached was even 7.5%, Mexico paid 13.36% for insuring a Centenario satellite (lost at launch failure on 16 May 2015 – with Proton LV); the insurers claimed the reason was the questionable reliability of Proton.
3. Manikowski P, *The Satellite Insurance Market and Underwriting Cycles*, Presentation at American Risk and Insurance Association Annual Meeting, Quebec City, 5–8 August 2007; Todd D., *Space Insurers Continue to Make Profits…but for How Much Longer?*, 29 January 2013.
4. The average premium amount is according to the insurers' information from 6% to 15%; launch plus one year in-orbit – premium varies from 8% to 13% of the sum insured). (7%–15% (7%–20%) Bathurst R., *No Space for Error When It Comes to Satellite Launches*, 2013. http://www.resilience.willis.com/articles/2013/04/22/no-space-error/; Harrington A.J., *Legal and Regulatory Challenges to Leveraging Insurance for Commercial Space*, 31st Space Symposium, Technical Track, Colorado Springs, Colorado, United States of America Presented on 13–14 April 2015; The premium for launch plus year; in-orbit 0.6%–1% annually; Todd D., *Space Insurers continue to make profits…but for how much longer?* 29 January 2013.

premiums charged for in-orbit insurance.[5] As said, the premium rate does not depend on the risk period, but the risk ratio.[6] That is why it is the highest in the case of the launch phase, though it is the shortest, while the lowest is for the operational stage. Though it is hard to compare the rates due to the fact that the cover for the launch phase is bought only once, and the rate for the operational phase is calculated annually. If cover is arranged for more than one phase of the operation, in one insurance contract, the premium for each stage is added together.[7]

[B] Basic Features of the Premium

The premium is a reciprocal obligation of the policyholder, correlating to the insurer's duty to cover the risk of loss. It constitutes a basic contractual duty of the policyholder whereby 'the duty of the assured or his agent to pay the premium, and the duty of the insurer to issue the policy to the assured or his agent, are concurrent conditions'.[8] As insurance policies state, the insurer agrees to pay the claim 'in consideration of the premium…'[9] From an economical point of view, it is the cost of the risk transfer. Though the obligation to pay the premium requires a legal approach, the premium itself, including the method of its calculation, is also strongly related to actuarial techniques.[10] Therefore, the premium cannot be, in general, set completely freely by the insurer, and in particular it must not be at dumping level, but must be compliant with the legal requirements concerning the insurance activity conducted, including the solvency and capital requirements. Premiums must be set at a level allowing the satisfaction of all the obligations under the insurance contracts as concluded by the given insurer, and there is a prohibition on setting the premium rates below that level, which is directly expressed in some national laws regulating insurance activity. In that sense, the obligation of the parties to the insurance contract differ significantly from other civil contracts, this specifics being augmented by the strongly technological character of the space risks, and strict supervisory rules over insurance companies.[11] As the insurance contract in space risks is written much in advance before the attachment of the risk, only a small part of the premium is paid at the policy inception. It also means that the insurer should have a reserve for unearned premiums, for quite a long time compared to other classes of insurance, as the premium is fully earned at

5. Daniel L., *Satellite Insurance: Operators Returning to Outside Providers*, *Satellite* Today, 1 November 2007.
6. Montpert P, *Space Insurance* in: Contracting for Space: Contract Practice in the European Space Sector (L.J. Smith, I. Baumann, eds), Ashgate Publishing, 2011, p. 283.
7. *Ibid.*
8. MIA, s. 52. *See also* Bird J., *Bird's Modern Insurance Law*, Sweet & Maxwell, 2016, p. 189.
9. Clarke M.A., Burling J.M., Purves R.L., *The Law of Insurance Contracts*, Informa, 6th ed., London 2009, p. 386.
10. Lambert- Faivre Y., Leveneur L., *Droit des assurances*, Editions Dalloz, 13e édition, Paris 2011, p. 338; *see also* Thoyts R., *Insurance Theory and Practice*, Routledge, Oxon 2010, p. 14, for an explanation of the pure premium (premium necessary to cover the mathematically expected loss), which must be increased by costs borne by the insurer of underwriting the risk, such as commission, etc. claims-handling costs, administration and profit (at least theoretically).
11. In Europe, these rules mostly derive from the Solvency II Directive and secondary legislation.

the attachment of risk.[12] The technical aspects of the premium in space insurance contracts will not be developed further.

The above does not limit the parties in freely setting out other rules concerning the premium, adjusted to the specific nature of the risk and the circumstances of concluding the contract. The insurance contract provides for the amount of the premium, the date of payment and the consequences of non-payment, sometimes also addressing such issues as the method of paying the premium.[13] Without contractual provisions, some general rules should be sought that are also fully applicable to space insurance contracts, enriched by practical characteristic to the specifics of the risk. The most important issues concern the rules of time, the place of paying the premium, the persons authorised to accept the premium with effect to the insurer, as well as the consequences of a breach in paying the premium in the amount and time stipulated by the contract.

In the majority of legal systems, the *premium should be payable at the place of business of the insurer.* Even in modern relations, where the premium is payable by bank transfer, this rule is significant. Payment at the place of the insurer means that the premium is deemed to be paid once it reaches the insurer (or its bank account).[14] This, in turn, is important for stating whether the premium has been paid on time (which may be decisive for the contract repudiation or interest on a delay), whether it is subject to taxes in the place of payment, which court has jurisdiction over the dispute concerning the payment of the premium.[15] In common law systems, this rule derives from practice and court verdicts, in civil law systems it is regulated in the statutes, either regulating this issue specifically for insurance contracts, or resulting from the general rules of paying pecuniary obligations. For example, in France, the place of paying the premium results directly from the provisions of the insurance law.[16] The rule of the place of payment may, however, be changed by contractual arrangement. An example of this is the ESA contract for Galileo launch insurance, where it is provided that the payment will be considered as made on time at the moment of the payment order reaching the bank of ESA (and not the insurer).

