Orbital

99-1736

July 19, 1999

U.S. Department of Transportation Dockets
400 Seventh Street, S.W.
Room Plaza 401
Washington, D.C. 20590

ORIGINAL

Re: Notice of Proposed Rulemaking (NPRM) on Commercial Space Transportation Reusable Launch Vehicle and Reentry Licensing Regulations (Docket No. FAA-1999-5535; Notice 99-04)

To Whom it May Concern:

Attached is Orbital Sciences Corporation's response to the request by the FAA's Office of the Associate Administrator for Commercial Space Transportation for industry comments on the NPRM referenced above, as set forth in the Federal Register on April 21, 1999.

As required, I have enclosed two copies of our response.

Sincerely,

Mark E. Bitterman
Vice President, Government Relations

Comments
on the
Notice of Proposed Rulemaking
(Docket No. FAA-1999-5535; Notice 99-04)
Addressing
Commercial Space Transportation Reusable Launch Vehicle and Reentry Licensing Regulations

Submitted By
Orbital Sciences Corporation

July 19, 1999

General Comments

- The Notice of Proposed Rulemaking (NPRM) demonstrates good understanding of technical issues related to Reusable Launch Vehicles (RLVs) and reentry vehicles.

- It provides a flexible, non-intrusive approach to regulation and licensing. For example, it certifies a potential operator's system safety approach rather than mandating a specific approach.

- It strikes a good balance between the safety of the general public and the compliance cost burden of a vehicle operator.

- Orbital agrees with the use of two distinct licenses (i.e., a mission specific license that would allow one or more launch/reentry and an operator license that would allow indefinite similar launch/reentry operations.)

- Orbital supports licensing launch and reentry of RLVs at the same time in advance of launch as well as defining reentry to include preparations leading up to irreversible initiation of reentry.

- The criterion of expected casualty rate (E_c) < 30 x 10^{-6} is consistent with current ELV launch licensing. However, the NPRM needs to be consistent in the use of the $E_c < 30 \times 10^{-6}$ criterion and not impose additional redundant or contradictory requirements.

- The Advisory Circular on System Safety Process is very thorough as well as consistent with current engineering practices and MIL-STD 882C.

- The Advisory Circular on Expected Casualty Calculation is also very thorough as well as consistent with current hazard analysis in the launch vehicle and airline industries.

Specific Comments on Supplemental Information

- The second paragraph on p.20 concludes that "a suborbitally operated RLV that achieves outer space would ... be subject to FAA reentry licensing authority." A definition of "outer space" should be added for clarification. Typically "outer space" has been defined as "space" above a certain altitude (e.g. 50 nautical miles). Orbital believes, however, that other suborbital RLVs should be covered. For example, a two-stage RLV might have a reusable stage that does not fly to "outer space" depending on the definition; however, it still could fly at hypersonic speeds and above the altitude where it would be regulated as an aircraft. This reusable stage could present a hazard to the public and should be covered under the regulations.

- The first paragraph on p. 29 defines "the end of licensed launch activity for an RLV launch at deployment of payload." Orbital does not believe that this definition is appropriate given the unique characteristics and potential missions of RLVs. Some planned or possible RLV missions will not involve payload deployment (e.g. reconnaissance or point-to-point payload cargo delivery on Earth). We believe that the definition of the end of licensed launch activity (not including licensing of the reentry phase) should be changed to "payload deployment, insertion into a stable orbit, or preparation for reentry, whichever comes first."

- We do not agree with the assertion on p.42 by "some industry representatives" that a thousand flights are needed to determine system reliability and failure modes. We would oppose requiring a specific number of "test" flights before allowing any licensing. This issue should be addressed on a case-by-case basis, and a particular vehicle operator should propose a rationale for why a particular number of flights are sufficient prior to grant of an operator's license.

- The second paragraph on p.48 forbids "total autonomous initiation of reentry." We believe that automated verification of configuration and status of reentry safety critical systems should be allowed. Given the current rate of growth in technologies for automated health monitoring and flight control, we believe that the on-board vehicle health monitoring system may often be in the best position to accurately determine the state of vehicle critical systems. We agree that automated

verification of airspace clearance, reentry site preparation, and weather should not be allowed.

- The first paragraph of p.51 states that a reentry vehicle or RLV should have a separate requirement of a .997 probability of landing at a defined "reentry site." Orbital believes that it is unnecessary to impose additional restrictions on the probability of landing at these sites, or on the location of these sites or their inhabitants, as long as an expected casualty rate of less than .00003 per mission is demonstrated through a conservative analysis like that contained in the associated Advisory Circular.

- The last paragraph of p.71 establishes a separate requirement of $E_c < 1 \times 10^{-6}$ for a 100-mile radius around a "reentry site." Orbital does not believe that the regulation should use a different expected casualty rate requirement for persons within 100 miles of a reentry site. (This requirement seems to be derived from the regulatory work done for the COMET and METEOR programs.) We believe that the adoption of the requirement for an expected casualty rate less than .00003 per mission, consistent with current ELV licensing requirements, is a very positive step that greatly simplifies the licensing process. Having two different expected casualty requirements seems arbitrary and unnecessarily complicates the analysis process required for RLV and reentry vehicle licensing.

