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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

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February 15, 1965

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PROJECT: PEGASUS - SATURN I

CONTENTS

Scheduled to be launched no sooner than Feb. 16.

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SATURN I TO LAUNCH
PEGASUS METEOROID
DETECTION SATELLITE

The National Aeronautics and Space Administration will launch the first Pegasus meteoroid detection satellite using a Saturn I from Cape Kennedy, Fla., no sooner than Feb. 16, 1965.

Pegasus, the largest unmanned instrumented satellite developed by NASA, will be launched on the eighth Saturn I flight. Vehicle performance will provide additional information and experience toward development of the larger Saturn IB and Saturn V vehicles. All previous Saturn I flights were successful.

The Pegasus satellite will "sweep" space, detecting and reporting collisions with meteoroids. The information obtained will give scientists a better indication of the distribution, size and velocity of such particles near the Earth. Pegasus will orbit the Earth every 97 minutes, ranging in altitude from about 310 to 465 statute miles and inclined 31.7 degrees to the equator.

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The large panels which the satellite will expose to the meteoroid environment resemble a pair of "wings." The structure (in orbit) will be 96 by 14 feet and have more than 2,300 square feet of instrumented surface. As particles collide with the surface of the panels, they will be registered and reported to Earth.

Desired lifetime of the solar-powered satellite is one year, although it may orbit three or more years.

Exposure of the large panel area over a long period will give the designers of manned and unmanned spacecraft a good sample of meteoroid data. To date, small samples of such data have been gathered by Explorers XVI and XXIII which are about 1/80 the size of Pegasus.

Outwardly, the vehicle-spacecraft in place on the launch pad will appear identical to the previous two Saturn I test vehicles, SA-6 and 7. Apollo command and service module boilerplate spacecraft and launch escape system tower will be atop the Saturn vehicle. Pegasus will be folded inside the specially adapted boilerplate service module. After injection into orbit, the command and service modules will be jettisoned and the satellite will be free to deploy its panels.

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No engineering test of the Apollo hardware is intended.

The launch vehicle for this flight (SA-9) is similar to the last Saturn I (SA-7) launched. It develops 1.5 million pounds thrust, stands 188 feet on the pad and weighs about 1,120,000 pounds at liftoff. The flight will be the eighth Saturn I test although the vehicle is designated SA-9. The two remaining Saturn I vehicles, SA-8 and SA-10, also are to launch Pegasus satellites later this year.

The Pegasus satellite weighs about 3,200 pounds. Total payload weight (the Pegasus remains attached to the S-IV stage) will be about 23,000 pounds, distributed as follows:

Spent S-IV stage	14,500
Instrument Unit	2,600
Pegasus	3,200
Pegasus Support Structure and Adapter	2,700
	23,000

