

Study of the Liability Risk-Sharing Regime in the United States for Commercial Space Transportation

1 August 2006

Prepared by

J. A. VEDDA
Center for Space Policy and Strategy
National Space Systems Engineering

Prepared for

VOLPE NATIONAL TRANSPORTATION SYSTEMS CENTER
U.S. DEPARTMENT OF TRANSPORTATION
Cambridge, MA 02142

Contract No. DTRT57-05-D-30103, Tasks 3 & 8

Space Launch Operations

PUBLIC RELEASE IS AUTHORIZED

REPORT DOCUMENTATION PAGE			<i>Form Approved OMB No. 0704-0188</i>		
<p>The public reporting burden for this collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing the burden, to the Department of Defense, Executive Services and Communications Directorate (0704-0188). Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to any penalty for failing to comply with a collection of information if it does not display a currently valid OMP control number.</p> <p>PLEASE DO NOT RETURN YOUR FORM TO THE ABOVE ORGANIZATION.</p>					
1. REPORT DATE (DD-MM-YYYY) 01-08-2006		2. REPORT TYPE Contractor Final Report		3. DATES COVERED (FROM - TO) January 21, 2005 – August 1, 2006	
4. TITLE AND SUBTITLE Study of the Liability Risk Sharing Regime in the United States for Commercial Space Transportation			5A. CONTRACT NUMBER DTRT57-05-D-30103		
			5B. GRANT NUMBER		
			5C. PROGRAM ELEMENT NUMBER		
6. AUTHOR(S) J. A. VEDDA*			5D. PROJECT NUMBER FA2R CL411		
			5E. TASK NUMBER Task Orders #3 and #8		
			5F. WORK UNIT NUMBER FA2R CL411		
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. Department of Transportation Research and Innovative Technology Administration Volpe National Transportation Systems Center Safety Information Systems Division Cambridge, MA 02142-1093			8. PERFORMING ORGANIZATION REPORT NUMBER DOT-VNTSC-FAA-06		
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) U.S. Department of Transportation Federal Aviation Administration Office of the Assoc. Administrator for Commercial Space Transportation Washington, DC 20591			10. SPONSOR/MONITOR'S ACRONYM(S) AST-3		
			11. SPONSOR/MONITOR'S REPORT NUMBER(S)		
12. DISTRIBUTION/AVAILABILITY STATEMENT PUBLIC RELEASE IS AUTHORIZED					
13. SUPPLEMENTARY NOTES *The Aerospace Corporation, El Segundo, CA 90245-4691					
14. ABSTRACT <p>The Aerospace Corporation was tasked to perform an independent and comprehensive study of the liability risk-sharing regime in the United States for commercial space transportation under section 70113 of Title 49, United States Code.</p> <p>The Commercial Space Launch Amendments Act of 2004 (Public Law 108-492) mandated a study on the U.S. government's risk sharing of third-party liability for commercial space launch providers licensed by the Federal Aviation Administration (FAA). This risk-sharing regime, as described in Title 49, section 70113 of the U.S. Code, was the subject of a previous congressionally directed report issued in April 2002 by the Department of Transportation (DOT) titled "Liability Risk-Sharing Regime for U.S. Commercial Space Transportation: Study and Analysis." The current study updates this report for congressional decision-makers who are considering the next steps beyond the current risk-sharing statute, which expires at the end of 2009. Specifically, this report provides the following:</p> <ul style="list-style-type: none"> • An objective assessment of methods by which the current liability risk-sharing regime could be eliminated or modified, including alternative steps needed to maintain a viable and internationally competitive U.S. commercial space transportation industry. • An evaluation of the direct and indirect impacts that elimination or modification of the regime would have on U.S. competitiveness in the world launch market, and on U.S. assured access to space. • Examination of liability risk-sharing in other nations with commercial space launch capabilities, including comparisons to the current liability risk-sharing regime in the U.S. 					
15. SUBJECT TERMS Commercial Space Transportation, Liability, Indemnification, Regulation, Risk-Sharing Regime					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT UU	18. NUMBER OF PAGES 73	19A. NAME OF RESPONSIBLE PERSON James N. Hallock, Ph.D.
A. REPORT U	B. ABSTRACT U	C. THIS PAGE U			

STUDY OF THE LIABILITY RISK SHARING REGIME IN THE UNITED
STATES FOR COMMERCIAL SPACE TRANSPORTATION

Prepared by

J. A. VEDDA
Center for Space Policy and Strategy
National Space Systems Engineering

1 August 2006

Space Launch Operations
THE AEROSPACE CORPORATION
El Segundo, CA 90245-4691

Prepared for

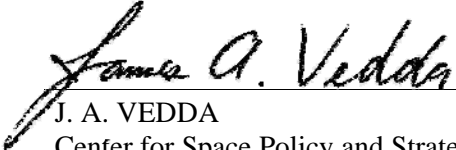
VOLPE NATIONAL TRANSPORTATION SYSTEMS CENTER
U.S. DEPARTMENT OF TRANSPORTATION
RESEARCH AND INNOVATIVE TECHNOLOGY ADMINISTRATION
Cambridge, MA 02142

Contract No. DTRT57-05-D-30103, Tasks 3 & 8

PUBLIC RELEASE IS AUTHORIZED

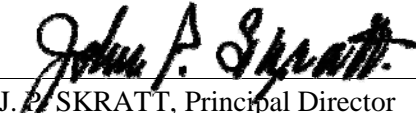
STUDY OF THE LIABILITY RISK SHARING REGIME IN THE
UNITED STATES FOR COMMERCIAL SPACE TRANSPORTATION

Prepared by:

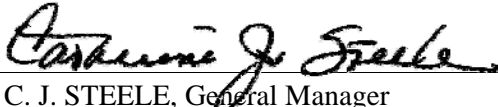


J. A. VEDDA
Center for Space Policy and Strategy
National Space Systems Engineering

Approved by:



J. P. SKRATT, Principal Director
Space Launch Projects
Launch Systems Division



C. J. STEELE, General Manager
National Space Systems Engineering
Systems Planning and Engineering Group

Contents

Acknowledgements	vii
Executive Summary	ix
1. Introduction	1
1.1 Purpose of the Study	1
1.2 Current Risk-Sharing Regime	1
1.3 U.S. Treaty Obligation for Third-Party Liability	2
1.4 Evolution of Third-Party Liability Coverage for Space Launch	3
1.4.1 Emergence of the U.S. Commercial Launch Industry	3
1.4.2 Amending the CSLA	5
1.4.3 Industry View of U.S. Government Risk-Sharing	6
1.5 Identifying Policy Objectives	7
2. The Current Market and U.S. Government Risk-Sharing	11
2.1 A Mature Industry?	11
2.2 International Competitiveness	12
2.2.1 Measuring Competitiveness	13
2.2.2 Is Competitiveness an Appropriate Measure?	18
2.3 Possible Concerns for National Security	19
2.4 Additional Considerations	19
2.5 Relevant Experience in Other Federal Government Indemnification Programs	20
2.6 Observations for Commercial Space Launch Indemnification	23
2.7 Elimination of Risk Sharing and “Betting the Company” – Perspectives from Other Large Loss Events	25
2.8 Summary of Observations on the Commercial Space Transportation Market and the Risk-Sharing Program	28
3. Elimination of U.S. Government Risk-Sharing and Possible Consequences	31
3.1 Alternatives	31
3.2 Possible Steps Toward Elimination	33
3.3 Launch Providers’ Perspective	36
3.4 Launch Customers’ Perspective	39
3.5 Space Insurance Industry Perspective	39
3.5.1 Maturity of the Launch Liability Insurance Market	39
3.5.2 Insurance Industry Concerns	42
3.5.3 New Demands on the Insurance Pool	42
3.5.4 Potential Effects of Unrelated Events or a Depressed Insurance Market	44
3.5.5 The Continuing Role of Indemnification	44
4. Risk-Sharing Regimes of Foreign Competitors	45
4.1 Background	45
4.2 Methodology	46
4.3 Liability Indemnification in Commercial Launching States	46
4.3.1 Australia	46
4.3.2 Brazil	46
4.3.3 China	48
4.3.4 Europe	48
4.3.4.1 Arianespace	48
4.3.4.2 Other Launchers at the Guiana Space Center	48

4.3.4.3 Starsem	49
4.3.4.4 Eurokot	49
4.3.4.5 United Kingdom	49
4.3.4.6 Sweden	50
4.3.5 India	50
4.3.6 Japan	50
4.3.7 Russia	51
4.4 Summary of Findings from Interviews and Questionnaires	52
5. Analysis and Options.....	55
5.1 Assure Adequate Liability Coverage for Catastrophic Launch-Related Events	56
5.2 Minimize U.S. Government Risk Exposure and Annual Outlays/Subsidies	56
5.3 Improve Economic Benefits and Strengthen the U.S. Industrial Base in Space Launch Capabilities	57
5.4 Options for Consideration	59
Appendix A: Acronyms and Abbreviations.....	63
Appendix B: Statutory Language.....	65
Appendix C: Participants	67

Figures

Figure 2.1. Herfindahl Index: Worldwide Commercial Launches 1989-2005	14
Figure 2.2. Herfindahl Index: Worldwide Commercial Launch Revenues 1989-2005	15
Figure 2.3. Commercial Launch Events by Country 1998-2005	17
Figure 2.4. Launch Revenues for Commercial Launch Events by Country 1998-2005	17
Figure 5.1 Possible Phase-Out Strategy.....	60

Tables

Table 2.1. U.S. Federal Disaster Aid.....	26
Table 2.2 The 10 Most Costly Terrorist Attacks in Terms of Insured Property Losses	27
Table 2.3 Composition of 9/11 Insured Loss Estimates as of July 2004.....	27
Table 2.4 Cash Flow and Total Equity of Publicly Held Manufacturing Aerospace Companies	28
Table 3.1. Third-Party Launch Liability Insurance Market 2005-2014	41
Table 4.1 Summary of Indemnification Regimes of Spacefaring Nations.....	52
Table 4.2 Summary of Interview Responses.....	53

Acknowledgements

The Aerospace Corporation was tasked by the DOT Volpe National Transportation Systems Center to provide technical support to the Federal Aviation Administration, Office of the Associate Administrator for Commercial Space Transportation (FAA/AST), in performing this independent and comprehensive study of the liability risk-sharing regime in the United States for commercial space transportation under section 70113 of title 49, United States code. Aerospace is pleased to submit this final report, in accordance with the requirements delineated in Section F, Deliveries or Performance, of Volpe Center Contract No. DTRT57-05-D-30103.

The author is grateful to FAA/AST and the Volpe Center for the opportunity to work on this project. Specifically, gratitude is extended to Mr. Kelvin Coleman, Special Assistant for Programs and Planning at FAA/AST, and to Dr. James N. Hallock and Ms. Ann R. DiMare, who served as the Contracting Officer's Technical Representatives (COTRs) at the Volpe Center. Gratitude is extended to Mr. Robert W. Seibold for his support and guidance as the Aerospace Corporation program manager.

Dr. Molly K. Macauley of Resources for the Future contributed substantially to Chapters 2 and 3, and Dr. Walter A. R. Peeters of the International Space University contributed Chapter 4. The author also wishes to acknowledge the support provided to Dr. Peeters by Dr. Michael Simpson and Ms. Macha Ejova.

The Aerospace Corporation is responsible for the findings and analysis contained in this report, which do not necessarily reflect the positions of its customers or the contributors to this report.

Executive Summary

Purpose of the study

The Commercial Space Launch Amendments Act of 2004 (Public Law 108-492) mandated a study of the U.S. government's risk sharing of third-party liability for commercial space launch providers licensed by the Federal Aviation Administration (FAA). This risk-sharing regime, as described in Title 49, section 70113 of the U.S. Code, was the subject of a previous congressionally directed report issued in April 2002 by the Department of Transportation (DOT) titled "Liability Risk-Sharing Regime for U.S. Commercial Space Transportation: Study and Analysis" (hereafter referred to as DOT/FAA 2002). The current study updates this report for congressional decision-makers who are considering the next steps beyond the current risk-sharing statute, which expires at the end of 2009.

Specifically, this report provides the following:

- An objective assessment of methods by which the current liability risk-sharing regime could be eliminated or modified, including alternative steps needed to maintain a viable and internationally competitive U.S. commercial space transportation industry.
- An evaluation of the direct and indirect impacts that elimination or modification of the regime would have on U.S. competitiveness in the world launch market, and on U.S. assured access to space.
- Examination of liability risk-sharing in other nations with commercial space launch capabilities, including comparisons to the current liability risk-sharing regime in the U.S.

Approach

For purposes of this study, U.S. commercial space launches are defined as those licensed by the FAA and conducted by a competitively selected private-sector launch provider. A large percentage of the world's annual space launches involve payloads that are captives of a particular nation's or region's launch vehicles (nearly 70% in 2005),¹ and therefore are not included in this discussion.

To gather a wide perspective on the influence of insurance issues on the future of commercial space transportation, this study 1) conducted interviews with representatives of the commercial space transportation and insurance industries, and 2) collected information from studies, reports, and forecasts of industry advisory groups, trade associations, academic research, and the trade press, including reports and peer-reviewed research of other industries in which government indemnification has played a role, such as the commercial nuclear power industry.

The current third-party liability indemnification regime remains in force until the end of 2009. As a result, this study's analysis considers not only current circumstances but also the business environment that the U.S. launch industry may face in the next decade. Many factors that would affect a decision on the future of government indemnification could change:

- International competition could continue to increase.
- The number and characteristics of domestic launch providers could change significantly.
- Domestic launch providers could expand their operations through new technologies (e.g., reusable launch vehicles), new markets (e.g., space tourism), or new government policies (e.g.,

¹ FAA/AST, "Commercial Space Transportation: 2005 Year in Review," February 2006.

loosening of export controls, “buy American” laws, or privatization of International Space Station operations).

- A major launch accident or Katrina-like natural disaster could disrupt the liability insurance market.

This study notes the enduring themes in U.S. public policy for the commercial space transportation industry: the long-held position of the executive and legislative branches that the success of the U.S. commercial launch industry is in the national interest, and that it is appropriate for the government to encourage and facilitate a healthy, internationally competitive industry. This study assumes that this view of the industry will continue for the foreseeable future. Indeed, it is likely to strengthen as the industry develops new markets, becomes a key player in NASA’s space exploration efforts, faces increasing competition from overseas, and wrestles with industrial base issues that affect government space programs across the board.

This study is intended to assist policy-makers as they judge which course of action better serves the national interest:

Maintenance of a policy/legal environment favoring the U.S. commercial space launch industry through government sharing of low-probability but potentially high-consequence third-party liability risk.

or

Phase-out of U.S. government (taxpayer) risk exposure for this hazardous private-sector activity.

This choice is the first step Congress must take to settle the indemnification issue. Each course of action brings with it a different set of implementation requirements and consequences. This study is designed to assist the Congress in determining which course of action best satisfies the following policy objectives, which collectively support the national interest in this area:

- Assure adequate liability coverage for catastrophic launch-related events.
- Minimize U.S. government (taxpayer) risk exposure and annual outlays/subsidies.
- Improve economic benefits and strengthen the U.S. industrial base in space launch capabilities by:
 - Enhancing international competitiveness of the U.S. space transportation industry.
 - Maintaining continuity in the business environment for U.S. launch providers.
 - Encouraging new U.S. entrants to the commercial launch market.

Findings and policy options

Nearly two decades after enactment of the Commercial Space Launch Act (CSLA) Amendments of 1988, private insurance markets still are not able to provide full liability (maximum possible loss) coverage to the commercial launch industry. Private liability insurance capacity remains fragile and far below what would be needed to compensate for government indemnification if it were eliminated. Foreign competition has increased, and all credible international competitors have risk-sharing schemes rivaling or surpassing that of the U.S.

Research and interviews have revealed the following regarding the current liability indemnification regime and proposed alternatives to it:

- The government has participated in liability risk-sharing in other areas, such as the nuclear power industry, floods, and terrorism. All of these areas have involved a gradual ramping down of government risk exposure. However, the space launch industry is not directly comparable in size, resources, or experience. Nor is it likely to evolve at a predictable rate, as demonstrated by the fact that insurance capacity in this business line is little changed from 1988.
- The current regime has become the industry standard. Its elimination could send the wrong signal (i.e., that the U.S. government has lost confidence in the commercial launch industry) to international customers and competitors and would be a negative factor in the competition for global launch business.
- Any alternative that involves government subsidies or increased oversight would cost more than the current regime.
- The launch and insurance industries are uncomfortable with trusts and insurance pools because they believe the number of participants would be too small to build reserves in a reasonable time. In addition to being small in number, many participants are small in size and do not have the resources to make a substantial contribution.
- The indemnification regime, originally envisioned as supplementary coverage in the event of a catastrophic accident, can also serve as a backup in case a large third-party liability claim anywhere in the world curtails the availability of private-sector insurance. Without this backup, the U.S. commercial launch industry could be forced to suspend launch activity for an indefinite period, possibly causing some participants to exit the business permanently. Under these circumstances, foreign competitors can be expected to use their government indemnification regimes to keep their launch providers active.
- Changes in foreign competitors' risk-sharing regimes are not on the horizon. Other launching states do not plan to react to U.S. changes in any way.

By some measures (continued investment, technological evolution, ongoing partnerships, consolidation, new entrants) the U.S. commercial launch industry is mature. At some point in its development, the U.S. commercial launch industry may be able to shoulder more (and maybe all) of its liability risk. But that point is not on the immediate horizon. Stability and profitability are lacking, and the industry is still shaping itself into something that may look very different from the launch industry of the 1980s and 1990s. The robustness of the insurance market and private operators' ability to meet obligations in a secondary fund both appear to be lacking. While the pace of the industry's development is impossible to predict, it is likely that it will be more than a decade before both the launch and insurance industries reach the point where risk can be accommodated without government help.

Entrepreneurial launch firms are likely to dramatically change the domestic market landscape over the next two decades. As of August 2006, small launch companies held only three active FAA licenses, and had yet to demonstrate their longevity and profitability. Several more companies with similar goals hope to prove themselves in the near future. In contrast to the large aerospace companies, whose portfolios include substantial government business in a variety of areas, commercial launch is a primary function of the entrepreneurial firms. Ultimately, the successful ones may account for the majority of U.S. commercial launch revenues. But to reach that point, this new wave of launch providers needs many more years to mature. The post-2009 indemnification regime will affect them much more than it does today, and its effect on their business plans may be more significant than it is for the plans of large launch companies today.

This analysis does not endorse the option of simply allowing government indemnification to expire at the end of 2009 with nothing to take its place. Such an abrupt change would be too disruptive of existing business plans, leaving the U.S. commercial launch industry with little time to implement alternatives.

Other than simply allowing government indemnification to expire, the Congress has two courses of action available. The first option is **maintenance of the indemnification regime** to ensure that the U.S. commercial launch industry will be able to match the liability coverage of its global competitors. Should the Congress choose this path, the following modifications to the current indemnification regime should be considered when addressing its renewal in 2009:

- **Make indemnification permanent.** The sunset provision introduces uncertainty in the business environment and provides ammunition for the marketing efforts of foreign competitors. Future changes to the risk-sharing regime should be dependent on dramatic growth in the U.S. commercial launch industry, substantially increased capacity in the liability insurance market, and/or other changes in the business environment that may make other options viable and desirable. This will not happen on a predictable schedule. The FAA should continue to monitor indicators of industry maturity, stability, and financial strength and alert the Congress when the landscape has evolved sufficiently to warrant changes.
- **Remove the \$1.5 billion (1988 dollars) cap on government indemnification.** Since the payment of a catastrophic claim is subject to the congressional appropriations process, a cap is unnecessary. The Congress has complete control over the size of any payment.

The Congress has a second option, which is to **phase-out** U.S. government risk-sharing. In this case, the following steps could be taken:²

- Direct the FAA to initiate a plan that gradually changes, and eventually reverses, responsibility for Tiers II and III. (Currently, the U.S. government is responsible for Tier II and the launch industry is responsible for Tiers I and III.) Modifications to Tier I maximum probable loss are not required.
- Upon expiration of the current indemnification statute, the FAA would initiate a requirement for industry to cover its Tier III risk exposure by creating a pool or trust. The government's Tier II commitment would remain unchanged initially. When the industry pool reaches a value of \$500 million, or after 5 years – whichever comes first – the government's Tier II commitment would be reduced to \$1 billion.
- When the pool reaches \$1 billion or 10 years, the government's Tier II commitment reduces to \$500 million.
- When the pool reaches \$1.5 billion or 15 years, the roles reverse. The industry pool (with a regulatory requirement to maintain a minimum value of \$1.5 billion) becomes Tier II. Government indemnification becomes Tier III, with no cap and no sunset provision, but retaining the requirement for an appropriations bill in the event of a claim.
- At this stage and at regular intervals thereafter, the FAA would assess the appropriate minimum required value of the industry pool, and recommend to Congress any changes in that requirement, if necessary.

If the Congress pursues this second option, there are several difficult issues that must be addressed:

² All dollar amounts in this description are in 1988 dollars to conform to the convention used in the CSLA Amendments. The conversion factor to 2006 dollars is approximately 1.71. In other words, \$1.5 billion in 1988 dollars is equivalent to slightly more than \$2.5 billion in 2006 dollars.

- Five years may not be a long enough interval between the stages described above. This pace would require industry to increase the pool's value an average of \$100 million per year (about \$171 million in 2006 dollars) to match the government indemnification withdrawn at each stage.
- Companies that leave the industry would rightfully expect their contributions to the pool, plus interest, to be returned. If the industry experiences high turnover during the process, this will hinder the effort to reach and maintain the pool's targets. This problem will be particularly troublesome if one or more of the larger players exits the commercial launch business.
- The U.S. commercial launch industry is diverse. Companies vary widely in size, financial resources, and experience. A determination would need to be made as to how these differences should be taken into account for the industry pool's contribution scheme. Should all companies contribute equally? Or should contributions vary based on a formula that accounts for financial resources, size of launch vehicles, frequency of launches, location of launch site, or other parameters? Would such a formula allow achievement of funding targets?
- A new requirement to make regular contributions to an industry pool may not, by itself, drive entrepreneurial launch providers out of the business, but it could become the proverbial "straw that breaks the camel's back." For small companies, the added cost and risk could discourage investors or become the tipping point for decisions about going offshore or going out of business. For large companies, management may seize on this issue in considerations of whether to stay in the commercial launch business.

These issues require further study and must consider the continuing evolution of the domestic launch industry and the global business environment.

1. Introduction

1.1 Purpose of the Study

The Commercial Space Launch Amendments Act of 2004 (Public Law 108-492) mandated a study of the U.S. government's risk sharing of third-party liability for commercial space launch providers licensed by the Federal Aviation Administration (FAA). This risk-sharing regime, as described in Title 49, section 70113 of the U.S. Code, was the subject of a previous congressionally directed report issued in April 2002 by the Department of Transportation (DOT) titled "Liability Risk-Sharing Regime for U.S. Commercial Space Transportation: Study and Analysis" (DOT/FAA 2002).³ The current study updates this report for congressional decision-makers who are considering the next steps beyond the current risk-sharing statute, which expires at the end of 2009.

Specifically, this report provides the following:

- An objective assessment of methods by which the current liability risk-sharing regime could be eliminated or modified, including alternative steps needed to maintain a viable and internationally competitive U.S. commercial space transportation industry.
- An evaluation of the direct and indirect impacts that elimination or modification of the regime would have on U.S. competitiveness in the world launch market, and on U.S. assured access to space.
- Examination of liability risk-sharing in other nations with commercial space launch capabilities, including comparisons to the current liability risk-sharing regime in the U.S.

1.2 Current Risk-Sharing Regime

Since November 1988, the U.S. liability risk-sharing regime for commercial space transportation has been comprised of three tiers:

Tier I: Maximum Probable Loss (MPL)-Based Financial Responsibility Requirements.

Third-party liability insurance requirements are set based on the FAA's determination of the MPL that would result from licensed launch or reentry activities. The insured parties must include the licensee, its customer, the U.S. government and its agencies, and the contractors and subcontractors. The insurance arrangement covers third parties, including government personnel, for injury, loss, or damage, up to a statutory ceiling of \$500 million or the maximum available on the world market at reasonable cost. (However, the government may pay claims from the first dollar of loss in the event of an insurance policy exclusion that is determined to be "usual.") Insurance against damage to U.S. government property is also required, with a statutory limit of \$100 million or the maximum available on the world market at reasonable cost. To date, the MPL insurance requirements specified by FAA for particular launch vehicles have been well within the statutory limits.⁴

³ The April 2002 study can be found at <http://ast.faa.gov/files/pdf/FAALiabilityRiskSharing4-02.pdf>.