Specific Comments on Proposed Amendment

Part 401 – Organization and Definitions

Section 401.5 – Definitions

As stated above, a definition of "outer space" should be added for clarification of the definitions of "reentry" and "reentry site". Typically "outer space" has been defined as "space" above a certain altitude (e.g. 50 nautical miles). This will become important in discussions in later sections concerning RLV stages that do not reach "outer space" before returning to Earth to land.

Part 431 – Launch and Reentry of a Reusable Launch Vehicle (RLV)

Section 431.3 – Types of reusable launch vehicle mission licenses

The first sentence reads: "A mission-specific license authorizing an RLV mission authorizes a licensee to launch and reenter, *or otherwise land,* one model or type of RLV to a *reentry site* approved for the mission." The definitions of "reentry site" and "reentry vehicle" are contingent on a vehicle coming back from Earth-orbit or outer space. A number of credible RLV concepts include reusable boosters that return to the launch site to land or land at a downrange site. These RLV boosters may travel above the altitude (e.g. 60,000 ft) at which they would normally be subject to regulation as an aircraft; however, they would travel below the "outer space" altitude at which they would be considered a reentry vehicle. Hence, under the proposed

regulation, their landing site would not be covered by the definition of "reentry site" and, hence, would not be regulated. This problem could be solved by changing the definition of "reentry site" to include the landing of any RLV, or it could be solved by separately defining and regulating "RLV landing sites," which are not necessarily "reentry sites."

Section 431.35 – Acceptable reusable launch vehicle mission risk

The second sentence reads: "…the mission commences upon initiation of the launch phase of flight, proceeds through orbital insertion of an RLV or vehicle stage, *or flight to outer space,* whichever is applicable, and concludes upon landing on Earth of the RLV." We recommend changing "flight to outer space" with "sub-orbital flight" for the reasons discussed above. A two-stage RLV might have a reusable stage that does not fly to "outer space" depending on the definition; however, it still could fly at hypersonic speeds and above the altitude where it would be regulated as an aircraft. This reusable stage could present a hazard to the public and needs to be covered under the regulations. However, it should also be clarified that these regulations do not apply to non-RLV sub-orbital vehicles, such as those used for target purposes.

Another sentence on p.141 reads: "For persons within a 100-mile distance from the border of the designated reentry site and contingency abort locations, if any, the risk level associated with a proposed mission does not exceed an expected average number of .000001 casualties per mission."

The sentence raises two concerns. First, "contingency abort location" is not clearly defined in the document. Does the three-sigma condition applied to a "reentry site" apply to a "contingency abort location"? Should a "contingency abort location" be licensed and regulated as a "reentry site"? How should it be regulated? For a location to be designated a "contingency abort location," what does the probability have to be that the reentry vehicle or RLV will ever land at that site? We recommend a much clearer definition of the term and a discussion of the regulatory status of a "contingency abort location." Second, as stated above, Orbital does not believe that the regulation should use a different expected casualty rate requirement for persons within 100 miles of a reentry site. This requirement seems to be derived from the regulatory work done for the COMET and METEOR programs. We believe that the adoption of the requirement for an expected casualty rate less than .00003 per mission, consistent with current ELV licensing requirements, is a very positive step that greatly simplifies the licensing process. Having two different expected casualty requirements seems arbitrary and unnecessarily complicates the analysis process required for RLV and reentry vehicle licensing.

Section 431.43 – Reusable launch vehicle mission operational requirements and restrictions

On p.146 the proposed amendment states that a nominal landing location or a contingency abort location is suitable for launch or reentry if "for any vehicle or vehicle stage, the area of the predicted three-sigma dispersion of the vehicle or vehicle stage can be wholly contained within the designated location." As mentioned

above for "contingency abort location," the term "nominal landing location" should be defined in more detail. Can a "nominal landing location" be different from a "reentry site"? Do the same regulations apply? Nowhere in the document does it say whether or not anyone can live on a reentry site, a contingency abort location or a nominal landing location. These locations are nominally defined to be areas that contain all three-sigma dispersions from the stage landing or impact points. Orbital believes that there should be no restrictions on the location of these sites or their inhabitants as long as an expected casualty rate of less than .00003 per mission is demonstrated through a conservative analysis like that contained in the associated Advisory Circular.

On p.147 the Amendment states that "any *unproven* RLV... [should] not have substantial dwell time over populated areas." This is a very vague statement. The term "unproven" could be replaced by "an RLV not operating under an operator's license." In general, we believe that this statement, which appears in numerous locations, should be eliminated altogether because satisfaction of the expected casualty rate requirement should be sufficient to address concerns of population overflight.

Also on p.147, the Amendment proposes a requirement that the expected casualty rate be less than .00003 "given a probability of vehicle failure *equal to 1* at any time the IIP is over a populated area." We believe that this requirement will completely eliminate flight over "populated" areas, which will unnecessarily constrain RLV operations. In fact, a commercial aircraft could not meet this requirement. In addition, the term "populated" is not

defined. Once again, as long as the expected casualty rate is demonstrated, there is no need for this or similar requirements.

At the bottom of p.147, the Amendment states that an RLV "may only be operated such that the vehicle *operator* is able to monitor the status of safety-critical systems immediately before enabling reentry flight." Orbital believes that a vehicle operator should be required to verify the reentry corridor is free of other flight vehicles, verify proper weather conditions exist, verify the proper preparation of the reentry site, etc. However, for the reasons stated earlier, we believe that automated verification of vehicle systems should be allowed as long as the expected casualty rate is demonstrated.