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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
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FOR RELEASE: MONDAY AM'S
March 1, 1965

PROJECT: CENTAUR 5 (AC-5)

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Launch is scheduled no earlier than Mar. 2.

NEWS NASA

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NASA'S FIFTH CENTAUR
FLIGHT TO TEST
SURVEYOR DYNAMIC MODEL

The hydrogen-fueled Centaur launch vehicle will be test-flown for the fifth time by the National Aeronautics and Space Administration from Cape Kennedy, Fla., no earlier than March 2.

This vehicle-development flight, designated Atlas-Centaur 5 (AC-5), continues a series of experimental test flights planned to prepare Centaur for future launches of the Surveyor soft landing spacecraft on the Moon.

AC-5 will carry as payload a Surveyor dynamic model; this is a dummy space frame ballasted to simulate the dynamic-response characteristics of a Surveyor spacecraft. The use of the dynamic model will permit an evaluation of the dynamic interaction between the Centaur and its payload during the powered phase of flight prior to injection.

AC-5, is the first Centaur vehicle to fly with an up-rated Atlas propulsion system and the Centaur upper stage propellant utilization system. The flight plan has been established to obtain data on these new features and on the operation of the guidance system. Data also will be obtained on many other components and systems which have been tested during previous flights.

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The AC-5 will be flown along a simulated lunar transfer trajectory until propellants are depleted or until full lunar transfer energy is achieved and guidance cut-off is accomplished. The dynamic model will be separated from the vehicle. Neither the vehicle nor the model will hit the Moon because the simulated trajectory is purposely designed to avoid this possibility.

Following separation from Centaur, the dynamic model will continue on a highly elliptical Earth orbit with an apogee of about 500,000 miles and a perigee of about 100 miles. The orbital period will be about 35 ½ hours.

Centaur, combined with an Atlas booster as its first stage, is being developed as NASA's prime vehicle to launch Surveyor spacecraft which will soft-land on the Moon to make surface studies in support of future manned lunar landings. Using liquid hydrogen in its upper stage, Centaur provides about 35 per cent more energy than vehicles using conventional rocket fuels.

The Centaur is being developed for NASA's Office of Space Science and Applications under technical direction of NASA's Lewis Research Center, Cleveland, Ohio.

Prime contractor is Convair Division of General Dynamics Corp., San Diego, Calif. The second stage RL-10 hydrogen engines are built under direction of NASA's Marshall Space Flight Center, Huntsville, Ala., by Pratt and Whitney Aircraft

Div., West Palm Beach, Fla. Honeywell Inc., St. Petersburg Fla., provides the vehicle's all-inertial guidance system. More than 300 other contractors throughout the country are participating in the project.

Centaur Launchings are conducted for the Lewis Research Center by NASA Goddard Space Flight Center's Launch Operations at Cape Kennedy.

(Background information follows)

TECHNICAL BACKGROUND AND FLIGHT HISTORY

AC-5 is the fifth of eight scheduled engineering development flights to qualify the Centaur vehicle for operational space missions. Once operational, Centaur's primary mission will be to place the instrumented Surveyor spacecraft on the Moon to conduct surface studies.

Centaur vehicle accomplished the first known successful flight of a vehicle using liquid hydrogen as propellant Nov. 27, 1963. Liquid Hydrogen also has been tested successfully in the Saturn I vehicle. The Saturn V also will use hydrogen engines and will propel American astronauts to the Moon. Hydrogen also is used in NERVA -- nuclear engine for rocket vehicle applications -- the joint NASA-Atomic Energy Commission program to develop nuclear rocket technology.

Since the initial flight success of Centaur, the vehicle has been flown twice, June 30 and Dec. 11, 1964.

The June 30 flight accomplished five of six primary objectives. However a premature shutdown of the second stage hydrogen engines resulted in a shorter-than-planned burning period.

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The Dec. 11 flight successfuly accomplished all primary objectives. These included the first use of its inertial guidance system to not only steer the Atlas-Centaur following booster shutdown but to perform other in-flight maneuvers.

As on the previous flight, Centaur's guidance loop will be "closed" for the AC-5 flight, i.e., guidance steering signals will be utilized for vehicle steering. The guidance system, located on the Centaur stage, will generate pitch and yaw steering signals to the autopilots for flight control from booster engine cutoff (BECO) plus eight seconds to termination of the Centaur retromaneuver.

