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Testimony

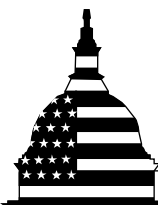
Before the Subcommittee on Science and
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COMMERCIAL SPACE TRANSPORTATION

Industry Trends, Government Challenges, and International Competitiveness Issues

Statement of Gerald L. Dillingham, Ph.D., Director
Physical Infrastructure Issues



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Highlights of [GAO-12-836T](#), a testimony before the Subcommittee on Science and Space, Committee on Commerce, Science, and Transportation, U.S. Senate

Why GAO Did This Study

The commercial space launch industry is changing as NASA plans to begin procuring commercial cargo transportation services to the International Space Station later this year and companies are developing vehicles that could carry passengers for space tourism flights. FAA is responsible for overseeing the safety of commercial space launches and promoting the industry. A catastrophic commercial space launch accident could result in injuries or property damage to the public, or “third parties.” In anticipation of such an event, launch companies are required to purchase launch insurance, per calculations done by FAA and, under the Commercial Space Launch Act, the federal government is potentially liable for claims above that amount of purchased insurance. Unless reauthorized, the indemnification provision expires this year.

This testimony addresses (1) trends and forecasts in the commercial space launch industry and challenges FAA faces in overseeing and promoting the industry, (2) preliminary information on issues concerning federal indemnification for third party losses, and (3) challenges to global competitiveness for the U.S. commercial space launch industry. This statement is based on a past GAO report and testimonies on commercial space launches, updated with information GAO gathered from FAA and NASA on industry trends and recent FAA and NASA actions, and on-going work on federal indemnification. GAO is making no recommendations in this statement.

View [GAO-12-836T](#). For more information, contact Gerald L. Dillingham at (202) 512-2834 or dillingham@gao.gov.

June 20, 2012

COMMERCIAL SPACE TRANSPORTATION

Industry Trends, Government Challenges, and International Competitiveness Issues

What GAO Found

Since a peak of 22 U.S. commercial space launches in fiscal year 1998, the annual number of launches generally ranged from 4 to 9 launches. The number of commercial space launches is expected to increase in the next 8 years as the National Aeronautics and Space Administration (NASA) plans to procure 51 launches from commercial cargo companies to resupply the International Space Station. FAA also expects space tourism to begin in the next several years, although no companies have applied for a FAA launch license and companies developing these services have experienced delays in the past. FAA faces several challenges overseeing the commercial space launch industry. For example, FAA expects its licensing and oversight responsibilities to expand in anticipation of an increased private sector role, suggesting that FAA and Congress must remain vigilant so that potential conflicts in FAA’s safety oversight and industry promotion roles do not occur. Also, as the commercial space launch industry grows and FAA continues to implement NextGen—FAA’s effort to develop a more automated, aircraft-centered, satellite-based air traffic management system—the agency will have to manage a mix of earth-based aircraft and space vehicles. FAA has begun to consider integrating spaceflight operations into NextGen. In past work, GAO recommended that FAA take several actions to improve its oversight of commercial space launches, including monitoring indicators of space tourism safety. FAA has taken some steps to address the recommendations.

Several factors have implications for federal indemnification policy. For example, under the current policy, the potential increase in the number of commercial space launches increases the probability of a catastrophic accident and the possibility of a cost to the federal government. Also, GAO’s preliminary work has raised questions about the soundness of the method currently used by FAA to calculate the amount of insurance that launch companies must purchase: FAA has not updated crucial components, such as the cost of a casualty, and its method is outdated, according to insurance industry officials and risk modeling experts. If the current indemnification policy is eliminated, the actual effects on the global competitiveness of the U.S. commercial space launch industry are unknown, in part, because it is not known whether launch customers might choose foreign launch companies over U.S. companies. However, launch companies said that the lack of government indemnification would decrease their global competitiveness by increasing launch costs.

The competitiveness of U.S. commercial space launch companies is affected by higher launch prices than those charged by companies in other countries and U.S. export controls, which affect U.S. companies’ ability to sell services abroad. The U.S. government has responded to foreign competition by providing the U.S. launch industry research and development funds, use of federal launch facilities, and indemnification for a portion of third-party claims.

Chairman Nelson, Ranking Member Boozman, and Members of the Subcommittee:

Thank you for the opportunity to testify today on the commercial space industry. Historically, commercial space launches took place primarily at federal launch sites and carried payloads (generally satellites) into orbit using unmanned vehicles that were only used once. The Federal Aviation Administration (FAA) is responsible for overseeing the safety of these launches and promoting the industry. Over the last several years the industry has begun to change. For instance, several companies are in the process of developing and testing manned, reusable launch vehicles for commercial space tourism. In addition, since the Space Shuttle fleet was retired in 2011, the National Aeronautics and Space Administration (NASA) plans to begin procuring commercial cargo transportation services to the International Space Station (ISS) later in 2012. With the successful mission of SpaceX's Dragon last month, the capability to do so has been demonstrated. NASA also intends to procure commercial manned launches to carry its astronauts to the ISS beginning in 2017.¹ Private companies and states are developing commercial spaceports—sites used for commercial (nongovernment) spacecraft launches to support the expected growth in commercial space launches. To foster a competitive environment for the U.S. space launch industry, the federal government provides, under the Commercial Space Launch Act Amendments of 1988 (CSLAA),² among other things, potential

¹Since NASA retired its Space Shuttle program in July 2011, it lacks a domestic capability to send crew and cargo to the ISS. To maintain the ISS through 2020, as required by the NASA Authorization Act of 2010, NASA is relying on international partners and commercial vehicles to transport cargo. Pub. L. No. 111-267, §501 All commercial cargo missions for NASA thus far have been demonstration missions conducted under Space Act agreements, which involve NASA providing significant funds to private industry partners to stimulate the development of large-scale commercial space transportation capabilities. Pub. L. 85-568, 72 Stat. In order to transport crew, NASA is currently purchasing seats on the Russian Soyuz vehicle. However, NASA has awarded a number of Space Act agreements to domestic private sector companies to stimulate development and demonstration of commercial human spaceflight capability, with an eventual goal of procuring crew transportation services in 2017. For more information on utilizing the ISS, see GAO, *NASA: Significant Challenges Remain for Access, Use, and Sustainment of the International Space Station*, [GAO-12-587T](#) (Washington, D.C.: Mar. 28, 2012). For more information on Space Act agreements, see GAO, *Key Controls NASA Employs to Guide Use and Management of Funded Space Act Agreements Are Generally Sufficient, but Some Could Be Strengthened and Clarified*, [GAO-12-230R](#) (Washington, D.C.: Nov. 17, 2011).

