



March 2017

COMMERCIAL SPACE LAUNCH INSURANCE

Weakness in FAA's Insurance Calculation May Expose the Federal Government to Excess Risk

Accessible Version

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Why GAO Did This Study

To assist in the development of the commercial space launch industry, the federal government shares liability risks for losses from damages to third parties or federal property. This risk-sharing arrangement requires space launch companies to have a specific amount of insurance for damages to third parties and federal property. The federal government is potentially liable for third-party claims above that amount, up to an estimated \$3.1 billion in 2017, subject to appropriations.

The Commercial Space Launch Competitiveness Act enacted in 2015 required the Department of Transportation—of which FAA is a part—to study the methodology used to determine launch companies' insurance requirements. The law also contains a provision for GAO to evaluate the study's conclusions and any planned revisions.

This report discusses the extent to which FAA has revised its methodology for calculating insurance requirements to address previously cited weaknesses and the potential effect of any changes on financial liabilities for the government. GAO reviewed documents from FAA and its contractors on alternative methods for calculating insurance requirements, interviewed FAA officials and a contractor involved in designing alternative methods, and reviewed GAO's prior work and relevant laws.

What GAO Recommends

FAA should prioritize planning for addressing the identified weakness in the cost-of-casualty amount and update the amount based on current information. The agency did not comment on this recommendation.

View GAO-17-366. For more information, contact Alicia Puente Cackley at (202) 512-8678 or cackleya@gao.gov.

What GAO Found

The Federal Aviation Administration (FAA) has revised its method for calculating insurance requirements to address some known weaknesses. FAA is the part of the Department of Transportation that determines the amount of insurance that commercial space launch companies must purchase to cover damages from accidents that harm third parties—that is, the uninvolved public—or federal property and personnel, unless companies otherwise demonstrate sufficient financial resources to cover the same calculated damages. The amount of insurance required is based on FAA's calculation of the maximum loss that can be reasonably expected. FAA contractors found the following:

- FAA's estimates of the **number of casualties** (serious injuries and deaths) that could result from a launch accident have likely been too high, and have been based on an unrealistic scenario;
- FAA's estimates of losses due to **property damage** may be too high in some cases, and too low in others;
- FAA's estimate of the **average cost of a casualty**—referred to as the cost-of-casualty amount—is based on outdated information and is likely too low. The amount has been fixed at \$3 million since 1988.

FAA implemented a new method for estimating the number of casualties in April 2016 that uses computer software to simulate a range of possible launch accidents that are intended to be more realistic than FAA's previous scenarios. FAA has also reduced the factor it uses to estimate losses due to property damage, based on tests of a new process for estimating such losses that showed the previous factor was too high. Both of these revisions have tended to reduce insurance requirements. In addition, FAA assigned one of its two contractors examining elements of the methodology to study potential improvements in estimating average casualty losses, but that contractor found significant limitations in each alternative approach that it reviewed.

Because FAA has not yet addressed the identified weakness in the cost-of-casualty amount used in its calculation, the federal government may be exposed to excess risk. FAA has identified potential steps to update the information the cost-of-casualty amount is based on, including seeking public input on whether and how to revise the amount, but the agency does not have a complete plan for updating the cost-of-casualty amount. Federal internal control standards require that agency management respond to risks related to achieving the entity's objectives, define how to achieve objectives, and set time frames for achieving them. FAA has not responded to the risk identified in using outdated data as the basis of the cost-of-casualty amount because FAA has prioritized other work, such as reviewing launch license applications, ahead of this issue. Further, because the weakness in the cost-of-casualty amount indicates that the amount is likely too low, the current calculation may not account for damages to third parties and federal property and personnel that can reasonably be expected from a launch accident, as required by FAA regulations. By leaving this weakness unaddressed, FAA's insurance requirements may not account for damages that can be reasonably expected, and may expose the government to more liability risk than intended under the risk-sharing arrangement.

Contents

Letter	1
Background	3
FAA Has Revised Elements of the MPL Calculation, but an Unaddressed Weakness May Expose the Federal Government to Excess Liability Risk	7
Conclusions	18
Recommendation for Executive Action	19
Agency Comments and Third-Party Views	19
Appendix I: GAO Contact and Staff Acknowledgments	20
GAO Contact	20
Staff Acknowledgments	20
Table	
Table 1: Illustration of Potential Effect of Various Cost-of-Casualty Amounts on Maximum Probable Loss Calculations	18
Figures	
Figure 1: Identified Weaknesses Impacting Maximum Probable Loss (MPL) Values	10
Figure 2: Example of a Maximum Probable Loss Risk Profile	12
<hr/> Abbreviations	
CBO	Congressional Budget Office
CSLAA	Commercial Space Launch Act Amendments of 1988
CSLCA	U.S. Commercial Space Launch Competitiveness Act
FAA	Federal Aviation Administration
MPL	maximum probable loss
OMB	Office of Management and Budget
STPI	Science and Technology Policy Institute

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U.S. GOVERNMENT ACCOUNTABILITY OFFICE

