1007 West Avenue M- 14, Suite C, Palmdale, CA 9355 1- 1443

59862

20 July 1999

U.S. Department of Transportation Dockets
Docket No. FAA-19995535
400 Seventh Street, S.W.
Room Plaza 401
Washington, DC 20590

ORIGINAL

e-mail: 9-NPRM-CMTS@faa.gov

Subject: Comments on Docket No. FAA-1999-5535 -18

Reference: Notice No. 99-04

To whom it may concern:

Space Access, LLC, has identified four critical issues which we suggest must be addressed if the referenced Proposed Amendment is to fulfill the Federal Aviation Administration's (FAA's) responsibility to both regulate and promote the aerospace industry. Accordingly, we make the following four crucial recommendations:

1. Clarify that the restrictions associated with the Instantaneous Impact Point (IIP) of an "unproven" vehicle "dwelling over populated areas" will not impose constraints on Reusable Launch Vehicles (RLVs) beyond those currently being applied to "unproven" Expendable Launch Vehicles (ELVs) on ascent. Since a restriction on the dwell time of the IIP over populated areas is not included in the Final Rule regulating ELVs, the inclusion of this restriction to only RLVs could be misinterpreted to mean that the FAA is applying stricter standards to RLVs than to ELVs. Space Access concurs that it is not prudent for the FAA to allow the IIP of any "unproven" launch vehicle to dwell over a populated area especially early in a mission when the launch vehicle is carrying considerable amounts of fuel. However, as the speed of the launch vehicle increases and approaches orbital velocity, the IIP travels well out in front of the launch vehicle, and will almost certainly cross over populated areas. Likewise, when an RLV is firing its retrorocket(s) to deorbit, its IIP will traverse rapidly over approximately half the circumference of the globe-potentially passing over populated areas during the course of just a few seconds of retrofire bum time. Hence, clarifying the definition of "substantial dwell time, populated areas, and unproven vehicle" is of critical importance. The FAA regularly approves ELV missions launched from Florida's spaceports in which the IIP passes over areas of population such as Africa. Space Access recommends that the Proposed Amendment include language to clarify that RLVs which fly profiles on either ascent or recovery similar to those flown by ELVs on ascent (approximately the equivalent dwell time over similar population densities) will not be considered by the FAA to have "substantial dwell time over populated areas." Furthermore, Space Access suggests that the FAA consider a launch vehicle as "proven" once it has been demonstrated in flight that the vehicle is operating in a manner substantially similar to that predicted by the operator's risk analysis and has adequate Factors of Safety at all the flight conditions which will be

Telephone: (805) 267-4000 Facsimile: (805) 267-4009 e-mail: SteveWurst @AOL.com

encountered during the proposed mission and any associated abort scenarios. Space Access has elected to use the well-proven Factors of Safety specified by the FAA for a Transport Category Certificate. Space Access concurs with the FAA that once the vehicle is "proven" the calculation of acceptable mission-based Expected Casualty Criteria (E,) are sufficient thus making restrictions associated with limiting dwell time over "populated" areas unnecessary.

2. Differentiate between a "reentry site" and "landing site" and assure operational restrictions are appropriate to each phase of the mission. For example, if a launch system's "reentry site" is over water, has about it a one hundred mile "clear-zone", and is accordingly a considerable distance from the ultimate landing site, then, once the Reusable Launch Vehicle (RLV) has completed its reentry, is definitely established under controlled flight, and is flying a recovery to its designated "landing site", to establish more stringent E_c along a "corridor" one hundred miles on either side of that recovery path all the way to landing is not necessary nor appropriate. Furthermore, arbitrarily establishing an E_c for RLVs during any phase of flight that is more than an order of magnitude more demanding than that required of ELVs during ascent is not appropriate. Space Access therefore recommends the restriction on E_c during recovery of RLVs be removed or, as a minimum, applied only at the "reentry site" for unproven RLVs.

3. Develop an Incremental Licensing Approval Plan which provides, early in the licensing process, formal feedback to the applicant regarding the FAA's pre-approval of the applicant's design, operations plans, and system safety analysis in conjunction with that applicant's proposed licensing strategy. This will clearly and unequivocally establish the applicant's eligibility for ultimately being awarded a license so that misperceptions about licensing eligibility do not unnecessarily hinder the growth of the aerospace industry. Lack of formal feedback tends to favor well-established large aerospace businesses while hindering small businesses in which growth is more dependent on raising commercial capital.