²Pub. L. No. 100-657, 102 Stat. 3903 (1988).

indemnification for a portion of third party liability claims that could arise from a catastrophic launch-related incident that results in injury or damage to uninvolved people or property.^{3,4} This legislation expires at the end of 2012, and Congress will need to determine whether to end, reform, or continue current commercial space launch indemnification.

My testimony today focuses on (1) trends and forecasts in the U.S. commercial space launch industry, (2) challenges FAA faces in overseeing and promoting the industry, (3) preliminary information on factors for Congress to consider as it determines the future of commercial space launch indemnification, and (4) challenges to U.S. global competitiveness as the commercial space industry grows and matures. This statement is based on our prior testimonies and report on commercial space issues and has been updated with information we gathered from FAA and NASA on industry trends and recent FAA and NASA activities.⁵ It is also based on on-going work we are conducting for this committee and the U.S. House of Representatives' Committee on Science and Technology. Additional information on our scope and methodology is provided in each issued product. We conducted the work on which this is based in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

³51 USC § 50915.

⁴The federal government, subject to appropriations, provides indemnification for losses that exceed the maximum probable loss up to a limit of \$1.5 billion adjusted for post-1988 inflation; in 2012, this amount was approximately \$2.7 billion. For each launch, FAA determines the maximum probable loss, which is the amount of third party losses against which a launch company must protect by buying third party liability insurance.

⁵See GAO, *Commercial Space Launch Act: Preliminary Information on Issues to Consider for Reauthorization*, [GAO-12-767T](#) (Washington, D.C.: June 6, 2012); *Commercial Space Transportation: Industry Trends and Key Issues Affecting Federal Oversight and International Competitiveness*, [GAO-11-629T](#) (Washington, D.C.: May 5, 2011); *Commercial Space Transportation: Development of the Commercial Space Launch Industry Presents Safety Oversight Challenges for FAA and Raises Issues Affecting Federal Roles*, [GAO-10-286T](#) (Washington, D.C.: Dec. 2, 2009); and *Commercial Space Launches: FAA Needs Continued Planning and Monitoring to Oversee the Safety of the Emerging Space Tourism Industry*, [GAO-07-16](#) (Washington, D.C.: Oct. 20, 2006).

Background

In 1984, the Commercial Space Launch Act required the Secretary of Transportation to “encourage, facilitate, and promote commercial space launches by the private sector.”⁶ Under the Act, FAA was charged with regulating the U.S. commercial space launch industry, which it does through licensing, compliance monitoring, and safety inspection activities. FAA licenses all commercial launches and reentries that take place in the United States and overseas by U.S. citizens or companies to ensure the safety of the public and property, to ensure compliance with international obligations of the United States, and to protect the national security and foreign policy interests of the United States.⁷ FAA is also responsible for licensing the operation of all U.S. spaceports from which commercial launches may occur. In addition to its safety oversight and regulatory responsibilities, FAA is tasked with facilitating the strengthening and expansion of the U.S. space launch infrastructure. In 2004, the Commercial Space Launch Amendments Act of 2004⁸ gave FAA the specific responsibility of overseeing the safety of space tourism. However, FAA is prohibited from regulating crew and passenger safety before October 2015, except in response to high risk incidents, serious injuries or fatalities, or an event that poses a high risk of causing a serious or fatal injury.

Other federal agencies also support the commercial space launch industry. NASA supports the industry by providing infrastructure and operations support and encouraging private sector investment in its launches and other activities. The Department of Defense (DOD), through the Air Force, provides infrastructure, operations support, guidance, and safety oversight for government and commercial launches at its launch sites. The Department of Commerce (Commerce) is also responsible for promoting the commercial space industry.

In addition, similar to other countries such as China, France, and Russia, the U.S. government provides indemnification for a portion of claims by

⁶51 U.S.C. 50903.

⁷FAA issues four types of licenses: a launch license (for expendable launch vehicles), a reusable launch vehicle mission license, a reentry license, and a launch or reentry site operator license. The first three types of licenses are issued to the operator of a launch vehicle, and the fourth is issued to the operator of a spaceport. FAA also issues experimental permits for test flights of reusable launch vehicles.

⁸ Pub. L. No 108-492.

third parties for injury, damage, or loss that result from FAA-licensed commercial launch-related incidents, provided Congress appropriates funds for this purpose.^{9,10} Prior to issuing a launch or reentry license, FAA determines the amount of third party losses against which a launch company must protect by buying third party liability insurance. FAA determines this by calculating the maximum probable loss, which is an estimate of the maximum third party losses likely to occur from a commercial space launch.¹¹ The federal government, subject to appropriations, provides indemnification for losses that exceed the maximum probable loss up to a limit of about \$2.7 billion.¹² Parties involved in launches—for example, passengers and crew—are not considered third parties, and thus damages to them would not be covered under the indemnification program.¹³ The commitments of the United States or other countries to pay third party claims have never been tested. Globally, there has never been a third party claim for damages from a commercial space launch failure that reached the level of government indemnification.

⁹51 USC 50914(a)(1)(A).

¹⁰China, France, and Russia provide more indemnification coverage than the United States. These countries each have an indemnification regime in which the government states that it will assume a greater share of the risk compared to that of the United States because each country places no limit on the amount of government indemnification.

¹¹More specifically, the maximum probable loss is based on estimates of losses from events having greater than a 1 in 10 million chance of occurring.

¹²The \$2.7 billion limit on the federal government's liability is for 2012; this amount is adjusted for inflation each year.

¹³A crew includes any employee who performs activities directly relating to the launch, reentry, or other operation relating to the vehicle that carries human beings. 51 U.S.C § 50902(2). A passenger—also called a spaceflight participant—is an individual who is not crew, carried aboard a launch vehicle or reentry vehicle. 51 U.S.C § 50902(17).