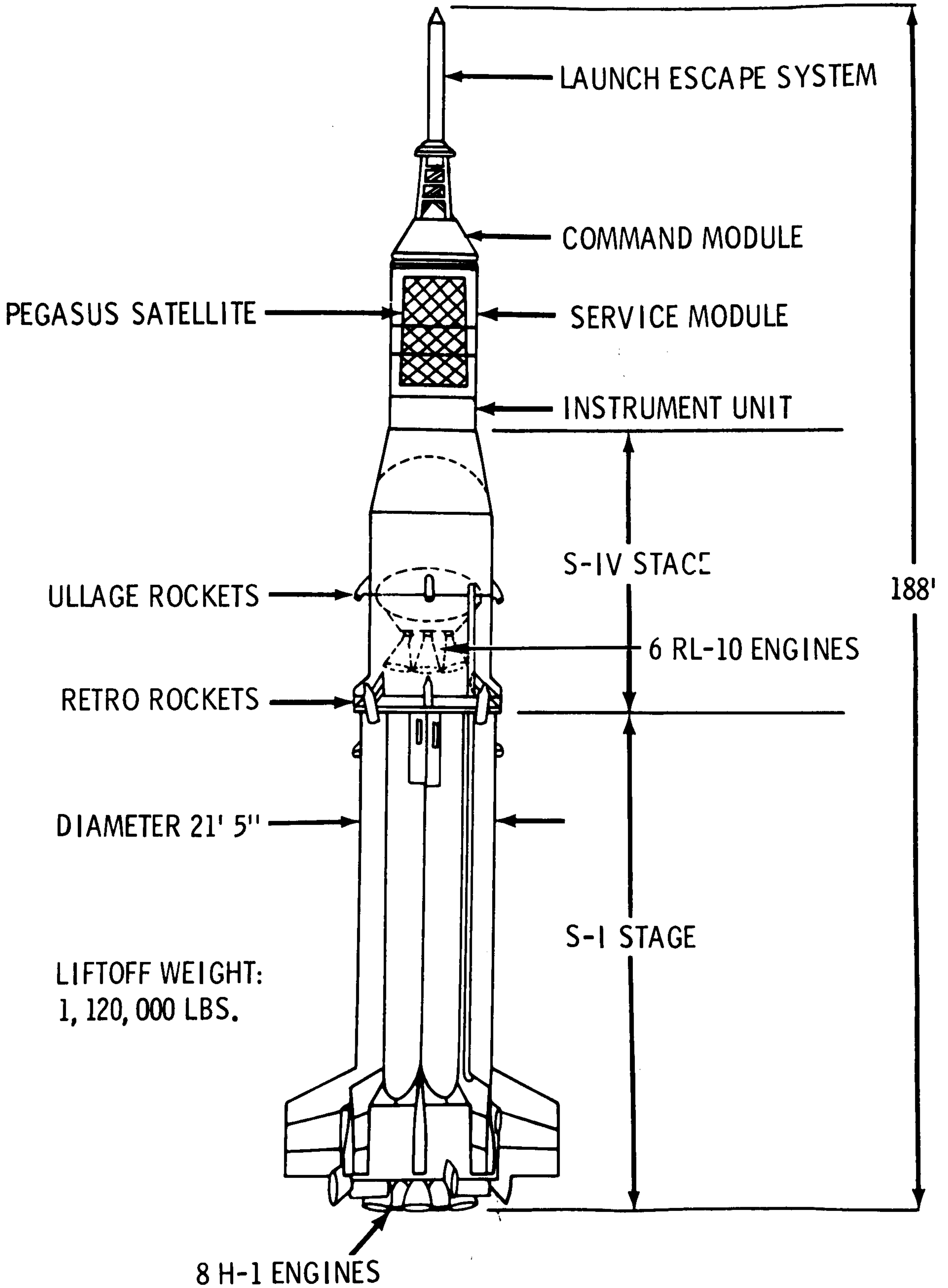
Additionally, at the beginning of the orbit, some 700 pounds of propellant will remain in the S-IV. It will gradually evaporate during the first few orbits.

The Apollo command and service modules will go into a separate orbit. Total weight of those units will be 10,000 pounds.

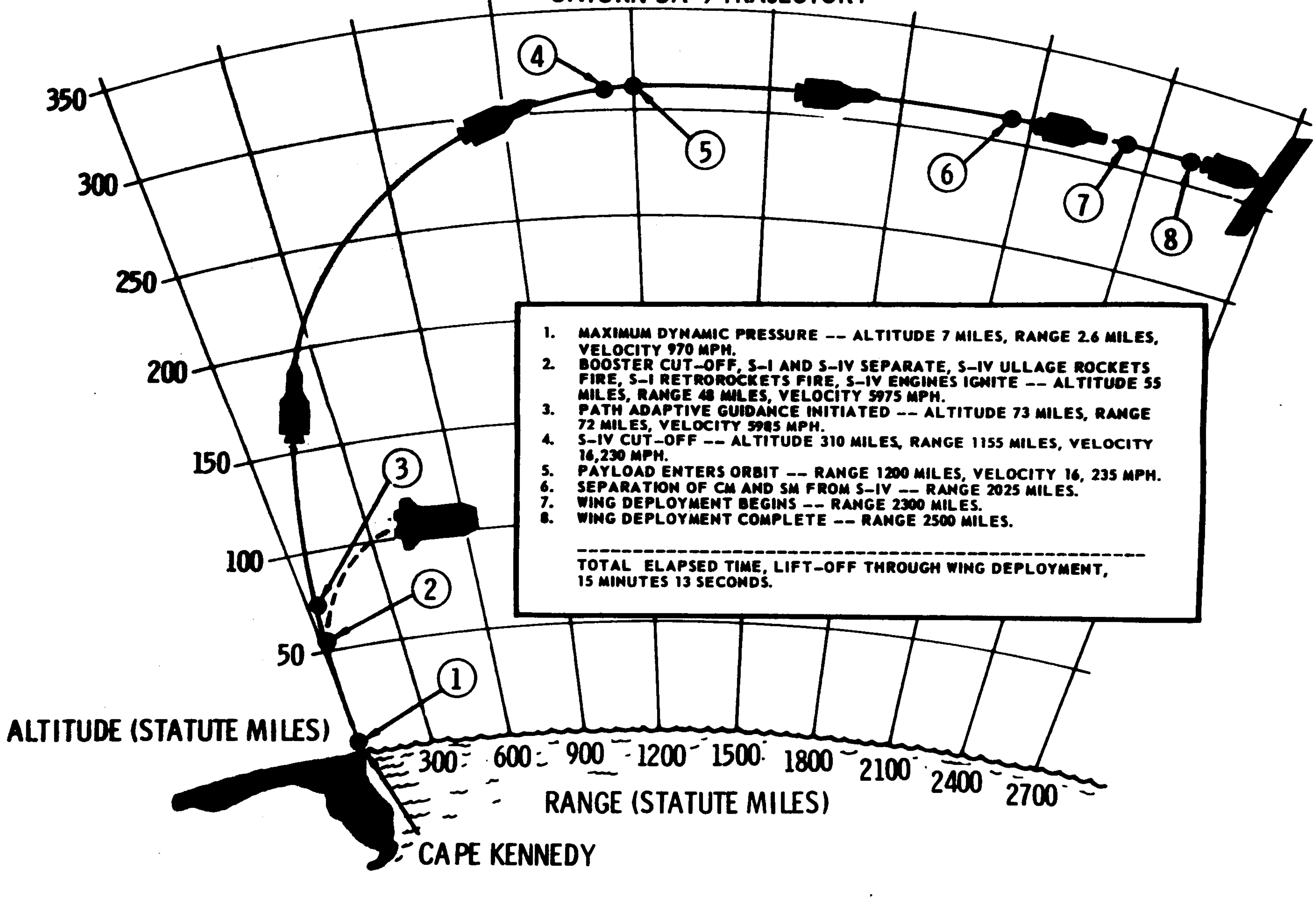
Pegasus will be visable from the Earth without the aid of telescope on clear nights.