⁴ With regard to the largest launchers: The Delta 4-M or M+ is required to carry flight insurance of \$261 million for third-party liability and \$37 million for government property damage. For the Atlas 5-521 configuration the respective requirements are \$193.5 million and \$100 million – the latter being equal to the statutory limit. Source: FAA Office of the Associate Administrator for Commercial Space Transportation, "Financial Responsibility Requirements as Determined by the Maximum Probable Loss (MPL) Process," October 20, 2004.

Launch participants also enter into no-fault, no subrogation reciprocal or cross-waivers of claims under which each participant accepts its own risk of property damage or loss and agrees to be responsible for injury, damage, or loss suffered by its employees.

Tier II: Catastrophic Loss Protection (Government Payment of Excess Claims, Known as “Indemnification”). The U.S. government may pay successful third-party liability claims in excess of required MPL-based insurance, up to an additional \$1.5 billion (adjusted for post-1988 inflation – approximately \$2 billion today). Such claims must be presented to the Congress by the President, upon the recommendation of the Secretary of Transportation, and the Congress must appropriate funds to pay the claim. For damage to government property, the U.S. government waives claims for property damage above the required insurance. However, the government does not indemnify a party's willful misconduct.

Tier III: Above MPL-Based Insurance plus Indemnification. If a claim exceeds the combined amount of the licensee's MPL insurance and the government's indemnification, financial responsibility remains with the licensee or legally liable party.

1.3 U.S. Treaty Obligation for Third-Party Liability

The Commercial Space Launch Act provisions for third-party liability indemnification do not limit U.S. government responsibility in the case of claims arising from damage to persons or property outside the United States. Such a case would be bound by the provisions of the Outer Space Treaty of 1967⁵ and the Liability Convention of 1972.⁶ Relevant language in the Outer Space Treaty is as follows:

Each State Party to the Treaty that launches or procures the launching of an object into outer space, including the moon and other celestial bodies, and each State Party from whose territory or facility an object is launched, is internationally liable for damage to another State Party to the Treaty or to its natural or juridical persons by such object or its component parts on the Earth, in air space or in outer space, including the moon and other celestial bodies. (Article VII)

The Liability Convention reinforces these points, assigning absolute liability for damages and requiring payment of compensation:

A launching State shall be absolutely liable to pay compensation for damage caused by its space object on the surface of the Earth or to aircraft in flight. (Article II)

Whenever two or more States jointly launch a space object, they shall be jointly and severally liable for any damage caused... A State from whose territory or facility a space object is launched shall be regarded as a participant in a joint launching. (Article V)

If a U.S. launch mishap resulted in damage internationally, and successful claims exceeded the MPL insurance requirement, the U.S. government would be obliged to settle the claim using mechanisms specified in the Liability Convention, which do not impose limits on such claims. The U.S. government could then attempt to recover the amount of its settlement from the participants in the launch campaign responsible for the damage.

⁵ Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and other Celestial Bodies (Outer Space Treaty, 1967).

⁶ Convention on International Liability for Damage Caused by Space Objects (Liability Convention, 1972).

The U.S. is also a signatory to the Registration Convention,⁷ which requires that objects launched into space be listed in a central registry maintained by the Secretary General of the United Nations. The registry is intended to be a means to identify space objects, in part to assist in liability claims.

1.4 Evolution of Third-Party Liability Coverage for Space Launch

1.4.1 Emergence of the U.S. Commercial Launch Industry

Prior to the 1980s, launch services were a government function. The government self-insured its property and assumed liability risk for itself and its contractors. Statutory authority for indemnification of private-sector contractors was provided to the Air Force⁸ and the National Aeronautics and Space Administration (NASA).⁹ Insurance available on the market at that time was costly and did not provide adequate coverage.

As the commercial space launch industry began to take shape in the early 1980s, established launch providers and entrepreneurs alike sought an environment that would allow them to conduct profitable business without undue regulatory burdens or financial risk. Industry representatives expressed the need for a liability risk-sharing arrangement similar to the traditional arrangement for government launches. Their primary competitor at the time, the European Arianespace consortium, modeled its risk-sharing scheme on the precedent set by NASA for commercial payloads on the space shuttle. NASA required shuttle payload customers to obtain the maximum liability insurance available at a reasonable premium, and NASA provided indemnification for any amount in excess of that coverage. Typically, \$500 million was required for a single payload, and multiple payload customers could combine their contributions to reach \$750 million in coverage.

The Reagan Administration set the stage for the emerging space launch industry in May 16, 1983 with National Security Decision Directive (NSDD-94), “Commercialization of Expendable Launch Vehicles” (ELVs). The policy endorsed commercialization and authorized commercial use of national launch ranges, but it also left the entire burden of liability to industry. Commercial launch operators were required to:

- provide adequate insurance to cover the loss of or damage to U.S. government-owned systems, equipment, facilities used by the private sector ELV operators;
- provide adequate insurance and agreements to indemnify and hold harmless the U.S. government against liabilities for damage to both domestic and foreign persons and property.

This liability risk responsibility was codified in the Commercial Space Launch Act (CSLA) of 1984.¹⁰ U.S. launch providers saw this level of risk as equivalent to “betting the company” on every launch. Regardless of the liability insurance requirement specified in their license by the DOT, they would ultimately be responsible for the maximum possible loss. In their view, adequate insurance coverage was not available to them, and even if it were, it would be prohibitively expensive. Meanwhile, foreign competitor Arianespace had put a cap on the liability insurance required of its customers, and had arranged for government indemnification of any claims above that cap. (Emerging foreign competitors, such as Russia and China, eventually did the same.)

⁷ Convention on Registration of Objects Launched into Outer Space (Registration Convention, 1975).

⁸ Public Law 85-804.

⁹ Section 308 of the National Aeronautics and Space Act of 1958, as amended.

¹⁰ Public Law 98-575.

Timeline: Policy and Legislation on Commercial Space Transportation

November 1983: President designates the Department of Transportation (DOT) as the federal government's lead agency for commercial launch activities.

February 1984: Executive Order 12465 directs DOT to act as focal point within the federal government for private sector launch contacts and to facilitate for commercial launch operators the process of identifying and satisfying the related requirements and regulations of other federal agencies concerning commercial space activities.

October 1984: Commercial Space Launch Act (P.L. 98-575) expresses congressional support for the commercial expendable launch vehicle (ELV) industry and gives Congress a direct role in the formulation and implementation of a commercial ELV policy and regulatory regime. The Secretary of DOT, in consultation with other appropriate agencies, is directed to establish insurance requirements as a condition of the ELV license it issues to commercial ELV operators to protect against risk to U.S. government property and against damages to third parties that might occur from commercial launches; the requirements must be consistent with existing tort law and with the international obligations of the U.S. including the Convention on International Liability for Damages Caused by Space Objects in Outer Space (in which the U.S. is held strictly responsible for any damage caused by a launch from the U.S.). No provision is included for government indemnification.

Early to mid-1980s: ELV services and operations are largely a government-sponsored activity. The National Aeronautics and Space Administration (NASA) launched commercial satellites either on the shuttle or on ELVs; the government required the maximum amount of third-party liability insurance available at a "reasonable" cost from the owners of the payloads and provided indemnification for losses above those requirements. (The U.S. government had not required any first-party property insurance since the government – primarily NASA or the Air Force – was conducting all of the launch operations.)

Principal non-U.S. ELV supplier is Europe's Ariane; export controls limit use of China's Long March; prohibitions preclude U.S. use of the Soviet Union's Proton. Foreign governments' support of national launch systems includes preferential tax treatment, below-market interest rates on the financing of vehicle production or launch activities, and charging less than full-cost or not at all for insurance.

December 1986: National Security Decision Directive 254 states that NASA will no longer provide launch services for commercial and foreign payloads unless they have unique, specific reasons for being launched aboard the shuttle.

November 1988: Commercial Space Launch Act Amendments (P.L. 100-657) establishes liability and insurance regime including provision for U.S. government indemnification until December 1993.

1989: First DOT-licensed commercial space launch.

November 1992: NASA Authorization Act for Fiscal Year 1993 extends the five-year sunset provision for indemnification from December 1993 through December 1999.

October 1998: The Commercial Space Act of 1998 (P.L. 105-303) extends the Secretary of Transportation's licensing authority to reentry vehicles and operation of reentry sites by non-federal entities; also extends requirements and provisions of the financial responsibility and risk-sharing regime to operators of reentry vehicles.

April 1999: The Departments of Veterans Affairs and Housing and Urban Development and Independent Agencies Appropriations Act of 2000 extends indemnification just one year, until December 2000. The next year, the Commercial Space Transportation Competitiveness Act of 2000 extended indemnification to December 2004.

December 2004: Commercial Space Launch Amendments Act of 2004 (P.L. 108-492) extends liability and insurance regime until 2009 and requests an independent comprehensive study of the regime.

Sources: Senate Report 100-583, 6 October 1988, 100th Congress 2nd Session, "Commercial Space Launch Amendments Act of 1988;" Senate Report 106-135, 4 August 1999, 106th Congress, 1st Session "Commercial Space Launch Industry Indemnification Extension;" U.S. Congress, Office of Technology Assessment, *Launch Options for the Future, Special Report*, OTA-ISC-383, Washington, DC, July 1988; U.S. Congressional Budget Office, *Setting Space Transportation Policy for the 1990s: A Special Study*, October 1986; DOT/FAA 2002 (Chapter 3), and Office of Commercial Space Transportation, Federal Aviation Administration.

The situation remained this way for four years, slowing the development of the U.S. commercial launch industry. The U.S. Air Force Model Expendable Launch Vehicle Commercialization Agreement issued in January 1988 did not alleviate the liability risk concerns, since it continued the practice of placing the full burden on the commercial launch provider. By this time, Arianespace had gained a dominant market share, especially after the failures of the space shuttle and other U.S. launch vehicles in the mid-1980s.

1.4.2 Amending the CSLA

Uncomfortable with the uneven playing field in the global launch market and eager to reduce risk exposure, the U.S. launch industry sought relief and found it in the CSLA Amendments of 1988.¹¹ The solution was less comprehensive than the industry desired, since it included a cap on government indemnification and a requirement to fund liability claims through the congressional appropriations process, but it was welcomed nonetheless. In the months that followed, the Air Force modified its model launch agreement to reflect the new law.

The 1988 Amendments also codified the standard practice in which participants in a launch campaign enter into cross-waivers of claims against each other. The cross-waivers relieve participants from the need to buy liability insurance to protect against claims for damage to each other's property, which would place additional burden on the insurance market and drive up costs for payload customers.

When the 1988 Amendments were being formulated in Congress, the House Committee on Science, Space, and Technology expressed the view that

... the government must play an active role in bringing about a commercial launch industry as a partner with the U.S. launch industry. This partnership role is fully justified in view of clearly established government obligations and responsibilities... The Committee views this [third-party liability] risk burden on the emerging commercial launch industry as an intolerable risk that poses a major threat to the emergence of an internationally competitive launch industry. The absence of any government role in sharing this risk is also inconsistent with recent government policies to foster the U.S. industry...¹²

As a result, the House did not propose a cap on government indemnification, nor did it include a sunset provision in its version of the bill. The only indication that the Committee may have seen indemnification as a temporary commitment is this sentence in its report on the bill:

The Committee fully anticipates that the increased planned activities of the U.S. commercial launch industry will mobilize required insurance to fully cover launch activities.

The Senate Commerce, Science, and Transportation Committee concurred with its House counterpart on the importance of encouraging the U.S. commercial launch industry. The Senate Committee also agreed with the need for

... an adequate risk-sharing arrangement between industry and Government to enable the emerging launch industry to compete on a more equal footing with foreign launch concerns... Some limitations on the amount of liability insurance required must be

¹¹ Public Law 100-657.

¹² House Report 100-639 on H.R. 4399, Commercial Space Launch Act Amendments of 1988, May 19, 1988.

*established if a domestic commercial industry is to establish itself in the world. No other competing launch organization bears the costs and risks of unlimited liability.*¹³

However, the Committee clearly did not envision an unlimited duration for indemnification. Under the Senate bill, risk sharing would end after 10 years (later changed to a five-year sunset provision), after which “the ELV [expendable launch vehicle] industry will be dependent upon existing insurance capacity in the marketplace. Therefore, it is in the best interests of the industry to work to increase total insurance capacity over the life of this legislation.” The Committee’s rationale for the 10-year limitation was that it is

... necessary to ensure that this risk to the Government is restricted. This is both a protection of the public treasury and a means to foster and enhance the growth of private insurance markets over the life of this legislation.

The Senate Committee expected the Secretary of Transportation to use the launch license review process to monitor and encourage the growth of private liability insurance markets to meet the future needs of the commercial launch industry. The Committee anticipated that in a decade, private insurance markets would provide full liability coverage, not just for U.S. commercial launchers, but for all commercial launch providers around the world, thus leveling the playing field for this aspect of the business.

Nearly two decades later, private insurance markets still have not achieved this goal. Worldwide, launch providers share the same insurance pool that the aviation industry uses for third-party liability coverage. Launch liability capacity remains fragile and far below what would be needed to replace government indemnification. Foreign competition has increased, and all credible competitors have risk-sharing schemes rivaling or surpassing that of the U.S. In other words, government indemnification regimes, rather than private insurance markets, have become the levelers of the playing field.

1.4.3 Industry View of U.S. Government Risk-Sharing

To properly assess industry’s position on third-party liability indemnification, it is important to consider an underlying assumption about the policy’s original rationale: Was the indemnification regime intended to provide temporary assistance to a nascent industry to help it get established? Or was it intended to be a permanent fixture in the business environment to give ongoing support to an inherently hazardous activity having economic value to the nation?

The U.S. launch industry believes that the “nascent industry” rationale is incorrect – the indemnification regime was not created with the notion that the industry would outgrow the need for it. As mentioned earlier, launch providers had established a procedure for accommodating third-party liability during their years of exclusively serving government launch customers. In the 1980s, they made the case that a similar arrangement would be needed to manage catastrophic risk in the new era of commercial launch services. The industry sees the indemnification regime as a key part of a system for managing everyone’s risk through a combination of insurance requirements that cover the launch provider, the payload owner, and the government; indemnification for catastrophic claims; and cross-waivers of liability for all participants in the launch campaign. As one respondent noted, space launch will always be a hazardous activity, and unbounded liability is a non-starter for businesses.

In contrast to the industry position, some policy-makers and analysts believe that government indemnification was intended as temporary help for the emerging launch industry. In this view, the

¹³ Senate Report 100-593 on H.R. 4399, Commercial Space Launch Act Amendments of 1988, October 7, 1988.

regime was initiated because the space insurance market of the late-1980s was not up to the task of adequately covering third-party liability at a reasonable price, but was expected to eventually take over full responsibility as the insurance pool became more robust. As a result, the statutory language establishing the indemnification regime included a sunset provision to ensure periodic reconsideration of the continuing need for government risk-sharing.

Clearly, at the inception of the indemnification regime there were differences between industry and policy-maker (particularly Senate committee) perceptions of the problem and its long-term resolution. These differing viewpoints persist today. A number of lawmakers see indemnification as an unnecessary subsidy to the launch industry, particularly its largest corporations. Industry representatives note that no federal funds, tax breaks, or other financial favors have been granted to them under the indemnification regime thus far, so it can hardly be considered a subsidy. They see it as an appropriate government role to share catastrophic risk (as in the nuclear power industry and flood insurance) and to level the international playing field.

Whatever their view on the original justification for indemnification, some analysts and space insurers point out that the context has changed since the risk-sharing regime began in 1988. The insurers have gained experience, but the market remains fragile. Foreign competition has increased, and competitors' governments are providing third-party indemnification as good as or better than that provided by the U.S. There is broad agreement among launch providers and payload customers that government risk-sharing for third-party liability has become an industry standard.

1.5 Identifying Policy Objectives

Determination of a course of action hinges on the establishment and prioritization of policy goals. Revision, or elimination of government indemnification for third-party liability could have potentially adverse consequences for the U.S. commercial launch industry and for national interests. Current national policy on space transportation¹⁴ states the following goal:

Encourage and facilitate the U.S. commercial space transportation industry to enhance the achievement of national security and civil space transportation objectives, benefit the U.S. economy, and increase the industry's international competitiveness.

This goal mirrors previous national policy statements.¹⁵ Toward that end, U.S. government departments and agencies shall:

Maintain, subject to periodic review and the competitiveness of U.S. industry, the liability risk sharing regime for U.S. commercial space transportation activities set forth in the Commercial Space Launch Act, as amended (49 USC, Subtitle IX, Chapter 701), including provisions for indemnification by the United States Government.

The inclusion of this statement in the national space transportation policy indicates that the current risk-sharing regime is viewed as contributing to national objectives, the economy, and U.S. competitiveness. It also recognizes the need for periodic review.

¹⁴ National Security Presidential Directive 40, "U.S. Space Transportation Policy," December 21, 2004.

¹⁵ Presidential Decision Directive 4, "National Space Transportation Policy," August 5, 1994; White House Fact Sheet, "Commercial Space Launch Policy," September 5, 1990; National Security Decision Directive 94, "Commercialization of Expendable Launch Vehicles," May 16, 1983.

For the past two decades, the White House and Congress have been in close agreement on this issue. When the House Committee on Science, Space, and Technology amended the Commercial Space Launch Act in 1988, the stated rationale for doing so was as follows:

- (1) a United States commercial space launch industry is an essential component of national efforts to assure access to space for government and commercial users;
- (2) the Federal Government should encourage, facilitate, and promote the use of the United States commercial space launch industry in order to continue United States aerospace preeminence;
- (3) the United States commercial space launch industry must be competitive in the international marketplace;
- (4) Federal Government policies should recognize the responsibility of the United States under international treaty for activities conducted by United States citizens in space; and
- (5) the United States must maintain a competitive edge in international commercial space transportation by ensuring continued research and development in launch vehicle component technology.¹⁶

The CSLA, which the Congress revisited in 2004, includes the following among its findings:

- The development of commercial launch vehicles, reentry vehicles, and associated services would enable the United States to retain its competitive position internationally, contributing to the national interest and economic well-being of the United States.
- Providing launch services and reentry services by the private sector is consistent with the national security and foreign policy interests of the United States.
- The United States should encourage private sector launches, reentries, and associated services.
- Space transportation ... is an important element of the transportation system of the United States, and in connection with the commerce of the United States there is a need to develop a strong space transportation infrastructure with significant private sector involvement.¹⁷

From this current and historical evidence, it is clear that the executive and legislative branches have consistently viewed the success of the U.S. commercial launch industry as beneficial to national interests. This view of the industry presumably will continue for the foreseeable future, and may strengthen as the industry develops new markets (such as space tourism), becomes a key player in NASA's space exploration efforts, faces increasing competition from overseas, and wrestles with industrial base issues that affect government space programs across the board.

This study is intended to assist policy-makers as they judge which course of action better serves the national interest:

Maintenance of a policy/legal environment favoring the U.S. commercial space launch industry through government sharing of low-probability but potentially high-consequence third-party liability risk.

or

Phase-out of U.S. government (taxpayer) risk exposure for this hazardous private-sector activity.

This choice is the first step Congress must take to settle the indemnification issue. Each course of action brings with it a different set of implementation requirements and consequences. This study is designed to

¹⁶ House Report 100-639 on H.R. 4399, Commercial Space Launch Act Amendments of 1988, May 19, 1988.

¹⁷ 49 USC §70101(a)(5)-(8).

assist the Congress in determining which course of action best satisfies the following policy objectives, which collectively support the national interest in this area:

- Assure adequate liability coverage for catastrophic launch-related events.
- Minimize U.S. government (taxpayer) risk exposure and annual outlays/subsidies.
- Improve economic benefits and strengthen the U.S. industrial base in space launch capabilities by:
 - Enhancing international competitiveness of the U.S. space transportation industry.
 - Maintaining continuity in the business environment for U.S. launch providers.
 - Encouraging new U.S. entrants to the commercial launch market.

* * *

Chapter 2 analyzes the current competitive environment and discusses U.S. government experience in risk sharing with other industries. Chapter 3 assesses options for eliminating the current indemnification regime, summarizes the views of industry, and discusses possible consequences of elimination. Chapter 4 presents the results of a survey on the current status and plans for government indemnification in other spacefaring nations. Chapter 5 presents analysis of the policy implications of the two courses of action identified above.

2. The Current Market and U.S. Government Risk-Sharing

The success of the U.S. commercial launch industry in delivering a host of new and expanded voice, video, navigation, and Earth observation services in the past two decades reflects in part the heritage of supportive U.S. national public policy. Beginning with the 1983 designation of the Department of Transportation as the federal government's lead agency for commercial space transportation, subsequent policy initiatives have sought to assist and nurture the industry in its evolution from government domination to commercial orientation.

Advocates of the indemnification provisions of the CSLA amendments argue that risk sharing has been and will continue to be an essential component of effective U.S. policy and that in their absence, the competitiveness of U.S. commercial launch services would be severely undermined. Another school of thought takes the opposite view, finding inadequate justification for continuing indemnification for a number of reasons and in some cases, expressing strong reluctance about government involvement in a commercial industry.

This chapter first presents the arguments on both sides, then discusses the data and analyses that are available to quantify the role of indemnification in supporting the industry as well as the policy objectives in the 1988 CSLA amendments. The analysis finds that publicly available quantitative data provides no direct evidence that indemnification is essential for competitiveness or that it otherwise accomplishes policy goals. Much of the information that could best inform this study is held as proprietary by industry. Even so, there are possibly compelling arguments for maintaining at least some degree of indemnification or, if eliminating it, doing so only gradually. Discussion of these findings paves the way for the options presented in the next chapter.

2.1 A Mature Industry?

By including the sunset provision, the original legislative intent of government risk-sharing clearly expected eventual elimination of indemnification. The record of debate shows nearly unanimous concern about the need to nurture a "nascent" commercial space transportation industry. The sunset provision was a compromise, however, as it was marked by sharp disagreement among the Senate, the House of Representatives, and the Reagan Administration.

The Senate had proposed a sunset to take place ten years after passage of the amendments. Expectations were that after ten years, (1) the fledgling launch industry would have gone through a "full cycle" of customer service (from taking a launch request of a payload owner/operator, to preparing the launch vehicle and integrating the payload, to scheduling and conducting the launch) and (2) the insurance industry would be able to provide coverage.

Discussion in the House was largely silent on any sunset provision, and its version of the amendments made no provision for elimination of the indemnification policy. At the other extreme, the Reagan Administration generally opposed *any* role for government in commercial space launch insurance, envisioning a fully private sector launch industry with little government intervention. In addition, the late 1980s were a time of large cyclical disruption in most major property and casualty insurance markets and the Administration was arguing for major tort reform throughout the entire insurance industry.

As a compromise, the final version of the amendments provided a five-year sunset provision. Indemnification would be available only for launches conducted pursuant to an application submitted to the Department of Transportation by the end of 1993. As noted previously, Congress has since extended indemnification four times.

Has a mature industry evolved along with the extensions of the risk-sharing regime? By all generally accepted measures of industry maturity, the conventional U.S. ELV industry is fully mature. The industry completed 161 successful launches by mid-2006.¹⁸ Also indicative of maturity, the industry has engaged in R&D on modifications to the existing fleet and the addition of new vehicles. These efforts have led to a new generation of expendable vehicles (modified versions of Delta and Atlas; Pegasus, Taurus, Athena, Falcon) and new practices such as sea-based (Sea Launch) and air-launched (Pegasus-type) approaches.

Another maturity measure is industry growth, acquisition, and reorganization. The launch industry has seen entry of newcomers (Orbital Sciences, SpaceX), consolidation among incumbent suppliers (for example, McDonnell Douglas and Boeing), and partnerships such as International Launch Services¹⁹ and Sea Launch.²⁰ Recently, companies have created partnerships to provide “integrated schedule assurance,” by which customers can turn to another company’s (as well as country’s) vehicle in the event of a problem with the original vehicle.²¹ In 1996, the FAA granted the first license for spaceport operation (to California Spaceport) and has since issued five more licenses for launch site operators (in Florida, Virginia, Alaska, Oklahoma, and Mojave Airport, California). These are measures of a mature industry; hence at least one of the concerns expressed by the Congress in 1988 has been satisfied.