As regards the *persons entitled to accept the premium*, apart from the insurer itself, the agent of the insurer should be authorised to such actions, but it must be stressed that not all the intermediaries may be recognised as an agent of the insurer for

12. Gould A., Linden O., *Estimating Satellite Insurance Liability*, Papers on Fall CASAC Conference, 2000, p. 60; *see also* the terms of contract for Galileo launch insurance.
13. Clarke M.A., Burling J.M., Purves R.L., *The Law of Insurance Contracts*, Informa, 6th ed., London 2009, p. 377; European Commission Directorate – General for Justice, Final Report of the Commission Expert Group on European Insurance Contract Law, 2014, p. 52.
14. Lambert- Faivre Y., Leveneur L., *Droit des assurances*, Editions Dalloz, 13e édition, Paris 2011, p. 354; Clarke M.A., Burling J.M., Purves R.L., *The Law of Insurance Contracts*, Informa, 6th ed., London 2009, p. 378.
15. Clarke M.A., Burling J.M., Purves R.L., *The Law of Insurance Contracts*, Informa, 6th ed., London 2009, p. 378.
16. In French Code des Assurance, according to L 113-2. *La prime est payable au domicile de l'assureur ou du mandataire désigné par lui à cet effet. Toutefois, la prime peut être payable au domicile de l'assuré ou à tout autre lieu convenu dans les cas et conditions limitativement fixés par décret en Conseil d'Etat.*

the purposes of accepting the premium.[17] If this is the case, the premium may be deemed as paid to the insurer at the moment of being paid to the agent.[18] The broker of the insured, as a rule, is not deemed to be the agent of the insurer for the purposes of accepting the premium. However, relations between the brokers and insurer on the London market are more complex, allowing for such a solution whereby under some arrangements the accounts between broker and insurer are settled periodically. For safety reasons, this should be reflected in the insurance contract and the contract between the broker and the insurer.[19] Again, the example may be given in the terms of insurance for Galileo coverage, where the payment of the premium is made by a coordinator (the broker acts in that capacity). This practice is also due to the number of insurers covering the same risk in portions, being standard in space insurance.

As a rule, the amount of the premium should be specified at the conclusion of the contract, though there are also clauses whereby the premium may be specified as 'TBA' ('to be agreed'), which derives from marine insurance and the express provision of MIA, section 31 (1). In this case, it is the 'reasonable premium' that is due – which in practice may be based upon tariffs applied by the insurer.[20] Such a rule would be more difficult to apply in space insurance, where no tariffs are issued and contract terms are negotiated on an individual basis. Still, in this case it seems that the average premium for similar risk could be imagined, this being a purely theoretical consideration. While in general the premium is agreed for the whole risk period and should be not changed, it is possible for the insurer to want to renegotiate the rate in the event of a material change in the risk. Not agreeing on a specific premium amount at the contract conclusion does not affect the validity of contract, nor does it suspend the cover.[21] This is still compliant with the reciprocity of the insurance contract, which says only that

17. Clarke M.A., Burling J.M., Purves R.L., *The Law of Insurance Contracts*, Informa, 6th ed., London 2009, p. 379.
18. In this respect, the EU provisions of IDD should be taken into account, which as one of the guarantees of protecting the insured's interest provide for the explicit effect of paying the premium to the agent as equal to the payment to the insurer. This, however, is dependent on the manner of implementing this provision into the domestic legal systems.
19. Clarke M.A., Burling J.M., Purves R.L., *The Law of Insurance Contracts*, Informa, 6th ed., London 2009, p. 381; Lowry J., Rawlings P., Merkin R., *Insurance Law. Doctrines and Principles*, Hart Publishing, Oxford and Portland, Oregon 2011, p. 157; *see also* on the possibility of the dual capacity of the broker under common law system: '[t]he courts in New York long have held that insurance brokers act as agents on behalf of an insured and not the insurer'. *Evvtex Co. v Hartley Cooper Assocs., Ltd.*, 911 F. Supp. 732, 738 (S.D.N.Y. 1996) (citing *Bohlinger v Zanger*, 117 N.E.2d 338 (N.Y. 1954) and explaining that the 'status of an insurance broker as an agent of the insured has been codified' under New York insurance law). Yet, even as a broker acts on the insured's behalf for purposes of securing coverage, the broker also can serve as the agent of the insurer in another capacity. In *Evvtex*, for example, the broker also '[held] premiums collected by its insured to be forwarded to the insurance company as an agent of the insurer'. 911 F. Supp. at 739. Thus, the broker served in a dual capacity by acting 'in a fiduciary capacity whether collecting premiums to be forwarded to the insurer or transmitting claim and/or settlement sums from insurers to insured'. Levy A.B., Dendinger M.J., Gastélum D.W., Kauffman L.M., *Broker Liability: An Overview of Key Considerations and Emerging Issues; Insurance Coverage Litigation Committee CLE Seminar*, 2013, p. 5.
20. Lowry J., Rawlings P., Merkin R., *Insurance Law. Doctrines and Principles*, Hart Publishing, Oxford and Portland, Oregon 2011, p. 156.
21. Posner K., Chrystal P., et al., *Margo on Aviation Insurance*, 4th ed., LexisNexis 2014, p. 177.

there must be a premium in consideration of the insurer's obligation to cover the risk. The amount and time is irrelevant from this point of view, and the parties are free to agree the terms thereof in the insurance contract.

The premium in space insurance is usually paid in instalments. This is due to the significant time difference between concluding the insurance contract and the attachment of the risk. Thus, the first, small part is paid at the conclusion of the insurance, and the remaining part in thirty days before the risk attachment.[22] This practice, of course, poses a risk for both parties of a change in market conditions in terms of the rates. 'Payment, or tender of payment, must be for the full amount due: part payment is without effect.'[23] This issue may also be in relation to the place of payment, according to which the premium in the due amount should reach the insurer's place (of business or a bank account). Therefore, the insured should ensure that the payment in that amount is delivered to the insurer, which may not be sufficient if the premium is diminished by bank fees or taxes while being transferred to the insurer. Instalments do not affect the obligation concerning the 'full payment of premium'. Properly and timely paid instalment is the full payment from the legal point of view.

