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**FEDERAL AVIATION
ADMINISTRATION**

Washington, D.C. 20591

FINAL REGULATORY EVALUATION, REGULATORY FLEXIBILITY DETERMINATION, TRADE IMPACT ASSESSMENT, AND UNFUNDED MANDATES ASSESSMENT

Commercial Space Transportation Reusable Launch Vehicle and Reentry Licensing Regulations

Final Rule
(14 CFR Parts 400, 401, 404, 405, 406, 413, 415, 431, 433, and 435)

**OFFICE OF AVIATION POLICY AND PLANS,
OPERATIONS REGULATORY ANALYSIS BRANCH, APO-310**

**Reviewed and Edited by
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LIST OF ABBREVIATIONS

14 CFR	Title 14, Code of Federal Regulations
AST	FAA Office of the Associate Administrator for Commercial Space Transportation
COMET	Commercial Experiment Transporter
DoD	U.S. Department of Defense
DOS	U.S. Department of State
DOT	U.S. Department of Transportation
E_c	Expected average number of casualties
ELV	Expendable Launch Vehicle
FAA	Federal Aviation Administration
FSS	Flight safety system
FY	Fiscal Year
LASD	FAA Licensing and Safety Division
LEO	Low-Earth Orbit
LV	Launch vehicle
METEOR	Multiple Experiment to Earth Orbit and Return
NASA	National Aeronautics and Space Administration
NEPA	National Environmental Policy Act
OCST	DOT Office of Commercial Space Transportation
RFA	Regulatory Flexibility Act of 1980
RLV	Reusable Launch Vehicle
RV	Reentry Vehicle
SSDD	FAA Space Systems Development Division

EXECUTIVE SUMMARY

This report presents an evaluation of the effects of revisions to Title 14, Code of Federal Regulations, Parts 400, 401, 404, 405, 406, 413, 415. This report also examines the effects of the addition of Parts 431, 433, and 435. As the result of the final rule, this report presents an analysis of the expected impacts of these revisions and additions by focusing on compliance costs that will be incurred by the U.S. commercial space transportation industry and costs borne by the Federal Aviation Administration (FAA) to administer its requirements. This report also presents potential estimates of safety benefits that will be realized by the general public.

The final rule is consistent with the FAA's authority to regulate commercial space reentry operations under the Commercial Space Act, which was enacted on October 28, 1998. This authority, as exercised in the form of the final rule, will protect public health and safety and the safety of property as the commercial space transportation industry matures technologically. The final rule will complement existing regulations that focus on the launch phase only of commercial space transportation vehicles.

The rule is expected to impose a total estimated cost of $151 million (undiscounted) in 1999 dollars on the commercial space transportation industry and the FAA over the 15-year period from 2001 to 2015. The U.S. commercial space industry will incur approximately 20 percent of these total costs, or $31 million (undiscounted), complying with the regulatory requirements. The FAA will spend approximately 80 percent of the total estimated cost, or $120 million (undiscounted), administering the rule.

The rule is expected to generate potential quantitative safety benefits of approximately $119 million (undiscounted), based on a range from $21 million to $217 million (undiscounted) over the 15-year period. These quantitative benefits will take the form of enhanced safety for the general public by ensuring that the expected average number of casualties from commercial space transportation reentry operations will not exceed 30 per one million reentry missions. The rule is also expected to generate qualitative benefits in the form of enhanced operational efficiency on the part of both the U.S. commercial space industry and the FAA. A formalized

licensing process for reentry operations will enhance communications between the FAA and the commercial space transportation industry in terms of frequency and efficiency of information exchange. In so doing, it will instill a regulatory climate that will promote and foster growth and technological advancement in this maturing industry, while protecting public health and safety, and the safety of property.

1.0 INTRODUCTION

1.1 Regulatory Background

The Commercial Space Launch Act of 1984, as amended and codified in 49 United States Code 70101-70119 (1994), Subtitle IX, chapter 701, Commercial Space Launch Activities, authorizes the U.S. Secretary of Transportation to regulate domestic commercial space launch operations to protect (1) public health and safety, (2) property, (3) national security, and (4) foreign policy. The Act and its amendments also charge the U.S. Department of Transportation (DOT) with enhancing and facilitating private sector involvement in and expansion of this emerging industry.

During the two-year period immediately following establishment of the Act, there was little injection of private funds to bolster the commercial launch industry. Launch services provided by the National Aeronautics and Space Administration (NASA) Space Transportation System (that is, the Space Shuttle) and Arianespace, a European launch operator, were more advantageous financially than services provided by establishing private facilities for launching commercial payloads. Following the Space Shuttle Challenger disaster in 1986, however, the Federal Government ended its role as principal launcher of commercial payloads and established new polices to promote the commercial launch industry.

A DOT objective is to maintain a regulatory environment consistent with this burgeoning industry by fostering technological advancement without presenting unacceptable risks to the general public. The DOT Office of Commercial Space Transportation (OCST) published licensing regulations for commercial space launches in April 1988. To date, there have been 126 licensed launches.[1] In 1992 OCST established policy and associated criteria for ensuring that a commercial space reentry mission could be conducted safely.[2]

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[1] Extracted from Federal Aviation Administration, Office of the Associate Administrator for Commercial Space Transportation Internet Website Home Page (http:/ast.faa.gov/launch/history.cfm), May 1, 2000, *Historical Launch Activity*.

[2] The Federal Register, Volume 57, Number 57 (Tuesday, March 24, 1992), Volume 57, Number 226 (Monday, November 23, 1992), and Volume 60, Number 148 (Wednesday, August 2, 1995) describe the

On November 15, 1995, overall responsibility for implementing the Act was delegated by the Secretary of Transportation to the Federal Aviation Administration (FAA) Administrator; OCST was moved intact and became the Office of the Associate Administrator for Commercial Space Transportation (AST). In recent years, AST has addressed issues important to commercialization of the space transportation industry, including licensing requirements for launches from Federal Government launch ranges and financial responsibility requirements for all licensed launch activities.

1.2 Problem Statement

Congress enacted the Commercial Space Act of 1998 on October 28, 1998, giving the FAA authority to regulate commercial space reentry operations. Consistent with this authority and its mission, the FAA is implementing a rule designed to protect public health and safety and the safety of property. The rule will establish industry-wide safety standards that complement existing regulations, which focus only on the launch phase of commercial space transportation vehicles. The rule is expected to create impacts that, within the context of this regulatory evaluation, will require identification, analysis, and to the extent practicable, measurement.

1.3 Scope and Limits

This regulatory evaluation identifies the expected economic impacts of amendments and additions to commercial space transportation licensing regulations that affect reentry missions, including launch of a reusable launch vehicle, reentry, and operation of a reentry site. Where possible, the magnitude of these impacts is estimated.[3] The evaluation concentrates on the principal regulatory requirements and addresses the direct

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criteria that formed the basis for Department of Transportation's treatment of a petition by a commercial entity to conduct a reentry mission.

[3] The principal requirements evaluated are the amendments and additions to the Commercial Space Transportation Licensing Regulations, Title 14, Code of Federal Regulations, Part 431, Launch and Reentry of a Reusable Launch Vehicle; Part 433, License To Operate a Reentry Site, and Part 435, Reentry of a Reentry Vehicle Other Than a Reusable Launch Vehicle. The amendments to Parts 400, 401, 404, 405, 406, 413, and 415 do not impact the Federal Aviation Administration, the commercial space transportation industry, or public health and safety, and the safety of property. Similarly, Sections 431.21 and .51, 433.1, .5, and .9, and 435.1, 3, .7, .9, .11, .13, .15, .21, and .41 do not impact the Federal Aviation

costs and benefits attributable to the rule that will be incurred by the commercial space transportation industry, the FAA, and the general public. Also included in this report are determinations of the impacts that the rule will have on (1) small entities, (2) international trade, and (3) State, local, and tribal governments.

Information supporting the quantitative evaluation of benefits and costs is contained in Appendix A. FAA responses to comments received concerning the initial regulatory evaluation associated with the notice of proposed rulemaking are presented in Appendix B.

Administration, the commercial space transportation industry, or public health and safety, and the safety of property.

2.0 INDUSTRY PROFILE

2.1 Market Overview

2.1.1 Commercial Launch Operators

The nation's commercial space transportation industry is experiencing growth, as evidenced by the dramatic increase in demand for private sector launches over the past 10 years. Thirty-seven domestic licensed commercial launches (8 failures and 29 successes) were conducted during the first five years (1989 through 1993) of private sector launch under the Commercial Space Launch Act of 1984. During the past five years (that is, 1995 through the present) there have been 83 launches (7 failures, 76 successes), an increase of approximately 124 percent.[4] Since enactment of launch licensing regulations, 12 entities have been licensed to conduct launch activities. Three of these 12 entities continue to maintain active licenses and account for 72 percent of all licensed launch activities to date, as many of the other entities have either merged with or been acquired by other commercial space launch companies.[5] Table 2–1 summarizes the status of all commercial space transportation launch licensees.

Currently, commercial operators licensed to launch space vehicles rely on support from Federal Government employees and contractors operating U.S. Department of Defense (DOD) ranges and civilian government facilities, such as NASA facilities, to launch expendable launch vehicles (ELVs). However, there are commercial and State-sponsored entities that have obtained licenses to operate non-Federal launch sites. The status of licenses for all site operators is summarized in Table 2–2.

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[4] Federal Aviation Administration, Office of the Associate Administrator for Commercial Space Transportation Internet Website Home Page (http:/ast.faa.gov/launch_info/launch/history.cfm), May 1, 2000, *Historical Launch Activity.*

[5] Extracted from Federal Aviation Administration, Office of the Associate Administrator for Commercial Space Transportation Internet Website Home Page (http:/ast.faa.gov/licensing/lic_issued/lic_issu.cfm), May 1, 2000, Active *Launch Licenses*; and supplemented with information from discussions with Carl Rappaport, Office of the Associate Administrator for Commercial Space Transportation, Space Systems Development Division, August 12, 1998.

TABLE 2–1. Status of Commercial Space Transportation Launch Licenses

Commercial Organization Name	Number of Launches	License Status	Expiration Date
McDonnell Douglas	43	Active[a]	May 1, 2001 January 2, 2004
Lockheed Martin Corporation	32	Active	February 20, 2001
Orbital Sciences Corporation	16	Active[b]	September 2, 2000 March 18, 2001 July 23, 2004 April 27, 2005
Society of Amateur Scientists	0	Active	September 1, 2000
Martin Marietta	12	Merged with Lockheed Corporation	
General Dynamics	9	Acquired by Martin Marietta	
EER Systems	6	No active license	
Sea Launch Limited Partnership	3	License expired April 30, 2000	
Space Services of America, Inc.	3	Merged with EER Systems	
American Rocket	1	No longer in commercial space launch business	
Space Data	1	Merged with Orbital Sciences Corporation	
Conatec	0	No longer in commercial space launch business	
Total	126	8 Active Licenses	

Source: Federal Aviation Administration Associate Administrator for Commercial Space Transportation Internet Web Site Home Page (http://ast.faa.gov/ as of May 1, 2000), and interviews with key Federal Aviation Administration personnel listed in Table A-1 in the Appendix.

[a] Two distinct licenses reflecting different mission operating characteristics.

[b] Four distinct licenses reflecting different mission operating characteristics.

TABLE 2-2. Private and State-Sponsored Launch Site Operator Licenses

Name of Organization	Launch Site Name	Launch Site Location	Status of License
Spaceport Systems International	Spaceport Systems International/ California Spaceport	Vandenberg Air Force Base, California (Federal Government range)	Issued September 19, 1996 Expires September 19, 2001
Spaceport Florida Flight Authority	Spaceport Florida Flight Authority/ Spaceport Florida	Cape Canaveral Air Force Station, Florida (Federal Government range)	Issued May 22, 1997 Expires May 22, 2002
Virginia Commercial Space Flight Authority	Virginia Commercial Space Flight Authority/ Virginia Space Flight Center	Wallops Island, Virginia (Federal Government range)	Issued December 19, 1997 Expires December 19, 2002
Alaska Aerospace Development Corporation	Alaska Aerospace Development Corporation	Kodiak Island, Alaska (not a Federal Government range)	Issued September 24, 1998 Expires September 24, 2003

Source: Federal Aviation Administration Associate Administrator for Commercial Space Transportation Internet Web Site Home Page (http://ast.faa.gov/), May 1, 2000.

2.1.2 Reusable Launch Vehicles

In addition to increases in the frequency of annual launches and the emergence of private sector launch site operators, the variety of commercial launch programs and associated vehicles is expanding. Just as the United States space program matured from single-use rockets to repeated-use space transportation vehicles (for example, the Space Shuttle is a partially reusable launch vehicle), the commercial space transportation industry has also advanced technologically. Driven by high launch costs and market demand for lower-priced space transportation services, commercial entities are studying a variety of repetitive use launch vehicle (LV) concepts and alternative designs — commonly referred to as reusable launch vehicles (RLVs) — to supplement and eventually replace ELVs. The levels of LV reuse being considered range from partial reusability, where components from at least one stage of a LV are recoverable for future use, to full reusability. The development cost to bring a RLV to the market — which includes

research, design, construction, test, and evaluation — generally are very high and can range from $150 million to over $500 million.[6]

Currently, there are seven known entities focused on establishing RLV programs that at varying stages of development. These organizations, listed in Table 2–3, are confronting both technological challenges and inherent safety risks that collectively present strong barriers to both entering the industry and sustaining an economically viable business. Although detailed information is not readily available, with the exception of Lockheed Martin Corporation, the majority of these entities are relatively small, having fewer than 100 employees. Although the commercial space transportation industry is capable of meeting anticipated launch demand with the current supply of launch sites and ELVs, existing and potential customers want lower-priced services — RLVs have the potential of fulfilling this need.

Barriers to entering the commercial space transportation industry and maintaining an economically viable business are significant, as financing reentry mission programs and the advanced technology associated with RLVs is not accomplished easily.[7] In light of the high development costs mentioned previously (that is, $150 million to over $500 million) and the desire to expedite commercialization of RLVs in order to help lower prices for space transportation services, the FAA is working diligently to keep pace with this evolving industry; FAA intervention is proceeding by maintaining a regulatory environment that continues to protect public safety without creating undue barriers to industrial growth.

[6] Development of the Kelly Space and Technology Astroliner vehicle is expected to cost $150 million while the Kistler Aerospace Corporation K–1 is estimated to cost $500 million, as reported in Associate Administrator for Commercial Space Transportation, January 1998, *Reusable Launch Vehicle Programs and Concepts,* Federal Aviation Administration, pp. 11 and 13, respectively.

[7] In addition to high economic and technological risks are long payback periods.

TABLE 2–3. Commercial Reusable Launch Vehicle Development Entities

Commercial Organization Name	Program Name	Technical Status	Funding Status and Source
Kelly Space and Technology	Astroliner	Under Development	Secured $3 million in private funding towards its $450 million goal
Kistler Aerospace Corporation	K–1	Under Development	Secured $250 million in private funding towards its $750 million goal
Lockheed Martin Corporation	VentureStar	Under Development	May be funded by Lockheed-Martin Corporation
Pioneer Rocketplane	Pathfinder	Under Development	Secured $3.5 million in funding towards its $250 million goal
Rotary Rocket Company	Roton C-9	Under Development	Secured $6 million from private sector sources
Space Access, LLC	SA-1	Concept	Secured $100 million towards its $5 billion goal
Vela Technology Development	Space Cruiser System	Under Development	Unknown

Source: Associate Administrator for Commercial Space Transportation, January 1998, *Reusable Launch Vehicle Programs and Concepts,* and January 2000, *2000 Reusable Launch Vehicle Programs and Concepts,* Federal Aviation Administration; *Space News*, March 23-29, 1998; "Wall Street Warms Up to Rocket Firms;" and The Orlando Sentinel, It Takes A Rocket Scientist — And Big Bucks — For These Projects," October 24, 1999.

2.1.3 Reentry Vehicles

The ability to return space transportation hardware to Earth for reuse, either in part or whole, will help to lower the steep costs that are currently reflected in the high price of space transportation services. RV technology is not limited to the LV itself. The space transportation industry has at one time developed a satellite payload that, although launched using an ELV, can return to Earth as a payload RV for some form of reuse; others may follow. For example, payloads used in experimentation may require direct examination on Earth to benefit from the effort, and related equipment may have salvage value that can be returned to service after refurbishment. The ability to reuse LVs offers additional cost savings that can significantly aid industry in lowering prices. Although all commercial RLVs are still under development and some remain in the conceptual and

preliminary design phases, the need to reduce the costs of space transportation services remains. In the interim — until RLVs are commercially available — the industry is expected to continue to demand that payloads and related hardware be returned to Earth for reuse.

2.2 Reentry Mission Projections

Estimates of the expected number of future commercial reentry missions (including launches and reentries of RLVs and payload RVs) must take into consideration the uncertainty in the rate of technological advancement, market demand conditions, and foreign competition as this industry continues to mature and respond to pressures to minimize costs. The Commercial Space Transportation Advisory Committee projects an average of 33 payloads annually will be launched to geosynchronous orbit over the next 11 years.[8] The FAA forecasts that there will be 34 launches annually to low-earth orbit (LEO) during this same period.[9] Many of these launches may be may not be for reentry missions or involve RLVs. This is because there is uncertainty regarding the rate at which RLVs will be substituted for ELVs. Conversely, the availability of RLVs may result in an increase in the number of reentry mission launches, pending lower RLV launch costs and the responsiveness of demand to market prices for such services.[10] Additionally, several entities are proposing using RLVs for suborbital and orbital launches for recreational purposes.[11]

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[8] Commercial Space Transportation Advisory Committee, May 1998, *Commercial Spacecraft Mission Model Update*, Federal Aviation Administration, Associate Administrator for Commercial Space Transportation.

[9] Federal Aviation Administration, May 1998, *LEO Commercial Market Projections*, Associate Administrator for Commercial Space Transportation.

[10] Kelly Space and Technology expects that launch prices for its Astroliner RLV will be less than $2000 per pound for a low earth orbit, as reported in Associate Administrator for Commercial Space Transportation, January 1998, *Reusable Launch Vehicle Programs and Concepts,* Federal Aviation Administration, p. 11.

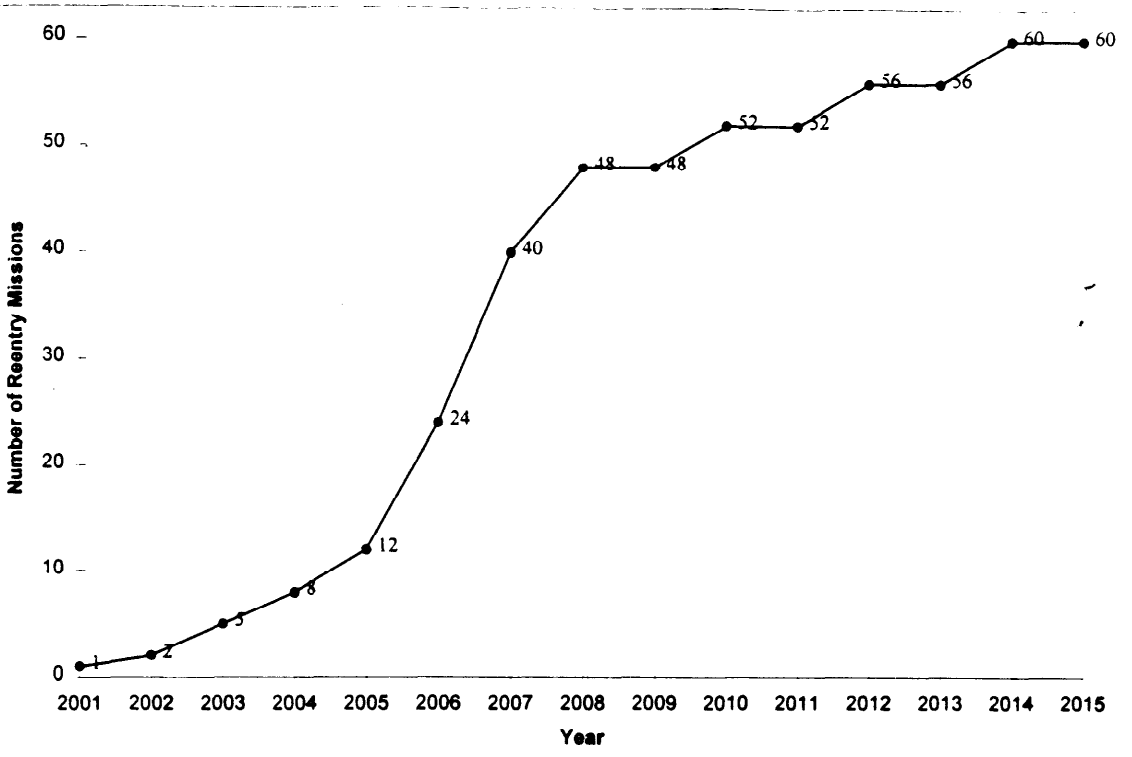
[11] Information extracted from Space Frontier Foundation, August 13, 1998,"The New Commercial Space Companies" and supplemented with information obtained from technical discussions with Brett Alexander, Federal Aviation Administration, Office of the Associate Administrator for Commercial Space Transportation, Space Systems Development Division, September 2, 1998.