4. Incorporate provisions to allow applicants to submit, and the FAA to incrementally approve, Comprehensive Integrated Licensing Plans which address licensing and certification of the launch system over its entire life span which, for example, may include:

   - Flight test operations under the equivalent of an "experimental certificate";
   - Cargo-only launch operations at first under a "mission-specific license" and then, as the system matures, under an "operator license"; and,
   - Carriage of both passengers and cargo for hire under the equivalent of a "transport category certificate" in those cases in which the applicant meets more stringent design criteria and flight test standards. The FAA's issuance of the equivalent of a "transport category certificate" to eligible U.S. launch service providers would unequivocally establish the reliability of their launch systems so that the applicants may then access the aviation insurance market on an equal footing with more "traditional" aircraft. This would allow U.S. commercial launch service providers to exploit their technological advantages and compete more favorably in the international marketplace for missions involving the carriage of both passengers and cargo for hire, thus increasing U.S. market share.

In addition to the four preceding most critical recommendations, Space Access has also identified nine other less crucial recommendations:

5. Normalize the E_c calculation of risk by the benefits associated with the launch activity to prevent unwarranted additional risk to the public caused by dividing up heavy launches into multiple smaller launches, which collectively may impose greater over-all risk to the public. Space Access suggests normalizing the E_c calculation by the launch system payload capacity. We suggest using the world's only current reusable launch system-the NASA Space Transportation System's Space Shuttle-as the benchmark. Thus, the rule should require that the collective E_c associated with the total number of missions a launch system would require to deliver the equivalent of a Space Shuttle-class payload mass to Low Earth Orbit should not exceed 30-in-a-million. Otherwise, the public will be exposed to much greater collective risk (potentially more than an order of magnitude worse) if a heavy mission were to be conducted by numerous smaller missions, each of which individually represents an E_c of 30-in-a-million.

6. Incorporate language in the Proposed Amendment which captures the intent of the statement regarding "effects of prior flight" which is discussed under "Operational Restrictions on Reusable Launch Vehicle Launch and Reentry" in the SUPPLEMENTARY INFORMATION, but not is not currently addressed in the Proposed Amendment itself. The statement provided in the discussion states: "Each flight of a reusable launch vehicle would be required to satisfy the safety criteria promulgated by the agency in licensing rules, and an applicant's demonstration that it has satisfied the criteria would have to account for effects of prior flight on vehicle performance ." Space Access suggests that same statement be incorporated in the Proposed Amendment itself in order to assure the public is not subjected to any unwarranted risks associated with re-use of the RLV.

7. Allow reduced time period for notification on certain launches. As both the launch customer's demand for rapid response on certain missions and the launch service providers capability to respond accordingly increase, it is appropriate for the FAA to allow certain missions-such as those involving rapid replacement of failed satellites-to be conducted with less than the normal notification periods. With proper pre-planning, all aspects except on-orbit deconfliction (collision analysis) and notification of the FAA and Coast Guard regarding dissemination of specific launch windows to affected air and sea traffic can be pre-approved. Thus the duration time necessary for "notification" of the actual launch in such cases can and should only depend upon the amount of time necessary to complete collision analysis, deconflict from on-orbit traffic, and provide appropriate warning to the affected air and sea traffic.

8. Identify a centralized point of contact to conduct collision analysis. The FAA's unparalleled track record in deconflicting air traffic makes it the logical choice for this responsibility. Since small businesses which do not have access to classified data bases will not be in position to conduct the collision analysis with certain potentially "inhabitable" classified mission traffic, it seems more appropriate to expand the FAA's role in traffic deconfliction from endo-atmospheric flight out to include on-orbit flight operations.

9. Exempt commercial launch service providers from including U.S. Government payloads in their cumulative E_c calculation. This would align all of the Proposed Amendment consistent with Section 431.51 which states "Payloads owned and operated by the U.S. Government.. . would be exempt from this subpart." Since the E_c associated with the recovery of particular Government payloads, especially classified payloads, may not be available to the commercial launch service provider deploying the payload, it is not appropriate for the FAA to require the launch service provider to include the effect of the Government payload in their E_c calculation.

