64622

FAA-99-5535-27

Date: 7/20/99 4:49 PM
Sender: "Jon D. Collins" <jdcollins@actainc.com>
To: 9-NPRM-CMTS
Priority: Normal
Subject: RLV NPRM Review

acta review of RLV NPRM, 7-99 doc

RFC822 TXT

To: U. S. Department of Transportation Dockets
Docket No. FAA-l 999-5535
400 Seventh St. SW, Room Plaza 401
Washington, DC 20590

From: ACTA Inc.
2590 Skypark Dr. Suite 310
Torrance, CA 90505

The following pages contain comments by the staff of ACTA inc. regarding the NPRM for RLVs. Questions regarding our response can be directed either to Jon D. Collins, President, ACTA inc. (310) 530-1008 **(collins@actainc.com)** or to Harold Reck, Manager of Advanced Projects, ACTA Inc. (805) 733-5054 **(reck@actainc.com).**

We are very enthusiastic about the future of the commercial space industry and are appreciative of the role that the FAA must play in the protection of the public. We would like the industry achieve its goals while satisfying the need for adequate public safety. If we can be of any additional service, we will be glad to help.

ACTA also submitted a response to the Advisory Circular on Expected Casualty Calculations. This was submitted by mail to Ronald Gress.

20 July 1999

ACTA Inc. Comments on Commercial Space Transportation Reuasble Launch Vehicle and Reentry Licensing

1. GENERAL COMMENTS

1.1 The requirements contained within the NPRM stimulate a mixed response. Certainly the safety objective of providing an adequate degree of public safety (E_c=30x10^{-6}) is likely to result but the concern is whether or not the fledging U.S. RLV industry can survive to maturity given the stringent regulation processes and requirements. In our view, the proposed NPRM will probably force RLV operations to coastal launch sites – overflight of even sparsely populated areas will be restricted as a result of applying the safety analysis methods in the Rule and Advisory Circulars.

1.2 The FAA should anticipate strong opposition to the proposed Rule from the RLV industry. Many of the basic FAA requirements and assumptions are inconsistent with industry announced RLV operational concepts. If imposed, the draft Rule could cause major changes or otherwise severely impact the current RLVs under development.

1.3 The scant use of paragraph numbers in the Supplemental *Information* section makes it difficult to provide comments. Suggest future Supplemental Information sections of NPRMs use an improved and more detailed paragraph numbering scheme.

1.4 Adding new Sections 431 and 435 dealing with the general topics of RLVs and separate reentry vehicles is considered a good approach and should be continued.

1.5 Both the Section-By-Section Analysis 431.43 and Proposed Amendment § 431.43 discuss a number of "operational requirements and restrictions." It is believed that several of the "operational restrictions" may be viewed by the RLV industry as too restrictive and that these will be challenged. Representative of such restrictions are:

(1) Human control of a flight safety system and a reentry enable system, *Isn't it possible to relax the human control requirement later in flight with the use of an autonomous abort/destruct system?*

(2) "IIP shall not have substantial *(?)* dwell time over densely(?) populated areas" or over any "populated area" for unproven RLVs, and

(3) For "any unproven *(?)* RLV" an $E_c \leq 30x10^{-6}$ is required given a probability of failure equal to 1 whenever the IIP is over a populated area. This appears to be far too restrictive. *If, for example, the FAA chose to* accept *0.75* as *the mission success probability of* a *new vehicle (suggested for EL Vs) and, for example the total powered flight time is* 250 *seconds. Then the failure* rate *per second would be .25/250 = .001 failures/sec. Multiply this by a dwell time of 5 seconds (rather long) and the probability of failure over the population center*

is, conservatively 0.005, a number much less than 7.0. The combination of failure probability of 7.0 and 30×10^{-6} is far too consewative. Why not a more reasonable number like 1×10^{-3} for the expected casualty given a failure probability of 1.0.

1.6 As is often the case with the format and organization of other FAA NPRMs, the document is difficult to use due to the repetition of slightly different wording between the three major sections.

2. SPECIFIC COMMENTS

2.1 Supplementary Information (SI), History of U.S. Commercial Reentry Capability, COMET/METEOR Safety Approval, Criteria 2 & 3: These items (and others) establish the "*normal background risk"* for reentry as *"one in a million on an annual basis"* for the public both within and outside a 100-mile zone (radius?) around the landing site. It is not clear why this distinction is made since the criteria is the same. Suggest clarification may be needed. Also, suggest the source or basis for this "normal background risk" should be mentioned.

2.2 SI, General Approach to RLV & Reentry Licensing, Mission Risk Assessment: Suggest the concept of combining launch and reentry risk assessments/authorizations under a single license is sound and the preferred method.

2.3 SI, General Approach to RLV & Reentry Licensing, Public Safety Strategy for Assessing RLV & Reentry Safety, 5th ¶: Mentions that "FAA will issue guidance materials describing an acceptable system safety process." Since AC 431.5-2 appears to provide this guidance, suggest this Advisory Circular, and others as appropriate, be referenced in the NPRM. Also, it is assumed that the balance of this section is consistent with AC 431.5-l *Expected* Casualty Calculations.

