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RITD – Wind tunnel testing

Harri Haukka (1), Ari-Matti Harri (1), Sergei Aleksashkin (2), Valeri Koryanov (3), Walter Schmidt (1), Jyri Heilimo (1), Valeri Finchenko (2), Maxim Martynov (2), Andrey Ponomarenko (2), Victor Kazakovtsev (3), and Ignazio Arruego (4)

(1) Finnish Meteorological Institute, Helsinki, Finland (jyri.heilimo@fmi.fi), (2) Federal Enterprise Lavochkin Association, Khimki, Russia, (3) Bauman Moscow State Technical University, Moscow, Russia, (4) Institutio Nacional de Técnica Aerospacial, Madrid, Spain

An atmospheric re-entry and descent and landing system (EDLS) concept based on inflatable hypersonic decelerator techniques is highly promising for the Earth re-entry missions. We developed such EDLS for the Earth re-entry utilizing a concept that was originally developed for Mars. This EU-funded project is called RITD - Re-entry: Inflatable Technology Development - and it was to assess the bene¬fits of this technology when deploying small payloads from low Earth orbits to the surface of the Earth with modest costs. The principal goal was to assess and develope a preliminary EDLS design for the entire relevant range of aerodynamic regimes expected to be encountered in Earth's atmosphere during entry, descent and landing.

The RITD entry and descent system utilizes an inflatable hypersonic decelerator. Development of such system requires a combination of wind tunnel tests and numerical simulations. This included wind tunnel tests both in transsonic and subsonic regimes.

The principal aim of the wind tunnel tests was the determination of the RITD damping factors in the Earth atmosphere and recalculation of the results for the case of the vehicle descent in the Mars atmosphere. The RITD mock-up model used in the tests was in scale of 1:15 of the real-size vehicle as the dimensions were (midsection) diameter of 74.2 mm and length of 42 mm. For wind tunnel testing purposes the frontal part of the mock-up model body was manufactured by using a PolyJet 3D printing technology based on the light curing of liquid resin. The tail part of the mock-up model body was manufactured of M1 grade copper. The structure of the mock-up model placed th center of gravity in the same position as that of the real-size RITD. The wind tunnel test program included the defining of the damping factor at seven values of Mach numbers 0.85; 0.95; 1.10; 1.20; 1.25; 1.30 and 1.55 with the angle of attack ranging from 0 degree to 40 degrees with the step of 5 degrees.
The damping characteristics of the RITD test model were determined by the technique of free oscillations. The dynamically representative mock-up model was installed on the holder with one degree of freedom. The test model mounted on the free oscillation holder was placed into gas flow of the wind tunnel at the known angle of attack. This facilitated the determination of conditions of stability or instability for the descending atmospheric entry vehicle.

The wind tunnel tests confirmed that the RITD-type re-entry vehicle making use of inflatable hypersonic decelerators will be able to have dynamically stable re-entry and descent sequence at the Earth atmosphere.