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EPT. OF TRANSPORTATION
DOCKETS

99 AUG 12 AM 10:15

RDS/011-99-020
August 10, 1999

61409

U.S. Department of Transportation Dockets
Docket No. FAA-19995535 -02
400 Seventh Street SW
Room Plaza 401
Washington, D.C. 20590

Subject: The Boeing Company Response to Docket No. FAA-1999-5535, "Commercial Space Transportation Reusable Launch Vehicle and Reentry Licensing Regulations"

Boeing has reviewed the Notice of Proposed Rulemaking, Docket Number FAA-1999-5535, Notice Number 99-04, "Commercial Space Transportation Reusable Launch Vehicle and Reentry Licensing Regulations." Boeing appreciates the FAA commitment of substantial resources in support of the effort that led to the publication of this Notice. Boeing believes that, combined with our enclosed comments, the Notice of Proposed Rulemaking will provide the nascent reusable launch vehicle (RLV) industry with the appropriate starting point from which the certification of second-generation RLVs (and beyond) will evolve. Boeing also recognizes the magnitude of effort required to organize such a body of information, and applauds the FAA authors for their efforts.

The Boeing review included several different perspectives from within the Reusable Space Systems business unit and the Airworthiness and Systems Engineering Group. Recommendations are based upon Boeing's vast experience in the certification of commercial passenger aircraft, and recognize the uniqueness of RLVs.

Attachment 1 contains technical comments organized in the order of the Notice of Proposed Rulemaking as it appeared in the April 21, 1999 Federal Register. Page number, Part, Subpart and section references are provided to facilitate FAA evaluation of comments.

Should you have any questions regarding these Boeing comments, please contact Mr. René Rey at (562) 922-5059.

Regards,



Rick Stephens
Vice President & General Manager
Boeing Reusable Space Systems

Attachment



Attachment 1

Boeing Comments on the Notice of Proposed Rulemaking (NPRM)

Overall, the NPRM offers a broadly defined, flexible foundation for licensing the **second-generation** of reusable launch vehicles. The Boeing Company believes, however, it is in the RLV industry's best interest to pursue a *certification and* licensing process over the long-term. The basis for this belief is Boeing's vast experience in the certification of commercial passenger aircraft. Boeing comments recognize the uniqueness of **RLVs**, and have been structured to allow the **NPRM's** proposed licensing regime to segue into a certification regime. A preliminary method for ensuring RLV flightworthiness has also been suggested.

Evolution of a Reusable Launch Vehicle Certification Process

Next-generation reusable launch vehicles (**RLVs**) will become catalysts for the codification of RLV-specific certification standards-their potential to evolve into globe spanning space transportation systems operating on a daily basis is immeasurable. To enable these operationally prevalent **RLVs** to achieve their maximum potential, they will need to function within the confines of an internationally accepted regulatory framework, and an established flightworthiness code as provided by Annex 8 to the Convention on International Civil Aviation. In conjunction with implementing a systems engineering approach in the reusable launch vehicle development process, certification standards will serve to synthesize requirements and validate next-generation RLV designs that are higher in quality, meet required performance and safety objectives, and are economically maintainable. With these objectives in mind, the following commentary is offered to introduce the evolution of the present-day licensing regime into a certification regime:

- Page 19659, Part 43.1, Subpart C, Section 43.1.3.1: The goal of the safety review is to bring the benefits of space travel to humanity through safe and reliable vehicles'. Certification requirements for these operations will assure a design capable of safely carrying out this purpose. Certification's goal is to assure flightworthiness of the launch system and reusability through continued flightworthiness requirements.

Licensing establishes a level of environmental safety that is appropriate for commercial expendable launch vehicles and the research, design and development of second-generation reusable commercial launch vehicles. The licensing requirement of not jeopardizing public health and safety and the safety of property is appropriate for the initial development of RLV systems. However, licensing should also encourage industry growth on a global scale, and provide consistency. A certification path will allow the RLV industry to establish an initial set of repeatable standards and practices, and build around a logical progression as it expands into passenger-rated operations.

