Testimony of

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Spurring Economic Growth and Competitiveness Through NASA Derived Technologies

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Chairman Palazzo and distinguished members of the Committee:

Thank you for the opportunity to address an issue that is of critical importance to our nation, the need for continued investment by the nation in advanced space technology and the commercial benefits it can provide to adjacent markets.

There has been an ongoing debate regarding the value of space-derived spinoff technologies and capabilities derived from NASA investment. When asked to identify products directly created by NASA, most Americans would name Velcro, Tang, and memory foam mattresses. There are also a significant number of well documented commercial spin-offs in many different areas including medical, transportation and communication which are derived from NASA investment. But what about the potential for commercial spin-offs derived from NASA's advanced liquid rocket engines like the ones produced by our company? This question is best answered by first understanding what is so special about these engines. They represent a special class of engineering described as high energy density products, or simply put, machines that generate an enormous amount of energy in a relatively small space.

Pratt & Whitney Rocketdyne has powered U.S. astronauts into orbit since the beginning of the U.S. human spaceflight program more than half a century ago, on the Mercury and Apollo programs as well as the 30-year long Space Shuttle program. In addition to powering hundreds of people into orbit, Pratt & Whitney Rocketdyne continues to power most DoD space launches, placing security, communication, navigation and weather satellites into orbit that are critical to the safety and security of our nation and our allies. Leveraging our understanding of how technology operates under the most extreme conditions, we are translating our core rocket propulsion knowledge into game-changing, innovative solutions to tackle some of our world's toughest energy challenges.

The main engines on the space shuttle are a great example of a high energy density product. They take liquid hydrogen, the second coldest liquid in existence, and combine it with liquid oxygen, and convert them into steam at temperatures of 6000 degrees Fahrenheit while being expelled at velocities more than three times the speed of sound, all in the space of a moderately sized commercial jet engine. The space shuttle main engine produces the thrust of more than ten 747 jetliner engines. In doing so it has to produce the 70,000 horsepower required just to pump the hydrogen to more than 6000 pounds per square inch, which then cools the combustion chamber and nozzle to protect them from the exhaust steam which is far beyond the boiling point of steel. To control this powerful reaction, the engine adjusts itself fifty times every second to assure it produces the optimal amount of thrust, and consumes the right amount of each propellant as the vehicle ascends into orbit.

The development of this amazing machine that would flawlessly power every single space shuttle mission required significant advances in the areas of material science, combustion modeling, high speed turbo-machinery, thermal management, structural assessment, safety engineering, advanced manufacturing, and rapid health management. By investing in and pushing the state-of-the-art in the initial development of the space shuttle main engine, the nation created a level of intellectual capital in each of these key technical competencies that is unmatched in the world. As the engine continued development and refinement over its decades of service, these skills were further honed, and even more modern techniques were developed and anchored against actual measured operating data. As the continuous development progressed, so did the learning.

The multi-disciplinary advances gained from this investment enabled the development of the nation's first large commercial rocket engine, the RS-68, which is currently powering the Delta IV family of launch vehicles, and most recently propelled a critical national security satellite into orbit on June 29th. We developed the RS-68, the world's largest hydrogen engine entirely on our own funds.

The RS-68 project was originally started in response to projections of significant growth in space launch demand. This demand never materialized. In addition, flat launch demand forecasts and the continual entry of new international and domestic launchers to serve this flat market make growth in this market very challenging.

It has therefore become increasingly important as a commercial space launch provider to branch our business out into adjacent markets in order to remain viable and healthy as a business. In the past, Rocketdyne has successfully commercialized products such as the water jet propulsion systems used in jet skis which were derived directly from rocket engine experience. The use of polymer selective laser sintering was pioneered to make complex molds for rocket engine parts and then subsequently spun off into a stand-alone business servicing the industry at large. There are numerous other examples such as chemical lasers, hydrogen recombiners, and flue gas cleaning devices.

Today, Rocketdyne is very focused on taking our rocket propulsion expertise in materials, temperatures, speeds and pressures under extreme conditions, and leveraging this knowledge into the energy arena. This is a rapidly growing commercial market that will significantly benefit from the introduction of space-derived advanced technologies to increase efficiency as well as reduce production costs.

We are working on the world's first commercial concentrated solar power plant with energy storage and dispatching capability allowing electricity generation even in the evening. It's being built in the Nevada desert using Rocketdyne's thermal management expertise to design the high temperature receiver and mirror tracking software. The ability to handle the concentrated heat of a thousand suns is directly derived from our rocket engine expertise. We are bringing this to market through an alliance with SolarReserve, a company that specializes in commercializing solar power plants.

