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RISKS OF COLLISION OF LAUNCH VEHICLES WITH THE CATALOGUED SPACE OBJECTS IN
THE ASCENT PHASE**Abstract**

According to up-to-date expert judgments there is a constant increase of objects of artificial origin in the near-earth space. Collisions of space objects lead to occurrence of new objects, thereby, increasing probability of mutual collisions (Kessler's syndrome). As a consequence, the probability of collision with operating satellites and launch vehicles injecting them grows. Such scenario of succession of events causes the necessity of determination of characteristics of rendezvous and estimation of risks of launch vehicles with space objects collision. Mathematical modelling of joint flight of the hypothetical launch vehicle in the active leg and group of space objects in diurnal launch window was conducted. Solar-synchronous orbits were considered as baseline orbits of the ascent and space conditions were catalogued ones. The paper contains distributions of key parameters of rendezvous, such as mutual relative distance, relative speed and angle of impact. According to study results the rendezvous take place mainly at relative velocities of more than 10 km/s and more than 90 deg angles of impact. Some rendezvous at relative distances less than 100 m were revealed. Relations of probability of rendezvous of the launch vehicle with space objects at distance less than 5 km versus flight altitude were determined. It was revealed that the greatest problems pose space objects, orbiting at average altitudes of 600-1000 km at inclinations of 80-110 deg. It is necessary to note that launch vehicle can also collide with the operating satellites. Both parties will be affected in that case, the one launching the launch vehicle, and the one operating the spacecraft. For this reason both parties are interested in decrease of degree of risks of the collision as a result of orbital launch. Hence it is reasonable to enter into the international cooperation to secure safe flight of launch vehicles during the satellite injection missions. The major objective would be to promptly update the parameters of space situation and inform the launch services provider about them. For the present, selection of time intervals with minimal risks of collision within the launch windows could be the effective way of regulating relationships of the parties.