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The Emerging Commercial Suborbital Reusable Launch Vehicle Market

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Subcommittee on Space and Aeronautics
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Opening Comments

Chairman Palazzo, Ranking Member Costello, and members of the Subcommittee, thank you for the opportunity to meet with you about the reusable suborbital vehicle marketplace. Although small today, this market's successful emergence is critical to America's future economic strength, global scientific leadership, educational supremacy and our national security. It is therefore timely that Congress look at the impact of regulatory uncertainty on these markets, how industry interacts with the FAA, and how this industry contributes to job creation, the health of the aerospace industrial base in the US, and our country's international space competitiveness against strong head winds caused by the current export licensing regime.

The Vision That Drives Us

But before I address these specific questions, I would like to paint a picture for you of the future of space access and development that we at XCOR envision. Our vision starts with the premise of "human settlement" and economic prosperity from space-based businesses and ventures that may drive prosperity for generations. In the not too distant future, we envision humans creating sustainable businesses in space, settling other bodies in our solar system, and in the distant future, even perhaps going beyond our solar system.

A great number of technical, legal, business and economic challenges must be solved before this happens, but the first challenge that must be solved has to be lower cost, safer, and more regular and dependable access to space. But in order to achieve this, industry and government customers must be able and willing to take the risks incumbent with any ground breaking, hard and difficult task, free of regulatory uncertainty and excessive constraints on the fundamental risk taking spirit that built our great country.

As with any mode of transport; rail, air, sea, or even roads, this means full reusability of vehicles with negligible servicing between operation, and for space, this means fully reusable propulsion systems, robust thermal protection systems and safe reentry mechanisms that support near-

daily operations. This has been our research and development focus at XCOR for over 12 years, and will remain our focus for another 12 years, and probably more.

In addition to being a viable commercial market in its own right, the suborbital RLV industry is also importance today because it is the proving ground for safer, fully reusable, and much more affordable orbital access technologies, concepts, and practices that we believe will create the next multi-trillion dollar global enterprise, the Commercial Space Enterprise, much like the Internet and the global communications networks we have today.

XCOR Introduction

XCOR Aerospace was founded by four individuals who had dreamed of going to space for much of their entire lives and had followed their vision into professional careers in the aerospace industry, sometimes giving up much more lucrative opportunities in other industries. They pursued their American Dream without the benefit of great personal wealth, but with determination, their knowledge, and their wits. And in 1999 when the four were laid off from a previous entrepreneurial rocket company, they did not give up. They chose to follow the ethos that Henry David Thoreau expressed when he said, "Go confidently in the direction of your dreams. Live the life you have imagined." And in so doing, have arguably created one of the most innovative and determined aerospace companies the US has seen in the last fifty years, XCOR Aerospace.

Now on the verge of commencing test flights of the Lynx suborbital reusable launch vehicle, XCOR has spent the past 12 years building a business from scratch, boot strapping themselves in the early days with credit cards, savings and the goodwill of friends and family, with not a billionaire in sight. The company has since designed, built and tested fourteen different rocket engine designs, and has several more in various stages of development. The company has a string of firsts and records that would be the envy of any aerospace company 100 times our size, including:

- In 2001, the first commercially designed, developed and flown rocket-powered vehicle in the world, the XCOR EZ Rocket;
- In 2003-4, proposed, and with partners and supporters in Congress and the Administration, won passage of the Commercial Space Launch Amendments Act of 2004, thereby establishing the regulatory basis of the new Commercial Space Flight Industry;
- In 2005, we delivered the first US Mail by rocket powered aircraft and in the same flight, set the recognized world record for rocket powered point to point flight (it is also the *shortest*, long distance flight in the Fédération Aéronautique Internationale, FAI, record books!)
- In 2007, designed, built and tested the first new liquid oxygen / methane engine in the US in over thirty years;

- In 2008, developed the first piston pump fed rocket aircraft ever built and flown in the world, the XCOR X-Racer;
- In 2008, the first time a rocket powered aircraft flew seven times in one day, and carried eight people in the same day;
- By 2009, had flown 66 manned rocket flights, which at the time was over 50% of the manned rocket flights in the 21st century; and
- In 2010, demonstrated one of the world's first flight-weight liquid hydrogen rocket piston pumps.

