SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS (D2)
Upper Stages, Space Transfer, Entry and Landing Systems (3)

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PECULIARITIES OF COMPUTER SIMULATION OF UNGUIDED REENTRY OF SPACE TRANSPORTATION SYSTEM PARTS

Abstract

The tendency of boosters unification for future space transportation systems (STS) results in increase in the relative mass and staging velocity of the boosters and subsequently in a considerable expansion of fall zones of separated parts (SP). It is shown, that this expansion can bear an "explosive" character.

The simulation method of SP falling in the atmosphere is based on an application of the theory of non-equilibrium atmospheric entry with subcircular velocities [1, 2]. The mathematical model uses the matrix of direction cosines with the optimal correction [3]. The special attention is given to objective monitoring of the solution accuracy that is important in view of a complex motion with essentially different characteristic times.

The peculiarities of the SP fall point dispersion and aerothermodynamic loading are investigated on the developed model. The existence of a broad field of parameters values, in which the area of SP fall point dispersion can essentially exceed expected sizes predicted on the basis of traditional simplified techniques and of an experience in current STS ballistic analysis, is shown even without taking a random factors and SP destructions into account. Uncertainty of fall points of such bodies as separated boosters results from instability of motion at uncontrollable reentry and from appearance of a continuum of stable trim velocity bank angles. A bifurcational character of changing of the fall point dispersion area is shown depending on such parameters as linear and angular velocities after SP separation from STS. A transition through bifurcation points is accompanied by an "explosive" growth in orders (from several kilometers up to 100 km and more) of the dispersion area size. The physical explanation of the established phenomena is provided. Vivid forms including hodograph and animated simulation are used for the presentation.

References

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