Payment deadlines should usually be provided in the contract, though if they are not, then the premium should be paid within a reasonable time.[24] Non-payment of the premium in accordance with the contract terms is a breach of one of the most important duties of the insured. However, under common law, unless specified in the policy, the payment of the premium is not a condition precedent of the cover, and it is also not an implied term. This differs from some civil law countries, where the payment of the first premium is a *condition suspensive* to the insurance cover.[25] Typically, insurance contracts also make the cover dependant on the payment of a premium, but even then this condition can be waived.[26] It means that, in spite of non-payment, the cover starts 'and continues until lateness of payment becomes of the essence'.[27] Then the insurer may start applying the available remedies. The remedies available to the insurer in the event of late payment include the possibility to suspend cover or repudiate the contract,[28] as well as to deduct the amount of the premium from any other payment due to the insured. The type of remedy and the prerequisites of applying them vary across

22. Whearty R., *Satellite Launch and In-orbit Insurance (Intro to Space Insurance. First party)* Presentation at International Conference and Exhibition on Satellite, Huston, USA, August 2015, http://satellite.conferenceseries.com/speaker-pdfs/2015/robert-p-whearty-marsh-space-projectsusa.pdf..
23. Clarke M.A., Burling J.M., Purves R.L., *The Law of Insurance Contracts*, Informa, 6th ed., London 2009, p. 379; *Slocum v. New York Life Ins Co* 228, US 364 (1913 – life).
24. *Supra*, p. 383.
25. European Commission Directorate – General for Justice, Final Report of the Commission Expert Group on European Insurance Contract Law, 2014, p. 52.
26. Lowry J., Rawlings P., Merkin R., *Insurance Law. Doctrines and Principles*, Hart Publishing, Oxford and Portland, Oregon 2011, p. 158.
27. Clarke M.A., Burling J.M., Purves R.L., *The Law of Insurance Contracts*, Informa, 6th ed., London 2009, p. 386.
28. According to the modern tendencies as represented by PEICL, there are special rules of making the premium a condition: PEICL 5:101: When the insurer makes the payment of the first or single premium a condition of the formation of the contract, or of the beginning of cover, that condition will be without effect unless: (a) the condition is communicated to the applicant in writing using clear language and warning the applicant that he lacks cover until the premium is paid, and (b)

the legal systems, even in Europe, where various consequences may depend on whether the non-payment concerns the first or subsequent premium (or its instalments).[29]

[C] Consequences of Non-payment and Late Payment

As mentioned above, the basic remedy for the non-payment of a premium is the possibility of the insurer repudiating the contract. This is not an absolute right, however, as it is limited by extensive jurisprudence applying legal concepts such as relief against forfeiture, waivers of the insurers and estoppel.[30] It is true, however, that the practical possibility of applying these concepts is limited when the insured is a professional and the insurance contract can be treated as a commercial (rather than a consumer) transaction.[31] The remedies for non-payment or late payment are strictly regulated in the civil law statutes, providing for specific remedies, usually different from the general law of contracts. Such remedies help specify when the delay takes place, and when the remedies may be applied.[32] Taking French law as an example, it provides for specific terms of applying such remedies. These remedies include at first a call for payment, subsequently the suspension of cover and finally the possibility to terminate the contract.[33] Cancellation as a consequence of non-payment of premium

a period of two weeks has expired after receipt of an invoice which complies with requirement (a) without payment having been made.

29. European Commission Directorate – General for Justice, Final Report of the Commission Expert Group on European Insurance Contract Law, 2014, p. 52.
30. Clarke M.A., Burling J.M., Purves R.L., *The Law of Insurance Contracts*, Informa, 6th ed., London 2009, pp. 387–390.
31. Famous cases of the *Scaptrade, Scandinavian Trading Tanker Co A/B v. Flota Petrolera Equatoriana* [1981] 2 Lloyd;s Rep 245; *Shiloh Spinners Ltd v. Harding* [1973] AC 691; in Clarke M.A., Burling J.M., Purves R.L., *The Law of Insurance Contracts*, Informa, 6th ed., London 2009, p. 393.
32. European Commission Directorate – General for Justice, Final Report of the Commission Expert Group on European Insurance Contract Law, 2014, p. 52.
33. Lambert- Faivre Y., Leveneur L., *Droit des assurances*, Editions Dalloz, 13e édition, Paris 2011, pp. 360–362. *See* Art. L113-3 of the Insurance Code, *A défaut de paiement d'une prime, ou d'une fraction de prime, dans les dix jours de son échéance, et indépendamment du droit pour l'assureur de poursuivre l'exécution du contrat en justice, la garantie ne peut être suspendue que trente jours après la mise en demeure de l'assuré. Au cas où la prime annuelle a été fractionnée, la suspension de la garantie, intervenue en cas de nonpaiement d'une des fractions de prime, produit ses effets jusqu'à l'expiration de la période annuelle considérée. La prime ou fraction de prime est portable dans tous les cas, après la mise en demeure de l'assuré. L'assureur a le droit de résilier le contrat dix jours après l'expiration du délai de trente jours mentionné au deuxième alinéa du présent article. Le contrat non résilié reprend pour l'avenir ses effets, à midi le lendemain du jour où ont été payés à l'assureur ou au mandataire désigné par lui à cet effet, la prime arriérée ou, en cas de fractionnement de la prime annuelle, les fractions de prime ayant fait l'objet de la mise en demeure et celles venues à échéance pendant la période de suspension ainsi que, éventuellement, les frais de poursuites et de recouvrement*; a similar concept has been adopted in Belgian law, where in Art. 69. *Le défaut de paiement de la prime à l'échéance peut donner lieu à la suspension de la garantie ou à la résiliation du contrat à condition que le débiteur ait été mis en demeure. Le contrat d'assurance peut toutefois prévoir que la garantie ne prend cours qu'après le paiement de la première prime.* Article 70 provides for details of being in delay: *Article* Art. 70. *La mise en demeure visée à l'article 69 est faite soit par exploit d'huissier soit par lettre recommandée. Elle comporte sommation de payer la prime dans le délai qu'elle fixe. Ce délai ne peut être inférieur à*

has also been provided in the Galileo terms of insurance, this being conditional upon cancellation notice of at least fifteen working days, during which the premium due still may be paid in order for the cover to remain effective (section 22 of the insurance terms). Similar requirements are imposed on the insurer before the release of the liability or the termination of the contract in PEICL.[34]

[D] Return of the Premium

The traditional principle is that it is not possible to demand the return of the premium. This is based on the case *Tyrie v. Fletcher (1777)*, where it was stressed by Lord Mansfield that 'if the *risk of that contract of indemnity has once commenced, there shall be no apportionment or return of premium afterwards*'. This rule was called the 'indivisibility of the premium'. However, even at that time, divisibility was applied in the case of diversified risks covered by one insurance contract.[35] The rule of the indivisibility of the premium has, however, changed since that time, and now the divisibility of the premium is more recognised by the courts and statutory provisions of law.[36] This rule applies even if the risk is not equal during the whole period of cover (e.g., flooding risk), as the insurer is able to divide the premium on the basis of the modern rules of calculating (including statistical ones), even on a daily basis, in a manner reflecting the actual level of risk. It appears from the above that the approach

quinze jours à compter du lendemain de la signification ou du lendemain du dépôt de la lettre recommandée. La mise en demeure rappelle la date d'échéance de la prime et le montant de celle-ci. Elle rappelle également les conséquences du défaut du paiement de la prime dans le délai fixé, le point de départ de ce délai et précise que la suspension de la garantie ou la résiliation du contrat prend effet à compter du lendemain du jour où le délai prend fin, sans que cela ne porte préjudice à la garantie relative à un événement assuré survenu antérieurement.

