

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

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PRELIMINARY DESIGN OF SUBORBITAL SPACEPLANE WITH LNG ENGINES BY A JAPANESE
UNIVERSITY START-UP WITH THE PARTNERSHIP OF INDUSTRIES**Abstract**

A Japanese university start-up SPACE WALKER Inc., which has been founded in December 25th of 2017, has been studying the commercialization of suborbital spaceplanes propelled by LNG engines with the partnership of Japanese aerospace, non-space industries and JAXA. The top management executives of SPACE WALKER Inc. exquisitely combines both the university professor, former executives and professional engineers involved in Japanese major space development called "Legacy Space", and the young generation entrepreneurs with new business ideas so-called "New Space".

The first concept of the suborbital spaceplane of vertical take-off and horizontal landing configuration has 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 second concept of the suborbital spaceplane, which has also the vertical take-off and horizontal landing configuration, separates the piggyback expendable rocket at the altitude of 40 km with the Mach number of around 5 to launch a small satellite of 100 kg to the sun-synchronous orbit of 700 km altitude. The third concept of the suborbital spaceplane is the space tourism with 2 pilots and 6 passengers performing horizontal take-off and horizontal landing to reach the 120 km altitude above the so-called Karman line.

This paper introduces the preliminary design of the first concept of suborbital spaceplane of vertical take-off and horizontal landing configuration studied by the design team consist of partner industries, which has the scientific mission for micro-gravity experiment, higher atmospheric research and space observation to reach the altitude of more than 120 km with 100 km payload. The preliminary design of the first suborbital spaceplane resulted in the total length of the suborbital spaceplane 10.9 m and the initial lift-off mass 11.7 tons propelled by 9 LNG engines with 20 kN thrust per engine. The development plan of the first suborbital spaceplane is discussed as well.