10. In response to the FAA's request for "recommendations that would assist in developing an acceptable analysis. . . " Space Access recommends that the FAA retain and continue to refine the Advisories Circulars such as those addressing RLV System Safety Process (AC 43 1.35-2) and Expected Casualty Calculations (431.35-1). Such documents provide an excellent basis for evolving an acceptable analysis process.

11. Define the suggested roles of each of the participants in the policy and safety reviews. For example, define what, if any, role NASA would play in the policy review of a commercial launch of a commercial satellite.

12. Clarify the method and means for critical reporting to the FAA. In Section 431.79 Reporting Requirements, Space Access recommends the FAA specify the recipient, location, and media (telephone, facsimile, e-mail) for critical reporting.

13. Refine cost estimates to better reflect the projected costs of industry compliance with the Proposed Amendment. The FAA's current cost estimates appear to be significantly less than our internal estimates of the cost of compliance with the Proposed Amendment. Note that Space Access does not object to conducting any of the actions required for compliance. However, it is important that our estimates of the cost of such compliance are consistent with the FAA's own projections to provide potential investors unambiguous insight into the financial needs of the company.

14. Clarify the starting and stopping points of the E_c calculations on a mission basis. Section 43 1.35 states ". . .the mission commences upon initiation of the launch phase of flight.. ." yet Section 401.5 Definitions states "The term launch includes the flight of a launch vehicle and pre-flight ground operations beginning with the arrival of a launch vehicle or payload at a U. S . launch site."

In addition to the brief summary and justification of each of the fourteen recommendations provided above, additional supporting rationale for our recommendations numbered 1 and 13 is attached. Thank you for the opportunity to participate in this review process.

Very truly yours,

SPACE ACCESS, LLC

Ronald K. Rosepink

Ronald K. Rosepink
Vice President, Flight Operations

Attachment l-Restrictions Associated with Instantaneous Impact Point

Space Access requests the FAA clarify that the restrictions associated with the Instantaneous Impact Point (IIP) of an "unproven" vehicle "dwelling over populated areas" will not impose constraints on Reusable Launch Vehicles (RLVs) beyond those currently being applied to "unproven" Expendable Launch Vehicles (ELVs) on ascent. Subpart C-Safety Review and Approval for Launch and Reentry of a Reusable Launch Vehicle; Section 431.43—Reusable Launch Vehicle Mission Operational Requirements and Restrictions contains restrictions regarding the dwell time of the launch vehicle's IIP over inhabited areas. Specifically, "... the projected IIP of the vehicle shall not have substantial dwell time over densely populated areas during any segment of mission flight" and the additional restriction on "unproven" vehicles that "The projected IIP of an unproven (reentry) vehicle must not have substantial dwell time over a populated, as opposed to a densely populated, area, during any segment of the mission unless the applicant can demonstrate that it satisfies stated risk criteria assuming the vehicle will fail while the IIP is over a populated area."

These types of restrictions have no prior documented history. They are not currently included in the Final Rule regulating ELV licensing and therefore it can be assumed are not currently being applied to ELVs. Therefore, it is imperative that the interpretation of these restrictions be consistent with the current ELV regulatory process to be equitable.

It is difficult to envision a practical scenario in which the IIPs of RLVs does not on any given mission overfly inhabited land. The only trajectory in which the IIP avoids overflying inhabited land masses appears to be a polar mission launched from eastern Siberia, which would traverse predominantly open water in the Atlantic and Pacific Oceans. Needless to say, this does not seem to be a practical solution for U.S. commercial launch service providers even for "demonstration flights." Therefore, it is necessary to quantitatively define how to apply the restrictions.

Many options for quantifying the restriction are possible. It is not well understood which method the FAA intends launch vehicle license applicants to use. To resolve this situation, Space Access requests FAA clarification of certain terms, including: proven; unproven; populated areas; densely populated areas; and, substantial dwell time. A short discussion of each of these terms and potential interpretations of each follows.

