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Today I will discuss the different ways in which aircraft regulation and launch vehicle regulation protect public safety, explain why the launch vehicle approach is more appropriate for the emerging suborbital spaceflight industry, and discuss where the line between aircraft and launch vehicle regulation should be drawn. I will close with a few remarks on commercial human spaceflight.

A few words about my experience in this area are in order. I am president of XCOR Aerospace, an entrepreneurial space company in Mojave, California. We have been working on safe and reliable rocket propulsion systems and vehicles since 1999. I have been involved in launch vehicle regulation issues since 1998 and have been traveling to Washington regularly to work with the FAA since 2000. In the last few years, XCOR has accumulated over 1,800 firings of rocket engines without any safety issues, and we have flown a manned rocket-powered vehicle fifteen times. These early flights took place as an experimental aircraft, and we are now ready to begin construction on higher energy vehicles. We are therefore bridging the two worlds of aircraft and launch vehicle regulation.

Aircraft regulation has always developed after the fact. The first aircraft regulations did not arise until after more than 20 years and tens of thousands of flights' experience. When the first regulatory actions were taken, the operating experience of the industry was used to identify best practices and to eliminate things that didn't work. The assumption has always been that to protect the public, we must prevent crashes. Over time, more and more such regulations have been written; usually toward a specific technology, e.g.; This kind of riveting is acceptable, that kind is not. This kind of instrument is acceptable, that kind is not. After 75 years of such rule making, the aircraft industry is among the safest enterprises in the world, and also one of the most resistant to the commercial introduction of new technology. Any innovation must prove itself safer than the established practices; a difficult burden indeed, given the millions of flights' worth of experience with established methods. Experimental aircraft are allowed to use new technology, but only for non-commercial applications.

Reusable launch vehicles (RLVs) are dramatically less mature. All space launches to date have been single-use expendable vehicles, except for the Space Shuttle and small suborbital rockets with parachute recovery. The safety record of expendable launch vehicles is poor, since a launcher with a failure rate of one in 50 is considered reliable. As a result, launch vehicle regulation has developed quite differently from aircraft regulation. In launch vehicles, we assume that failures will happen and we take steps to ensure that those failures will not endanger people on the ground. As a result, no launch vehicle accident has ever caused a casualty among the uninvolved public.

This safety is achieved by a combination of flying in sparsely populated regions and providing high-reliability means of stopping the flight if it goes awry.

In 1998, Congress expanded the regime for launch vehicles to include reusables. Since then, AST developed regulations for RLVs based on what they expected operational practices would be. It has taken four years of constant effort by AST and industry to devise and refine interpretations of those rules in the absence of precedents to point to, but we are finally getting there. Today, at least three companies, including XCOR, are going through the licensing process for suborbital RLVs.

The only way that the emerging RLV companies will ever be able to develop into a profitable, job-creating and tax-paying industry is to fly, and fly for revenue. And while we fly for revenue, the uninvolved public has to be kept safe. The launch vehicle regulatory regime is the only available means to protect the public while permitting revenue flight.

As recently as a year ago, I would have thought it obvious that our vehicle would be regulated as a launch vehicle. But events over the past year have shown that there are contrary opinions, which I hope we will lay to rest. The Commercial Space Launch Act of 1984, as amended, states clearly that if you have a launch license, no permission from any other executive agency is required. That language was put in place because the first attempts to launch commercially were stymied by overlapping jurisdiction; dozens of Federal agencies all claimed the authority to say "no," but had no responsibility for the consequences, and hence no motive to say "yes."

Now, because some of the suborbital RLVs being developed have wings and pilots, some argue that these are not launch vehicles, they are airplanes. This claim is made despite the fact that NASA's Space Shuttle orbiters and Orbital Sciences's Pegasus both have wings. In 1984 Congress defined *launch vehicles* to include *suborbital rockets*. One might say "Well, it's a rocket, and it doesn't go to orbit, so it's a suborbital rocket." However, we don't want to create a loophole, in which an otherwise conventional aircraft could mount a rocket on it and claim exemption from aircraft regulation. After almost a year of work, AST proposed a new definition, in which *a suborbital rocket* is a *rocket-powered vehicle whose thrust exceeds its lift for the majority of its powered flight*. Since airplanes are defined as vehicles supported by lift, we think this is a good definition.