34. Article 5:102 (1) A clause, providing for the insurer to be relieved of its obligation to cover the risk in the event of non-payment of a subsequent premium, shall be without effect unless (a) the policyholder receives an invoice stating the precise amount of premium due as well as the date of payment; (b) after the premium falls due, the insurer sends a reminder to the policyholder of the precise amount of premium due, granting an additional period of payment of at least two weeks, and warning the policyholder of the imminent suspension of cover if payment is not made; and (c) the additional period in requirement (b) has expired without payment having been made. (2) The insurer will be relieved of liability after the additional period in para. 1(b) has expired. Cover will be resumed for the future as soon as the policyholder pays the amount due unless the contract has been terminated in accordance with Art. 5:103. Article 5:103: On expiry of the period referred to in Art. 5:101(b) or Art. 5:102 para. 1(b), without payment of the premium being made, the insurer shall be entitled to terminate the contract by written notice, provided that the invoice required by Art. 5:101(b) or the reminder required by Art. 5:102 para. 1(b), as the case may be, states the right of the insurer to terminate the contract. (2) The contract shall be deemed to be terminated if, as the case may be, the insurer does not bring an action for payment (a) of the first premium within two months after expiry of the period mentioned in Art. 5:101(b); or (b) of a subsequent premium within two months of expiry of the period mentioned in Art. 5:102 para. 1(b).
35. Clarke M.A., Burling J.M., Purves R.L., *The Law of Insurance Contracts*, Informa, 6th ed., London 2009, p. 397.
36. Otherwise, however, in the case *JA Chapman & Co Ltd v. Kadirga Denzicilik ve Tikaret AS* [1998] Lloyd's Rep IR 377, where it was stated that even if the premium is paid in instalments, it is still a single premium for the entire period – in order to make the premium divisible, the parties must stipulate so in the contract. Lowry J., Rawlings P., Merkin R., *Insurance Law. Doctrines and Principles*, Hart Publishing, Oxford and Portland, Oregon 2011, p. 155.

to the divisibility of the premium is still not homogenous around the world, though a common approach seems to be found in PEICL, which claims the abolition of the indivisibility of the premium principle (though it may be changed by mutual agreement of the parties).[37] The divisibility of the premium is also established in civil law systems, e.g. in France (Article L 121-9 C. assur.),[38] where specific provisions on the terms of returning the premium are set out. Certain rules of the premium return are regulated in insurance contracts.[39] *Nevertheless, it seems that the rule of divisibility has a limited application to space insurance, especially regarding the launch and early-in-orbit cover, while it could be considered for in-orbit insurance cover.*

Another rule concerning the payment of the premium is the rule of 'no risk no premium', which may be applicable in case the risk has not been attached at all. It deals with another aspect of paying the premium not mentioned above. This is similar to a situation when the cover has commenced, but an exception (exclusion) has been working from the beginning, so the insurer bears no risk at all. In such circumstances, the policyholder should have the right to recover the premium paid, unless there was a fraud or other illegal action from his side.[40] Also in the case of fraudulent misrepresentation, the insurer is authorised to avoid the contract with no obligation to return the premium.[41] *The rule of 'no risk no premium' is binding equally in England and the US,*[42] *and is also reflected in space insurance contracts* where special clauses can be found to address the situation when the risk does not attach at all (e.g., due to the total loss of the satellite before the risk attachment), or at a much later date. It may be the case if the launch operation is re-scheduled or revoked, so the risk does not attach during the policy period. In this case, the premium is to be refunded to the insured. It may be agreed between the parties that the right to the return of the premium occurs in the case of a launch delay by more than an agreed time from the estimated date. In such a case, however, the insurance policy may still remain in force (so all its terms are binding, but are only suspended), and once the new launch date is scheduled, the

37. If an insurance contract is terminated before the contract period has expired, the insurer is only entitled to a premium in respect of the period prior to termination. Basedow J., Birds J., Clarke M., Cousy H., Heiss H., Loacker L., *Principles of European Insurance Contracts Law*, 2nd ed., ottoschmidt, Koln, 2016, p. 217; in French law, the code des assurance provides for the obligation to return a premium in the event of a total loss for a reason not covered by insurance, for that part of the coverage period during which no cover is granted; Lambert- Faivre Y., Leveneur L., *Droit des assurances*, Editions Dalloz, 13e édition, Paris 2011, p. 352.
38. *Ibid.*
39. *See*, for example, Posner K., Chrystal P., et al., *Margo on Aviation Insurance*, 4th ed., LexisNexis 2014, p. 183, providing, with respect to aviation insurance, for exemplary provisions dealing the return of the premium; mostly they are coherent with the case law, allowing for such a return in the event of no insurable interest, no common understanding between the parties as to the subject matter insured, where the policy is illegal, etc.
40. Bird J., *Bird's Modern Insurance Law*, Sweet & Maxwell, 2016, p. 191, the explicit regulation to this effect has been introduced by the Insurance Act 2015 also for non-consumer insurance.
41. Clarke M.A., Burling J.M., Purves R.L., *The Law of Insurance Contracts*, Informa, 6th ed., London 2009, p. 398; in case of innocent misrepresentation and avoidance of the contract, the insurer must, however, repay the premium, Lowry J., Rawlings P., Merkin R., *Insurance Law. Doctrines and Principles*, Hart Publishing, Oxford and Portland, Oregon 2011, p. 158.
42. Clarke M.A., Burling J.M., Purves R.L., *The Law of Insurance Contracts*, Informa, 6th ed., London 2009, p. 398, e.g. case *Kansas City College of Osteopathic Medicine v. Employers Surplus Lines Ins Co* 581 F 2d 299 (1 Cir 1978).