Space Access recommends that a reusable launch vehicle be considered **"proven"** for any given mission when it has been demonstrated that it is operating substantially as predicted and that the required Factors of Safety exist at all projected flight conditions and associated abort trajectories applicable to the proposed flight. Exposing any vehicle to its ultimate stress levels in flight is not a sound practice, and may do more damage than good. Therefore, the key is the in-flight demonstration that sufficient factors of safety exist at the conditions that may be encountered, so that a buffer exists between what the vehicle is capable of withstanding and what the vehicle is projected to be required to accommodate. Space Access has elected to use transport category Factors of Safety, because of the long history of successful application of these standards. Space Access recommends that using anything else would have to be justified based on extensive analyses and testing. Note that exceptions to this design standard for transport aircraft are rarely, if ever, accepted.

Furthermore, Space Access recommends that the FAA does not delay in its decision to accept relatively conservative design criteria while determining whether less conservative design criteria are acceptable. Those who chose to apply more aggressive criteria should expect that approval of such decisions will take longer than approval of more conservative approaches.

It should also be emphasized that a vehicle may be "proven" for certain flight conditions and trajectories while remaining "unproven" for other flight conditions and trajectories. This should allow the operator to conduct missions as a "proven" vehicle if the operator has previously

demonstrated the vehicle capability along substantially similar trajectories, while at the same time requiring the operator to comply with "unproven" restrictions along those trajectories and flight conditions which have not previously been adequately demonstrated.

Of concern is the FAA's use of the term "flight lifetime" in its statement that "before the FAA would allow an RLV or reentry vehicle to fly over densely populated areas, an applicant would need to prove that its vehicle maintains structural and aerodynamic integrity throughout its proposed flight regime (i.e., flight lifetime), and that the operator can maintain command and control of the vehicle during flight." The statement could be interpreted to mean the vehicle must be proven over its whole projected life before it is considered "proven." Adequate combinations of design Factors of Safety, analyses, ground tests, flight tests, and inspections have been used regularly on transport aircraft to establish flight lifetimes. Space Access suggests that such data be used to determine if any particular mission would exceed the life of the aircraft at that time, rather than needing to prove the entire flight lifetime upfront before any mission could be considered safely within the life of the vehicle.

Space Access recommends that any vehicle not meeting the above stated requirements for being considered proven should be considered "**unproven**" and as such, would be subject to the additional restrictions placed on the operation of unproven launch vehicles. No further definition of unproven is required.

Several options exist regarding the definition of **"densely populated areas"** and **"populated areas."** The Proposed Amendment offers the following: "if the consequence of a mission accident at a particular location would result in a significant number of casualties, then the FAA would view that area as densely populated for safety purposes." Unfortunately, this doesn't offer a quantitative means for an applicant to determine if a trajectory is indeed acceptable, but merely creates the need for a quantitative definition of the phrase "significant number of casualties."

Space Access suggests the FAA adopt one of two quantitative measures. The first is the direct use of regional population, that is

> Metropolitan area of over 100,000 = populated area
> Metropolitan area of over 1,000,000 = densely populated

A second, and preferred method since it is more aligned with the intent of the FAA restriction, would be the use of population density along the path of the IIP:

> Population density of over 25 per square mile = populated area
> Population density of over 125 per square mile = densely populated area

Several options also exist regarding the definition of **"substantial dwell time."** One interpretation could be that dwell time is the time it takes the casualty area or "footprint" to pass over any particular spot on the earth's surface. The dwell time would be calculated by dividing the "length" of the casualty area by the rate at which the casualty area was traveling across the surface of the earth. For example, a one (1) mile long footprint of the casualty area traveling at 4 miles/second across the surface of the earth would equate to a dwell time of 0.25 seconds. This would equate to that spot on the earth (and presumably the person on that spot) being potentially exposed to danger for essentially one quarter second as the vehicle's IIP passes by. An maximum allowable "dwell time" could then be established by the FAA and applicants would provide evidence that the dwell time over any populated area was not in excess of the maximum. The FAA would specify the maximum allowable dwell time for all vehicles over densely populated areas and for unproven reentry vehicles over populated areas. However, rather than arbitrarily establishing either allowable dwell time, Space Access suggests the FAA review ELV (ascent only) and Space Shuttle (ascent and reentry) dwell times and establish allowable dwell times for commercial RLVs consistent with their findings. It would not be appropriate to arbitrarily restrict one class of launch

vehicle (RLVs) when no similar restriction is placed on another class of launch vehicles (ELVs) providing essentially the same service.