The XCOR Product Lines:

XCOR has two primary product lines: fully reusable rocket engines and related hardware, and suborbital RLV launch services and sales (wet leasing) using those engines. In the future, we expect to develop a fully reusable orbital system and place that vehicle into service at US locations.

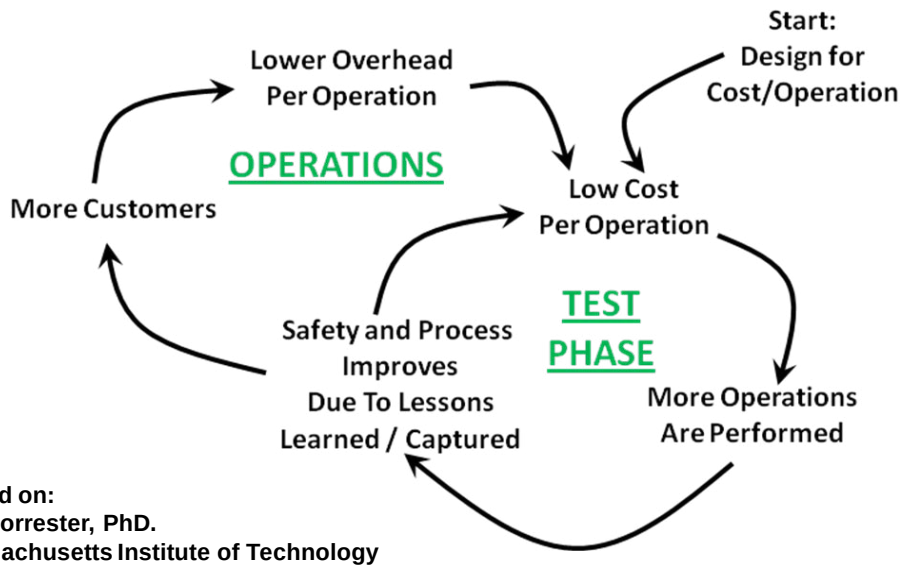
We sell non-toxic, liquid rocket engines and related design and testing services to US prime contractors, the government and second tier suppliers.

We intend to start operating Lynx vehicles commercially from Mojave, CA and other sites for ourselves, but the longer term plan is to "wet lease" Lynx RLVs to private and government customers in the US and, if allowed to export, around the world. This latter opportunity is key: if law and policy allow us, XCOR and our friendly competitors can return the US to global Space industry preeminence with a dominant position in technology and innovative approaches to customer needs, while helping to rebuild the weakened aerospace supplier base that threatens our national security space enterprise.

XCOR and our commercial sales partners have already sold over 200 flights (seats) for Lynx vehicles and announced wet lease contracts for the establishment of future independent "spacelines", thereby proving the market demand for flights and vehicles. [As in the early days of flight, Boeing became the airframe supplier, and United Airlines became the airline, we see the suborbital RLV market evolving along similar lines.]

What makes XCOR's rocket engines and vehicles unique are their full reusability, non-toxic propellants, environmentally-friendlier exhaust composition, exceedingly low cost of operation, and "designed for safety" philosophy.

To enhance safety, we believe in the Systems Dynamics model of holistic positive feedback originated by the noted MIT professor, Dr. Jay Forrester. As we design-in lower operational costs of our engines and Lynx vehicles, the more we can afford to test the system, thereby allowing us to improve the overall safety of the engine or vehicle at a quicker pace than those who have more costly and/or less operable systems. As systems, processes and safety improves, this should draw additional customers, which improves our unit costs, and thereby allows us to lower prices when the market dictates or we choose to do so. The improved safety and lower prices drive additional demand, and the virtuous cycle reinforces itself. This philosophy is shown in the simple figure below.



Based on:
Jay Forrester, PhD.
Massachusetts Institute of Technology
Systems Dynamics

Market Success and Market Growth:

To date, XCOR has seen significant market success and we see significant market growth in front of the industry as suborbital RLVs come on line.

The potential emerging markets for suborbital RLVs that XCOR Aerospace is targeting include:

- Vehicle sales and wet leasing (the future "spacelines," "personal and fractional ownership models," government, and "utility operators"),
- Launch services (personal space flight, nanosatellite launch, training, research, education, test / qualification, and others)
- Engine and related equipment sales and service.