(BACKGROUND INFORMATION FOLLOWS)

SATURN SA-9 VEHICLE



SATURN SA-9 TRAJECTORY



Flight Sequence

SA-9 will be fired from Launch Complex 37, Cape Kennedy. At eight seconds after launch, it will begin a roll into the flight azimuth of 105 degrees. At the same time the pitch program will begin. The following significant events occur in the S-I (booster) phase of powered flight:

Roll maneuver ends, T (time from liftoff) + 23 seconds; Mach one velocity reached, T+54; maximum dynamic pressure encountered, T+66, (970 mph); pitch program arrested, T+138; inboard engines cutoff, T+142; outboard engines cutoff, T+148.

Booster cutoff occurs at 55 miles altitude, 48 miles downrange from the launch site, while the body is traveling at 6,000 mph.

In the next two seconds, the S-IV separates from the S-I, S-IV stage ullage rockets ignite, S-I retrorockets fire, and the six S-IV engines ignite. Ten seconds later, at T+160, the S-IV ullage motor cases and the Launch Escape System (LES) tower are jettisoned. Path-adaptive guidance is initiated at T+166 seconds.

The guidance systems initiate S-IV cutoff at about T+630 seconds. The satellite is placed in orbit with a velocity of about 16,200 mph. Insertion occurs some 1200 miles downrange from the launch site. Inclination to the equator will be 31.7 degrees.

During flight the vehicle will telemeter to ground stations some 1388 measurements of rocket performance, as follows: S-I, 759; S-IV stage, 412; and instrument unit, 217. Additionally, the spacecraft will telemeter 179 measurements.

Unlike previous such flights, this vehicle does not carry motion picture cameras. It does carry one television camera, mounted on the interior of the service module adapter, which will provide pictures of Pegasus deploying in space.

The S-IV spacecraft unit will "coast" for three minutes following S-IV cutoff. At T+813 seconds the Apollo command and service modules will be separated from the S-IV, through the use of spring mechanisms leaving the Pegasus ready to expand. One minute later, at T+873 seconds, motors are energized and the structure is deployed in steps covering a period of about 40 seconds.

Details follow.

PEGASUS SATELLITE

The Pegasus satellite is part of an expanding meteoroid detection program directed by the NASA Office of Advanced Research and Technology. The Marshall Space Flight Center, Huntsville, Ala., has project management responsibility for Pegasus and the Saturn launch vehicle under direction of the Office of Manned Space Flight.