2.2 International Competitiveness

During nearly two decades of deliberations on extension, it can be argued that public debate has come to confuse the maturity of an industry with its competitive or financial success. To be sure, both characteristics were important to policymakers in 1988. In fact, a statutory objective of the CSLA is that “the United States commercial space launch industry must be competitive in the international marketplace.” But a public policy dilemma often arises when an industry evolves to maturity but then struggles competitively and financially, particularly in international markets (the situations of the steel, auto, and electronics industries are examples). At that point, the role for government intervention typically becomes particularly contentious. The distinction is important because the appropriate public policy for maturity may differ markedly from the appropriate policy for competitive or financial success.

The space transportation industry representatives interviewed for this report are adamant that indemnification is essential for their international competitiveness (their comments are reported in Chapter 3). International competitiveness can be measured to some extent, but identifying the contribution of indemnification is impossible to discern in the absence of good data. The publicly available data show that U.S. companies have a very small share of the commercial market, but the role indemnification may play in improving this situation cannot be conclusively demonstrated. For this reason, if the goal of maintaining or increasing market share in the international commercial market is a desired policy objective, then other steps (such as price supports) may be necessary. This course of action is not addressed by this report, but the point is relevant to this policy debate.

¹⁸ Department of Transportation, FAA/AST, “Historical Launch Activity” at http://ast.faa.gov/info_vs/site/historical_la.cfm (accessed July 2006). An additional 17 launches were attempted but unsuccessful for a variety of reasons.

¹⁹ Lockheed Martin (50%) and Khrunichev State Research & Production Space Center of Russia (50%).

²⁰ Boeing (40%), RSC-Energia of Russia (25%), Kvaerner ASA of Norway (20%), SDO Yuzhnoye/PO Yuzhmash of Ukraine (15%).

²¹ If Sea Launch encounters a problem and is unable to launch a payload, the customer can turn to the Ariane 5, Zenit 3SL, and H-IIA launch vehicles under the Launch Service Alliance formed by Arianespace, Boeing Launch Services, and Mitsubishi Heavy Industries. International Launch Services offers customers Altas or Proton vehicles as back-up. (2006 Forecast, p. 23).

2.2.1 Measuring Competitiveness

There are two sources of competition in commercial markets: competition among existing companies and the competitive threat posed by potential new companies (this mere “threat” can serve to keep prices low). Analytically, the data which demonstrate competitiveness are market shares, which reflect a mix of both quantity and price – that is, number of launches and the revenue they bring in. The most effective ways to gain market share in a competitive market are to lower prices or to offer a unique product that is in high demand.

Unfortunately, price (revenue) information for commercial launches is not publicly available. The FAA reports prices for commercial launches but emphasizes that these are at best a rough approximation, stating in footnotes to its *Quarterly Launch Reports* that price data “vary for each commercial launch.” Reported prices are widely known to be highly imprecise for several reasons. A contracted price may differ from the reported price because it includes individually negotiated customer concessions, differences in launch facility pricing policies, and a host of other factors. One of the concerns emphasized by U.S. industry in commenting on the need for continued indemnification is the price concessions that U.S. companies must continue to make to attract customers. The trade press reports that launch providers are offering prices that are so greatly reduced that vehicles are marketed at a loss.²² The difficulty in evaluating this argument is that the nature and size of these concessions is not public record. The FAA data show no price trends, either up or down, even with the market entry of foreign vehicles during the last decades. *Reported* launch prices have remained roughly unchanged during this period.

The data problem is not unique, however, and the federal government endorses alternative methods for assessing competition. Industries are typically reluctant to report price information, and the launch industry is no exception. A proxy measure, the H index, has come to be routinely used by the U.S. Department of Justice and other analysts as an indication of competitiveness. (The index is named for its developers, O.C. Herfindahl and A.O. Hirschman). The index is not a perfect measure of competition (and economists and other analysts have long expressed concern about its biases and interpretation) but does shed some light on the degree to which existing companies face and meet competition. The index uses a weighted average of market shares and indirectly measures companies’ ability to exercise power by setting prices above the prices that would prevail in a competitive market.

The H index combines data about the number of existing companies and the size of their share of the market.²³ Because a market could have many companies but one or a few companies may dominate, the formula of the index attempts to combine these data in a statistically acceptable way. An index close to zero indicates a competitive market – no company’s market share is very large. As the index approaches 1, a single entity dominates the market. If the market has just one seller, the index is at its maximum value of 1 – that seller is a monopolist. The index declines with an increasing number of companies.

The H index calculated for the share of the market represented by the commercial launching states of the U.S., Russia, Europe, and China is one guide for observing the extent of competition faced by U.S. companies. Data on the number of launches by launch vehicle and launch revenue are available for 1989-1998 from Isakowitz (1999) and for 1999-2004 from FAA/AST.²⁴ As both of these data sources

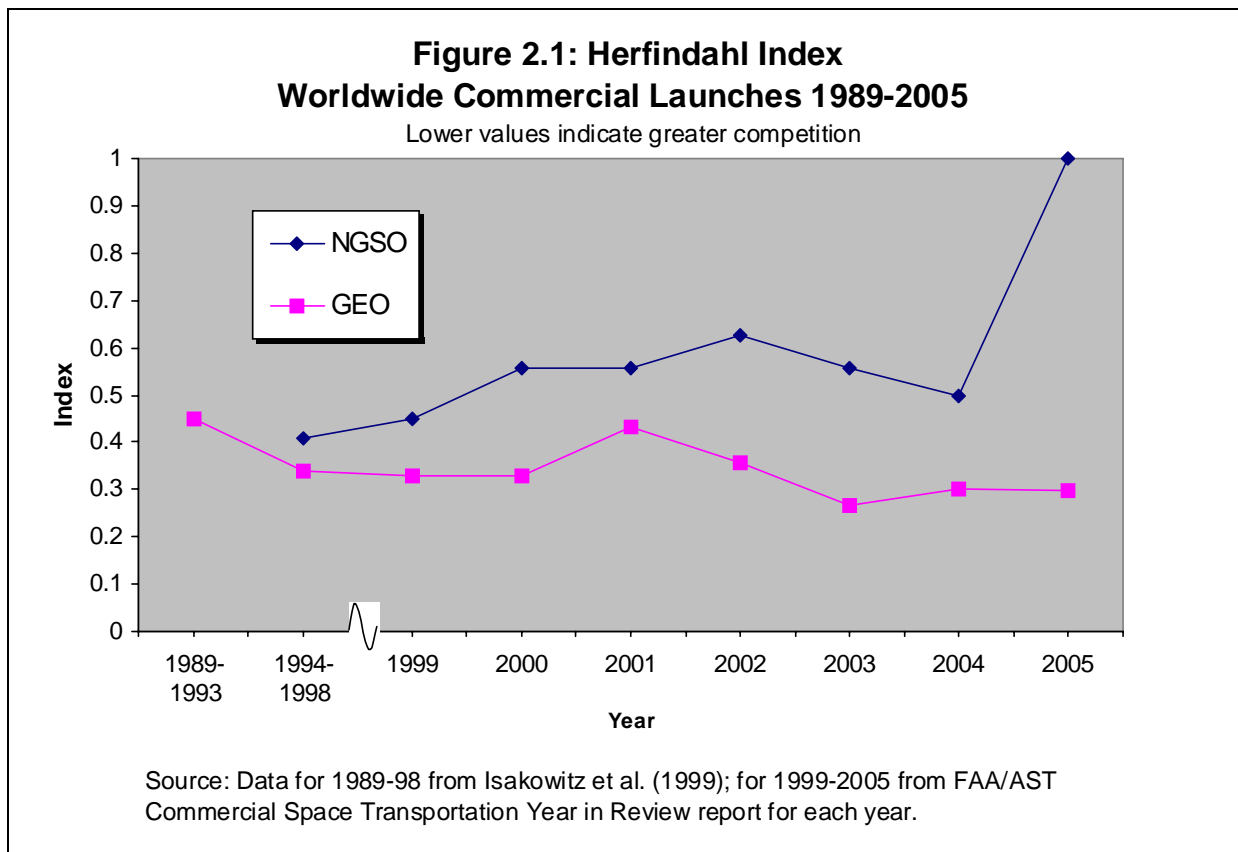
²² John Edwards, “ELV Market on the Up,” *Aviation Week and Space Technology 2005 Aerospace Source Book* (McGraw Hill), January 17, 2005, 135-136.

²³ The index is defined as $H = (s_1)^2 + (s_2)^2 + \dots + (s_n)^2$ where s is a firm’s percentage of total sales (market share) and n is the number of firms.

²⁴ Steven J. Isakowitz, Joseph P. Hopkins Jr., and Joshua B. Hopkins, *International Reference Guide to Space Launch Systems* (Reston, VA: American Institute of Aeronautics and Astronautics), 1999; Federal Aviation

emphasize, revenue information is approximate because of the poor quality of price data. Following FAA/AST practice, launches of Sea Launch are treated separately as “multinational launches” rather than classifying them as launches by one country. (If launches by Sea Launch are classified as U.S. launches, or if a “fraction” of a Sea Launch is so classified, to reflect the U.S. ownership share, the H values for the launch market are larger, reflecting the relatively large share of the market increasingly represented by Sea Launch.)

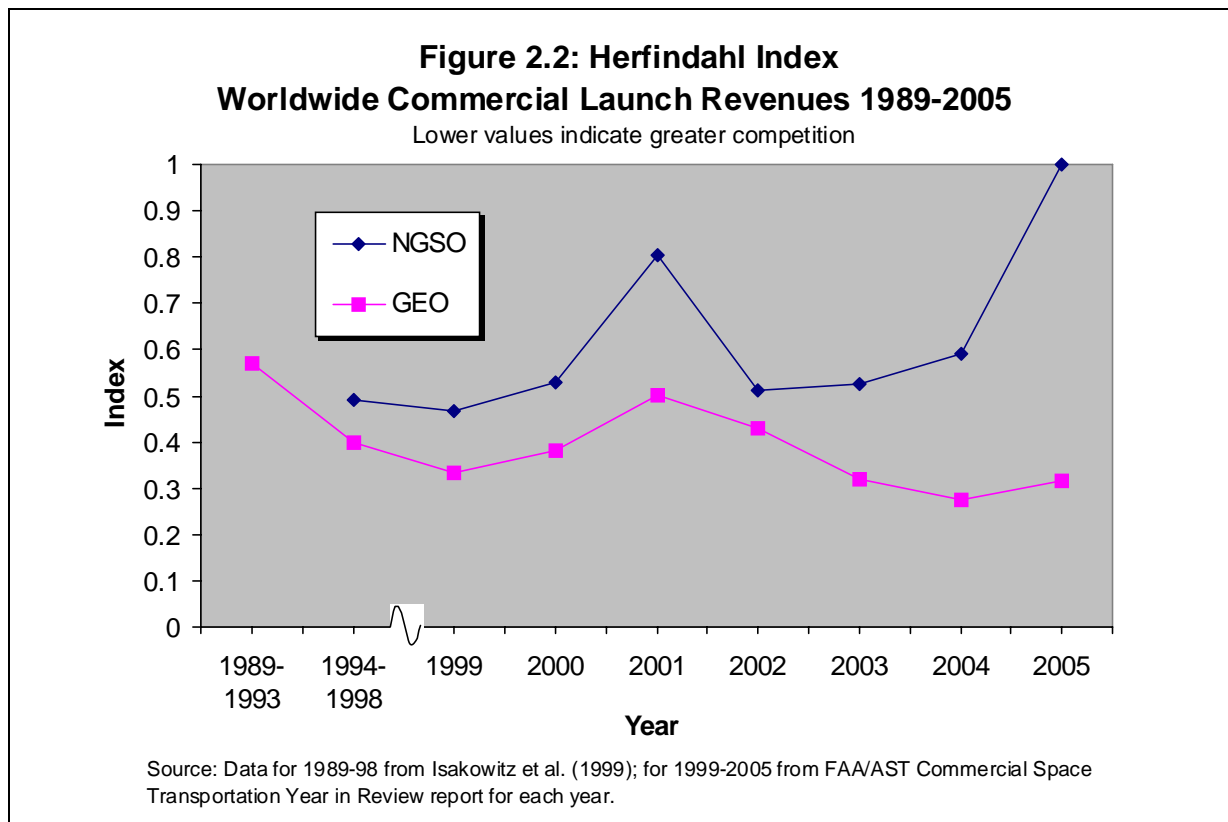
The usefulness of reviewing both number of launches and launch revenue is that launch *quantities* are often referenced in public debate about competitiveness, but launch *revenues* more directly impact the bottom line. For example, a more competitive market in terms of shares of launches could mean that each individual company supplies fewer launches. A less competitive market in terms of revenue may mean that a few companies supply a few expensive launches, taking larger revenue shares and causing competition in terms of revenue to fall.



Figures 2.1 and 2.2 show the H indices for worldwide number of commercial launches and launch revenues for non-geostationary Earth orbit (NGSO) and geostationary Earth orbit (GEO) launch markets from the 1980s to the present. By measures of both launches and revenues, the GEO market has become more competitive over time.

Administration, Administrator for Commercial Space Transportation, *Year in Review*, each year, 1999 – 2004. Because the earlier data are collected by slightly different collection methods, data for 1989 – 1998 are represented as two five-year averages (1989-1993 and 1994-1998).

The NGSO market has been consistently more concentrated than the GEO market and, in terms of launches, has become less competitive over time.²⁵ In 2005, this market was completely supplied by Russia. FAA projections for 2006 also show that the NGSO commercial market will be completely supplied by Russia.²⁶



The potential and actual market entry of new launch vehicles and suppliers is another source of market competitiveness. The history of the commercial launch industry reflects competition from additional foreign vehicles (new versions of existing vehicles or altogether new vehicles, such as India's Geosynchronous Satellite Launch Vehicle) as well as new launch practices that reconfigure existing technology (for instance, Sea Launch). In figures 2.1 and 2.2, the increase in GEO competition (lower H values) beginning in 2001 are due to the relatively large number of launches by Sea Launch.

Figures 2.3 and 2.4 disaggregate the data underlying the H-index. These figures show launches and revenues by country during 1998-2005 for both NGSO and GEO. The absolute size of market shares based on number of launches have been largest for the U.S. in two years (2001, 2002); for Europe in two years (2000, 2005); and for Russia in two years (1998, 2004). Market shares in terms of revenue have been dominated by Europe during 1999 to 2003 and again in 2005. The U.S. share has been on par with or exceeded Russia's share in recent years (2001-2004) but dipped in 2005.

²⁵ The H indices in DOT/FAA 2002 were calculated as five-year averages for 1989 to 2001 and showed increasing competition in both LEO and GEO markets. The indices above if calculated as five-year averages are consistent with this trend towards increasing competition.

²⁶ FAA/AST, *Quarterly Launch Report: 2nd Quarter 2006* (includes 2006 forecasts; no commercial NGSO launches occurred during the first quarter 2006).

The position of U.S. industry in the global market appears markedly different depending on whether Sea Launch is considered a U.S. company. The FAA designates Sea Launch as “multinational” (as represented in Figures 2.3 and 2.4). Since Sea Launch is 40% U.S. owned and operates under a U.S. launch license, it can also be viewed at least in part as included in the U.S. market. Inclusion of Sea Launch flights strengthens the U.S. position markedly on the bases of launches and revenue, although how to statistically represent the contribution is unclear. In any case, with the significant exception of Sea Launch, the general trend since the late 1990s in both number of launches and revenue is downward for U.S. firms..

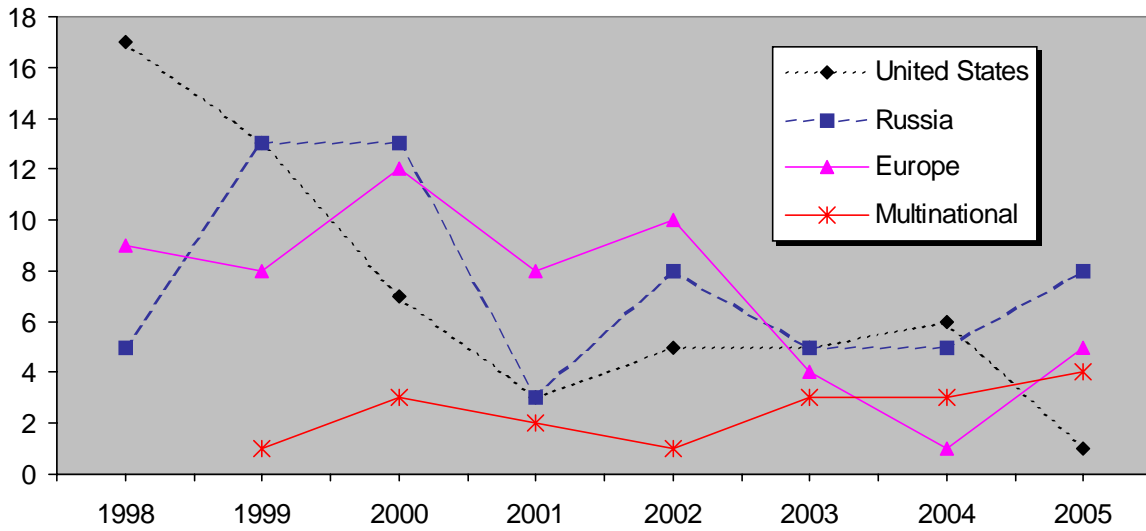
Preliminary data²⁷ not shown in the figures offer some outlook for the near term and farther into the next decade:

- For the first half of 2006, a total of eight commercial GEO launches and four commercial NGSO launches took place. Two of the GEO launches were U.S. commercial launches (with one involving a U.S. government payload, GOES N). There were also three launches by Sea Launch. The remaining launches were by Russia and India.
- For the third quarter 2006, projections show six commercial GEO and two commercial NGSO launches, with none of these by U.S. launch companies. Two of the projected launches are expected to be Sea Launch.
- For 2007, projections are for 20 GEO and 14 NGSO commercial launches. Of these, two GEO and two NGSO launches are expected to be by U.S. companies. Nine are anticipated to be Sea Launch and Land Launch, the land-based version of the Boeing-Ukraine-Russia-Norway joint venture. The source of these projections acknowledges a “realization factor” by which only some 60% to 80% of projected launches actually take place in the year anticipated. On this basis, the GEO and NGSO launch forecasts may actually represent 12 to 16 GEO and 8 to 11 NGSO launches for 2007 (the distribution of potentially realized launches among Sea Launch, Land Launch, and other vehicles is not reported).
- Through 2017, the FAA/AST COMSTAC report projects total annual launch demand, although not on a per-country or per-vehicle basis. Total annual forecasted demand averages about 16 GEO launches (10 to 13 launches per year on a realized basis) and about seven NGSO launches (four to six launches per year, realized). The projections show a decline of about 20% in GEO demand during 2008-2011 and then an increase to 2006 levels, and a 30% decline in NGSO demand beginning in 2008.

By way of summary of the quantitative evidence on competitiveness, the worldwide launch market since 1998 has become slightly more competitive for GEO and markedly less competitive for NGSO. **U.S. companies are not “holding their own” in the market. If future projections are correct, the near-term relative U.S. performance in the GEO commercial market (with the exception of Sea Launch/Land Launch) worsens on the basis of number of launches. Data on forecasted revenue are unavailable, but the worldwide launch forecast does nothing to suggest reasons for a resurgence of U.S. performance.**

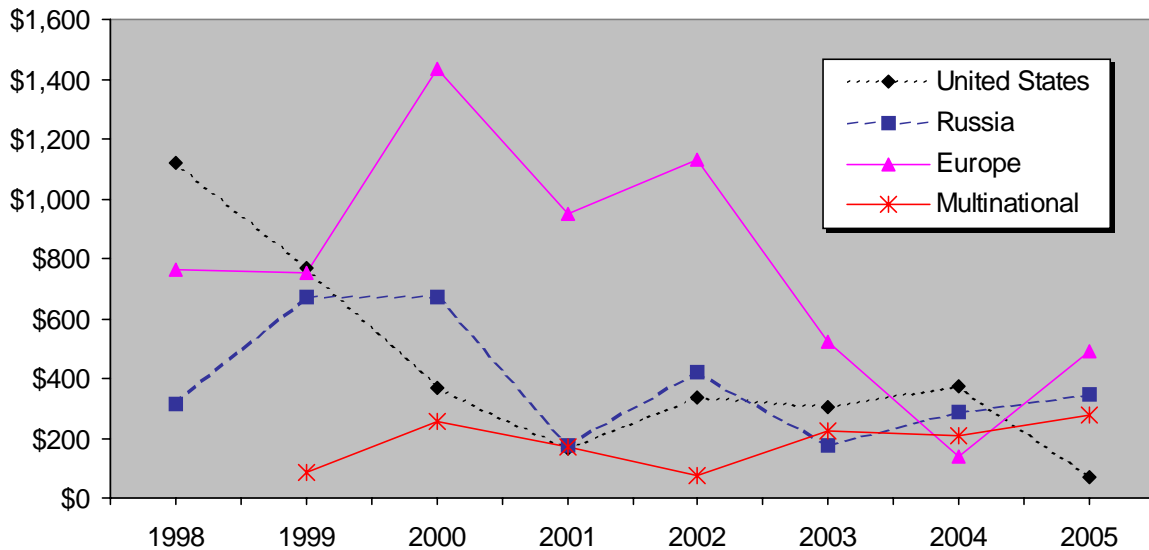
²⁷ FAA/AST, *2nd Quarter 2006 Launch Report*; FAA/AST Commercial Space Transportation Advisory Committee (COMSTAC), *2006 Commercial Space Transportation Forecasts*, May 2006; *Jonathan’s Space Report*, <http://www.planet4589.org> (accessed July 2006).

Figure 2.3: Commercial Launch Events by Country 1998-2005



Source: FAA/AST Commercial Space Transportation Year In Review reports for 1998-2005, tables on Worldwide Orbital Launch Events. Launches by China in 1998-99 and Ukraine in 1998 not shown.

Figure 2.4: Launch Revenues for Commercial Launch Events by Country 1998-2005 (approximate in \$U.S. millions)



Source: FAA/AST Commercial Space Transportation Year In Review reports 1998-2005, tables on Launch Revenues for Commercial Launch Events. Revenue from launches by China in 1998-99 and Ukraine in 1998 not shown.

2.2.2 Is Competitiveness an Appropriate Measure?

The statutory language in the 1988 CSLA refers to competitiveness but the public policies enacted since then have not allowed competitive market forces to operate. (The same is less true of the newly emerging RLV market, however – more on this below). Moreover, various policies and practices on the part of all launching countries have sheltered their domestic launch companies, protecting them from market forces. A recent report by the Congressional Research Service (CRS)²⁸ describes these and other practices in detail. They include:

- **Launch quotas.** In the decade following the 1988 CSLA Amendments, the U.S. negotiated bilateral trade agreements with China, Russia, and Ukraine on “rules of the road” (including launch quotas) for participating in the market to ensure that these countries did not offer unfair competition because of their non-market economies. Although the quotas on foreign launches expired in 2000 (Russia, Ukraine) and 2001 (China), their strictness provided shelter to the U.S. commercial launch industry in its early years and partly explains the trends in launch market shares discussed earlier.
- **Buy domestic.** Government policies induce payload owners to “buy domestic.” For example, member governments of the European Space Agency (ESA) had long agreed to pay a surcharge of as much as 15-20% to use Ariane in order to financially support Arianespace. The surcharge led some governments to buy from U.S. suppliers; the surcharge was reduced in 1995. Pressure to buy domestic, along with proximity to the launch site and ease of doing business in a home country, can also influence the choice of launch vehicle. For instance, in 2003, ESA agreed to a European Guaranteed Access to Space (EGAS) program that would provide 960 million euros for Arianespace to return the larger Ariane 5 to flight and procure the vehicles through 2009. More recently, European ministers reaffirmed that ESA should give preference to European vehicles to prevent them from being undermined by lower-cost alternatives.²⁹
- **Export controls.** Satellites made by U.S. companies or containing U.S. components require export licenses. The U.S. will currently not issue export licenses for satellites or components for Chinese launches; accordingly, the Chinese commercial launch program will seek customers whose payloads incorporate substitutes for U.S. components until U.S. export control regulations become more favorable.
- **Treaty provisions.** A host of requirements contained in various treaties and other bilateral agreements also significantly affect the launch market. For example, the START Treaty requires Soviet-era SS-18s to be converted into civilian launch vehicles by 2020.