441 G St. N.W.
Washington, DC 20548

March 23, 2017

The Honorable John Thune
Chairman
The Honorable Bill Nelson
Ranking Member
Committee on Commerce, Science and Transportation
United States Senate

The Honorable Lamar Smith
Chairman
The Honorable Eddie Bernice Johnson
Ranking Member
Committee on Science, Space, and Technology
House of Representatives

Since 1988, the federal government has sought to assist in the development of the commercial space launch industry by sharing liability risks for accidents leading to damages to third parties, that is, the uninvolved public, or federal property and personnel.¹ This risk-sharing arrangement requires that space launch companies—firms that launch satellites or other payloads into space or reenter vehicles from space—purchase insurance against claims by third parties and for loss or damage to federal property and personnel up to an amount determined by the Federal Aviation Administration's (FAA) Office of Commercial Space Transportation.² For claims that exceed that threshold, the federal government provides payment for damages, subject to appropriation and up to a specified cap of an amount equivalent to \$1.5 billion in 1988.³ We

¹Commercial Space Launch Act Amendments of 1988, Pub. L. No. 100-657, § 5, 102 Stat. 3900, 3901-3905 (1988).

²The office serves several purposes, including the regulation of the U.S. commercial space transportation industry to protect the public health and safety, safety of property, and national security and foreign policy interests of the United States as well as encouraging and promoting commercial space launches and reentries by the private sector.

³51 U.S.C. § 50915(a)(1). The federal government would only make payments for damages to the extent that the funds were provided in advance by appropriations law. The law also provided that additional legislative authority could be enacted to provide for paying claims in a compensation plan. The law called for the \$1.5 billion cap to be adjusted for post-1988 inflation.

estimate that the cap on the federal government's assumption of risk in 2017 would be about \$3.1 billion.⁴

We found in 2012 that the FAA method for calculating the amount of required launch insurance may not be sound because FAA had not updated crucial components to the method in use since 1988.⁵ In addition, insurance industry officials and risk-modeling experts at the time said that FAA's method was outdated. We found that either the federal government or launch companies could be harmed by an unsound calculation method. Specifically, a method that understates the amount of insurance coverage a launch company must obtain would increase the likelihood of costs to the federal government, and a calculation that overstates the amount of insurance coverage needed would raise the cost of insurance for launch companies. We recommended that FAA reassess its maximum probable loss methodology—including assessing the reasonableness of the assumptions used—as discussed later in this report.

As part of the U.S. Commercial Space Launch Competitiveness Act (CSLCA) enacted in 2015, Congress directed the Department of Transportation—of which FAA is a part—to evaluate the methodology used to calculate the amount of insurance launch companies must obtain, and, if necessary, develop a plan to update that methodology so that the federal government is not exposed to greater costs than intended and launch companies are not required to purchase more insurance than necessary.⁶ The results of that evaluation were to be reported to Congress in a study due in May 2016, and CSLCA included a provision for GAO to examine the conclusions in the study and the planned approach for any revisions. However, as of March 15, 2017, the Department of Transportation had not yet released the study mandated by Congress, and agency officials said that the report has been delayed in an internal review process.

⁴To estimate the 2017 cap on federal liability indemnification, we used averages of monthly indexes from the U.S. Department of Labor, Bureau of Labor Statistics, from 1988 to 2015 and estimated inflation data from the Congressional Budget Office (CBO) for 2016 and 2017. For more information on CBO data, see Congressional Budget Office, *An Update to the Budget and Economic Outlook* (Washington, D.C.: August 2016).

⁵GAO, *Commercial Space Launches: FAA Should Update How It Assesses Federal Liability Risk*, [GAO-12-899](#) (Washington, D.C.: July 30, 2012).

⁶Pub. L. No. 114-90, § 102(b), 129 Stat. 704, 705 (2015).

FAA is the part of the Department of Transportation that calculates the amount of insurance launch companies must obtain. In July 2016, FAA officials informed us that they had made some revisions to the method for calculating insurance requirements for commercial space launches. However, because the Department of Transportation has not yet released its study as required, we will more fully assess the analysis and conclusions that led to these revisions in a subsequent report after the release of the study.

This report focuses on the extent to which FAA has revised its method for calculating insurance requirements to address previously cited weaknesses and the potential effect of any methodological changes on financial liabilities for the government. To address this objective, we reviewed documents from FAA and its contractors that describe options for revising various elements of the formula for calculating insurance requirements, and we interviewed FAA officials and representatives of FAA's contractor responsible for designing the revisions FAA has implemented. We also reviewed our prior work, the requirements of CSLCA, and federal internal control standards.⁷

We conducted this performance audit from May 2016 to March 2017 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.

