NASA’s ASTEROID REDIRECT MISSION (ARM)

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Introduction: To achieve its long-term goal of sending humans to Mars, the National Aeronautics and Space Administration (NASA) plans to proceed in a series of incrementally more complex human spaceflight missions. The next logical step for human spaceflight is to gain flight experience in the vicinity of the Moon. These cis-lunar missions provide a “proving ground” for the testing of systems and operations while still accommodating an emergency return path to the Earth that would last only several days. Cis-lunar mission experience will be essential for more ambitious human missions beyond the Earth-Moon system, which will require weeks, months, or even years of transit time.

Mission Description and Objectives: NASA’s Asteroid Redirect Mission (ARM) consists of two mission segments: 1) the Asteroid Redirect Robotic Mission (ARRM), a robotic mission to visit a large (greater than ~100 m diameter) near-Earth asteroid (NEA), collect a multi-ton boulder from its surface along with regolith samples, and return the asteroidal material to a stable orbit around the Moon; and 2) the Asteroid Redirect Crewed Mission (ARCM), in which astronauts will explore and investigate the boulder and return to Earth with samples. The ARRM is currently planned to launch at the end of 2021 and the ARCM is scheduled for late 2026. The Asteroid Redirect Mission is designed to address the need for flight experience via conducting integrated crewed and robotic vehicle mission operations in cis-lunar space and provide opportunities of for testing the systems, technologies, and capabilities that will be required for future human deep space missions. A principle objective of the ARM is the development of a high-power Solar Electric Propulsion (SEP) vehicle, and the demonstration that it can operate for many years in interplanetary space, which is critical for deep space exploration missions. A second prime objective of ARM is to conduct a human spaceflight mission involving in-space interaction with a natural object, in order to provide the systems and operational experience that will be required for eventual human exploration of Mars, including the Martian moons Phobos and Deimos. The ARCM provides a focus for the early flights of the Orion program, which will take place before the infrastructure for more ambitious flights will be available. Astronauts will participate in the scientific in-space investigation of nearly pristine asteroid material, at most only minimally altered by the capture process. The ARCM will provide the opportunity for human explorers to work in space with asteroid material, testing the extravehicular activities that would be performed and the tools that would be needed for later exploration and investigation of primitive body surfaces in deep space.

Target Asteroid Candidates: NASA has identified the NEA (341843) 2008 EV5 as the reference target for the ARRM, but is also carrying three other NEAs as potential options [(25143) Itokawa, (162173) Ryugu, and (101955) Bennu]. The final target selection for the ARRM will be made approximately a year before launch, but there is a strong recommendation from the scientific and resource utilization communities that the ARM target be volatile and organic rich. Three of the proposed candidates are carbonaceous NEAs. Specifically, the reference target, 2008 EV5 is a carbonaceous (C-type) asteroid that has been remotely characterized (via visual, infrared, and radar wavelengths), is believed to be hydrated, and provides significant return mass (boulders greater than 20 metric tons).

Conclusion: While NASA continues to use the International Space Station to prepare for deep space exploration, the ARM will enable our next steps on the journey to Mars. NASA’s ARM is key to our deep space endeavors, providing important advancement of exploration capabilities and aiding the

development of scientific operations for future robotic and human missions.

Keywords: Near-Earth Asteroids, Human Exploration, Sample Return, Cabonaceous Meteorites