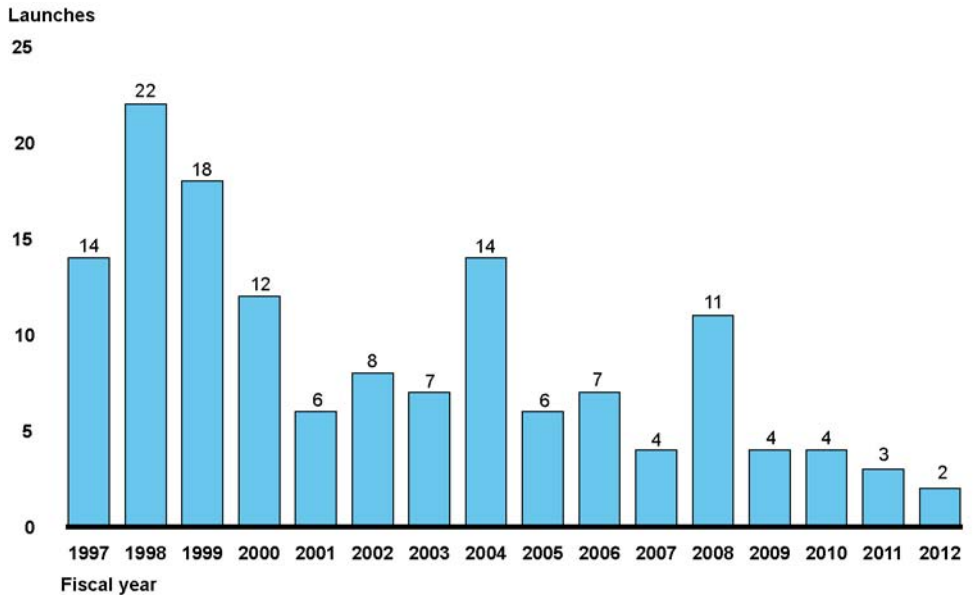
The Number of FAA-Licensed Space Launches Peaked in 1998, but an Increase Is Anticipated

Launch Trends

Since 1989, FAA has licensed 207 commercial space launches. Since a peak of 22 launches in fiscal year 1998, the annual number of launches generally ranged from 4 to 8 launches. (See fig. 1.) Space launches by private sector companies were relatively high in the late-1990s as U.S. commercial launch companies responded to the increase in global demand for commercial satellite launch services. Since then, the demand for commercial launches has generally declined, except for slight increases in fiscal years 2004 and 2008. The increase in fiscal year 2004 was due in part to the inclusion of 4 demonstration flights by SpaceShipOne and the increase in fiscal year 2008 was due, in part, to the return to service of one of the most common launch vehicles following a failure in the previous year.¹⁴ Since fiscal year 2009, FAA has licensed 13 commercial space launches, including the launch of the Falcon 9 rocket that carried the Dragon capsule that docked with the International Space Station last month.

¹⁴SpaceShipOne, which resembles an airplane, was launched from an airplane into space, where it traveled nearly 70 miles above the earth, and returned to the original launch site.

Figure 1: FAA-Licensed Launches, Fiscal Year 1997 Through June 1, 2012



Source: GAO analysis of FAA data.

Note: These numbers include launches by Sea Launch—a multinational consortium that is licensed by FAA because one of its principals is a U.S. company. The numbers also include 5 launches by SpaceShipOne—4 in fiscal year 2004 and 1 in fiscal year 2005—which were not FAA-licensed as they were demonstration flights. All launches were orbital, except those of SpaceShipOne, which were suborbital.

Despite the low number of licensed launches in recent years, according to FAA, research and development activity in commercial spaceflight continues and the tests associated with this activity are not captured in launch numbers. According to industry experts that we spoke with, since 2006 the commercial space launch industry has experienced a steady buildup of research and development efforts, including ground tests and low-altitude flight tests of reusable rocket-powered vehicles that are capable of numerous takeoffs and landings. (See fig. 2 for examples of commercial spacecraft being developed.) These activities do not require licensing. In 2006, FAA began issuing experimental permits to companies seeking to conduct test launches of reusable space launch vehicles that could be used for manned commercial flights.

Figure 2: Examples of Commercial Spacecraft under Development



Sources: Virgin Galactic (left); Blue Origin (middle); and XCOR Aerospace (right).

The number of commercial space launches is anticipated to increase in the years ahead as NASA begins procuring commercial cargo transportation services to the ISS and private industry continues developing vehicles for space tourism flights. As previously noted, SpaceX recently completed the first commercial mission to deliver cargo to the ISS and bring back scientific samples and other supplies. (See fig. 3.) As a result of this success, SpaceX will begin to fly its 12 missions under NASA's Commercial Resupply Services contract for delivery of cargo to the ISS. Orbital Sciences Corporation has also been awarded a contract for cargo resupply missions to the ISS through 2016, but has yet to conduct any demonstration missions. Together, the companies are scheduled to complete about 39 percent of NASA's planned launches to the ISS through 2020. (See table 1.)

Figure 3: SpaceX Dragon Docked with the ISS, May 2012



Source: NASA.

Table 1: NASA's Planned Launches to Resupply the ISS from 2012 to 2020 (as of March 2012)

Vehicle	2012	2013	2014	2015	2016	2017	2018	2019	2020	Total
European Automated Transfer Vehicle (ATV) ^a	1	1	1	0	0	0	0	0	0	3
Japanese H-II Transfer Vehicle (HTV) ^a	1	1	1	1	1	1	1	1	1	9
SpaceX	2	2	2	3	3	0	0	0	0	12
Orbital	1	2	1	2	2	0	0	0	0	8
Follow-on commercial resupply ^b	0	0	0	0	0	5	5	5	4	19
Total	5	6	5	6	6	6	6	6	5	51

Source: GAO analysis of NASA data.

^aThe ATV and HTV are unmanned vehicles that have flown to the ISS.

^bNASA does not have contracts with commercial providers or negotiated agreements with international partners for flights from 2017 through 2020.