Background

The Commercial Space Launch Act Amendments of 1988 (CSLAA) established the foundation for the current U.S. policy to potentially provide federal payment for a portion of claims by third parties for injury, damage,

⁷GAO, *Standards for Internal Control in the Federal Government*, GAO-14-704G (Washington, D.C.: September 2014).

or loss that results from a commercial launch or reentry accident.⁸ A stated goal of CSLAA was to provide a competitive environment for the U.S. commercial space launch industry. The act also provides for, among other things, government protection against some losses—referred to as indemnification—while still minimizing the cost to taxpayers. All FAA-licensed commercial launches and reentries by U.S. companies, whether unmanned or manned and from the United States or overseas, are covered by federal indemnification for third-party damages that result from the launch or reentry.⁹

The U.S. indemnification policy has a three-tier approach for sharing liability between the government and the private sector to cover third-party claims:

- The **first tier** of coverage is the responsibility of the launch company and is handled under an insurance policy purchased by the launch company or through a demonstration of financial responsibility.¹⁰ As part of FAA's process for issuing a license for a commercial launch or reentry, the agency determines the amount of insurance a launch company is required to purchase so the launch company can compensate third parties and the federal government for any claims for damages that occur as a result of activities carried out under the license.¹¹ The amount of insurance coverage that FAA can require is capped at a maximum of \$500 million for damages to third parties and

⁸Payments by the federal government are subject to appropriation. Damages to parties involved in launches and reentries—for example, space flight participants—are not eligible for indemnification coverage. Regulation defines third parties to launches as any person other than: (i) the United States, any of its agencies, and its contractors and subcontractors involved in launch or reentry services for a licensed or permitted activity; (ii) a licensee, permittee, and its contractors and subcontractors involved in launch or reentry services for a licensed or permitted activity; (iii) a customer and its contractors and subcontractors involved in launch or reentry services for a licensed or permitted activity; (iv) a member of a crew; and (v) a space flight participant. Government personnel, as defined in this section, are considered to be third parties. See 14 C.F.R. § 440.3.

⁹51 U.S.C. § 50904(a); 51 U.S.C. § 50914(a)(1)(A). Launches and reentries by foreign entities are also licensed by FAA if they take place from or into the United States and are covered by federal indemnification.

¹⁰Throughout this report, unless otherwise noted, when referencing an insurance policy under the first tier of coverage note that a demonstration of financial responsibility would also be permissible.

¹¹By regulation, the federal government portion of the MPL is defined, in part, as “losses to the Government property and Government personnel involved in licensed or permitted activities....” 14 C.F.R. § 440.3.

\$100 million for damages to federal government property and personnel.¹²

- The **second tier** of coverage is to be provided by the U.S. government and covers any third-party claims in excess of the specific first-tier amount up to a limit of approximately \$3.1 billion.¹³ For the federal government to be liable for these claims, Congress would need to appropriate funds.¹⁴
- The **third tier** of coverage is for third-party claims in excess of the second tier. Like the first tier, this third tier is the responsibility of the launch company, which may seek insurance above the required first-tier amount for this coverage. Unlike the first tier, no insurance is required under federal law.

The amount of insurance coverage that FAA requires launch companies to purchase is intended to reflect the greatest dollar amount of loss to third parties and the federal government for bodily injury and property damage that can be reasonably expected to result from a launch or reentry accident.¹⁵ This amount is known as the maximum probable loss (MPL). For each launch license that it issues, FAA determines MPL values for third parties with the intent of estimating the greatest dollar amount of losses that could be expected from a launch or reentry accident, which have no less than a 1 in 10 million chance of occurring.¹⁶ Given the structure of the indemnification policy, an MPL calculation that overestimates the amount of losses that can reasonably be expected would increase the costs for launch companies by requiring them to purchase more coverage than is necessary, while an MPL calculation that does not account for losses that can be reasonably expected would expose the federal government to excess risk.

¹²51 U.S.C. § 50914(a)(3)(A). This maximum amount is not automatically adjusted for inflation.

¹³51 U.S.C. § 50915(a)(1).

¹⁴51 USC § 50915(a).

¹⁵14 C.F.R. § 440.3. This amount includes potential damages from accidents that could occur in both the pre-flight and during-flight phases of a launch.

¹⁶14 C.F.R. § 440.3. FAA calculates separate MPL values for potential damages to third parties and the federal government. For damages to the federal government, FAA determines MPL values with the intent of estimating the greatest dollar amount of property losses that could be expected from a launch or reentry accident, which have no less than a 1 in 100,000 chance of occurring.

FAA has used a statistical approach to calculate MPL values that considers three primary elements: a number of estimated casualties, an estimate of the average loss per casualty, and the estimated amount of losses from property damage. Prior to recent changes that we discuss in greater detail later in this report, FAA estimated these three elements in the following ways:

- **Number of estimated casualties.** To estimate the number of direct casualties that could result from a launch accident, including serious injuries and deaths, FAA has (1) estimated the total area of the debris field that would result in the event of a launch vehicle's self-destruction system being triggered as a safety measure, (2) estimated the area within that debris field that would cause a casualty if a person were within it, and (3) multiplied that area by the maximum population density of the selected population center.¹⁷ In addition, FAA estimated the number of casualties that could result from secondary effects, such as fires and collapsing buildings, to be 150 percent of the number of direct casualties. FAA added direct and secondary casualties together to estimate the total number of casualties.
- **Estimated loss per casualty.** To determine the cost of judgments and settlements that would result from the estimated casualties, FAA has used \$3 million as an estimate of the average loss per casualty. FAA has used this \$3 million figure, referred to as the "cost-of-casualty amount" throughout this report, since 1988, when it was selected to be a conservative estimate of jury awards for transportation casualties at that time.¹⁸
- **Estimated losses due to property damage.** FAA has estimated losses due to property damage to be 50 percent of its estimated

¹⁷The debris field in this scenario was assumed to be caused by nonexplosive debris produced by using a flight safety system to cause the launch vehicle to self-destruct. Flight safety systems protect the public and property from harm in the event of a problem in the launch. Launches from the United States typically use vehicle destruct systems to end the flight if significant problems occur, and the system can be triggered automatically or by a Missile Flight Control Officer if the vehicle moves off of its planned trajectory by a predetermined amount.