Collectively, mission model projections, the expected rate of industry maturation, anticipated market conditions, and expert opinion suggest that over the 15-year period, beginning 2001 and ending 2015, the commercial space transportation industry may be able to supply a total of 524 reentry mission launches, with most launches occurring in the later years as shown in Figure 2–1.[12] Furthermore, the FAA projects that five commercial entities will be conducting these missions over the 15-year period 2001 to 2015.[13]. The shape of the curve in this figure is based on the assumption that in the first half of the 15-year period the number of RLV or reentry missions is expected to increase dramatically as additional firms enter the market. Toward the end of the period the rate of increase in the number of missions is expected to slow down as market demand reaches a steady state or equilibrium.

[12] Information provided by Brett Alexander, Federal Aviation Administration, Office of the Associate Administrator for Commercial Space Transportation, Space Systems Development Division, August 13, 1998. No estimate is provided as to how the number of projected reentry missions will be split between RLVs and RVs launched using ELVs.

[13] The FAA conservatively estimates that five entities, meeting the requirements to be classified as small business establishments, will constitute the commercial space industry over the 15-year period 2001 to 2015. This is based on information provided by Brett Alexander, Federal Aviation Administration, Office of the Associate Administrator for Commercial Space Transportation, Space Systems Development Division, August 13, 1998 and updated on March 10, 2000.

FIGURE 2–1. Distribution of Expected Reentry Vehicle Missions



Source: Developed with information provided by Brett Alexander, Federal Aviation Administration, Office of the Associate Administrator for Commercial Space Transportation, Space Systems Development Division, developed on August 13, 1998 and updated on March 10, 2000.

3.0 REQUIREMENTS OF THE FINAL RULE

3.1 Historical Perspective

The licensing of private sector conduct of space transportation activities that include reentry operations has not been previously addressed explicitly by formal Federal Government regulations. However, in 1992 the OCST, predecessor to the AST, evaluated the Commercial Experiment Transporter (COMET) Program (developed by Westinghouse Electric Corporation and Space Industries, Inc.), including a request for approval to conduct a reentry mission. Although OCST did not have explicit regulatory authority to license a commercial reentry operation, it performed this function under its payload determination authority associated with its launch license evaluation responsibilities. In accordance with its statutory mandate to protect public safety, OCST developed a process and associated performance-based criteria for evaluating the COMET reentry mission. The COMET Program was discontinued in May 1994 without performing its reentry mission. In 1995 NASA initiated a restart of the program; EER Corporation assumed development of the RV and renamed it the Multiple Experiment to Earth Orbit and Return (METEOR) Program. The OCST, and eventually AST, continued to assume responsibility for evaluating the request for permission to conduct a reentry mission under its payload determination authority. Reentry mission approval was subsequently granted to the METEOR Program. Unfortunately, the LV failed and consequently the METEOR Program did not perform the planned reentry mission. Since 1995 there have been no requests for permission to reenter a commercial reentry vehicle or payload.

3.2 Final Rule Requirements

The subject commercial space transportation licensing regulations for reentry operations incorporate much from the OCST and AST experience from evaluating the COMET/METEOR programs, as well as relevant considerations contained in current regulations governing launch licensing. The principal additions to commercial space transportation regulations in the final rule contain provisions for (1) two types of licenses

for RLV missions — mission-specific and operator licenses, (2) a license for operation of a reentry site, and (3) two types of licenses for reentry of a vehicle other than a RLV — reentry-specific and reentry operator license. A RLV mission-specific license pertains to a single model or RLV type, and authorizes a specified number of RLV missions. A RLV operator license pertains to missions involving a "designated family of RLVs" to a designated site that adheres to certain operational parameters, such as payload and trajectory.[14] Similarly, a non-RLV reentry-specific license pertains to one model or type of RV, while a reentry operator license for non-RLVs authorizes reentry of a designated family of RVs to a designated site that adheres to certain operational parameters, such as payload and trajectory. Operational restrictions on a reentry site pertain to its use for RLVs or RVs. The remainder of this section of the report presents a brief discussion of the principal components of the final rule that impact industry, the FAA, and the public — 14 CFR Part 431, Part 433, and Part 435.

3.2.1 Final Rule Part 431, Launch and Reentry of a Reusable Launch Vehicle

Subpart B — Policy Review and Approval for Launch and Reentry of a Reusable Launch Vehicle

Subpart B of the rule defines the responsibilities of the FAA for issuing policy approval to a RLV mission license applicant, summarizes the application requirements subject to policy review, and addresses denial of policy approval.[15] In general, policy approval will be denied if the proposed mission is contrary to national security or foreign policy interests, would jeopardize public health and safety or the safety of property, or would not be consistent with international obligations of the United States.[16] The results of this determination will be formally transmitted to the applicant in writing. The FAA will be responsible for responding to appeals and reacting to revised applications.

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[14] Federal Aviation Administration, Commercial Space Transportation Reusable Launch Vehicle Reentry Licensing Regulations, Final Rule (Unpublished version; June 2, 2000), p. 141.

[15] There is no distinction made between a RLV mission or RLV operator license with regard to this requirement, as it applies to both types.

[16] Federal Aviation Administration, Commercial Space Transportation Reusable Launch Vehicle Reentry Licensing Regulations, Final Rule (Unpublished version; June 2, 2000), p. 147.

Subpart C — Safety Review and Approval for Launch and Reentry of a Reusable Launch Vehicle

Subpart C contains most of the principal requirements of the rule that will have a direct impact on the FAA, the commercial space transportation industry, and the general public. Specifically, the rule will require the FAA to perform a safety review of a RLV mission application and notify an applicant in writing of any issues raised during the review that will impede issuance of safety approval. The review includes a technical assessment to determine if the applicant is "...capable of launching a RLV and payload, from a designated launch site, and reentering the RLV and payload, if any, to a designated reentry site or location, or otherwise landing the RLV and payload, if any, on Earth without jeopardizing public health and safety and the safety of property."[17] Accordingly, this subpart contains requirements designed to ensure that the expected average casualty risk (E_c) to the public for any RLV mission will not exceed 30 casualties in every one million RLV missions (which translates to 30×10^{-6}). Successful applicants for RLV mission licenses will be required to establish an organizational infrastructure that shall include a safety organization and independent safety official. The responsibilities of the safety official include supporting and approving of internal safety and readiness reviews; reviewing the risk and systems safety engineering analyses; monitoring of personnel compliance with an applicant's safety policies and procedures; conducting operational rehearsals; and demonstrating that the overall RLV mission program can achieve a margin of safety consistent with the required expected casualty risk criterion and reenter to Earth a RLV in a manner commensurate with stipulated safety goals. Industry will have to demonstrate that personnel having direct control over the RLV mission adhere to specified work and rest standards; that the mission plan possesses the necessary procedures and emergency response plans; and that personnel are able to perform the planned mission and respond to, investigate, and report accidents and unplanned events and incidents to the FAA.

[17] Ibid., pp.145-146.

Subpart D — Payload Reentry Review and Determination

Subpart D addresses the responsibilities of the FAA to determine if reentry of a payload presents any issues that will adversely affect U.S. national security or foreign policy interests, any issues that will jeopardize public health and safety or the safety of property, or any issue that will be inconsistent with international obligations of the United States.[18] In conducting a payload review, the FAA will consult with the DOD, DOS, and other Federal Government organizations, such as NASA, before advising an applicant in writing as to the results of its review. Applicants are notified in writing of issues raised during the review that will impede a favorable determination so that they may respond, as appropriate. Persons applying for a license will be required to provide the FAA with certain information, such as the presence of hazardous substances and the explosive potential of payload materials, in order to perform its payload review.

Subpart E — Post-Licensing Requirements — Reusable Launch Vehicle Mission License Terms and Conditions

This subpart of the rule contains the requirement that licensees must reapply to the FAA for modification of the principal license if the planned RLV mission and its safety-related procedures differ from that authorized by the initial license. Any changes that could have an impact on public health and safety or the safety of property can trigger the need to request a modification approval. Modifications requiring FAA approval include revised reentry plans and procedures, altered payload, alternate vehicle design or type of RLV, modified launch or reentry sites, modified trajectory, and altered safety system and policy. This requirement will cause a licensee to submit an application for license modification and cause the FAA to review and, if appropriate, approve such modification requests. A RLV licensee must provide AST with certain launch, flight path, reentry, and payload information at 60- and 15-day intervals prior to each planned mission, maintain all records pertaining to the mission for a period of three years, and make these records available to the FAA upon request. Within 30 days of a RLV mission a licensee must also provide the FAA with specific information (including the international designator, general function, and orbital parameters) on all object(s) placed in outer space.

Subpart F — Environmental Review

This subpart addresses the FAA's responsibility to analyze RLV mission operations for environmental impacts. Accordingly, an applicant must furnish the FAA with information that will permit this analysis in accordance with the requirements contained in the National Environmental Policy Act as codified in 42 U.S.C. 4321, related regulations, and FAA procedures and policies.

3.2.2 Final Rule Part 433, License to Operate a Reentry Site

This part addresses the FAA's authority to issue a license to operate a reentry site, provided that the applicant demonstrates that the operation is consistent with safety requirements. Also addressed is the FAA's responsibility to analyze reentry site operations for environmental impacts. Accordingly, an applicant must furnish the FAA with information that will permit this analysis in accordance with the requirements contained in the National Environmental Policy Act as codified in 42 U.S.C. 4321, related regulations, and FAA procedures and policies.

3.2.3 Final Rule Part 435, Reentry of a Reentry Vehicle other than a Reusable Launch Vehicle

Subpart B — Policy Review and Approval

The requirements for policy review for both types of non-RLV reentry licenses, as they relate to the reentry phase of a mission, are identical to those for RLVs discussed previously in Section 3.2.1, for Subpart B (and are not repeated here).

Subpart C — Safety Review and Approval

The requirements for safety review and approval for both types of non-RLV reentry licenses, as they relate to the reentry phase of a mission, are identical to those for RLVs discussed previously in Section 3.2.1, for Subpart C (and are not repeated here).

Subpart D — Payload Reentry Review and Determination

[18] Ibid., p. 160.

The requirements for payload determination for both types of non-RLV reentry licenses, as they relate to the reentry phase of a mission, are identical to those for RLVs discussed previously in Section 3.2.1, for Subpart D (and are not repeated here).

Subpart E — Post-Licensing Requirements

The post-licensing requirements for both types of non-RLV reentry licenses, as they relate to the reentry phase of a mission, are identical to those for RLVs discussed previously in Section 3.2.1, for Subpart E (and are not repeated here).

Subpart F — Environmental Review

The requirements for environmental review for both types of non-RLV reentry licenses, as they relate to the reentry phase of a mission, are identical to those for RLVs discussed previously in Section 3.2.1, for Subpart E (and are not repeated here).

4.0 IMPACT OF AMENDMENTS TO U.S. COMMERCIAL SPACE TRANSPORTATION LICENSING REGULATIONS

4.1 Overview of Analytical Approach

An evaluation of the impacts of the principal parts of the rule on the commercial space transportation industry, the Federal Government, and the general public is presented in this section. Also presented are estimates the total incremental costs and benefits of the rule. This is accomplished by comparing operations under the rule with current practice, commonly referred to as the baseline. Quantifying the primary impacts of the rule in dollars yields costs — the out-of-pocket expenditures incurred by the commercial space transportation industry in complying with its requirements and the expenses borne by the FAA from administering the rule. Benefits are estimated as the dollar value of fatalities, injuries, and property damage prevented or mitigated. Cost savings to the FAA or the commercial space transportation industry directly attributable to the rule are also captured in this process, as appropriate.

Identification of Baseline

The baseline case used for this analysis views the rule as a new requirement imposed on an emerging segment of the commercial space transportation industry that plans to operate reusable launch vehicles (RLVs) or conduct reentry operations with reentry vehicles (RVs). Although the final rule implements certain policies developed by AST in 1992 with respect to public safety for the first commercial space reentry operation, the safety criteria in this rulemaking use different measures that better reflect current agency and range safety practices. The 1992 policy established safety criteria pertaining to a unique and specific request to conduct a first-of-a-kind payload reentry mission; that is, the COMET, later renamed METEOR, reentry vehicle. At that time a comprehensive regulatory (benefit-cost) analysis was neither required nor performed for this request. Absent FAA safety policy actions exercised for COMET/METEOR, some compliance costs would not have been incurred by entities planning to conduct RLV missions (launch and reentry) and RV operations today that are associated with launches from Federal

ranges. (Regulatory costs and benefits associated with launches from Federal ranges are assessed as part of a separate rulemaking on launch licensing requirements for launches from Federal ranges.)

4.1.2 Incremental Impact Analysis

Incremental impact analysis, within the context of this study, focuses on determining the difference between all relevant FAA and commercial space transportation industry actions under the baseline and under the rule. As noted in Section 4.1.1 above, the incremental effects of the rule are identified and measured relative to common commercial space transportation practice only (that is, the baseline case). Accordingly, if the rule creates a situation that departs from this baseline, then the cost to the commercial space transportation industry to comply with it, the cost to the FAA to administer it, and the impacts on safety are identified and estimated in dollars to the extent practicable.

4.2 Impact of the Final Rule on Commercial Space Transportation Entities

4.2.1 Current Commercial Space Transportation Industry Practice

The COMET/METEOR experience demonstrated that commercial space transportation entities could develop reentry programs capable of minimizing unplanned events and mitigating safety risks during reentry missions. Many of DOT's performance-based requirements for reentry mission approval contained in the 1992 policy were already being addressed voluntarily by the applicants as a matter of standard operating procedure and good business practice. For example, since the Challenger disaster, industry has emphasized rigorous quality assurance programs and associated safety organizations with the authority to take the necessary actions to avoid risk to public health and safety and the safety of property. These practices continue to evolve today, as commercial space transportation entities and the FAA maintain frequent communication to ensure that technological advances are consistent with emerging safety considerations, and Federal government intervention creates an environment that helps facilitate industry maturation.

4.2.2 Incremental Effects on Commercial Space Transportation Entities

The historical evidence of COMET/METEOR was supplemented with data from interviews with FAA (that is, AST) staff and commercial space transportation industry experts to identify the incremental effects of the rule relative to the baseline.[19] Collectively this information supports the assertion that the principal requirements contained in the rule will pose additional impacts on commercial space transportation entities.

A prudent commercial entity is not likely to jeopardize the success of a mission and risk future business by discounting important engineering techniques and related operating practices. Accordingly, industry is expected to behave rationally and develop reentry mission programs that increase inherent system reliability in order to mitigate the risk of mission failure. In so doing, these entities are also taking many of the necessary precautions to prevent or mitigate any adverse impacts on safety and health. Consequently, many of the technical requirements contained within the rule are already being addressed voluntarily by industry (to varying degrees) as a matter of standard operating procedure and good business practice.[20] Additionally, based on past licensing experience and practices, the FAA expects to work closely with reentry license applicants during the pre-application consultation period to facilitate the licensing process and help reduce the associated costs.[21]

The principal sections of the rule have a wide spectrum of effects on commercial space transportation entities. Impacts range from no measurable effect, as is the case for

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[19] Specific documents referring to COMET and METEOR contained in the List of References at the end of this report, such as U.S. Department of Transportation, August 4, 1995, *Payload Determination Evaluation for the METEOR Reentry Vehicle, Vehicle Safety Assessment and Operations Review*, Office of Commercial Space Transportation, Licensing and Safety Division provide ample evidence of the actions taken by OCST. This evidence was supplemented with information obtained from interviews with key FAA personnel identified in Table A-1 in the Appendix to this report that, as part of their responsibility as AST personnel, maintain frequent communication with representatives from the commercial space transportation industry. Additional information was obtained from The Aerospace Corporation personnel also identified in Table A-1.

[20] Interviews with Federal Aviation Administration, Office of the Associate Administrator for Commercial Space Transportation personnel: Ronald Gress and Carole Flores, Licensing and Safety Division; Charles Larsen, Space Systems Development Division, August 12, 1998.

Sections 431.75 and .79 (which are equivalent to current practice), to commercial space transportation entities incurring costs implementing additional safety-related activities to comply with major requirements, such as those contained in Sections 431.33 and .35. This comparative incremental impact analysis is summarized in Table 4-1 below.

[21] Ibid.

TABLE 4-1. Impact of Revision of Commercial Space Transportation Licensing Regulations on the Compliance Actions Performed by the Commercial Space Transportation Reentry Licensees

Section of Final Rule	Summary of Rule-Required Actions	Comparable Baseline Actions Performed by Commercial Space Transportation Entities	Principal Difference Between Baseline and Final Rule That Impact Industry
431.25: Application for Policy Review	Provide written information identifying RLV model, type, configuration, ownership, reentry sites, trajectories, and planned events.	Documentation is already generated and available to submit to the Federal Aviation Administration.	Administrative burden of providing to the Federal Aviation Administration information documenting the overall reentry program consistent with application guidance.[a]
431.33: Safety Organization	Describe safety organization, including lines of communication and designated independent safety official to assume responsibility for safety and performing rehearsals and readiness reviews.	Roles and responsibilities defined for the safety organization currently being performed voluntarily.	Administrative burden of providing to the Federal Aviation Administration reentry safety organization and reentry personnel roles in application materials, formal identification of an independent safety official and associated responsibilities.[b]

[a] Applicants are expected to be required to follow guidance similar to that contained in U.S. Department of Transportation, January 4, 1991, *Information Required for OCST to Review Commercial Reentry* (Interim), Office of Commercial Space Transportation, Licensing and Safety Division; and U.S. Department of Transportation, November 15, 1993, *Strategic Plan for Operations Review of the COMET Reentry Vehicle*, Revision 1.0, Office of Commercial Space Transportation, Licensing and Safety Division, p. 2.

[b] Applicants are expected to be required to follow guidance similar to that contained in U.S. Department of Transportation, January 4, 1991, *Information Required for OCST to Review Commercial Reentry* (Interim), Office of Commercial Space Transportation, Licensing and Safety Division, p.7; U.S. Department of Transportation, November 15, 1993, *Strategic Plan for Operations Review of the COMET Reentry Vehicle*, Revision 1.0, Office of Commercial Space Transportation, Licensing and Safety Division, p. G-4; and U.S. Department of Transportation, August 4, 1995, *Payload Determination Evaluation for the METEOR Reentry Vehicle, Vehicle Safety Assessment and Operations Review*, Office of Commercial Space Transportation, Licensing and Safety Division, p. 22.

TABLE 4-1. Impact of Revision of Commercial Space Transportation Licensing Regulations on the Compliance Actions Performed by the Commercial Space Transportation Reentry Licensees (Continued)

Section of Final Rule	Summary of Rule-Required Actions	Comparable Baseline Actions Performed by Commercial Space Transportation Entities	Principal Difference Between Baseline and Final Rule That Impact Industry
431.35: Acceptable Mission Risk	Perform a risk analysis; expected average number of casualties to the general public is not to exceed 30 per million missions ($E_c \leq 30 \times 10^{-6}$).	Risk analyses are performed and documented, although the level of rigor applied is less than that required to achieve the criterion for expected average number of casualties to the general public per the rule.	Perform more rigorous risk analyses; validate analyses; and establish that expected average number of casualties to the general public will not exceed 30 per million missions ($E_c \leq 30 \times 10^{-6}$).
431.37: Mission Readiness	Submit procedures verifying mission readiness in key areas, including personnel; RLV; payload; safety-critical systems; launch site and related equipment and property; reentry flight and recovery; mission rules, constraints, and contingency abort plans; dress rehearsals; and licensee currency.	Documentation is already generated and available for submission to the Federal Aviation Administration.	Administrative burden of providing to the Federal Aviation Administration information documenting the overall reentry program consistent with application guidance.[a]

TABLE 4-1. Impact of Revision of Commercial Space Transportation Licensing Regulations on the Compliance Actions Performed by the Commercial Space Transportation Reentry Licensees (Continued)

Section of Rule	Summary of Rule-Required Actions	Comparable Baseline Actions Performed by Commercial Space Transportation Entities	Principal Difference Between Baseline and Rule That Impact Industry
431.39: Mission Rules, Procedures, and Contingency Plans	Written mission rules, procedures, and contingency plans compiled and approved by safety official; personnel complete current checklists.	Rules, procedures, and contingency plans compiled, documented, and approved.	Administrative burden of interfacing and exchanging materials periodically with the Federal Aviation Administration in order to provide sufficient written information to adequately document the reentry mission program; and responding to compliance monitoring.[c]
431.41: Communications Plan	Documented communication networks, procedures, and protocols concurred with by site operator and provided to all site personnel.	Communication networks, procedures, and protocols documented.	Administrative burden of interfacing and exchanging materials with the Federal Aviation Administration periodically in order to provide sufficient written information to adequately document the communications plan.[c]

[c] Applicants are expected to be required to follow guidance similar to that contained in U.S. Department of Transportation, August 4, 1995, *Payload Determination Evaluation for the METEOR Reentry Vehicle, Vehicle Safety Assessment and Operations Review*, Office of Commercial Space Transportation, Licensing and Safety Division, p. 22.