During future Atlas-Centaur Surveyor operational missions, Centaur's guidance will perform such complex maneuvers as stopping and starting the hydrogen engines in space. Centaur's two-burn capability will permit much greater flexibility in determining "launch windows," periods during which a vehicle must be launched from Earth to intercept a body in space. Centaur could fly into a "parking" Earth orbit, coast for a brief period until the Moon is in the proper position, then re-start its engines to achieve a lunar-transfer trajectory.

During the past two and one-half years, the Centaur vehicle has undergone one of the most rigorous ground-testing programs of any U.S. rocket. Both the Atlas booster and Centaur second stage and all their associated systems and sub-systems have been subjected to a series of ground tests to determine how the vehicle reacts during actual flight. These include vibration and load tests with a full-scale Atlas-Centaur/Surveyor structural model combination; separation tests of the Atlas-Centaur; insulation panel and nose fairing jettison and heat tests; ground-chill tests of the hydrogen engines; high-speed rocket sled tests of the guidance system; and other tests.

A new ground-test facility, called a Combined Systems Test Stand, was built for NASA by General Dynamics in San Diego, Calif. This facility, soon to become operational, will permit complete pre-launch ground tests of Atlas-Centaur/Surveyor prior to shipment to Cape Kennedy, thus eliminating many similar tests currently required after the vehicle is erected for launch.

LAUNCH VEHICLE

Total liftoff weight: 300,000 pounds

Total liftoff height: 112 feet

	Atlas-D Booster	Centaur Stage
Weight	260,000 pounds	40,000 pounds
Height	66 feet	46 feet (with nose fairing)
Thrust	389,000 pounds at sea level	30,000 pounds at altitude
Propellants	Liquid oxygen and RP-1, a kerosene-like fuel	Liquid hydrogen and liquid oxygen
Propulsion	MA-5 system, built by Rocketdyne Div., North American Aviation, Inc.	Two RL-10 engines by Pratt and Whitney Aircraft Div., United Aircraft Corp.
Speed	6400 mph at BECO, 8800 mph at SECO	24,500 mph at injection
Guidance	Pre-programmed auto-pilot through BECO	Honeywell Inc. all inertial
Contractor	GD/Convair	GD/Convair

AC-5 consists of a modified Series D Atlas booster combined with a Centaur second stage. Both stages are 10 feet in diameter, connected by an interstage adapter. There are no internal braces in Atlas or Centaur; both maintain their rigidity through pressurization.

The Atlas first stage, 66 feet in length including the interstage adapter, is referred to as a 1-1/2 stage configuration since the booster engines are jettisoned after use. Atlas employs conventional kerosene as a propellant and liquid oxygen as the oxidizer.

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Using an MA-5 propulsion system, built by Rocketdyne Division of North American Aviation, Inc., Atlas develops about 390,000 pounds of thrust. For the AC-5 mission, Atlas will be equipped with up-rated booster engines developing about 165,000 pounds of thrust each, a sustainer engine with 57,000 pounds and two vernier engines developing 1,000 pounds each.

Following first stage flight, the Atlas and Centaur are separated by a flexible linear-shaped charge which severs the interstage adapter. Eight retro-rockets mounted on the aft end of Atlas are fired to increase the separation rate.

The Centaur upper stage, 46 feet long including the nose fairing, is a high-specific impulse space vehicle powered by two Pratt and Whitney RL-10 engines rated at 15,000 pounds of thrust each. Centaur's tank is constructed of Type 301 stainless steel, the same material used for the Atlas tanks. Payload, guidance and electronic equipment packages are mounted on the forward bulkheads of Centaur's hydrogen tank.

To minimize the boiloff of liquid hydrogen, which is maintained at -423 F. degrees, external thermal insulation fiberglass panels are mounted on the hydrogen tank. The four panels weigh about 1,250 pounds and are jettisoned after the vehicle leaves the earth's atmosphere.

A nose fairing, constructed of honeycombed fiberglass, surrounds the payload and equipment mounted on Centaur and provides thermal and aerodynamic protection during flight through the atmosphere. The nose fairing weighs about 1,850 pounds and is jettisoned shortly after the insulation panels.