2.4 SI, General Approach. ---Licensing, 3. Operational Restrictions on RLV launch & reentry, A. Restricting Flight Over Populated Areas, 1st ¶: States "The projected IIP of a vehicle can be calculated with some degree of accuracy if the vehicle's aerodynamic characteristics are known." Suggest "-vehicle's state vector and aerodynamic characteristics-" is better. Also, not only is the dwell time for the intact vehicle's IIP of interest, but also of concern is the dwell time for following debris cloud of fragments – suggest rewording to clarify. Perhaps reference to the ACTA CRTF model or similar methodologies would be appropriate. Note in the 2nd ¶ that the FAA discussion requires the analysis to assume that a failure will occur (p_f=1) whenever the IIP is "-over each populated area." It is believed this approach will effectively eliminate inland/overland flights of RLVs. Suggest this is not a reasonable alternative to using a validated "engineering estimate" of vehicle reliability. Also, in the 3rd ¶, note FAA restriction of any "substantial dwell time over a populated area" for "unproven vehicles." Suggest some definition or clarification of the size of "substantial" and "a populated area" is needed since these terms, along with reliability, are key inputs to effective estimation of casualty expectation. Similarly, in 4th ¶, clarification of "proven vehicle," "substantial dwell time" and "densely populated areas" are needed. See comment 1.5(3) above for a suggested alternative.

2.5 SI, (same as 3.4) B. Monitoring Critical Systems & Positive Enabling of Fail-safe Reentry: While these requirements will likely increase public safety, the systems

needed to comply will be very costly and could make U.S. RLV non-competitive. Suggest autonomous systems, based on GPS and INS, could be developed that determine when RLV flight conditions are within tolerances – in effect these are "flight continuation" rather than 'flight termination" systems. These systems allow continuation of the mission only if predetermined conditions are met, any variance results if initiation of an abort/recovery mode. Suggest FAA leave open the option for these and other innovative systems instead of dictating a ground based FSS.

2.6 The FAA uses the term three sigma in several places to designate the impact distribution. First, the probability of impacting inside a three-sigma area specified by a normal distribution is 0.9889. The probability associated with three sigma is based on the dimension of the space (in this case two) and the choice of distribution. Technically three sigma is just three times the standard deviation, not a number. We suggest a numerical probability such as 0.99 or 0.999 which corresponds to 3.035 or 3.717 times sigma for a bivariate normal distribution.

2.7 SI, RLV Mission & Other Reentry Licenses, 1. RLV Mission Licensing Overview: This section, and others, imposes requirements for RLV abort or emergency landing sites. Be aware, based on X-33 and other current RLV designs, that the excess energy needed to maneuver crossrange to reach such sites is usually extremely limited – aborts on-azimuth are the more likely outcome. Also question several uses of the phrase "test flight" in this section since "test" seems out of context in those discussions, and should either be deleted or clarified.

2.8 Section-By-Section Analysis (SBSA) 431.35 5th ¶ and Proposed Amendment (PA) § 431.35 (d)(3): These items require a user to "Identify and describe safety critical systems." On the surface this seems reasonable BUT the definition proposed in 401.5 says "safety critical means, essential to safe performance or operation." Given this broad reaching definition, it would appear few if any components, subsystems or systems on a RLV would not be "safety critical." This is of concern since much analysis and data are subsequently required by other sections throughout the NPRM. Suggest this definition be revisited to introduce the concept that the safety critical systems are restricted to those that have a direct potential effect on public safety.

2.9 SBSA 431.43 1 st ¶ & PA § 431.43 (a)(4) & (5): Discusses requirement for ground-based system capability to monitor "safety critical systems" during RLV flight and "activate a flight safety system" to "safely terminate flight." Further, this section states "an autonomous system to abort launch flight is not sufficient---" and that "---human control capability is critical to safety." It is suggested that design and performance factors for specific RLVs should be the determining consideration dictating the need for ground-based monitoring and control authority. The FAA requirement for a "man-in-the-loop" with tracking, display and command capability could significantly increase the cost of RLV operations and limit innovation.

2.10 SBSA 431.43 3rd ¶ & PA § 431.43(c): These require that a collision avoidance analysis for inhabitable spacecraft be performed. While this may be needed, it is still uncertain how and who should perform the function. Suggest the implementation of this requirement be further discussed.

2.11 SBSA 431.43 4th ¶ & PA § 431.43(c)(2) & (d)(2): These items include requirements for controlling the dwell time of the IIP while over populated areas.

However, the definitions of the terms used are not sufficient. For example is the dwell time of concern based on the IIP (vacuum or drag?) for the intact vehicle or the composite debris pattern? Also specific definitions of such terms as unproven, substantial, densely, etc. would be helpful. Note that § 431.43(d)(2) stipulation of a $p_f=1$ "anytime the IIP is over a populated area" probably drives most RLVs to the coastal launch sites. Use of a $p_f=1$ seems an unreasonable stipulation. Many of these concerns might be alleviated by the use of risk-based real-time decision criteria similar to those under development for the X-33 at the AFFTC.

2.12 SBSA 431.75 2nd ¶ & § 431.75(b)(2): The SBSA states the requirement for NOTAMs and "other public safety measures involving air routes." This seems appropriate but the PA states "----closing of air routes during the respective launch---" that could imply closing any air route under the trajectory. It is understood the federal ranges close airways only if (1) the NOTAM box encompasses any part of an airway or (2) the vehicle or any of its scheduled jettisoned debris penetrates the airway at an altitude under 100,000 feet. Suggest that arbitrarily closing air routes under the flight path may be too restrictive.