Taken together, these policies establish an environment determined by a complex mix of government policies that may or may not be mutually consistent in intent or outcome. It is likely that these policies have much more substantially influenced the U.S. commercial space transportation industry than the indemnification practices. But measuring the contribution of indemnification itself – which is critical to considering amendments to eliminate it or, at the other extreme, altering it to reallocate more risk to government – is impossible. The identical conclusion was reached in the DOT/FAA 2002 study of indemnification. However, **it is essential to note that regardless of the role of indemnification, the**

²⁸ Marcia S. Smith, “Space Launch Vehicles: Government Activities, Commercial Competition, and Satellite Exports,” *Congressional Research Issue Brief for Congress*, Order Code IB93062, May 27, 2005.

²⁹ Peter B. deSelding, “ESA Ministers Reject ‘Buy European’ Launch Proposal,” *Space News*, December 12, 2005, p. 4. The article’s title refers to rejection of a stronger measure – probably unenforceable – that would have forced all European nations and organizations (e.g., the European Union and Eumetsat) to rely on Ariane and Vega for their space launch requirements.

statutory goal of an internationally competitive U.S. industry, with the exception of international partnerships such as Sea Launch, is not being met.

2.3 Possible Concerns for National Security

Another of the findings in the 1988 CSLA amendments is that the commercial space launch industry is “an essential component of national efforts to assure access to space for government and commercial users.” An argument among advocates of maintaining indemnification is that a robust U.S. commercial industry supports military launch vehicle supply, thus enhancing national security. Government space officials tend to believe that a healthy U.S. commercial launch industry helps sustain the space industrial base and keep costs down for government customers.

A 2005 annual industry overview implies that this support is cyclical, and support in recent years may go in the direction of military business supporting commercial business. The overview concludes, “In the U.S., the military satellite market is booming and there is a seemingly never-ending list of programs for which launches are planned during this decade and the next.”³⁰ In addition, there is some evidence that civil space payloads follow a similarly cyclical pattern in their share of launches. The “commercial” payloads listed in the yearly FAA Launch Reports show a sizeable number of U.S. government civil space payloads rather than commercially owned payloads. The continued weak demand for U.S. commercial Evolved ELV launches has led Boeing and Lockheed Martin to propose a joint venture, United Launch Alliance, to serve the U.S. government market.³¹ Looking towards the future for commercial launch capability, recent comments on the direction of government policy give mixed signals for commercial and government markets. The NASA Administrator reminded the space science community, “I would also like to note for the science community that, if you advocate large missions exceeding the capabilities of the current EELV fleet, you should consider taking advantage of new heavy-lift capabilities currently under development for human exploration.”³²

Empirically measuring what role, if any, commercial activity plays in assuring access to space, and the extent to which indemnification contributes to any possible role, is difficult in the absence of production cost data. If a production advantage arises from commercial activity, then exploiting that advantage may not be directly aided by indemnification. Other, more direct public policies would go farther in achieving such an objective.

2.4 Additional Considerations

There are some additional arguments for consideration of the role and efficacy of risk sharing. These arguments center on (1) the large and direct role of government in its responsibility for third-party safety, and (2) a more convoluted but arguably real link between the costs borne by the industry of restrictive government policy and the implicit “compensation” offered to industry by indemnification.

Government itself is in charge of the physical launch activity and hence, government should bear responsibility for third party risk. A strong argument for maintaining indemnification, at least at federal ranges, is based on the appropriateness of linking responsibility for risk directly to the party in charge of safety. At federal ranges, the government, by way of the Air Force and the Department of

³⁰ Edwards, note 22, p. 135.

³¹ In October 2005, Space Exploration Technology filed an antitrust complaint opposing the venture. The Department of Defense has given provisional approval. The U.S. Federal Trade Commission has yet to render a decision.

³² Remarks by NASA Administrator Michael Griffin to the NASA Advisory Council Science Subcommittee, 6 July 2006, at http://www.spaceref.com/news/viewsr.nl.html?pid_21438 (accessed July 2006).

Transportation, is largely in control of third-party safety. The government approves flight termination systems (FTS) (to destroy a vehicle traveling beyond approved limits), gives the final go-ahead for each launch, and has its “finger on the trigger” to deploy the FTS if the government deems it necessary. Timely activation of an FTS assures that vehicle debris will impact within a designated area so as to reduce the probability of public injury. This practice transfers the bulk of the third-party risk associated with the actual launch activity to the government. It is fully appropriate, then, for government to share in this risk.

In acknowledging this responsibility, a 1988 Senate committee report noted the argument that because the government is so closely involved in (1) evaluating the degree of risk in each launch, (2) setting the insurance requirements, and (3) controlling range safety, it “should also accept some of the risk and provide indemnification above the insurance requirements.”³³ The report went on to point out that even without government indemnification, a domestic third party could sue both the commercial launch company and the government for damages, with the question of government liability resolved in the courts based on the Federal Tort Claims Act.³⁴

At commercial spaceports where the Air Force and the DOT are not involved in the actual launch (and reentry, in the case of RLVs), government still assumes some third-party risk responsibility because the DOT licenses these launches and establishes the requirements for the first tier of insurance. However, this relationship alone does not justify risk-sharing for vehicles using spaceports. Government licenses or regulates a variety of risky aspects of all types of commercial activity in the United States and in many cases, requires licenses to demonstrate financial assurance. In most cases, government itself is not physically involved in the activity.³⁵ For this reason, the rationale for third-party indemnification of launches at U.S. commercial space transportation facilities solely on the basis of government being somewhat responsible for third-party risk is much weaker. (Existing FAA policy requires all vehicle licensees to insure third-party risk but does not require spaceport operators to have this insurance. The FAA requires licensees to demonstrate the same level of safety at spaceports as at federal ranges. State-run or sponsored spaceports may even choose a higher level of safety. For example, California, Alaska, and Washington state have more stringent requirements than federal rules for potential oil spills from terminals and pipelines (see this and additional examples in DOT/FAA 2002)).

Indemnification as a benefit could offset some costs of other restrictions on the commercial launch industry. A second justification for indemnification is that it can function to partly offset the costs of other government policy borne by the industry. As noted earlier, export controls restrict the international market for U.S. launch vehicles and impose direct costs on the commercial launch industry and its customers. As a means of alleviating these costs, indemnification could be considered compensatory. Just how compensatory is a matter of speculation. However, at present there is no credible way to compare the benefits and costs of indemnification with those of export controls, making indemnification a highly imperfect approach to balancing costs and benefits of other government intervention.

2.5 Relevant Experience in Other Federal Government Indemnification Programs

A “default” strategy in analysis of programs for which key data and information is lacking is reasoning by analogy with other programs. Another federal indemnification program, the Price-Anderson

³³ Committee on Commerce, Science, and Transportation, United States Senate, “Insurance and the U.S. Commercial Space Launch Industry,” 100th Congress, 2nd Session, S. Print 100-112, July 1988, p. 12.

³⁴ See the report above, p. 13.

³⁵ An analogy is that the licensing role of state agencies in issuing drivers’ licenses is not a basis for government indemnification of third-party damages associated with motor vehicle operation.

Act for the nuclear power industry, served as a model for the 1988 CSLA risk-sharing approach.³⁶ The federal government has assumed financial risk in backing many other private sector activities. For instance, the Overseas Private Investment Corporation (OPIC) offers protection to U.S. investors in developing countries and countries with emerging markets. The National Flood Insurance Program (NFIP) makes federal flood insurance available to property owners in communities that are accepted into the program. The Terrorism Risk Insurance Act (TRIA), passed by Congress after the September 11, 2001 attacks, establishes a temporary federal program of some backing for most lines of commercial property and casualty insurance for catastrophic losses from terrorism.

These programs offer some guidance for risk-sharing policy in the commercial space transportation industry. However, it should also be noted that none of these programs combines all elements of the CSLA provisions. Only Price-Anderson addresses third-party risk, and none of the programs have among their rationale the additional goals of an internationally competitive industry or assured access to a market on the basis of dual use of assets to support national security. In these regards, the CSLA provisions are unique. Their uniqueness in seeking to support goals such as these limits the generalizability of analogous experiences.

With this caveat, elements of these programs that overlap with the CSLA provisions and their possible modification include:

- **Program financing.** OPIC operates as a self-financing agency in that its income is largely derived from premiums and fees, but the program has \$100 million in borrowing authority from the U.S. Treasury. Over the life of the program, the government has made money from the Corporation. Although not intended to be self-financing, TRIA requires a portion of any federal compensation to be recouped through surcharges on policyholder premiums. NFIP derives income from premiums and fees but is not actuarially sound. Congress typically appropriates funds to finance the program in the aftermath of large-scale damages from flooding.
- **Actuarial determination.** Officials with OPIC and the U.S. Department of Treasury, which is responsible for administering TRIA, admit that no actuarial models exist to quantify risks in these programs. Actuarial modeling for commercial nuclear power risk is similarly difficult because, as in the launch industry, accidents have been rare and the technology has changed markedly over time, complicating the relevance of past experience for actuarial determination.
- **Sunset provisions.** TRIA and Price-Anderson have sunset provisions establishing expiration dates for the programs although both have been extended. In recently extending TRIA to December 2007, the Congress reiterated that the Act is still intended as a temporary measure.
- **Shifting the burden to the private sector as industries mature.** TRIA and Price-Anderson explicitly provide that over time, government backing should decrease and private sector liability should increase. Federal financial backing under Price-Anderson has decreased significantly, commensurate with evidence of the adequacy of the insurance market and private operators' ability to meet obligations in the secondary fund. This reallocation is consistent with the original intent of the Act to serve as temporary support for the industry as it matured. In a similar spirit, the provisions for terrorism insurance under the TRIA are expected to be temporary as property and casualty insurance and reinsurance markets establish coverage and pricing policy. Congress increased private sector deductibles and co-payments in renewing TRIA (but also increased the maximum liability for which the government would assume responsibility).³⁷

³⁶ See discussion in the *Congressional Record*, October 14, 1988, p. 31128.

³⁷ In a 2005 report to the Congress assessing TRIA, the Treasury Department noted that during the period 2002 to 2005, the property and casualty insurance market had demonstrated capacity to underwrite a greater share of terrorism risk. See U.S. Department of Treasury, Office of Economic Policy, "Assessment: The Terrorism Risk Insurance Act of 2002 – Report to Congress," June 30. See also Testimony of Ben S. Bernanke, Chairman of

Because the CSLA was premised on Price-Anderson, some discussion of how that Act has evolved with maturation of the commercial nuclear power industry is illustrative.³⁸

The original Act, a 1957 amendment to the Atomic Energy Act, limited liability for any single nuclear accident to \$500 million in government funds, plus the maximum amount of liability insurance available in the private market – at that time, \$60 million – for a total of \$560 million. The Act was to be effective for ten years. Congress has periodically renewed the Act with a variety of alterations. The most recent renewal of the Act, by way of the Energy Policy Act of 2005 (P.L. 109-58), extended Price-Anderson through 2025. The extended version significantly differs from the original in reallocating risk from the government to industry.

In 1979, the federal government’s statutory role in indemnity was phased out because the total level of private coverage had reached \$560 million, a limit set in the 1957 Act. In 1988, congressional revisions to the Act included a provision stipulating that if this limit were reached, Congress would determine whether additional compensation should be awarded, and who should provide the compensation. The version of the Act currently in effect does not explicitly require Congress to fund damages that exceed the private amount, but commits the Congress to investigate the accident and to take whatever action it deems necessary. This action could include, among other things, appropriating funds or requiring the nuclear industry to provide additional funding to satisfy remaining claims.

Under the current Act, operators of reactors must obtain insurance in an amount up to the maximum of private insurance available to an operator. This amount is currently about \$200 million per reactor per accident. In addition, in the event of an accident at a single reactor that resulted in losses exceeding the amount of private liability, all operators of the 104 commercial nuclear power reactors in the United States would be required to provide additional coverage by paying into a secondary insurance fund. Depending on the amount of these claims, these contributions could be as high as \$88.1 million per reactor per accident. Following an incident, the operators of commercial power reactors would be required to pay as much as \$10 million annually for nine years to fill the secondary insurance fund. The nuclear industry’s current exposure to third party liability claims would be approximately \$9.5 billion before the Congress intervenes. In the event of an accident for which damages exceed this amount, the Congress is required to investigate the accident and, as noted above, to take whatever action it deems necessary.

The U.S. Government Accountability Office notes that nuclear accidents since Price-Anderson have been fully covered by the available private insurance. As a result, the industry has never had to pay into the secondary insurance fund, and (as in the case of the launch industry) Congress has not been required to take action on excessive losses.³⁹

the Council of Economic Advisors, before the Committee on Banking, Housing, and Urban Affairs, U.S. Senate, “On the Terrorism Risk Insurance Act of 2002,” July 14, 2005.

³⁸ See discussion of the modifications to Price-Anderson in U.S. General Accounting Office, “Terrorism Insurance: Alternative Programs for Protecting Insurance Consumers,” statement of Richard J. Hillman before the House Committee on Financial Services, October 24, 2001, GAO-02-175T; and information provided by the Nuclear Energy Institute at <http://www.nei.org/index.asp?catnum=4&catid=319> (accessed November 2005).

³⁹ U.S. General Accounting Office, previous note.

International Agreements on Nuclear Power Liability

The primary international conventions on nuclear power liability include the 1960 Paris Convention on Third Party Liability in the Field of Nuclear Energy, the 1963 Vienna Convention on Civil Liability for Nuclear Damage, the 1974 Brussels Convention Supplementary to the Paris Convention on Third Party Liability in the Field of Nuclear Energy, and the 1988 Joint Protocol Relating to the Application of the Vienna Convention on Civil Liability for Nuclear Damage and the Paris Convention on Third Party Liability in the Field of Nuclear Energy.

The Paris Convention has 15 signatories: Belgium, Denmark, Finland, France, Germany, Greece, Italy, the Netherlands, Norway, Portugal, Slovenia, Spain, Sweden, Turkey, and the United-Kingdom. In parallel with the development of the Paris Convention for Western European countries, the International Atomic Energy Agency adopted its own nuclear liability regime in 1963 through the Vienna Convention on Civil Liability for Nuclear Damage. Stating similar principals to those laid down in the Paris Convention, some 30 non-OECD countries mainly from Eastern Europe, South America, Africa and the Pacific ratified the Vienna agreement in 1974. The Paris and Vienna Conventions limit liability of operators and require that operators secure insurance or other financial guarantees up to a stipulated amount. Amendments proposed in 2004 (but not yet ratified) to both conventions include an increase in the amount of operator liability.

The Brussels Supplementary Convention (BSC) to the Paris Convention created an additional financing mechanism for compensation available to victims of nuclear damage to supplement that already provided for under the Paris Convention. This supplementary compensation would be paid from public money provided by the signatories between them. Taken together, the Paris and Brussels conventions create three tiers: liability is covered by the operator for a first tier of insurance; by the accident state in the second tier, and by the contracting parties to the BSC on a prorated basis with respect to their respective contributions for the third tier.

Much like the influence of CSLA in inducing other launching countries to provide government indemnification, the Price-Anderson Act has become model legislation for nuclear industry indemnification policies throughout much of the world. A large number of countries with nuclear power facilities are signatories to international conventions limiting liability and providing for government financial backing if damages are large. In countries where there may be insufficient industry funds available to compensate all claims, compensation may be reduced proportionately (Canada, Sweden) or may be funded after a vote by Parliament (Canada, United Kingdom). In other countries, the government (Japan, Switzerland) or the operator (Switzerland) is required to pay the difference.⁴⁰ In some countries, operators participate in insurance pools. For example, British Nuclear Insurers is one of several insurance pools around the world. It comprises 13 commercial insurance companies and 40 Lloyds Syndicates.⁴¹

2.6 Observations for Commercial Space Launch Indemnification

The federal programs discussed above illustrate some general guidelines for modifications to the current space launch indemnification system. By and large, these modifications move *gradually* towards a larger role for the private sector, but include government as a backstop. Key aspects include the following:

- Shifting of the potential government burden to private industry over time is a policy objective that has shaped other programs. This outcome may argue for downward adjustment in the potential federal liability for launch coverage given the maturity of the industry. The self-financing

⁴⁰ Organization for Economic Cooperation and Development, Nuclear Energy Agency (OECD/NEA), *Indemnification of Damage in the Event of a Nuclear Accident*, Workshop Proceedings, 26-28 November 2001, at <http://www.nea.fr/html/pub/ret.cgi?div=LEG>.

⁴¹ See information provided by the Nuclear Industry Association of the U.K. at http://www.niauk.org/printer_56.shtml (accessed November 2005).

provision of OPIC is a possible approach in this direction; for example, a portion of premiums paid by the space transportation industry could be directed to an insurance pool. The pool could be federally maintained, as with OPIC, or it could be mandated by government but privately maintained, as under Price-Anderson. The amount could be smaller in the early years to ease the transition, and increase over time. A private pool could be comprised of U.S. launch operators or it could include operators in other countries.

- Borrowing authority from the U.S. Treasury, following provisions in OPIC, could be an additional provision if the indemnification program moves towards self-financing.
- Following the Price-Anderson Act, industry could establish a phased-in, self-funded secondary insurance pool from which each licensee could pay a prorated share of damages in excess of required primary insurance.
- As programs evolve, monitoring any possible disincentives for insured parties to take precautionary actions is essential for program efficacy. When government bears some risk, insured parties may not invest in the optimal amount of safety, including R&D directed towards reducing risk. This concern has figured prominently in other risk sharing programs. Review of the incentives provided to industry by the indemnification regime, whereby so much of the third-party risk is controlled by the Air Force and Department of Transportation at the federal ranges, is necessary for fully evaluating this (unintended) possible cost of indemnification. Industry may not face adequate incentives to pursue as much safety-related R&D as it would in the absence of government sharing of the risk.

In assessing TRIA, the Treasury Department found an overall but slight increase in the amount spent on terrorism coverage once that market began to emerge (an outcome of two opposing trends: an increasing share of policyholders paying for coverage and declining prices among those who reported paying for coverage).⁴² The Treasury Department acknowledged that it was not possible to discern if government backing had facilitated the ability of the private insurance market to accept risk or whether the market would have evolved in the absence of the Act. The Treasury report concluded that TRIA had succeeded in providing a transition period for insurers and those insurers had been able to cope with increased exposure to risks as the federal provision of reinsurance diminished. In congressional testimony, the Chairman of the Council of Economic Advisors, Ben Bernanke, stated that TRIA provided an appropriate “temporary federal backstop in terrorism risk insurance and allowed the insurance industry a transition period to adjust to post-9/11 realities.”⁴³ Bernanke also noted that “We cannot observe the counterfactual of what would have happened to the pricing and availability of terrorism risk insurance had TRIA not been enacted.”

The absence of the counterfactual limits the ability to discern any potential *disincentives* faced by industry in light of government financial assurance. For instance, studies of the commercial nuclear power industry under Price-Anderson have questioned whether the cushion provided by the Act reduced the industry’s willingness to invest in safety research and development or to implement safety-related improvements in operations or plant infrastructure.⁴⁴ A study by the Congressional Budget Office of federal reinsurance for disasters raises a similar question in concluding that such reinsurance “... weakens

⁴² Terrorism coverage in property and casualty markets prior to 2001 was typically unclear as an explicit provision of many policies; in addition, when it was provided, no premium or fee was charged.

⁴³ Ben S. Bernanke, Testimony before the Committee on Banking, Housing, and Urban Affairs, United States Senate, “On the Terrorism Risk Insurance Act of 2002,” July 14, 2005.

⁴⁴ Jeffrey A. Dubin and Geoffrey S. Rothwell, “Preparing for the Improbable: Safety Incentives and the Price-Anderson Act,” Social Science Working Paper 642, California Institute of Technology, Pasadena, CA, May 1987.

people's incentives to take actions that would reduce the cost of future natural disasters."⁴⁵ In a comprehensive review of TRIA, insurance experts expressed concern that the insurance not conflict with incentives for investment by individuals and businesses in security and related risk-mitigation.⁴⁶ It is reasonable to question (but difficult to answer) whether similar disincentives arise in the commercial launch industry as a result of government indemnification. As long as indemnification remains in place, it may not be possible to disentangle its effects (if any) on incentives to invest in safety innovation. To date, there is no evidence that indemnification has hindered safety measures in the U.S. commercial launch industry, given its outstanding safety record. Conjecturing about an answer is difficult in the absence of experience with major changes in the current regime, but insurance policy analysts have long recognized the potential danger of "moral hazard" – that is, when insured entities take more risk because "someone else" pays.

2.7 Elimination of Risk Sharing and "Betting the Company" – Perspectives from Other Large Loss Events

Another key issue in evaluating the indemnification regime is the empirical question of how large might the actual financial risk be. Again, the tendency is to look to analogous experience in other industries, particularly where losses have been large.

The FAA's MPL calculation ranges from about \$250,000 to \$261 million. It is important to understand the basis of the risk assessment process underlying determination of the MPL. FAA uses the threshold probability of occurrence of one in ten million, based on the government experience in launch activities at federal ranges. The FAA emphasizes that because of the stringent safety requirements used at these facilities, the general public in the vicinity of the range has little chance of being adversely affected by a launch event. As stated by the FAA in its advisory circular giving details for expected casualty calculations for commercial space launch and reentry missions, commercial space operations are to be carried out such that the risk to the public is several orders of magnitude less than the risk of fatality from non-space accidents.⁴⁷

But even if unlikely, what if a "catastrophic" event occurred? It is important to note first that it is far from clear what would constitute catastrophic. Such an accident might involve large numbers of casualties, significant property damage or loss, or damages to the environment and ecosystems (such as those from the Exxon Valdez oil spill). Even if such losses were quite low, an accident can threaten public acceptance of a technology (for example, no new U.S. commercial nuclear power plants were licensed for thirty years after the 1979 Three Mile Island accident).

⁴⁵ Congressional Budget Office, "Federal Reinsurance for Disasters," 2002. Such concern is also expressed in Robert Litan, "Sharing and Reducing the Financial Risks of Future Mega-Catastrophes," *Issues in Economic Policy*, Brookings Institution, March 2006.

⁴⁶ The Wharton Risk Management and Decision Processes Center, the Wharton School, University of Pennsylvania, *TRIA and Beyond: Terrorism Risk Financing in the U.S.*, August 2005, available at <http://knowledge.wharton.upenn.edu/papers/1299.pdf> (accessed July 2006).

⁴⁷ FAA/AST Advisory Circular 431.35-1, "Expected Casualty Calculations for Commercial Space Launch and Reentry Missions," 30 August 2000.

Examples of third-party financial responsibility requirements under the MPL

<i>Vehicle (Company)</i>	<i>Amount (\$ millions)</i>
Delta IV M or M+ (McDonnell Douglas)	\$264.0
Atlas V 521 (Lockheed Martin)	196.5
Zenit 3 SL (Sea Launch)	20.0
Tachyon (Interorbital Systems)	0.25

Source: FAA/AST “Financial Responsibility Requirements as Determined by the Maximum Probably Loss (MPL) Process,” 20 July 2005.

Tables 2.1 through 2.3 offer perspective on the high end of some types of catastrophic losses for a range of actual events. These illustrations are NOT intended to approximate in any manner the possible size of space transportation third-party damages. The tables are merely offered for perspective on the kinds and amounts of extreme losses and how insurance markets have accommodated these losses.

Table 2.1 – U.S. Federal Disaster Aid (Billions of 2005 dollars)

<i>Year</i>	<i>Event</i>	<i>Amount</i>
2005	Hurricane Katrina	50+
1992	Hurricane Andrew	21
2001	9/11 terrorist attacks	20
1994	Northridge earthquake	16
2004	Hurricane Charley	8
2005	Hurricane Wilma	4-10
2004	Hurricane Ivan	7
1989	Hurricane Hugo	6
2004	Hurricane Frances	5
2004	Hurricane Jeanne	4
2005	Hurricane Rita	3-6

Source: Robert E. Litan, “Sharing and Reducing the Financial Risks of Future Mega-Catastrophes,” *Issues in Economic Policy*, Brookings Institution, March 2006. The Hurricane Katrina amount is expected to exceed \$100 billion sometime in 2006.

