

MATERIALS AND STRUCTURES SYMPOSIUM (C2)  
Space Vehicles – Mechanical/Thermal/Fluidic Systems (7)

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VERSIONS OF ORBITERS' FLIGHT SYSTEMS FOR NONNUCLEAR ACTION ON ASTEROID  
APOPHIS

**Abstract**

Nowadays, the issue of how to prevent asteroid Apophis from collision with the Earth is rather urgent. In 2029, Apophis will be flying over the Earth's surface at a distance of about 40,000 km. At the same time its trajectory change in terrestrial gravitational field may turn out to be so considerable that the collision with the Earth is not ruled out in 2036. Scientists and designers have got down to actively define more exactly the trajectory of Apophis as well as design space rocket systems that would be able to deliver the means to study the asteroid's composition and physical properties to Apophis. Methods and means for modification of the asteroid's trajectory to eliminate the possibility of its collision with the Earth are being developed. The report presents versions of modules for nonnuclear action on the asteroid (including its flight systems and tools of integration with launch vehicles), which are developed by Yuzhnoye State Design Office (Ukraine); and those means are compared with the designs that are well known from materials of conferences and scientific publications.

Alternatives of two sequential phases are considered. The first phase is before the asteroid comes close to the Earth in 2029: - Delivery of module with equipment for the asteroid remote sensing from a short distance (about 100 m) from board of a carrier flying beside the asteroid; - Delivery and attachment of a "beacon" to the asteroid's surface, which would allow tracking the asteroid's trajectory beyond telescopes visibility, without kinetic effect on the asteroid and without its destruction. The second phase is before 2036: - Application of modules equipped with acceleration tools using the environmental energy, particularly the energy of magnetic field; application of modules equipped with laser devices of intermittent (short-term) action, which are able to evaporate spot areas on the asteroid's surface, providing impulse of action on the asteroid.

Versions of launch vehicles proposed to deliver the action modules to the asteroid are reviewed in the report. The first step to solve the first phase tasks is a version of a launch vehicle consisting of the first two stages of Zenit LV, the third stage Fregat, and a newly-developed orbiter that is able to deliver a set of equipment for short-distance sensing to Apophis, which is proposed for studying.