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APOLLO SPACECRAFT

TO TEST ESCAPE SYSTEM

IN WHITE SANDS TEST

The National Aeronautics and Space Administration will flight test the Apollo spacecraft from the White Sands Missile Range, N.M., no earlier than Dec. 8.

Major objective of the flight is to demonstrate satisfactory performance of the Apollo spacecraft launch escape system under conditions simulating a catastrophic launch vehicle failure at the altitude the spacecraft is under maximum aerodynamic pressures. At the White Sands Range, which is 4,000 feet above sea level, the maximum pressure region (Max-Q) is about 31,000 feet above the range.

The launch escape system, a 33-foot tower configuration, atop the spacecraft, is an emergency unit designed to jettison the command module and the astronauts to safety in the event of booster failure before or during launch.

The test will employ a Little Joe II launch vehicle, producing approximately 340,000 pounds thrust, to boost Apollo boilerplate command and service modules with a production launch escape system.

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In this test that launch escape system will utilize canards -- a pair of wings or fins -- located near the top of the tower jettison motor. The canards deploy to turn the command module heat shield forward to lessen descent oscilla-tions during an emergency abort.

Another spacecraft subsystem to be flight tested for the first time is the boost protective cover. Consisting of a shell contoured to fit the sloping section of the com-mand module, the cover is designed to protect the lunar ex-cursion module docking mechanism from excess heating during first stage boost, protect the command module windows from soot and erosion caused by the launch escape motor. It also protects the thermal control paint on the ablative material. The boost protective cover is jettisoned with the launch escape tower.

Also, during this test, two spacecraft drogue parachutes will be used instead of one.

Previous tests of the Apollo launch escape system con-ducted from the White Sands range were:

Nov. 7, 1963 - Successful pad abort simulation test

May 13, 1963 - Successful high dynamic pressure test, although one of the three spacecraft parachutes failed to deploy.

FLIGHT PLAN

The test vehicle will be launched from White Sands Missile Range (4,000 feet above sea level). It will be oriented in a northerly direction at an angle of approximately 84 degrees with respect to the horizontal. The signal to launch, transmitted by land-line from the blockhouse, will ignite the two Algol and four Recruit solid rocket motors simultaneously.

The test vehicle will follow a controlled trajectory to the test point. Approximately two seconds prior to abort, on a radio command, the launch vehicle attitude-control subsystem will execute a pitch maneuver to attain an angle which approximates the emergency escape attitude for the spacecraft.

The abort will be initiated by a launch vehicle timer shortly after the radio command for the pitch-up maneuver is received. The abort is scheduled to occur about 37 seconds after liftoff. The abort signal initiates the separation of the command module from the service module, ignition of the pitch-control and launch escape rocket motors, and activation of the mission sequencer 11-second time delay. Eleven seconds after abort initiation, the canard surfaces will be deployed causing launch-escape vehicle turn-around and stabilization with the command module aft heat shield forward. Altitude of the launch-escape vehicle will be about 46,000 feet above the range, 65 seconds after liftoff.

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The launch-escape subsystem, boost-protective cover, and forward heat shield will be jettisoned as a unit by the tower jettison rocket motor, initiated by a baroswitch at about 21,000 feet above the range. The dual-drogue parachutes will be deployed in a reefed condition two seconds later and will be opened six seconds after deployment. At 8,000 feet above the range, the dual-drogue parachutes will be released and the main parachutes will be deployed in a reefed condition for a period of six seconds at which time the main parachutes will be opened. Command module impact is scheduled for about seven minutes after liftoff.

Following is the detailed test sequence:

T minus Zero	Liftoff
T plus 35.5 seconds	Pitch-up maneuver at about 26,000 feet above the range
T plus 37.5 seconds	Abort initiation at about 31,000 feet above the range
T plus 48.5 seconds	Canard deployment
T plus 116 seconds	Launch-escape tower, boost protective cover, and forward heat shield, jettison at about 21,000 feet above the range
T plus 118 seconds	Drogue parachute deployment at about 19,000 feet above the range
T plus 133.8 seconds	Launch vehicle and service module impact about 32,000 feet uprange

T plus 165.4 seconds	Main parachute deployment at about 8,000 feet above the range
T plus 166.1 seconds	Launch-escape tower impact about 31,500 feet uprange
T plus 416.9 seconds	Command module landing about 34,000 feet uprange

TEST VEHICLE COMPONENTS AND CHARACTERISTICS

Height: 85 feet, 7 inches

Little Joe II: Height, 32 feet, 10 inches; diameter, 154 inches; weight at launch, approximately 66,000 pounds including approximately 40,000 pounds of fuel. Powered by two Algol motors, each with 103,200 pounds of thrust; and four Recruit motors, each with 33,395 pounds of thrust. Total thrust of the launch vehicle, approximately 340,000 pounds.

The Little-Joe II launch vehicle incorporates an attitude control subsystem which consists of aerodynamic and reaction control subsystems controlled by an airframe autopilot.

The launch vehicle command subsystem will receive the ground-transmitted, coded radio signals to initiate the pitch-up maneuver and the launch vehicle abort timer.