¹⁸FAA's analysis at the time found that jury awards for transportation fatalities were often around \$1 million but fluctuated widely. FAA officials said that \$3 million per casualty was selected to be conservative.

losses from casualties. FAA has added this amount to the estimated losses from casualties to calculate the total MPL.¹⁹

We reported in 2012 that the average third-party MPL value for active launch licenses, and thus the average amount of insurance coverage required for commercial launches, was about \$99 million, with a range of about \$23 million to \$267 million. According to FAA, it issued five active licenses in 2016, which had an average third-party MPL of about \$51 million, and ranged from \$10 million to \$99 million.

FAA Has Revised Elements of the MPL Calculation, but an Unaddressed Weakness May Expose the Federal Government to Excess Liability Risk

FAA has revised its MPL calculation methodology to address some identified weaknesses, but because another identified weakness remains unaddressed, the current methodology may expose the government to excess risk. FAA-contracted experts and others have found that FAA's estimates of the number of casualties have tended to be too high, that estimates of losses from property damage may have been too high in some cases and too low in others, and that the \$3 million cost-of-casualty amount was likely too low because it is based on outdated information. FAA implemented a revised process for estimating the number of casualties and reduced the 50 percent factor it uses to estimate losses due to property damage by half, and these revisions have tended to reduce insurance requirements, with some exceptions. However, FAA has not addressed the identified weakness of an outdated cost-of-casualty amount, which may indicate that FAA is not requiring launch companies to have insurance coverage for losses that can be reasonably expected and therefore may be exposing the government to excess risk.

¹⁹The complete formula for the MPL calculation has been ((estimated direct casualties + 1.5 x estimated direct casualties) x 1.5) x \$3 million, or 3.75 x estimated casualties x \$3 million.

Weaknesses Have Been Identified in Elements of FAA's Calculation Methodology

FAA-contracted experts and others have identified weaknesses in the three primary elements of the MPL calculation. An FAA contractor, ACTA Inc., reported to FAA in 2005 that FAA's method for estimating the number of casualties produced numbers of casualties that were too high.²⁰ ACTA found that the scenario that FAA based its casualty estimates on—that the inert debris resulting from the self-destruction of the launch vehicle would land on the area in the vicinity of the launch site with the highest population density—was implausible. In other words, if a launch vehicle's self-destruct mechanism were triggered as a safety measure, the resulting debris could not reach these population areas because the vehicle would be destroyed before it could reach them. For a vehicle to reach the maximum populated area, the vehicle's self-destruct system would have to fail. An ACTA official said that under more realistic scenarios for losses from launch accidents that have no less than a 1 in 10 million chance of occurring, the inert debris caused from the self-destruction of a launch vehicle would likely land on less densely populated areas, and thus the estimated number of casualties would be lower in most cases. FAA officials that we spoke with confirmed that their method for estimating the number of casualties was not as reasonable or realistic as it could have been, and that it was generally too conservative. ACTA also reported to FAA in 2006 that FAA's assumption that secondary casualties would be 150 percent of direct casualties was very conservative.

ACTA also found two weaknesses in FAA's method for estimating losses from property damage as 50 percent of losses from casualties, one that could lead to overestimates and one that could lead to underestimates. First, if a launch accident affected a residential area, FAA's estimate of losses from property damage would likely be too high because residential structures have relatively low values compared to losses from casualties. Second, as ACTA reported in 2007, in some accidents the number of casualties may be low but property losses could still be very large, in which case FAA's estimates of losses from property damage would be

²⁰ACTA has provided flight risk and safety hazard analyses of space launches for the U.S. Air Force and the National Aeronautics and Space Administration.

too low.²¹ For example, a launch vehicle could strike an unoccupied structure that is very expensive, such as a neighboring launch complex.

In addition, ACTA and GAO have found that basing the cost-of-casualty amount on outdated information is a weakness that indicates that the \$3 million amount is likely too low. ACTA reported to FAA in 2006 that the \$3 million cost-of-casualty amount was probably too low, and that data at that time suggested a more accurate value could be as much as three times higher. In a 2012 report on commercial space launches, we found that because FAA's \$3 million cost-of-casualty amount had not changed since FAA began using it in 1988, it may not adequately represent the current cost of liability for injury or death caused by commercial space launch failures.²² Based in part on this finding, we recommended that FAA reassess its maximum probable loss methodology—including assessing the reasonableness of the assumptions used.²³

Subsequently, FAA contracted with the Science and Technology Policy Institute (STPI) in 2015 to study the damages awarded in judgments and settlements for casualties in airplane crashes, as well as other data that might inform an updated cost-of-casualty estimate. While STPI was limited in the amount of data it could access, as we discuss later in more detail, STPI concluded in 2016 that FAA's cost-of-casualty amount should be increased based on its analysis of the data it collected. STPI also reported that this conclusion was unanimously confirmed in its interviews with industry experts. STPI's study indicated that a cost-of-casualty amount of approximately \$6 million per casualty might be appropriate, but the study did not make a recommendation of what amount FAA should use.

