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September 23, 1999

U.S. Department of Transportation
Docket No. FAA-1999-5833 – 8
400 Seventh Street SW.
Room Plaza 401
Washington, DC 20590

Attention: J. Randall Repcheck
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Reference: Notice of proposed rulemaking (NPRM) for
Licensing and Safety Requirements for Operation of a Launch Site.

Gentlemen:

Space Access, LLC, reviewed the reference document and has the following general comments and five specific topics for change. Within the five specific topics, there are several individual recommendations. A quick summary of major points is made at the end with a list of recommendations.

The general comments are:

Since these proposed rules are to govern activity both currently under consideration and well into the future, Space Access would like to see rules that are universally applicable to all commercial space activity. This would include existing Expendable Launch Vehicles (ELVs), proposed Reusable Launch Vehicles (RLVs), the launch activity and any reentry activity. The rule should be consistent with all other rules and require as few exceptions, waivers, or exclusions as possible. Space Access recommends that each rule stand alone in separate documents to avoid duplicity and avoid guidance that is conflicting.

Since this proposed rule covers licensing and safety requirements for operation of a launch site, it should put primary interest on the activity occurring on a site. The preparation for a launch, launch and any activity or process conducted on or near the site that might endanger the public health and safety are then considered significant events for this licensed activity. Other rules and proposed rules cover the vehicles, both expendable and reusable, and reentry activity. The guidance in these rules should not be duplicated or repeated in this rule. In addition, the FAA has published supplementary information to help potential licensees understand and consistently apply specific methodology or practices. Specifically, Advisory Circulars for Expected Casualty, AC 43 1.35 1, and the RLV System Safety Process, AC 43 1.35-2, are in draft form now.

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Lastly, any rule must be adequate to provide for the public safety, but not stifle or constrain the industry. Crucial financial and business decisions must be made in order to bring any vehicle or site into existence. The rule must achieve minimum safety standards but not require excessive agency oversight or business duplication of effort. Incentives should be in place at all levels that encourage product and process improvement. This is the greatest method to move significantly towards improved public health and safety. Both existing regulations and these proposed rules avoid changes to the status quo. Instead they should be instruments providing visionary practices to motivate and accelerate positive change.

The document becomes very difficult to accept in the two following areas:

The first major area of concern is overlap with mission-based Expected Casualty (E_c) calculations. A large section of the document is dedicated to providing methodology to simplify this complicated process for site operators. The document states in several locations that detailed analyses must be accomplished by the launch operator and that these computations are beyond the scope of this document. Space Access agrees that these issues should remain outside the scope of site licensing and that all flight-related and mission-based calculations are the responsibility of the launch operator. These, therefore, should be covered under separate rules specifically for launch vehicles. Providing several methods to simplify E_c in this proposed rule is confusing, potentially conflicting with other published guidance, AC 43 1.35-1, and could be considered precedent setting. Overall, these calculations must be done with the greatest degree of accuracy and in a standardized and consistent method to ensure all commercial space activity is held to the same objective standard.

The second major failure within these proposed rules is the tables of quantity distance values provided for liquid propellants. The supplementary information states that the FAA is involved in work to revise these numbers and that they should change in the future. Space Access recommends the FAA accelerate this work and provide these values as soon as possible. These numbers will have major financial impacts to both the site operators and launch vehicle operators in terms of land acquisition, usage, safe separation distances for storage and public access and procedures for use in all phases of operations leading up to the launch. If these numbers were to go down significantly, then total land acquisition for launch sites might go down by the same order of magnitude and operations and maintenance activity could also be directly effected. With absurd safety requirements, launch operators will never achieve aircraft-like operations if they are continually evacuating sites and areas to meet outdated policies and there is no flexibility to meet safety criteria by means other than total separation distances.

The document does describe some of the differences in potential origins of the data and FAA rationale for picking which parent organization's data to use. There seems to be a lack of discussion of the distances required by the FAA parent organization, the Department of Transportation (DOT). These are the regulations that cover all ground transportation of liquid propellants. Space Access is very interested in a single standard being used for

propellants. For example, DOT road or rail transportation may use numbers in tens of feet for public safe distances and then when it enters a launch facility that safe distance may be changed to hundreds or even thousands of feet. Numerous other standards also exist in National Fire Protection Association publications and in local fire codes. For example, the use of kerosene-based fuels in large transport aircraft vices the same fuel being used in a space launch vehicle. In the first case, the public is placed inside a pressure vessel sitting atop a massive fuel tank that is vented to the atmosphere effectively making it a small bomb. In the second case of a space launch vehicle, the public will be kept several thousand feet away from the storage of the fuel alone and up to 2.14 nautical miles, 12,983 feet, away from the vehicle if ready for takeoff. Space Access fuel tanks will have double steel walls, precisely controlled pressure environments and only inert nitrogen or helium gas introduced into the fuel tank preventing any potential explosion and further eliminating risk.

