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Hearing Titled "There's a Bad Moon on the Rise:
Why Congress and NASA Must Thwart China in the Space Race"

I. Introduction

Chairman Cruz, Ranking Member Cantwell, and distinguished Members of the Committee, I'm grateful to all of you as well as your intrepid staff for the opportunity to testify regarding America's existential struggle with China in the final frontier. Not only do I want to thank you for bringing attention to this critical competition, but I would be remiss if I did not thank Chairman Cruz in particular for his unflagging and singular leadership on behalf of the American space enterprise generally, and most recently, for restoring vital NASA funding for human spaceflight within the One Big Beautiful Bill Act (OBBBA). Senator Cruz and I share a strong affinity for Star Trek, and the highest compliment I can pay the Senator is that he is the Captain Kirk of the Senate. Additionally, like in Star Trek, a good Captain depends upon their crew, and the work of Maddy Davis, Duncan Rankin, and the entire Commerce Committee staff on both sides of the aisle deserve high praise.

Per the title of this hearing, Congress has been an invaluable partner to NASA in its efforts to thwart Chinese domination of space, and the stakes have never been higher. Space represents the ultimate high ground. Dominance in space brings with it incalculable scientific, economic, geopolitical, and national security benefits. I am confident that the nation that controls the Moon will ultimately control the Earth, and we stand on the precipice of ceding that control to the Chinese Communist Party. If NASA fails to implement the vital space-related provisions of the OBBBA with alacrity, we will not only fail to beat China back to the Moon, but will suffer dramatic consequences here on Earth. Of the many critical provisions of the OBBBA, among the most important is America upholding its commitment to the Lunar Gateway.

II. Gateway: Projecting American Power in Cislunar Space and on Earth

Before looking forward we must look to the past. Specifically, when it comes to beyond low Earth orbit (LEO) human spaceflight, America has failed to sustain a program since Apollo. For beyond LEO, failure hasn't just been an option, it has been a certainty. No beyond LEO human spaceflight program has made the leap from one partisan administration to another until, for the very first time, Artemis successfully navigated this transition from its birth in the first Trump administration, to the Biden administration, and now back to President Trump's second term. Successful space development requires years if not decades of continuity, which is why the unprecedented bipartisan success of the Artemis program must be maintained.

Moreover, much of the Gateway's hardware has already been built. For example, at Redwire, we are proud to have evolved the innovative Roll Out Solar Array (ROSA) technology, which was initially developed for and is currently being used on the International Space Station (ISS), to build even larger versions of these already enormous arrays for the Gateway's Power and Propulsion Element (PPE). This summer, with the support of our customer, Maxar, we conducted deployment tests of these arrays which unfurled like futuristic sails, filling an enormous high bay building at Redwire's ROSA manufacturing facility. Similarly, our colleagues at Northrup Grumman are in the process of outfitting the Habitation and Logistics Outpost (HALO) module which will be united with the PPE and launched together on a SpaceX Falcon Heavy rocket to lunar orbit. This could be done by the summer of 2027, a mere two years from now, if America can simply demonstrate the wherewithal not to give up on the race when we are so close to crossing the finish line.

Terminating Gateway would result in a horrific waste of time, money, and effort. Conversely, if we follow the law, and continue with Gateway per the explicit direction of the OBBB, then the U.S. can become the first nation to deploy a crewed outpost around the Moon, achieving a trailblazing victory for NASA, the administration, Congress, and the American people. The alternative is to squander years of funding, hardware, and effort, while willingly ceding the initiative and control of the Moon to the tender mercies of the Chinese Communist Party. The right choice is abundantly clear, but can only be achieved if NASA abides by its legal obligations under the OBBBA.

Continuing with Gateway also provides extraordinary benefits here on Earth. Over 60% of the Gateway's costs are being born by NASA's international partners, specifically, the European Space Agency, and the governments of Japan, Canada, and the United Arab Emirates. President Trump has wisely pushed our NATO allies to fund their fair share of defense contributions. Here we have an example of our international partners doing the right thing, providing robust funding to support American leadership yet, despite the crystal clear and explicit directives of the OBBBA, and even supportive language from the White House complimenting the space provisions of the Bill, NASA is still unable to explicitly reassure our international partners that Gateway will continue.

NASA's waffling on Gateway has left our international partners confused, frustrated, and exploring alternatives to American partnerships. If we fail to continue with Gateway, we will force our partners to consider shifting support from Artemis and America, to China and its International Lunar Research Station (ILRS) program. Unlike the U.S., China has maintained strong and consistent continuity for its lunar beyond LEO spaceflight program, making a collaboration with China potentially far less risky than gambling on what, prior to Artemis, has been a mercurial American beyond LEO space strategy. If our international partners make such a shift to China, it will not only impact the space field but will have substantial diplomatic, geopolitical, and economic consequences on Earth.

