Statement

Of

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Good Afternoon Chairman Babin, Ranking Member Edwards, and distinguished Members of the Subcommittee and Staff. I appreciate this opportunity to testify before you on behalf of Orbital ATK regarding our concept for a deep space habitat as part of a long term path to Mars exploration.

This is an exciting and inspiring time for our nation's human space exploration program. NASA is on course to send humans beyond low earth orbit leveraging the current International Space Station (ISS), Commercial Crew and Cargo programs, as well as the Space Launch System (SLS), Orion and the new cislunar habitat, to achieve the goal of landing humans on Mars in 2033. Orbital ATK is proud to be supporting our NASA customer every step of the way.

Orbital ATK Introduction

Orbital ATK is a global leader in aerospace and defense technologies. We design, build and deliver space, defense and aviation systems for customers around the world, both as a prime contractor and as a merchant supplier. Our spacecraft operate in low earth orbit, geosynchronous orbit and in deep space. Our Cygnus spacecraft has "human-rated" features required to rendezvous and berth with the International Space Station. The OA-6 Cygnus spacecraft is currently berthed to ISS, and will remain there until June 14, spending over 90 days on-orbit, providing vital supplies to the astronauts on board and conducting important scientific research in microgravity.

Our space launch vehicles support a range of missions for commercial, civil government, and national security customers. We are a prime contractor for the NASA SLS, building the world's largest solid rocket boosters that will launch the Orion spacecraft beyond low earth orbit to cislunar habitats and eventually to Mars.

Over its history, Orbital ATK has built and launched 174 satellites, 71 space launch vehicles, 268 human-rated boosters, and more than 1300 strap-on boosters. Today we have over 1346 successful years of on-orbit satellite experience, and there are currently 91 of our satellites in operating in space. Orbital ATK is committed to continuing its collaboration with NASA to transition our knowledge base into a safe and cost effective solution for cislunar habitation.

Transition to Beyond Low Earth Orbit

NASA's next major milestone on the path toward deep space exploration is the unmanned launch of Orion atop the SLS for Exploration Mission-1 in 2018. In 2021, a crewed Orion spacecraft will be launched to cislunar space. Following these missions, the SLS and Orion will conduct increasingly ambitious missions throughout the proving ground of cislunar space. In order to increase stay times in cislunar space and accommodate a range of technology demonstrations and scientific experiments, additional habitat space and consumables are necessary. A habitat in cislunar space can be accomplished at relatively modest cost by leveraging NASA, U.S. commercial and international resources. The experience gained in the cislunar proving ground will lead directly to longer mission durations in deep space and eventually enable a manned mission to Mars.

The roadmap to human Mars exploration has been studied by many organizations, including NASA, the International Cooperation Mission (ICM), and the International Space Exploration Coordination Group (ISECG). All groups concluded that the next step beyond low earth orbit is a habitat in the vicinity of the moon, called cislunar. The key feature of the cislunar proving ground is that it provides the experience of operating independent of Earth. Currently, if there is an emergency aboard ISS, astronauts can return to Earth in a matter of hours. Returning from cislunar space requires days, in the best case, and provides an effective proving ground for Mars missions that will require autonomy from Earth for months to years.

More recently, Orbital ATK was selected to study an initial version of a cislunar habitat that could evolve over time to a much larger habitat with capabilities for a

human mission to Mars. These studies fall under NASA's Next STEP Phase 1. Figure 1 shows a cislunar habitat concept from our Next STEP study. The earliest variant of a cislunar habitat should be as simple and cost effective as possible and augment the capability of the Orion capsule to achieve missions of 60 days in deep space. A very good starting point for the design of a cislunar habitat is the Orbital ATK Cygnus spacecraft. Cygnus (shown in Figure 2) is a flexible design that meets the human-rating design requirements of the ISS. Figure 3 shows Cygnus on-orbit with the ISS crew inside the module. Our cislunar habitat design incorporates all of the "lessons learned" from delivering cargo to ISS.