Already, in the last 24 months, XCOR and our sales partners have recorded over 200 reservations for Lynx flights. In the last 12 months, there were over 150 sold, with the last three months seeing commitments signed for over 50 flights. I present these nested numbers to demonstrate to the committee that the velocity of sales is increasing as we get closer to commercial flight. We attribute this increased sales velocity to expected and easily estimated "network effects." One of these sales is a firm contract for tens of flights from a single purchaser as part of their commercial business strategy rewarding their customers, employees and partners. This "promotional or media" related sale is 100% of the projected annual market of a recent overly-conservative market demand forecast. Based on our sales to date, XCOR sees a demographic of personal space flight buyers that is quite broad; those with net investable assets of $1-2 Million and above, but many sales to enthusiasts well below that level of wealth. We are also seeing multiple flight purchases on our vehicles and from customers who are buying flights on our competitor's platforms. This bodes well for the future of our industry.

The personal spaceflight demand is separate and distinct from the scientific and industrial uses of Lynx and other suborbital RLVs. The unique benefits that suborbital RLVs offer the scientific community for research, and the industrial base for in-space equipment testing and certification services, are frequent access to space, significantly lower cost of experiment development and vehicle integration, almost instantaneous access to experiments upon completion, an ability to do multiple space flights per day, enhanced readiness levels for launch, and more potential launch sites than today.

XCOR projects these markets to eventually surpass the personal spaceflight markets in four to five years as the research, educational and industrial communities learn of the unique advantages of these platforms versus today's existing options for access to the upper atmosphere and micro-gravity (primarily, sounding rockets and parabolic aircraft flights) and make the appropriate program investments over time.

XCOR's Record of Active Engagement on Safety, Regulation, and Policy

XCOR has played a leading role within industry for over a decade by actively engaging with the FAA's Office of Commercial Space Transportation to work through many legal and regulatory issues facing reusable launch vehicles and commercial human spaceflight. For example:

- XCOR personnel helped FAA create a definition of "suborbital rocket" that allows airplane-like spaceships to fly under commercial space launch licensing, rather than commercial aviation certification rules.
- XCOR filed the first "substantially complete" license application for a piloted reusable launch vehicle, largely as a regulatory pathfinder.
- XCOR's Chief Executive Officer, Jeff Greason (and other staff) have actively participated for many years as a Member of the FAA's Commercial Space Transportation Advisory Committee, and as Co-Chair and long-time participant in its Reusable Launch Vehicle Working Group. Furthermore, XCOR has actively responded or otherwise participated in several draft rulemakings and guidance development efforts, as well as industry standards efforts.
- Finally, Greason has testified twice before Congressional committees, and led or participated in many briefings to Senators, Representatives, Executive Branch officials, and their respective staff on broad industry initiatives to promote ever-increasing levels of safety and related policy and regulatory issues.

With regards to specific regulatory issues, XCOR has a full time Director of Federal Relations who also serves as XCOR's safety officer and maintains direct contact with FAA staff in Southern California and Washington, D.C., about XCOR's vehicle design, development, and test plans. XCOR is very appreciative of AST Associate Administrator Dr. George Nield's efforts to move AST staff out into the field where they can directly observe and even participate in industry

development and test efforts. We would request that Congress provide AST with greater funding flexibility and encouragement to move more staff out of Washington and into the field.

Evolution of Industry Safety

As XCOR officials have stated consistently since the earliest days of consideration of the CSLAA, reusable launch vehicles – particularly those which are piloted and/or designed to carry spaceflight participants into space – are a new class of transportation vehicle, neither aircraft nor expendable launch vehicles, and they should not be regulated the same way as these century- or half-century-old technologies. Commercial human spaceflight in particular is a new industry, and neither industry nor government knows the absolutely safest way to design, build, and test these systems. Except of course not to try at all.

Our challenge is to learn what works and what doesn't work as quickly as possible, which ultimately requires flying hundreds and even thousands of flights. This in term implies flying for revenue, while fully disclosing the risks involved to our customers. That was the purpose of Congress' creation of a "learning period" in the original CSLAA, during which limited regulation of participant safety based on actual events was allowed, but speculative regulation: it would allow both industry and, frankly, the government, to learn together how to best achieve continuously-improving safety as the industry grows and innovates.

