

## **Forward Bay Cover Separation Modeling and Testing for the Orion Multi-Purpose Crew Vehicle**

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Spacecraft multi-body separation events during atmospheric descent require complex testing and analysis to validate the flight separation dynamics model and to verify no re-contact. NASA Orion Multi-Purpose Crew Vehicle (MPCV) teams examined key model parameters and risk areas to develop a robust but affordable test campaign in order to validate and verify the Forward Bay Cover (FBC) separation event for Exploration Flight Test-1 (EFT-1). The FBC jettison simulation model is highly complex, consisting of dozens of parameters varied simultaneously, with numerous multi-parameter interactions (coupling and feedback) among the various model elements, and encompassing distinct near-field, mid-field, and far-field regimes. The test campaign was composed of component-level testing (for example gas-piston thrusters and parachute mortars), ground FBC jettison tests, and FBC jettison air-drop tests that were accomplished by a highly multi-disciplinary team. Three ground jettison tests isolated the testing of mechanisms and structures to anchor the simulation models excluding aerodynamic effects. Subsequently, two air-drop tests added aerodynamic and parachute parameters, and served as integrated system demonstrations, which had been preliminarily explored during the Orion Pad Abort-1 (PA-1) flight test in May 2010. Both ground and drop tests provided extensive data to validate analytical models and to verify the FBC jettison event for EFT-1, but more testing is required to support human certification, for which NASA and Lockheed Martin are applying knowledge from Apollo and EFT-1 testing and modeling to develop a robust but affordable human spacecraft capability.