premium is repaid to the insurer within an agreed time. This issue is also regulated in the insurance terms for Galileo coverage.[43] The only situation where the premium is not subject to return is when a fraudulent misrepresentation takes place. This principle is common for almost all legal systems, including common law. It is also the case in France and Belgium[44] and in accordance with PEICL.[45] Apart from the above general rules that are applicable to space insurance in full, maybe just minor adjustments to the specific risks, there are also some issues characteristic for this kind of risk. That kind of premium is a reattachment premium concerning the potential coverage of situations where an aborted ignition takes place and there may be a need to reattach risks at a subsequent intentional ignition.[46]

Theoretically, a '*no claim bonus*' is also a possible clause, though it is hard to apply in space insurance, and not practicable very often. That kind of bonus can be agreed, for example, in the case of a successful launch (as defined in the insurance contract and launch contract) and is calculated as a percentage of the total premium (in some contracts the 'no loss return premium' varied in the past between 15% and 33% of the premium in case the launch is successful.[47]

§4.03 WARRANTIES, DUTIES AND CONDITIONS

This section deals with various obligations of the insured that are significant to the insurance coverage being binding and effective. They are not homogenous and substantial differences exist among legal systems with respect to their legal character and consequences of a breach thereof, being traditionally more restrictive in the common law systems and 'softer' in the civil law systems.

[A] Warranties and Conditions

Warranties and conditions of insurance coverage are concepts known to common law, where they serve to limit the liability of the insurer in the event of a potential risk aggravation of various sorts, both subject to the insured's behaviour as well as objective changes in risk. In the continental systems, these issues are rather provided

43. It provides for the payment of 5% of the deposit premium after the policy inception, and 95% of the premium (balance premium) thirty calendar days before the launch; the premium is to be returned in case the launch does not take place within the policy period or the launch is delayed for more than ninety days after the payment of the balance premium.
44. Article 59 of the Belgian insurance law.
45. PEICL, Art. 12:101 Lack of Insured Risk (1) If the insured risk does not exist at the time of concluding the contract or at any time during the insurance period, no premium shall be due. However, the insurer shall be entitled to a reasonable sum for expenses incurred. (2) If the insured risk ceases to exist during the insurance period, the contract shall be deemed to have been terminated at the time that the insurer is notified thereof.
46. International Space Brokers Limited; Memorandum: http://www.publications.parliament.uk/pa/cm199900/cmselect/cmtrdind/335/335ap04.htm; accessed 14 January 2017; Ritorto R, Mitchell M.S., *Telecommunications Satellite Insurance*, 18 Air & Space L., 136, 1993, p. 137.
47. Horl K.U., *Legal Aspects of Risks Involved in Commercial Space Activities*, Montreal 2003, p. 159; I.I. Kuskuvelis (1993), p. 112.

under a broad notion of the insured's duties and, though they are not homogenously regulated, in principle the insurance duties are much less strict by nature. Usually, if regulated by law, they take the form of precautionary measures, sometimes being perceived as clauses neighbouring onto the risk aggravation regulation.[48] The tendencies present in modern insurance law usually limit the possibility of avoiding the liability of the insurer in situations that would lead to the unjustified detriment of the insured's reasonable expectations.[49] Space insurance contracts seem to show peculiarities in this respect.

The common law recognises two types of insured's duties on which the insurance coverage may depend. These are warranties (called also promissory warranties) and conditions precedents, both being slightly different in nature, but both entailing the possibility of the insured losing the cover if breached.[50] The idea of warranties[51] derives from marine insurance, and has been codified in MIA, according to which:

> 'a warranty means a promissory warranty (...) which means (...) a warranty by which the assured undertakes that some particular thing shall or shall not be done, or that some condition shall be fulfilled, or whereby he affirms or negatives the existence of a particular state of facts'.

Warranty is recognised as a condition that must be exactly complied with, whether it is material to the risk or not. What is more, it may be express or implied.[52] Recently, these rules were subject to extensive changes in the UK on the basis of 2015 Insurance Act.[53]

Warranties are recognised as fundamental terms of insurance, and in that aspect they are different from conditions. They are defined as 'a condition on which the contract is founded',[54] without which the insurer would not undertake to be bound.[55] The concept adopted in the UK, though it derives from the MIA, is fully applicable to all other types of insurance. The warranty is claimed to go 'to the root of the transaction', 'ensuring that insurance is of the nature that the underwriter believed it to be when rating and accepting the insurance'.[56] The fundamental nature of the warranty is also

48. *See* for example European Commission Directorate – General for Justice, Final Report of the Commission Expert Group on European Insurance Contract Law, 2014, p. 47.
49. Basedow J., Birds J., Clarke M., Cousy H., Heiss H., Loacker L., *Principles of European Insurance Contracts Law*, 2nd ed., ottoschmidt, Koln, 2016, p. 186.
50. *See* for example, Bird J., *Bird's Modern Insurance Law*, Sweet & Maxwell, 2016, pp. 170, 183.
51. They are of different meaning than is present in the general contract law, where the warranties are of much less significance than the conditions, *see* for example McKendrick E., *Contract Law*, Palgrave, New York 2000, p. 208.
52. MIA regulates explicitly some of the warranties, such as nationality, neutrality, good safety, seaworthiness of the ship and goods, and their character of being implied or not. *See also* Thoyts R., *Insurance Theory and Practice*, Routledge, Oxon 2010, p. 69.
53. It should be noted that the relevant provisions 'in the Marine Insurance Act 1906 – (a) in s. 33 (nature of warranty), in subs. (3), the second sentence is omitted, (b) s. 34 (when breach of warranty excused) is omitted' on the basis of the Insurance Act 2015.
54. Lord Mansfield in case: *Bean v. Stupart* (1778).
55. Clarke M.A., Burling J.M., Purves R.L., *The Law of Insurance Contracts*, Informa, 6th ed., London 2009, p. 635.
56. Lowry J., Rawlings P., Merkin R., *Insurance Law: Doctrines and Principles*, 221, 2011; Turner H.A., *The Principles of Marine Insurance*, 1951, p. 43.