Of course, in 2004 many people believed that commercial flights might start the very next year, and therefore an eight year restriction would grant us eight years of learning. This did not happen, primarily because industry did not try to rush an early capability into commercial operation and we've seen an unprecedented economic slowdown that has impacted many companies's ability to maintain investor in flows to support more rapid development. Given that the learning period would have expired in December of this year, we applaud Congress' extension of that for the duration of the FAA reauthorization bill enacted earlier this year. In particular we appreciate this Committee's forbearance to allow that extension to become law as part of another Committee's legislation.

That said, next year we will come back to Congress to seek restoration of the entire eight-year learning period. Ideally, the eight year clock should not begin with the passage of legislation, but with the first licensed flight of a spaceflight participant for revenue, so that all parties gain from a full eight years of data-gathering before unfettered regulation may begin.

At the same time, XCOR has strongly advocated that AST use its existing authority to engage with industry – and vice versa – to discuss regulatory approaches, technical issues, and other safety concerns now. While no licensed or permitted flights have occurred that could lead to a formal rulemaking, there was never any statutory or policy limitation on discussing safety, indeed the CSLAA encouraged such efforts. It simply restricted AST's ability to promulgate rules in the absence of data, and even then the so-called "moratorium" was only for eight years.

XCOR is therefore enthusiastic about AST's recent initiative, as reported in *Space News* on July 23rd, to begin actively discussing safety issues and potential "guidance" that AST might promulgate today. Indeed, an XCOR consultant was largely responsible for securing greater policy flexibility within FAA to allow AST to pursue these discussions. XCOR staff have already met with Pam Melroy who is leading the effort for the FAA/AST and followed up on those conversations to demonstrate our commitment to supporting her efforts.

Regulatory Uncertainties and Their Potential Impact on the Industry

When XCOR was formed in 1999, the greatest risk we faced was that a commercial spaceflight vehicle with wings might be regulated as a commercial airplane, using the 75+ years of regulations that FAA and its predecessor agencies have built up to police commercial aviation. Congress solved that with passage of the CSLAA in 2004. Most recently, our concern was that the expiration of the regulatory learning period for human spaceflight could lead to unfettered regulation based on analysis and speculation, rather than actual flight data, or on reliance on inappropriate aircraft technical standards. Congress has partially addressed our concern by extending the learning period until October 1st of 2015, but this remains of great concern to industry and XCOR.

Recent statements by at least one elected official have suggested that even this short extension may be diluted in the final months of this Congress, a very negative outcome that we would request this Committee to oppose on a bipartisan basis. Any sudden changes or inconsistency in rules and regulations would have a chilling effect on the industry, and the thousands of jobs we represent, and the even more jobs we plan on creating in the next few years.

It is important for Congress to realize that the industry and FAA have been active in discussions with other regulatory agencies around the world, and we have been successful in persuading them to commence the process of adopt similar regulatory regimes to our own (the "licensing/informed consent" regime). This has resulted in a critical market opportunity for the companies at this table and others, pending export licensing, to potentially operate U.S.-designed and built suborbital vehicles at many locations around the world. Suddenly changing the US regulatory regime from a "licensing / informed consent regime" to a "certification" regime will cause other countries to stop their adoption of the "US System" and encourage the creation of local space vehicle certification regimes. Such activities would create the real potential of an uneven playing field for US competitors in foreign markets due to home grown regulatory and certification standards and also slow down the market introduction of US products and services in those foreign markets, thereby hurting high tech / high paying job creation at home.

The industry's and FAA's regulatory evangelism means that the same designs and operating practices that we refine and mature here in the U.S. will be able to satisfy other nations' regulatory requirements, gaining us not only revenue but additional flight experience and accelerated learning towards even greater safety, not to mention the job creation from the export opportunities.

Another impact (or probable unintended consequence) of not extending the learning period to the original eight year period, or eliminating the learning period in its entirety, is the real potential to actually decrease safety levels or at least inhibit continual safety improvement that is the characteristic of the *licensing* environment currently in place. This is seen when an item is "certified" there is great hesitancy to change it. In the aviation industry, that is justified, since the standards are based on over 100 years of experience and billions of hours of flight time.