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PAYLOAD CONFIGURATION

The dummy payload for AC-5 is a Surveyor dynamic model designed to simulate the dynamic-response characteristics of the Surveyor spacecraft.

The model consists of a spaceframe supplied by Hughes Aircraft Co., Culver City, Calif., contractor to NASA's Jet Propulsion Laboratory for the Surveyor project, and a retromotor simulator assembly built by General Dynamics/Convair.

The spaceframe is similar to that of the actual Surveyor spacecraft, except for certain reinforcing structures which are deleted. Dummy masses are mounted on the spaceframe to simulate the mass properties of those items they replace. The planar antenna, solar panel and mast assembly are similar in appearance to their Surveyor counterparts. A simulated Surveyor landing gear is incorporated.

Mounted on a mast above the spaceframe is an omni-directional antenna, which is used with the S-band transponder. The transponder is required for post-separation tracking by the Deep Space Network.

The Dynamic model is instrumented with temperature sensors, accelerometers, microphones, position potentiometers and strain gages, all designed to monitor its behavior during the Atlas-Centaur boost phase.

The S-band transponder on the dynamic model permits ground radar tracking following separation from Centaur. The transponder power supply is designed for a 20-hour mission.

The purpose of the retromotor simulator is to replace the live Surveyor retrorocket engine, which will later be used to decelerate the operational spacecraft for landing on the Moon. The dummy retromotor simulates the mass, moment of inertia and center of gravity of the Surveyor retromotor and also carries the telecommunications system.

The dummy retromotor is mounted on the spaceframe in much the same manner in which the actual Surveyor retrorocket will be attached to Surveyor. However, since it does not have to be separated from the spacecraft, as in the case of Surveyor, the assembly is attached with non-explosive bolts.

The dynamic model weighs about 1,400 pounds. Actual Surveyor spacecraft will weigh approximately 2,250 pounds.

INSTRUMENTATION AND TRACKING

AC-5 will be heavily instrumented. The telemetry system will radio data measurements from Centaur for about six hours, or until its battery power is depleted.

Measurements on the upper stage will send information on engine performance, guidance system and autopilot operation, and structural behavior. Booster stage measurements relate primarily to engine function and guidance systems, plus standard vibration, bending and temperature data.

A number of measurements will be made on the Surveyor dynamic model, with particular emphasis on aerodynamic heating effects during boost flight and separation of the spacecraft from Centaur.

AC-5 will be tracked during powered flight and portions of its orbital flight to obtain performance information.

Atlas-Centaur powered flight tracking down the Eastern Test Range will be accomplished by C-band radar and Azusa Mark II/Glotrac systems by stations at Cape Kennedy, Antigua, Grand Bahama, San Salvador and Bermuda.

Separation, reorientation and retromaneuver data will be received downrange by Air Force Eastern Test Range (AFETR) ground stations extending from Cape Kennedy to Pretoria, South Africa, and a telemetry ship on station in the South Atlantic.

Following injection into orbit, an S-band transponder attached to the Surveyor model will be tracked by stations of the Deep Space Network until depletion of its battery power, estimated at about 20 hours.

A C-band transponder on the Centaur stage will be tracked by AFETR radar tracking stations for about 10 hours after liftoff.

MISSION DESCRIPTION

Liftoff. For the first two seconds the Atlas-Centaur vehicle rises vertically, then for eight seconds rolls from a fixed launcher heading of 105 degrees to the desired flightplane azimuth of from 90 degrees to 111 degrees depending upon launch time.

T plus 15 seconds. The vehicle begins pitching over to the programmed flight trajectory. This gradual pitchover continues throughout the Atlas-powered phase of the flight.

T plus 142 seconds. Boost flight is terminated (BECO) by a signal issued by Centaur guidance when an acceleration level of 5.7 G's is sensed. This is followed by jettisoning of the booster package 3.1 seconds later. The sustainer engine continues to propel the vehicle.

T plus 172 seconds. The four fiberglass insulation panels surrounding the Centaur stage are jettisoned.

T plus 197 seconds. The fiberglass nose fairing which protects the payload during flight through the atmosphere is jettisoned.