TABLE 4-1. Impact of Revision of Commercial Space Transportation Licensing Regulations on the Compliance Actions Performed by the Commercial Space Transportation Reentry Licensees (Continued)

Section of Final Rule	Summary of Rule-Required Actions	Comparable Baseline Actions Performed by Commercial Space Transportation Entities	Principal Difference Between Baseline and Final Rule That Impact Industry
431.43: Operational Requirements and Restrictions	Submit procedures to ensure conformance with public risk criteria, the system safety process, monitoring of safety-critical systems, and human activation of safety systems. Identify suitable sites for RLV contingency abort, RLVs must be operated in a manner such that the expected average number of casualties to the general public does not exceed 30 per million RLV missions ($E_c \leq 30 \times 10^{-6}$). Restricted from substantial dwell time over populated areas; monitor safety-critical reentry systems during launch and reentry; must have a flight safety system; ability to issue command enabling reentry; avoid physical contact with other space vehicles; do not generate debris; perform collision avoidance analysis; 3 sigma dispersion reentry sites; crew work and rest limitations.	Monitoring, flight safety systems, and determination of suitable abort sites are currently being performed voluntarily. Monitor safety-critical reentry systems during launch and reentry; must have a flight safety system; ability to issue command enabling reentry; avoid physical contact with other space vehicles.	Operate a RLV in a manner such that the expected average number of casualties to the general public does not exceed 30 per million missions ($E_c \leq 30 \times 10^{-6}$). Stringent flight path parameters to achieve an expected average number of casualties to the general public not to exceed 30 per million missions ($E_c \leq 30 \times 10^{-6}$); implement crew work and rest hour limitations based on NASA Goddard Wallops Flight Facility Code 800 requirements and maintain associated records to administer requirement; and responding to compliance monitoring.[d]

[d] Applicants are expected to be required to follow guidance similar to that contained in U.S. Department of Transportation, August 4, 1995, *Payload Determination Evaluation for the METEOR Reentry Vehicle, Vehicle Safety Assessment and Operations Review*, Office of Commercial Space Transportation, Licensing and Safety Division, p. 24; National Transportation Safety Board, July 26, 1993, *Special Investigation Report, Commercial Space Launch Incident*, NTSB/SIR-93/02, PB93-917003,Washington, D.C., pp. 31-32; and Range Safety Office, Patrick Air Force Base, *Eastern and Western Range 127-1*, October 31, 1997, which addresses the NASA Goddard Wallops Flight Facility Code 800.

TABLE 4-1. Impact of Revision of Commercial Space Transportation Licensing Regulations on the Compliance Actions Performed by the Commercial Space Transportation Reentry Licensees (Continued)

Section of Final Rule	Summary of Rule-Required Actions	Comparable Baseline Actions Performed by Commercial Space Transportation Entities	Principal Difference Between Baseline and Final Rule That Impact Industry
431.45: Mishap Investigation and Emergency Response Plan	Plan and procedures for investigating, reporting, and responding to reentry emergencies and timely interface with the Federal Aviation Administration Operations Center	Emergency plans are developed.	Incorporating interface with the Federal Aviation Administration Operations Center into the plan; preparing for, accommodating, and reacting to compliance monitoring activities; and administrative burden of interfacing and exchanging materials periodically with the Federal Aviation.[e]
431.57: Information Requirements for Payload Review	Provide payload characteristics, including explosive potential and securing methods	Payload characteristics are documented.	Administrative burden of providing the Federal Aviation Administration with sufficient documentation on the reentry mission.[f]
431.73: Continuing Accuracy, Application for Modification	Submit application pending nature of modifications.	Modifications are generally documented.	Conditional requirement, pending whether modifications are made. Administrative burden of providing the Federal Aviation Administration with sufficient documentation on modifications.[g]

[e] Applicants are expected to be required to follow guidance similar to that contained in U.S. Department of Transportation, August 4, 1995, *Payload Determination Evaluation for the METEOR Reentry Vehicle, Vehicle Safety Assessment and Operations Review*, Office of Commercial Space Transportation, Licensing and Safety Division, p. 3.

[f] Applicants are expected to be required to follow guidance similar to that contained in U.S. Department of Transportation, August 4, 1995, *Payload Determination Evaluation for the METEOR Reentry Vehicle, Vehicle Safety Assessment and Operations Review*, Office of Commercial Space Transportation, Licensing and Safety Division, p. 24; and U.S. Department of Transportation, November 15, 1993, *Strategic Plan for Operations Review of the COMET Reentry Vehicle*, Revision 1.0, Office of Commercial Space Transportation, Licensing and Safety Division, p. 2.

[g] Applicants are expected to be required to follow guidance similar to that contained in U.S. Department of Transportation, August 4, 1995, *Payload Determination Evaluation for the METEOR Reentry Vehicle, Vehicle Safety Assessment and Operations Review*, Office of Commercial Space Transportation, Licensing and Safety Division, p. 22.

TABLE 4-1. Impact of Revision of Commercial Space Transportation Licensing Regulations on the Compliance Actions Performed by the Commercial Space Transportation Reentry Licensees (Continued)

Section of Final Rule	Summary of Rule-Required Actions	Comparable Baseline Actions Performed by Commercial Space Transportation Entities	Principal Difference Between Baseline and Final Rule That Impact Industry
431.75: Agreement with Federal Range	Secure formal agreement with Federal range.	This is standard operating procedure.	None, except for providing the Federal Aviation Administration with sufficient documentation on agreement secured with a Federal range.[h]
431.77: Records	Retain records pertaining to missions for a three-year period. Records related to an unplanned event shall be preserved for at least three years and not destroyed until advised by the FAA.	This is standard operating procedure. Records are maintained for a three-year period.	None, except for responding to requests from the Federal Aviation Administration for information, or maintaining data beyond a three-year period in the case of an unplanned event.
431.79: Reporting Requirements	Reporting to AST at 60- and 15-day intervals prior to reentry; reporting to the FAA unplanned events .	Reporting unplanned events.	Minimal administrative burden of reporting to AST at 60- and 15-day intervals prior to mission.
431.93: Environmental Information	Provide information to permit FAA review of environmental impacts	None, although this is a requirement under the National Environmental Policy Act.	Prepare and submit to the Federal Aviation Administration sufficient information to conduct an environmental assessment.[i]

[h] U.S. Department of Transportation, August 4, 1995, *Payload Determination Evaluation for the METEOR Reentry Vehicle, Vehicle Safety Assessment and Operations Review*, Office of Commercial Space Transportation, Licensing and Safety Division, p. 22.
Federal Register, August 2, 1995, p. 39479.

[i] Applicants are expected to be required to follow guidance similar to that contained in U.S. Department of Transportation, August 1995, *Environmental Assessment for EER Systems Corporation's METEOR Vehicle and Payload,* Office of Commercial Space Transportation; U.S. Department of Transportation, January 4, 1991, *Information Required for OCST to Review Commercial Reentry* (Interim), Office of Commercial Space Transportation, Licensing and Safety Division; and U.S. Department of Transportation, August 4, 1995, Payload Determination Evaluation for the METEOR Reentry Vehicle, Vehicle Safety Assessment and Operations Review, Office of Commercial Space Transportation, Licensing and Safety Division.

TABLE 4-1. Impact of Revision of Commercial Space Transportation Licensing Regulations on the Compliance Actions Performed by the Commercial Space Transportation Reentry Licensees (Continued)

Section of Final Rule	Summary of Rule-Required Actions	Comparable Baseline Actions Performed by Commercial Space Transportation Entities	Principal Difference Between Baseline and Final Rule That Impact Industry
433.7 Environmental	Provide information to permit FAA review of environmental impacts	None, although this is a requirement under the National Environmental Policy Act.	Prepare and submit to the Federal Aviation Administration sufficient information to conduct an environmental assessment.
435.23: Policy Review	Same requirements as 431.25 listed above	Same as response to Section 431.25 listed above	Same as response to Section 431.25 listed above
435.33: Safety Review	Same requirements as Sections 431.33, .37, .39, .41, .43, and .45 listed above.	Same as response to Sections 431.33, .35, .37, .39, .41, .43, and .45 listed above.	Same as response to Sections 431.33, .35, .37, .39, .41, .43, and .45 listed above.
435.35 Acceptable Reentry Risk	Same requirements as paragraphs (a) and (b) of Section 431.35. This pertains to the expected average number of casualties to the public (E_c) of 30 x 10^{-6} as listed above for 431.35.	Same as response to Section 431.35 listed above.	Same as response to Section 431.35 listed above.
435.43: Payload Review	Same requirements as Section 431.57 listed above.	Same as response to Section 431.57 listed above.	Same as response to Section 431.57 listed above.
435.51:Post-Licensing Requirements (General)	Same requirements as Sections 431.73, .75, .77, and .79 listed above.	Same as response to Sections 431.73, .75, .77, and .79 listed above.	Same as response to Sections 431.73, .75, .77, and .79 listed above.
435.61: Environmental Review (General)	Same requirements as Section 431.93 listed above.	Same as response to Section 431.93 listed above.	Same as response to Section 431.93 listed above.

4.2.3 Incremental Cost Impact on Commercial Space Transportation Entities

As summarized in Table 4-1 above, 21 principal sections of the rule contain requirements that collectively are expected to create incremental costs to the commercial space transportation industry. Many of the reentry requirements contained in Part 431 for RLVs are also common to Part 435 pertaining to reentry of RVs that are not RLVs. Therefore, these requirements are addressed collectively to the extent practicable.[22] Derivation of the incremental compliance cost estimates is summarized in Table 4-2. Following this table is a discussion of the rationale for establishing the incremental cost impact of these requirements on a commercial space transportation entity.

[22] The significant technological differences between ELV-launched RVs and RLVs are likely to create a compliance cost differential for commercial space transportation entities. However, these differences are not addressed in terms of discrete compliance cost estimates for RLV and RV missions. This is because sufficient information is not readily available upon which to base an estimate as to how many of the 524 reentry missions projected in Figure 2-1 would be divided between RLVs and RVs. However, once RLV technology is proven, it is likely to replace ELVs as the LV for RV payloads. Accordingly, most of the 524 projected reentry missions may be required to comply with the RLV-related requirements. Therefore, this regulatory analysis uses a worst case approach from a compliance cost standpoint (that is, RLV compliance costs will prevail), rather than developing discrete compliance cost estimates for RLV and non-RLV reentry missions.

TABLE 4-2. Commercial Space Transportation Entity Compliance Cost[a]
(In 1999 Dollars)

Section of Final Rule	Costs Incurred by a Single Entity Approved for Reentry Operations in the First Year of Operations Only			Costs Incurred Annually by a Single Entity Approved for Reentry Operations in all Years of Operation After the First Year		
	Technical	Administrative	Total	Technical	Administrative	Total
431.25: Policy Review[b]	$0	$406	**$406**	$0	$0	**$0**
431.33: Safety Organization[c]	$105,885	$5,294	**$111,179**	$105,885	$5,294	**$111,179**
431.35: Acceptable Reentry Risk[d]	$741,195	$37,060	**$778,255**	$0	$3,706	**$3,706**
431.37: Mission Readiness[e]	$0	$4,059	**$4,059**	$0	$0	**$0**

Source: The Aerospace Corporation, Gwynne Gurevich; and Federal Aviation Administration, Office of the Associate Administrator for Commercial Space Transportation personnel: Ronald Gress, Licensing and Safety Division, Charles Larsen (Space Systems Development Division), 1998.

Note: All cost estimates for personnel hours are based on a conservative value for annual salary of $85,771 provided by The Aerospace Corporation. Applying a fringe benefit factor of 23.45% (see Appendix A, Tables A-2 and A-3) yields $105,885, which is the estimated cost to a commercial space transportation entity for one professional staff.

[a] These costs are independent of the frequency of reentry mission events.

[b] Dividing $105,885 by 2087 hours per year and multiplying the result by eight hours yields $406 in administrative costs.

[c] Technical cost is estimated at 1.0 staff; administrative cost is estimated at 5 percent of technical cost.

[d] Technical cost is estimated at 7 staff; administrative first year cost is 5 percent of technical cost; recurring administrative cost is estimated at .5 percent of technical first year cost.

[e] Dividing $105,885 by 2087 hours per year and multiplying the result by 80 hours yields $4,059 in administrative costs.

TABLE 4-2. Commercial Space Transportation Entity Compliance Cost (Continued)
(In 1999 Dollars)

Section of Final Rule	Costs Incurred by a Single Entity Approved for Reentry Operations in the First Year of Operations Only			Costs Incurred by a Single Entity Approved for Reentry Operations in all Years of Operation After the First Year		
	Technical	Administrative	Total	Technical	Administrative	Total
431.39: Mission Rules, Procedures, Contingency Plans, and Checklists[f]	$52,943	$2,647	**$55,590**	$0	$2,647	**$2,647**
431.41: Communications Plan[f]	$52,943	$2,647	**$55,590**	$0	$2,647	**$2,647**
431.43: Operational Requirements and Restrictions[g]	$1,694,160	$84,708	**$1,778,868**	$105,885	$5,294	**$111,179**
431.45: Mishap Investigation and Emergency Response Plan[h]	$105,885	$5,294	**$111,179**	$26,471	$5,294	**$31,765**
431.57: Information Requirements for Payload Review[b]	$0	$406	**$406**	$0	$0	**$0**
431.73: Continuing Accuracy, Application for Modification[i]	$32,471	$1,624	**$34,095**	$0	$0	**$0**
431.75: Agreement with Federal Range[j]	$0	$0	**$0**	$0	$0	**$0**
431.77: Records[b]	$0	$406	**$406**	$0	$406	**$406**

[f] Technical cost is estimated at 0.5 staff; all administrative costs are estimated at 5 percent of technical first year cost.

[g] Technical first year cost is estimated at 16 staff; administrative first year costs estimated at 5 percent of technical first year cost; recurring technical cost is estimated at 1 staff; recurring administrative cost is estimated at 5 percent of recurring technical cost.

[h] Technical first year cost is estimated at 1.0 staff; recurring technical cost is estimated at 0.25 staff; all administrative cost are estimated at 5 percent of technical first year cost.

[i] Dividing $105,885 by 2087 hours per year and multiplying the result by 640 hours yields technical cost; administrative cost is estimated at 5 percent of technical costs.

[j] No incremental cost impact.

TABLE 4-2. Commercial Space Transportation Entity Compliance Cost (Continued)
(In 1999 Dollars)

Section of Final Rule	Costs Incurred by a Single Entity Approved for Reentry Operations in the First Year of Operations Only			Costs Incurred by a Single Entity Approved for Reentry Operations in all Years of Operation After the First Year		
	Technical	Administrative	Total	Technical	Administrative	Total
431.79: Reporting Requirements[j]	$0	$0	**$0**	$0	$0	**$0**
431.93: Environmental Information[k]	$264,713	$13,236	**$277,949**	$0	$0	**$0**
433.7: Environmental[l]	$158,828	$7,941	**$166,769**	$0	$0	**$0**
435.23: Policy Review	Incremental compliance costs reflected in Section 431.25 above.					
435.33:Safety Review	Incremental compliance costs reflected in Sections 431.33, .37, .39, .41, .43, and .45 above.					
435.35: Acceptable Reentry Risk for a Reentry Vehicle	Incremental compliance costs reflected in Section 431.35 above.					
435.43: Payload Reentry Review	Incremental compliance costs reflected in Section 431.57 above.					
435.51: Post-Licensing Requirements (General)	Incremental compliance costs reflected in Sections 431.73, .75, .77, and .79 above.					
435.61: Environmental Review (General)	Incremental compliance costs for this section are reflected in Section 431.93 costs above.					
Total[m]	$3,209,023	$165,728	**$3,374,751**	$238,241	$25,288	**$263,529**

[k] Technical fixed cost is estimated at 2.5 staff; administrative costs are estimated at 5 percent of technical fixed costs.

[l] Technical fixed cost is estimated at 1.5 staff; administrative costs are estimated at 5 percent of technical fixed costs

[m] Total is for a single commercial space transportation entitiy entering the industry in 2001 and remaining in operations for 15 years (that is, until 2015).

Section 431.25 Application Requirements for Policy Review, and Section 435.23:Policy Review Requirements and Procedures

This requirement — to provide specific information to the FAA — presents an administrative paperwork burden to a commercial entity. The cost impact of packaging and submitting the requisite information to the FAA in a prescribed format, such as completing a specific application, is based on the expectation that it will require eight hours to perform this task. An individual whose annual cost to a commercial entity is conservatively estimated to be approximately $105,900 will performed this task. The result is a paperwork cost to a commercial entity of approximately $400 (undiscounted 1999 dollars) per application submittal.[23] Over the 15-year period five such submittals are expected collectively (see footnote number 13) from the commercial space transportation industry, resulting in a total cost to industry of $2,000 (undiscounted 1999 dollars).[24]

Section 431.33: Requirements for Safety Organization, and Similar Requirements Contained in Section 435.33: Safety Review Requirements and Procedures

Under the baseline, a safety organization with clearly defined roles, responsibilities, authorities, and lines of communication is consistent with the findings and recommendations of the Rodgers Commission and National Transportation Safety Board reports.[25] However, the requirement to "...designate a qualified safety official...to monitor independently compliance...with...[all] safety policies and procedures" is not necessarily customary and usual practice. Inclusion of this requirement suggests that it is a refinement to industry baseline practices designed to mitigate safety risks to the public. For example, to be "...responsible for the conduct of all...mission activities..." implies a degree of comprehensiveness that may not be common practice in industry. Because the safety official must be independent, the function cannot be assigned as a collateral duty to an individual with line responsibility for reentry operations. Furthermore, the magnitude of responsibilities of the safety official suggests that the level of effort required to

[23] See Table 4-2 for derivation of the estimate for this compliance cost.

[24] See Section A.3 and Tables A-5 and A-6 in the Appendix to this report.

[25] These reports are referenced in Federal Aviation Administration, January 27, 1999, *Revision of Commercial Space Transportation Licensing Regulations,* Notice of Proposed Rulemaking (Draft). For specific recommendations see Rogers, William P. et. al., June 6, 1986, *Report of the Presidential Commission on the Space Shuttle Challenger Accident*, Presidential Commission, Washington, D.C., p. 199, and National Transportation Safety Board, July 26, 1993, *Special Investigation Report, Commercial Space Launch Incident*, NTSB/SIR-93/02, PB93-917003,Washington, D.C., pp. 36 and 52. To date, the FAA still considers this information to be valid.

perform this function will exceed part-time employment. This also supports the notion that the independent safety official function cannot be successfully performed as a collateral duty. Accordingly, this requirement will result in a commercial space transportation entity hiring a person to fulfill the safety official role. As shown in Table 4-2, the annual cost to a commercial entity to perform the safety official function will be approximately $105,900, supplemented with almost $5,300 in administrative costs.[26] Accordingly, a single commercial space transportation entity will incur incremental compliance costs of approximately $111,200 (undiscounted 1999 dollars) for each year of operation over the 15-year period from 2001 to 2015. Industry will incur a total cost of approximately $6.4 million (undiscounted 1999 dollars).[27]

Section 431.35: Acceptable Reusable Launch Vehicle Mission Risk, and Section 435.35: Acceptable Reentry Risk for Reentry of a Reentry Vehicle

Commercial space transportation entities will incur additional costs performing risk analyses of vehicle and payload reentry, and assessing the probabilities and consequences of all reentry hazards, events, and system failures that place the public at risk. Additionally, commercial entities will expend effort preparing documentation and establishing an associated document control system for drawings and schematics that will be acceptable to the FAA, and fulfill the level of rigor implied by the requirements contained in the rule. A shown in Table 4-2, the cost impact to a single commercial entity attributable to this requirement will be approximately $778,000 in the first year of operation, with recurring costs of $3,700 annually in subsequent years of operation. The total cost to industry will be approximately $4.1 million (undiscounted) over the 15-year period.[28]

[26] A conservative estimate of annual salary of $85,771 for this position is used provided by The Aerospace Corporation, Gwynne Gurevich, June 1998. Applying a fringe benefit factor of 23.45% yields $105,885, which is the estimated cost to a commercial space transportation entity to employ this individual. See Table 4-2 for derivation of compliance costs, as well as Appendix A, Tables A-2 and A-4.