Conversely, by honoring our commitment to Gateway, and following the direction of the OBBB, we can gain access to continued investments by our international partners to support Artemis and American leadership. The international partners have invested roughly billions of dollars in Artemis thus far, and will likely be willing to invest billions more throughout the

lifetime of the Artemis program. These investments by the international partners represents a windfall to the American taxpayer, supporting robust U.S. leadership on the Moon and Mars at no cost. The alternative is for these international partners and funds to be funneled into China's ILRS program. Again, the decision to continue with Gateway should be simple and clear.

Additionally, while not a military facility, the presence of Gateway in cislunar space will provide a platform that will inherently allow America and its partners to monitor Chinese activities. A permanent spacecraft, orbiting the Moon, will project American influence and power forward, discouraging illegal and illicit operations by rival nations that may otherwise occur in the shadows.

Gateway also represents an excellent opportunity for the private sector and for NASA to further leverage public-private partnerships. Specifically, the PPE and HALO will be deployed by a commercial vehicle, Gateway logistics will be carried out via commercial contracts similar to the extraordinarily successful commercial resupply services agreements that have worked so well in LEO. Also, Gateway can serve as a hub for commercial logistics, bolstering the private sector's ability to execute lunar missions generally and extraterrestrial resource extraction in particular.

Gateway is the key to enabling vital innovative activities such as in-situ resource utilization (ISRU) and to ensure that America can successfully access the Moon's resources. With Gateway and full logistics services, American astronauts could remain on the lunar surface for 60-90 days. Without Gateway, American astronaut time on the lunar surface drops precipitously to a mere 5-7 days. In addition to enabling dramatically more robust lunar surface activities, the Gateway provides a safe haven for astronauts, substantially enhancing the safety of lunar operations and ultimately saving lives.

Gateway, and the PPE in particular, will also help ensure American technological leadership over China. Gateway's PPE, powered by the aforementioned innovative Redwire ROSAs, and developed in a collaboration between Maxar and NASA Glenn Research Center, will represent the pinnacle of solar electric propulsion (SEP) technology. Mastering SEP is a critical capability for both civil space exploration and national security space operations. Again, it would be tragic to waste hardware such as the PPE ROSAs which are already constructed and currently undergoing testing and qualification. While bad for America, such a regressive decision would certainly be applauded by China since it clears its competitor as well as a critical rival technological capability from their path to the Moon.

Gateway's benefits even extend beyond the Moon creating advantages for future missions to Mars. Gateway will serve as a critical testbed for Martian operations by providing NASA with vital experience operating an orbiting spacecraft in support of surface activities. The Apollo missions were short duration sojourns into cislunar space. America was dipping its toe into a vast ocean. With the long duration operations enabled by Gateway, we can learn to swim in the ocean of deep space through the use of this permanent lunar outpost.

For all of these reasons, I thank the Members of this Committee for their support of Gateway, and urge the Committee to ensure that NASA immediately reaffirms its commitment to Gateway via explicit communications to both domestic commercial and international partners.

III. The Importance of Being First

As the old saying in sports goes, if you're not first, you're last, and that is certainly the case when it comes to the Moon. The first nation to return to the Moon will enjoy tremendous technological, geopolitical, and military benefits. Additionally, there is so much more to be discovered on the Moon. Until 2009, we believed the Moon was bone dry. Today, we now know that there are vast amounts of frozen water ice, a resource that will support robust development and allow the Moon to become a fuel depot for missions to Mars and even more ambitious journeys of discovery throughout the solar system. If America isn't the first to return to the Moon, we risk ceding the best ice reserves to China, losing the ability to effectively create not only drinkable water, but air and rocket fuel. Additionally, by falling behind, we also risk leadership in the extraction and utilization of Helium-3, which already has great economic potential and, in the future, could support a clean and abundant power revolution. Worst of all, by ceding leadership on the Moon to China, we not only miss out on the opportunities that we understand today, but all of the unknown resources that are sure to be the discoveries of tomorrow.