Table 2.1 shows the largest amounts of U.S. federal disaster aid. These range from more than \$100 billion for Hurricane Katrina to about \$6 billion for Hurricane Hugo. Table 2.2 gives the ten most costly terrorist attacks in terms of insured property losses during 1970-2001. These range from \$145 million in insured property damages from the Oklahoma City truck bomb in 1995 to the \$22 billion insured property loss due to the 9/11 attacks. Table 2.3 shows the composition of 9/11 insured loss estimates by lines of insurance, illustrating an important observation that insured losses can extend beyond property and life to involve business interruption and workers’ compensation. The FAA MPL calculation expressly excludes workers compensation, environmental liability, business loss interruption, and other insurance requirements (although licensees are not relieved of any federal, state, or local requirements to comply with them).

<i>Insured Property*</i>	<i>Event</i>	<i>Injured</i>	<i>Fatalities</i>	<i>Date</i>	<i>Location</i>
22,100	Terror attacks against World Trade Center, Pentagon, and Pennsylvania by hijacked airliners	2,250	3,000	11 Sep 01	U.S. (NYC, Wash. DC, PA)
907	Bomb explodes near NatWest tower (City)	54	1	24 Apr 93	UK (London)
744	Irish Republican Army car bomb near shopping mall	228	0	15 Jun. 96	UK
725	Bomb explodes in garage of World Trade Center	1,000	6	26 Feb. 93	USA (New York)
671	Bomb explodes in financial district	91	3	10 Apr 92	UK (London)
398	Rebels destroy 3 airliners, 8 military aircraft and heavily damage 3 civilian aircraft	15	20	24 Jul. 01	Sri Lanka (Colombo Airport)
259	IRA bomb attack in South Key Docklands	100	2	9 Feb 96	UK (London)
145	Truck bomb attack on government building in Oklahoma City	467	166	19 Apr 95	U.S. (Oklahoma City)
138	PanAm Boeing 747 crashes due to bomb	0	270	21 Dec 88	UK (Lockerbie)
127	Hijacked Swissair DC-8, TWA Boeing 707 and BOAC VC-10 dynamited	0	0	6 Sep 70	Jordan (Zerqa)

* U.S. \$ million, indexed to 2001; excludes liability and life.
Source: Wharton Risk Management and Decision Processes Center, "TRIA and Beyond," 2005 (Chapter 3 (based on data from Swiss Re and Insurance Information Institute))

<i>Line of insurance coverage</i>	<i>Loss Estimates (\$ billion)</i>	<i>Loss Estimates (% of total)</i>
Business Interruption	11.0	33.8
Property – Other	6.0	19.5
Other Liability	4.0	12.3
Property – World Trade Center	3.6	11.1
Aviation Liability	3.5	10.8
Workers Compensation	1.8	5.8
Life	1.0	3.1
Event Cancellation	1.0	3.1
Aviation Hull	0.5	1.5
Total	32.4	

Sources: Wharton Risk Management and Decision Processes Center, "TRIA and Beyond," 2005, Chapter 3 (based on data from Insurance Information Institute).

If the FAA's assertion that its MPL calculation is extremely conservative is correct, and the procedures practiced by the Air Force and FAA at federal ranges are likely to maintain the impeccable third-party safety record, then the likelihood of third-party losses approaching the amounts in these tables is slim. And, under Tier III of the risk-sharing program, the commercial space transportation industry is liable for losses exceeding about \$2 billion dollars in any case. The willingness of the industry to operate

and assume risk for \$2 billion or more implies that the industry conceives of such losses as sufficiently unlikely. In the absence of Tier II risk sharing, companies would need additional commercial insurance or other means of demonstrating financial capacity for an accident with a probability of damages on the order of \$300 million to \$2 billion.

Would companies be “betting the farm” to assume all or part of the responsibility for Tier II under these assumptions? Table 2.4 presents annual cash flow from operating activities and total equity for aerospace manufacturing companies for 2000. Three companies have a monetary value of \$2 billion or more. Their willingness to allocate part of these funds to self-insure their commercial space transportation activities would be a decision made in tandem with their own assessment of likely third-party risk, the price of commercial insurance, and the attractiveness of other means of finance (for example, the possibility of pooling risk in group “captive insurance” arrangements, or the purchase of catastrophe bonds as a primary purchaser or through intermediaries). The availability of commercial insurance and possible other risk management arrangements are described further below.

Table 2.4 – Cash Flow and Total Equity of Publicly Held Manufacturing Aerospace Companies (Calendar Year 2000)		
<i>Company</i>	<i>Cash from Operating Activities (\$ million)</i>	<i>Total Equity (\$ million)</i>
Alliant Techsystems Inc.	110	115
B.F. Goodrich	297	1,500
Boeing	5,900	11,000
GenCorp	23	195
Lockheed Martin	2,000	30,300
Orbital Science Corp.	30	44
United Technologies Pratt & Whitney	2,500	8,100
Source: DOT/FAA 2002		

2.8 Summary of Observations on the Commercial Space Transportation Market and the Risk-Sharing Program

Proponents of a fully commercial space transportation industry have argued that at some point, perhaps sooner rather than later, the industry should operate without government support in the form of third-party insurance. This was the intent of the original 1988 CSLA establishing the risk-sharing program. By conventional measures of industry “maturity,” a space transportation industry deemed “nascent” nearly two decades ago is now mature.

Maturity is not synonymous with “successfully competitive,” however. Mature industries often struggle financially to capture and maintain market share – the auto, steel, and electronics manufacturing industries illustrate the point. Government is typically implored to help. The data brought to bear in this chapter show that with the exception of the partly U.S.-held Sea Launch company, the U.S. commercial space transportation industry has a small share of the international market in terms of numbers of launches and revenue. Worse, the forecast for the next decade is not much brighter.

The industry argues that weak performance underscores the critical importance of indemnification. This chapter has demonstrated that the difficulties in evaluating this argument are threefold. One problem arises because the evidence of the contribution of indemnification to the bottom line has never been revealed by industry, so a decision to maintain – or even increase – indemnification is completely uninformed. A second problem is that if the national goal is international competitiveness, public policy targeted directly towards price supports or other intervention may be a more effective means

of boosting the poor performance of U.S. companies in the market. Such intervention lies outside the scope of this study.

The third difficulty is somewhat unique to the commercial space industry in contrast with autos or steel or electronics. A complex set of public policies is at work in space transportation, including but not limited to: the legacy of extensive government involvement in and control of the industry; the continuing role of government as the customer for a relatively large share of the market; international agreements governing the disposition of excess missiles in other countries; “buy domestic” policies in other countries; and export controls which restrict both suppliers and payload customers. The 1988 CSLA also emphasized the dual-use aspect of space transportation in serving military as well as civilian purposes – although as this chapter notes, good data are unavailable to evaluate the importance of this assertion. The interplay of these policies is such that some support, others undermine the industry. Identifying the relative influence of indemnification – again, is it the right size? too big? too small? – is far from easy. The link between the insurance regime and spillover effects facilitating cost effective dual use is particularly tenuous.

Related to the uniqueness of commercial space transportation is another factor, and this is perhaps the one factor which offers an easily defensible argument for government risk-sharing at federal ranges: the particular responsibility of the federal government (the Air Force and the FAA) as the decision-maker of last resort – having its “finger on the trigger” in the decision to abort a launch and thus the critical link between the launch and third-party safety. Risk-sharing at commercial spaceports is less defensible on the basis of this argument.

The chapter also draws from the experience of government indemnification in other sectors but notes again that characteristics of space transportation limit generalization. A common theme in all risk-sharing programs is that indemnification is a temporary measure. The fundamental conviction is that commercial markets eventually should and will be able to operate on their own. Other experiences also involve gradual rather than immediate termination of risk-sharing. They also include the need to guard against moral hazard if risk-sharing blunts incentives for companies to take safety measures or engage in safety-related R&D. If they operate without risk-sharing, the extent to which space companies would be “betting the company” by assuming responsibility for Tier II losses (as well as the responsibility the industry already bears for losses exceeding the inflation adjusted statutory limit on Tier II) depends on the companies’ financial capacity, the willingness of commercial insurers and insured companies to exploit risk-spreading financial instruments (which have evolved since the 1988 CSLA), and perhaps most importantly, the willingness of industry to avail itself of other opportunities. Chapter 3 turns to these options.

3. Elimination of U.S. Government Risk-Sharing and Possible Consequences

In this chapter we first outline a set of general options for modifying the risk-sharing regime. The list of options highlights new types of financial instruments which have evolved in the insurance industry in recent years and which, even if not presently used by the commercial space industry, illustrate the range of approaches that are available in the event of modifications to indemnification. The chapter then suggests possible steps toward elimination.

3.1 Alternatives

Alternatives to the current indemnification policy could include trust funds, self- and captive (pooled or group) insurance, and public tax subsidies for the costs of insurance. Different alternatives can be paired (a trust fund with a subsidy, for example). All of these are described in detail in the previous study of indemnification (DOT/FAA 2002, Chapter 9).

Self Insurance. Under self-insurance, companies would reserve their own funds for third-party compensation greater than the MPL amount. The company would provide regulators overseeing their insurance with a demonstration of profitability and stability; regulators would monitor asset ratios, profitability indicators, and bond ratings. A parent corporation may choose to provide a financial guarantee or indemnity agreement. Self-insurance is common in workers' compensation, general liability, and product and property liability. Self-insurance affords a company control over financial assets, but the reserve funds may represent a sizable commitment of resources. Small businesses often combine self-insurance with commercial insurance.

Trust funds would be financed by an individual company or multiple companies in the industry; involve an independent trustee, and when used to demonstrate financial assurance, would be under the approval of a regulator. Many liability regimes use trust funds to which parties contribute based on a fee per barrel, passenger mile, and so forth. A space transportation trust fund could be established by legislation, financed by fees based on risk calculations, and used to compensate property and third-party damages. The government or the private sector could serve as manager. Spaceports could also establish trust funds for third-party damages much like states fund underground storage tank assurances (set up by Congress in 1986 by an amendment to the Resource Conservation and Recovery Act). An advantage to the companies is that interest on the fund is returned to the companies. A firm that decided to exit the industry could receive a portion of the fund's assets. Firms can have a say in how the fund is managed and its assets invested. Perhaps the largest difficulty in a trust fund approach is the degree to which risk is correlated across companies, such as the extent to which the value of the assets are correlated with the value of a particular firm. It is unlikely that a systemic problem would occur that is common to all launch vehicles at the same time.

Captive Insurance. In this arrangement, insurance among two or more companies is pooled and then jointly owned and controlled. A single-parent captive involved ownership and control by one company and its subsidiaries. A group captive involves two or more companies. Contributions reflect each member's relative risk – a company operating a new space vehicle may need to pay more until a safety record is established, or a company operating a vehicle overflying a highly populated area may need to pay more. Any surplus in the captive is returned to members after each accounting period. In the U.S., group captives are licensed by a domiciliary state and use a fronting carrier, or they operate under the Federal Risk Retention Act. At least two insurance experts have proposed use of group captives for

space transportation and one suggested that they be used together with other forms of insurance.⁴⁸ A captive could include not only space vehicle providers but satellite manufacturers and operators as well. Regulatory oversight would probably include the federal government and state regulators in which the captive is licensed or in which the suppliers operate.

Group captives are used by commercial aviation. Amendments to the Price-Anderson Act required establishment of self-funded secondary insurance pools by the commercial nuclear power industry.

Catastrophe Bonds. In 1997, a wholly new financial instrument, catastrophe (CAT) bonds, was developed for managing the risks of relatively rare natural events (earthquakes, floods). Investors in CAT bonds assume that the risk associated with a rare event can be widely spread (a hurricane may hit the U.S. but not in the same year that an earthquake occurs overseas). Returns to investors are typically higher than market rates (bonds offered by Tokyo Marine and Fire Insurance for earthquake risk in Japan paid 4 to 4.5 percentage points above the London InterBank Offered Rate). CAT bonds involve investors who purchase the bonds, a reinsurance company, and an insurance company purchasing the reinsurance (which could be a company or another reinsurer). Interest on the CAT bonds goes to the investors; if no catastrophic event occurs prior to the maturity of the bonds (often about 10 years), investors receive their interest payments plus a full return of principal. If an event occurs, the investor may lose all of their investment. The risks are hedged by reinsurers who mix lines of business covered and the geographic spread of business to build a portfolio.

The U.S. Department of Treasury, in a 2001 interview conducted for the previous assessment of the indemnification regime (see DOT/FAA 2002, p. 9-6), brought the option of CAT bonds to the table for space vehicle indemnification. The CAT market was initially slow to develop beyond a few applications. An impediment to these bonds is that catastrophic risks require insurers to hold large amounts of liquid capital, but institutional factors (accounting and tax law and regulation, together with takeover risk) make insurers reluctant to do this.⁴⁹ Experts in insurance market research as of 2006 find CAT bonds becoming more attractive for diversifying extreme risks. Recently, Swiss Re has reported that the CAT bond market has grown much larger, reaching some \$3 billion as of 2003. Swiss Re also notes that the methodology for structuring the bonds is now well established, and that experience is showing that there is almost zero correlation between extreme risks and other financial risks, making the bonds attractive to investors managing portfolios of different risks.⁵⁰ Specific new instruments such as “Act of God” bonds, catastrophe futures, and CAT options contracts are also being developed.⁵¹

Publicly Subsidized Insurance. Tax-based policies in the form of tax credits or deductions could be offered to space vehicle companies to underwrite their purchase of launch insurance. If the goal were to support the commercial launch industry but remove government from the insurance business, this approach has an advantage. However, it is arguable whether space transportation merits preferential treatment (the question arises as well with indemnification of the industry) in the absence of broad agreement on the policy goals and whether their attainment justifies the cost of favored tax policies.

⁴⁸ Neil Doherty, “Insurance, Risk Sharing, and Incentives for Commercial Use of Space,” in Molly K. Macauley, ed., *Economics and Technology in U.S. Space Policy*, Washington, DC, Resources for the Future, 1986; Jerome Simonoff, 1985, testimony before the Subcommittee on Science, Technology, and Space, Committee on Commerce, Science, and Transportation, U.S. Senate, 99th Congress, First Session, on “Satellite Insurance and Space Commercialization,” November 7.

⁴⁹ See Dwight M. Jaffee and Thomas Russell, “Catastrophe Insurance, Capital Markets, and Uninsurable Risks,” *Journal of Risk and Insurance*, 1997, 64(2), 205-240 and “TRIA and Beyond: Terrorism Risk Financing in the United States,” Wharton Risk Management and Decision Processes Center, August 2005.

⁵⁰ “A Growing Market for Catastrophe Bonds” at <http://www.swissre.com> (accessed July 2006)

⁵¹ Jaffee and Russell, note 49.

Because the current regime has not imposed costs on the taxpayer, it is hard to argue that tax subsidies are cost-effective. However, if new vehicles and spaceports come on line, and if third-party risk exposure increases, then a tax-based approach to redistribute the full costs of financial assurance, without government indemnification, could be seen as desirable by policymakers. Tax treatment could also be limited only to launch pools or cooperatives formed by space transportation companies and collectively represented in bargaining with insurers for price and policy conditions.

3.2 Possible Steps Toward Elimination

In an overview of a wide range of federal insurance programs, the General Accounting Office (now the Government Accountability Office) stated guiding principles: safeguard interests of the government and taxpayer, ensure that industry is assuming a fair share of risk, avoid displacing the private insurance market, and encourage private market incentives “for prudent and efficient behavior that are not replaced by an attitude that says ‘Don’t worry about it, the government is paying.’”⁵²

Despite such an admonition, some analysts surmise that government is likely to step up to the plate under any risk allocation scheme. In a study undertaken in 2005 on government’s role in insurance after events such as Hurricane Katrina, an analyst at the Brookings Institution, Robert Litan, has articulated this well:

*History has demonstrated time after time that when disaster strikes, especially mega-disasters, governments will not sit idly by and let injured people suffer. Government has provided disaster aid and always will do so in the future. The issue for policymakers is how to pay for that aid: wait until the disasters happen, and then borrow or print money; to impose higher taxes or cut back other programs; or to pre-fund, to the extent possible, the costs of future mega-catastrophes by charging insurance premiums (through private insurers) to those most exposed to those losses.*⁵³

The pre-funding program Litan proposes in his study is a formal federal reinsurance program open to primary insurers and re-insurers and administered by a quasi-independent arm of the Treasury Department. Litan argues that risk-sharing achieved through such an approach provides correct incentives for insured parties to identify and develop risk mitigation activities. In the case of the launch industry, these could include R&D for safer vehicles and launch procedures. The existing CSLA indemnification approach may or may not be encouraging the socially optimal amount of safety R&D, but amendments to reallocate at least some of the burden from government to industry may induce greater effort in mitigating third-party losses.

In this approach, the transition from the current regime to a reinsurance program could be phased in over time – say, a decade or so. An advisory group of insurance experts, including individuals from industry as well as neutral parties (such as leading university-based analysts in insurance and finance markets), representatives of industry, and FAA/AST could be set up to explore program design and implementation. The response of the insurance industry may involve increasing the use of private

⁵² Richard J. Hillman, “Terrorism Insurance: Alternative Programs for Protecting Insurance Consumers,” U.S. General Accounting Office, Testimony before the Subcommittee on Capital Markets, Insurance, and Government Sponsored Enterprises, Committee on Financial Services, U.S. House of Representatives, October 24, 2001.

⁵³ Robert E. Litan, “Sharing and Reducing the Financial Risks of Future Mega-Catastrophes,” *Issues in Economic Policy*, Brookings Institution, March 2006. Litan defines a “mega-catastrophe” as a single natural disaster or a combination of lesser disasters in a year with financial impacts on insurers such that *going forward* the potential events become uninsurable or excluded in standard policies – that is, the events cause insurance markets to fail.

reinsurance, building surplus by tapping into capital markets, and raising premiums or placing exclusions on some policies. Such adjustments are likely to involve both short-term and longer-term changes in coverage and pricing.

An approach of this type for the commercial launch industry could be structured as follows:

- (1) The first layer of losses would be paid by the private sector. This would be a continuation of the current Tier I practice.
- (2) Primary insurers, reinsurers, and catastrophe-linked securities would pay for the next layer of losses up to some large amount. This step would reassign liability for Tier II from government to insurers.⁵⁴
- (3) Federal government insurance is triggered beyond this large amount. Litan discusses ways to determine this third-tier amount and proposes that the government retain independent experts in risk assessment to play an objective role in defining the amount.

This model offers a framework for evolving launch indemnification policy. It suggests a path for increasing the role of the private sector in recognition of industry maturity and the capacity of the insurance market to creatively respond to a new market opportunity. At the same time, the role of government as a backstop is maintained, securing responsibility for treaty provisions (as discussed in Chapter 1) and recognizing the dual role of space transportation in commercial and government markets.

The closest precedent underpinning this model of gradual allocation of risk from government to the private sector is the amended Price-Anderson Act governing the commercial nuclear power industry. That industry, like space transportation, involves inherently hazardous technology-driven activities with a low probability of high-consequence accidents. Both industries have also benefited from government risk-sharing programs since their inception as commercial activities and in neither industry has there been an accident in which the Congress has been required to take action on excessive losses. The risk sharing practices in both industries have become emulated in the public policy of nearly if not all countries having these technologies – thereby influencing the playing field for commercial industry sales of both nuclear plants and space vehicles. Both risk-sharing programs were originally designed for limited duration, are keyed to the availability of liability insurance in the private sector market, and have been extended several times, although unlike indemnification for commercial space transportation, extensions of Price-Anderson have included increasing reallocation of risk to the private sector. The Price-Anderson Act, as amended, has placed U.S. government financial support in a third tier, while the industry must cover the first (insurance policy) and second (industry pool) tiers.

Is this model appropriate for the commercial space transportation industry? One concern might be the relative size of the industries. In commercial nuclear power, 12 large utilities plus the Tennessee Valley Authority, each with multi-billion dollar annual revenues, own and operate 75% of total capacity and about two-thirds of the nation's 100 nuclear power plants.⁵⁵ The industry pool which funds the second tier thus has a larger number of entities making contributions and over which to spread risk. In contrast, the commercial launch services market at present is made up of a small number of buyers and sellers.

⁵⁴ Litan envisions a role for state catastrophe funds at this tier. In his focus on natural disasters, he argues for state involvement on the basis of fairness, linking liability to those states in which the economic activity takes place and generates jobs and revenue. States with populations most at risk from launch accidents, such as Florida and California, could be included at this second tier.

⁵⁵ U.S. Department of Energy, "Nuclear Reactors Built, Being Built, or Planned in the United States: 2003," DOE/NE-0118, December 2003; Scully Capital, "Business Case for New Nuclear Power Plants," Report to the Department of Energy, July 2002 (<http://www.ne.doe.gov/home/bc/businesscase.html>).

Seven companies have active FAA launch licenses.⁵⁶ For the largest U.S. launch providers (Boeing, Lockheed Martin, and Orbital Sciences Corporation), commercial space launch is a very small part of their business portfolio.⁵⁷ But comparisons based on these numbers do not tell the whole story. Because the commercial nuclear power industry is much larger than the commercial space transportation industry and the nature of third-party risk is quite different, the absolute dollar amounts that trigger each tier are not comparable. For example, government backing is now triggered at losses of about \$9.5 billion under Price-Anderson.

Even so, if the model of gradual risk reallocation to the private sector were employed, it could take years to build up an adequate funding pool. In the case of Price-Anderson, government backing was drastically cut back and third-party risk was increasingly redistributed to industry but only as the industry grew in terms of both number of owners and industry revenue. There were fewer than 10 plants and even fewer owners until 1971; until that time, many plants were experimental, joint programs with government, or pilot plants. The number of plants doubled by 1974, however, and the number of plants and owners grew rapidly. This pace of successful risk reallocation from government to industry suggests that timing matters, hence the proposal for the phased approach outlined above.

It is also the case that although contributions ideally would be keyed to the relative third-party risk associated with each member's transportation technology and operations, contributions could increase the cost of entry to new players in the space transportation market. Failed ventures, or established providers who choose to leave the commercial market, would seek refunds of contributions they had made to the pool, creating uncertainty regarding the pool's capacity and stability. It is also worth noting that this approach – as any approach that involves government as partner and involves compliance with the FAA licensing rules – would require management by a federal bureaucracy, so the government would incur routine administrative costs even if no liability claims were made.

Chapter 2 noted that operating an industry liability pool that was open to participation by foreign launch companies was one way of making up for the small number of domestic participants. However, it is not clear whether foreign companies would see a benefit in participating. In the case of commercial aviation, insurance pools and other arrangements are international. The multinational joint venture of Sea Launch and the “integrated schedule insurance” by which companies based in different countries pool their vehicle availability to provide backup capacity for customers (see Chapter 2) are recent developments which bode well for willingness to pool resources internationally. However, as noted in Chapter 4, foreign launching states already have indemnification arrangements in place, and no plans to eliminate them. For this reason, participating in a pool to support second-tier coverage may be unattractive to launch providers in these states. Additionally, they may not wish to join a fund that is managed or regulated by the U.S. government, established for the purpose of aiding their U.S. competitors.

⁵⁶ The companies are Boeing, Lockheed Martin, Orbital Sciences Corporation, Sea Launch, Interorbital Systems, SpaceX, and XCOR Aerospace. See http://ast.faa.gov/lrra/current_licenses.cfm (accessed January 2006). Currently, commercial marketing of Boeing's Delta is on hold, so Boeing's participation in the commercial launch market is limited to its 40% stake in Sea Launch.

⁵⁷ Boeing's 2005 revenue was \$54.8 billion (<http://www.boeing.com/companyoffices/aboutus/brief.html>), a tiny fraction of which came from the company's 40% interest in Sea Launch's four commercial launches. Lockheed Martin had 2005 sales of \$37.2 billion (<http://www.lockheedmartin.com/>), which included commercial launch revenues from its 50% share of five ILS launches (one Atlas, four Russian Protons). Orbital Sciences Corporation had approximately \$700 million in revenue in 2005, about 10% of which was for space launch vehicles (Orbital Sciences Corporation Investor Fact Sheet, December 2005). Its three launches for the year included two for DoD and one for NASA (<http://www.orbital.com/SpaceLaunch/>).