The combined impact of these issues on the amount of insurance coverage that launch companies are required to purchase is unclear. While FAA contractors have identified some weaknesses that likely overstate MPL values and some weaknesses that likely understate MPL values, they have not reported the magnitude of the effects of these

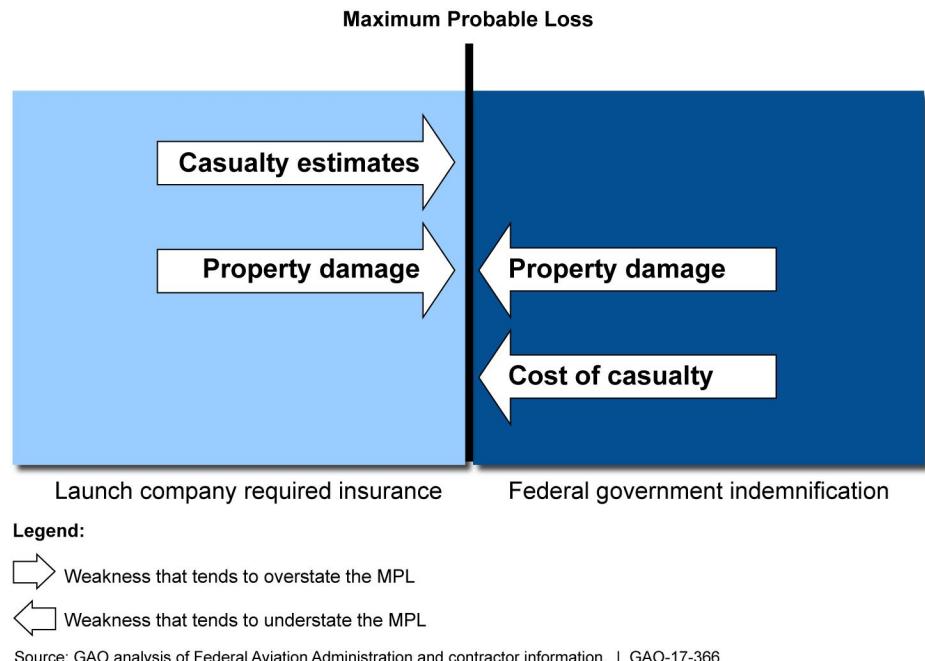
²¹J.D. Collins, C.P. Brinkman, and S.L. Carbon, ACTA Inc., and Federal Aviation Administration, *Determination of Maximum Probable Loss* (2007).

²²[GAO-12-899](#).

²³We have closed this recommendation as implemented based on studies of the cost-of-casualty amount and other elements of the MPL calculation methodology that FAA has hired contractors to conduct, which we discuss later in this report.

weaknesses on insurance requirements. Further, because some weaknesses likely overstate MPL values, while others likely understate MPL values, to some extent the effect of one may offset the effect of another (see fig. 1).

Figure 1: Identified Weaknesses Impacting Maximum Probable Loss (MPL) Values



FAA Has Revised Its Methodology for Estimating the Number of Casualties and Property Damage

In April 2016, FAA implemented a new MPL calculation methodology that incorporates revisions to the processes for estimating the number of casualties and losses due to property damage to address the weaknesses identified in these elements of the MPL calculation.

Estimating the number of casualties. In 2016, ACTA completed the design of a method for estimating the number of casualties that uses computer software to simulate a range of possible launch accidents that are intended to be more realistic than the scenario used in FAA's

previous method. FAA officials stated that FAA has used the revised method to calculate MPL values since April 2016.²⁴

FAA's revised method for estimating the number of direct casualties in the MPL calculation uses additional data and modeling software to simulate more realistic accident scenarios. The data used in FAA's previous method were a list of potential debris for each launch vehicle, which was supplied by the launch company, and the population densities of areas near the launch site. The revised method uses additional vehicle launch data, such as launch trajectory and fuel type, as well as failure rates for different phases of flight and types of failures. FAA uses software known as the Range Risk Analysis Tool to create physics-based simulations of possible accidents using these data, and it assigns each simulated accident a probability of occurrence based on the failure rates of the different elements of the launch vehicle.²⁵ Based on the types of debris that are simulated, where the debris are predicted to fall, and population data, the software estimates a number of direct casualties for each simulated accident.

FAA officials told us that FAA also revised how it incorporates secondary casualties into its MPL calculation. In each simulated accident, secondary casualties from inert debris and explosive debris are estimated separately. Secondary casualties from inert debris are assumed to be 25 percent of direct casualties from inert debris, while secondary casualties from explosive debris continue to be estimated as 150 percent of direct casualties.

