

IAF SPACE TRANSPORTATION SOLUTIONS AND INNOVATIONS SYMPOSIUM (D2)
Future Space Transportation Systems (4)

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PRELIMINARY DESIGN STATUS OF UNMANNED SUBORBITAL SPACEPLANE WITH
LOX/METHANE ENGINES BY TOKYO UNIVERSITY OF SCIENCE'S START-UP WITH THE
PARTNERSHIP OF INDUSTRIES: PART 2**Abstract**

Tokyo University of Science start-up SPACE WALKER Inc. is conducting commercialization of three kinds of unmanned and manned suborbital spaceplanes propelled by LOX/Methane Engines with the partnership of Japanese aerospace, non-space industries, JAXA, and university laboratories [1]. This paper introduces the updated preliminary design status of the first concept of unmanned suborbital spaceplane called FuJin (project name), which performs vertical take-off and horizontal landing and conducts the scientific mission for micro-gravity experiment, higher atmospheric research and space observation to reach the altitude of more than 120 km with 100 kg payload. The maximum angle-of-attack is 40 deg. at the maximum flight Mach number of 3.8 during the reentry. The current FuJin design has the total length of 10.4 m and the initial lift-off mass 10.0 tons propelled by two LOX/Methane engines with 94 kN thrust in vacuum (77 kN at sea level, nozzle expansion ratio of 19) per each. The design life of FuJin is 20 years based on the assumption of 50 launches per year by employing aircraft-like hard time, on-conditions and condition monitoring maintenance system. The design life of LOX/Methane engine is 2 years with minimum 100 launches including replacement of critical parts. The maximum operational load of FuJin is 6 G and the safety factor of 1.5 according to the airworthiness classification of acrobatic airplane. The total system reliability probabilities is considered $10e-6$ tentatively. The fault tolerant design criteria of FuJin is as following: If one critical device or system fails, FuJin abort the mission to fly back and land on the run way. For the case of two critical devices or systems fail, FuJin terminates its flight by getting into spin motion to secure safety of the third parties on ground. FuJin approaches to the landing site with a steep glide slope of -15 deg. with the flight velocity of 106 m/s by keeping 1.25 G maneuverability in the front side of L/D characteristics. FuJin allow its 1.7 G of flare motion in the back side of L/C characteristics to clear the threshold height of 50 ft and touch down on the runway with the speed of 99 m/s. The FAR field length required is estimated 1,210 m. The tentative candidate of space port locates in Taiki town, Hollaido in Japan.

[1] Yonemoto, K. and Fujikawa, T., "Preliminary Design of Suborbital Spaceplane with LNG Engines by a Japanese University Start-up with the Partnership of Industries," IAC-19-D2.4.6.