they may lead to the loss of cover,[69] and have shown a tendency to restrict the consequences of the breach of condition precedent, for example in the event that notification of loss was delayed, but information was received by the insurer from other sources. As in the case of exceptions, a breach of a condition may suspend the cover, which may reattach after the condition is complied with again.[70] The conditions are usually express, but also there is a category of implied conditions, such as insurable interest, good faith, binding by force of law.[71]

An analysis of space insurance contracts shows that, once the policy is drafted by the broker, acting as a representative of the insured, there are usually not many warranties in the strict meaning as explained above. At least the express warranties are not numerous, though it does not exclude the possibility to interpret certain duties of the insured as warranties, on a case-by-case basis. The standard wording used in space insurance contracts suggests, however, that no consequences of a breach of warranties may be used by the insurers. First, the obligation of due diligence is drafted in such a general way that it may not be treated as a warranty. Second, the specific duties concerning the risk alteration provide for precise consequences that do not include the termination of the contract by the insurer in the event of a breach of the notification duty or avoidance of the liability in total.[72] Finally, as space insurance contract standard clauses suggest, only material changes are subject to the duties of the insured, while the materiality of a breach and its relation to the loss is not relevant by applying warranties.

Nevertheless, the common practice is to include in the space insurance policy wordings conditions stipulating that the insured is obliged to take all reasonable steps to protect the satellite properly and prevent the loss.[73] While the clauses to the above effect are present in property and liability insurance, in liability insurance their meaning should be quite different, especially if the liability is based on fault. The requirement of due diligence or reasonable precautions may create absurd effects and turn the coverage unenforceable.[74] In any case, all such obligations should be precisely included in the insurance contract and cannot be applied, unless are stipulated by law (which is a rare situation). In case no precautionary measures are included in the agreement, the insured is only obliged not to cause the event insured through wilful

69. Lowry J., Rawlings P., Merkin R., *Insurance Law. Doctrines and Principles*, Hart Publishing, Oxford and Portland, Oregon 2011, p. 244; also in France, any clauses leading to the loss of cover must be in a clear language: L 112-4 *Les clauses des polices édictant des nullités, des déchéances ou des exclusions ne sont valables que si elles sont mentionnées en caractères très apparents.*
70. Thoyts R., *Insurance Theory and Practice*, Routledge, Oxon 2010, p. 71.
71. *Supra*, p. 72.
72. Compare with the alteration of risk warranties explained by Clarke M.A., Burling J.M., Purves R.L., *The Law of Insurance Contracts*, Informa, 6th ed., London 2009, p. 651.
73. The wording of the clauses provides for the obligation of the Insured to use reasonable best efforts to ensure that it has up to date anomaly information on the Satellite, including the obligation to request and obtain such information from the manufacturer, or to take reasonable steps to eliminate the risk of a similar anomaly on the Satellite, and finally an obligation to inform the Insurer of such steps. *See*, for example, the Galileo terms of insurance.
74. Thoyts R., *Insurance Theory and Practice*, Routledge, Oxon 2010, pp. 204–205.

misconduct. In addition, it seems that, according to the principle of fortuity,[75] one of the fundamental principles in insurance, the policyholder warrants to the insurer, whether it is expressly written or not (an implied term), that the loss has not occurred before the risk attachment is binding.[76] If the policy is concluded long before the attachment of risk, the crucial moment in this respect is not the date of the policy, but the moment of the risk attachment.

[B] Precautionary Measures

The closest concept to the warranties that can be met in civil law systems seem to be *precautionary measures* that should be taken by the insured during the term of cover, and which are to minimise the possibility of the risk materialising. The regulation thereof in national insurance laws is not coherent.[77] In certain systems, the obligations result explicitly from the law, in the others they do not, and they must be regulated in the contract, as they are not implied. As an example, in France, any basis for such provisions is the obligation of the insured, 'before the event insured' known as '*measures de prevention*'.[78] They may be included in the insurance contract to that effect, whereby a breach thereof may lead to the avoidance of the liability by the insurer (*clauses de decheances*). There are, however, some concerns as to the application of such clauses due to the similar effect to clauses excluding certain risks from the insurance coverage.[79] It is, in fact, questionable whether a breach of the preventive duties by the insured may lead to the loss of cover, if it is not due to wilful misconduct (or at least gross negligence). The French jurisprudence distinguishes at least two types of *clauses de decheances*, differentiating the situation where the breach of preventive measures affects the coverage of the risk (divided for sub-categories of *condition de garantie* and *exclusion de garantie*), and where it does not affect.[80]

In space insurance, a general rule of the insured's due diligence is recognised. This obligation is much broader than the precautionary measures. According to the general rule, the insured is to maintain due diligence while conducting a space operation covered by insurance.[81] The policy terms often include the obligation of 'reasonable care', thus the test of reasonableness must be applied in such a situation. In other words, the insured should behave as a prudent uninsured as in other types of

75. Meredith P.L., *Space Insurance Law-with a Special Focus on Satellite Launch and In-Orbit Policies*, 21(4) Air & Space Law., 13–15, 2008.
76. The event insured must be fortuitous in relation to the period covered.
77. European Commission Directorate – General for Justice, Final Report of the Commission Expert Group on European Insurance Contract Law, 2014, p. 47.
78. Such a definition was adopted also in PEICL (Art. 4:101), where 'a precautionary measure means a clause in the insurance contract, whether or not described as a condition precedent to the liability of the insurer, requiring the policyholder or the insured, before the insured event occurs, to perform or not to perform certain acts.'
79. Basedow J., Birds J., Clarke M., Cousy H., Heiss H., Loacker L., *Principles of European Insurance Contracts Law*, 2nd ed., ottoschmidt, Koln 2016, p. 188.
80. *See* more Lambert- Faivre Y., Leveneur L., *Droit des assurances*, Editions Dalloz, 13e édition, Paris 2011, pp. 336–337.
81. Meredith P.L., *Space Insurance Law-with a Special Focus on Satellite Launch and In-Orbit Policies*, 21(4) Air & Space Law., 13–15, 2008.

insurance,[82] and exercise due care with respect to the insured satellite[83] or launch operation. It is emphasised, however, by the academics that the above rule is not an implied one and must be explicitly included in the insurance contract, and only recklessness should release the insurer.[84] Though due diligence is present in all types of insurance, a particular reason for this obligation in space insurance is the value of the assets insured, and the relatively small influence of the insurers on what may happen to the satellite once launched into orbit, including the impossibility of performing inspections and the inability to check the risk level on its own (as may be the case of flood insurance or others). The aim of the due diligence requirement is also to diminish the moral hazard on the side of the insured. The latter, however, is anyway relatively small compared to other industries.