Service-Module (Boilerplate): Cylindrical design; height 13 feet, 2 inches; diameter, 154 inches; weight, 9,600 pounds.

Command-module (Boilerplate): Conical design; height 11 feet, 3 inches; diameter at base, 154 inches; weight, 10,000 pounds. The command module shell consists of two subassemblies: the forward and aft sections of the crew compartment. The forward section of the crew compartment is attached to the launch-escape tower attach fittings in the forward bulkhead. Other attach fittings are provided for the aft heat shield struts, service module tension ties, ground support equipment, and service module thrust bearing and shear points.

The main hatch provides access to the interior of the command module. Eight openings are provided in the forward crew compartment shell for antennas.

The forward cover consists of an inner shell (the forward heat shield for flight and reentry protection) and an outer shell (boost-protective cover) for protection from aerodynamic heating during boosted flight.

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The forward heat shield is a truncated cone shaping the upper third of the command module and protecting the parachutes, egress hatch and other equipment. It is attached to each of the four tower legs of the launch-escape subsystem. This shield, along with the boost-protective cover, is removed when the launch-escape tower is jettisoned.

The boost-protective cover extends over the entire conical surface of the command module. The upper third of the cover (hard cover) consists of ablative cork, supported by glass-honeycomb over a Teflon-impregnated glass cloth. The lower two-thirds of the cover (soft cover) consists of ablative cork over Teflon-impregnated glass cloth. The Teflon-impregnated glass cloth is used not only for structural support, but also to assure a smooth surface for ease of removal when the tower is jettisoned.

The aft heat shield consists of an inner and outer glass laminated skin with an aluminum honeycomb core. Its purpose is to protect the command module from aerodynamic heating and earth impact during the Earth-landing phase.

The electrical power subsystem consists of one 1,500 watt-hour and four 140 watt-hour silver zinc batteries. On-board instrumentation consists of a telemetry system, motion picture cameras and a tape recorder.

The Earth-landing (parachute) subsystem consists of pyrotechnics and protechnic-actuated devices, dual-conical-ribbon drogue parachutes (13.7 feet in diameter), three pilot parachutes, three ring-sail main parachutes (88.1 feet in diameter), deployment bags, bridles, risers, and an Earth-landing subsystem sequencer.

Launch-Escape System: The launch-escape subsystem consists of a tower structure, launch-escape motor, pitch-control motor, tower-jettison motor, tower-release mechanism, canard subsystem, Q-ball assembly, and ballast.

The tower structure of the launch-escape subsystem is the intermediate structure between the command module and the launch-escape motor-mounting skirt. It is approximately 120 inches long and has a base approximately 40 x 50 inches. It is attached to the command module by the tower-release mechanism.

The launch escape motor weighs approximately 4,800 pounds, is 26 inches in diameter, 183 inches long, and burns approximately 3,200 pounds of solid fuel while providing a nominal thrust of 155,000 pounds for approximately six seconds.

The pitch-control motor is a solid propellant reaction motor, 9 inches in diameter and 22 inches long. The housing for the motor forms the structure between the Q-ball assembly and forward end of the jettison motor.

The tower-jettison motor is also a solid-propellant reaction motor. It is 26 inches in diameter, 47 inches long, has a gross weight of 550 pounds and develops 33,000 pounds of thrust for one second.

The tower-release mechanism consists of four single-mode explosive bolts. Each bolt contains a single explosive charge which incorporates a dual ignition feature to increase reliability.

The canard subsystem is mounted in the pitch-control motor housing between the Q-ball assembly and the forward end of the jettison motor. The canard consists of two pyrotechnic-actuated stabilizing "wings" about 18 inches wide and 24 inches long which are deployed about 11 seconds following the launch-escape subsystem rocket motor ignition. The canard effects the turn-around maneuver to turn the command module to the blunt-end-forward position to minimize command module descent oscillations. Tumbling actions within acceptable limits are expected during the turn-around maneuver.

The Q-ball assembly is a conical-shaped unit placed on the forward end of the pitch-control motor housing. Its weight is approximately 23 pounds. By means of four static pressure pickups in the front section of the Q-ball system, angles of attack can be obtained for use in test vehicle trajectory analysis and evaluation.

Dynamic pressure can also be determined from these pressure pickups.

The launch-escape subsystem has provisions for the installation of ballast which will be used to achieve desired dynamic characteristics of the launch-escape vehicle during the abort sequence.

Launcher: The launcher is a fabricated steel structure, using heavy I-beams for main supports. The components include a pivot frame mounted on a double flange, crane-type truck for rotation to the required azimuth position, a support platform incorporating pads and pins for vehicle support, screw jacks for tilting the support platform to required elevation angles, and a launcher mast.

CONTRACTOR PARTICIPATION

North American Aviation, Inc., Downey, Calif., prime contractor, spacecraft command,service module.

General Dynamics/Convair, San Diego, Calif., Little Joe II.

Aerojet-General Corp., Sacramento, Calif., Algol motors.

Thiokol Chemical Corp., Bristol, Pa.,Recruit Motors.

Lockheed Propulsion Co., Redlands, Calif., launch escape and pitch control motors.

Thiokol, escape system jettison motor.

Northrop Corp., Beverly Hills, Calif., landing system.

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