[27] See Section A.3 and Tables A-6 in the Appendix to this report.

[28] See Section A.3 and Tables A-6 in the Appendix to this report.

Section 431.37: Mission Readiness, and Similar Requirements Contained in Section 435.33: Safety Review Requirements and Procedures

This requirement — to provide specific procedures to the FAA that verify mission readiness — presents an administrative paperwork burden to a commercial entity. The cost impact of packaging and submitting the requisite information to the FAA in a format that may be easily reviewed by a knowledgeable individual is based on the expectation that it will require 80 hours to perform this task.[29] An individual whose annual cost to a commercial entity is conservatively estimated to be approximately $105,900 will perform this task. As shown in Table 4-2, the result is a paperwork cost to a commercial entity of approximately $4,059 (undiscounted 1999 dollars) per application submittal. Over the 15-year period five such submittals are expected collectively from the commercial space transportation industry, resulting in a total cost of approximately $20,300 (undiscounted 1999 dollars).

Section 431.39: Requirements for Mission Rules, Procedures, Contingency Plans, and Checklists, and Similar Requirements Contained in Section 435.33: Safety Review Requirements and Procedures

Commercial space transportation entities are generally expected to fulfill this requirement as part of their standard operating procedures. However, it is anticipated that some additional effort will be expended to conform to FAA requirements. Furthermore, commercial entities will expend effort exchanging documents with the FAA periodically, and preparing for, accommodating, and reacting to FAA inspection and monitoring activities. Accordingly, the incremental cost impacts will be incurred initially during the application phase and throughout the operating lifetime of commercial operations as an entity interfaces with the FAA, as required, to accommodate compliance monitoring activities. As shown in Table 4-2, the cost impact to a single commercial space transportation entity to comply with this requirement is approximately $55,600 in the first year of operation with $2,600 of recurring costs annually in subsequent years of operation. Industry will incur $418,000 (undiscounted 1999 dollars) over the 15-year period.

[29] Based on information provided by The Aerospace Corporation, Gwynne Gurevich, June 1998.

Section 431.41: Requirements for Communications Plan, and Similar Requirements Contained in Section 435.33: Safety Review Requirements and Procedures

Commercial space transportation entities are expected to have in place communications plans that are consistent with much of the regulatory requirement as a matter of standard business practice. However, they are expected to incur incremental costs from initial compliance with the requirement, and annual recurring costs from interfacing and exchanging documents with the FAA periodically, and preparing for, accommodating, and reacting to FAA inspection and compliance monitoring activities. As shown in Table 4-2, the cost impact to a single commercial space transportation entity to comply with this requirement is approximately $55,600 in the first year of operation with $2,600 of recurring costs annually in subsequent years of operation. Industry will incur $418,000 (undiscounted 1999 dollars) over the 15-year period.

Section 431.43: Reusable Launch Vehicle Mission Operational Requirements and Restrictions, and Similar Requirements Contained in Section 435.33: Safety Review Requirements and Procedures

Commercial space transportation entities will expend additional resources to comply with the RLV and RV flight path requirements during nominal and non-nominal operations, specifically as it pertains to minimizing dwell time over populated areas during all segments of a reentry phase, and performing a collision avoidance analysis during launch windows to maintain adequate separation from inhabitable orbiting objects.

The work and rest requirements will also burden commercial space transportation entities. For example, an individual having direct control over reentry or involved in decisions affecting reentry operations (for RLV and RV missions) is restricted to 60 hours over a seven-day period. Further, the rule reduces the maximum permissible hours worked per shift, limits the maximum number of consecutive workdays, and specifies the minimum rest required between five consecutive 12-hour work shifts. This is summarized below in Table 4-3.

TABLE 4-3. Final Rule Work and Rest Requirements

Maximum Hours Over Seven Day Period	Maximum Hours Per Shift	Maximum Consecutive Work Days	Minimum Rest After Five Consecutive Shifts of Twelve Hours
60 Hours	12 Hours	14 Days	48 Hours

Source: Federal Aviation Administration, Commercial Space Transportation Reusable Launch Vehicle and Reentry Licensing Regulations, Final Rule (Unpublished version; June 2, 2000).

Currently it is common practice among commercial space transportation entities to follow NASA work and rest standards for launches. Ordinarily launch mission operations personnel work less than the maximum currently permissible, such as a 40-hour work week comprised of five eight-hour shifts. Hence, the 72-hour work week is generally an extreme condition that occurs infrequently. Furthermore, industry is voluntarily supplementing NASA work and rest standards with additional provisions limiting the maximum work shift to 12 hours and including a mandatory rest period of at least 8 hours between these extended-hour shifts.[30] These practices, which are consistent with the final rule requirements, are expected to continue for RLV and reentry operations.[31]

The duration of a reentry operation is likely to determine the impact that the work and rest requirements will have on commercial space transportation entities. However, this impact will occur under extreme or limiting conditions only. Under such conditions, commercial entities will have to revisit their duty rosters and make scheduling adjustments that may cause them to add one additional reentry operations personnel.

Generally, commercial space transportation entities currently conducting ELV programs either avoid the limiting conditions or have sufficient numbers of similarly trained back-up personnel to accommodate such restrictions without impacting mission schedules.[32] However, given the

[30] National Transportation Safety Board, July 26, 1993, *Special Investigation Report, Commercial Space Launch Incident*, NTSB/SIR-93/02, PB93-917003,Washington, D.C., p. 32.

[31] Interviews with key AST personnel identified in Table A-1 in the Appendix to this report indicate that it is not uncommon for commercial space transportation entities to supplement NASA duty time standards with more limiting requirements for launch activities. It is expected that this practice will continue for reusable launch vehicles and reentry operations in general.

[32] Interviews with key AST personnel identified in Table A-1 in the Appendix to this report (principally Charles Larsen on November 20, 1998) indicate that small as well as large launch organizations have ample personnel to cover extended work shifts. In some cases, individuals working on the planning for launch and reentry operations

relatively small size of the entities comprising the emerging reentry segment of the commercial space transportation industry, only one additional staff is likely. The annual cost to a commercial entity for this individual is estimated to be approximately $105,900. Additionally, the FAA anticipates that additional costs will be incurred for recordkeeping to ensure compliance with required work and rest standards, and preparing for, accommodating, and reacting to FAA inspection and monitoring activities.

As shown in Table 4-2, the incremental cost to a commercial entity to comply with this requirement will be about $2 million (undiscounted 1999 dollars) in the first year of operation, followed by annual costs in subsequent years of operation of approximately $111,200 attributable to the work and rest requirement. The total cost to industry for the 15-year period will be about $15 million (undiscounted 1999 dollars).[33]

Section 431.45: Requirements for Mishap Investigation and Emergency Response Plan, and Similar Requirements Contained in Section 435.33: Safety Review Requirements and Procedures

Commercial entities are expected to have prepared emergency response plans that are consistent with much of the regulatory requirement as a matter of standard business practice. However, the FAA anticipates that these plans will require additional annual maintenance (for example, periodic training drills and annual exercises) to comply with certain elements of the rule. For example, entities are likely to incur additional costs to establish and demonstrate their ability to successfully respond to accidents occurring in remote areas having sparse populations (where overflight may be permitted, provided the E_c does not exceed 30×10^{-6}). Furthermore, additional annual maintenance costs are expected to arise from preparing for, accommodating, and reacting to FAA inspection and monitoring activities. As shown in Table 4-2, a commercial space transportation entity will incur incremental costs of approximately $111, 200 initially and $32,000 annually in subsequent years of operation. Industry will incur total compliance costs of approximately $2 million (undiscounted 1999 dollars) for the 15-year period.

for subsequent missions may be used to support a current mission in order to avoid encroaching on work and rest limits.

[33] See Section A.3 and Tables A-6 in the Appendix to this report.

Section 431.57: Information Requirements for Payload Reentry Reviews, and Similar Requirements Contained in Section 435.43: Payload Reentry Review Requirements and Procedures

The requirement to provide specific payload information to the FAA presents an administrative paperwork burden to a commercial entity. The cost impact of packaging and submitting the requisite data to the FAA in a prescribed format is based on the expectation that it will require eight hours to perform this task. An individual whose annual cost to a commercial entity is conservatively estimated to be approximately $105,900 will perform this task. The result is a minimal paperwork cost to a commercial entity of approximately $400 per application submittal.[34] Over the 15-year period five such submittals are expected collectively from the commercial space transportation industry, resulting in a total cost of $2000 (undiscounted 1999 dollars).

Section 431.73: Requirements for Modification of a License, and Similar Requirements Contained in Section 435.51: Post Licensing Requirements — Reentry License Terms and Conditions (General)

Depending on the nature of modifications to an existing license, this requirement may or may not impact a commercial space transportation entity. For instance, trivial changes to missions that do not impact public health and safety and the safety of property will cause a commercial space transportation entity to expend a negligible level of effort advising the FAA. In contrast, changes made to a mission that materially affect mission rules, plans, and contingency procedures, will cause an entity to expend considerable effort responding to this requirement. Conditional upon these latter types of changes, it is assumed that, on average, a commercial space transportation entity will incur incremental compliance costs of approximately $34,000 (undiscounted 1999 dollars) per modification application.[35] Industry will incur total compliance costs of approximately $170,000 (undiscounted 1999 dollars) for the 15-year period.

Section 431.75: Requirements for Securing Agreement with Federal Range, and Similar Requirements Contained in Section 435.51: Post Licensing Requirements — Reentry License Terms and Conditions (General)

It is a Federal range requirement for commercial space transportation entities launching ELVs from such ranges to enter into formal agreements prior to using such facilities. Commercial

[34] See Table 4-2 for derivation of the estimate for this compliance cost.

entities planning to use these same facilities for RLV and RV reentry missions are expected to act in similar fashion. While the requirement may cause an applicant to enter into an agreement sooner, it has no impact on commercial entities other than the negligible level of effort expended (that is, less than one hour) to advise the FAA of its existence. Therefore, the incremental cost to industry to comply with this requirement will be zero.

Section 431.77: Requirements for Records, and Similar Requirements Contained in Section 435.51: Post Licensing Requirements — Reentry License Terms and Conditions (General)

It is generally accepted practice among all commercial concerns to maintain business operations records for some period of time, often more than three years.[36] Furthermore, the availability and capability of electronic storage systems renders records retention a manageable task. Accordingly, the three-year requirement to maintain records for FAA review, upon request, will not impact commercial space transportation entities. From a worst case perspective, this evaluation assumes the FAA will exercise its record request authority. As a result, the impact to a commercial entity is the effort expended duplicating these records, which is not expected to exceed eight person-hours. Assuming one request annually for records duplication, the cost to a commercial entity will be approximately $400 annually. Total costs to industry will be approximately $24,000 (undiscounted 1999 dollars) for the 15-year period.

Section 431.79: Reporting Requirements, and Similar Requirements Contained in Section 435.51: Post Licensing Requirements — Reentry License Terms and Conditions (General)

The information to be supplied by the licensee per this requirement is similar to that supplied to the FAA during the application process in accordance with Section 431.57. The burden placed on the licensee is to provide accurate and current data supplied previously to ensure that the required information will be available to the FAA no later than 60 and 15 days prior to conducting a licensed mission, as appropriate. This responsibility is not expected to impact commercial space transportation entities, as it involves the conveyance of previously supplied

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[35] See Table 4-2 for derivation of the estimate for this compliance cost.

[36] To be consistent with or respond to any provision of the U.S. Internal Revenue Code, businesses must keep records from three to seven years, and in some instances indefinitely (U.S. Department of the Treasury, February 1998, p. 14). Commercial entities in the business of providing services generally maintain meticulous records for insurance purposes in order to address liability claims. Therefore, it is not unreasonable to assume that commercial space transportation entities will maintain their licensed mission operations records for a period at least equivalent to the shortest period (that is, three years) stipulated by the U.S. Internal Revenue Service.

information and generates a negligible level of effort (that is, less than one hour). Therefore, the incremental cost to industry to comply with this requirement will be zero.

Section 431.93: Requirements for Environmental Information, and Similar Requirements Contained in Section 435.61: Environmental Review (General)

Absent the rule, it is possible that a commercial space transportation entity may be required to address the environmental effects of its operations in accordance with environmental regulations issued by state governments in addition to National Environmental Policy Act (NEPA) requirements. Apart from this occurrence, commercial entities planning to conduct reentry missions will be required to submit an assessment to the FAA of the environmental impacts of its activities. This will cause a commercial entity to incur incremental compliance costs of $278,000 (undiscounted 1999 dollars).[37] Industry will incur compliance costs of $1.4 million (undiscounted 1999 dollars) over the 15-year period.

Section 433.7: Environmental Information

A commercial entity applying for a license to operate a reentry site, regardless of whether it is independent of those organizations applying for licenses to conduct a RLV or non-RLV reentry mission, must submit to the FAA information to permit an analysis of the environmental impacts of its activities. Because reentry sites are not as complex as the vehicles that will be using them (that is, RLVs and RVs), the level of effort required to assemble this information will be relatively less. Accordingly, this requirement will cause a commercial entity to incur incremental compliance costs of $167,000 (undiscounted 1999 dollars).[38] Industry will incur total compliance costs of approximately $834,000 (undiscounted 1999 dollars) over the 15-year period.

As summarized in Table 4-2, a single space transportation entity initiating operations in the year 2001 and continuing for 15 years (that is, through 2015) is estimated to incur approximately $3.6 million (undiscounted 1999 dollars) to comply with the principal requirements contained in Sections 431, 433, and 435 of the rule. Based on a projected industry population of five entities

[37] See Table 4-2 for derivation of the estimate for this compliance cost.

[38] See Table 4-2 for derivation of the estimate for this compliance cost. For purposes of this regulatory evaluation, the projected number of entities receiving a reentry site operator license over the 15-year period is presumed to be equivalent to the number of commercial space transportation entities performing reentry missions (that is, five).

over the 15-year period from 2001 to 2015, and considering what year they initiated operations and for how many periods (that is, time-phasing), collectively they will incur approximately $31 million (undiscounted 1999 dollars) to comply with the final rule.[39] Approximately 82 percent (or $25 million, undiscounted) of these costs will be incurred to comply with Sections 431.33, .35, and .43 of the rule.

4.3 Impact of the Final Rule on the Federal Aviation Administration

4.3.1 Current Federal Aviation Administration Practice

Fifteen principal sections of the rule contain requirements that impact the FAA. Each of these regulatory requirements is compared with the baseline to identify the incremental cost to the FAA. While it may be necessary for the FAA to confer with other Federal Government organizations in performing its responsibilities under the rule, such as NASA and the Departments of Defense and State, the cost to these other agencies is minimal. This is because their involvement is assumed to include only coordination of administrative information, limited reviews of application materials, and limited consultation on technical matters.[40] Therefore, the incremental analysis associated with administering the requirements of the rule pertains to the effects on the FAA only.

A request for a RLV or RV reentry license today will be processed by the FAA's Licensing and Safety Division (LASD). LASD would exercise the function inherited from OCST that was performed on the COMET/METEOR requests for permission to conduct a reentry mission.[41] Hence, the rule implements LASD responsibilities and duties to licensing reentry operations.

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[39] See Section A.3 and Tables A-6 in the Appendix to this report for time-phasing of entrants into the industry and a summary of total compliance costs by each section of the final rule.

[40] The Federal Aviation Administration is expected to use consultants from private industry to evaluate applications, as was done for the COMET and METEOR programs, according to information extracted from interviews with key AST personnel (see Table A-1 in the Appendix) and Federal Aviation Administration, 1998, "AST-200 FY 2000 Budget Estimates (Working Papers), Associate Administrator for Commercial Space Transportation, Licensing and Safety Division.

[41] The FAA Licensing and Safety Division (LASD) currently is responsible for (1) evaluating license applications, (2) recommending approval or disapproval, and (3) monitoring licensee compliance with the license requirements; Federal Aviation Administration, March 11, 1998, *Licensing and Safety Division Order No. 001, Launch Licensing and Compliance Monitoring Process and Procedures*, Associate Administrator for Commercial Space Transportation, Licensing and Safety Division.

Currently, upon receipt of a launch-related license application, the FAA has 180 days (or 6 months) in which to evaluate an application and make a decision to approve or disapprove the request. Formal evaluation of an application, however, may be preceded by a voluntary pre-application consultation process that can involve a substantial amount of interface between the FAA and the applicant. During the consultation period, an applicant may submit to the FAA a draft application for review and comment. Pending the results of the consultation review, additional drafts may be prepared and submitted to the FAA for further assessment. This iterative process enables an applicant to prepare and submit a final license application for evaluation that is less likely to require modification and create costly delays during the formal 180-day evaluation period. Hence, by the time an application is presented to the FAA for evaluation, most if not all problems, concerns, and issues have been identified and resolved.

4.3.2 Incremental Effects on the Federal Aviation Administration

The process and requirements used by the OCST in evaluating the COMET/METEOR programs were reviewed and supplemented by interviews with key AST personnel to identify the impact of the rule on the FAA. Many of the principal actions required of the FAA under the rule would have been performed (by the FAA) for the COMET/METEOR program.[42] Therefore, the effort expended to administer the rule for a single applicant may be compared to the actions taken to apply the 1992 policy, augmented with the additional duties associated with other requirements not reflected in the reentry policy established for COMET/METEOR.

To the extent that the rule injects a level of formality into the reentry licensing process, it may improve the efficiency with which the FAA performs this function through standardization and consistency (discussed in Section 4.5). This could result in cost savings. However, these cost savings may be completely eroded by the rule itself, because creating a regulation to institutionalize and formalize past policy may introduce additional administrative costs.[43]

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[42] The referenced document (U.S. Department of Transportation, November 15, 1993) entitled, *Strategic Plan for Operations Review of the COMET Reentry Vehicle* succinctly describes the process followed to evaluate the operations of the COMET Freeflyer reentry vehicle proposed by Space Industries, Inc.

[43] For purposes of this regulatory evaluation it is assumed that these situations, should they arise, would have off-setting results.

The principal sections of the rule — Parts 431, 433, and 435 — will cause the FAA to incur additional costs administering their respective requirements. This analysis is summarized in Table 4-4 below.

TABLE 4-4. Impact of Revision of Commercial Space Transportation Licensing Regulations on the Administrative Functions Performed by the Federal Aviation Administration

Section of Final Rule	Summary of Rule-Required Actions	Comparable Actions Performed by OCST and AST	Difference Between Baseline and Final Rule That Impact FAA
431.23: Policy Review	Coordinate policy review, focusing on national security, foreign policy interests, public health and safety, and property; coordinate with other government agencies; notify applicant in writing.	None.	Administrative burden of coordinating activities with DOS, DOD, and NASA and notifying applicants in writing of issues, concerns, and approvals.
431.27: Denial of Policy Approval	Notify applicant in writing.	None.	Administrative burden of notifying applicants in writing of denial of policy approval.
431.31: General (Safety Review)	Conduct general safety review focusing on public health and safety and property; notify applicant in writing.	None.	Perform technical review of operations.[a, b].
431.47: Denial of Safety Approval	Notify applicant in writing.	None.	Administrative burden of notifying applicants in writing of denial of safety approval.

Source: Interviews with key AST personnel identified in Table A-1 in the Appendix to this report.

[a] Activities to be performed are expected to be similar to those contained in U.S. Department of Transportation, November 15, 1993, *Strategic Plan for Operations Review of the COMET Reentry Vehicle*, Revision 1.0, Office of Commercial Space Transportation, Licensing and Safety Division.

[b] Activities to be performed are expected to be similar to those contained in U.S. Department of Transportation, December 6, 1994, *Space Industries, Incorporated COMET Freeflyer, Vehicle Safety Assessment,* Office of Commercial Space Transportation, Licensing and Safety Division.