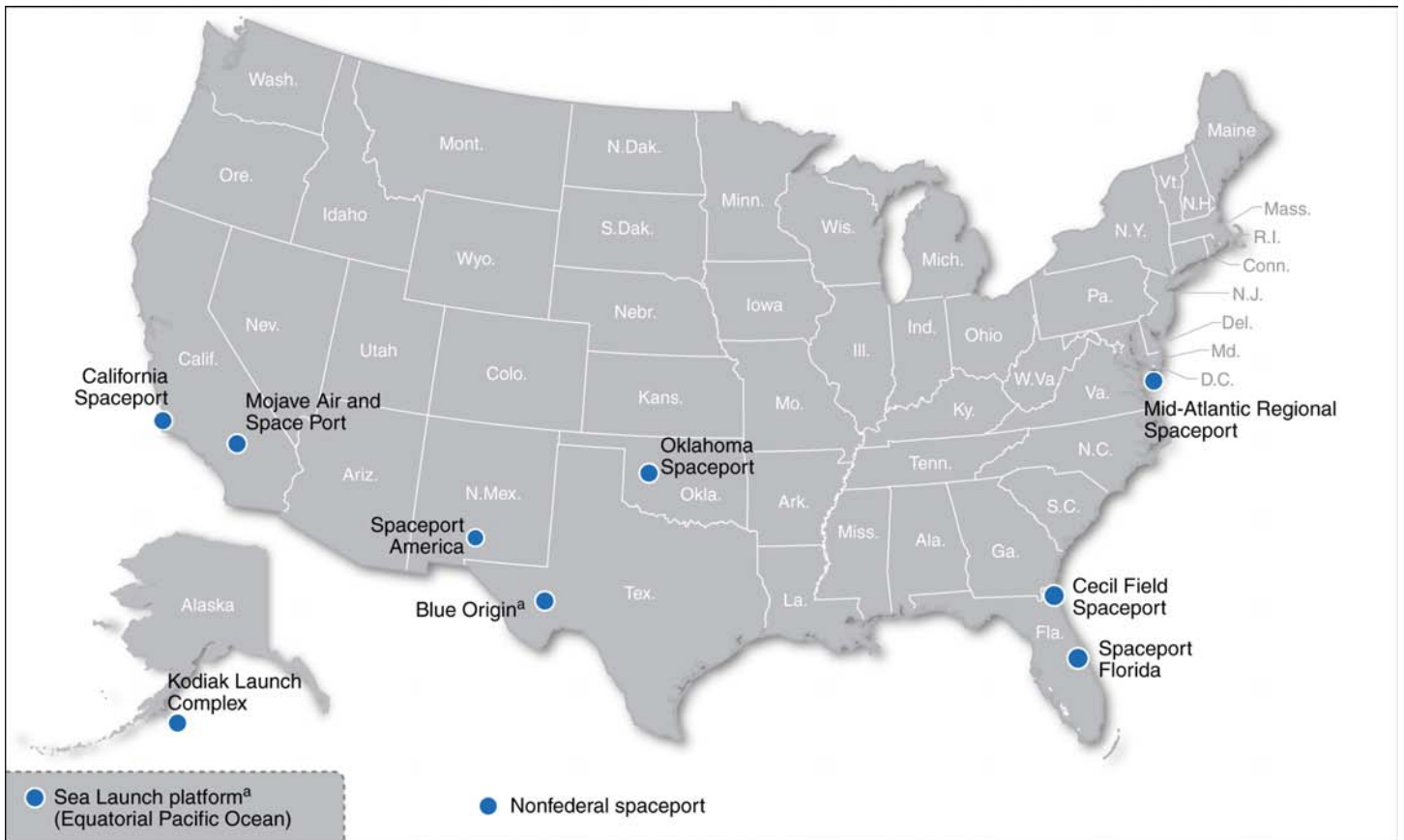
FAA expects space tourism activity to begin in the coming years and, while companies are developing vehicles to provide space tourism services, the industry has experienced delays in its development in the past. The prospect for commercial space tourism materialized in 2004

with the successful flights of SpaceShipOne, which have been the only manned commercial flights to date. Virgin Galactic, which formed a joint venture with Scaled Composites to develop SpaceShipTwo, is the farthest along among the space tourism companies and has taken deposits from more than 500 customers to reserve a place on a future flight. However, Virgin Galactic has not yet applied to FAA for a launch license and its planned schedule for flights has experienced delays in the past. The planned and anticipated increase in launches, from NASA and potentially from space tourism, has implications for FAA's oversight responsibilities and the federal government's potential liability in providing third party indemnification, as we discuss later in this statement.

Commercial Spaceports

In the United States, private companies and state governments have been developing additional spaceports to accommodate the anticipated space tourism flights and expand the nation's launch capacity. There are currently eight nonfederal FAA-licensed spaceports as well as two private facilities each with one resident launch provider—Blue Origin and Sea Launch—which are termed sole-site operators. (See fig. 4.) In addition, state governments and local communities have proposed establishing commercial spaceports in six additional locations.

Figure 4: Licensed Spaceports as of February 2012



Sources: FAA and GAO.

^aPrivate facility with a sole site operator.

Both states and FAA have provided support for the development of commercial spaceports. States have provided economic incentives to developers to build spaceports to attract space tourism that could in turn provide economic benefits to localities. For example, New Mexico provided approximately \$209 million to construct Spaceport America¹⁵ and the Florida Space Authority, a state agency, invested over \$500 million in new space industry infrastructure development at Cecil Field Spaceport, including upgrades to the launch pad, a new space operations

¹⁵Approximately \$133 million came from state appropriations. The remainder came from tax bonds collected from Dona Ana and Sierra counties in New Mexico.

support complex, and a reusable launch vehicle support complex. In addition, Virginia recently enacted legislation to provide \$9.5 million annually to support the capital needs, maintenance, and operating costs of facilities owned and operated by the Virginia Commercial Space Flight Authority—including the Mid-Atlantic Regional Spaceport—and has provided state tax exemptions for companies launching payloads from the spaceport or doing space-related business activities in Virginia. However, according to a senior FAA official, continued state support for spaceports in the current fiscal environment has been mixed. The official added that although there are eight licensed spaceports, there has not been launch activity at all of them. Until there is a launch provider that begins operations and brings revenue to a spaceport, support is difficult to justify. In addition, federal support for spaceports has been affected by the fiscal environment. In 2010, FAA distributed a total of \$500,000 in appropriated funds to four spaceports in the first Commercial Space Transportation Grants. Since then it has drawn from its operations budget to sustain the program.

FAA Faces Several Significant Challenges as It Oversees a Changing Commercial Space Launch Industry

As it oversees a changing commercial space launch industry, FAA faces various challenges. These include addressing a potential growth in its licensing and oversight workload, ensuring that its safety regulations are equally suitable for commercial spaceports and federal launch sites, avoiding potential conflicts between its dual roles of safety oversight and industry promotion, and adequately accommodating space flight in its air traffic management system.

Potential Industry Growth and FAA's Workload

FAA expects its licensing and oversight responsibilities of commercial space launches to expand in the next few years with the licensing of NASA-contracted launches as NASA begins this year to use new commercially-developed and operated vehicles to deliver cargo and later crew to the ISS. NASA plans to contract with commercial launch companies for these services. FAA and NASA announced on June 18, 2012, that FAA will license NASA-contracted vehicles and services. FAA expects the number of commercial launches to increase as private companies work toward providing flight services to paying passengers. FAA requires either a launch and a reentry license or a permit. As mentioned earlier in this statement, manned commercial launches have not occurred since 2004, and Virgin Galactic is the company closest to developing a vehicle for space tourism, but it has not

filed for FAA licenses. Therefore, it is not clear when FAA's workload would be affected by space tourism.