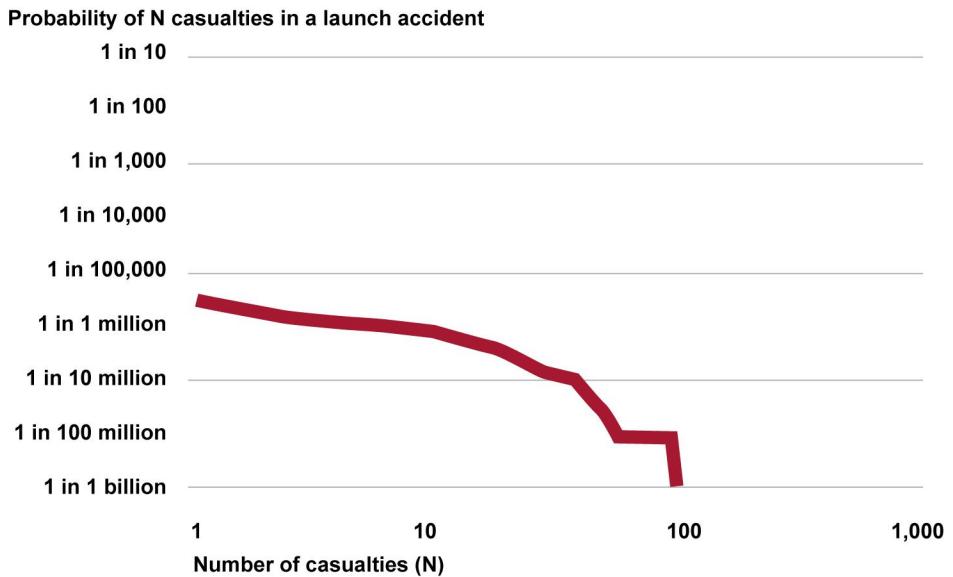
FAA simulates millions of launch accidents with different probabilities of occurrence and records the number of casualties that result in each

²⁴FAA officials stated that it has used the revised method for estimating casualties in MPL calculations four times as of January 2017. ACTA's work on the design was conducted in several stages, the earliest of which began in 2003.

²⁵This software tool is also used in FAA's launch safety certification process, as well as by other agencies and the military. Integrating the MPL calculation with the launch safety certification process was one of ACTA's primary goals when designing the revised methodology so that most of the additional data used in the process were already submitted by the launch company. However, FAA officials added that the revised calculation methodology is still more labor intensive for FAA staff than the previous method. As a result, FAA designed a less labor-intensive version of this process for low-risk launches, such as launches in very low-population areas. FAA developed a separate software tool for this version of the revised process, and the National Aeronautics and Space Administration validated the use of the system.

simulation. Taken together, the estimated numbers of casualties create a “risk profile” of the launch, which is a representation of the estimated number of casualties that would occur for accidents with a range of probabilities of occurrence, as shown in figure 2. FAA then uses the number of casualties that are estimated to have a 1 in 10 million chance of occurring in its MPL calculation.

Figure 2: Example of a Maximum Probable Loss Risk Profile



Source: Adapted from Federal Aviation Administration. | GAO-17-366

FAA officials stated that the revised methodology generally reduces the number of casualties estimated and ultimately the amount of insurance coverage required. FAA officials said that they calculated MPL values with both the revised method and the previous method for some recent launches to compare the results. FAA officials noted that in these cases the revised method generally estimated lower numbers of casualties than the previous method, although there were exceptions. ACTA reported while developing the revised methodology for estimating casualties that it consistently produced lower MPL values than the previous method.

Estimating losses from property damage. FAA has revised the factor it uses to estimate losses from property damage in the MPL calculation and is also testing a new process. FAA officials stated that they have decreased estimates of property damage losses from 50 percent of losses due to casualties to 25 percent. FAA made this revision because it is testing a new process for estimating losses from property damage that

was also designed by ACTA, and officials said that in test applications, this process has produced estimates of property damage losses that are lower than 25 percent of losses due to casualties. As such, they said that they believe that the lower factor for property damage losses estimates is still conservative but more realistic than the previous estimates.

As of January 2017, FAA had not determined whether it will use the new process that it is testing in future MPL calculations, or continue to base estimates of property damage on losses from casualties. The process that ACTA designed for estimating losses from property damage is intended to be integrated with the software tool that is now used to estimate the number of casualties in the MPL calculation. This revised process estimates losses from property damage using the same simulated launch accidents that are used to estimate the number of casualties. Property damage estimates are based on damage models that simulate the effect of inert and explosive debris impacting different types of structures, such as residential and commercial. FAA officials have stated that they have begun to test this revised process but have not yet implemented it in MPL calculations. These officials said that they have not determined whether the new process is necessary because the impact of property damage on the total MPL value is relatively minor, and continuing to use a more simple method may be a more effective use of limited FAA resources. However, an ACTA official noted that in some cases losses from property damage can be the most significant contributor to the total MPL value, and raised concerns about continuing to calculate losses from property damage as a factor of losses due to casualties.