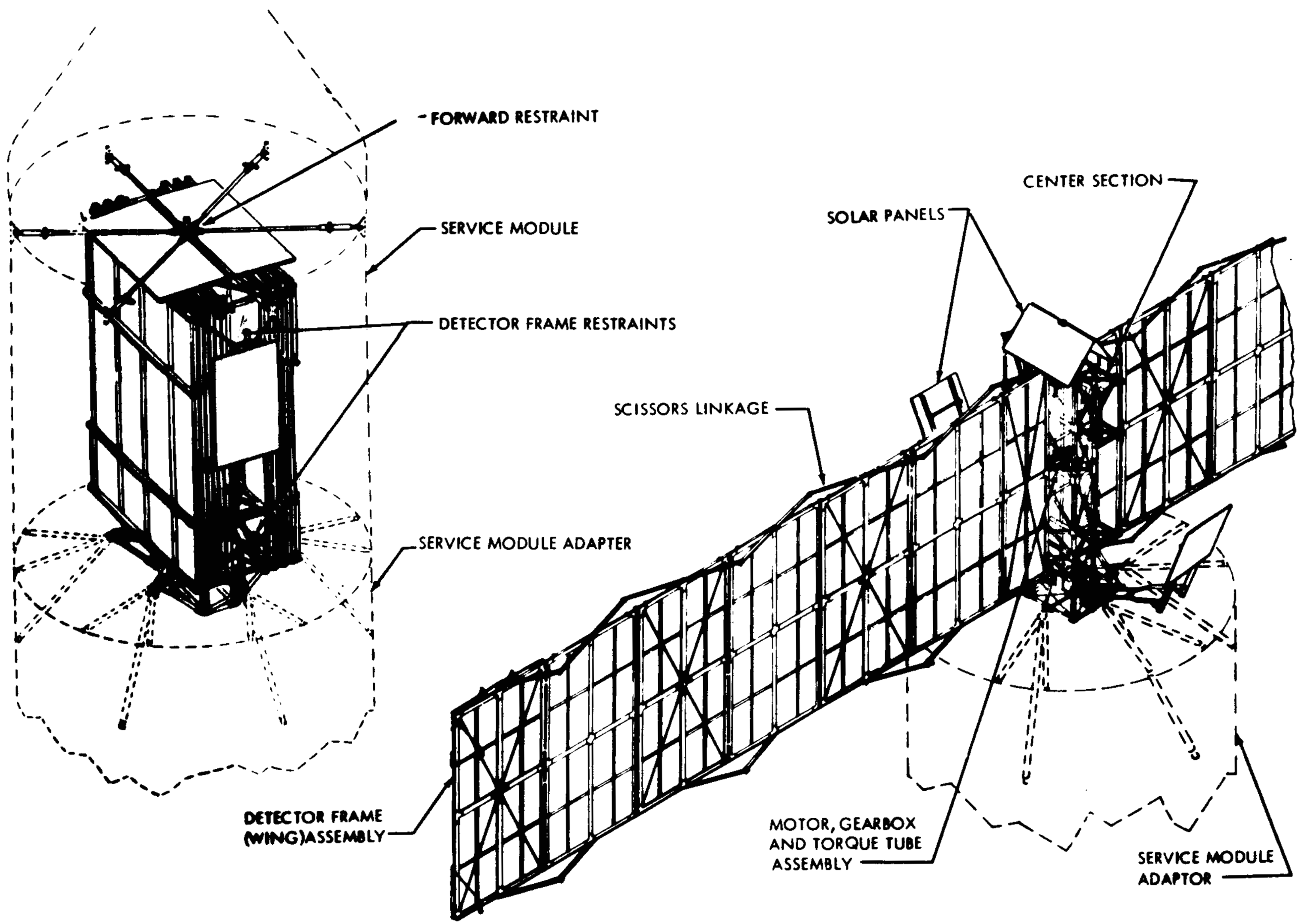
With more emphasis being placed on larger, long-life spacecraft, spacecraft designers need more information on quantity, size and velocity of micrometeoroids.

In February 1963, NASA began development of the Pegasus spacecraft, named for the mythical flying hourse. This is the first of three such satellites to be launched this year by Saturn I vehicles.

Pegasus was developed by the Fairchild Hiller Corp., under contract to the NASA Marshall Center. Design and electronics work was performed by the firm's Space Systems Division at Bladensburg and Rockville, Md. Final assembly and checkout was accomplished at the Aircraft-Missiles Division facility at Hagerstown, Md.