The obligation to maintain *due diligence is a continuing* one (like many warranties) and lasts from the moment of the policy inception until the claims adjustment process. First, the insured *shall use due diligence and shall do and concur in doing all things reasonable and practical to avoid the loss, and in case it occurs, to undertake actions in order to diminish the loss.*[85] In such a case, the insured must take any measures in order to avoid the increase of the damage (or to try to minimise it).[86] The insured is expected to make reasonable efforts to that purpose, including if possible any corrective measures.[87] In this respect, the case *Hughes aircraft Company v. Lexington Insurance Company (1986)* may be given, where the insured was obliged to, 'in the event of an occurrence likely to result in claim (...): (a) use due diligence and do and concur in doing all things reasonable practicable to avoid or diminish any loss under

82. *See also* Horl K.U., *Legal Aspects of Risks Involved in Commercial Space Activities*, Montreal 2002 p. 154, where the author correlates the duty of due diligence with the proper risk declaration (i.e. the insured warrants not to misrepresent or conceal any information or change thereof); also *see* Meredith P.L., Robinson G.S., *Space Law: A Case Study for the Practitioner. Implementing a Telecommunications Satellites Business Concept*, Martinus Nijhoff Publishers, 1992, p. 363; Posner K., Chrystal P., et al., *Margo on Aviation Insurance*, 4th ed., LexisNexis 2014, p. 417.
83. Meredith P.L., *Space Insurance Law-with a Special Focus on Satellite Launch and In-Orbit Policies*, 21(4) Air & Space Law., 13–15, 2008; Posner K., Chrystal P., et al., *Margo on Aviation Insurance*, 4th ed., LexisNexis 2014, p. 417.
84. Clarke M., *Policies and Perceptions of Insurance Law in the Twenty- First Century*, Oxford University Press, New York, 2005, p. 166 expresses the view supported by the case law that the behaviour of the insured should be reasonable and should not be reckless, but it is the insurance purpose to cover the carelessness of the policyholders, so the insured's duties are breached only in the case of 'extreme carelessness.'
85. The view has been expressed that this condition refers to the circumstances after the event insured occurred, *see* Posner K., Chrystal P., et al., *Margo on Aviation Insurance*, 4th ed., LexisNexis 2014, p. 205, which has been expressed in the case *United States v. Eagle Star Insurance Co Ltd* 201 F2d764, (9th Cir 1953).
86. Such an obligation is present in some national insurance laws, such as Belgian, where according to *Article 75 Dans toute assurance à caractère indemnitaire, l'assuré doit prendre toutes mesures raisonnables pour prévenir et atténuer les conséquences du sinistre.* Consequently, as provides art *76 § 1er. – Si l'assuré ne remplit pas une des obligations prévues aux articles 74 et 75 et qu'il en résulte un préjudice pour l'assureur, celui-ci a le droit de pretender à une réduction de sa prestation, à concurrence du préjudice qu'il a subi. § 2. – L'assureur peut décliner sa garantie si, dans une intention frauduleuse, l'assuré n'a pas exécuté les obligations énoncées aux articles 19 et 20.*
87. Fabre H., *Risques spatiaux et strategie de couverture du risque par les mecanismes de l'assurance*, Revue geoeconomie nr 20, hiver 2001–2002, p. 286.

this policy [and must act at all times as uninsured]'.[88] It should be noted that, depending on the law applicable to the contract, certain obligations may be qualified as precautionary measures (under civil law systems) or warranties (under common law system). In each of them, different consequences of a breach may be applied. It is particularly important whether a given obligation can be considered as a warranty, or as merely a condition precedent without the feature of a warranty, and if so, whether the insurer may use the customary remedies available under common law.

Though all the warranties and conditions are fully applicable to space third-party liability insurance, in addition to the obligations included in insurance contracts and the law of insurance, some of the insured's obligations also result from the mandatory character of TPL insurance. For example, the obligations concerning mandatory TPL insurance in the UK licensing procedure include the obligation of the insured to take 'all necessary action to ensure that the policy of insurance effected by the licensee pursuant to the provisions of *this* licence continue in force and are valid and enforceable and the licensee shall do nothing that would enable the insurer to avoid any such policy'.[89] It should be noted that, since the aim of liability insurance is to protect the victims of the insured, some legal systems have regulated in a special way the possibility of releasing the insurer from its liability. This is done via the non-enforceability of such clauses against the injured third party. An example of such a solution is Belgian law, especially if the breach of the duties took place after the occurrence of the event insured.[90]

§4.04 LOSS

[A] General

The classification of the types of insurance for indemnity and contingency insurance is one of the most important criteria applied in insurance. The main feature of indemnity is the obligation of the insurer to 'indemnify' the insured or the injured party ('*indemniser l'assure ou la victime*') as opposed to contingency insurance, where the insurer is obliged to pay a contingency sum (*la somme forfaitaire determine au moment de la conclusion du contrat*[91]). Indemnity insurance is based upon the principle of

88. Tucker S., *Some Strategic Defense Initiatives Toward Preventing U.S Space Insurance Related Disputes and Litigation*, in 21 J. Space L., 126–127, 1993; *see also* s. 27 of Galileo insurance terms.
89. UK template licence.
90. *Article 151:* § 1er. – *Dans les assurances obligatoires de la responsabilité civile, les exceptions, nullités et déchéances dérivant de la loi ou du contrat, et trouvant leur cause dans un fait antérieur ou postérieur au sinistre, sont inopposables à la personne lésée. Sont toutefois opposables à la personne lésée l'annulation, la résiliation, l'expiration ou la suspension du contrat intervenues avant la survenance du sinistre. § 2. – Pour les autres catégories d'assurances de la responsabilité civile, l'assureur ne peut opposer à la personne lésée que les exceptions, nullités et déchéances dérivant de la loi ou du contrat et trouvant leur cause dans un fait antérieur au sinister.*
91. Lambert- Faivre Y., Leveneur L., *Droit des assurances*, Editions Dalloz, 13e édition, Paris 2011, p. 51. This is reflected in the division of insurance into 'damage insurance' and personal insurance – as included for the first time in the Insurance Law in France dated 13 June 1930; the same concept is present in Belgian insurance law; the indemnity insurance has its basis in Art.