Unaddressed Weakness in FAA's Cost-of-Casualty Amount May Expose the Federal Government to Excess Liability Risk

FAA has not addressed the weakness identified in the cost-of-casualty amount used in the MPL calculation, and, as of January 2017, it had not determined when it would do so. FAA officials said that they have identified potential steps to address the outdated data on which the cost-of-casualty amount is based, which may include revising the amount. However, FAA's potential steps to address the outdated data are not fully developed, and FAA has not established time frames for taking action.

FAA officials said that their first step would be to evaluate more current information to form the basis for revising the cost-of-casualty amount.

However, FAA has faced challenges in identifying reliable information because each of the sources that its contractor reviewed had significant limitations.

- **Airplane crash damages.** FAA and STPI both noted that the preferred method for updating the cost-of-casualty amount would be to base it on legal judgments and settlements from casualties in airplane crashes, given that there have not been any commercial space launch accidents that have resulted in casualties. However, STPI reported that it was only able to access very limited information on settlement awards from airplane crashes.²⁶ As a result, STPI said it could not make a reliable estimate of the average loss per casualty based on this information because it was not a representative sample of all awarded damages and the damages awarded varied substantially.
- **Federal agency regulatory analysis.** STPI also reviewed estimates of the value of a “statistical life” that federal agencies use in the analysis of proposed regulations as a possible basis for the cost-of-casualty amount. However, FAA officials stated that this method is not suitable because these estimates are based on people’s willingness to pay for safety, and the estimates do not necessarily reflect the losses from casualty settlements or legal judgments that would be expected from commercial space launch accidents.²⁷
- **Inflation adjustment.** The final method for updating the cost-of-casualty amount that STPI reviewed was to simply adjust the existing cost-of-casualty amount for inflation using the Consumer Price Index. However, FAA officials noted that they do not know whether settlements and judgments for casualties have increased at the same rate as inflation, and thus an inflation-adjusted amount may be too high or too low.

FAA officials said they are still considering how to overcome these challenges. FAA officials said that they are not planning to make

²⁶STPI noted that settlement data are the property of the insured parties, and thus insurance companies that have these data were unable to share them.

²⁷The Office of Management and Budget advises federal agencies to consider using a methodology called “willingness to pay” to measure benefits and costs of proposed health and safety regulations. “Willingness to pay” measures the costs—often in the form of monetary costs—for benefits that include reduced risk of harm to the public. When benefits include a reduced risk of death and can be quantified in dollar terms, that dollar amount is known as the “value of a statistical life.” See Office of Management and Budget, Circular A-4, September 17, 2003.

additional attempts to access insurance data on airplane accident damage awards at this time, because STPI considered enough options for collecting these data that they believe additional attempts would be unproductive. Officials said they plan to use the information collected by STPI, despite its limitations, as well as any additional information the agency may gather, to reach agreement within the agency for revising the basis for the cost-of-casualty amount, though officials do not have a detailed methodological approach.

Once FAA has developed a revised basis for the cost-of-casualty amount within the agency, officials said their next step would be to propose this amount for public comment. Officials said that this step is necessary to obtain input on whether and how to revise the amount and help ensure that the revised amount would not place too much financial burden on launch companies, thus disrupting the industry. FAA officials said they may propose a revised cost-of-casualty amount in the *Federal Register* or use other methods to request public input on the proposal.²⁸ For example, officials said they may seek input on a proposed amount from FAA's committee of industry advisors, the Commercial Space Transportation Advisory Committee. However, agency officials have not yet determined how to obtain public input or identified specific time frames for proposing a revised cost-of-casualty amount.

Federal internal control standards require that agency management identify, analyze, and respond to risks related to achieving the entity's objectives, and use current data. These standards also require that agency management define how to achieve objectives and the time frames for achieving them. However, while FAA has hired a contractor to study the cost-of-casualty issue, it has not responded to the risk presented by using outdated data as the basis of the cost-of-casualty amount. Further, because FAA's contractors have concluded that the cost-of-casualty amount is likely too low, the current MPL calculation may not account for all damages to third parties and federal government property and personnel that can reasonably be expected to result from a

²⁸If the decision to revise the current \$3 million figure is made, FAA officials said they may implement the change through a formal rule-making process.

launch accident, as required by FAA regulations.²⁹ An MPL methodology that does not account for all damages that can reasonably be expected could cause the government to be liable for some of those damages. This would not align with the mandated considerations of the CSLCA-required FAA review, which includes helping to ensure that the federal government is not exposed to liability risk for more damages or losses than can be reasonably expected or intended. To achieve this purpose, Congress directed the Department of Transportation, which includes FAA, to determine whether the MPL calculation needs to be revised and to develop a plan for any necessary revisions by May 2016.³⁰

However, FAA's identified steps to update the cost-of-casualty amount remain incomplete because the agency has not prioritized this issue. FAA officials said that they have prioritized other work, such as reviewing launch license applications, ahead of addressing the weakness in the cost-of-casualty amount. They also noted that they did not want to delay the implementation of other revisions in the MPL methodology while they reviewed the cost-of-casualty issue, indicating that those revisions were also a higher priority.