Some concluding observations about differences between commercial nuclear power and commercial space transportation highlight the policy implications of any changes in the indemnification program. To a greater degree than in commercial nuclear power, commercial space has long been and remains an industry supported in part as a means of demonstrating international technological prowess. Commercial space, and space transportation in particular, have also long been thought to be a market in which the U.S. would like international dominance. And to a lesser extent than in commercial nuclear power (with the significant exception of control of nuclear waste disposal and associated proliferation issues), the relationship between national security and commercial activities in space (for example, dual use of assets, control of missile technology) remains a dominant concern.

The Price-Anderson Act continues to specify the third-party liability risk-sharing regime for the nuclear power industry, with the potential for government backing, a half-century after it was introduced. Its recent extension to 2025 – nearly seven decades after it was put in place – would seem to indicate that very long timelines are required for a complete transition to privately managed liability risk. For the foreseeable future, it will continue to be a hazardous industry with a low probability of high-consequence accidents, making it a candidate for government oversight and possible risk-sharing. U.S. launch providers would argue that the same is true for the commercial space launch industry 18 years after the CSLA Amendments.

3.3 Launch Providers' Perspective

The FAA's Tier I third-party liability insurance requirement is designed to let private-sector parties (i.e., launch providers and insurers) absorb full responsibility for non-catastrophic accidents. Tier II (government) indemnification would come into play only if damage claims were made that exceeded Tier I insurance, a circumstance that, by FAA's determination, has a one in ten million chance of occurring. An opponent of government indemnification likely would assess this situation by saying, "If the probability of catastrophic loss is so miniscule, why does industry need the government to help share the risk?" A proponent of government indemnification likely would respond, "If the probability is so miniscule, why should the government be concerned about accepting some risk?" Indeed, the government's risk is further mitigated by the requirement for claims to be paid through the congressional appropriations process. Since the indemnification regime does not provide for automatic payment of claims, it can be viewed as merely a procedure established to allow industry to request government help – with no guarantee that it will be forthcoming.

Launch industry players surveyed for this report cite market factors that they believe argue for government retention of third-party liability risk sharing. All of them add up to a belief that elimination or significant reduction of the U.S. indemnification regime would tilt the playing field in favor of foreign competitors. According to the U.S. launch industry:

- Indemnification has become a worldwide industry standard and is a factor in contract negotiations. Removing it would be a "market killer" because foreign competitors could then offer customers a level of insurance coverage that U.S. firms could not match.
- The U.S. regime's shortcomings – a cap on government support and the requirement for a lengthy approval process that includes congressional appropriation – already are used against U.S. companies by foreign competitors. Customers of U.S. companies generally understand how the U.S. system works, but often ask about shortcomings that the competition has highlighted. Elimination of the current regime would only prompt further marketing attacks.
- Elimination of indemnification would send yet another signal to the world that the U.S. government does not support its commercial space industry. Currently, the industry is fighting the negative consequences of export control limitations that go beyond those faced by foreign competitors. Also, the use of Air Force launch facilities involves additional limitations and

requirements, prompting foreign competitors to scare potential customers away from U.S. companies by saying, “The Air Force could bump your payload!”

Even though there has never been a claim under the risk-sharing regime, and even though the current regime has its shortcomings, industry respondents indicated that its elimination would have a negative effect on their business calculus. Here are consequences of elimination that were enumerated by launch providers:

- Corporate decision-makers would rethink the benefits and risks of staying in the commercial launch business. All respondents believed elimination of indemnification would be a further step toward making U.S. companies non-competitive in the global launch services market.
- Most respondents would feel compelled to purchase additional insurance, but would not make any guesses as to how much would be enough. Lack of information on the additional cost contributes to the undesirability of this solution. Higher insurance costs would be passed along to customers, further eroding competitiveness.
- Foreign vehicles could become the commercial launchers of choice for U.S.-affiliated companies offering both U.S. and non-U.S. vehicles. If a foreign government is providing risk-sharing while the U.S. government is not, this will make the foreign launcher more attractive to customers and less risk for the launch provider.
- The space industrial base supporting national security could be undermined if launch providers for U.S. government missions lose market share, increasing their per-unit costs and possibly driving them out of the commercial launch business. Similarly, a catastrophic damage claim that is not adequately covered by insurance could drive a company out of the launch business or into bankruptcy.

When asked about possible revisions to the indemnification regime, agreement among launch providers was not universal. Most feel that all licensed launch providers should be treated equally in the indemnification process, regardless of size or historical success rate. But some believe that Tier II coverage should take into consideration the historical performance of the launch vehicle. Others suggest varying indemnification based on the size of the rocket and the location of the launch. One suggestion to account for the size variance was to categorize launchers into three groups, to be indemnified at different levels:

- Big launchers, which can do more damage over greater distances, and are operated by companies with deep pockets.
- Small launchers, which are likely to do less damage, and are typically operated by companies that do not have deep pockets.
- Sub-orbital rockets, which are small and have localized flight paths.

This approach raises several questions. It may not be possible to assign specific levels of coverage to each category that will satisfy all the players. Should big launchers get more coverage because they can cause more damage, or less because big companies have deeper pockets and operate evolved versions of U.S. government legacy systems? How should the FAA quantify the difference between “more” damage and “less” damage for low-probability catastrophic events? How should the FAA categorize small launchers from large companies, like Lockheed Martin’s Athena or Orbital Sciences’ Taurus? Although these complexities weigh against the approach, the FAA MPL determination in practice accounts for most of these differences, and results in a wide range of MPL requirements by type of vehicle, launch site, and other factors.

Current U.S. policy and law encourage entrepreneurial companies to enter the space launch market. Most respondents – including some U.S. and foreign payload customers – believe elimination of indemnification would discourage entrepreneurial launch efforts. One representative of a large launch company suggested that launch entrepreneurs who haven't flown yet aren't showing much interest in the indemnification issue yet, but they will eventually. However, it's clear that some smaller companies are already thinking about this. They insist that elimination of indemnification by itself would not keep them from entering the market, but they would alter their business and operational plans. As with the big players, they may seek to buy additional insurance coverage, but fear that the buying power of their big competitors would absorb all of the coverage available at a reasonable price. An alternative approach would be to move launch operations away from population centers – out to sea or to a remote location such as Wake Island or Kwajalein Atoll. Entrepreneurial firms would pass the costs of either approach to customers, contributing to a market price disadvantage.

In sum, all launch providers in the survey strongly believe the current risk-sharing regime for third-party liability should be retained, and even strengthened – whatever it takes to maintain a level playing field with global competitors. The majority of respondents also feel that all licensed launch providers should be treated equally, regardless of vehicle size or history.

Industry's position is perhaps best summarized by the following recommendations, expressing the consensus of the membership of the Aerospace Industries Association (AIA):

- **Make the current third party liability risk-sharing regime permanent by eliminating the sunset clause.**
- **Eliminate the current cap on the U.S. government's commitment to pay successful third party claims.** The cap creates an arbitrary barrier that, among other things, unnecessarily limits the U.S. government's flexibility with respect to paying claims in excess of the cap should it be deemed appropriate to do so.
- **Streamline the process for reviewing and approving claims.** The complexity and potential duration of this process creates uncertainty. Currently, before a payment is made, notice of a claim must be given to the U.S. government, which must be given an opportunity to participate or assist in the defense of the claim. Once it is determined that liabilities exceed the requisite amount of purchased insurance, the Secretary of Transportation must review the causes and extent of damages, approve the settlement, and then submit a report to the Congress. Additionally, on the recommendation of the Secretary, the President must submit a compensation plan to the Congress requesting appropriations or legislative authority, and Congress must take appropriate action.

The AIA contends that since its inception, the current risk-sharing regime has afforded the U.S. space transportation industry predictability and stability. Launch providers know that third-party liability is covered up to a certain limit. Satellite customers know that risk sharing is provided regardless of the launch vehicle and the launch site. New entrants to the launch market are covered by the same set of conditions for third-party liability as existing providers.

If the current third-party liability risk-sharing regime is allowed to expire or is phased out over time, the U.S. launch industry expects three major impacts:

- **A tilt in the playing field in favor of foreign launch competitors.** The long-time practice of protection provided to U.S. launch providers by the United States would disappear, leading the global customer base to question how risk will be addressed by U.S. companies. The current third-party liability risk-sharing regime helps to level the playing field by incorporating rules and

conditions into the FAA licensing process that are known and relied upon by all players in the industry.

- **Introduction of unpredictability and instability in the market.** The insurance market is already uncertain. The pool of insurance available at any time fluctuates from year to year. But the current risk-sharing regime provides a self-adjusting mechanism linked to the amount of insurance that is available on the open market. If the U.S. government role were removed, one may expect potential customers to demand higher and more liberal insurance protection in their launch contracts, resulting in higher costs that either squeeze the U.S. providers' margins or adversely impact competitiveness. Satellite customers may not want to risk flying on a U.S. launch vehicle if the third-party liability risk management regime becomes uncertain.
- **Additional barriers to entry for new competitors in the market.** Smaller companies would have less access to insurance because of their inability to compete with the buying power of larger, more established companies. Smaller companies may be forced to “bet the company” that their available liability insurance coverage is sufficient to cover potential claims.

3.4 Launch Customers' Perspective

Like the launch providers, payload customers surveyed for this study view government third-party liability indemnification as an industry standard. It is a prerequisite for choosing and doing business with any launch services provider. While liability indemnification coverage varies among the launch service providers of different nations, it is generally understood that each launch company maintains sufficient amounts of coverage to provide adequate compensation in the event of a launch mishap. In one case, a satellite operator noted that his nation's law requires companies to demonstrate sufficient insurance protection for third-party liability as a condition of the operator's license. *Both foreign and U.S. payload customers indicated that elimination of government indemnification would discourage their use of U.S. launchers.*

As an example of the seriousness with which satellite operators treat third-party liability issues, one operator of a global constellation carries liability insurance for the life of its satellites to cover the various governments whose slots are being used, at a total annual cost of about \$700,000. This operator would need to reconsider reliance on U.S. launchers if their use would increase risk exposure or prompt the purchase of large additional amounts of insurance.

Some respondents see the prospect of elimination of indemnification as a second major blow to U.S. competitiveness in space commerce in recent years, the first being the export control restrictions put in place in 1999, which have discouraged potential foreign customers and resulted in marketing advantages for foreign competitors. In the words of a foreign payload customer, “If the government wants a dynamic, viable satellite launch business to be in place it needs to ensure that it foster the correct environment.”

3.5 Space Insurance Industry Perspective

3.5.1 Maturity of the Launch Liability Insurance Market

In addition to nurturing a commercial launch industry, the indemnification regime was also intended to tide the industry over until the space launch insurance market demonstrated adequate capacity. Developing capacity of the launch insurance market is not a statutory goal of the CSLA amendments but congressional concerns about the ability of the market to meet requirements of commercial launch companies are prominent in accompanying report language. A number of hearings were held specifically to focus on the insurance issue. Two concerns were dominant in these discussions. One was a concern that commercial launch insurance would be a new market and it would take some time

for insurers to structure and build the market (the market for payload insurance was well developed but the market for launch insurance was less developed). Another concern was the financial capacity of launch insurers. On one hand, proponents of indemnification noted that “the volatility of premiums even in the absence of losses suggests that any third-party liability claim could send premiums exorbitantly high.” On the other hand, some experts concluded that the current (1988) capacity of the insurance market was very high, up to \$1 billion.⁵⁸

The historic availability of government indemnification likely influences the size of the private insurance market that is observed today. In the absence of indemnification, the observed capacity of the market may be greater and insurers may have exploited the increasingly large array of evolved and new financial instruments (as discussed earlier, these include the greater use of an evolved reinsurance industry, as well as CAT bonds and insurance pools), although it is not clear that this would have been sufficient to replace the entire amount currently covered by indemnification.

Insurance markets for all types of commodities and activities generally follow an industry cycle of soft and hard market conditions; these include increases and decreases in premiums, profits, and coverage. Premiums are a major but typically not the only source of revenue for insurers. They also have investment portfolios, policyholders’ surpluses in the form of retained earnings, and capital raised from outside. Primary insurance companies typically purchase reinsurance to spread the primary insurer’s risk; reinsurance enables the primary insurer to manage their overall risk exposure and to underwrite more policy coverage. Reinsurers themselves may purchase reinsurance and hold surplus. Taken together, these characteristics of insurance markets give insurers significant flexibility in responding to market conditions.

Total annual third-party launch liability insurance premiums worldwide were estimated to be between \$2 million and \$10 million in the DOT/FAA 2002 report (Appendix D) and now, as then, are part of an aerospace insurance market that includes commercial airlines, general aviation, satellites, aviation product liability, government space launch range facility property liability, and space launch third-party liability. According to the 2002 study, premiums collected for third-party liability represent only about 0.1 percent of all aerospace premiums, from a total aerospace insurance market with annual premiums between \$3 billion and \$5 billion. Claims that might exceed third-party premiums would be paid from capacity built from other insurance industry capacity, although insurance markets are not typically cross-utilized to cover losses in other markets.

Insurance industry representatives interviewed for the DOT/FAA 2002 study either favored continuation of the existing risk-sharing regime or modifications that eliminate the stipulation that Congress has to appropriate funds for the indemnification provision. Even though elimination could result in more business for insurers, they were concerned that elimination could reduce the competitiveness of U.S. launch companies and in turn, offset insurers’ potential business gains.

In discussions with insurers for the present study, the most frequent adjective used to describe the insurance market conditions for commercial launch third-party liability was “fragile.” According to insurers today, not much has changed since 1988.

As noted, third-party liability for commercial launch is a very minor subset of the Aviation Products and General Liability portfolio. As a result, the availability and cost are subject to all the influences that govern this wider portfolio rather than being limited to factors affecting only commercial space launch. Launch liability insurers currently are willing to risk \$300-500 million per event. But this

⁵⁸ U.S. Senate Committee on Commerce, Science, and Transportation, “Insurance and the U.S. Commercial Space Launch Industry,” 100th Congress, 2nd Session, S. Print 100-112, July 1988, p. 12.

amount fluctuates widely, and one big claim against this pool would change the situation dramatically. The launch industry has an impressive safety record in this area, but insurers express the concern that the annual number of commercial space launches hasn't increased enough since 1988 to enable the insurance industry's earning capability to support a catastrophe loss. In fact, Table 3.1, from the International Space Brokers Group, illustrates that the industry lacks the robustness to recover quickly even from a single maximum probable loss claim.

Based on expected launches for a 10-year period through 2014, the analysis shows that decades of future premiums would be required to replenish the loss from just one maximum probable loss claim, regardless of the size of the rocket. According to insurers, even a modest claim would be enough to drive prices up, if not diminish available capacity. So far, the industry has been fortunate that no such claims have been made. But eventually, at a launch site somewhere in the world, stringent standards, hard work, and luck could fail to prevent a catastrophic accident, and the launch liability insurance system will face its first real test.

Table 3.1: Third-Party Launch Liability Insurance Market, 2005-2014

NUMBER OF LAUNCHES SEEKING LIABILITY INSURANCE	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	Total	Annual Average
GSO – Medium to Heavy LV	19	16	15	14	14	15	17	17	17	20	164	16.4
Non-GSO – Medium to Heavy LV	1	8	7	2	1	1	1	1	2	1	25	2.5
Non-GSO Small LV	5	5	5	4	4	4	3	3	4	2	39	3.9

10-YR. PROJECTED INSURANCE PROCEEDS	Amount Insured	Premium Per Launch	Total Premium Anticipated	Average Annual Premium
GSO – Medium to Heavy LV	\$140M-165M	\$150,000	\$24,600,000	\$2,460,000
Non-GSO – Medium to Heavy LV	\$100M-140M	\$100,000	\$2,500,000	\$250,000
Non-GSO Small LV	\$25M-75M	\$50,000	\$1,950,000	\$195,000
Total			\$29,050,000	\$2,905,000

REQUIRED PREMIUM TO COVER ONE MAXIMUM PROBABLE LOSS	Assumed Value	Accrued Premium to Pay One Maximum Probable Loss Claim
GSO - Medium to Heavy LV	\$165,000,000	56.80 years
Non-GSO – Medium to Heavy LV	\$140,000,000	48.19 years
NGSO Small LV	\$75,000,000	25.82 years

Source: International Space Brokers Group

Based on this assessment, a maximum loss would wipe out historic profitability in this class of coverage and would force insurers to rethink their investment in this area. As one insurer put it, “the larger the loss, the more likely the availability of this insurance will cease to exist.” It is highly likely capacity would be unavailable for some time after an MPL payout, which means no new premiums would be collected and therefore recovery would be delayed further. Since third-party liability coverage for space launch is not a dedicated market, but rather a derivative of the aviation liability market, major

claims in the aviation arena (and, in some cases, catastrophic loss liability insurance in general) could have similar negative effects on insurance availability for space launches.

Given the current fragility of the insurance pool available for Tier I requirements, space insurers are in agreement that if Tier II coverage were eliminated, the additional coverage they could offer to launch providers would not constitute a significant fraction of what can be accommodated under the U.S. government's indemnification regime.

3.5.2 Insurance Industry Concerns

In most ways, the space insurance community, launch providers, and payload customers participating in this study are in agreement regarding the market environment and the potential consequences of elimination of third-party liability indemnification. Insurers agree that government indemnification has become an industry standard and should continue to be provided equally to all U.S. launch providers regardless of size or launch history. Insurers do not necessarily see indemnification as having been an issue to date in choosing a launch vehicle, but they believe it will become an issue if it is terminated. There was no consensus among insurers on whether termination would discourage new U.S. launch providers from entering the market.

One of the difficulties in assessing the implications of eliminating indemnification is that empirical data is insufficient to quantify how much additional insurance U.S. launch providers would buy under such circumstances, and how much they would be willing to pay for it. According to space insurers, marginal additional coverage likely would be available at reasonable cost, but if insurance buyers begin to demand substantially more than the coverage currently required (i.e., a significant fraction of today's Tier II indemnification), market capacity would fall short, the price would go up, and larger companies may choose to use their financial muscle to ensure their insurance needs are filled at the expense of smaller companies.

Another concern is the effect on the launch providers' subcontractors. Today, FAA regulations mandate that subcontractors be covered under the Tier I insurance policies of the prime contractors, and all relevant parties operate under cross-waivers of liability. But if the liability coverage commercially available to the prime contractors is unable to handle all probable claims in the absence of government indemnification, the primes may seek to reallocate financial risk to their subcontractors. If a reallocation scheme were to be approved by the FAA to accommodate the primes, third-party claimants would not hesitate to go after subcontractors (especially those with deep pockets), sending a chill throughout the industry that could undermine the supply chain. Subcontractors could see their risks increase and their profit margins eroded by requirements to purchase new liability insurance. Increased insurance demand from subcontractors would become another factor driving up premiums and absorbing limited capacity.

3.5.3 New Demands on the Insurance Pool

New space insurance customers must be considered as well, since they will increase demand on the insurance market. Because RLV and reentry vehicles come under FAA licensing, they must demonstrate financial responsibility for the MPL and are covered by risk-sharing once they are granted an operational license. Domestic entrepreneurs such as SpaceX and foreign programs in countries such as India and Brazil could become additional players seeking commercial third-party liability coverage. Looking past the expiration of the current U.S. indemnification regime in 2009, the likelihood increases that U.S. launchers will face more competitors for a finite pool of insurance. If the payload traffic at that time can sustain these new launch providers, the demand for liability insurance may result in higher premiums until the insurance market's capacity and the relative safety of the new vehicles improve.

Another factor must be considered as new launch providers enter the global market: launch accidents involving new, unproven vehicles – which historically have experienced the most failures – could result in sizable liability claims. The cost and availability of insurance for U.S. companies is affected by the claims history of all space launch ventures around the world. To date, accidents affecting third parties have been few and claims have been minimal. FAA licensing requirements stipulate that new US vehicles must be operated to meet the same safety standards, but the practices of other countries’ launching authorities for new vehicles remain to be established. If traditional safety and reliability standards are not maintained as more players join the launch industry, then a catastrophic accident could drain the worldwide liability insurance pool for all commercial launch providers for a period of time. Public safety regulations for space launch are unique to each launching state, and the U.S. has no control over launch safety standards other than its own.

A different example of a new space industry player that could make demands on the liability insurance pool is the European consortium that will operate the Galileo constellation of positioning, navigation, and timing satellites. The Galileo consortium plans to guarantee the accuracy of its signals for commercial and government customers. A mishap (such as a plane crash) resulting from a faulty signal could leave the consortium liable for damages. The Galileo managers are addressing this issue, and have received proposals from space insurers who were among those consulted for this report.⁵⁹ When queried for this study, insurers acknowledged that there will be some exposure to this new risk for the same pool of insurers that handle third-party launch liability. This greater risk of loss will put further demands on the launch liability insurance market.

The insurance needs of the Galileo consortium would differ from those of launch providers. In the case of the latter, the insurance coverage is associated with an event. Once a launch is successfully completed, insurance resources are freed up for use by another launch provider. Galileo, on the other hand, will require continuous coverage. If Galileo buys an insurance policy that draws on the launch liability pool for \$X million in coverage, then the pool effectively shrinks by that amount for all other customers for the duration of Galileo’s insurance policy.

Similarly, reusable launch vehicles (RLVs) could tie up insurance funding for longer periods than ELVs. Insurance capacity is committed not just for the launch, but for the reentry as well. That could occur in minutes, hours, days, or longer. Over time, RLV flight durations can be expected to increase. In today’s market, insurers do not want to be committed to a single launch event for longer than a year. To allow for launch delays, policies typically are written three to six months prior to a scheduled launch. As RLVs mature, they may challenge the insurance industry’s tolerance for the duration of its commitment to a single event.

Taking a step further, a private company like Bigelow Aerospace may succeed in deploying large structures in low Earth orbit (LEO) to serve multiple purposes. Large structures cannot be counted on to burn up completely on reentry, and therefore would also be candidates for third-party liability insurance. This is another example of a need for continuous coverage that could increase the demand for insurance capacity.

There is always the possibility that the addition of successful new players in the market will entice more insurers to invest in it, enlarging the size of the pool. This cannot be predicted with confidence since it is driven by many variables, including insurers’ perceptions of growing profitability. However, it can be predicted that a major claim against the pool would discourage its growth, and probably cause it to shrink for a considerable time.

⁵⁹ Peter B. de Selding, “Galileo Completion Not Anticipated Until About 2011,” *Space News*, September 12, 2005, p. 15.

3.5.4 Potential Effects of Unrelated Events or a Depressed Insurance Market

Any assessment of the behavior of the launch liability insurance market must consider events unrelated to space launch that will have ripple effects throughout the greater liability insurance market. The obvious example is the recovery from the devastating 2005 hurricane season in the U.S., which could cause a tightening of capacity across all lines of the insurance business due to the enormity of the catastrophe. Additionally, as noted earlier, launch liability insurance is a very small portion of the aviation insurance pool, so a catastrophic airline accident resulting in third-party claims will absorb capacity at the expense of the space launch pool.

The Tier I insurance requirement is either a vehicle-specific amount specified by the FAA or the *maximum available on the world market at reasonable cost*. If market capacity is reduced and vehicle-specific targets cannot be met, the likelihood of needing Tier II coverage in the event of an accident is increased. In the wake of a large third-party claim anywhere in the world, the maximum available on the world market for some time afterwards may approach zero. In that case, government indemnification may be the only third-party liability coverage available to U.S. launch providers.

If U.S. launch companies found themselves in a situation where little or no third-party coverage was available for a significant period of time, the FAA would have limited options for dealing with this in the licensing process. Launch licenses could be denied unless launch providers found some other way of fulfilling their MPL requirement, or until the insurance market recovered. Alternatively, licenses could be granted despite insufficient market availability of MPL coverage with the knowledge that any catastrophic accident resulting in third-party claims would depend on Tier II indemnification, possibly from the first dollar. Of course, if Tier II indemnification were eliminated, the only option may be the first alternative – denial of licenses, possibly for an extended period – which could mean the end of the U.S. commercial launch industry.

3.5.5 The Continuing Role of Indemnification

Over the years, other launching states have looked to the U.S. example and instituted their own similar indemnification regimes. The result is an industry standard that the U.S. initiated.