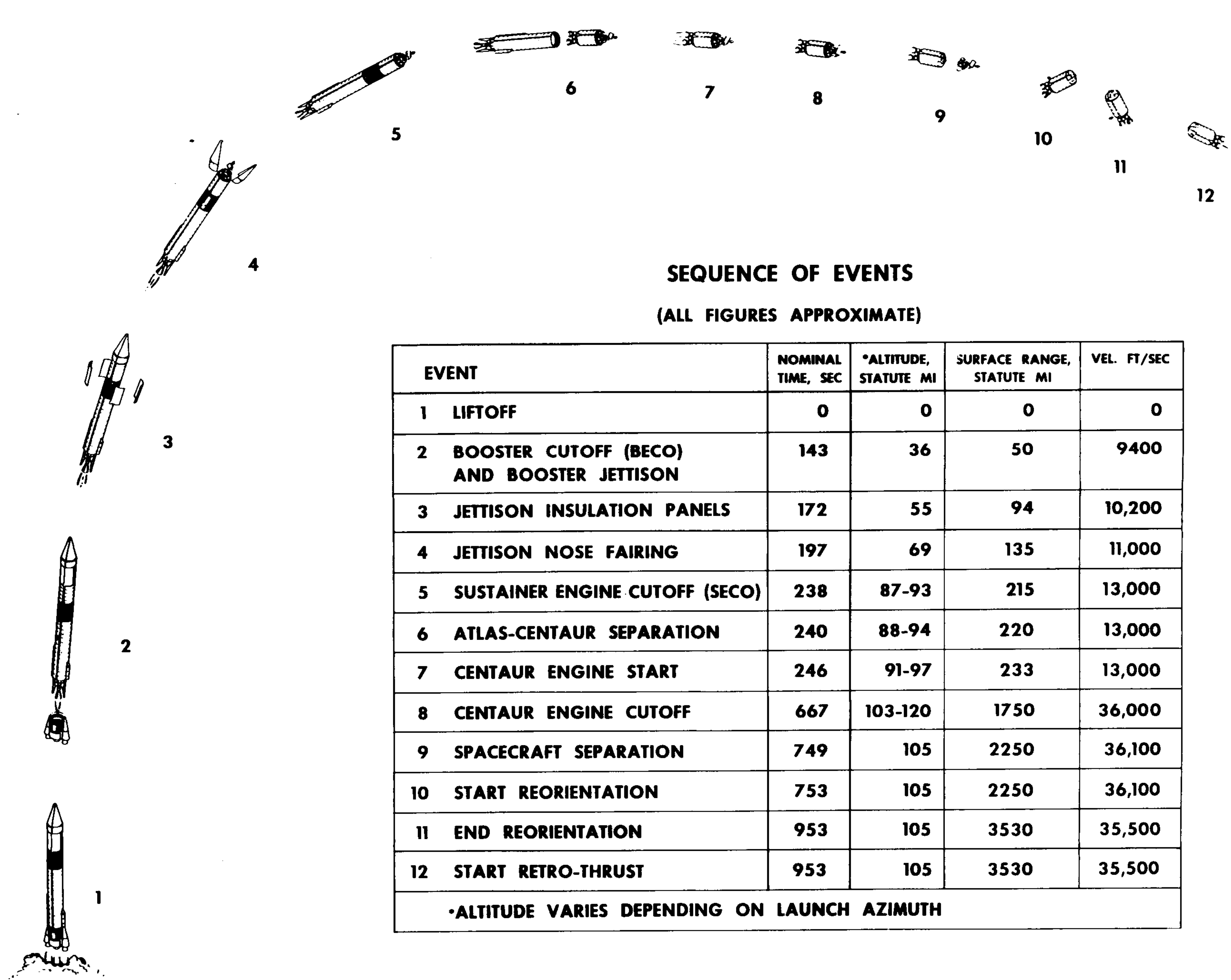
T plus 238 seconds. The Atlas sustainer engine is shut down (SECO) at fuel depletion. This occurs at an altitude of about 90 miles.

T plus 240 seconds. Following SECO, Atlas and Centaur are separated. Eight retro-rockets mounted on the aft end of Atlas increase the rate of separation.