indemnity, whereby the beneficiary should not be enriched by obtaining compensation higher than the loss suffered. Thus the loss stands in the centre of the indemnity principle. Indemnity insurance is commonly divided into property insurance and liability insurance,[92] and the first type can be further sub-divided into more specific categories. In addition to classical material property losses, insurance may cover almost any type of financial losses, including loss of use (*perte d'exploitation*).[93] *All these types of insurance are present in space insurance contracts and, in addition to the specific methods of calculating the loss included in the insurance contracts, the general rules concerning indemnity insurance are applicable.*

The general insurance law defines a loss relevant to insurance as 'any loss, damage[94] or deprivation[95] suffered by the insured as a result of an event insured against, and which leaves him financially poorer than he was before'.[96] Whatever is the basis for calculating the loss, it must be proved in order for the insured to become entitled to compensation by virtue of the insurance contract, *as a condition precedent to the payment of claim*. The payment is to compensate the loss. The above principle has not been changed, even by the fact that the space insurance is based upon the value agreed. The other common features of loss covered by insurance that applies to space insurance are the material character of loss, in the meaning that no immaterial (e.g., sentimental) value of the subject matter insured is covered,[97] neither is consequential loss covered, unless under a specific type of insurance, such as loss of revenue insurance.[98] The above features are correlated with the rules of setting the insurable value and the sum insured (*see* more in Chapter 3, §3.06). The indemnity feature of space insurance determines the condition of a claim against the insurer.

The type of loss in space insurance contract is usually defined in the insurance contract and is calculated according to a predetermined ratio of loss as provided in the contract. It is related to such factors as loss of capacity and loss or shortening the lifetime of the satellite in comparison to the nominal capacity and lifetime anticipated by the manufacturer, as well as the application of the satellite (e.g., depending on whether it is communications, navigation, meteorological or other). Further, it is based upon the number of transponders, the electrical power supplied by the solar panels and

105, according to which: *Toute assurance de dommages a un caractère indemnitaire* and in accordance with Art. 93 *la prestation due par l'assureur est limitée au préjudice subi par l'assuré. Ce préjudice peut notamment consister dans la privation de l'usage du bien assuré ainsi que dans le défaut de profit espéré.*

92. Lambert- Faivre Y., Leveneur L., *Droit des assurances*, Editions Dalloz, 13e édition, Paris 2011, p. 52.
93. *Ibid.*
94. Damage is understood as a changed physical state.
95. Deprivation should be permanent to be treated as a loss; temporary deprivation of the subject matter of the insured is not a loss, unless it has been damaged, Clarke M.A., Burling J.M., Purves R.L., *The Law of Insurance Contracts*, Informa, 6th ed., London 2009, pp. 467–468.
96. *Ibid.*
97. For example Clarke M., *Policies and Perceptions of Insurance Law in the Twenty- First Century*, Oxford University Press, New York 2005, p. 220.
98. Clarke M.A., Burling J.M., Purves R.L., *The Law of Insurance Contracts*, Informa, 6th ed., London 2009, p. 467.

battery, the reserves of on-board fuel and life expectancy set by the manufacturer.[99] In case of any type of loss, the deductibles, or other types of self-insurance layers, are first taken into account.[100] Finally, the loss depends also on the possibility of backup services. The possibility of using redundancies usually disqualifies the claim, or reduces the loss to be indemnified (can also be qualified as a first layer of self-insurance). As regards launch insurance, the loss is usually defined as a failure to achieve the intended orbit, while for in-orbit insurance the loss covered concerns the failure of the satellite, transponder failure,[101] insufficient fuel[102] or insufficient power.[103]

A loss in space insurance is directly related to the functionality of the satellite, and this factor determines whether there is a loss or not. For example, if a satellite was hit by debris, but it is still fully operational, with no proof of a shortened lifetime, then there is no loss. Loss of functionality is, however, claimed to be a type of physical damage and it takes place if, due to a physical incident, the satellite is physically incapable of performing its essential function in part or in full. Loss of functionality may constitute a partial loss or a total loss, depending on the functionality percentage left after the insured event occurred and the insurance policy terms. The loss of functionality is a major risk during the in-orbit stage and it is related to the reliability of the components and the critical systems. The level of loss is correlated to the replacement value of the satellite, as specified in the insurance contract, and to the financial loss linked to the overall loss affecting the satellite functionality.[104]

In space insurance, any type of loss, not only present loss, but *also future loss* can be compensated.[105] In that sense, space insurance is somewhat similar to business interruption insurance (though should be clearly distinguished from loss of revenue insurance, also offered as a dedicated insurance for satellites).[106] In this respect, there is a clear difference between lost capacity and deferred capacity, which may be restored, as well as the continuing degradation of the satellite's performance. Thus, even a future loss must be certain/inevitable, or at least it must be demonstrated that the loss will be continuing after the period of cover, but results from an event occurred

99. Efimova Y., Butchers M., *Space Insurance Report*, Knowledge Transfer Network, 2014, p. 9.
100. Ritorto R, Mitchell M.S., *Telecommunications Satellite Insurance*, 18 Air & Space L., 136, 138, 1993.
101. Agreed value per transponder.
102. The value agreed can be based upon weight of the fuel (*see* for example the invitation for tender for Galileo satellites, where information on the weight of the fuel was part of the risk assessment process).
103. Meredith P.L., Robinson G.S., *Space Law: A Case Study for the Practitioner. Implementing a Telecommunications Satellites Business Concept*, Martinus Nijhoff Publishers, 1992, p. 361.
104. Fabre H., *Risques spatiaux et strategie de couverture du risque par les mecanismes de l'assurance*, Revue geoeconomie nr 20, hiver 2001–2002, p. 286.
105. It should be noted that, under general liability rules, the mere exposure to the risk of damage cannot itself be perceived as actionable damage, with only few exceptions accepted in the court verdicts. Risk can be regarded as damage only when the risk materialised; *See* more Turton G., *Risk and the Damage Requirement in Negligence Liability*, 35(1) Legal Stud., 75–95, 2015.
106. The general concept for BI insurance is the 'protection against a loss of future earnings', *see* Cloughton D., *Riley on Business Interruption Insurance*, London, Sweet & Maxwell, 1999, p. 1.