As of November 2011, FAA's workload included 15 active launch licenses, 8 active launch site operator licenses, and 2 active experimental permits. FAA evaluates applications for launch licenses by reviewing the safety, environmental, payload, and policy implications of a launch and determining the launch company's insurance liability or financial responsibility. FAA's licensing process is described in fig. 4.

Figure 4: FAA's Launch Licensing Process



Source: GAO presentation of FAA information.

According to FAA officials, FAA's Office of Commercial Space Transportation has 72 full-time staff, as of June 2012, to oversee commercial space launches. FAA's fiscal year 2013 budget request includes resources to hire an additional 10 safety experts to evaluate license applications, conduct safety inspections, and provide oversight in its field offices.

FAA expects its workload to increase over the next several years as it begins to develop safety regulations for commercial human spaceflight. Although a moratorium on FAA regulations for passenger safety has been extended to October 2015, we have previously recommended that FAA

identify and continually monitor indicators of space tourism industry safety.¹⁶ Although FAA was not able to address our recommendation directly because there have been no launches with passengers, it is taking other steps—e.g., reviewing NASA’s certification of space launch vehicles as worthy of transporting humans (i.e., human rating) and its own aircraft certification processes—that will help FAA be prepared to regulate passenger safety. We believe that these are reasonable preliminary steps to regulate crew and passenger safety.

Suitability of Safety Regulations for Spaceports

As noted earlier, spaceports are being developed to accommodate anticipated commercial space tourism flights. However, FAA faces challenges related to regulating commercial spaceports. Specifically, FAA must ensure that its regulations on licensing and safety requirements for launches and launch sites, which are based on safety requirements for expendable launch vehicles (i.e., vehicles that are only used once and do not return to Earth) at federal launch sites, will also be suitable for operations at commercial spaceports. We have reported that the safety regulations for expendable launch vehicles may not be suitable for space tourism flights because of differences in vehicle types and launch operations, according to experts we spoke with.¹⁷ Similarly, spaceport operators and experts we spoke with raised concerns about the suitability of FAA safety regulations for commercial spaceports. Experts told us that safety regulations should be customized for each spaceport to address the different safety issues raised by various types of operations, such as different orbital trajectories and differences in the way that vehicles launch and return to earth, whether vertically or horizontally. To address these concerns, we reported that it will be important to measure and track safety information and use it to determine if the regulations should be revised. We did not make recommendations to FAA concerning these issues because the Commercial Space Launch Amendments Act of 2004 required the Department of Transportation (DOT) to commission an independent report to analyze, among other things, whether expendable and reusable vehicles should be regulated differently from each other,

¹⁶[GAO-07-16](#).

¹⁷We recommended that FAA develop a formal process for consultations between its Office of Commercial Space Transportation and Office of Aviation Safety about licensing reusable launch vehicles. In response, the two offices developed an agreement defining their roles and responsibilities regarding the review of hybrid aircraft/launch vehicles. See [GAO-07-16](#).

and whether either of the vehicles should be regulated differently if carrying passengers. The report, issued in November 2008, concluded that the launch of expendable vehicles, when used to lift reusable rockets carrying crew and passengers, as well as launch and reentry of reusable launch vehicles with crew and passengers should be regulated differently from the launch of expendable vehicles without humans aboard. The report also noted that the development of a data system to monitor the development and actual performance of commercial launch systems and to better identify different launch risk factors and criteria would greatly assist the regulatory process.¹⁸

Dual Oversight and Promotion Roles

In 2006, we reported that FAA faced the potential challenge of overseeing the safety of commercial space launches while promoting the industry.¹⁹ While we found no evidence that FAA's promotional activities—such as sponsoring an annual industry conference and publishing studies of industry trends—conflicted with its safety regulatory role, we noted that potential conflicts may arise as the space tourism sector develops. We reported that as the commercial space launch industry evolves, it may be necessary to separate FAA's regulatory and promotional activities. Recognizing the potential conflict, Congress required the 2008 DOT-commissioned report to discuss whether the federal government should separate the promotion of commercial human spaceflight from the regulation of such activity. The 2008 commissioned report concluded there was no compelling reason to remove promotional responsibilities from FAA in the near term (through 2012) noting that FAA allocated approximately 16 percent of the commercial space budget in fiscal year 2008, which was significantly less than what was allocated for activities directly related to safety. FAA's requested allocation for promotional activities is 12 percent of the commercial space budget request for fiscal year 2013, according to an FAA official. The report further stated that periodic review of the issue was warranted as the commercial space launch industry changed. We continue to concur with the commissioned report's assessment and see no need for Congress to step in at this time to require a separation of regulatory and promotional activities since resource allocations for promotion remains at a relatively low level, and

¹⁸The Aerospace Corporation, et al., *Analysis of Human Space Flight Safety, Report to Congress* (El Segundo, CA: Nov. 11, 2008).

¹⁹[GAO-07-16](#).

few commercial space launches are occurring. However, FAA and Congress must continue to remain vigilant that a situation in which FAA jeopardizes the public interest by subordinating it to that of the commercial space launch industry does not occur.

Spaceflight and NextGen

NextGen—FAA’s efforts to transform the current radar-based air traffic management system into a more automated, aircraft-centered, satellite-based system—will need to accommodate spacecraft that are transitioning to and from space through the national airspace system. As the commercial space launch industry grows and spaceflight technology advances, FAA expects that the agency will need tools to manage a mix of diverse aircraft and space vehicles in the national airspace system. In addition, the agency will need to develop new policies, procedures, and standards for integrating spaceflight operations into NextGen. For example, FAA will have to define new upper limits to the national airspace system²⁰ to include corridors for flights transitioning to space; establish new air traffic procedures for flights of various types of space vehicles, such as aircraft-ferried spacecraft and gliders; develop air traffic standards for separating aircraft and spacecraft in shared airspace; and determine controller workload and crew rest requirements for space operations. FAA has begun to consider such issues and generally includes them in its concept of operations for NextGen.

Factors Congress Should Weigh Concerning Commercial Space Launch Indemnification

Several factors have implications for federal indemnification policy. These include the potential for manned launches, the soundness of FAA’s calculation of maximum probable loss, a gap in the indemnification policy, and the potential effects that ending federal indemnification could have on the global competitiveness of the U.S. commercial space launch industry.

²⁰The national airspace system currently extends to 60,000 feet above mean sea level.