Also through the application of our rocket engine experience, we are developing a high pressure, high temperature compact gasifier which can more cleanly and efficiently convert coal, petcoke, or biomass into syngas, a product that can be used to produce multiple fuels, chemicals and electricity. Through the application of our design capabilities we are able to provide a 90% reduction in gasifier volume which results in a 20% reduction in plant capital cost while yielding a 15% to 20% reduction in end-product cost. All this, while reducing water usage by 30% and CO2 emissions by 10% over existing gasifiers. When you look at the global demand for coal gasification, particularly in developing countries, these are game changing numbers. This technology has undergone successful pilot plant testing in Des Plaines, Illinois at the Gas Techology Institute and is currently testing a revolutionary dry solids pump at the Energy & Environmental Research Center in Grand Forks, North Dakota. We are partnered with the U.S. Department of Energy, ExxonMobil Research and Engineering, and Alberta Innovates to develop this product for market.

Other, less mature energy technologies currently in work at Rocketdyne include a one-step hydrogen generator capable of bringing similar savings to that market as our gasifier project, a down-hole steam generator capable of heavy oil production from deep, off-shore or extremely cold environment reservoirs, flame assisted water treatment for oil recovery in tar sands, an acoustic generator capable of enhancing hydraulic fracturing used in shale gas production, and an advanced combustion boiler and high-efficiency turbine capable of increasing electric power plant efficiency by 30% while enabling affordable carbon sequestration. Additionally, we have started working in concert with the oil industry to apply rocket launch derived safety analysis and practices to greatly reduce the potential safety and environmental risk from exploration and production in deep and off-shore oil platforms.

In addition to the positive benefit to our business in diversifying our commercial portfolio outside of the space market, this diversification also allows us to better serve our launch engine customers by spreading our fixed operating costs over a larger market base, thus reducing costs for all of our customers, most notably the United States Government.

Each of these technologies have benefited from the learning and development experience gained from our work with NASA. There is no commercial analog to push such investment since the term of any payback is not clearly understood at the start of the projects. The benefit comes from challenging and pushing what we think are our limits and finding ways to push those limits even higher and further. By taking on difficult science and exploration missions in space, we force ourselves into multi-disciplinary advancement, which in turn enables new solutions to some of our toughest challenges here on earth.

The challenge going forward is to keep NASA focused on their charter of tackling new, big challenges. Only through the introduction of new barriers to overcome can we be assured of creating those new breakthrough technologies. Current budgetary pressure on NASA creates an environment where we limit our future missions to those achievable through application of existing technology. While this can be a cost effective approach to reducing development cost, it also deprives the nation of many of the capability growth benefits seen from past investment.

The key to best value in our space expenditure is to create challenging goals that use solutions to past problems as much as possible while simultaneously working challenges where the solution requires technological advancement. A good example of this is in the current push for beyond earth orbit human exploration. The launcher harvests past developments to create an affordable, near-term heavy launch capability capable of a number of never performed space missions. The in-space portions require significant advances in planetary landing craft, human radiation shielding, energy conversion, high efficiency propulsion, and long-term environmental control and life support systems, just to name a few challenges. There are no off-the-shelf answers to these problems. By solving them, the nation will gain valuable intellectual property which will be applied to many yet to be recognized areas.

In my invitation letter to speak to this committee, it was asked what issues we in industry see in working with NASA, and what recommendations we have to enhance the rapid transition of ideas to new commercial products. We would recommend the creation of a unified national space policy able to withstand political changes of wind. It must be a policy that recognizes the need for stable production combined with concurrent development of both new products as well as advanced technologies. These tiers are essential for robust technology transfer. Continuous improvement in a stable production environment identifies the quantified value of advanced technology. New product development forces the application of advanced technologies into practice, enabling them to be applied to adjacent products in non-space sectors. Advanced technology development explores and then pushes the boundaries of what is possible, spending the time and energy to explore areas that could never be examined in the commercial world because of the unquantified return on investment required in any commercial business .NASA's partnership with industry in each of these three areas enables us to leverage of our nation's precious investment in space technology in ways that have tremendous benefit to our nation and our planet. It is critical that we avoid the unnecessary reinventing of capabilities that have already existed for decades, sandbox studies that don't have an industry partner, and "make work" projects for NASA staff that is not otherwise gainfully employed in meaningful work that speaks to NASAs true charter. There needs to be a balance to assure the maximum benefit from our nation's investment in technology.

What I have addressed here is only the technology derived from the development of liquid rocket engines. While some may wonder if an investment in rocket science has bearing on our daily lives, our work provides concrete evidence of world-leading, game changing capabilities that can directly affect the quality of life for everyone on the planet through our rocket engines and the commercial spin-offs resulting from the Government's investment in space technology. We plan to keep them coming. We ask that NASA continues to have the opportunity to keep challenging our nation's current capability and continue going beyond what we believe is possible today.

Thank you again for the opportunity to address the committee today. I look forward to responding to any questions you may have.