For those who have exclusively flown experimental-type aircraft, the launch vehicle regulatory world can seem daunting. On closer examination, it is less so: all that is needed is to demonstrate that the public is safe. This is only more burdensome than for experimental aircraft because the precedents are not yet set. The regulations and regime for test flying experimental aircraft are well known, and the failure modes are well explored. There are procedures for communications, emergency response, etc., written down. XCOR believes that requiring launch providers to document their procedures is worthwhile.

The largest burden in moving from aircraft to launch vehicle operation, and the least justified, is that launch providers and launch site operators have to assess their environmental impact. Aviation, including experimental aviation, operates under a categorical exclusion (CATEX) to the National Environmental Policy Act. We have discussed pursuing a CATEX with AST, but until there have been a number of reusable launch vehicles using non-toxic propellants, it is difficult to establish parameters for a category to exclude. Let me make it clear that the vehicles we and others are developing have very low environmental impact. And while the burden of documenting this is substantial, it is likely unavoidable.

Another advantage of the launch vehicle regulatory regime is that liability insurance is already established. Launch vehicles are required to carry liability insurance up to a level called the maximum probable loss (MPL). Let me make that a bit clearer. For me to launch, I have to carry sufficient insurance to cover any reasonably possible damage to third parties. The loss probability is set to a one in ten million threshold, which is so high that we could fly four times every weekday for ten thousand years before an event exceeding the MPL would occur. Only in the case of a freak accident, with losses exceeding the MPL, does the U.S. government's promise of indemnification come into play. By eliminating the need for insurance carriers to consider wildly improbable accidents in setting insurance premiums, the insurance costs to launch providers are reduced, so far at no cost to the taxpayer.

I would like to close with a few remarks on the question of carrying people in launch vehicles. Launch vehicle regulation already protects the uninvolved public. Just as with aviation in its early days, many adventurous people see this enterprise as exciting and important. They want to go. Again, just as with aviation, this enterprise will be risky and costly in its beginning; but if allowed to proceed, the cost and the risk will go down over time. We need to go through the same process as aviation; start flying, find what works and what doesn't, then make improvements. If we insist on perfect safety, we will get it… because no one will ever fly.

I have been responsible for over a dozen flights of a piloted, rocket powered vehicle. I assure you that I and my engineers will fly aboard our vehicles long before we consider them safe enough for paying customers. Nor would we ever consider flying someone who was not fully informed of the risk involved. If Americans are willing to risk their lives and wealth to open a new frontier, why should we stop them. America would not exist if our ancestors hadn't done the same. Our first flights may seem small and unimportant – but they are only the first steps on a very important road.

Jeff Greason

President, XCOR Aerospace

Jeff Greason co-founded XCOR in September 1999. At XCOR, Mr. Greason has managed a team developing small rocket engines and complete rocket-powered aircraft at a cost and schedule far superior to prior practice. XCOR has demonstrated a very low cost reusable rocket vehicle, the EZ-Rocket, which has had fifteen flights. Previously, he spent two years managing the propulsion team at the Rotary Rocket Company. There he built a world-class development team, and led key technical efforts in rocket engines. Mr. Greason has been involved in space vehicle regulation since 1998 during the rulemaking process for reusable launch vehicles and has been an active member of the FAA's Commercial Space Transportation Advisory Committee (COMSTAC) RLV Working Group since 1999.

Prior to joining Rotary Rocket, Mr. Greason served as a technical manager at Intel Corporation. In 1992, he received the Intel Achievement Award for his work discovering a less expensive BiCMOS technology than competitors, which became the basis for the Pentium product line. Mr. Greason is an experienced technical manager, has wide knowledge of rocket engine and rocket vehicle design from five years study and four years experience, and has nine years experience in other high tech product development. He holds 18 U.S. patents, has authored numerous publications and has a BS degree in engineering from California Institute of Technology.

Professional awards:

- Received Intel's Portland Technology Development S.T.A.R. award in 1997, an award given only twice before to recognize outstanding technical achievement, for work in defining the interconnection technology on Intel's 0.18u CMOS process.
- Received the 1992 Intel Achievement Award for contributions to "defining and implementing a unique, cost-effective approach to BiCMOS processing for Intel"
- Received Intel PTD divisional recognition awards:
    - 1992: "Implementing and validating Full Self Test features on the 51S6."
    - 1989: "The development of CLCD programs for hot electron checking."

Professional memberships

AIAA, IEEE, Society of Allied Weight Engineers, British Interplanetary Society, National Space Society, Space Access Society, Reaction Research Society.