Potential Manned Launches

Our ongoing work indicates that the expected increase in manned commercial launches raises a number of issues that have implications for the federal government's indemnification policy for third party liability. First, the number of launches and landings covered by federal indemnification could increase with NASA's planned manned launches, which will be FAA licensed. NASA expects to procure from private launch companies two manned launches per year to the ISS from 2017 to 2020.²¹ In addition, the development of a space tourism industry may also increase the number of launches and landings covered by federal indemnification, but the timing of tourism launches and landings is uncertain.

According to insurance company officials with whom we spoke, the potential volume of manned launches for NASA and for space tourism could increase the overall amount of insurance coverage needed by launch companies, which could raise insurance costs, including those for third party liability.²² By increasing the number of launches, the probability of a catastrophic event is also increased, and any accident that occurs could also increase future insurance costs, according to insurance company officials. A catastrophic accident could also result in third party losses over the maximum probable loss, which would invoke federal indemnification, provided Congress appropriates funds for this purpose.

Second, because newly developed manned launch vehicles have a limited launch history, they are viewed by the insurance industry as more risky than "legacy" launch vehicles. Insurance company officials told us that a launch vehicle such as United Launch Alliance's Atlas V, which launches satellites and may be used for future manned missions, is seen as less risky than new launch vehicles, such as SpaceX's Falcon 9, which could also be used for manned missions. According to insurance company officials with whom we spoke, they expect to charge higher

²¹NASA-contracted launches for its science missions are not currently covered by CSLAA; rather, NASA requires its launch contractors to obtain insurance coverage for third party losses. The amount of the insurance required by NASA is the maximum amount available in the commercial marketplace at reasonable cost, but not to exceed \$500 million per launch. The facts and circumstances for claims in excess of this amount would be forwarded by NASA to the Congress for its consideration 51 U.S.C. § 20113 (m) (2). NASA-contracted launches for the Commercial Resupply Services to the ISS will be licensed by FAA under CSLAA, and will be covered by CSLAA indemnification.

²²Launch providers obtain insurance in addition to that for third party liability, including coverage of assets, such as the launch vehicle.

insurance premiums for newly developed launch vehicles than legacy launch vehicles given their different risk profiles. Insurance company officials' opinions varied as to when a launch vehicle is deemed reliable—from 5 to 10 successful launches. They also told us that whether vehicles are manned is secondary to the launch vehicle's history and that the launch's trajectory—over water or land—is also considered in determining risk and, consequently, the price and amount of third party liability coverage.

Third, having people on board a space vehicle raises issues of informed consent and cross waivers, which could affect third party liability and the potential cost to the federal government. CSLAA requires passengers and crew on spaceflights to be informed by the launch company of the risks involved and to sign a reciprocal waiver of claims (also called a cross waiver) with the federal government—meaning that the party agrees not to seek claims against the federal government if an accident occurs. CSLAA also requires cross waivers among all involved parties in a launch. Two key issues dealing with cross waivers include the estates of spaceflight passengers and crew and limits on liability for involved parties. One issue is the estates of spaceflight passengers and crew, which are considered third parties to a launch, are not covered by informed consent and cross waiver of claims, according to two insurance companies and one legal expert. Another issue, according to two insurance companies and two legal experts, requiring cross waivers among passengers, crew, the launch company, and other involved parties may not minimize potential third party claims as they would not place limitations on liability.

Maximum Probable Loss

The potential costs to the government under CSLAA—that is, the federal government's exposure to liability—depends on FAA's maximum probable loss calculation, which assesses a launch's risk. If the calculation is understated, then the government's exposure to liability is higher; conversely, if the calculation is overstated, then launch companies are required to purchase more insurance than intended. Therefore, it is important that FAA use an appropriate process for determining the maximum probable loss. Our preliminary work identified several issues that raise questions about the soundness of FAA's maximum probable loss methodology:

- FAA uses a figure of \$3 million when estimating the cost of a single potential casualty—that includes either injury or death—which FAA officials said has not been updated since they began using it in 1988. Two insurers, as well as representatives of two risk modeling

companies that specialize in estimating damages from catastrophic events, said that this figure is likely understated. Because this number has not been adjusted for inflation or updated in other ways, it may not adequately represent the potential current cost of injury or death caused by commercial space launch failures.

- FAA’s methodology for determining potential property damage from a commercial space launch starts with the total cost of casualties and adds a flat 50 percent to that cost as the estimate of property damage, rather than specifically analyzing the number and value of properties that could be affected in the event of a launch failure. One insurer and two risk modelers said that FAA’s approach is unusual and generally not used to estimate potential losses from catastrophic events. For example, officials from both modeling companies noted that the more common approach is to model the property losses first and derive the casualty estimates from the estimated property losses. One modeler stated that FAA’s method might significantly understate the number of potential casualties, noting that an event that has a less than 1 in 10 million chance of occurring is likely to involve significantly more casualties than predicted under FAA’s approach. Moreover, a 2007 FAA review conducted with outside consultants said that this approach is not recommended because of observed instances where casualties were low yet forecasted property losses were very large.
- More broadly, FAA’s method does not incorporate what is known in the insurance industry as “catastrophe modeling.” One modeler told us that catastrophe modeling has matured over the last 25 years—as a result of better data, more scientific research, and advances in computing—and has become standard practice in the insurance and reinsurance industries. Catastrophe models consist of two components: a computer program that mathematically simulates the type of event being insured against and a highly detailed database of properties that could potentially be exposed to loss. Tens of thousands or more computer simulations are generated to create a distribution of potential losses and the simulated probability of different levels of loss. In contrast, FAA’s method involves estimating a single loss scenario. FAA officials told us that they have considered the possibility of using a catastrophe model. However, they expressed concern about whether the more sophisticated approach would be more accurate, given the great uncertainty about the assumptions—such as the probability and size of potential damages—that must be made with any model. Also, both experts and FAA officials told us that developing a catastrophe modeling capability would entail significant costs.

FAA officials said that they believe the maximum probable loss methodology is reasonable and produces conservative results. The same officials noted that they periodically evaluate their current maximum probable loss methodology, but acknowledged that they have not used outside experts or risk modelers for this purpose. They agreed that such a review could be beneficial, and that involvement of outside experts might be helpful for improving their maximum probable loss methodology. As we finalize our review of CSLAA indemnification policy, we will address any additional federal actions needed in response to our analysis.