T plus 241 seconds. For a few seconds prior to second stage ignition, propellants are pumped through the Centaur fuel and oxidizer system, chilling down the hardware to prevent cavitation at Centaur main engine start.

T plus 246 seconds. Centaur's hydrogen-fueled engines are started for a planned burn of 420 seconds. Second stage ignition occurs at an altitude of about 95 miles. During Centaur powered flight, the vehicle's Propellant Utilization System will be flown closed-loop; i.e., the system will determine proper utilization of available liquid hydrogen and liquid oxygen to ensure that Centaur uses all available propellants, thus attaining maximum energy necessary to inject a payload on an intercept trajectory with the Moon. AC-5 will be the first mission to fully test the Propellant Utilization System.

T plus 666 seconds. Following second stage shutdown, a number of events are programmed. The dynamic model will be separated from Centaur by firing three squibs which release three latches on the payload adapter. Three spring-loaded cylinders then force the Centaur and the model apart. At this point, the velocity will be approximately 36,100 ft/sec, or 24,500 mph.



SEQUENCE OF EVENTS

(ALL FIGURES APPROXIMATE)

EVENT	NOMINAL TIME, SEC	*ALTITUDE, STATUTE MI	SURFACE RANGE, STATUTE MI	VEL. FT/SEC
1 LIFTOFF	0	0	0	0
2 BOOSTER CUTOFF (BECO) AND BOOSTER JETTISON	143	36	50	9400
3 JETTISON INSULATION PANELS	172	55	94	10,200
4 JETTISON NOSE FAIRING	197	69	135	11,000
5 SUSTAINER ENGINE CUTOFF (SECO)	238	87-93	215	13,000
6 ATLAS-CENTAUR SEPARATION	240	88-94	220	13,000
7 CENTAUR ENGINE START	246	91-97	233	13,000
8 CENTAUR ENGINE CUTOFF	667	103-120	1750	36,000
9 SPACECRAFT SEPARATION	749	105	2250	36,100
10 START REORIENTATION	753	105	2250	36,100
11 END REORIENTATION	953	105	3530	35,500
12 START RETRO-THRUST	953	105	3530	35,500

*ALTITUDE VARIES DEPENDING ON LAUNCH AZIMUTH

T plus 753 seconds. Since future Surveyor operational spacecraft will be oriented with respect to the Sun and the star, Canopus, the Centaur vehicle must be separated sufficiently from the spacecraft to preclude Surveyor's star seeker from locking onto the launch vehicle erroneously. This will be accomplished by:

1. Rotating Centaur 180 degrees by its attitude control system.

2. Blowing residual propellants through Centaur's engines to apply retro-thrust. This "retromaneuver" lasts about 15 minutes.

The successful execution of the retromaneuver will separate Centaur and dynamic model sufficiently. However, the dynamic model being flown on AC-5 will not be equipped with a star seeker, nor will it have any mid-course maneuver capability as will future Surveyors.

Following separation, the dynamic model will continue in its elliptical orbit around Earth. The Centaur vehicle also will circle Earth, but in a shorter orbit than the model.

CENTAUR DEVELOPMENT TEAM

The Centaur program is directed in NASA Headquarters by the Office of Space Science and Applications. Dr. Homer Newell is Associate Administrator for Space Science and Applications. Vincent L. Johnson is Director, Launch Vehicle and Propulsion Programs. R.D. Ginter is Centaur Program Manager.

Project management is assigned to NASA's Lewis Research Center. Dr. Abe Silverstein is Director of Lewis. Bruce T. Lundin is Associate Director for Development. David S. Gabriel, is Centaur Program Manager.

Centaur launches are conducted for Lewis by Goddard Space Flight Center's Launch Operations Branch, Cape Kennedy. Robert Gray is Chief, GSFC Launch Operations.

Convair Division of General Dynamics Corp. is prime contractor for the Centaur Vehicle, including the Atlas booster. Grant L. Hansen is Centaur Program Director and Vice President, GD/Convair.

Pratt and Whitney is an associate prime contractor for Centaur's RL-10 hydrogen engines. Gordon Titcomb is P&W's RL-10 Project Manager.

Honeywell Inc., St. Petersburg, Fla., is an associate prime contractor for Centaur's inertial guidance system. R. B. Foster is Program Manager.

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