National Aeronautics and Space Administration (NASA), World Spaceflight News (WSN), U. S. Government

Apollo - America's Moon Landing Program National Aeronautics and Space Administration (NASA), World Spaceflight News (WSN), U. S. Government, 2017-05-04 The primary objective of this paper is to present an analysis and a historical review of the Apollo Lunar Module landing dynamics from the standpoint of touchdown dynamic stability, landing system energy absorption performance, and evaluation of the first-order terms of lunar soil mechanical properties at the Apollo 11 landing site. The first-order terms of lunar surface mechanical properties consisted primarily of the surface bearing strength and sliding friction coefficient. The landing dynamic sequence started at first footpad contact. The flight dynamics data used to assess the Apollo 11 landing system performance and the lunar soil mechanical properties included the body axis pitch, roll, and yaw rate time histories as measured by the on-board guidance computer during the Apollo 11 Lunar Module touchdown maneuver, and the landing gear stroke data derived from post-landing photographs. The conclusions drawn from these studies were that the landing gear system performance was more than adequate from a stability and energy absorption standpoint for all Apollo lunar landings, and the lunar soil parameters were well within the limits of the design assumptions for all Apollo landing sites. Chapter 1.0 - Introduction \* Chapter 2.0 - Landing Dynamic Analysis \* Chapter 3.0 - Drop Testing of Subscale and Full-scale Lunar Module Models \* Chapter 4.0 - The Lunar Module \* Chapter 5.0 - Critical Design Cases \* Chapter 6.0 - Analysis of the Apollo 11 Lunar Module Landing Dynamics and Lunar Surface Mechanical Properties \* Chapter 7.0 - The Apollo Lunar Module Landings \* 7.1 Apollo 11 Lunar Landing \* 7.1.1 Summary: Apollo 11 Lunar Module Landing \* 7.2 Apollo 12 Lunar Landing \* 7.2.1 Summary: Apollo 12 Lunar Module Landing \* 7.3 Apollo 13 Lunar Landing (Aborted) \* 7.4 Apollo 14 Lunar Landing \* 7.4.1 Summary: Apollo 14 Lunar Module Landing \* 7.5 Apollo 15 Lunar Landing \* 7.5.1

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Apollo and America's Moon Landing Program World Spaceflight News, National Aeronautics and Space Administration (NASA),2018-01-07 Three comprehensive official NASA documents chronicle the incredible flight of Apollo 13, which returned safely to Earth after aborting its planned lunar landing in April 1970. (Please note that due to space constraints, the Cortright Apollo 13 Review Board report is available as a separate ebook.) Two technical mission reports, the Manned Spacecraft Center (MSC) Apollo Mission Report and the NASA Headquarters Mission Operation Report (MOR), provide complete details about every aspect of the mission. Apollo 13 MSC Mission Report: Mission description, pilots' report, communications, trajectory, command and service module performance, mission support performance, assessment of mission objectives, launch vehicle summary, anomaly summary (CSM, LM, government furnished equipment), conclusions, vehicle descriptions. Apollo 13 MOR: Mission design and execution, spacecraft performance, flight anomalies, detailed objectives and experiments, launch countdown, detailed flight mission description, back contamination program, contingency operations, configuration differences, mission support, recovery support plan, flight crew, mission management responsibility, program management, abbreviations and acronyms. Apollo 13 Press Kit: Detailed preview from countdown to landing. The Apollo 13 mission, planned as a lunar

landing in the Fra Mauro area, was aborted because of an abrupt loss of service module cryogenic oxygen associated with a fire in one of the two tanks at approximately 56 hours. The lunar module provided the necessary support to sustain a minimum operational condition for a safe return to earth. A circumlunar profile was executed as the most efficient means of earth return, with the lunar module providing power and life support until transfer to the command module just prior to entry. Although the mission was unsuccessful as planned, a lunar flyby and several scientific experiments were completed. The space vehicle, with a crew of James A. Lovell, Commander; Fred W. Haise, Jr., Lunar Module Pilot; and John L. Swigert, Jr., Command Module Pilot; was launched from Kennedy Space Center, Florida, at 2:13:00 p.m. e.s.t. (19:13:00 G.m.t.) April 11, 1970. Two days before launch, the Command Module Pilot, as a member of the Apollo 13 backup crew, was substituted for his prime crew counterpart, who was exposed and found susceptible to rubella (German measles). During S-II stage boost, an automatic shutdown of the center engine occurred because of a divergent dynamic structural condition associated with that engine. At approximately 56 hours, the pressure in cryogenic oxygen tank 2 began to rise at an abnormally high rate and, within about 100 seconds, the tank abruptly lost pressure. The loss of oxygen and primary power in the service module required an immediate abort of the mission. The crew powered up the lunar module, and the first maneuver following the incident was made with the descent propulsion system to place the spacecraft once again on a free-return trajectory. A second maneuver performed with the descent engine 2 hours after passing pericynthion reduced the transearth transit time and moved the earth landing point from the Indian Ocean to the South Pacific. Two small transearth midcourse corrections were required prior to entry. The lunar module was jettisoned 1 hour before entry, which was performed nominally using the primary guidance and navigation system. Landing occurred at 142:54:41 within sight of the

recovery ship. The landing point was reported as 21 degrees 38 minutes 24 seconds south latitude and 165 degrees 21 minutes 42 seconds west longitude. The crew were retrieved and aboard the recovery ship within 45 minutes after landing.

Lem Lunar Excursion Module Familiarization Manual Grumman Aircraft Engineering Co.,2011-05 Designed by Grumman's brilliant Tom Kelly, the Apollo Lunar Excursion Module (or LEM for short) was a triumph of purpose-built engineering. In the six years 1962-1968 between drawing board and first flight, a myriad of challenges were overcome related to weight, reliability and safety. The final design, designated the Lunar Module or LM, boasted tiny windows instead of large portholes, four legs instead of five and most famously had no seats instead relying on the astronauts' legs to cushion a lunar landing. Ten LMs made it into space including three flown in development and test missions, and six which landed on the Moon. A seventh famously saved the crew of Apollo 13 when that mission's Command Module suffered a catastrophic malfunction. Originally created for NASA by Grumman in 1964, this LEM Familiarization Manual provides an operational description of all subsystems and major components of the lunar lander. It includes sections about the LEM mission, spacecraft structure, operational subsystems, prelaunch operations, and ground support equipment.

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