Although FAA has faced challenges in accessing sufficient data to use as a basis for updating the cost-of-casualty amount, by not prioritizing this weakness FAA may be exposing the federal government to excess risk. By continuing to use the \$3 million cost-of-casualty amount in its MPL calculation methodology that we and others have noted is outdated, FAA may not be requiring launch companies to have sufficient insurance to cover all losses that can be reasonably expected. For example, if a cost-of-casualty amount based on more current data were set twice as high as the existing \$3 million amount, then industry insurance requirements would cover only half of all losses that could reasonably be expected (see table 1).³¹ If launch companies' insurance requirements do not cover all

²⁹As previously discussed, FAA regulations state that MPL values should require launch companies to have insurance coverage for damages to third parties and federal government property and personnel that can reasonably be expected to result from launch or reentry accidents. Federal law caps this amount at \$500 million for third parties. For the purposes of determining MPL values for third parties, FAA defines losses that can reasonably be expected as those that have a probability of occurrence of no less than 1 in 10 million.

³⁰Pub. L. No. 114-90, § 102(b), 129 Stat. 704, 705 (2015).

³¹Conversely, if more current data were to suggest that the cost-of-casualty amount should be lower, then financial responsibility assigned to space launch companies would be more than the amount necessary to cover reasonably expected losses.

reasonably expected losses, the federal government will be exposed to more risk than intended under the indemnification regime and may be liable for some damages that should be covered by the launch company's insurance in the case of a launch or reentry accident.

Table 1: Illustration of Potential Effect of Various Cost-of-Casualty Amounts on Maximum Probable Loss Calculations

Estimated number of casualties ^a	Cost-of-casualty amount (dollars in millions)	Estimated property damage ^b (dollars in millions)	Maximum probable loss (dollars in millions)
Example based on existing cost-of-casualty amount	14	3	10.5
Example based on 50 percent increase in cost-of-casualty amount	14	4.5	15.75
Example based on 100 percent increase in cost-of-casualty amount	14	6	21
			105

Source: GAO analysis of FAA information. | GAO-17-366

Note: The Federal Aviation Administration's (FAA) method for determining space launch companies' insurance requirements—known as the maximum probable loss calculation (MPL)—incorporates estimates of the number of casualties, the estimated average loss per casualty (the cost-of-casualty amount), and estimated losses due to property damage.

^aFor each commercial space launch, FAA uses computer simulations for a range of possible launch accidents to estimate the maximum number of casualties that have no less than a 1 in 10 million chance of occurring in a launch or reentry accident. The number of casualties shown, which includes direct and secondary casualties, was chosen to reflect results for the average MPL for third-party damages in 2016 under the revised MPL calculation process. MPL values for third-party damages averaged about \$51 million for active licenses issued in 2016, according to FAA.

^bThe property damage estimate is 25 percent of the estimated number of casualties times the estimated cost-of-casualty amount.

Conclusions

FAA's mission includes promoting the development of the commercial space launch industry as well as managing risk to the public and the federal government. FAA has taken steps to address weaknesses in some parts of its MPL calculation, which have tended to reduce the amount of insurance coverage that launch companies are required to have. However, FAA has not yet addressed the weakness identified in the \$3 million cost-of-casualty amount and does not yet have a fully developed plan to do so, which would include time frames for taking action. While there is substantial uncertainty in the MPL calculation, the use of outdated data as the basis of the cost-of-casualty amount represents a risk that the current MPL calculation may not account for damages to third parties and federal property and personnel that can reasonably be expected from a launch accident, as required by FAA regulations. As a result of this unaddressed weakness in the cost-of-casualty amount, FAA may not be requiring launch companies to hold

enough insurance, which, as a result, may expose the government to more risk than intended.

Recommendation for Executive Action

To help ensure that the government is not exposed to more liability risk than intended, the Secretary of Transportation should ensure that the FAA Administrator prioritizes the development of a plan to address the identified weakness in the cost-of-casualty amount, including setting time frames for action, and update the amount based on current information.

Agency Comments and Third-Party Views

We provided a draft of this report to the Department of Transportation for its review and comment. We also provided relevant excerpts to the agency's contracted expert ACTA Inc. for technical comment. The Department of Transportation did not comment on the findings or recommendation, but provided technical comments that we have incorporated into the report, as appropriate. ACTA Inc. also provided technical comments, which we incorporated as appropriate.

We are sending copies of this report to interested congressional committees and the Secretary of the Department of Transportation. In addition, this report will be available at no charge on GAO's website at <http://www.gao.gov>.

If you or your staff have any questions or would like to discuss this work, please contact Alicia Puente Cackley at (202) 512-8678 or cackleya@gao.gov. Contact points for our Offices of Congressional Relations and Public Affairs may be found on the last page of this report. Individuals making key contributions to this report are listed in appendix I.



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Appendix I: GAO Contact and Staff Acknowledgments

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Staff Acknowledgments

In addition to the contact named above, Jill Naamane (Assistant Director), Jeremy Conley (Analyst-in-Charge), Stephen Robblee, Jessica Sandler, Jennifer Schwartz, Joseph Silvestri, Jena Sinkfield, and Shana Wallace made key contributions to this report.

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