SELF-CONSISTENT MODEL FOR CALCULATION OF PARAMETERS OF DEVICES PROVIDING SPACE VEHICLES FLIGHTS IN ULTRA-LOW EARTH ORBITS [[1]](#footnote-1)\*)

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In recent years, the organization of spacecraft (SC) flights in ultra-low Earth orbits (LEO) (180 - 300 km) has become relevant, opening up broad prospects for the development of telecommunications, transport operations, as well as a wide range of scientific research. The main problem of GNSS flights is the high resistance of the residual atmosphere, which leads to a rapid loss of spacecraft altitude. The way out is to equip the spacecraft with electric rocket engines (EP) capable of compensating for speed losses. However, calculations show that the fuel reserves required for long-term operation of the spacecraft at altitudes of 180–200 km are unjustifiably large. In this regard, intensive work is being carried out in the world to study the possibility of using the flow of residual atmospheric gases as a working process of an electric propulsion engine.

An electric propulsion system that uses gases that make up the residual atmosphere of the Earth as a working fluid consists of an air intake device and an electric motor capable of creating thrust T, which compensates for the aerodynamic friction force D. The latter can be mathematically expressed as follows [1]:

 𝑇 = 𝑚∞ (𝜂𝑐𝑢𝑒 - 𝑢∞,𝑒) > 𝐷

where 𝜂𝑐 is the ratio of the flow of neutral particles that have reached the gas-discharge chamber of the electric propulsion engine to the flow of particles entering the air intake through its frontal section, 𝑢𝑒 is the effective velocity of the neutral and ion components from the electric propulsion engine, 𝑢∞,𝑒 ≅ 𝑢∞ is the effective velocity of neutral particles, entering the air intake, 𝑚∞ is the mass flow rate of gas entering the air intake..

It should be noted that the values of the frontal section of the air intake, its design and length determine the flux and velocity of neutral particles entering the EP inlet. In turn, the energy efficiency of the operating modes of the electric propulsion engine significantly depends on the flow of the working gas. In this regard, this paper presents the first results on the development of the air intake - EP model, which makes it possible to match the inlet section of the air intake, its length with the parameters of the EP, designed to compensate for losses to overcome the resistance of the residual atmosphere. The global model of an inductive RF motor [2] was used for calculations, as well as the values of the friction coefficient at ultra-low altitudes obtained in [3].

References

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1. \*) [abstracts of this report in Russian](http://www.fpl.gpi.ru/Zvenigorod/L/Pt/ru/GF-Kralkina.docx) [↑](#footnote-ref-1)