TABLE 4-4. Impact of Revision of Commercial Space Transportation Licensing Regulations on the Administrative Functions Performed by the Federal Aviation Administration (Continued)

Section of Final Rule	Summary of Rule-Required Actions	Comparable Actions Performed by OCST and AST	Difference Between Baseline and Final Rule That Impact FAA
431.55: Payload Reentry Review	Perform and coordinate payload reentry review and notify applicant of issues impeding favorable determination.	None.	Perform payload determination evaluation.[c, d]
431.59: Issuance of Payload Reentry Determination	Notify applicant in writing.	None.	Administrative burden of notifying applicants in writing of payload determination.
431.73: Application for Modification of a License	Perform policy and safety reviews.	None.	As required, perform policy and safety reviews on mission changes.[a]
431.83: Compliance Monitoring	Review documentation and observe activities of licensee, contractors, and subcontractors associated with the RLV mission.	None.	Site visits to relevant facilities to review material and observe operations.
431.91: General Environmental Review	Perform environmental impact assessment.	None.	Perform environmental assessment.[c, e]

Source: Interviews with key AST personnel identified in Table A-1 in the Appendix to this report.

[c] Activities to be performed are expected to be similar to those contained in Jackson, Stewart, August 4, 1995, Memorandum to Ronald K. Gress; "EER systems Corporation METEOR Payload Determination Application," U.S. Department of Transportation, Office of Commercial Space Transportation

[d] Activities to be performed are expected to be similar to those contained in U.S. Department of Transportation, August 4, 1995, *Payload Determination Evaluation for the METEOR Reentry Vehicle, Vehicle Safety Assessment and Operations Review*, Office of Commercial Space Transportation, Licensing and Safety Division.

[e] Activities to be performed are expected to be similar to those contained in U.S. Department of Transportation, August 1995, *Environmental Assessment for EER Systems Corporation's METEOR Vehicle and Payload,* Office of Commercial Space Transportation.

TABLE 4-4. Impact of Revision of Commercial Space Transportation Licensing Regulations on the Administrative Functions Performed by the Federal Aviation Administration (Continued)

Section of Final Rule	Summary of Rule-Required Actions	Comparable Actions Performed by OCST and AST	Difference Between Baseline and Final Rule That Impact FAA
433.3: Operation of a Reentry Site	Conduct general review focusing on issues affecting public health and safety, property, national security, foreign policy, and international obligations. It includes a review of environmental information.	None.	Review of reentry site operator application.
435.23: Policy Review	Same requirements as Sections 431.23 and .27 listed above.	Same as response to Sections 431.23 and .27 listed above.	Same as response to Sections 431.23 and .27 listed above.
435.31: Safety Review and Approval (General)	Same requirements as Sections 431.31 and .47 listed above.	Same as response to Sections 431.31 and .47 listed above.	Same as response to Sections 431.31 and .47 listed above.
435. 43: Payload Reentry Review	Same requirements as Sections 431.55 and .59 listed above.	Same as response to Sections 431.55 and .59 listed above.	Same as response to Sections 431.55 and .59 listed above.
435.51: Post-Licensing Requirements	Same requirements as Sections 431.73 and .83 listed above.	Same as response to Sections 431.73 and .83 listed above.	Same as response to Sections 431.73 and .83 listed above.
435.61 Environmental Review (General)	Same requirement as Section 431.91 listed above.	Same as response to Section 431.91 listed above.	Same as response to Section 431.91 listed above.

4.3.3 Incremental Cost Impact on the Federal Aviation Administration

As summarized in Table 4-4 above, 15 principal sections of the rule contain requirements that collectively are expected to create incremental administrative costs to the FAA. The rationale for establishing the incremental cost impact of these requirements is provided below. Following the discussion of each principal part of the rule — 431, 433, and 435 — derivation of the incremental compliance cost estimates is summarized in a tabular format.

Section 431.23: Application Requirements for Policy Review, and Similar Requirements Contained in Section 435.23: Policy Review Requirements and Procedures

The FAA will be required to expend additional person-hours to review applications and consult with other Federal government organizations. The estimated cost to the FAA to administer this requirement is addressed in Table 4-5.

Section 431.27: Requirements for Denial of Policy Approval, and Similar Requirements Contained in Section 435.23: Policy Review Requirements and Procedures

The FAA will be required to expend additional person-hours to inform applicants, in writing, of issues raised during the policy review that resulted in denying approval. The estimated cost to the FAA to administer this requirement is addressed in Table 4-5.

Section 431.31: Requirements for Safety Review, and Similar Requirements Contained in Section 435.31: Safety Review and Approval for Reentry of Reentry Vehicle (General)

The FAA will be required to expend additional person-hours to conduct a thorough review of an application in order to determine whether an applicant is capable of performing a reentry mission in a manner consistent with the requirements contained in the rule. The review will focus on program infrastructure, technical and operational characteristics of the vehicle, mission plan, and payload. The estimated cost to the FAA to administer this requirement is addressed in Table 4-5.

Section 431.47: Requirements for Denial of Safety Approval (General), and Similar Requirements Contained in Section 435.31: Safety Review and Approval for Reentry of Reentry Vehicle (General)

The FAA will be required to incur additional costs to inform applicants, in writing, of the basis for denying approval to their reentry application. The estimated cost to the FAA to administer this requirement is addressed in Table 4-5.

Section 431.55: Requirements for Payload Reentry Review, and Similar Requirements Contained in Section 435.43: Payload Reentry Review Requirements and Procedures

The FAA will be required to expend additional person-hours to conduct a review of the payload to ensure it is consistent with the requirements in the rule. The estimated cost to the FAA to administer this requirement is addressed in Table 4-5.

Section 431.59: Requirements for Issuance of Payload Reentry Determination, and Similar Requirements Contained in Section 435.43: Payload Reentry Review Requirements and Procedures

The FAA will be required to incur additional costs to inform applicants, in writing, of its payload determination. The estimated cost to the FAA to administer this requirement is addressed in Table 4-5.

Section 431.73: Continuing Accuracy of License Application; Application for Modification of a License, and Similar Requirements Contained in Section 435.51: Post-Licensing Requirements — Reentry License Terms and Conditions (General)

The FAA will be required to incur additional costs to review applications to modify licenses and to inform applicants, in writing, of its decision to approve or deny the request. The estimated cost to the FAA to administer this requirement is addressed in Table 4-5.

Section 431.83: Compliance Monitoring, and Similar Requirements Contained in Section 435.51: Post-Licensing Requirements — Reentry License Terms and Conditions (General)

The FAA will be required to incur additional costs to gain access to the facilities of the licensee or its contractors and subcontractors, in order to review information and observe activities relevant to the mission. The estimated cost to the FAA to administer this requirement is addressed in Table 4-5.

Section 431.91: Environmental Review (General), and Similar Requirements Contained in Section 435.61: Environmental Review (General)

The FAA will be required to incur additional costs to analyze the environmental impacts associated with operation of the subject vehicle. The analysis will be based on information supplied by the applicant and performed by the FAA in accordance with the requirements of the National Environmental Policy Act, the Council on Environmental Quality Regulations for Implementing the Procedural Provisions of the National Environmental Policy Act, and FAA

Procedures for Considering Environmental Impacts. The estimated cost to the FAA to administer this requirement is addressed in Table 4-5.

The FAA experience evaluating an application to conduct a reentry mission is limited to the COMET and METEOR programs, as no other requests have been presented since. As was mentioned previously, certain of the risk limitations contained in the rule reflect the 1992 safety policies established to ensure that COMET/METEOR reentry missions would not jeopardize public health and safety and the safety of property. Consequently, this experience provides a partial basis for establishing the costs to the FAA for administering the rule. Using this past experience, AST expects that the costs to be incurred performing its reentry licensing pre-application consultation, application evaluation, and compliance monitoring duties in the near term to be higher than that incurred for COMET/METEOR for a single application.[44] The extent to which such costs will be higher than that incurred for COMET/METEOR is unknown since there is no history of U.S. commercial reentry activity. The assessment of higher application evaluation costs, however, is largely due to the expectation that the inherently more complex RLV programs will dominate reentry missions in the future; and initially these will require greater evaluative effort on the part of FAA personnel until they have developed experience in this area.

Because discrete time allocation is not documented within the FAA, it is not possible to readily develop a method for allocating budgetary administrative cost estimates to each regulatory section of the rule based on the COMET/METEOR experience. However, AST fiscal year 2000 budget estimates of the cost to perform its pre-application consultation and application evaluation licensing responsibilities may be correlated collectively to Sections 431.23, 431.27, 431.31, 431.47, 431.55, 431.59, and 431.91; 433.9; and 435.23, 435.31, 435.43, and 435.61 of the

[44] This was addressed in "AST-200 FY 2000 Budget Estimates" (working papers supplied by Ronald Gress, Federal Aviation Administration, Associate Administrator for Commercial Space Transportation, Licensing and Safety Division). AST budget estimates developed for fiscal year 2000 reflect the additional funding needed to exercise its reentry mission approval function consistent with and in anticipation of codification of the rule, and remain applicable to the 2001-2015 period. These budget estimates reflect the complexity associated with the advancing technology being evaluated, and the limited experience base resident at the Federal Aviation Administration in the immediate and near term.

regulation.[45] Therefore, using information provided by FAA technical personnel, the FAA can be expected to spend $3.6 million — an amount equivalent to that expended for COMET/METEOR — to administer these requirements for a single application.[46]

The costs that will be incurred by the FAA to perform its compliance monitoring responsibilities corresponding to Sections 431.73, 431.83, and 435.51 can vary widely, as the spectrum of changes to RLV and reentry program operations can range from trivial to major. Although information upon which to base a robust estimate of compliance monitoring costs is limited, consistency suggests that it will be equivalent to that incurred for COMET/METEOR, which is estimated to be 20 percent of pre-application consultation and application evaluation costs, or approximately $730,000[47] The pre-application process enables commercial space transportation entities and the FAA to determine the potential for reentry license approval prior to the formal evaluation. For entities taking full advantage of the pre-application consultation, the possibility of application approval may be very high, given that the FAA consultation encourages formal submittal of an acceptable application. In situations where the consultation process results in a less than favorable assessment of the application, or firms do not take full advantage of the benefits of pre-application consultation, the risk of denial may have a higher probability, and may be determined with less expenditure by the FAA. Accordingly, pre-application consultation and application evaluation costs borne by the FAA associated with applicants denied and reconsidered for reentry licenses are estimated to be 10 percent of pre-application consultation and application evaluation costs for those applicants who are approved, or about $365,000. The incremental costs to the FAA to administer the rule per applicant are summarized in Table 4-5.

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[45] The incremental costs to the FAA to evaluate applications for a license to operate a reentry site are included among the costs to evaluate a RLV and RV mission application. This assumption simplifies estimating the unique costs that may be associated with evaluating applications submitted by commercial entities that are operating the reentry site only, and are independent of the organizations owning the vehicle and using the reentry site to conduct the reentry mission.

[46] Federal Aviation Administration Office of the Associate Administrator for Commercial Space Transportation, "AST-200 FY 2000 Budget Estimates" (working papers supplied by Ronald Gress, Federal Aviation Administration Licensing and Safety Division). Although not addressed in this analysis, it is not unreasonable to expect some FAA costs to decrease over time due to experience (that is, the learning curve effect), thereby reflecting increased efficiency.

[47] Interviews with Federal Aviation Administration, Office of the Associate Administrator for Commercial Space Transportation personnel: Ronald Gress, Licensing and Safety Division, August 12, 1998.

TABLE 4-5: Incremental Cost to the Federal Aviation Administration per Applicant to Administer the Principal Revisions to Parts 431, 433, and 435 of the Final Rule (In 1999 Dollars)

Activity and Personnel Performing Work	Final Rule Sections 431.23, .27, .31, .47, .55, .59, and .91; 433.9; and 435.23, .31, .43, and .61 Pre-Application Consultation and Application Evaluation	Final Rule Sections 431.73 and .83, and 435.51 Compliance Monitoring[a]
Application Approval Process:		
Federal Aviation Personnel	$2,058,620	$411,724
Contractor Personnel	$1,592,160	$318,432
Total	$3,650,780	$730,156
Review of Application Denials and Reconsideration Process :		
Federal Aviation Personnel	$205,862	Not Applicable
Contractor Personnel	$159,216	Not Applicable
Total	$365,078	Not Applicable

Source: Federal Aviation Administration Office of the Associate Administrator for Commercial Space Transportation, "AST-200 FY 2000 Budget Estimates." Information provided included the number of Federal Aviation Administration full-time personnel required and the total costs to obtain the services of private contractor.
[a] Compliance monitoring costs are estimated to be 20 percent of pre-application consultation and application evaluation costs based on information provided by the Federal Aviation Administration.

Based on projections of the level of application activity over the 15-year period from 2001 to 2015, the FAA is expected to spend approximately $120 million in administering the safety requirements of Parts 431, 433, and 435. Approximately 94 percent (or $112 million) of these costs will be incurred to approve the projected license applications for RLV missions and other reentries, and license modifications to be evaluated over the 15-year period. Approximately 6 percent (or $8 million) of the cost to administer Parts 431, 433, and 435 will be expended on the review of application denials and reconsideration process. This is summarized in Table 4-6.[48]

[48] See Table A-7 in the Appendix to this report for more detailed information.

TABLE 4-6. Incremental Cost to the Federal Aviation Administration to Administer the Principal Revisions to Parts 431, 433. and 435 of the Final Rule (In 1999 Dollars - Undiscounted)

Applications Approved				Review of Application Denials and Reconsideration Process	
Number of New Requests	Pre-Application and Application Evaluation Cost	Number of Modifications Evaluated[a]	Compliance Monitoring Cost	Pre-Application and Application Evaluation Cost	Total Administrative Cost
5	$18,253,900	129	$94,190,124	$7,666,638	$120,110,662

[a] Only entities with existing (that is, approved) licenses apply for modifications, which can be either approved or denied. Accordingly, entries under this column include all applications from approved licensees for modification that are evaluated by the FAA and either approved or denied.

4.4 Summary of Cost Effects of Final Rule

The total costs of the final rule are approximately $151 million (undiscounted 1999 dollars). Commercial space transportation entities will incur 20 percent of these costs, or approximately $31 million, to comply with the requirements contained in the rule. The FAA will incur 80 percent of the total costs, or approximately $120 million to administer the rule. These costs are summarized in Table 4-7.

TABLE 4-7. Summary of Costs Effects (In 1999 Dollars)

Category	Undiscounted	Discounted[a]
Commercial Space Transportation Industry Compliance Costs	$30,840,792	$20,397,052
Federal Aviation Administration Administrative Costs	$120,110,662	$65,922,998
Total Costs	$150,951,454	$86,320,050

[a] Discounted at seven percent over a 15-year period from 2001 to 2015.

4.5 Safety Benefits

4.5.1 Accident Types

Many different types of unplanned events can occur during a RLV or reentry mission, given the spectrum of payloads, vehicle designs, and mission paths. For purposes of this analysis, these events are represented by two categories of unplanned event, hereafter referred to as accidents: (1) an airborne break-up, explosion, or collision, and (2) a ground point-of-impact crash. Under each accident category — airborne or ground — the population of the area surrounding the accident scene or accident zone can be (1) none, (2) sparse (i.e., rural), or (3) dense (that is, urban).[49] Accordingly, this results in the six accident types presented in Table 4-8.

TABLE 4-8. Accident Types

Population	Airborne Explosion	Ground Point-of-Impact Crash
None	Accident Type I	Accident Type IV
Rural	Accident Type II	Accident Type V
Urban	Accident Type III	Accident Type VI

Note: An airborne explosion and ground impact crash are assumed to be equally likely due to a lack of empirical data.

4.5.2 Accident Consequences

To arrive at accident consequences, the accident scenes or zones for airborne and ground accidents are characterized in terms of fatalities, injuries, and property damage.[50] Space vehicle type, velocity, trajectory, weather, payload, presence of hazardous materials, and other factors that would contribute to generating a complicated and large spectrum of accident consequences are avoided, resulting in a relatively simple and conservative approach to accident consequence determination. Fixed wing aircraft and launch vehicle accident data are used to derive the

[49] In this regulatory evaluation, reentry accident refers to an unplanned event resulting in adverse consequences to persons and property not directly associated or involved with the RLV or reentry mission. This definition differs from that used in the final rule for regulatory purposes.

[50] Debris fields established on the basis of industry expert opinion and fixed-wing aircraft and launch vehicle airborne and ground accident information, collectively supplied by Gwynne Gurevich, The Aerospace Corporation, Gwynne Gurevich, June 1998.

accident consequence zones for airborne and ground accidents illustrated in Figure 4-1.[51] The area of these zones (measured in square miles) is multiplied by population and housing density statistics (also measured in square miles) for rural and urban land areas to calculate the number of fatalities, injuries, and property damaged in the associated lethal and injury zones.[52] Dollar values are assigned to fatalities, injuries, and property damage to quantify accident consequences (that is, accident costs) for each accident type.[53] For example, the area of the lethal zone for an airborne explosion is .03 square miles (from Figure 4-1 below). Multiplying this value by the population density for a rural area, which is 18 people per square mile (from Table A-9 in the Appendix to this report), results in a population density of .54 for a rural area corresponding to a Type II accident. Multiplying .54 by $2,700,000, which is a minimum value assigned to a statistical fatality avoided for comparison purposes (from Table A-10 in the Appendix to this report) results in the cost of fatalities associated with a Type II accident, or $1,458,000.[54] Multiplying the area of the lethal zone (that is, .03 square miles) by the residential housing density for a rural area, which is 8 units (from Table A-9), results in a housing density of .24 for a rural area corresponding to a Type II accident. Multiplying .24 by $57,780, which is the value of rural property damage (from Table A-10 in the Appendix to this report) results in the cost of property damage associated with a Type II accident, or $13,867. Multiplying the area of the injury zone (that is, .15 square miles from Figure 4-1) by the population density for a rural area, which is 18 people per square mile (from Table A-9 in the Appendix to this report), results in a population density of 2.7 for a rural area corresponding to a Type II accident. Multiplying 2.7 by $280,150, which is the average value of an injury (from Table A-10 in the Appendix to this report) results in the cost of injuries associated with a Type II accident, or $756,405. Summing all accident costs (that is fatalities, injuries, and property damage) results in a cost estimate for a Type II accident of $2,228,272 (undiscounted 1999 dollars). This process is repeated for all cells in Table 4-9 below to quantify accident consequences by accident type.

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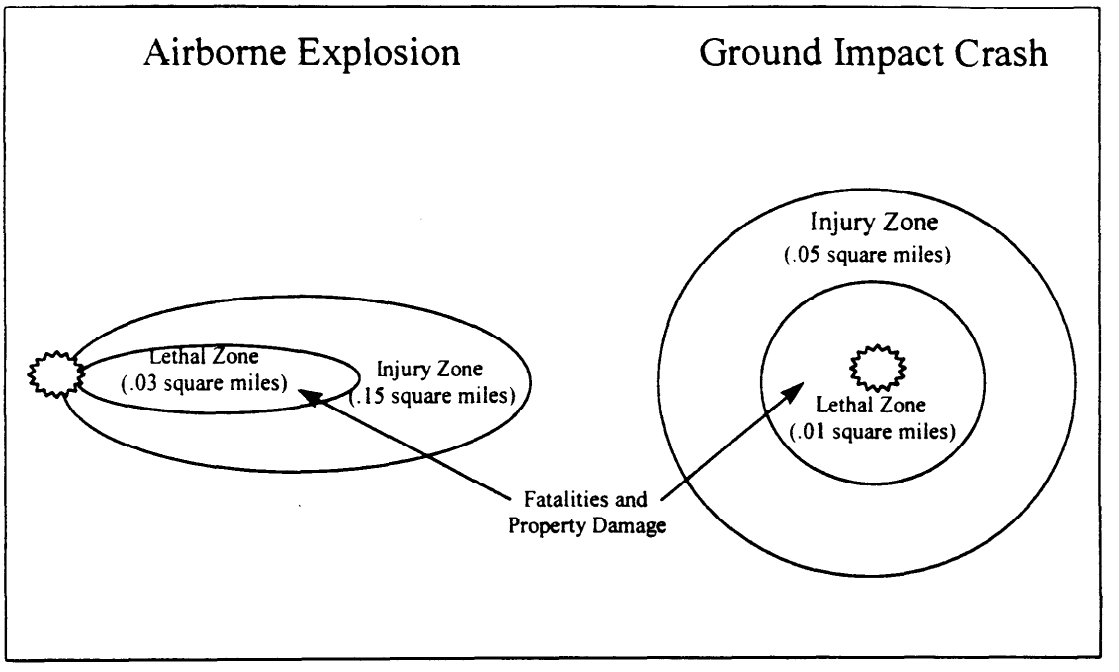
[51] The Aerospace Corporation, Gwynne Gurevich, June 1998.

[52] Residential housing units is used as a proxy for property damage.

