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LUNAR-GRAVITY AND MARS-GRAVITY RESEARCH, DEVELOPMENT AND QUALIFICATION TEST-FLIGHTS SUPPORTING THE EXPLORATION PROGRAM

Abstract

Since 2005, taking off and landing in Florida using the NASA Space Shuttle L.F. at the Kennedy Space Center, the SpaceLand program has been operational for cutting-edge research, development and testing activities in actual Moon-gravity and, respectively, Mars-gravity conditions without leaving the Earth atmosphere.

Such test flights are possible thanks to the particular parabolic flight profiles flown by an adapted Boeing 727-200 aircraft, as authorized by the USA Federal Aviation Administration, to fly parabolas whose curvature is smoother than standard zero-gravity flight patterns, to generate on board lower gravitational fields inside the fuselage as the crew were on the surface of the Moon or, respectively, Mars.

The so-called SpaceLand Lunar-g and/or Martian-g parabolic flights provide up to 35 users with a total test-time of up to 26 minutes per each Mars-gravity flight and approximately 20 minutes per each Moon-gravity flight, with the possibility to carry out multiple flights per campaign with quick payload assembly turn-over times. In general, on board this "flying laboratory" engineered by SpaceLand according to varying user requirements, research, analysis, design, development, tests and qualification can be carried out in a realistic gravitational environment to optimize prototypes, engineering and functional models as well as flight models of equipment and systems insofar as functions, procedures, methodologies and processes which are gravity-dependent need to be simulated in actual kinematic and dynamic conditions proper of the future lunar and Mars exploration programs, both robotic and crewed ones.

The Moon-g or Mars-g test-flight aircraft is fully ensured as an ordinary western airliner and is certified to board people from 11 to 93 years of age, even with disabilities, as demonstrated by the records set by the SpaceLand flight program at international level.

The aircrat can be internally equipped with several 3-CCD film-cameras and can be outfitted with analog terrains to simulate obstacles and slopes typical of the Moon and Mars surfaces, testing actual kinematics and dynamics of, for instance, rovers, robots, drillers and manipulators.

This paper shall provide detailed diagrams of the on-board gravitazional levels as compared to the acceleration levels of test subjects during the Mars-gravity and Moon-gravity testing periods as attained from recent SpaceLand research flights at the NASA Kennedy Space Center, in order to demonstrate the validity of such an alternative approach to minimize design and development costs and optimize concurrent engineering and AIV activities to ensure full success of the upcoming missions.

Particular emphasis shall be given to the concepts of ISRU and ISSFR, namely standing for In-Situ Resource Utilization and In-Situ Space Fabrication and Repair: such fundamental sets of activities for successful long-term operations of lunar and martian automatic or crewed basis can be immediately implemented at extremely low "cost-vs-results" ratios on low gravity parabolic flights in order to ensure realistic feasibility tests, concurrent engineering, "hand-on" development and fail-safe validation phases to turn the upcoming projects of the Exploration Program in a win-win operation, saving money to agencies and industry and scientists.