

Controlled deorbiting of an upper stages from placing orbit of SLV with oxygen-kerosene main liquid propulsion engine

J. Makarov⁽¹⁾, G. Raykunov⁽²⁾, J. Shatrov⁽²⁾, A. Baranov⁽³⁾, V. Trushlyakov⁽⁴⁾, V. Kudentsov⁽⁴⁾

⁽¹⁾ Roscosmos, Moscow, ⁽²⁾ TsNIImash, Korolev, ⁽³⁾ TsSKB-Progress, Samara, ⁽⁴⁾ OmSTU, Omsk

Main liquid propulsion engine (LPE) using expander cycle on the components of rocket propellant (CRP), "oxygen-hydrogen," for example, LPE RL-10 (Pratt & Whitney) for the second stage of the space launch vehicle (SLV) «Delta-4», «Vinci» for the second stage« Ariane-5", «LB-5B-2" in the second stage SLV «HII-B» allow implement a restart for the deorbiting stage from placing orbit after its launch mission.

Conducted a successful flight experiments on controlled direct deorbiting an upper stages SLV «Delta-4" in 2006, SLV «HII-B» in 2011 defined impact areas of the World Ocean have confirmed the effectiveness of the method using the residual energy on board of a stage:

- unused residues of liquid CRP in the tanks;
- remains of the compressed gas in the tank pressurization system;
- resources of a guidance onboard system.

Russian SLV with main LPE or on high boiling CRP "nitrogen tetroxide - uns-dimethylhydrazine" for example, SLV "Proton", "Rokot", or on the CRP of "oxygen-kerosene" for SLV "Zenit", families of SLV "Souz", families of SLV "Angara".

Realization of re-ignition on Russian main engine by CRP "oxygen - kerosene", by analogy with the LPE, using expander cycle, does not possible for a variety of reasons, such as LPE RD-0124 for the second stage SLV "Souz-2.1.B", "Angara", from due to the principles of the it design, including a one-time start system, restrictions on the cavitations resistance pumps, etc.

To apply the method of deorbiting, implemented on SLV «Delta-4», «HII-B», for example, in the second stage SLV "Soyuz-2.1.B" using CRP "oxygen-kerosene", is offered the design of an autonomous onboard system for gasification of residues unused CRP.

Gasification system residues of oxygen in the tank is similar to that used on the LPE with the expander cycle, but the gasification of kerosene residues, in contrast to the hydrogen residues gasification must be substantially more energy costs.

Another fundamental difference between the method used, the implementation of the residual energy at the board of a stages proposed use is not main LPE for burning of gasified products, but special gas rocket engine, in particular, a four chambers engine, installed on upper bottom of the propellant compartment.

The report reviews development of the onboard gasification system for unused residues of CRP "oxygen-kerosene" and gas rocket engine. Illustration of the proposed method performed on a second stage SLV "Souz-2.1.B" with main LPE RD-0124.