In addition to having realistic numbers for quantity distance, there needs to be procedures and policies such that incentives are in place for actually designing and operating in a safe manner. Existing quantity distance regulations allow tradeoffs between dirt or distance such that effective earthen berms or containment walls can be used to reduce safe distances. This should be the same with adequate design and procedures. By use of proper tank design that prevents and contains explosive hazards and proper procedures such as tank pressurization and venting, the safe distances required can be mitigated. In the proposed guidance, there is no motivation for improving the design or procedures since all that matters is total quantity or TNT equivalency. The TNT equivalency for large transport aircraft carrying 200,000 pounds of jet fuel is 40,000 pound of TNT equivalency. In this case the public would not be allowed within 1,370 feet of the aircraft. However, known safe practices and design principles allow people on-board and within inches of those fuel tanks. However, if that aircraft is used as part of a launch vehicle, then on takeoff the public is required to be up to 12,983 feet of safe separation. In addition, the DC-X program had specific goals to demonstrate new procedures for space launch operations and this included fueling and automation capability. Numerous studies and work by NASA and the Air Force over the past 40 years of space activity indicate that the procedures can be updated and improved. Space Access strongly recommends the FAA take active measures to get all federal agencies to adopt a single realistic standard for liquid fuels. The FAA should strongly advocate the use of methodology that trades design and procedures for distance. The regulatory agencies should put into place incentives for industry to improve the design and safety of launch vehicles instead of stifling these efforts by allowing the status quo to dictate the procedures for all existing and proposed new designs.

Considering this above general philosophy, Space Access considers the impact of the proposed rule to be significant and has the following specific topic areas and associated recommendations:

1. The proposed rule effectively precludes approval of any new commercial launch sites. The non-approval of new U.S. based sites will force additional use of foreign sites and launch vehicles. This action therefore opposes National Space Policy goals. This is true based on the following reasons:

A. In order to verify the proposed ruling calculations, Space Access hired ACTA Inc. to analyze the Cape Canaveral launch site using the Appendix A and C methodology provided in the reference document. The data and methods provided are based on the most reliable existing acceptable commercial expendable launch vehicles. The ACTA calculated casualty expectation is 0.527 for the FAA provided generic large launch vehicle on a 90" launch azimuth. The number is extremely large compared to the FAA E_c criteria of 30 x 10^{-6}. As the report states, "The Florida launch site results indicate that all risk is due to the population centers beyond 3,000 nm downrange. Thus, the FAA methodology produces extremely high casualty expectation results compared to previous downrange over-flight risk analyses performed by ACTA." Because the E_c is 4 orders of magnitude greater than allowed, ACTA performed the analysis for a medium launch vehicle as well. The smaller expected casualty area allocation provided a much smaller E,. The result for an FAA provided medium vehicle, such as a Delta, was an E_c of 6.11 x 10^{-4}. This E_c still fails to meet the FAA criteria of 30 x 10^{-6}. Therefore, under the simplest provided methodology, Cape Canaveral would be disapproved as a launch site for Delta, Atlas and Titan vehicles if it were not on federal property.

B. Utilizing instead the Appendix B and C method will yield little significant difference in E_c since this method uses the same casualty area numbers from Table C-3. These casualty areas are the significant driver in the calculations.

(1). The Expected Casualty Area (A_c) provided in Table C-3 for a large launch vehicle is 100,000 times larger than a small vehicle and 1,000 times larger than medium launch vehicles. The effective casualty areas should all decrease with range as the supplemental data states, however the large vehicle data gets larger. In actuality, the dry weight of a large launch vehicle may only be 2 or 3 times as much as a small launch vehicle. This should equate directly into the number and mass of debris fragments that can cause casualties.

(2). ACTA believes a realistic number for A_c is on the order of 900 to 1,000 square feet for upper stages. The FAA uses a minimum of 0.717 square miles or 26,470,045 square feet for the casualty area of a large launch vehicle in the final stages of acceleration. In perspective, this is 588 football fields of casualty area. The small launch vehicle area ranges from 129 square feet up to 15,874,644 square feet. Medium launch vehicle areas are 30,641 square feet up to 19,566,421 square feet. Medium Large vehicles are 3,987,119 square feet up to 26,211,62 1 square feet and large vehicles are 26,470,045 square feet up to 71,620,485 square feet. To achieve these extremely large casualty areas, a launch vehicle would have to break up into 1.4 million pieces; each with a 50 square foot casualty area having a Ballistic Coefficient over 3. The use of the Appendix C provided data would appear to be excessively conservative and overwhelms all other calculations.