Since its inception in 1988, third-party launch liability indemnification has been viewed as a supplement that would be needed only in the event of a catastrophic accident exceeding available insurance coverage – a one-in-10 million event, by the FAA's reckoning. Despite the time that has elapsed since the indemnification regime was put in place, the global insurance market cannot provide affordable coverage at a level that would make up for withdrawal of government indemnification, according to industry representatives. In their view, a government-backed supplement is still needed in the absence of launch industry resources sufficient to cover catastrophic risk.

The perceived fragility of the launch liability insurance market and the likelihood of increasing demands on the limited insurance pool suggest that the indemnification regime has a second major function in addition to its role as a supplement. It is a backup mechanism that can sustain the liability insurance needs of the U.S. launch industry in case the insurance industry is unable to do so on its own. Without such a backup, insurers feel that a single catastrophic event anywhere in the world could severely curtail availability of insurance for a significant period of time, effectively shutting down U.S. commercial launches.

4. Risk-Sharing Regimes of Foreign Competitors

4.1 Background

Space launch third-party liability indemnification remains a sensitive topic in this highly competitive global market. Although past experience has shown that the probability of incurring a liability obligation is very low, the amount of potential liability could be great enough to play a role in the choice of a launching state based on the provisions of its indemnification regime.

There are very few examples of commercial launches that have caused property damage and/or injury to third parties. The estimated amount of third-party damage to date is very modest when compared to the requirements imposed on U.S. launch providers for Tier I insurance and comparable requirements in other launching states. As a result, governments that have space launch risk exposure are dependent on analyses that are chiefly concerned with theoretical potential.

Two prominent cases illustrate the minimal financial impact of third-party liability cases to date. The first is the Soviet military satellite Cosmos 954, which made an uncontrolled reentry in northern Canada on January 24, 1978 carrying a nuclear power source, which spread radioactive debris over a wide area.⁶⁰ There were no human casualties, but Canada suffered serious environmental consequences from the scattered debris. As an injured third party and signatory to the Liability Convention, Canada sought compensation of approximately six million Canadian dollars from the USSR for environmental cleanup.⁶¹ After three years of diplomatic negotiation, Canada obtained only half of the amount.⁶²

A more recent case was the launch failure of a Chinese Long March 3B which took place at China's Xichang Satellite Launch Center on February 15, 1996.⁶³ The launch carried an Intelsat 708 satellite, which was intended primarily for direct broadcast satellite services to Latin America. The failure caused property damage to third parties in the immediate area. Six people were reported killed, and another 57 were reported injured. The third-party liability payout was approximately \$2 million.

The lack of large liability claims tends to reduce the priority assigned to the issue by official sources. A large-scale incident could change this priority rapidly and lead many governments to review their liability policy.

In examining the launch liability risk-sharing of other spacefaring nations, this chapter includes country-specific descriptions which demonstrate that indemnification on the international scene remains essentially the same as it was reported in the DOT/FAA 2002 study. To assist in assessing the future of the U.S. regime, this study attempted to discover whether foreign launching states were contemplating any changes to their risk-sharing regime, and whether changes by the U.S. would elicit any reactions from these states. In general, responses indicate that foreign changes in risk-sharing are not on the horizon. If the U.S. alters its course, foreign nations do not plan to react in any way unless the actions would change U.S. obligations under the Liability Convention.

⁶⁰ M. Mateesco-Matte, "Cosmos 954," *Annals of Air and Space Law*, Vol. 3, McGill University, 1978.

⁶¹ Department of External Affairs, Canada, "Claim Against the Union of Soviet Socialist Republics for Damage Caused by Cosmos 954," No. FLA-268, January 23, 1979.

⁶² Department of External Affairs, Canada, "Settlement of Claim between Canada and the Union of Soviet Socialist Republics for Damage Caused by Cosmos 954," *Communique No. 27*, April 2, 1981.

⁶³ G. Abbey & N. Lane, "United States Space Policy – Challenges and Opportunities," *American Academy of Arts and Sciences*, 2005 (<http://www.amacad.org/publications/spacePolicy.pdf>).

4.2 Methodology

Seeking to forecast possible changes in national approaches and to uncover reactions to a possible change in U.S. policy, interviews were conducted using a questionnaire to facilitate and standardize the feedback. Questionnaires were sent to key representatives of launching states, and many were interviewed at locations in Europe and at the October 2005 International Astronautical Congress in Fukuoka, Japan. The persons contacted were selected on the basis of their familiarity with the topic. As expected, *official* statements of government positions were not forthcoming due to the competitiveness of the launch market and the disinclination to reveal future strategies. Nonetheless, all persons interviewed gave well-informed personal opinions. Many of them are in legal advisory roles for this issue and would be contacted automatically in their country in case a change in liability policy were to be considered. This provides confidence that the opinions gathered are highly representative of the situation.

The countries reviewed here were selected based on their likely competitiveness in the launch market in the coming years. In alphabetical order, they are Australia, Brazil, China, Europe (with details on France, United Kingdom, and Sweden), India, Japan, and Russia. All of these countries have ratified the Outer Space Treaty and the Liability Convention, and all but Brazil have ratified the Registration Convention.

4.3 Liability Indemnification in Commercial Launching States

4.3.1 Australia

Australia enacted the Space Activities Act in 1998 to facilitate commercial space launch activities and launching of Australian payloads from overseas sites. Australia has launch facilities in Woomera. The Space Licensing and Safety Office (SLASO) administers the Space Activities Act.⁶⁴

Section 48 of the Space Activities Act requires a license to operate a launch facility in Australia in conjunction with a specific launch vehicle along particular flight paths. The Act further establishes the conditions for issuance of such licenses for the applicant, who has to demonstrate the competence to obtain all environmental approvals as well as to minimize the risk to public health and safety to the maximum extent feasible.

It is also necessary to have a permit for the launch of a space object from Australia and for any associated return of that object or part thereof. The Act requires third-party liability insurance coverage for up to 750 million Australian dollars (equivalent to approximately \$565 million U.S.) or the maximum probable loss amount. In order to calculate the amount of maximum probable loss, one must take into account third-party casualty loss, property loss, environmental damage, and economic loss. The responsible party is not liable for damages in excess of the insured amount.

The liability period is defined to be within 30 days from launch, and from the beginning of a reentry maneuver to the time when the space object comes to rest on Earth. However, the Act does not address the liability of the launch operator or a responsible party for damage caused outside the liability period.

4.3.2 Brazil

Brazil's national space agency is Agencia Espacial Brasileira (AEB). The country has ratified the Outer Space Treaty and Liability Convention, but not the Registration Convention.

⁶⁴ Commonwealth of Australia, Space Activities Act 1998, No. 123, amended in 2001 and 2002.

Of particular interest in Brazilian space legislation is Administrative Edict N. 27 which approves the “Regulation of procedures and the definition of requirements necessary for request, evaluation, issuance, control and follow-up of licenses for carrying out space launching activities on Brazilian territory.”⁶⁵ In 2002, Brazil issued a second and complementary act with the same focus, which approves the “Regulation of procedures for the authorization to carry out space launching operations on Brazilian territory.”⁶⁶ These two pieces of space legislation were proposed by AEB and approved by its High Council and President. They oblige any private entity interested in carrying out launch activities in Brazil to obtain a license and an authorization for launch operations, providing the legal basis for governmental control over all the private launching activities in Brazil.⁶⁷

Article 9 of the license regulation stipulates that one of the economic and financial conditions to obtain a license is the “purchase of insurance to cover possible damages to third parties, according to the degree of risk of the activities to be carried out by applicant, where appropriate, in the value previously established by the AEB.” Article 9 of the authorization regulation requires applicants to present proof of insurance related to the particular launch operation, and Article 4 states that “the Licensee is required to contract an insurance company to cover damages to third parties that might be involved in each space launching operation, and noting that AEB shall establish the insurance's value.”

Article 5 of the license regulation gives the definition of damage: “loss of life, personal injuries, or other damage to health, loss of State property or of natural or legal persons’ property, or damages inflicted to such property.” The terms used here are very similar to those in the Liability Convention (Article I). The definition of damage in the authorization regulation is broader than the equivalent definition in the Liability Convention, however, as it includes not only the damage to intergovernmental organizations’ property, but also damage to the environment. This may be explained by the fact that the Brazilian government and local public opinion consider it of paramount importance to safeguard the entire Alcantara region's environment.

According to the Article 4, of the authorization regulation, “the liability for damages due to space launching shall be settled in accordance with space treaties and conventions of which Brazil is signatory, as well as other applicable norms, without prejudice to any contract that might have been entered into between the parties that laid down rules for the accountability of financial obligations.” Thus, Brazil recognizes its international obligations as a “launching state” and is liable for every space object launched from Brazilian territory, including private launches. At the same time, Brazilian legislation indicates the possibility of contractually sharing with other involved parties the financial obligations derived from damage caused by launched space objects.

The license and authorization regulations consider the insurance contract to be mandatory. However, they only state that the value of insurance will be fixed by the AEB without indicating the fixed amount. These regulations do not enter into details concerning the insurance coverage, because the Administrative Edict has no competence to regulate questions involving governmental expenses. These issues are an exclusive domain of the National Congress. However, the AEB has stated that the Brazilian government would be responsible for claims exceeding liability insurance coverage.

⁶⁵ Brazilian Space Agency, Ministry of Science and Technology, Administrative Edict N. 27, June 20, 2001.

⁶⁶ Brazilian Space Agency, Ministry of Science and Technology, Administrative Edict N. 05, 2002.

⁶⁷ José Monserrat Filho, “Recent Developments of the Brazilian Space Law,” *International Institute of Space Law*, 1998.

4.3.3 China

China became a spacefaring nation in 1970 when the first Chinese satellite DHF-I was orbited by the Long March launch vehicle. The China National Space Administration is the agency that carries out the country's space activities. At present, China does not have a specific national space law, but does recognize the importance of the topic.⁶⁸ The risk-sharing regime in China is difficult to link to a specific piece of legislation, but there are some internal regulations, including the first administrative regulation on space activities in China.⁶⁹

All international commercial space launches performed by China are supplied by the China Great Wall Industry Corporation (CGWIC) which was founded in 1980 and authorized by the Chinese government. This commercial launch services company has to purchase third-party liability insurance protection in the amount of \$100 million or the maximum coverage available on the world market. The insurance remains in effect for a period of two years following the launch. Full indemnification will be provided by the Chinese government for claims that exceed the third-party liability insurance coverage.

There have been a number of requests to formalize the third-party liability regime in China. It is highly desirable that such regime be adopted in the near future, and that it follow closely the international practices already in place.

4.3.4 Europe

4.3.4.1 Arianespace

According to Article 3.8 of the Declaration⁷⁰ signed on July 14, 1980 and revised on October 4, 1990, Arianespace shall be required to reimburse the French government, up to a ceiling of 60 million euros (approximately \$72 million) per launch in the case of damages caused by Ariane launches. Arianespace typically purchases insurance to cover this amount. If the damages exceed this amount the French government is obliged to indemnify the difference.

The risks covered are the liabilities for property and bodily harm caused to a third party by the launch vehicle, the satellite or secondary payload, or their components.

4.3.4.2 Other Launchers at the Guiana Space Center

On November 7, 2003, France and Russia signed an agreement that addressed long-term cooperation on the development, implementation, and use of the Soyuz-ST and the installation of its launch facilities at the Guiana Space Center.⁷¹ Article 10.2 of the agreement, which deals with liability issues, establishes that liability for third-party damages will be borne by the operator of the launcher (Arianespace) with the ceiling of 60 million euros per launch, the same as noted above for Ariane launches. If damages exceed this amount, then the additional liability will be indemnified equally by the governments of France and Russia. For circumstances related to the use and custody of ESA-provided assets (facilities, equipment, hardware, tooling), Article 9 states that Arianespace shall bear unlimited

⁶⁸ Liu Xiaohong, Wang Xiaoqing, "The First Administrative Regulation on Space Activities in China," United Nations/International Institute of Space Law (UN/IISL) Workshop on Capacity Building in Space Law, 2002.

⁶⁹ Administrative Regulation on Registration of Space Objects, February 8, 2001.

⁷⁰ European Space Agency, "Declaration by certain European governments relating to the Ariane Launcher Production Phase," July 14, 1980.

⁷¹ Convention between the European Space Agency and Arianespace on the exploitation of the Soyuz Launcher from the CSG (Guiana Space Center), November 7, 2003.

liability for damages caused to third parties. For this case Arianespace is obliged to take out third-party liability insurance.

France will register as the launching state for Soyuz launches carried out from the Guiana Space Center, in accordance with Article II of the Registration Convention and Article 10 of the ESA/Arianespace Convention.

For Guiana Space Center launches of the Italian-led Vega small launch vehicle, France will indemnify one-third of any liability claims beyond the insured amount and the remaining two-thirds will be divided among ESA member nations participating in the Vega program.⁷²

4.3.4.3 Starsem

Starsem is a space launch joint venture between European and Russian space industry. The company was created in August 1996 under French law in the context of a competing market fueled by a rapid growth of requests for launchers with new capacities. The alliance is a partnership between European Aeronautic, Defense, & Space Company (EADS) (35%), the Russian Space Agency (25%), Samara Space Center (TsSKB-Progress) (25%), and Arianespace (15%).

The company markets the Russian Soyuz rocket, currently operated from the Baikonur Cosmodrome and therefore subject to Russia's liability regime. However, in the near future the Soyuz launch operations will be moved to the French Guiana Space Center. The first Soyuz launch from that location is scheduled for 2008.

4.3.4.4 Eurockot

This joint venture between European and Russian space industry was created in 1995 in order to provide commercial launch services with the Rockot launch system, based on the SS-19 ballistic missile, for low Earth orbit (LEO) satellites. Eurockot is located in Bremen, Germany, and is 51% owned by EADS Space Transportation and 49% by the Russian company Khrunichev State Research and Production Space Center. Eurockot operates from dedicated launch facilities at Plesetsk in northern Russia, governed by the Russian liability regime. Eurockot includes third-party launch insurance coverage in Article 13 of its standard Launch Service Agreement (LSA). Typically it covers the period from lift-off until 12 months after the launch for the amount of 100 million euros (approximately equivalent to \$120 million).

4.3.4.5 United Kingdom

The U.K. established national space legislation in 1986 through its Outer Space Act. This legislation was drafted with the close collaboration of satellite operators and suppliers rather than launch service providers due to their greater relevance to U.K. space industry activities.

The Outer Space Act requires U.K. individuals and organizations to apply for a license from the British National Space Center (BNSC), which is responsible for the control of space activities. The license is needed for launching or procuring the launch of a space object, operating a space object, or for any other activity in outer space.

The U.K. government requires insurance against third-party liability claims arising from commercial space launches. Companies, which conduct space activities, have to take out third-party

⁷² Peter B. deSelding, "Liability at Guiana To Be Shared," *Space News*, December 19, 2005.

liability insurance for launch or in-orbit stages of the mission up to a minimum of 100 million British pounds (equivalent to approximately \$177 million). The insurance must also cover the possible expenses of the U.K. government. If damages are incurred by a third party, the launch operator is obliged to indemnify the U.K. Government for the international claims presented to the U.K. under the Liability Convention.

The implementation of the Outer Space Act of 1986 is under review, especially the current policy on insurance requirements for applicants for licensed activities. Satellite operators are concerned about the amount of third-party liability insurance and the required indemnification of the government. They believe the insurance market capacity is too limited and current rates are too expensive based on the lack of liability claims to date.

4.3.4.6 Sweden

Sweden is one of the few countries in Europe that has met its obligations through space legislation at a national level. The Act on Space Activities and the Decree on Space Activities⁷³ laid the foundation for the legal regime applicable to commercial space launches. Section 2 of the Act on Space Activities establishes that space activities cannot be carried out from Swedish territory without a license. This principle is equally applicable to both natural and juridical persons.

The governmental body responsible for issuing licenses is the National Board for Space Activities. The provisions of international conventions regarding strict liability and risk allocation have been incorporated into Swedish legislation by special statutes. These statutes provide the legal basis for reimbursement of liability incurred by the State. It is noteworthy that a precise amount is not specified in the relevant decrees.

4.3.5 India

India has ratified the Outer Space Treaty, Liability Convention, and Registration Convention. Consequently, India is liable under the 1972 Liability Convention to third parties for launch-related damages as a launching state. However, India does not have a national space law to harmonize international conventions which are necessary to meet international liability obligations at the national level.⁷⁴

One reason for the absence of national space law on liability is that commercial space launches are conducted by the Indian Space Research Organization (ISRO) and not by the private sector. However, when space launches are carried out from Indian launch sites, India currently provides third-party insurance of up to \$100 million. This figure may vary in relation to the expected trajectory of the space launch and an estimate of the likely damage an accident could cause.

4.3.6 Japan

Japan became a party to the Liability Convention in 1983. The Japan Aerospace Exploration Agency (JAXA) is the governmental body responsible for the space activities in Japan. The agency was formerly known as the National Space Development Agency of Japan (NASDA).

⁷³ Act on Space Activities (1982:963); Decree on Space Activities (1982:1069).

⁷⁴ Mehmood Pracha, "Indian Space Law and Policy – A Private Sector Perspective," United Nations/International Institute of Space Law (UN/IISL) Workshop on Capacity Building in Space Law, 2002.

Since developing a new family of H-II launch vehicles, based exclusively on Japanese technology, Japan has become more sensitive to third-party liability. The H-II technology is capable of both increasing the country's launch capability and opening the possibility of commercial satellite launches, thus raising issues of potential liability. Although there are not specific regulations concerning third-party liability, portions of the law establishing JAXA, Articles 21 and 22 in particular, are related to this topic.⁷⁵

Article 21 states that JAXA shall not launch any satellites without an insurance contract that can provide the necessary compensation for any damages are incurred. The law does not define the specific amount of such insurance. The law states only that the amount of the compensation allowed by the insurance contract has to be defined by the competent government minister and the contract has to be appropriate for protection of the victims. The Minister of Education, Culture, Sports, Science and Technology holds authority in this area.

In order to establish the appropriate amount of insurance, a maximum probable loss calculation is used. As in the U.S., the amount of the insurance coverage differs depending on the launch vehicle. For the H-IIA, for example, the third-party liability insurance is 20 billion yen (approximately \$168 million). For the smaller solid-fuel M-series rockets, the third-party liability insurance is usually 5 billion yen (approximately \$42 million).⁷⁶

4.3.7 Russia

Russia operates several different launch facilities. These include Plesetsk, Svobodny, Baikonur (located on the territory of Kazakhstan) and Kapustin Yar. Baikonur is the Russia's largest cosmodrome, used for both human spaceflights and unmanned launches, with facilities for Cyclone, Dneper, Molniya, Proton, Rockot, Soyuz, and Zenit launch vehicles.

On October 2, 1992 Russia and Kazakhstan signed an intergovernmental agreement, prohibiting privatization of the Baikonur Cosmodrome facilities.⁷⁷ Because the Baikonur launch facilities are of primary importance for the conduct of Russian space activities, Russia and Kazakhstan signed an agreement on the basic principles and terms of use of the Baikonur Cosmodrome on March 28, 1994. According to the terms of this agreement, Russia leased the Baikonur facilities for 20 years for the amount of \$115 million per year. On January 9, 2004, the two countries signed a revised agreement with similar conditions, but the lease period was extended to 50 years.

The Russian space agency Roscosmos has recently changed its reporting relationship. Since the March 9, 2004 presidential decree "On the systems and structure of federal bodies representing executive power," Roscosmos is under the control of the Ministry of Industry and Energy. The presidential decree and Article 8 of the Federal Law on Space Activity give the agency the right to hold direct negotiations and sign contracts with foreign space agencies, issue licenses for space activities, finance the federal space program, and organize and coordinate commercial space projects. Article 9.1 of the Federal Law provides the legal basis for the licensing procedure and addresses the testing, manufacturing, storage, launch preparation, and launch of space objects. According to the Article 11 of the Federal Law, before a license can be issued a special commission has to carry out an expert review of the space technology involved.

⁷⁵ Law concerning Japan Aerospace Exploration Agency, Law Number 161, December 13, 2002.

⁷⁶ Masahiko Sato, "The Japanese Legal Framework: Third-Party Liability Resulting From NASDA Launch Activities," *International Institute of Space Law*, 1998.

⁷⁷ M. Bjornerud, "Baikonur Continues: The New Lease Agreement Between Russia and Kazakhstan," *Journal of Space Law*, Vol. 30, No. 1, 2004, pp. 13-36.

An August 1993 Russian law (revised in November 1996) regulates the organization of space activities, licensing procedures, the use and transfer of space technology, and liability.⁷⁸ Article 25.1 deals with the obligation to obtain the mandatory insurance to conduct space activities. This insurance has to cover damages caused by a space object to astronauts, ground personnel, and any third party. The minimum amount of launch liability insurance depends on the specific launch vehicle and is determined by Roscosmos. Typical levels of compulsory insurance vary from \$80 million for Start launch vehicles to \$300 million for Soyuz and Proton. The Russian government pays liability claims in excess of insurance coverage if this is specified in the launch services contract. If it is not, the launch customer is liable for these claims.

Table 4.1 – Summary of Indemnification Regimes of Spacefaring Nations			
<i>Country</i>	<i>Regime</i>	<i>Amount</i>	<i>Comments</i>
Australia	Space Activities Act 1998	\$750 million Australian (~\$565 million U.S.) or MPL amount	Limit up to \$3 billion (Australian) for claims by Australian nationals
Brazil	License Regulation Authorization Regulation	No fixed amount	
China	No specific legislation	\$100 million	3 rd -party liability insurance is in effect for a period of 2 years following the launch.
France	Declaration by certain European governments relating to the Ariane Launcher Production Phase 1980	60 million euros (~\$72 million)	
UK	Outer Space Act 1986	100 million British pounds (~\$177 million)	
Sweden	Act on Space Activities (1982:963); Decree on Space Activities (1982:1069)	No fixed amount	
India	No National Space Legislation	\$100 million	
Japan	Law Concerning Japan Aerospace Exploration Agency, Law Number 161 of 13 th December 2002	20 billion yen for H-IIA (~\$168 million); 5 billion yen for smaller rocket (~\$42 million)	Amount of the insurance depends on the specific launch vehicle.
Russia	Decree No. 5663-1 “About Space Activity,” 1993	\$80 million for Start launch vehicles; \$300 million for Soyuz and Proton	Amount of the insurance depends on the specific launch vehicle.

4.4 Summary of Findings from Interviews and Questionnaires

On the question of whether any individual governments are planning to make changes, the general response was negative. Respondents noted a general satisfaction with the present risk-sharing regime in most countries reviewed. However, there are initial indications of efforts taking place in Europe and Australia to study some alternatives for sharing responsibility. Also, some changes are occurring in space organizations, particularly in Russia where a global review of the structure and function of its space agency is underway. This is unlikely to lead to immediate attention to third-party liability policy, but this position may change as new structures become established. Taking into account normal lead times, this is not likely to be the case for several years.

⁷⁸ Law of the Russian Federation, “About Space Activity,” Decree 5663-1, 1993; Decree No. 104, Statute on Licensing Space Operations, 1994.

It is noteworthy that the revised text being discussed in the UK for the Outer Space Act, as well as the draft French national space law due to be published in 2007, do not foresee any substantial changes in this area. This information is based upon discussions with the authors of both documents.

In the event of a change in U.S. policy in this matter, it appears unlikely that there would be any significant reaction as long as the general principles of the Liability Convention remain intact. Depending on the substance of such a change, some reactions seem possible where a change appears likely to influence competition. However, in view of the relatively low cost of liability insurance premiums, the probability of such reaction seems quite limited.