In the fledgling commercial space industry, this is the exact opposite of what a responsible safety officer would desire. The rapid insertion of safety enhancements into rapidly maturing systems and processes is vastly preferential to the cautious "don't change it" approach characteristic of a certification regime. This latter approach would be especially counterproductive since spaceflight certification standards written in 2012 or even 2015 would be based on very limited flight experience, or worse still on human supposition about the meaning of this limited experience. At the same time, they would likely increase costs to manufacturers and operators, and therefore customers, all without any real increase in safety.

Another critical concern is that the FAA may be persuaded to rely on a specific government customer's unique requirements as the basis for safety standards. NASA's unique system requirements should not be turned into FAA regulatory certification requirements, now or in the future. NASA's "internal standards" are typically uniquely tailored to NASA's unique needs or culture, and therefore are inappropriate for commercial operations. NASA, as a customer, has the right and the obligation to set their own requirements to meet their mission needs, and has the right and the ability to waive those standards when appropriate. However, if a NASA standard is automatically adopted as a FAA regulation, then the commercial industry is stuck with the NASA customer requirement as a de facto standard. And it is perceived that the FAA and industry cannot "waive it" without extensive and costly deliberations. NASA should not be in the business of establishing or recommending standards to the FAA for commercial space flight.

A consensus industry-led body should be tasked with such efforts, much like the industry led body, RTCA, is tasked with developing technical standards for the aviation community, that then get promulgated into FAA airplane certification rules. As with the RTCA, government customer input can be welcomed and even actively sought when eventually establishing commercial space standards, but the government customer should not be the originator of draft standards nor set these requirements by fiat.

Export Licensing for Manned Winged Suborbital RLVs

A primary issue that is inhibiting a more robust international marketplace for US-designed and built manned winged suborbital RLVs is the export licensing regime. Currently, there is strong interest, and demonstrated demand, for these vehicles; however, such demand is severely dampened by the inherent uncertainty caused by the export licensing regime for these vehicles. Recent rulings have defined any manned suborbital reusable vehicle that crosses the 100 kilometers (62 miles) Karman line (an imaginary line that is the unofficial boundary of space and

the atmosphere) as being a "satellite" and hence on the US Munitions List (USML). This was, to our belief, never the intent of the original Thurman Act that placed unmanned satellites on the USML but explicitly excluded the only manned rocket craft of the day, the Space Shuttle, and the manned International Space Station.

Significant market opportunity, US technical leadership, and the related US-based manufacturing and operational jobs that will come with such sales, is not being capitalized upon due to the US export licensing regime. XCOR, nor the industry is asking for unfettered permission to sell winged, manned suborbital vehicles and systems to just anyone, but certainly, areas of the world that are allies to the United States should be considered "open for business." We encourage this subcommittee to take the leadership to explicitly identify "manned suborbital reusable launch vehicles" as a Commerce Control List (CCL) item, and open up the free world to US products, service and competitors.

Summary

I thank the committee for the opportunity to present these thoughts on the record for your consideration when considering future policies for our emerging industry.

The reusable suborbital launch vehicle industry is the proving ground, the initial step, to the necessary and required future systems and technologies that will enable a future Trillion Dollar Commercial Space Enterprise.

By serving as the pathfinders for fully reusable systems, the suborbital RLVs are also viable economic and innovation engines in their own right, with the promise of: creating tens of thousands of jobs over the next five to ten years; inspiring a new generation students to pursue the sciences, mathematics, engineering and technology professions; and reinvigorating the moribund tier two and tier three aerospace industrial base that threatens to impact our national security space apparatus.

An inconsistent and/or "certification" based regulatory environment at this stage of the industry's maturity would have a chilling effect on systems implementation, commencement of service, job creation, and the promulgation of a the "US System" of space-licensing that will promote the expansion of US exports and influence around the globe. We encourage Congress to pass the originally established "eight year learning period" after the first commercial suborbital RLV flight.

The export licensing regime currently in place is being interpreted aggressively by officials resulting in manned suborbital RLVs being placed on the USML and inhibiting the growth of these markets in countries friendly to the US, and negatively impacting the job market at home. We encourage the subcommittee to recommend legislation to move manned Suborbital RLVs to the CCL and enable US companies to meet pent up demand for these US designed and manufactured products and related services.