[53] Economic Values for Evaluation of Federal Aviation Administration Investment and Regulatory Programs, Federal Aviation Administration, Office of Policy and Plans, June 1998.

[54] The area of the injury zone does not include the lethal zone. Although injuries are likely to occur in the lethal zone, they are not considered for purposes of simplification.

FIGURE 4-1. Accident Category Lethal and Injury Zones



Source: Based on expert opinion and relevant information provided by Gwynne Gurevich, The Aerospace Corporation, June 1998.

TABLE 4-9. Accident Consequences Per Reentry Mission
(Value in 1999 Dollars)

Accident Type	Fatalities		Injuries		Property Damage		Total Value
	Number	Value	Number	Value	Number[a]	Value	
Airborne Explosion							
I. Nonpopulated	0	$0	0	$0	0	0	**$0**
II. Rural Population	0.54	$1,458,000	2.70	$756,405	0.24	$13,867	$2,228,272
III. Dense Population	64.5	$174,150,000	322.50	$90,348,375	26.28	$3,036,917	$267,535,292
Ground Impact							
IV. Nonpopulated	0	$0	0	$0	0	0	**$0**
V. Rural Population	0.18	$486,000	2.70	$756,405	0.08	$4,622	$1,247,027
VI. Dense Population	21.50	$58,050,000	107.50	$30,116,125	8.76	$1,012,306	$89,178,431

[a] Number of housing units.

4.5.3 Baseline Accident Probabilities and Expected Costs of an Accident

One of the more difficult areas to ascertain is the probability of a LV or RV failure having accident consequences in the absence of government regulation. This information is needed to calculate the expected value of an accident under the baseline in order to estimate the incremental safety benefits of the rule. While the expectation of prudent and rational judgment on the part of commercial space transportation entities suggests that failures or accident probabilities will be low (that is, close to or equivalent to the expected casualty rate criterion contained in the rule), experience suggests otherwise. This is evidenced by the recent Titan IV and Delta III failures, although neither of which resulted in accident consequences, as there was no third party injuries or damage. Accordingly, given past experience and uncertainty regarding future reentry mission performance, it is appropriate to consider a range of accident probabilities. In this evaluation, reentry mission accident probability may range from .3 (or 300,000 accidents per million missions) to .03 (or 30,000 accidents per million missions).[55]

Accident rates are not constant, as they are expected to vary among LV and RV designs and mission conditions. Furthermore, accident rates are expected to improve over time as the industry matures; and RLV programs in particular will experience reliability growth over the next 15-years. In the absence of intervention by Federal government in the form of regulatory requirements, the FAA believes that this industry will be able to reduce the probability of a LV, RV, or RLV accident from a probability of .3 to a probability of .05).[56] Consequently, a range of reliability growth and improved accident probabilities are considered in this analysis over the 15-year period from 2001 to 2015. For example, accident probabilities can range from .3 to.03 for the period 2001 to 2005, and can be expected to improve over time, from .10 to .01 for the period 2006 to 2010, and from .05 to .005 for years 2011 to 2015.[57]

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[55] Based on the probability of success for new generation ELVs, which is 0.7; The Aerospace Corporation, Gwynne Gurevich, June 1998. Hence, 1.0 - 0.7 = 0.3, which is taken as the (worst case) probability of a reentry mission accident.

[56] Based on expert industry opinion, the commercial space transportation industry may be able to reduce the probability of an accident by as much as 80 to 85 percent in year 15, The Aerospace Corporation, Gwynne Gurevich, June 1998.

[57] Uncertainty regarding the extent to which industry has already implemented appropriate technology and safety practices, or the rate at which they will improve the safety of their operations over time warrants using a range of

The spectrum of accident probabilities used in this analysis is summarized in Table 4-10. Accident probabilities are assigned to each of the six accident types on the basis of landmass. (The assignment process used is described in the Appendix to this report.) Each accident probability is multiplied by accident consequences in Table 4-9 (that is, accident costs) to calculate the expected value for each accident type in the absence of regulatory requirements — the baseline case. These calculations are summarized in Table 4-11. For example, using the lower and upper probability values for the years 2001 to 2005 for a Type II accident, .00488 and .04877 are multiplied by the total value of a Type II accident from Table 4-9, or $2,288,272, to arrive at the lower and upper bound expected value of a Type II accident under the baseline — $10,874 and $108,673 (undiscounted 1999 dollars). This process is repeated for all cells in Table 4-10 below to derive the lower and upper bound expected values for all accident types under the baseline over the 15-year period from 2001 to 2015 shown in Table 4-11.

TABLE 4-10. Baseline Accident Probability Profile[a]

Accident Type[b]	Years 2001 to 2005 Accident Probability		Years 2006 to 2010 Accident Probability		Years 2011 to 2015 Accident Probability	
	Lower Probability	Upper Probability	Lower Probability	Upper Probability	Lower Probability	Upper Probability
I	0.00975	0.09754	0.00329	0.03292	0.00165	0.01646
II	0.00488	0.04877	0.00165	0.01646	0.00082	0.00823
III	0.00037	0.00369	0.00012	0.00122	0.00006	0.00062
IV	0.00975	0.09754	0.00329	0.03292	0.00165	0.01646
V	0.00488	0.04877	0.00165	0.01646	0.00082	0.00823
VI	0.00037	0.00369	0.00012	0.00122	0.00006	0.00062
Total	0.03000	0.30000	0.01012	0.10120	0.00506	0.05062

[a] Total probabilities based on information pertaining to ELV and RV experience and engineering estimates developed by Gwynne Gurevich, The Aerospace Corporation, June 1998. Probabilities pertain to reentry missions and launches from Federal ranges.

[b] Due to uncertainty, the probability of airborne and ground impact accidents are given equal weight.

probability values. The values used are based on information provided by The Aerospace Corporation, Gwynne Gurevich, June 1998.

TABLE 4–11. Accident Consequences Per Reentry Mission Under Current Industry Practice — Baseline Case
(In 1999 Dollars)

Accident Type	Accident Prevention					
	2001-2005		2006-2010		2011-2015	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Airborne Explosion						
I. Nonpopulated	$0	$0	$0	$0	$0	$0
II. Rural Population	$10,874	$108,673	$3,677	$36,677	$1,827	$18,339
III. Urban Population	$98,988	$987,369	$32,104	$326,393	$16,052	$165,872
Ground Impact						
IV. Nonpopulated	$0	$0	$0	$0	$0	$0
V. Rural Population	$6,085	$60,818	$2,058	$20,526	$1,023	$10,263
VI. Urban Population	$32,996	$329,123	$10,701	$108,798	$5,351	$55,291
Total Costs	$148,943	$1,485,983	$48,540	$492,394	$24,253	$249,765

4.5.4 Accident Prevention and Damage Limitation Effects

The 21 principal sections of the rule impacting commercial space transportation entities — Sections 431.25, .33, .35, .37, .39, .41, .43, .45, .57, .73, .75, .77, .79, and .93; Section 433.9; and Sections 435.23, .33, .35, .43, .51, and .61 — are expected to have positive impacts on the safety of reentry missions. These positive safety impacts include accident prevention and damage limitation effects, and are valued as accident consequences avoided. The accident prevention effect of the rule is the reduction in the probability of an accident. The damage limitation effect of the rule is the reduction in accident severity if an accident occurs. Incremental accident prevention benefits are calculated by determining the difference between the expected value of an accident (that is, the product of the probability of an occurrence and the dollar cost of an accident) under the baseline and under the rule. Similarly, damage limitation benefits are calculated by determining the difference in the dollar value of an accident under the baseline and under the rule.

Assigning discrete accident prevention and damage limitation effects to each of the relevant 21 principal sections is not possible, as information is not available to support estimating their relative contribution to achieving the expected average number of casualties per event criterion

for public risk. However, it is possible to assign accident prevention effects to Sections 431.25, .33, .35, .37, .39, .41, .43, .57, .73, .75, .77, .79, and Sections 435.23, .33, .35, .43, and .51 collectively — that is, together compliance with these sections will cause a commercial entity to undertake certain actions that will reduce the probability of an accident under the baseline case and contribute to meeting the expected public casualty risk criterion. It is expected that Sections 431.93 and .9, and Sections 435.61 and .45 will yield damage limitation effects. [58] This is summarized in Table 4-12.

4.5.5 Accident Probabilities and Expected Costs Under the Final Rule

Under the rule, the probability for each accident type under the rule must collectively sum to the public risk criteria (that is, the probability for each accident type contributes to the overall criteria for public casualty risk, $E_c \leq 30 \times 10^{-6}$.[59] Accident probabilities are assigned to each of the six accident types on the basis of land mass as was done for the baseline. (The assignment process used is identical to that applied for the baseline as is described in the Appendix to this report.). The result of this process is presented below in Table 4-13.

Estimates for the expected value for each accident type under the rule are calculated in much the same way as was done for the baseline case. The probability of each accident type in Table 4-13 is multiplied by the accident consequence values (that is the cost of an accident) presented in Table 4-9. For example, the expected value of a Type II accident under the rule for public risk is calculated by multiplying $2,228,272, the cost of a Type II accident from Table 4-9, by the accident probability of a Type II accident occurring for the general public found in Table 4-13, or 0.000004. The result is an expected value of a general public Type II accident of nine dollars (that is, $2,228,272 x 0.000004 = $9). This calculation is summarized in Table 4-13 below. This

[58] While certain sections of the rule will limit damage to the public because they impact flight paths, such as the environmental-related requirements, the majority of the section requirements will impact the probability of an accident. Furthermore, many of these requirements are interrelated, and it is not possible to isolate and quantify the discrete damage limitation impacts.

[59] The general public risk criterion (that is, $E_c \leq 30 \times 10^{-6}$) is a mathematical approximation to the probability of an accident = .00003. Thus, the risk criterion casualty rate of .00003 approximates the probability of an accident, for the purpose of this evaluation. The basis for this assessment of approximating the expected casualty rate for the general public as an accident probability is based on information contained in the report entitled, " the, *Casualty-Expectancy Computations in DAMP*, Research Triangle Institute September 30, 1995 (RTI/5180/60-41F), p. 5.

process is repeated for all relevant cells in Table 4-13 to derive expected values for all accident types under the rule over the 15-year period from 2001 to 2015.

TABLE 4-12. Benefit Effects of Principal Requirements from Parts 431, 433, and 435 of the Final Rule

Section of Final Rule		Benefit Effects	
		Accident Prevention	Damage Limitation
§ 431.25	Policy Review	Collectively these sections of the rule will reduce the probability of Accident Types I, II, III, IV, V and VI to the expected average number of casualties for public and reentry site risk — 30×10^{-6}.	Collectively these sections do not have damage limitation effects — they have accident prevention effects. (See footnote number 57.)
§ 431.33	Safety Organization		
§ 431.35	Mission Risk		
§ 431.37	Mission Readiness		
§ 431.39	Rules and Plans		
§ 431.41	Communications		
§ 431.43	Requirements		
§ 431.57	Payload Review		
§ 431.73	Modification		
§ 431.75	Range Agreement		
§ 431.77	Records		
§ 431.79	Reporting		
§ 435.23	Policy Review		
§ 435.33	Safety review		
§ 435.35	Reentry Risk		
§ 435.43	Payload Review		
§ 435.51	Post-Licensing		
§ 431.93	Environmental	Collectively these sections of the rule do not reduce accident probability, but do reduce accident costs, given an accident. (See footnote number 57.)	Collectively these sections of the rule reduce accident costs by 50 percent for all accident types. (See footnote number 57.)
§ 433.9	Environmental		
§ 435.61	Environmental		
§ 431.45	Mishap Investigation and Emergency Response Plan		

TABLE 4-13. Accident Consequences Per Reentry Mission to the General Public (Value in 1999 Dollars)

Accident Type	Accident Values	General Public Risk Probability (30×10^{-6})[a]	Expected Value[b]
I	$0	0.000008	$0
II	$2,228,272	0.000004	$9
III	$267,535,292	0.000003	$803
IV	$0	0.000008	$0
V	$1,247,027	0.000004	$5
VI	$89,178,431	0.000003	$268
Total	[redacted]	0.00003	$1,085

[a] The general public risk criterion (that is, $E_c = 30 \times 10^{-6}$) is a mathematical approximation to the probability of an accident.

[b] Calculated by multiplying accident values by the probability of an accident.

4.5.6 Incremental Safety Benefits

The incremental safety benefits attributable to the rule may be viewed as accident costs avoided. They are calculated as the difference between the expected value of an accident under the baseline (from Table 4-11) and under the rule for general public risk (from Table 4-13). These calculations are summarized in Table 4-14 for a single RLV or reentry mission. For example, for the period 2001 to 2005 the expected value of avoiding a Type II accident to the general public under the rule is $9 (from Table 4-13). The difference between $9 and the lower bound expected value of a Type II accident under the baseline (from Table 4-11) is $10, 865 (that is, $10,874 - 9 = $10,865), and the difference between $9 and the upper bound expected value of a Type II accident under the baseline (from Table 4-11) is $108,664 (that is, $108,673 - $9 = $108,664).[60]

[60] Although not addressed quantitatively in this evaluation, there may be some incremental safety benefits resulting from the reentry site risk criteria also. However, because reentry sites are generally expected to be located in remote areas absent the rule, reentry site accidents will result in few (if any) casualties (that is, fatalities and injuries) and little or no property damage. For example, if oceans were used as reentry sites absent the rule, then the incremental safety benefits attributable to the rule will be zero.

TABLE 4–14. Incremental Safety Benefits Per Reentry Mission
(In 1999 Dollars)

Accident Type	Accident Prevention[a]						Damage Limitation[b]
	2001-2005		2006-2010		2011-2015		2001-2015
	Lower Bound	Upper Bound	Lower Bound	Upper Bound	Lower Bound	Upper Bound	
Airborne Explosion							
I. Nonpopulated	$0	$0	$0	$0	$0	$0	$0
II. Rural Population	$10,865	$108,664	$3,668	$36,668	$1,818	$18,330	$5
III. Urban Population	$98,185	$986,566	$31,301	$325,590	$15,249	$165,069	$402
Ground Impact							
IV. Nonpopulated	$0	$0	$0	$0	$0	$0	$0
V. Rural Population	$6,080	$60,813	$2,053	$20,521	$1,018	$10,258	$3
VI. Urban Population	$32,728	$328,855	$10,433	$108,530	$5,083	$55,023	$134
Total Accident Prevention Benefits	$147,858	$1,484,898	$47,455	$491,309	$23,168	$248,680	$543
Total Accident Prevention and Damage Limitation Benefits	$148,401	$1,485,441	$47,997	$491,852	$23,710	$249,223	

[a] Accident prevention effectiveness of the final rule is assumed to be very high, as the incremental safety benefits are close to accident costs under the baseline. This is evident by comparing the cell values between Table 4-11 and 4-14; the differences are close to zero in most cases.

[b] Estimated as 50 percent of the expected value of a general public accident under the rule. For example, using a Type II accident, this will be 50 percent of $9 (from Table 4-13) or approximately $5.00.

Safety benefits (that is, accident costs avoided) are realized as missions are performed (without incident). Therefore, the number of (completed) reentry missions projected over the 15-year period (presented in Table A-8 in the Appendix to this report) is multiplied by incremental safety benefits per reentry mission (that is, the data in Table 4-14) to estimate total incremental safety benefits over the period 2001 to 2015. Using a range of accident probabilities and associated safety benefits, the total safety benefit that will result from the rule is estimated to range from $21.1 to $216.6 million (undiscounted 1999 dollars). To account for the uncertainty in reentry mission performance over the 15-year period, the midpoint safety benefit value is used to quantify the expected impact of the rule, or $118.9 million (undiscounted 1999 dollars).[61]

Estimates of the collective accident prevention and damage limitation effects of the regulatory sections must be tempered, however, as industry may be compliant with some aspects of the technical requirements voluntarily as a result of industry standard operating practices. This supports using a range of reentry mission accident probabilities, as current industry practices consistent with requirements contained in the rule may result in accident prevention effects that otherwise would be attributable solely to the regulation, thereby over-estimating the incremental benefits of the rule.

4.6 Qualitative Benefits from the Rule

The rule offers a variety of impacts that will benefit both the FAA and the commercial space transportation industry that are not readily quantified. Formalizing licensing responsibilities for RLV and reentry operations (by establishing a specific regulation) will emphasize LASD duties and FAA expectations. It will also better define the licensing process relative to the ad hoc approach implemented for COMET and METEOR.[62] This will afford applicants with clearly defined direction, possibly helping to facilitate the iterative pre-application consultation process. As the number of requests for RLV and reentry licensing increases, formality will also help

[61] This number is the midpoint between $21.1million and $216.6million (undiscounted 1999 dollars) for the period 2001 to 2015.

[62] By its ad hoc nature (that is, there was no general regulation) the licensing approach implemented for COMET and METEOR did not jeopardize public health and safety, or the safety of property. The process was established for a single case, and accordingly was not necessarily the most efficient approach to regulating commercial reentry operations.

ensure consistency in implementing the licensing process. Additionally, consistent application of the licensing process will help commercial space transportation entities gain familiarity with its requirements, leading to proficiency in their ability to interact with the process and the FAA. This in turn will lead to industry cost savings, possibly due to less rework or paperwork avoided. This could lead to cost savings to the FAA as a result of economies of scale from repetitive operations. These cost savings will spill over to commercial space transportation entities by reducing the turnaround time between application submittal and licensing approval.

A formalized licensing process for reentry operations will enhance communications between the FAA and the commercial space transportation industry in terms of frequency and efficiency of information exchange. In so doing, it will instill a regulatory climate that will promote and foster growth and technological advancement in this maturing industry, while protecting public health and safety, and the safety of property.

4.7 Summary of Incremental Costs and Safety Benefits

The rule is estimated to result in incremental costs totaling approximately $151 million (undiscounted 1999 dollars) over the 15-year period from 2001 to 2015. Commercial space transportation industry compliance costs will account for approximately 20 percent of this amount, or $31 million (undiscounted 1999 dollars) over the 15-year period. The costs to the FAA for administering the rule will account for approximately 80 percent of total incremental costs, or $120 million (undiscounted 1999 dollars) over the 15-year period. The general public will realize incremental quantitative safety benefits of approximately $119 million (undiscounted 1999 dollars).[63] These results are summarized in Table 4-15. Additionally, commercial space transportation entities and the FAA are expected to realize a variety of qualitative benefits that will enhance the efficiency of their respective operations.

[63] Based on a range from $21million to $217million (undiscounted 1999 dollars) over the 15-year period 2001 to 2015 — $119 million (undiscounted 1999 dollars) is the midpoint of this range. This value is used to account for the uncertainty of reentry mission performance over the 15-year period.

TABLE 4-15. Summary of Total Costs and Benefits (In 1999 Dollars)

Category	Undiscounted	Discounted[a]
Commercial Space Transportation Industry Compliance Costs	$30,840,792	$20,397,052
Federal Aviation Administration Administrative Costs	$120,110,662	$65,922,998
Total Costs	$150,951,454	$86,320,050
Accident Costs Avoided: Lower Bound (Safety Benefits)	$21,064,320	$11,798,627
Accident Costs Avoided: Upper Bound (Safety Benefits)	$216,644,042	$120,886,972
Accident Costs Avoided: Midpoint (Safety Benefits)	$118,854,181	$66,342,799

[a] Discounted at seven percent over a 15-year period from 2001 to 2015.

5.0 CONCLUSION

Based on the assumptions and data used herein, the rule will impose incremental costs on the commercial space transportation industry and the FAA to respectively comply with and administer its requirements. The costs borne by industry will comprise approximately 20 percent of all incremental costs attributable to the rule.[64] The general public will realize additional safety benefits attributable to accident costs avoided. Additionally, the rule will yield noteworthy secondary benefits that should improve the quality of the regulatory process while maintaining an environment that facilitates the maturation of this developing industry.

[64] This is based on the undiscounted incremental compliance and implementation costs from Table 4-15.

6.0 FINAL REGULATORY FLEXIBILITY DETERMINATION

6.1 Final Regulatory Flexibility Determination

The Regulatory Flexibility Act of 1980 (RFA) was enacted by Congress to ensure that small entities (i.e., small business and small not-for-profit government jurisdictions) are not unnecessarily and disproportionately burdened by Federal Government regulations. The RFA, which was amended in March 1996, requires regulatory agencies to review rules to determine if they have "a significant economic impact on a substantial number of small entities."

The Small Business Administration has defined small business entities relating to space vehicles (Standard Industrial Codes 3761, 3764, and 3769) as entities comprising fewer than 1,000 employees. The FAA has determined that the rule will potentially impact five small businesses, imposing on an entity average compliance costs of approximately $6.2 million over the 15-year period (in 1999 dollars).