Table 4.2 – Summary of Interview Responses			
	<i>Has your government's risk-sharing arrangement changed since 2002? Are there any plans to change it in the next few years?</i>	<i>Is your government satisfied that its level of third-party risk sharing is appropriate, or would it like to reduce its risk exposure?</i>	<i>How would your country/company react if the U.S. government reduced or eliminated its third-party risk-sharing regime? Would your government be inclined to reduce its risk sharing?</i>
Australia	No current plan to change the legislation.	Satisfied for time being, but there are some proposals to lower the maximum Australian insurance standards.	No impact on Australian government policy in the short term.
Brazil	No plan to change the legal framework because the Brazilian Alcantara launch range is not in operation.	The question is not yet in open discussion.	Brazil will not react to these changes.
China	No plan to change it in the near future.	As long as 3 rd -party liability insurance is properly arranged and is in place before a commercial launch, the current risk-sharing arrangement is acceptable to the government and no reduction scheme can be foreseen at the moment.	Chinese government might consider a change if governments of all other commercial launch providers react and make changes. If U.S. export control laws and regulations remain unchanged, China does not have opportunities for marketing and business development.
Europe/ France	No changes in the near future.	Not calling into question the insurance with a ceiling of 60 million euros. French government would like to share the responsibility with others States (Russia for Soyuz-launcher at the Guiana Space Center and European States for VEGA launcher)	Very small probability that the French government would be inclined to reduce its risk sharing regime. Arianespace will seek to exploit the U.S. change for marketing advantages but the impact will be not very important because of the small 3 rd -party liability premium.
Europe/ UK	No changes in the past three years, but BNSC is currently reviewing the Outer Space Act licensing system.	The current 3 rd -party liability arrangement is a major part of the review, looking at different options for ensuring that risk is managed adequately.	Under review, but the probability is small that the UK government would have a reaction.

Table 4.2 – Summary of Interview Responses			
	<i>Has your government's risk-sharing arrangement changed since 2002? Are there any plans to change it in the next few years?</i>	<i>Is your government satisfied that its level of third-party risk sharing is appropriate, or would it like to reduce its risk exposure?</i>	<i>How would your country/company react if the U.S. government reduced or eliminated its third-party risk-sharing regime? Would your government be inclined to reduce its risk sharing?</i>
India	No changes in the past three years and no plan to change in the near future.	The level of the risk is appropriate for the time being.	If the U.S. government changed its current risk sharing regime, the Indian government would probably reconsider its legislation.
Japan	No plan to change the legal framework. The content of JAXA law uses the same formulation as the NASDA law amended in 1998.	The level of the risk is appropriate for the time being.	Because the level of activity in the commercial launch market is not very high, there is no reaction as long as the Liability Convention is intact.
Russia	No plan for changes.	The Russian Government is satisfied with the risk sharing regime for the time being.	It will depend on the position of the U.S. government.

5. Analysis and Options

The current third-party liability indemnification regime remains in force until the end of 2009. As a result, this study's analysis considers not only current circumstances but also the business environment that the U.S. launch industry may face in the next decade. Many factors that would affect a decision on the future of government indemnification could change:

- International competition could continue to increase.
- The number and characteristics of domestic launch providers could change significantly.
- Domestic launch providers could expand their operations through new technologies (e.g., reusable launch vehicles), new markets (e.g., space tourism), or new government policies (e.g., loosening of export controls, "buy American" laws, or privatization of International Space Station operations).
- A major launch accident or Katrina-like natural disaster could disrupt the liability insurance market.

Chapter 1 noted the long-held position of the executive and legislative branches that the success of the U.S. commercial launch industry is in the national interest, and that it is appropriate for the government to encourage and facilitate a healthy, internationally competitive industry. With this in mind, this chapter returns to the policy choice posed in Chapter 1: Which course of action better serves the national interest?

Maintenance of a policy/legal environment favoring the U.S. commercial space launch industry through government sharing of low-probability but potentially high-consequence third-party liability risk.

or

Phase-out of U.S. government (taxpayer) risk exposure for this hazardous private-sector activity.

Policy objectives that collectively support the national interest in this area are as follows:

- Assure adequate liability coverage for catastrophic launch-related events.
- Minimize U.S. government (taxpayer) risk exposure and annual outlays/subsidies.
- Improve economic benefits and strengthen the U.S. industrial base in space launch capabilities by:
 - Enhancing international competitiveness of the U.S. space transportation industry.
 - Maintaining continuity in the business environment for U.S. launch providers.
 - Encouraging new U.S. entrants to the commercial launch market.

This analysis does not endorse the option of simply allowing government indemnification to expire at the end of 2009 with nothing to take its place. Such an abrupt change would be too disruptive, leaving the U.S. commercial launch industry with little time to implement alternatives. At some point in its development, the industry may be able to shoulder more (and maybe all) of its liability risk. But that point is not on the immediate horizon. The robustness of the insurance market and private operators' ability to meet obligations in a secondary fund both appear to be lacking. While the pace of the industry's development is impossible to predict, it is likely that it will be more than a decade before both the launch and insurance industries reach the point where risk can be accommodated without government help.

5.1 Assure Adequate Liability Coverage for Catastrophic Launch-Related Events

This was one of the primary objectives of the 1988 amendments to the CSLA. The insurance industry at that time lacked sufficient capacity to handle a growing launch industry. By the time of the April 2002 DOT/FAA study (which based its findings on pre-9/11 interviews), capacity had grown so that up to \$1 billion in liability coverage was available per launch event. However, as noted earlier, capacity today stands at \$300-500 million per event, according to insurance industry representatives.

The fragility of the launch liability insurance market demonstrates the continuing need for a supplement to the Tier I insurance requirement. Marginal increases in Tier I coverage could be provided by the insurance industry, but not in amounts that would constitute a significant fraction of the Tier II indemnification available today from the U.S. government. Insurers would be happy to write contracts for greater coverage that would bring in higher premiums, but acknowledge that they can't do so at a reasonable price for amounts approaching the U.S. government's current indemnification limit. There is no evidence to indicate that the global insurance industry pool, in the absence of U.S. government indemnification, would ever make up the difference by growing to four or five times its current capacity as other launching states maintain their government indemnification regimes.

A further concern is that the amount of insurance available on the market to cover Tier I requirements could shrink to near zero in the event of a single large payout resulting from a launch mishap anywhere in the world. In such a circumstance, Tier II would become an essential backup to keep the U.S. launch industry alive until the insurance market recovers or other means are found to address liability risk-sharing. Without this backup, the U.S. commercial launch industry may have to suspend launch activity for an indefinite period, which could force some participants to exit the business permanently. In the absence of indemnification, the FAA may be compelled to suspend commercial licenses unless launch companies demonstrate the ability to provide alternative coverage of catastrophic risk. Meanwhile, foreign competitors can be expected to use their government indemnification regimes to keep their launch providers active.

If Tier II coverage were to be replaced by some sort of industry insurance pool, it is likely that such a pool would take a considerable number of years to grow to meaningful size. U.S. government indemnification would need to continue at gradually decreasing levels during this time. Government participation in liability risk-sharing in other areas, such as the nuclear power industry, floods, and terrorism, has involved a gradual ramping down of government risk exposure. If this approach is applied to the commercial space launch industry, it is essential to recognize that this industry is not directly comparable to the others in size, resources, or experience. (For example, as noted in Chapter 2, the nation's 104 nuclear power plants are distributed among more than 30 owners, with the top 13 accounting for three-quarters of U.S. nuclear power production and having multi-billion-dollar annual revenues.) Nor is it likely to evolve at a predictable rate, as demonstrated by the fact that insurance capacity in this business line is little changed from 1988.

There is a clear need for some type of Tier II coverage – the question is whether that tier is financed by the U.S. government or by industry. Assurance of adequate liability coverage for catastrophic launch-related events has been well served by the current arrangement. Maintaining this arrangement would be the simpler solution to fulfilling this policy objective since no new funding mechanisms or bureaucracy would need to be created.

5.2 Minimize U.S. Government Risk Exposure and Annual Outlays/Subsidies

The potential magnitude of the risk is large, but its probability is very low due to industry safety efforts and the FAA's enforcement of commercial launch license requirements. The current

indemnification regime has not resulted in any outlays for liability claims since it was initiated in 1988. It requires no government funding except in the extremely rare circumstance of an FAA-licensed launcher causing third-party damage in excess of maximum probable loss. In contrast, alternatives to the current regime would entail routine costs to the government. Industry risk-sharing initiatives such as trust funds and insurance pools would require, at a minimum, monitoring by the FAA or some other government agency, and at a maximum, direct management by the government, thus expanding the regulatory bureaucracy. Direct subsidies would involve outlays from appropriated funds. Tax subsidies would reduce government revenues and would only benefit well-established launch firms that have taxable income. In the absence of a major accident incurring a large liability claim against the government, any alternative that involves government subsidies or increased oversight would cost more than the current regime.

Of course, a major launch mishap would alter this calculus in unpredictable ways. If U.S. launch providers are fortunate enough to continue their spotless record in avoiding catastrophic third-party liability, the current regime minimizes the cost to the taxpayer because there are no outlays for either claims or routine administrative costs. However, if a major accident does occur and the government pays a sizable claim, the administrative costs of overseeing an industry insurance pool, by comparison, would seem insignificant.

Ideally, a mature industry in a competitive market should be able to internalize its risk, managing it without government help. However, the global launch market is distorted by factors unrelated to the desire to make a profit. Launch capability is developed for non-commercial reasons as well, including national security and national pride. As a result, governments bestow subsidies and other preferential treatment upon domestic or regional launchers. This is true in the U.S., where some commercial launchers evolved from government rocket programs, and U.S. government payloads are required to ride on U.S. launch vehicles. As long as national (non-commercial) interests remain a key rationale for maintaining a healthy industry, it is in the government's (and taxpayers') interest to accept some risk-sharing. Another factor to consider for commercial launches that take place on federal ranges is that the range safety function is performed by a government employee, which suggests that the government shares some responsibility for damage caused by errant rockets.

To minimize U.S. government risk and outlays, the choice between maintenance or phase-out of indemnification is not clear in the absence of knowledge about the occurrence of future catastrophic launch events. However, the government cannot be absolved of all risk from launches that utilize federal ranges, or from international launch incidents that are covered by treaty obligations, as noted in Chapter 1.

5.3 Improve Economic Benefits and Strengthen the U.S. Industrial Base in Space Launch Capabilities

As discussed in Chapter 2, by some measures (continued investment, technological evolution, ongoing partnerships, consolidation, new entrants) the U.S. commercial launch industry is mature. But stability and profitability are questionable. The large aerospace companies do not separately report profits from commercial launch services, but industry representatives and the trade press leave the impression that profit margins are small or nonexistent. Commercial launch efforts, a minor part of these companies' portfolios, are important to the companies because they keep production lines active (which may help reduce unit costs in U.S. government contracts) and exercise the technical skills of the workforce. Even so, Boeing has chosen not to commercially market the Delta 2 and Delta 4 at this time despite holding active FAA licenses for these rockets. Lockheed Martin markets its Atlas 5 through the International Launch Services partnership, but in 2005 the partnership's competitive commercial launches included

four on Russian Proton rockets and only one on an Atlas.⁷⁹ With global competition increasing, these companies will be faced with decisions in the years to come regarding their continued presence in the commercial launch industry. Undoubtedly, third-party liability risk will be one of the factors considered.

The continued health of the U.S. industrial base has been a concern for many years.⁸⁰ An internationally competitive space launch industry is one component of a strong space industrial base. A successful commercial launch industry will help sustain the skills and facilities essential to all U.S. space sectors. The launch liability indemnification regime alone does not drive the success or failure of the nation's space industrial base, but coupled with other variables in today's environment, its disappearance could drive critical business decisions in a particular direction. Some industry participants in the study linked it with the changes in the export control regime since 1999. They believe that the space industry was hurt badly by the stricter export regulations, and that loss of government indemnification would be another serious blow, this one specifically aimed at the launch companies, which could have a negative impact on future corporate decisions regarding involvement in the commercial launch business.

There is no quantitative evidence showing that the current indemnification regime improves U.S. competitiveness, or that it was the deciding factor in any specific international launch service contracts. However, since government indemnification has become the norm on the world market, there is serious concern in industry regarding the extent that U.S. competitiveness could be hurt if the nation terminated or significantly reduced government indemnification. Participants in the study felt that such a withdrawal of support would be interpreted internationally as the U.S. government losing confidence in the industry – and would be portrayed as such in competitors' marketing efforts. As noted in Chapter 4, the governments of foreign competitors are not anticipating any changes to their risk-sharing regimes, nor do they plan to react to any changes the U.S. might make in this area.

Continuity and predictability in the business environment are factors that encourage a strong industrial base. To minimize costs and disruptions, companies tend to prefer changes that are incremental. Industry is familiar with the current indemnification regime and has built it into business plans for its launch enterprises. Sudden, dramatic changes to current circumstances, such as eliminating indemnification, would disrupt plans, increase costs, and prompt a rethinking of the business case for each of the players. Participants in the study were hesitant to offer suggestions on how to best phase out indemnification because they didn't want to endorse such a path. But clearly, if changes are to be made, such as an increase to Tier I coverage requirements and/or a decrease to Tier II indemnification, they should be done gradually, over a period of several years, to minimize disruption to the industry. When considering other possible changes, it is important to note that the launch and insurance industries are uncomfortable with trusts and insurance pools because the number of participants would be too small to build reserves in a reasonable time. Also, many participants are small in size and do not yet have the resources to make a substantial contribution.

One indicator of a healthy industry is the continued influx of new players and the eventual success of some of them. Encouragement of new entrants into the U.S. launch market is in the national interest, since many technological and cost-saving ideas are likely to come from this source. But resource scarcity among entrepreneurs means that any actions that increase their costs or time-to-market (e.g., higher insurance coverage requirements, routine contributions to an industry pool) will inhibit their development.

⁷⁹ International Launch Services launch archive, <http://www.ilslaunch.com/launches/> (accessed February 2006).

⁸⁰ GAO has published many reports on this subject since the mid-1980s. Numerous reports from industry groups and think tanks have emerged in recent years as well. For example, see Booz Allen & Hamilton, "U.S. Defense Industry Under Siege – An Agenda for Change," 2000.

The mix of participants in the U.S. commercial launch industry could look very different in a few years. As of August 2006, small launch companies held only three active FAA licenses, and had yet to demonstrate their longevity and profitability. Several more companies with similar goals hope to prove themselves in the near future. In contrast to the large aerospace companies, commercial launch is the primary function of these firms. Ultimately, the successful ones may account for a much more significant part, and perhaps the majority, of U.S. commercial launch revenues. But to reach that point, this new wave of launch providers needs many years to mature. The post-2009 indemnification regime will affect them much more than it does today, and its effect on their business plans may be more significant than it is for the large launch companies today.

The effects of U.S. government risk-sharing on economic and industrial strength are impossible to measure with any precision. However, it is reasonable to conclude that the effects of maintaining indemnification would be potentially positive and at worst neutral, while the effects of phasing it out would be at best neutral but potentially negative.

5.4 Options for Consideration

The first option is **maintenance of the indemnification regime** to ensure that the U.S. commercial launch industry will be able to match the liability coverage of its global competitors. Should the Congress choose this path, the following modifications to the current indemnification regime should be considered when addressing its renewal in 2009:

- **Make indemnification permanent.** The sunset provision introduces uncertainty in the business environment and provides ammunition for the marketing efforts of foreign competitors. Future changes to the risk-sharing regime should be dependent on dramatic growth in the U.S. commercial launch industry, substantially increased capacity in the liability insurance market, and/or other changes in the business environment that may make other options viable and desirable. This will not happen on a predictable schedule. The FAA should continue to monitor indicators of industry maturity, stability, and financial strength and alert the Congress when the landscape has evolved sufficiently to warrant changes.
- **Remove the cap on Tier II indemnification.** Since the payment of a Tier II claim is subject to the congressional appropriations process, a cap is unnecessary. The Congress has complete control over the size of any payment.

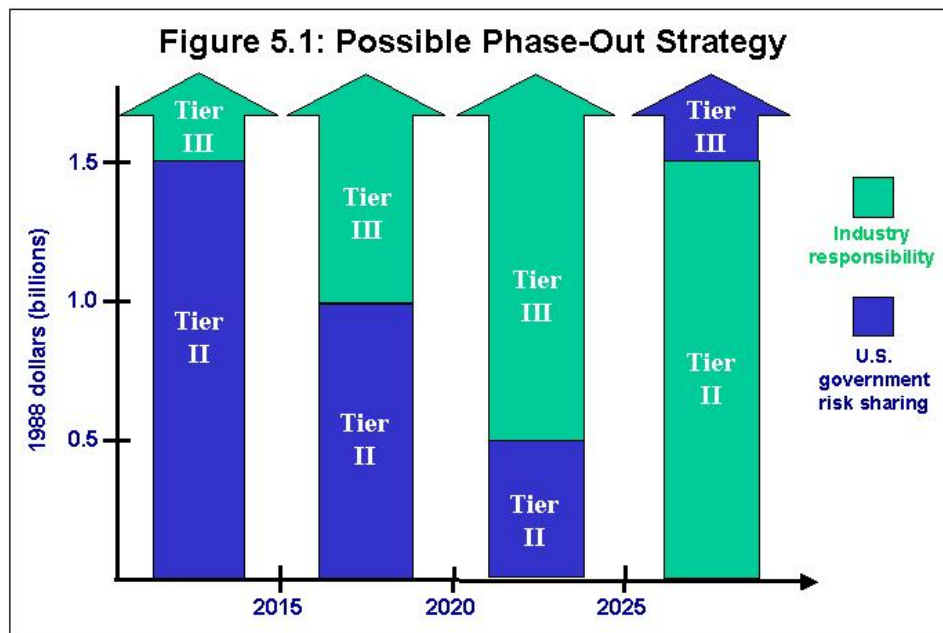
The Congress has a second option, which is to **phase-out** U.S. government risk-sharing. In this case, the following steps could be taken:⁸¹

- Direct the FAA to initiate a plan that gradually changes, and eventually reverses, responsibility for Tiers II and III. (Currently, the U.S. government is responsible for Tier II and the launch industry is responsible for Tiers I and III.) Modifications to Tier I maximum probable loss are not required.
- Upon expiration of the current indemnification statute, the FAA would initiate a requirement for industry to cover its Tier III risk exposure by creating a pool or trust. The government's Tier II commitment would remain unchanged initially. When the industry pool reaches a value of \$500 million, or after 5 years – whichever comes first – the government's Tier II commitment would be reduced to \$1 billion.

⁸¹ All dollar amounts in this description are in 1988 dollars to conform to the convention used in the CSLA Amendments. The conversion factor to 2006 dollars is approximately 1.71. In other words, \$1.5 billion in 1988 dollars is equivalent to slightly more than \$2.5 billion in 2006 dollars.

- When the pool reaches \$1 billion or 10 years, the government's Tier II commitment reduces to \$500 million.
- When the pool reaches \$1.5 billion or 15 years, the roles reverse. The industry pool (with a regulatory requirement to maintain a minimum value of \$1.5 billion) becomes Tier II. Government indemnification becomes Tier III, with no cap and no sunset provision, but retaining the requirement for an appropriations bill in the event of a claim.
- At this stage and at regular intervals thereafter, the FAA would assess the appropriate minimum required value of the industry pool, and recommend to Congress any changes in that requirement, if necessary.

This is shown graphically in Figure 5.1.



If the Congress pursues this second option, there are several difficult issues that must be addressed:

- Five years may not be a long enough interval between the stages described above. This pace would require industry to increase the pool's value an average of \$100 million per year (about \$171 million in 2006 dollars) to match the government indemnification withdrawn at each stage.
- Companies that leave the industry would rightfully expect their contributions to the pool, plus interest, to be returned. If the industry experiences high turnover during the process, this will hinder the effort to reach and maintain the pool's targets. This problem will be particularly troublesome if one or more of the larger players exits the commercial launch business.
- The U.S. commercial launch industry is diverse. Companies vary widely in size, financial resources, and experience. A determination would need to be made as to how these differences should be taken into account for the industry pool's contribution scheme. Should all companies contribute equally? Or should contributions vary based on a formula that accounts for financial resources, size of launch vehicles, frequency of launches, location of launch site, or other parameters? Would such a formula allow achievement of funding targets?

- A new requirement to make regular contributions to an industry pool may not, by itself, drive entrepreneurial launch providers out of the business, but it could become the proverbial “straw that breaks the camel's back.” For small companies, the added cost and risk could discourage investors or become the tipping point for decisions about going offshore or going out of business. For large companies, management may seize on this issue in considerations of whether to stay in the commercial launch business.

These issues require further study and must consider the continuing evolution of the domestic launch industry and the global business environment.

Appendix A: Acronyms and Abbreviations

AEB	<i>Agencia Espacial Brasileira</i> (Brazil)
AIA	Aerospace Industries Association
AST	Associate Administrator for Space Transportation
BNSC	British National Space Center
BSC	Brussels Supplementary Convention
CAT	Catastrophe (bonds)
CGWIC	China Great Wall Industry Corporation
CNSA	China National Space Agency
COMSTAC	Commercial Space Transportation Advisory Committee
COTR	Contracting Officer's Technical Representative
CRS	Congressional Research Service
CSLA	Commercial Space Launch Act
DLR	Deutschen Zentrums für Luft und Raumfahrt (German Space Agency)
DOD	Department of Defense
DOT	Department of Transportation
EADS	European Aeronautic Defence and Space Company
EELV	Evolved Expendable Launch Vehicle
EGAS	European Guaranteed Access to Space (Program)
ELV	Expendable Launch Vehicle
ESA	European Space Agency
FAA	Federal Aviation Administration
FTS	Flight Termination System
GEO	Geosynchronous Earth Orbit
GSC	Guiana Space Center
GSO	Geostationary Orbit
ILS	International Launch Services
ISRO	Indian Space Research Organization
JAXA	Japan Aerospace Exploration Agency
LEO	Low Earth Orbit
LSA	Launch Service Agreement
LV	Launch Vehicle
MPL	Maximum Probable Loss
NASA	National Aeronautics and Space Administration
NASDA	National Space Development Agency of Japan
NEA	Nuclear Energy Agency
NFIP	National Flood Insurance Program
NGSO	Non-Geostationary Earth Orbit
OECD	Organization for Economic Co-operation and Development
OPIC	Overseas Private Investment Corporation
P.L.	Public Law
R&D	Research and Development
RLV	Reusable Launch Vehicle
SIA	Satellite Industry Association
SLASO	Space Licensing and Safety Office (Australia)
START	Strategic Arms Reduction Treaty
TRIA	Terrorism Risk Insurance Act
U.K.	United Kingdom
U.S.	United States
USC	United States Code

Appendix B: Statutory Language

Commercial Space Launch Amendments Act of 2004

SEC. 3. STUDIES.

(a) RISK SHARING.—Not later than 60 days after the date of enactment of this Act, the Secretary of Transportation shall enter into an arrangement with a nonprofit entity for the conduct of an independent comprehensive study of the liability risk sharing regime in the United States for commercial space transportation under section 70113 of title 49, United States Code. To ensure that Congress has a full analysis of the liability risk sharing regime, the study shall assess methods by which the current system could be eliminated, including an estimate of the time required to implement each of the methods assessed. The study shall assess whether any alternative steps would be needed to maintain a viable and competitive United States space transportation industry if the current regime were eliminated. In conducting the assessment under this subsection, input from commercial space transportation insurance experts shall be sought. The study also shall examine liability risk sharing in other nations with commercial launch capability and evaluate the direct and indirect impact that ending this regime would have on the competitiveness of the United States commercial space launch industry in relation to foreign commercial launch providers and on United States assured access to space.

Appendix C: Participants

Space Insurance

Aon Space
International Space Brokers
U.S. Aviation Underwriters
Willis Space

Launch Providers

Arianespace
Boeing / Sea Launch
DTI Associates
Eurokot
Garvey Spacecraft Corp.
Kistler Aerospace (now Rocketplane Kistler)
Lockheed Martin / ILS
Orbital Sciences
Starsem

Launch Customers

EADS Astrium
ManSat LLC
Optus Communications
SES Americom

Industry Associations and Advisory Boards

Adelta Legal (Australia)
Aerospace Industries Association (AIA)
Brazilian Association of Air and Space Law (Brazilia)
Commercial Space Transportation Advisory Committee (COMSTAC)
Satellite Industry Association (SIA)

Academic and Research Organizations

City University of Hong Kong School of Law
International Space University (contributor, Chapter 4)
Naval War College
Resources for the Future (contributor, Chapters 2 & 3)
Université de Bourgogne, France
University of Mississippi School of Law
University of Pennsylvania, Wharton School

Foreign Government Organizations

British National Space Centre (BNSC)
China National Space Administration (CNSA)
Deutschen Zentrums für Luft und Raumfahrt (DLR – German Space Agency)
European Space Agency (ESA)
Japan Aerospace Exploration Agency (JAXA)