SPACE EXPLORATION SYMPOSIUM (A3)
Mars Exploration – Part 1 (3A)

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# EXOMARS EDM DESIGN AND DEVELOPMENT PLAN

**Abstract**

ExoMars is the first European mission of the Aurora program led by European Space Agency.

ExoMars will demonstrate key flight and in situ enabling technologies: among them Entry Descent and Landing (EDL) capability. The ExoMars architecture and design has passed the System PDR with Thales Alenia Space Italy as Industrial Prime Contractor. It is also responsible of the Entry Descent Landing Demonstrator Module (EDM), including its Guidance Navigation Control (GNC) system and the so-called EDL End-to-End (E2E) Simulator for a safe land on Mars. The verification philosophy is based on an incremental approach, starting from a unit level validation to a system level final validation by implementing a suitable balance of costs and risks. The driving line is to modularize as much as possible the development by de-coupling the various sub-systems such as to allow a parallel processing and saving time. The EDL end-to-end test is unaffordable for cost reason and impractical due to the differences between terrestrial and Martian conditions. The E2E EDL Simulator allows the simulation of the entire EDM mission applying a multiple probabilistic approach (Monte Carlo analyses) starting from separation, along the Coast and EDL phases up to touchdown on Mars surface. The EDL sequence is simulated, including the analytical validation of the GNC algorithms: triggering of the Front Shield separation, deployment of parachute, back shell with deployed parachute avoidance maneuver, Surface Platform active braking and attitude control by integrated GNC/RCS operations for a safe touchdown. In order to test the entry performance, EDM scaled models were used to validate the aerodynamic and aerothermodynamics mathematical models in wind tunnel tests. Descent performance verification of the parachute and probe transonic stability will be provided by a 12 degree of freedom simulation taking into account wind tunnel test data and using High Altitude Drop Test (HADT) to refine and qualify the model. Landing sequence will be verified by a combination of simulation runs on the E2E EDL simulator, performance qualification at GNC sensors level, field tests on RDA engineering model, hydraulic and firing tests performed on dedicated RCS mock-ups. This paper describes the EDM design consolidation and the associated verification for the coasting, entry, descent and landing phases describing the EDM STM models, liquid propulsion hydraulic mock-ups, avionic test benches and flight dynamics simulations on the EDL E2E simulator where atmospheric and terrain math models, multi-body modelling, separations triggering and closed loop controllers are simulated.