Gap in Federal Indemnification

Officials from the insurance industry and space launch companies, as well as an expert, characterized the lack of coverage of on-orbit activities—that is, activities not related to launch or reentry, such as relocating a satellite from one orbit to another orbit—as a gap in federal indemnification, but they did not agree on the need to close this gap. FAA licenses commercial launches and reentries, but does not license on-orbit activities. Federal indemnification only applies to FAA-licensed space activities. One expert noted that federal oversight of on-orbit activities may be needed to provide consistency and coordination among agencies that have on-orbit jurisdiction. He pointed out that the Federal Communications Commission and the National Oceanic and Atmospheric Administration have jurisdiction over their satellites and NASA has jurisdiction over the ISS. Thus, according to the expert, there should be one federal agency that coordinates regulatory authority over on-orbit activities. On the other hand, officials from two launch companies told us that they did not believe that on-orbit activities need to be regulated by FAA or that federal indemnification coverage should be provided.

According to senior agency officials, FAA may seek statutory authority over on-orbit activities, although not for satellite or spectrum usage. An insurer told us that having FAA in charge from launch to landing would help ensure that there were no gaps in coverage. According to this insurer, this would help bring stability to the insurance market in the event of an accident as involved parties would be clear on which party is liable for which activities. Congress would decide whether FAA's on-orbit authority would include licensing on-orbit activities. If FAA were granted the authority to license on-orbit activities, this would increase the potential costs to the federal government for third party claims as its exposure to risk would increase.

Indemnification and U.S. Competitiveness

Our on-going work indicates it is difficult to predict how insurance premiums or other costs might change as well as the availability of coverage if indemnification were eliminated. In addition, we do not know whether or to what extent launch customers might choose foreign launch companies over U.S. companies. Furthermore, it is difficult to separate out the effects of withdrawing indemnification on the overall competitiveness of the U.S. commercial space launch industry. Many factors affect the industry's competitiveness, including other U.S. government support, such as research and development funds, government launch contracts, and use of its launch facilities, in addition to the third party indemnification.

Our work to date suggests that while the actual effects on competition of eliminating CSLAA indemnification are unknown, several launch company representatives and customers with whom we spoke said that in the absence of CSLAA indemnification, higher costs and increased risk would directly affect launch companies and indirectly affect their customers and suppliers. The same participants said that two key factors—launch price and launch vehicle reliability—generally determine the competitiveness of launch companies. According to two launch customers, launch prices for similar missions can vary dramatically across countries. For example, two customers said that a similar launch might cost about \$40 million to \$60 million with a Chinese company, about \$80 million to \$100 million with a French company, and approximately \$120 million with a U.S. company. Other considerations also would be involved in selecting a launch company, according to launch customers with whom we spoke. For example, some said that export restrictions for U.S. customers could add to their costs or prevent them from using certain launch companies. One launch customer also said that it considers the costs of transporting the satellite to the launch site as well as other specific aspects of a given launch.

U.S. launch company representatives said that the lack of government indemnification would decrease their global competitiveness by increasing launch costs. Those officials said their costs would increase as a result of their likely purchase of greater levels of insurance to protect against third party losses, as the launch companies themselves would be responsible for all potential third party claims, not just those up to the maximum probable loss amount. Some launch companies told us that they would likely pass additional costs on to their customers by increasing launch prices. Two launch customers told us that in turn, they would pass on additional costs to their customers.

Launch company representatives and customers said that ending CSLAA indemnification would also decrease the competitiveness of U.S. launch companies because launch customers would be exposed to more risk than if they used launch companies in countries with government indemnification. For example, representatives from several launch companies and customers said that if some aspect of the launch payload is determined to have contributed to a launch failure, they could be exposed to claims for damages from third parties and therefore might be more likely to use a launch company in a country where the government provides third party indemnification. Some also noted that the increased potential for significant financial loss for third party claims could cause launch companies, customers, or suppliers to decide if it was no longer worthwhile to be involved in the launch business, resulting in lost jobs and industrial capacity. Lastly, one industry participant pointed out that some suppliers, such as those that build propulsion systems, have to maintain significant amounts of manufacturing capacity whether they build one product or many. If there are fewer launches, the cost of maintaining that capacity will be spread among these fewer launches, resulting in a higher price for each launch. To the extent that the federal government is a customer that relies on private launch companies for its space launch needs, it too could face potentially higher launch costs.

Alternatives for Addressing Space Launch Risk

Because launch failures and changing market conditions could change the amounts of coverage available in the private market, you have expressed interest in other possible ways of managing catastrophic risk. While we have not conducted specific work to analyze the feasibility of alternative approaches for providing coverage currently available through CSLAA, FAA and others have looked at possible alternatives to CSLAA indemnification and we have examined different methods for addressing the risk of catastrophic losses associated with natural disasters and acts of terrorism.²³ These events, like space launch failures, have a low probability of occurrence but potentially high losses. Some methods

²³See FAA, *Liability and Risk-Sharing Regime for U.S. Commercial Space Transportation: Study and Analysis* and Aerospace Corporation, *Study of the Liability Risk-Sharing Regime in the United States for Commercial Space Transportation*. See also GAO, *Catastrophe Insurance Risks: The Role of Risk-Linked Securities and Factors Affecting Their Use*, [GAO-02-941](#) (Washington, D.C.: Sept. 24, 2002); *Catastrophe Insurance Risks: The Role of Risk-Linked Securities*, [GAO-03-195T](#) (Washington, D.C.: Oct. 8, 2002); and *Natural Disasters: Public Policy Options for Changing the Federal Role in Natural Catastrophe Insurance*, [GAO-08-7](#) (Washington, D.C.: Nov. 26, 2007).

involve the private sector, including going beyond the traditional insurance industry, in providing coverage, and include the use of catastrophe bonds or tax incentives to insurers to develop catastrophe surplus funds. Other methods aid those at risk in setting aside funds to cover their own and possibly others' losses, such as through self-insurance or risk pools.²⁴ Still other methods, such as those used for flood and terrorism insurance, involve the government in either providing subsidized coverage or acting as a backstop to private insurers.²⁵

Use of any such alternatives could be complex and would require a systematic consideration of their feasibility and appropriateness for third party liability insurance for commercial space launches. For example, according to a broker and a risk expert, a lack of loss experience complicates possible ways of addressing commercial space launch third party liability risk, and according to another risk expert, any alternative approaches for managing this risk would need to consider key factors, including the

- number of commercial space launch companies and insurers and annual launches among which to spread risk and other associated costs;
- lack of launch and loss experience and its impact on predicting and measuring risk, particularly for catastrophic losses; and
- potential cost to private insurers, launch companies and their customers, and the federal government.

As such, alternatives could potentially require a significant amount of time to implement.

²⁴See GAO, *Catastrophe Insurance Risks: Status of Efforts to Securitize Natural Catastrophe and Terrorism Risk*, [GAO-03-1033](#) (Washington, D.C.: Sept. 24, 2003). Self-insurance occurs when an entity assumes the risk for its losses and can involve the formation of an insurance company solely for that purpose. Risk pooling occurs when two or more entities agree to set aside funds to help pay for the others' losses.