The 15-year annualized compliance cost to each small business is approximately $681,000 (in 1999 dollars). Ordinarily, this section of the evaluation would be based on typical financial data (for example, annual net income, current assets, current liabilities) for those small entities potentially impacted by the rule. Such financial data are intended to aid in determining the extent to which the rule will impact any of the small entities. However, the traditional use of such financial data for these small entities cannot be employed since some RLV operators represent relatively new companies and they have no revenue history. In fact, these small operators are in the process of raising funds to finance their new ventures. Due to the lack of data on the financial characteristics of these small RLV operators, this evaluation is using the 1999 average revenue received per launch for ELV operators.[65] Accordingly, RLV revenue is expected to be broadly similar to and not the same as that for ELV operators. RLV revenue data based on ELV operators' experience will be used for the purpose of assessing the extent to which compliance with the rule will impose economic impacts on each of the five potentially impacted small RLV operators. This assessment will be done by comparing the annualized cost of

compliance to the annual average revenue expected to be received by each of the five small RLV operators over the next 15 years. While the long-term revenues of RLV operators are expected to exceed those of ELV operators, for the purpose of this evaluation the revenues of the former are assumed to be broadly similar to the latter over the 15-year period. For this reason, the average revenue of about $50 million (in 1999 dollars) generated by each ELV launch in 1999 will be used as an indicator of what RLV operators would be expected to generate per RLV mission in future years. This assessment is based primarily on information received for orbital launch events for ELV operators from the FAA's Office of Commercial Space Transportation Report entitled, "Commercial Space Transportation: 1999 Year In Review", Table 1 and the Appendix (January 2000).

Each of the five potentially impacted small RLV entities is expected to average about seven missions per year over the next 15 years. Using $50 million as an average expected revenue per mission, each entity will be expected to receive about $350 million in revenue ($50 million x 7 missions annually) for all missions annually. The FAA has determined that none of the five small entities will incur a significant economic impact, since the average annualized cost of compliance (that is, $681,000) will be only about 0.2 percent ($681,000 ÷ $350 million = .002) of the anticipated average annual revenues of $350 million for missions conducted annually.

The FAA certifies that the rule will not impose a significant economic impact on a substantial number of small businesses. Therefore, a regulatory flexibility analysis is not required. Furthermore, the rule is not likely to cause small business failures or adversely impact their competitive position relative to larger businesses

6.2 Conclusion

The rule will not impose a significant economic impact on a substantial number of small businesses. Therefore, a regulatory flexibility analysis is not required. Furthermore, the rule is not likely to cause small business failures, or weaken their competitive position relative to larger

[65] The FAA maintains that the revenue of established ELV operators can serve as a broad indicator of the revenues that RLV operators can expect from their customers.

businesses. The limited amount of financial information on these small entities precludes a more thorough financial analysis.

7.0 INTERNATIONAL TRADE IMPACT ASSESSMENT

The Trade Agreement Act of 1979 prohibits Federal agencies from engaging in any standards or related activities that create unnecessary obstacles to the foreign commerce of the United States. Legitimate domestic objectives, such as safety, are not considered unnecessary obstacles. The statute also requires consideration of international standards and where appropriate, that they be the basis for U.S. standards. In addition, consistent with the Administration's belief in the general superiority and desirability of free trade, it is the policy of the Administration to remove or diminish to the extent feasible, barriers to international trade, including both barriers affecting the export of American goods and services to foreign countries and barriers affecting the import of foreign goods and services into the United States.

In accordance with the above statute and policy, the FAA has assessed the potential effect of this final rule and has determined that the revisions to commercial space transportation licensing regulations will not constitute a barrier to international trade, including the export of domestic goods and services out of the United States; and it will equally affect the costs of domestic and international entities. Therefore, based on this determination and the impacts reported herein and summarized in Table 4-15, the rule is not expected to affect trade opportunities for U.S. firms doing business abroad or for foreign firms doing business in the United States.

8.0 UNFUNDED MANDATES REFORM ACT ASSESSMENT

The Unfunded Mandates Reform Act of 1995 (the Act) was enacted as Public Law 104-4 on March 22, 1995. It was established, in part, to curb the practice of imposing unfunded Federal mandates on State, local, and tribal governments. Title II of the Act requires each Federal agency to prepare a written assessment of the effects of any Federal mandate in a proposed or final rule that may result in a $100 million or more expenditure (adjusted annually for inflation) in any one year by State, local, and tribal governments, in the aggregate, or by the private sector; such a mandate is deemed to be a "significant regulatory action."

Based on the impacts presented herein and summarized in Table 4-15, the final rule does not contain such a mandate. Therefore, the requirements of Title II of the Unfunded Mandates Reform Act of 1995 do not apply to the final rule.

APPENDIX A: SUPPORTING DATA AND CALCULATIONS

A.1 Principal Interviewees

Table A-1 identifies the key individuals providing information to performing the regulatory evaluation of the final rule.

TABLE A-1. Interviewees Providing Key Technical Information

Interviewee	Affiliation	Specific Areas Providing Technical Assistance and Related Information
Ronald Gress	Federal Aviation Administration (FAA), Office of the Associate Administrator for Commercial Space Transportation (AST), Manager, Licensing and Safety Division (LASD)	• Administrative and compliance costs • Budget Estimates • Market profile
Stewart Jackson*	FAA, AST, Space Systems Development Division (SSDD)	• Regulatory background • Administrative and compliance costs • Market profile
Brett Alexander	FAA, AST, SSDD	• Regulatory background • Market profile • License activity projections
Carole Flores*	FAA, AST, LASD	• Regulatory background • FAA administrative costs • Market profile
Gwynne Gurevich	The Aerospace Corporation Los Angeles, California	• Market Profile • Industry compliance costs
Charles Larsen	FAA, AST, SSDD	• Industry compliance costs
Pat Martin	FAA, AST, LASD	• FAA licensing process
Ruben Mitchel*	FAA, AST, SSDD	• FAA personnel costs
Carl Rappaport*	FAA, AST, SSDD	• Regulatory background • Market profile

*Former Department of Transportation, Office of Commercial Space Transportation personnel currently working in the Federal Aviation Administration, Office of the Associate Administrator for Commercial Space Transportation; this is a direct result of the 1995 reorganization at the Department of Transportation which transferred, intact, the Office of Commercial Space Transportation to the Federal Aviation Administration, resulting in the formation of the Office of the Associate Administrator for Commercial Space Transportation.

A.2 Economic Factors

Tables A-2, A-4, and A-4 present the information used to calculate salaries and wages for commercial space transportation industry and Federal Aviation Administration personnel.

TABLE A-2. Public and Private Sector Fringe Benefit Factors

Category	Government Factor	Commercial Factor
Retirement and Disability	23.7%	10.3%
Health and Life Insurance	5.60%	7.10%
Medicare	1.45%	1.45%
Miscellaneous	1.70%	4.60%
Total Fringe Benefit	**32.45%**	**23.45%**

Source: Federal Aviation Administration, January, 1998, p. 4-22.

TABLE A-3. Commercial Space Transportation Personnel Cost (In 1999 Dollars)

Annual Salary	Fringe Benefit Factor	Cost to Space Transportation Entities		
		Annual	Hourly[a]	Eight-Hours
$105,885	1.2345	$105,885	$49.39	$406[b]

Source: Commercial space transportation entity personnel costs based on information supplied by The Aerospace Corporation, Los Angeles, California, Gwynne Gurevich, June 1998. To date, the FAA still considers this information to be valid.

[a] Hourly costs calculated by dividing annual cost by 2087 hours per year. (See Federal Aviation Administration, January 1998, *Economic Analysis of Investment and Regulatory Decisions – Revised Guide*, Office of Aviation Policy and Plans, p. 4-21.).

[b] The actual cost of $406.12 is rounded to the nearest dollar.

TABLE A-4. Federal Aviation Administration Personnel Costs (In 1999 Dollars)

Salary	Fringe Benefit Factor	Costs to Federal Aviation Administration	
		Annual Salary	Hourly Wage
$77,713	32.45%	$102,931	$49.32

Source: Cost to the Federal Aviation Administration for Federal government full-time staff is derived by increasing the 1999 Federal government pay of 73,000 for GS-14 Step 5 white-collar (non-postal) workers in the Washington, D.C. by 32.45 percent to account for fringe benefits. This results in an annual cost of $102,931 per worker in 1999 dollars. Dividing the latter amount by 2087 yields an hourly rate of $49.32 in 1999 dollars.

A.3 Commercial Space Transportation Industry Compliance Costs

Table A-5 presents the estimated incremental cost stream that will be incurred by the commercial space transportation industry to comply with the final rule. It shows initial year and recurring annual compliance costs over the 15-year period based on the projected industry population.

TABLE A-5. Commercial Space Transportation Industry Incremental Costs to Comply with the Principal Requirements of Parts 431. 433, and 435 of the Final Rule (In 1999 Dollars)

Year	Discount Factor[a]	Projected Number of Entites Comprising the Industry	Industry Costs in the First Year of Operations Only (Undiscounted)	Industry Costs in all Years of Operation After the First Year (Undiscounted)	Total Industry Costs (Undiscounted)	Total Industry Costs (Discounted)
2001	1.0700	1	$3,374,751	$0	$3,374,751	$3,153,973
2002	1.1449	3	$6,749,502	$263,529	$7,013,031	$6,125,453
2003	1.2250	3	$0	$790,587	$790,587	$645,354
2004	1.3108	3	$0	$790,587	$790,587	$603,135
2005	1.4026	3	$0	$790,587	$790,587	$563,678
2006	1.5007	3	$0	$79,587	$790,587	$526,801
2007	1.6058	4	$3,374,751	$790,587	$4,165,338	$2,593,963
2008	1.7182	4	$0	$1,054,116	$1,054,116	$613,505
2009	1.8385	4	$0	$1,054,116	$1,054,116	$573,369
2010	1.9672	5	$3,374,751	$1,054,116	$4,428,867	$2,251,411
2011	2.1049	5	$0	$1,317,645	$1,317,645	$626,004
2012	2.2522	5	$0	$1,317,645	$1,317,645	$585,050
2013	2.4098	5	$0	$1,317,645	$1,317,645	$546,776
2014	2.5785	5	$0	$1,317,645	$1,317,645	$511,005
2015	2.7590	5	$0	$1,317,645	$1,317,645	$477,575
Total	----------	----------	**$16,873,755**	**$13,967,037**	**$30,840,792**	**$20,397,052**

[a] Dividing the undiscounted benefit values by the present value factor yields the discounted benefit value. Often the inverse of this factor is used (for example, 1 ÷ 1.07 = 0.93457), and in this instance it is multiplied by the undiscounted benefit value.

For all requirements it is projected that that there will be 5 entities entering the commercial space transportation industry at various years over the period 2001 through 2015. One entity will enter in year 2001 and will be subject to initial compliance costs in that year and annual recurring compliance costs for all 14 subsequent years, from 2002 through 2015. In year 2002 two additional entities (for a total of three entities) will enter the industry and each will incur initial

compliance costs in 2002 and annual recurring compliance costs for all 13 subsequent years, from 2003 through 2015. In year 2007 another entity (for a total of four entities) will enter the industry and will be subject to initial compliance costs in that year and annual recurring compliance costs in for all eight subsequent years from 2008 to 2015. Finally, one more entity (for a total of five entities) will enter the industry in year 2010 and will be subject to initial compliance costs in that year and annual recurring compliance costs in for all five subsequent years from 2011 through 2015. The time-phasing of entities entering the commercial space transportation industry is considered in calculating total industry compliance costs for each section of the rule. Derivation of these costs (undiscounted) is presented below and summarized in Table A-6 (for both undiscounted and discounted values).

Section 431.25: Each of the five entities will incur initial compliance costs only of $406.00 in the year that they enter the industry, for an industry total calculated as follows: 5 x $406 = $2,030.

Section 431.33: Each entity will incur initial and annual recurring compliance cost of **$111,179**, or:

Firm One:	1 entity x $111,179 x 15 years =	$1,667,685
Firm Two:	1 entity x $111,179 x 14 years =	$1,556,506
Firm Three:	1 entity x $111,179 x 14 years =	$1,556,506
Firm Four:	1 entity x $111,179 x 9 years =	$1,000,611
Firm Five:	1 entity x $111,179 x 6 years =	$ 667,074
Total (Industry)		**$6,448,382**

Section: 431.35: Each entity will incur initial compliance cost of $778,255 and annual recurring compliance cost of $3,706, or:

Firm One:	(1 entity x $778,255 x 1 year) + (1 entity x $3,706 x 14 years) =	$830,139
Firm Two:	(1 entity x $778,255 x 1 year) + (1 entity x $3,706 x 13 years) =	$826,443
Firm Three:	(1 entity x $778,255 x 1 year) + (1 entity x $3,706 x 13 years) =	$826,443
Firm Four:	(1 entity x $778,255 x 1 year) + (1 entity x $3,706 x 8 years) =	$807,903
Firm Five:	(1 entity x $778,255 x 1 year) + (1 entity x $3,706 x 5 years) =	$796,785
Total (Industry)		**$4,087,693**

Section 431.37: Each of the five entities will incur initial compliance costs only of $4,059 in the year that they enter the industry, for an industry total calculated as follows: 5 x $4, 059 = $20,295.

Section 431.39: Each entity will incur initial compliance cost of $55,590 and annual recurring compliance cost of $2,647, or:

Firm One:	(1 entity x $55,590 x 1 year) + (1entity x $2,647 x 14 years) =	$92,648
Firm Two:	(1 entity x $55,590 x 1 year) + (1 entity x 2,647 x 13 years) =	$90,001
Firm Three:	(1 entity x $55,590 x 1 year) + (1 entity x 2,647 x 13 years) =	$90,001
Firm Four:	(1 entity x $55,590 x 1 year) + (1 entity x 2,647 x 8 years) =	$76,766
Firm Five:	(1 entity x $55,590 x 1 year) + (1 entity x 2,647 x 5 years) =	$68,825
Total (Industry)		**$418,241**

Section 431.41: Same as Section 431.39.

Section 431.43: Each entity will incur initial compliance cost of $1,778,868 and annual recurring compliance cost of $111,179, or:

Firm One:	(1 entity x $1,778,868 x 1 year) + (1entity x $111,179 x 14 years) =	$3,335,374
Firm Two:	(1 entity x $1,778,868 x 1 year) + (1 entity x $111,179 x 13 years) =	$3,224,195
Firm Three:	(1 entity x $1,778,868 x 1 year) + (1 entity x $111,179 x 13 years) =	$3,224,195
Firm Four:	(1 entity x $1,778,868 x 1 year) + (1 entity x $111,179 x 8 years) =	$2,668,300
Firm Five:	(1 entity x $1,778,868 x 1 year) + (1 entity x $111,179 x 5 years) =	$2,334,763
Total (Industry)		**$14,786,827**

Section 431.45: Each entity will incur initial compliance cost of $111,179 and annual recurring compliance cost of $31,765, or:

Firm One:	(1 entity x $111,179 x 1 year) + (1entity x $31,765 x 14 years) =	$555,889
Firm Two:	(1 entity x $111,179 x 1 year) + (1 entity x $31,765 x 13 years) =	$524,124
Firm Three:	(1 entity x $111,179 x 1 year) + (1 entity x $31,765 x 13 years) =	$524,124
Firm Four:	(1 entity x $111,179 x 1 year) + (1 entity x $31,765 x 8 years) =	$365,299
Firm Five:	(1 entity x $111,179 x 1 year) + (1 entity x $31,765 x 5 years) =	$270,004
Total (Industry)		**$2,239,440**

Section 431.57: Same as Section 431.25.

Section 431.73: Each of the five entities will incur initial compliance costs only of $34,095 in the year that they enter the industry, for an industry total calculated as follows: 5 x $34, 095 = $170,475.

Section 431.75: Zero compliance cost.

Section 431.77: Each entity will incur initial and annual recurring compliance cost of $406, or:

Firm One:	1 entity x $406 x 15 years =	$6,090
Firm Two:	1 entity x $406 x 14 years =	$5,684
Firm Three:	1 entity x $406 x 14 years =	$5,684
Firm Four:	1 entity x $406 x 9 years =	$3,654
Firm Five:	1 entity x $406 x 6 years =	$2,436
Total (Industry)		**$23,548**

Section 431.79: Zero compliance cost.

Section 431.93: Each of the five entities will incur initial compliance costs only of $277,949 in the year that they enter the industry, for an industry total calculated as follows: 5 x $277,949 = $1,389,745.

Section 433.9: Section 431.73: Each of the five entities will incur initial compliance costs only of $34,095 in the year that they enter the industry, for an industry total calculated as follows: 5 x $166,769 = $833,845.

TABLE A-6. Commercial Space Transportation Industry Incremental Costs to Comply with Principal Requirements of the Final Rule (In 1999 Dollars)

Section of Final Rule	Total Industry Costs	
	(Undiscounted)	(Discounted)
431.25	$2,030	$1,548
431.33	$6,448,382	$3,600,937
431.35	$4,087,693	$3,073,042
431.37	$20,295	$15,475
431.39	$418,241	$287,581
431.41	$418,241	$287,581
431.43	$14,786,827	$9,959,094
431.45	$2,239,440	$1,331,595
431.57	$2,030	$1,548
431.73	$170,475	$129,989
431.75	$0	$0
431.77	$23,548	$13,150
431.79	$0	$0
431.93	$1,389,745	$1,059,696
433.9	$833,845	$635,816
435.23	Costs reflected in Section 431.25	
435.33	Costs reflected in Sections 431.33, .37, .39, .41, .43, and .45	
435.35	Costs reflected in Section 431.35	
435.43	Costs reflected in Section 431.57	
435.51	Costs reflected in Sections 431.73, .75, .77, and .79	
435.61	Costs reflected in Sections 431.93	
Total	**$30,840,792**	**$20,397,052**

A.4 Federal Aviation Administration Costs

Table A-7 presents the estimated cost stream that will be incurred by the Federal Aviation Administration to administer the final rule based on projected license activity.

TABLE A-7. Federal Aviation Administration Incremental Costs to Administer the Principal Requirements of Parts 431, 433, and 435 of the Final Rule
(In 1999 Dollars)

Year	License Modifications Reviewed	Consultation and Evaluation Costs		Compliance Monitoring Costs	Total Costs	
		Applicants Approved	Applicants Denied		Undiscounted	Discounted
2001	0	$3,650,780	$0	$0	$3,650,780	$3,411,944
2002	0	$7,301,560	$0	$0	$7,301,560	$6,377,465
2003	2	$0	$0	$1,460,312	$1,460,312	$1,192,050
2004	4	$0	$0	$2,920,624	$2,920,624	$2,228,130
2005	4	$0	$0	$2,920,624	$2,920,624	$2,082,365
2006	7	$0	$365,078	$5,111,092	$5,476,170	$3,649,003
2007	11	$3,650,780	$365,078	$8,031,716	$12,047,574	$7,502,624
2008	13	$0	$730,156	$9,492,028	$10,222,184	$5,949,404
2009	14	$0	$365,078	$10,222,184	$10,587,262	$5,758,769
2010	13	$3,650,780	$730,156	$9,492,028	$13,872,964	$7,052,311
2011	13	$0	$730,156	$9,492,028	$10,222,184	$4,856,486
2012	12	$0	$1,095,234	$8,761,872	$9,857,106	$4,376,673
2013	12	$0	$1,095,234	$8,761,872	$9,857,106	$4,090,349
2014	12	$0	$1,095,234	$8,761,872	$9,857,106	$3,822,756
2015	12	$0	$1,095,234	$8,761,872	$9,857,106	$3,572,669
Total	**129**	**$18,253,900**	**$7,666,638**	**$94,190,124**	**$120,110,662**	**$65,922,998**

A.5 Safety Benefit Information

Tables A-8, A-9, and A-10 present the information used to calculate the value of accident consequences avoided — or safety benefits — attributable to the final rule. Safety benefits are based on the projected number of reusable launch vehicle missions.

TABLE A-8. Projected Reentry Mission License and Launch Activity

Period	Year	New Licenses Approved	Modifications Approved	Modifications Denied	New License Applications Denied	Total Applications Reviewed	Cumulative Licenses	Completed Reentry Missions
1	2001	1	0	0	0	1	1	1
2	2002	2	0	0	0	2	3	2
3	2003	0	2	0	0	2	3	5
4	2004	0	4	0	0	4	3	8
5	2005	0	3	1	0	4	3	12
6	2006	0	6	1	1	8	3	24
7	2007	1	10	1	1	13	4	40
8	2008	0	12	1	2	15	4	48
9	2009	0	12	2	1	15	4	48
10	2010	1	12	1	2	16	5	52
11	2011	0	12	1	2	15	5	52
12	2012	0	12	0	3	15	5	56
13	2013	0	12	0	3	15	5	56
14	2014	0	12	0	3	15	5	60
15	2015	0	12	0	3	15	5	60
Total	-----	**5**	**121**	**8**	**21**	**155**	----------	**524**

Source: Federal Aviation Administration, Office of the Associate Administrator for Space Transportation, Space Systems Development Division, Brett Alexander, August 13, 1998 and updated on March 10, 2000.