Another means of determining an acceptable dwell time would be to calculate the cumulative time the IIP takes to travel over the inhabited areas of interest. For example, if an IIP was traveling at 4 miles/second across the surface of the earth, it would take 25 seconds to pass over a "populated area" which was one hundred (100) miles wide. Again, Space Access suggests that the FAA establish allowable times by reviewing ELV licensed trajectories and Space Shuttle operations to determine allowable dwell times consistent with industry standards rather than selecting arbitrary and possible inconsistent requirements. Then, applicants of proven vehicles could calculate their IIP dwell time over densely populated areas and compare it to the allowable time to quantitatively determine if their proposed trajectory was acceptable. Likewise, applicants of unproven reentry vehicles could calculate their IIP dwell time over populated areas and compare it to the allowable time to quantitatively determine if their proposed trajectory was acceptable. This approach seems more appropriate since it lends itself well to objective quantitative assessment.

It is of interest to note that the discussion associated with "populated" areas refers to "reentry vehicles" while the wording in Section 431.43 regarding the actual restriction associated with "populated areas" refers specifically only to "vehicles" without mention of "reentry." Space Access requests that the FAA clarify whether the restriction associated with populated areas applies to all vehicles or only to reentry vehicles.

The Proposed Amendment provides an exception to the restriction associated with the limitation on dwell time for unproven reentry vehicles if the applicant can demonstrate that it satisfies stated risk criteria assuming the vehicle will fail while the IIP is over a populated area. This appears to ignore the utility of provisions to enhance EC and instead leads to a potentially inappropriate solution: many flights of smaller vehicles, which collectively would be likely to subject the public to much greater overall risk. Further clarification of this "exclusion" would be appreciated.

Space Access also recommends the FAA acknowledge that with proper planning, appropriate design criteria, quality control in manufacturing, and a combination of both ground and flight test demonstrations, an applicant could expect the issuance of a transport certificate or the equivalent which would remove many of these restrictions.

In summary, Space Access recommends that the FAA review and quantify the risk exposure created by ELV and Space Shuttle operations and, consistent with those findings, provide quantifiable criteria regarding the dwell time of RLV IIPs over inhabited areas.

Attachment 13. Industry Compliance Costs

Industry compliance costs appear to be underestimated. Space Access estimates compliance costs as follows:

Section 431.25 – estimate 80 hours vice 8.

Section 431.33 & 435.33 Safety Organization and Safety Official. Space Access estimates the safety organization will most likely be 4 to 5 individuals, not one.

Section 431.35 & 433.35 RLV Mission Risk. Space Access estimate is $700,000 / year for 3 to 5 years prior to operations and at least $100,000 / mission for risk analysis. In any given year with an average of 20 missions this is $2M to do the required mission analysis for risk.

Section 431.37 & 433.37 Mission Readiness. Dress rehearsals 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, the Space Access estimate is 3,600 man-hours vice the 80 hours indicated. This does not include monitoring between flight activity for mission readiness FAA compliance.

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

Section 431.45 & 435.33 Mishap Investigation Plan and Emergency Response Plan. Each inspection may average 5 people over a one day period so this equates to 40 man-hours / inspection. Expecting a total of 6 inspections per year into various functional areas this would be 240 man-hours alone each year. Over 15 years this is 3,600 hours. This cost is in addition to maintenance of described plans. This cost estimate may be close at $542,000 / operator.

Section 431.57 and 435.43 Payload reentry review. FAA estimates $400 per application. Space Access believes well over 50 payload types may be flown over a course of 15 years. This would equate to $20,000 / operator.

Section 431.73 Continuing Accuracy of License Application. Space Access projects this to be a major cost driver—to document and maintain configuration control over all vehicles in Space Access fleet, to know 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 (AD) used in aircraft. Compliance with ADs 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.

Section 431.77 & 435.5 1 Post Licensing Requirements. Maintenance of flight data can be very costly since 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 mission / year over 3 years will make the storage costs alone $60,000 / operator rather than the $6,000 indicated.

Section 431.93 & 435.61 Environmental Information. Space Access estimates the cost to accomplish an Environmental Impact Statement (EIS) and keep it updated is between $500,000 and $1,000,000 vice the $271,000.