C. Prospective sites that use the provided methodology of Appendix A & C will get an answer that says their site is considered unsafe and will not pass the FAA criteria. The Appendix B and C method, incorporating actual launch vehicle trajectory data, will most likely not improve the answer significantly.

D. The provided Appendix C Expected Casualty Areas may allow only the approval of small launch vehicles. This encourages more launches of small payloads, each with an E_c of 30 x 10^{-6}, and therefore increases overall risk to the public by exposing them to a large number of launches. A normalized risk evaluation, such as risk per pound of payload, minimizes total risk to the public and should be considered in any risk methodology. Space Access, LLC, provided inputs on risk normalization in the NPRM response for RLVs and will provide that and additional rationale for this approach as requested.

E. The impact is that potential launch site operators will fail to get sufficient local and state support, financial and legislative inputs, to work through issues with the FAA and potential launch operators. The enforcement of these proposed rules at this time would negatively affect the development of new safe launch sites for all class of launch vehicles.

F. Space Access Recommends:

(1). The FAA delete all E_c calculations from the proposed rulemaking for site operators. The Appendix A and C methodology appears to be extremely inaccurate. Appendix B and C methodology lacks the fidelity required for use by launch operators for licensing, as the FAA states in the supplemental information. The Appendix B and C method E_c will most likely not change much over the number provided by the Appendix A and C method and is therefore no additional value. This would leave actual vehicle E_c data as the only valid method.

(2). The FAA standardize E_c calculations and methods as referenced in the FAA Advisory Circular 43 1.35-l. These E_c calculations should be performed by launch operators in conjunction with experts in range safety analysis, such as ACTA, RTI, or The Aerospace Corporation. The results of a valid E_c calculation could then be provided to a site operator as required. This is the third and most accurate option available for site operators to use in the proposed rules. If E_c is required, a valid number produced by approved methodology should be the only E_c value used. Evaluation of the methodology indicates this may be the only way a site operator will likely prove the ability to meet acceptable E_c criteria for the launch vehicle mission. If actual launch vehicle E_c is required, then approved methodology should be established to do this analysis. The FAA has stated it uses “DAMP” for some of the calculations to validate the other methods. If the FAA owns this program or approach, Space Access suggests it should be provided to potential launch operators for preliminary and final E_c calculations.

(3). The Launch Point, Debris Dispersion Area and Overflight Exclusion Zone definition and descriptions in the proposed rules are of specific concern to a site operator and should be formalized. This guidance will directly benefit potential site operators by providing clear planning and procedures to use for proper land acquisition and site development work. Space Access recommends these areas be defined with more accurate liquid propellant quantity distance data and the use of appropriate vehicle reliability data. Probability of Failure data should be as accurate as possible to allow appropriate safety measures and procedures. By proper definition of these areas and rules, the FAA can provide incentives for improved vehicle design and operation.

(4). The FAA should delete the discussion of Launch Area and Downrange Area from the proposed rule. The proposed Launch Area and Downrange Area, including distances up to 5,000 nm, should not be of concern to the site operator since they have little or no legal control, liability or responsibility in these areas. The launch vehicle control and liability after leaving the immediate vicinity of the launch site are by law borne by the launch operator to the FAA and the international community. Requiring the site operator to be knowledgeable or responsible for E_c calculations in these areas is in conflict with existing guidance.

Note: Possible demarcation of responsible areas or the range of influence for a site operator is suggested to be when a launch vehicle enters into international airspace (100 km or approximately 300,000 feet in altitude or the crossing of a vehicle into airspace above international waters). This requires the site operator to evaluate safety and overflight issues until any proposed launch vehicle exits "Sovereign" control. This definition helps to establish "good practices" such that coastal launch locations launching over water would normally be approved for the site operator. Launch operator approval will still depend on final E_c calculations. However, inland launch locations or coastal locations launching inland over large land masses or populated areas must be concerned with overflight corridors and airways until reaching the coast or above 100 km as required. If the site operator proposes or can conduct only these type operations, the site may require an E_c analysis provided by the launch operator to satisfy overflight, airspace and site safety concerns before a license is approved. Another possible way to define where site operator responsibility stops and launch operator responsibility continues is when takeoff or liftoff occurs.