TABLE A-9. Demographic Data

	Land Area (Square Miles)	Population (Per Square Mile)	Residential Housing Units (Per Square Mile)
Rural	3,449,000	18	8
Urban	87,000	2,150	876

Source: Statistical Abstract of the United States (1992; 1997), U.S. Department of Commerce.

TABLE A-10. Accident Consequence Values
(In 1999 Dollars)

	Injury			Property Damage	
Fatality	**Serious**	**Minor**	**Average**	**Urban**	**Rural**
$2,700,000	$521,800	$38,500	$280,150	$115,560	$57,780

Source: "Economic Values for Evaluation of Federal Aviation Administration Investment and Regulatory Programs," U.S. Department of Transportation, Federal Aviation Administration, Office of Aviation Policy, Plans; and Statistical Abstract of the United States (1992; 1997), U.S. Department of Commerce.

A.6 Assignment of Accident Type Probabilities

The process of assigning accident probability among the various accident types is accomplished using proportional analysis based on the assumption that all RLV's and RV's will land within the mass of the United States (including Alaska and Hawaii) and its territories. This process, described below, is applied to allocating the probability of an accident to the six accident types under the baseline (see Table 4-11) and under the rule (see Table 4-14). The process is described using an example case.

Example: The probability of an accident under the baseline for the period 2001 to 2005 is estimated to be .30, which corresponds to an accident regardless of where (that is, rural or urban) and how (that is, airborne or ground). The task is to allocate this probability among the six accident types, which, when summed, equal .30. Using proportional analysis, the probability of .30 is allocated on the basis of urban land mass as follows:

$$.3/3,536,000 = X/87,000$$

Where 3,536,000 is the total land mass of the United Sates in square miles, and 87,000 square miles is the urban land mass. Solving for X in the above equation results in .00738. This is the probability of an urban accident — accident types III and VI. Therefore, this probability is split between each, resulting in a probability of .00369 each for accident types III and VI as shown in Table A-11, a truncated version of Table 4-10. Subtracting .00738 from .30 leaves .29262 in probability value to be allocated among the remaining four accident types (that is, I, II, IV, and V).

Absent information as to the likelihood of an accident over a rural populated area relative to a non-populated area, it is necessary to make an assumption regarding the probability of these occurrences. Given this uncertainty, and the expectation that reentry mission flight paths will avoid populated areas in order to ensure satisfying the E_c criteria, it is reasonable to assume that the probability of an accident over a nonpopulated area is twice as great as an accident over a rural populated area. Accordingly, the probability of Types II and V (rural populated) accidents are half that of Types I and IV (nonpopulated) accidents. Further, the probability of a Type I accident is equivalent to a Type IV, as both occur in nonpopulated areas. Similarly, the probability of a Type II accident is equivalent to a Type V, as both occur in rural populated areas. Hence, the following algebraic equation can be established:

$$2X + 2(.5X) = .29262$$

Where X = a Type I or IV accident, and .5X pertains to an Accident Type II or V. Solving for X results in .09754, the probability assigned to both a Type I and Type IV accident. Half of this value, .04877, is assigned to Accident Types II and V.

This process is repeated to complete the accident probability profiles for the upper bound baseline. Dividing these probability values by 10 yields the lower bound probabilities. The same process is used to allocate the accident probability of .00003 (30×10^{-6} or 3×10^{-5}) under the rule.

TABLE A-11. Baseline Accident Probability Profile — Upper Bound

Accident Type	Years 2001 to 2005	Years 2006 to 2010	Years 2011 to 2015
I	0.09754	0.03292	0.01646
II	0.04877	0.01646	0.00823
III	0.00369	0.00122	0.00062
IV	0.09754	0.03292	0.01646
V	0.04877	0.01646	0.00823
VI	0.00369	0.00122	0.00062
Total	0.30000	0.10120	0.05062

Note: Due to a lack of empirical data, the probability of a ground impact crash is assumed to be equivalent to the probability of an airborne crash.

A.7 Probability of Accident and Expected Average Number of Casualties

The criteria for limiting public risk from reentry operations is called the expected casualty risk (E_c), which is the collective risk to a population measured as the expected average number of casualties per reentry operation of a reentry vehicle or for a RLV mission. The limit for this measure is 30×10^{-6}. Mathematically, it is the sum, over all possible events, of the product of the probability of the event and its consequences. In this evaluation an accident refers to casualties, which includes fatalities, injuries, and property damage, and numerically E_c approximates the probability of an accident. In certain situations, the two measures may be identical. More specifically, the probability of an accident and the expected average number of casualties are approximately equal numerically when the probability of a single accident is much greater than the probability of multiple casualties. Therefore, 30×10^{-6} is used as the maximum permissible probability of an accident under the rule. An in-depth discussion and mathematical proof of this concept are presented in a study by Research Triangle Institute (beginning on page 5) entitled, *Casualty-Expectancy Computations in DAMP*, September 30, 1995 (report number RTI/5180/60-41F).

A.8 Safety Benefits

Table A-12 presents the estimated benefit stream that will be realized by the public due to implementation of the final rule. Shown are a range of annual safety benefits over the 15-year period.

TABLE A-12. Undiscounted and Discounted Incremental Safety Benefits (In 1999 Dollars)

Year	Undiscounted Benefits		Discounted Benefits		Present Value Factor[a]
	Lower Bound		Lower Bound	Upper Bound	
2001	$148,401	$1,485,441	$138,692	$1,388,262	1.0700
2002	$296,801	$2,970,881	$259,237	$2,594,883	1.1449
2003	$742,003	$7,427,203	$605,695	$6,062,810	1.2250
2004	$1,187,204	$11,883,524	$905,712	$9,065,884	1.3108
2005	$1,780,806	$17,825,286	$1,269,690	$12,709,183	1.4026
2006	$1,151,937	$11,804,436	$767,585	$7,865,794	1.5007
2007	$1,919,896	$19,674,060	$1,195,614	$12,252,016	1.6058
2008	$2,303,875	$23,608,872	$1,340,876	$13,740,578	1.7182
2009	$2,303,875	$23,608,872	$1,253,155	$12,841,662	1.8385
2010	$2,495,864	$25,576,278	$1,268,771	$13,001,683	1.9672
2011	$1,232,924	$12,959,570	$585,753	$6,156,998	2.1049
2012	$1,327,764	$13,956,460	$589,543	$6,196,835	2.2522
2013	$1,327,764	$13,956,460	$550,975	$5,791,435	2.4098
2014	$1,422,604	$14,953,350	$551,710	$5,799,167	2.5785
2015	$1,422,604	$14,953,350	$515,617	$5,419,782	2.7590
Total	**$21,064,320**	**$216,644,042**	**$11,798,627**	**$120,886,972**	----------

[a] Dividing the undiscounted benefit values by the present value factor yields the discounted benefit value. Often the inverse of this factor is used (for example, 1 ÷ 1.07 = 0.93457), and in this instance it is multiplied by the undiscounted benefit value.

APPENDIX B: PUBLIC COMMENTS HAVING ECONOMIC IMPLICATIONS

B.1 Background

During the public comment period associated with the notice of proposed rulemaking, numerous comments were received addressing certain economic aspects of the initial regulatory evaluation. Each discrete comment was reviewed and assessed by the FAA; many were similar. Accordingly, to avoid repetitiveness, this section presents the collective comments to the initial (draft) regulatory evaluation having economic implications, and the associated FAA response. Those remarks under the heading of "comment" represent the combined comments received from the potentially impacted commercial space industry operators addressing the same or similar issue(s) with regard to the proposed rule for RLV and reentry mission licensing requirements. Those replies under the heading of "FAA Response" represent the FAA's response to comments received from the commercial space industry on the proposed rule. Additionally, all dollar values are expressed in 1997 dollars to be consistent with the initial regulatory evaluation and the comments thereto.

B.2 Comments and FAA Responses

B.2.1 Compliance Costs

Comment — Understanding the Proposed Rule and Policy Review

Some aspects of the initial (draft) regulatory evaluation of the proposed rule understate the potential cost of compliance. For example, the FAA assumes that application for the policy review will consume eight hours of time for each application, and that compliance with the safety application requirements would consume the equivalent of one full time staff position. These assumptions greatly understate the regulatory burden placed on RLV companies. The actual time spent evaluating the proposed regulations (if adopted as a rule) would require one month of work by a skilled employee, which translates into an estimated cost of $8,583 per application.

In terms of policy review, the commenter states that the amount of labor time required to comply with Section 431.25 (Application Requirements for Policy Review) is 80 hours rather than 8 hours as estimated by the FAA.

FAA Response

The FAA disagrees with the comment. The FAA's estimate of an average of 8 hours required for the preparation of the policy review section of this rulemaking is based on the best judgement of its technical personnel and their contacts with commercial space industry representatives. Industry is expected to behave rationally and develop reentry mission programs that maximize inherent system reliability in order to minimize the risk of mission failure. In so doing, these entities are also taking many of the necessary precautions to prevent or minimize any adverse impacts on safety and health. Consequently, many of the technical requirements contained within the proposed rule are already being addressed voluntarily by industry (to varying degrees) as a matter of standard operating procedure and good business practice. The FAA's estimate of 8 hours is based largely on the policy review portion, which is far less technical. In fact, it is descriptive of the characteristics of the mission. Thus, the 8 hours estimate reflects the incremental difference between existing ELV and new RLV requirements.

Comment — Overall Compliance

The FAA understated the potential cost of compliance in its regulatory evaluation. Comparisons of costs by traditional ELV applicants — particularly those whose license evaluation relies heavily on pre-established AST baseline assessments — vastly underestimates RLV costs. A previous reentry vehicle application evaluation by the FAA required 0.75-1.25 person years. The cost to the applicant was approximately one person-year per annum (or about $100,000 annually) to prepare application materials, coordinate activities and address technical issues with FAA. These costs are probably at the lower end of the spectrum.

FAA Response

The FAA disagrees with the comment. The FAA continues to believe that its cost of compliance estimate is reasonable based on the best available information. Due to the lack of data on RLV mission activity, the FAA used estimated costs of current requirements on ELV applicants and its

experience from COMET/METEOR as a broad yardstick in assessing the potential additional cost of compliance for this rulemaking. The FAA recognizes that the application cost differences between ELV and RLV commercial space operators will be different, though to what extent is unknown at this time.

Comment — Safety Official and Safety Organization

The amount of labor required to comply with Sections 431.33 & 433.35 (Safety Organization and Safety Official) is four to five individuals, rather than one as estimated by the FAA.

FAA Response

The FAA disagrees with the comment. In accordance with the best judgement of its technical personnel, based on the best information available, the FAA's estimate of one staff needed to fulfill the safety official role to ensure compliance with this rulemaking action is still considered to be valid. For launch purposes, this is not a new requirement. In the absence of the proposed rule, any prudent operator would have a safety organization official for its own safety purposes. For ELV launches on a federal range, a safety official is already required.

Comment — Mission Risk

The estimate to comply with Section 431.35 & 433.35 (RLV Mission Risk) is $700,000 annually for 3 to 5 years prior to operations, and at least $100,000 per mission for risk analysis. Hence, with an average of 20 missions annually, it is estimated that is will cost industry $2M to perform the required mission analysis for risk.

FAA Response

The FAA disagrees with the comment. The FAA projects there will be 524 reentry missions preceded by launches between the years 2000 and 2014. The estimate of 524 equates to about 35 mission launches per year for the entire U.S. commercial space industry or about 7 (on average) per operator. The estimate that they would engage in 20 missions per year (for each operator) is nearly three times greater than the FAA's estimate of an average 7 per operator per year.

Moreover, ELV operators are already required to do it. Mission design change would require a new E_c.. Besides, the estimate of 524 reentry missions is considered to be at the high end of the forecast for RLV/RV activity in future years.

Comment — Mission Readiness

To comply with Section 431.37 & 433.37 (Mission Readiness) will include dress rehearsals that alone will require a complete staff of 20 to 40 people over an 8 to 16 hour mission simulation equating to 360 man-hours for each dress rehearsal. At least one dress rehearsal for every two missions so a minimum of 10 dress rehearsals per year. Therefore, it is estimated that 3,600 man-hours vice the 80 hours indicated. This does not include monitoring between flight activity for mission readiness FAA compliance.

FAA Response

The FAA disagrees with the comment. A prudent operator would routinely perform this task. They would have to do this task for ELV operations, anyway. The FAA believes that its 15-year paperwork cost of compliance estimate of $4,100 per entity represents a good assessment of anticipated impact, which translates into an employee working 80 hours per year at $50 per hour.

Comment — Mission Rules, Procedures, Contingency Plans, and Checklists

Government records indicate that the cost of producing a technical order page is about $635 per page. To comply with Section 431.39 & 435.33 (Mission Rules, Procedures, Contingency Plans, and Checklists) would include providing the FAA with a master checklist that is likely to be a 200-page document and cost at least $127,000 to produce. The cost estimate for updating documentation alone will be at least this figure annually.

FAA Response

The FAA disagrees with the comment. An operator would have to perform these requirements to launch from a federal range, anyway. This requirement would only ensure that standard procedures are in place. The FAA believes that its cost of compliance estimate of $465,000, for the entire U.S. commercial industry over the next 15 years, represents a reasonable assessment based on the best information available.

Comment — Mishap Investigation Plan and Emergency Response Plan

Compliance with Section 431.45 & 435.33 (Mishap Investigation Plan and Emergency Response Plan) will require an average of 5 people per inspection over a one-day period, or 40 man-hours per inspection. Expecting a total of 6 inspections annually results in 240 man-hours annually, or 3,600 hours over 15 years. This cost is in addition to maintenance of described plans. Hence, compliance cost may be approximately $542,000 per operator.

FAA Response

The FAA disagrees with the comment. U.S. commercial industry operators already have an equilvalent of a mishap investigation plan to launch. The additional cost for reentry would be for the emergency plan which a prudent operator would need in order to contain and retrieve the vehicle. The commenter apparently confused inspections with investigations. The number of inspections would vary depending on the nature and frequency of mishap events. The FAA believes that its cost of compliance estimate of $556,000, for each U.S. commercial industry operator, over the next 15 years, represents a reasonable assessment based on the best information available.

Comment — Payload Reentry Review

Compliance with Section 431.57 and 435.43 (Payload Reentry Review) would be in excess of the FAA estimate of $400 per application. More than 50 payload types may be flown over a course of 15 years, resulting in $20,000 per operator.

FAA Response

The FAA disagrees with the comment. Payload types can be classified by the nature of hazards and national interest presented by the payload. Thus, different payload types may be considered as a single class approved under one payload reentry determination. This agency maintains that the cost impact of packaging and submitting the requisite data to the FAA in a prescribed format would require only require an eight-hour level of effort (by an employee with an annual income of $103,000).

Comment — Continuing Accuracy of License Application

Compliance with Section 431.73 (Continuing Accuracy of License Application) will be a major cost driver. It will include documenting and maintaining configuration control over all vehicles in its fleet, and knowing which parts, components, subsystems and systems are installed and in what state to meet required reliability. In the absence of FAA guidance, standards must be developed, verified, and implemented to document the continuing accuracy of the License Application. This section may well be the most costly to adhere to and an accurate cost estimate would require the FAA to defines what is considered a "modification to operator vehicles." This process could be analogous to the Airworthiness Directives used in aircraft. Compliance with Airworthiness Directives in aircraft may run into millions of dollars annually. Space Access has estimated the life of the vehicles to be 10 years so the manufacture of a new vehicle will most likely come with additional modifications based on the first 10 years of experience. The number of modifications anticipated over 15 years for unproven vehicles may well exceed 100. If the cost per modification application is $33,000 then Space Access anticipates $3,300,000 costs over 15 years.

FAA Response

The FAA disagrees with the comment. The FAA acknowledges that there is lots of uncertainty as to the nature of plans pertaining to modifications made by commercial space operators anticipated future missions. The FAA still maintains that commercial space operators would make only incur minor modifications. If missions were to succeed as intended, then the FAA anticipates few, perhaps minor, modifications.

Comment — Post Licensing Requirements

Maintenance of flight data in accordance with Section 431.77 & 435.5 1 (Post Licensing Requirements) can be very costly, as the volume of flight data is immense. Compliance is estimated to be at least $ 1,000 per mission to save all pertinent data for a three year time period. Average of 20 missions annually over 3 years will make the storage costs alone $60,000 per operator rather than the $6,000 indicated.

FAA Response

The FAA disagrees with the comment. Based on the informed judgement of FAA technical personnel and their association with U.S. commercial space industry representatives, proposed section 431.77 would only require an employee about 8 hours per year to duplicate records. A 3-year record retention requirement exists under part 415 for launches. There are inexpensive and efficient means of storing and retrieving data. (i.e., computer disk, microfiche, etc.).

Comment — Environmental Information

The cost to comply with Section 431.93 & 435.61 (Environmental Information) is between $500,000 and $1,000,000 vice the $271,000.

FAA Response

The FAA disagrees with the comment. The FAA continues to believe that its cost of compliance estimate is reasonable based on the best available information. In terms of section 431.93, this requirement only pertains to unique characteristics of a vehicle and mission not previously considered in environmental documentation. In terms of section 435.61, the FAA anticipates the

cost of gathering information to assess reentry impact would be lower than that for launch because of the fewer impacts expected. (i.e., new fuel, fire, etc).

B.2.2 Benefits

Comment — Benefits

The FAA's calculation of is extremely esoteric for several reasons. Some of those reasons include: (1) identification of six accident types grouped in two categories related to airborne explosions and ground impact point-of-impact crashes, (2) estimated expected values for each accident type under the baseline and the proposed rule, and (3) assigned monetary values to each of the various types of accidents expected to occur during launch and reentry. More information is required in terms of specific numbers used for these calculations.

FAA Response

The use of risk analysis is not an everyday analytical technique for a layman and does not appeal to most people. Nonetheless, it is an acceptable and highly used analytical technique in benefit-cost analysis. This technique was used extensively by the FAA in its evaluation of safety benefits pertaining to this rulemaking action. The FAA's analysis of benefits is considered to be complete.

B.2.3 Regulatory Flexibility

Comment — Small Entity Cost Impact

The preamble to the notice of proposed rulemaking shows that cost impacts on small entities are significantly understated. The FAA estimate that small entities will experience a cost impact of $34 million over a 15-year period is too low; an estimate between $68 million and $78 million would be more realistic.

FAA Response

The FAA disagrees with the comment. Based on the use of recent ELV revenue data, the FAA concluded the small entities potentially impacted by this proposed rule would not be significant. This assessment was based on the belief that each of the potentially impacted small reentrey

operators would incur an average annualized cost of compliance of $700,000 over the 15-year period and would only comprise 0.2 percent ($700,000/$350 million) of their projected annual revenues. Even if you were to double or triple this estimate, it would still not have a significant economic impact on the small reentry operators. The FAA recognizes that ELV revenue serves as a broad barometer for projected annual revenues for RLV operators and it is subject to some uncertainty as to its accuracy. Nonetheless, this approach is considered to be a reasonable assessment of the potential impact on small entities in absence of better information.

Comment — Revenue Projections

Revenue projections used by the FAA in determining the regulatory burden on small entities are unrealistic. The FAA incorrectly assumes that RLV operations will be fundamentally similar to the operations of existing ELVs — few missions per year at high revenue per mission. RLV missions are expected to be many and at a significantly lower cost than ELV missions.

FAA Response

The FAA disagrees, in part, with the comment. The FAA believes that the use of ELV revenue information was realistic for the purpose of assessing the impact of the proposed rule on the ability of small commercial space entities to enter the market and be competitive. Furthermore, the use of ELV revenue information in the regulatory flexibility determination was realistic because it allowed the FAA to arrive at the same conclusion as the comment: "The proposed rule is not likely to cause small business failures or adversely impact their position relative to large businesses." The FAA does agree that ELV revenues are not expected to mirror those for RLVs in the long-run (beyond year 2005) because of their inherent technological and operational differences. Since RLV commercial missions are virtually non-existent, the revenue information chosen for ELVs was intended to serve as a broad yardstick as to what to the potential cost of compliance impact would be on small entities.

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