Certification requires a higher level of safety for the design and processes for **passenger-rated** operations. In addition, vehicle components must demonstrate "predictable" operational capability (i.e., continued flightworthiness). Certification regulations similar to

¹ **Edgar Zapata**, *Reusable Launch Vehicle Certification* (Kennedy Space Center: National Aeronautics and Space Administration, 1995).

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conventional aircraft must be established to reach the goals of commercial-space-passenger operations.

Ensuring Present&y Reusable Launch Vehicle Flightworthiness

Reusable launch vehicles must be inherently robust to accommodate high utilization rates and rapid turnaround times with minimum maintenance, which implies a specified level of flightworthiness. A variety of factors contribute to flightworthiness, and several measures have to be taken into account to ensure the continuing flightworthiness of an RLV throughout its complete life cycle:

1. Design (to meet specifications)
2. Manufacture (to meet design standards)
3. Structure and components testing (to verify compliance with requirements under simulated conditions)
4. Flight testing (to verify compliance with requirements under representative conditions)
5. Acceptance (of individual **RLVs** to specified requirements)
6. Operation (within design parameters)
7. Development in service (to improve performance, economics, safety, etc.)
8. Maintenance (to specific standards)

Since this NPRM does not specifically address RLV “type certification,” it is assumed that the “Hazard Identification and Risk Assessment” described in Section 43 1.3 5(c) and the requirements levied in Section 43 1.35(d), AC 43 1-01 (proposed) and AC 43 1-02 (proposed) will indirectly take into account items 1 through 7 above. However, the importance of maintenance has been totally neglected, and should be included as follows:

- Page 19660, Part 43 1, Subpart C, Section 43 1.37: A new subsection, “Instructions for Continued Flightworthiness,” should be added with provisions for an applicant’s development of the maintenance-related examination, testing and inspection procedures necessary to verify an **RLV’s** flightworthiness *for recurring missions*. Maintenance procedures should include inspection, overhaul, repair, preservation, and the replacement of parts. Derived **RLV** maintenance requirements (e.g., systems and propulsion maintenance requirements derived from time-age-cycle data, etc.) should also be included as part of the maintenance instructions contained in the “Instructions for Continued Flightworthiness.”

The RLV System Interface with A TC

Section 43 1.4 1, Communications plan, does not address the RLV system interface with ATC, nor does it mention real time communication links between RLV operators and ATC controllers.

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These external interfaces are equally as important as internal, safety-critical communication networks, and should be included as follows:

- Page 19660, Part 43.1, Subpart C, Section 43.1.41: A new subsection should be added that requires the applicant to describe the RLV launch and mission management control system interface with ATC. In addition, communication protocols and procedures with ATC should be defined. Finally, an independent verification and validation plan should be required for all human and electronic interfaces between the RLV system and ATC.

Summary of Boeing Commentary

The Boeing Company views this NPRM as the first step in defining the regulatory regime for the design, manufacture and operation of reusable launch vehicles. However, for the RLV industry to grow to its full potential, follow-on generation RLVs will benefit much more from a certification *and* licensing regime. The benefits of a certification regime far outweigh those of a “licensing only” regime for the following reasons:

- Better insures the public safety
- Reasonable repeatability of performance
- Wider standardization view-consistent application of flightworthiness standards “across-the-board”
- Minimizes long-term need for substantial FAA resources involved in repetitive licensing processes
- Reduced pressure on FAA oversight-FAA performs audit function

The Boeing Reusable Space Systems business unit is developing a *Reusable Launch Vehicle System Certification Plan* that addresses domestic and International flightworthiness requirements for RLVs, and formulates a methodology for defining a reusable launch vehicle system certification process. Boeing endeavors to work hand-in-hand with the FAA in the development and implementation of this Plan.