The Space Launch System and Orion capsule represent the best and only practical means of beating China to the Moon before 2030. Therefore, per the provisions of the OBBBA, we must continue to leverage these systems to both win the space race with China and maintain an American presence in lunar orbit and on the lunar surface. At the same time, we're fortunate that companies such as Blue Origin and SpaceX are developing human landing systems that represent a key commercial contribution to the Artemis architecture. These systems will provide affordable, sustainable, and robust lunar and even Martian capabilities. Fielding multiple spacecraft, or at least two alternatives, for lunar transportation will be vital to win the space race with China. Two or more lunar transportation systems will avoid dependence on any single spacecraft or company. This will enhance safety while also ensuring healthy competition that will encourage efficiency, affordability, and innovation.

Moreover, the first country to return to and develop the Moon will ultimately write the rules of the road. The Artemis Accords, developed and implemented during the first Trump administration, have represented a historically unprecedented victory for American space policy. 56 countries have now signed the Artemis Accords, in contrast to the 13 that have signed China's ILRS agreements. America must lead not just in technology, but in policy, and the Accords have accomplished this goal. However, if China lands on the Moon before America, those numbers will likely shift in China's favor, and the actions that China takes on the Moon will set broad and varied precedents that will be extremely difficult to overcome.

For all of these reasons, we must be first. Someone who has an innate understanding of this challenge is NASA Interim Administrator and Secretary of Transportation Sean Duffy who, in his short time at NASA, has shown strong leadership, vision, and summarized the situation

quite well by saying "Beijing wants to land on the Moon before 2030. The clock is ticking …. but NASA is up to challenge. I have full confidence in our ability to get there FIRST."[1]

We cannot afford to lose the space race to China on the Moon or Mars, and winning will require an 'all of the above' strategy. We must come together as a united space community. Only by fighting for our future, instead of fighting each other, can we prevent a bad moon from rising.

IV. Living Off of the Land Through Commercial Partnerships

China will eventually outspend the U.S. government in space. Such a scenario may be inevitable. Therefore, America must out-entrepreneur the Chinese. NASA should continue to leverage public-private partnerships to the greatest extent possible. An excellent example of this is NASA's Commercial Lunar Payloads Services (CLPS) program. CLPS has been able to take a modest government investment and substantially bolster it with robust private sector funding. A whole new ecosystem of lunar development and lunar entrepreneurship has been created by the CLPS program. NASA should be commended for its continued commitment to CLPS, and the further development of this innovative initiative via CLPS 2.0 and its initial work to extend the CLPS paradigm to Mars.

Additionally, for several CLPS and even some non-CLPS companies, during the first Trump administration, NASA executed a historic series of agreements to purchase lunar regolith from commercial providers. This practice, of purchasing resources from lunar exploration companies, should no longer be the exception but should become the rule. Specifically, this innovative practice should be implemented with every CLPS mission, to encourage the continuous growth of ISRU capabilities and resource extraction technologies.

At Redwire, we're building innovative technologies in collaboration with NASA to transform lunar regolith into useful structures. Specifically, via the 'Mason' program we are developing a system that uses microwaves to sinter regolith. The potential first application for Mason is to create flat landing pads to support safe and successful spacecraft landings. This technology, which can be carried and utilized by a variety of mobile systems, can not only be used to create landing pads, but also roads, berms, and even habitats. Mason is part of the NASA Space Technology Mission Directorate's Tipping Point program, and is an example of the kind of public-private partnership that the agency should do more of, ideally via the use of Broad Agency Announcements and simple single-page initial applications, reflecting best practices used by DARPA.

In summary, America's success in the race against China on the Moon will unquestionably be determined by which country can most effectively learn to live off of the land, hence the need to continue and expand NASA's innovative lunar resource purchases and public-private partnerships.

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[1] https://x.com/SecDuffyNASA/status/1961129995364876486.

V. The Importance of LEO

In any foot race, it can be won or lost by how an athlete jumps off the starter's block, and the race to the Moon begins in LEO. The technologies, capabilities, partnerships, and business cases that are developed and implemented in LEO will have a substantial influence on the overall efficacy of any nation's space program. Therefore, the importance of NASA's continued success in LEO cannot be separated from its future success on the Moon and Mars. Fortunately, the OBBBA provides support for LEO operations. Under the OBBBA, NASA will maintain four astronauts on the ISS, enabling the station to remain a critical testbed for Artemis activities and an engine for innovation and job creation.

At Redwire we are leveraging the ISS to conduct a wide variety of trailblazing microgravity work. For example, using our BioFabrication Facility (BFF), we printed the first meniscus in space. Subsequently, based on our experience with the meniscus fabrication, we printed live cardiovascular tissue on the ISS, and returned it to Earth while the tissue was still alive. Additionally, the most recent cargo resupply mission to the ISS, which launched last month, included provisions for Redwire to conduct a liver tissue print with the BFF. Due to the lack of gravity aboard the ISS, biological tissues can be manipulated and used to fabricate increasingly complex organic structures. Our goal at Redwire is to eventually print whole organs in space, and the work that is being done now by the BFF is bringing that future closer to reality. Imagine a world where there is no organ donor list, and instead those in need can quickly receive an organ that was grown for them. Not only would such a capability save an untold number of lives in America and around the world, but since the organs could be grown from a patient's own stem cells, they would be able to avoid expensive and painful anti-rejection therapies.