(5). Guidance for site explosive safety planning, scheduling, notification, and control issues are all appropriate. The ability of a site to provide safe storage of propellants, restricted access and to adequately provide for the protection of the environment are the critical issues they must address and be responsible for to the FAA. Space Access again asks that the correct numbers be determined and incentives be put into place. The use of proper safe distances and allocation of better design and procedures should be incorporated into this guidance.

2. Space Access would like potential site operators to use an appropriate Probability of failure (P_f).

A. P_f as indicated in document is 0.1 for all cases.

B. The proposed rule does not allow different calculations based on changing reliability data. The proposed rule, $P_f = 0.1$, will stifle or prohibit new launch site development by arbitrary use of static historical first generation launch vehicle statistics.

C. Space Access recommends the FAA provide a methodology that depends on current reliability data for the specific vehicle or class of launch vehicles under consideration. The use of well proven standards of reliability for commercial aircraft by Space Access will significantly reduce overall public risk, especially during atmospheric phases of flight. With the advent of highly reliable Space Access SA-1 launch vehicles, the probability of failure and therefore

expected casualty numbers change significantly. Future additional launch sites wanting to host the SA-1 family of launch vehicles should be allowed to use appropriate Launch Point, Debris Dispersion and Overflight Exclusion Zone values based on the proven reliability of the system and proper quantity distance measures.

3. No benefits are provided by a Federal Launch Range exemption to these proposed rules.

A. All commercial launches should be treated equally from any location.

B. The perception by new commercial launch operators and new commercial site operators is they are being held to a higher standard. Lack of an objective standard applicable to all launch vehicles and sites is a detriment to development of new launch vehicles and sites at this time. Fair and impartial rules for all launches should be established.

C. Space Access recommends the FAA not exempt commercial site operators established at federal ranges from future application of these rules.

4. With deletion of EC calculation by potential launch sites there is no reason for Reusable Launch Vehicle (RLV) exclusion.

A. Almost all potential new commercial launch sites in the planning stages are for RLVs or are located on federal property. Clear and succinct guidance for potential RLV sites is most appropriate now instead of qualifying ELV rules applicable to the license renewal of one known expendable launch site not collocated at a federal range-i.e., Alaska.

B. Space Access recommends the FAA provide proposed universal rules applicable for RLVs and ELVs as soon as possible rather than using this effort as applicable to only one ELV site not on federal property. With adoption of Space Access recommended changes, these rules are universally applicable to all launch sites. However, the rule should not be published until RLVs can be included.

5. The unproven vehicle exclusion is unjustified.

A. Not having a clear definition of proven versus unproven status will only confuse launch site and launch operators on which rules apply. The FAA should provide a clear definition of proven versus unproven vehicles. Proven and unproven vehicles will most likely differ in the accepted values for probability of failure. This is additional rationale for the use of proper reliability and failure data.

B. Space Access recommends the site rules for both proven and unproven vehicles be established if possible.

In summary, Space Access found the document covers much more than we anticipated and has potential impacts to not only site operators. Space Access found the proposed rules conflict with

guidance for E_c and that they confirm the status quo for quantity distance values. Space Access highly recommends that the FAA lead or accelerate the effort to clarify the actual hazard and potential incentives to commercial industry on liquid propellant and potential product improvements in fuel tank design and safety procedures.

Space Access specifically recommends the FAA:

1. Delete of all E_c calculations and requirements from the proposed rules.
2. Standardize E_c calculations in a separate launch vehicle rule. Refer sites to those rules.
3. Establish Launch point, Debris Dispersion, and Overflight Exclusion Zones based on incentives to improve vehicle design not just based on class of vehicle.
4. Delete Launch Area and Downrange Area definitions and calculations.
5. Formalize rules for safety planning, scheduling, notification and accident investigation.
6. Adopt a method to use appropriate Probability of Failure data.
7. Delete exemption for commercial sites on Federal Launch Ranges.
8. Hold off on establishing rules until RLVs can be included.
9. Define unproven and proven launch vehicle site operating rules.

I hope you can use the information provided to produce an improved rule in the future. If you have any questions or comments, please call me at (303) 478-4745. Space Access, LLC, would be pleased to participate in a meeting with ACTA Inc., and the FAA to review actual Appendix A and C calculations to determine if procedural errors, table values or database errors occurred. Space Access would also like additional time to assess the potential impacts of these proposed rules since they have far reaching effects on the emerging RLV launch industry today. Several potential operating sites for Space Access are concerned with what these rules might mean, but have had limited time and resources to fully evaluate and respond since the proposed rule practically requires a complete E_c calculation to establish validity of potential launch site location.

Very truly yours,

SPACE ACCESS, LLC

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