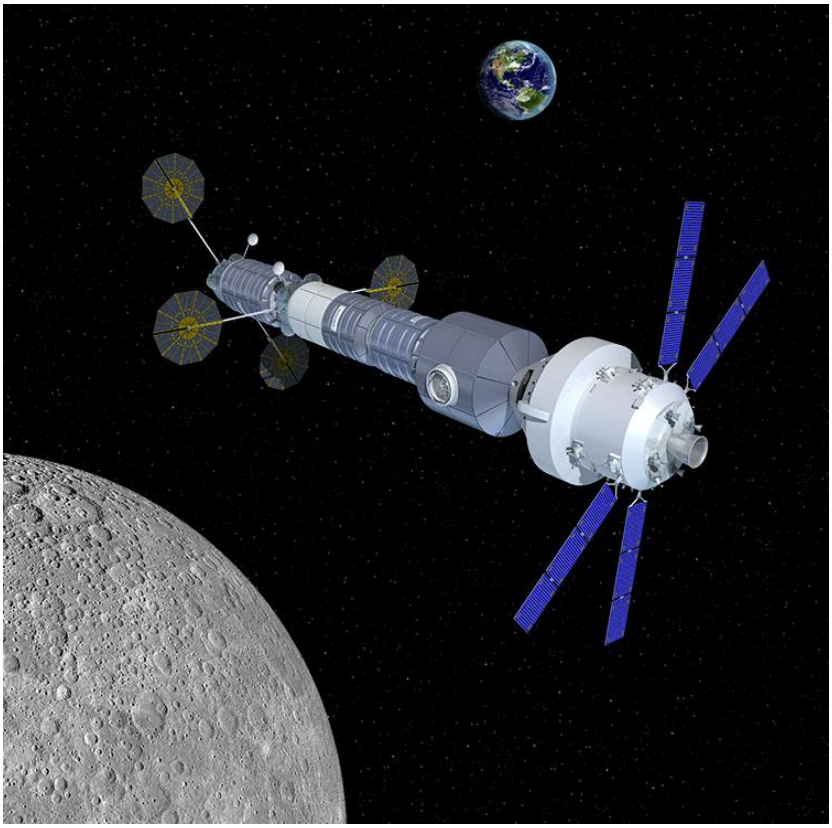

Figure 1: Orbital ATK Concept of a Cislunar Habitat

Figure 2: Cygnus Cargo Vehicle

Figure 3: Human Rated Cygnus with the Space Station Crew inside

Technology Risk Reduction Using Cygnus and ISS

Cygnus and the ISS will play integral roles in establishing a cislunar habitat. Cygnus has regular flights to the ISS scheduled over the next eight years. Technology demonstrations of subsystems intended eventually for deep space, and new science instruments can all be flown in test mode as part of a Cygnus cargo mission to the ISS. The first technology demonstration is currently on-orbit on the OA-6 Cygnus. Following its departure from the ISS, Cygnus will conduct the Spacecraft Fire Experiment-1 (SAFFIRE-1), designed by the Glenn Research Center, that will intentionally light a large-scale fire in the Cygnus' Pressurized Cargo Module. SAFFIRE will be the largest man-made fire ever in space. Up until now, NASA could only conduct small combustion experiments in the microgravity environment of the ISS. Fire on a space station is one of the most significant dangers to astronauts. The SAFFIRE experiment will enable NASA to investigate fire detection, advanced fire extinguishing methods, and post-fire clean up.

This type of technology demonstration and scientific experimentation will be vital for the development of systems that will eventually fly to Mars. Testing them on existing operational systems such as Cygnus can be done at a much lower cost than on dedicated missions.

Commercial Acquisition Practices

The implementation of a cislunar habitat is a good opportunity to apply commercial acquisition practices and commercial development standards. This approach worked well under the NASA Commercial Resupply Services contract, resulting in the government having two operational systems operated by two different companies. The emphasis on services, instead of hardware, and the use

of commercial development technical standards and contracting saved the government substantial costs.

International Collaboration

A cislunar habitat is integral part to the U.S. government's overall plans for space exploration. Operations in the cislunar proving ground will be international in nature. The habitat could be a focal point for additional space systems provided by other nations. For example, an international partner could develop and provide a lunar lander compatible with docking at the cislunar habitat. From this central node, robotic lunar surface exploration could be accomplished. Early missions could lay out a sensitive radio astronomy antenna on the radio quiet far side of the moon. Other missions could search for water at the lunar South Pole – Aitken impact basin. Lunar samples could be returned to the habitat and from there on to Earth. This operations concept could be applied to a Mars mission where initially a manned outpost on a moon of Mars (Phobos or Diemos) could teleoperate a rover on the surface of Mars. These are just a couple of examples of how international cooperation could significantly expand capabilities developed for cislunar and beyond.

Human Research in Deep Space

As an astronaut who lived aboard the ISS myself, I am particularly interested in Human Research beyond Low Earth Orbit. The environment in deep space is different than on the Earth or at the International Space Station. Trips to the moon or Mars take us beyond the protective Magnetosphere that deflects much of the galactic and solar radiation. A cislunar habitat is a perfect location to both characterize the radiation environment and determine effects on humans. We can

also study possible mitigation. This is a high priority for long duration deep space missions.

Commercial Role/Market for Cislunar Habitats

The non-government/commercial market for the cislunar proving ground is speculative in the near term. Many of the applications that require a space environment could more efficiently be accomplished in low earth orbit. There are certainly some activities that would involve utilization of the resources of the lunar surface, but may be too risky for private industry to take on without first establishing a basic transportation and habitation infrastructure funded by the government.

Conclusion

I believe NASA is following congressional guidance contained in the NASA Reauthorization Acts and is pursuing the human to Mars option. It is important that Congress continue robust funding to allow NASA to focus its attention, capabilities and resources on the Mars goal. NASA is developing a plan to achieve that goal, putting into place the critical pieces of an architecture and defining precursor missions, including the cislunar habitats we are discussing today.

Human exploration of Mars can be accomplished and my presentation today lays out a methodical, affordable approach to a new level of national and commercial achievement in deep space. NASA has designated cislunar space the "Proving Ground" for a good reason. Many aspects of operations in deep space are as yet untested and confidence must be developed through repeated flights to cislunar space. This complex, multi-decade approach to space exploration will bring out

the best in our nation. Orbital ATK continues to operate our Cygnus cargo resupply vehicle as a flagship product. We are ready to quickly and affordably implement a habitat in cislunar space based on the flight proven heritage of the Cygnus spacecraft. But more than anything else, Orbital ATK is ready to be a partner in this adventure called Deep Space Exploration.

Thank you.