The NTER: A proposed innovative propulsion concept for manned interplanetary missions

C. Dujarric, A. Santovincenzo, L. Summerer, European Space Agency 8-10 rue Mario Nikis, 75738 Paris Cedex 15, FRANCE Christian.dujarric@esa.int

Abstract: Conventional propulsion technology (chemical and electric) currently limits the possibilities for human space exploration to the neighbourhood of the Earth. If farther destinations (such as Mars) are to be reached with humans on board, a more capable interplanetary transfer engine featuring high thrust, high specific impulse is required.

The source of energy, which could in principle best meet these engine requirements is nuclear thermal. However the nuclear thermal rocket technology is not yet ready for flight application. The development of new materials, which is necessary for the nuclear core will require further testing on ground of full-scale nuclear rocket engines. Such testing is a powerful inhibitor to the nuclear rocket development, as the risks of nuclear contamination of the environment cannot be entirely avoided with current concepts.

Alongside already further matured activities in the field of space nuclear power sources for generating onboard power, a low level investigation on nuclear propulsion has been running since long within ESA, and innovative concepts have already been proposed at an IAF conference in 1999.[1][7] Following a slow maturation process, a new concept was defined which was submitted to a concurrent design exercise in ESTEC in 2007. Great care was taken in the selection of the design parameters to ensure that this quite innovative concept would in all respects likely be feasible with margins. However, a thorough feasibility demonstration will require a more detailed design including the selection of appropriate materials and the verification that these can withstand the expected mechanical, thermal and chemical environment. So far, the predefinition work made clear that, based on conservative technology assumptions, a specific impulse of 920s could be obtained with a thrust of 110kN. Despite the heavy engine dry mass, a preliminary mission analysis using conservative assumptions showed that the concept was reducing the required Initial Mass in Low Earth Orbit compared to conventional nuclear thermal rockets for a human mission to Mars. Of course the realisation of this concept still requires proper engineering and the dimensioning of quite unconventional machinery. A patent was filed on the concept. Because of the operating parameters of the nuclear core, which are very specific to this type of concept, it seems possible to test on ground this kind of engine at full-scale in close loop using a reasonable size test facility with safe and clean conditions. Such tests can be conducted within fully confined enclosure, which would substantially increase the associated inherent nuclear safety levels. This breakthrough removes a showstopper for nuclear rocket engines development.

The present paper will disclose the NTER (Nuclear Thermal Electric Rocket) engine concept, will present some of the results of the ESTEC concurrent engineering exercise, and will explain the concept for the NTER on-ground testing facility.

Human far space exploration constitutes a challenge, which is commensurate only with global cooperation. The Nuclear Thermal Electric Rocket engine proposed in this perspective may potentially be a technical enabler for a manned exploration mission to Mars as well as other farther exploration missions.

This propulsion concept is offered to be deeper investigated at worldwide Agencies level in order to assess its benefits as compared to other propulsion options.

The present paper is being readied for publication in Advances in Aerospace Sciences, Propulsion Physics (PP) edition with non exclusive rights.