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TRANSITIONING FROM FIRST TO SECOND GENERATION LUNAR INFRASTRUCTURES

Abstract

At some point the transportation infrastructure that supports the initial phase of human exploration of the Moon, should either transition to, or be replaced by, a second generation infrastructure to support early permanent occupation and exploitation. This transition was explored as part of the Scorpion studies, moving from a transport infrastructure base on a single transport nuclear system (the Scorpion) which is solely supported from Low Earth Orbit, to an infrastructure using multiple systems (with several transport and fixed elements) and the exploitation of lunar resources. Several second generation architectures were explored using refuelling and with some scenarios using Lunar produced liquid oxygen. The capacity and costs of these various options were assessed and from this study some general observations can be made.

The second generation infrastructure can be small, indeed not much larger than the first generation, but it will have to be reusable. The reusability means that even a very small infrastructure can support significant permanent surface activity with hundreds of people and thousands of tonnes of Earth-Moon traffic. The main constraint being the capacity and cost limitations of the Earth to LEO launch infrastructure. Which implies, once a second generation infrastructure is established, it could have a long life with its capability and costs improving as improvements in the supporting launch systems reflect through.

It was found that a chemical lander system using Lunar produced liquid oxygen and Earth supplied liquid hydrogen is by far the most efficient architecture. The scale of this effect suggests a high priority should be given to practical in-situ oxygen production as a precursor to establishing the second generation infrastructure. It also highlights that the transition can be more successful if the likely requirements of the Second Generation are understood and incorporated into the first generation. An example would be to use liquid oxygen as a primary propellent in the first generation lander, even if the initial lander system is not used in its totality, it could provide a proven highly throttleable engine for the subsequent generation.

While these observations confirm several previous studies, the lessons are timely given the return to the Moon initiative. In particular the main conclusion is that the longer term view should be allowed to impact the requirements of first generation systems, even if it increases the development costs.