While organ fabrication remains a potential, albeit increasingly likely, capability, the future is now for the pharmaceutical industry. Specifically, Redwire has already flown 32 Pharmaceutical In-Space Laboratory (PIL) Boxes on the ISS which have tested 17 different compounds. These PIL Box missions have demonstrated that, under microgravity conditions, drug seed crystals can be created in space which are larger and more uniform than terrestrially grown crystals. These improved seed crystals can subsequently be used to create drugs with better efficacy, longevity, and fewer side effects. New drugs can be introduced and existing drugs can be improved. For example, due to knowledge gained from microgravity research and development, Merck has been able to create an improved version of a cancer treatment called Keytruda. The newly formulated version of Keytruda will potentially allow patients to avoid lengthy, painful, and expensive chemotherapy at hospitals or clinics, and instead enjoy the ease and affordability of taking a shot home for injection. Redwire's PIL-BOX experiments have shown example after example of the power of microgravity to create differentiated seed crystal results. After a collaboration with Eli Lilly flying insulin, Redwire was told by the company that we created the 'prettiest seed crystals they have ever seen'.

Due to the success and maturity of these efforts, last month Redwire signed a trailblazing agreement with the pharmaceutical company ExesaLibero. Under this agreement, Redwire will receive a percentage of sales from a pharmaceutical for osteoperosis that ExesaLibero will develop in space. To the best of my knowledge, this is the first time that an agreement unites the potential revenue from the pharmaceutical industry with the capabilities of a space company.

This agreement therefore represents an inflection point, with space and pharma/biotech coming together in a manner that will transform both fields. Redwire has even formed a new subsidiary entity called 'SpaceMD' to explicitly focus on the creation of new and/or improved drugs in space, and feeding those drugs into the pharmaceutical industrial development chain.

However, at a time when we are just now beginning to realize the incredible potential of microgravity for pharmaceutical development and a wide variety of other fields, the ISS is facing budget cuts that could cripple its vital operations. Specifically, without the funding provided by the OBBB, the number of American astronauts in LEO will drop from four to three and eventually to only two. Falling to three and then two astronauts will dramatically impact America's ability to support innovative commercial activities, as well as damaging the critical industrial base created by the commercial cargo and crew programs. Moreover, for the first time in history, China will have more astronauts in space than America. Such a situation should be unacceptable to this Committee, NASA, and the nation as a whole. Again, I applaud this Committee for fighting for American leadership in space and restoring ISS funding to a level that will allow the U.S. to continue with four astronaut in LEO. Unfortunately, while this direction from Congress is commendable, I fear that more vigilance and action by this Committee will be required. Specifically, NASA will have to purchase a new cargo resupply mission within, at most, the next 90 days. If NASA does not take this action America will lose the ability next year to support four astronauts on the ISS, putting China in parity with the U.S. astronaut program for the first time in history.

I believe dropping the number of U.S. astronauts and failing to take advantage of the innovations created by the commercial crew program would be both ill-conceived and unwarranted. As described previously, we are on the precipice of incredible breakthroughs in microgravity that could transform not only the pharmaceutical and biotech industries, but numerous other diverse fields ranging from semiconductor production to next-generation agriculture. There is no question in my mind that microgravity R&D and manufacturing will provide transformative industrial benefits. The only question is, will those benefits be enjoyed here in the U.S. or in China.

VI. Conclusion

Again, the space race with China is one that cannot be lost. It doesn't matter that we reached the Moon in the 1960's any more than a victory by a sports team from over sixty years ago is relevant for this season's performance. Space is the ultimate high ground, providing an environment with untold strategic advantages, as well as technological, geopolitical, and economic benefits. The countries that master microgravity and develop the Moon will shape humanity's future. When we go to space, we launch not just our spacecraft and astronauts but our values, and we must rededicate ourselves to ensuring that the future reflects American values rather than those of an autocracy hostile to human rights and the very nature of democracy. However, due to the courage, leadership, and vision shown by the Members of this Committee and its staff, I remain confident that while our journey will be to LEO, the Moon, and Mars, that our ultimate destination will be freedom, peace, and prosperity.