²⁵See GAO, *Flood Insurance: FEMA's Rate-Setting Process Warrants Attention*, [GAO-09-12](#) (Washington, D.C.: Oct. 31, 2008) and *Terrorism Insurance: Status of Efforts by Policyholders to Obtain Coverage*, [GAO-08-1057](#) (Washington, D.C.: Sept. 15, 2008).

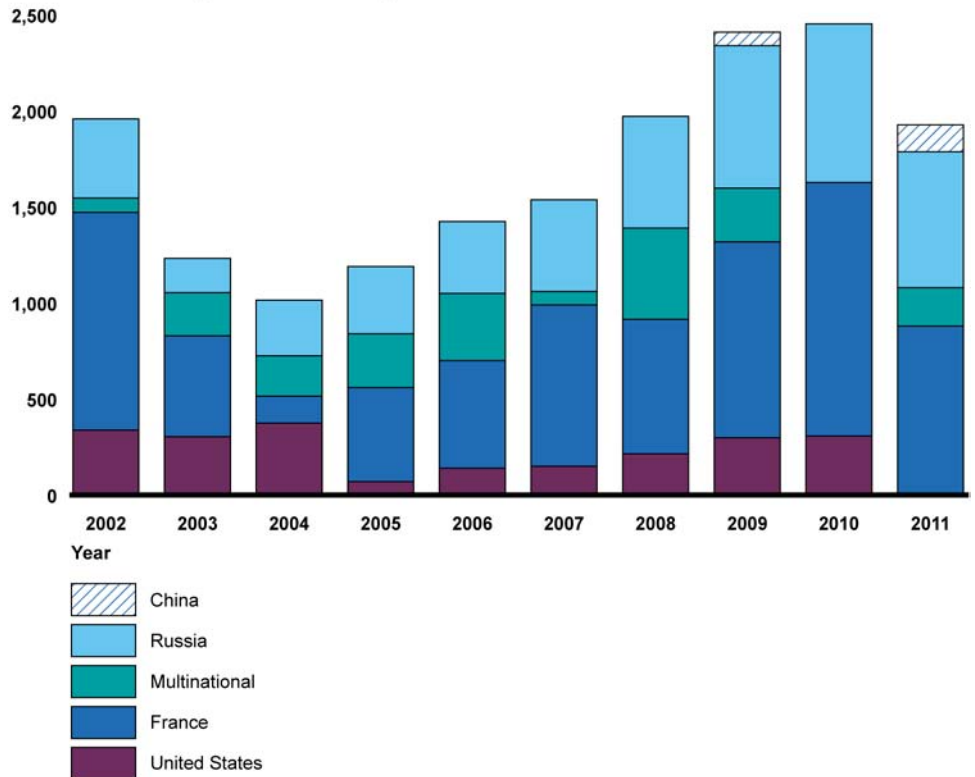
Several Factors Hinder the Competitiveness of the U.S. Commercial Space Launch Industry

The competitiveness of the U.S. commercial space launch industry is affected by high launch prices and export controls, which affect its ability to sell its services abroad. Based on several measures of global competitiveness, the U.S. commercial space launch industry has generally trailed Russia and France in recent years. For example, in 8 of the last 10 years, U.S. commercial space launch companies generated less revenue than either Russia or France. U.S. companies generated no commercial launch revenue in 2011 because they conducted no launches.²⁶ (See fig. 5.)

²⁶The one FAA-licensed launch that occurred in 2011 was by Sea Launch, which is a multinational company, not a U.S. company.

Figure 5: Worldwide Commercial Space Launch Revenues, 2002-2011

Commercial revenue (in millions of dollars)



Source: GAO analysis of FAA data.

Note: International revenue data for 2012 is not available.

We previously reported that as the U.S. commercial space launch industry expands, it will face key competitive issues, including high launch prices and export controls, that affect its ability to sell its services abroad.²⁷ Foreign competitors have historically offered lower launch prices than U.S. launch providers, as mentioned previously in this statement. The U.S. government has responded to foreign competition by providing the commercial launch industry support, including research and development funds, government launch contracts, use of its launch

²⁷ GAO-07-16.

facilities, and, as already discussed, indemnification for third-party losses that exceed the maximum probable loss.²⁸

Industry representatives that we interviewed told us that export licensing requirements affect the ability of the U.S. commercial space launch industry to sell launch vehicles abroad because they can deliver chemical, biological, and nuclear weapons. In previous work, a senior Commerce official told us that the U.S. commercial space launch industry had asked Congress to consider amending the statute that restricts space manufacturing items for export. A change in statute would allow for the Department of State (State) and DOD to review individual items for export, as they do for other industries.

Finally, the commercial space launch industry operates without the benefit of a national strategy. Numerous agencies—including FAA, NASA, State, and Commerce—are responsible for space activities and have developed their own strategies. A national space launch strategy could identify and fill gaps in federal policy concerning the commercial space launch industry, according to senior FAA and Commerce officials. According to those officials, the need for an overall U.S. space launch policy, which includes commercial space launches, was being discussed within DOT and across other departments as part of the administration's review of national space activities, but developing a national policy had not yet begun. Guidance on launch acquisitions will, however, be included in the updated National Space Transportation Policy, which is currently under development and a date for issuance has not been publically announced.

Concluding Observations

In closing, despite the decrease in FAA-licensed commercial launches since fiscal year 1998, commercial space launch is a dynamic industry with newly developing vehicles and missions. As the realization of space tourism nears and NASA relies more heavily on commercial providers to deliver cargo and crew to the ISS, the number and types of flights may increase, which will have implications for FAA oversight and federal indemnification support. As we previously recommended, FAA should continue to take steps to gather and review launch data that will enable it

²⁸There have been no commercial space launch accidents that resulted in third-party losses that required government indemnification.

to be prepared to regulate human spaceflight when the regulation moratorium expires in 2015. In addition, as the industry changes and grows, continually assessing federal liability indemnification policy to ensure that it protects both launch companies and the federal government will be important. As we complete our analysis of federal indemnification, we will more fully address any additional federal actions needed in response to these developments. Finally, the potential changes to the industry may present the conditions under which a subsequent review of FAA's dual role in promoting and overseeing commercial space launch safety is warranted.

Chairman Nelson, Ranking Member Boozman, and Members of the Subcommittee, this concludes my prepared statement. I would be pleased to answer any questions at this time.

GAO Contact and Staff Acknowledgments

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