Description of Spacecraft

In its stored position with panels folded inside the Apollo service module, Pegasus is 17 feet 4 inches high, 7 feet wide and 11 inches deep. It is divided into two major



FORWARD RESTRAINT
SERVICE MODULE
DETECTOR FRAME RESTRAINTS
SERVICE MODULE ADAPTER
DETECTOR FRAME
(WING)ASSEMBLY
SCISSORS LINKAGE
SOLAR PANELS
CENTER SECTION
MOTOR, GEARBOX
AND TORQUE TUBE
ASSEMBLY
SERVICE MODULE
ADAPTOR

parts, the center section and the wing assemblies. The satellite's framework is made of riveted aluminum alloy extrusions.

The center section is attached to the launch vehicle's second stage. It provides a mounting for the deployment mechanism, electronics cannister, solar power panels and sensors.

Each "wing" consists of seven hinged frames. The hinges are spring loaded so that the wings unfold in accordion fashion. The unfolding action is controlled by a scissors linkage connected to a motor and torque tube assembly.

Arrays of panels, each panel measuring 20 by 40 inches, are mounted on the frames. Six frames provide mountings for 16 panels and one provides for 8 panels, making a total of 208 panels on the satellite.

The outer surface of the panels are thin sheets of aluminum varying up to 16/1000-inch thickness. Under the aluminum is a sheet of Mylar plastic. The back surface of the Mylar is coated with a thin layer of copper. The "sandwich" of aluminum, Mylar and copper is mounted to a soft foam, and, in turn, the larger "sandwich" is mounted to a rigid foam center core.

How Pegasus Works

A 40-volt electrical charge is placed across the surface of each side of each panel to give Pegasus a total of 416 capacitor detectors. The charge is established between the outer aluminum skin and the inner copper coating.

Each time a panel is penetrated by a meteoroid, the material removed by the impact is vaporized, forming a conducting gas which discharges the capacitor. The gas dissipates almost immediately and the capacitor recharges. Recharge time is three one-thousands of a second. If seen on the screen of an oscilloscope, the "blip" would be a sharp saw-tooth below the horizontal line. These blips are characteristic for each of the panels, providing a means of determining which panel was penetrated.

When a panel is penetrated, several items of related information must be recorded: a cumulative count of hits classified according to panel thickness; an indication of the panel penetrated; attitude of the satellite with respect to both the Earth and the Sun; temperature at various points on the spacecraft; the time at which each hit is recorded; and the condition of the power supply and other equipment supporting overall spacecraft operation.

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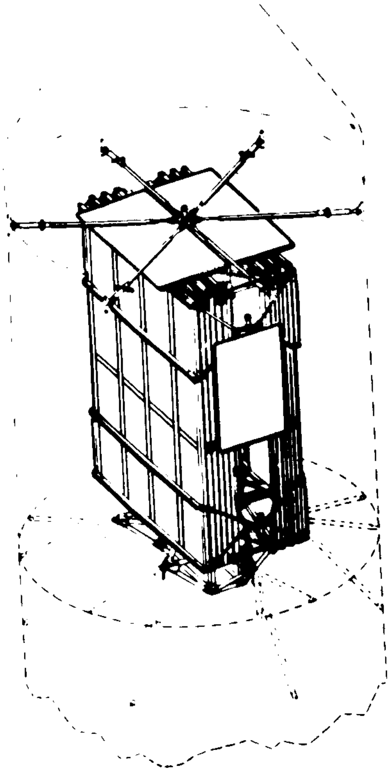
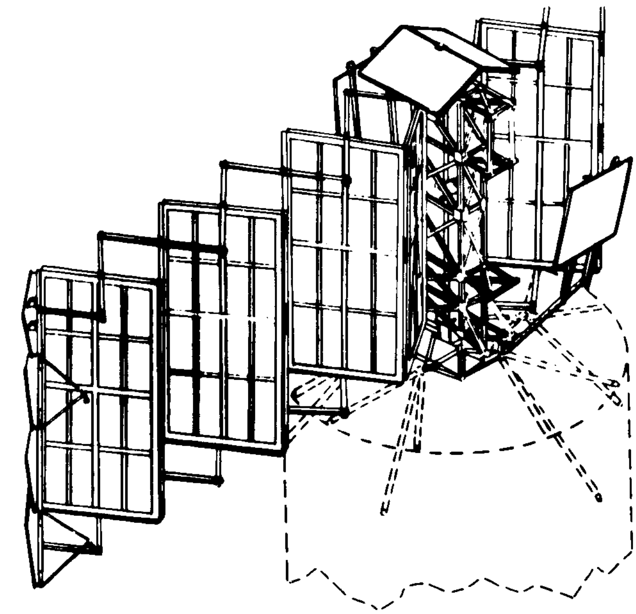
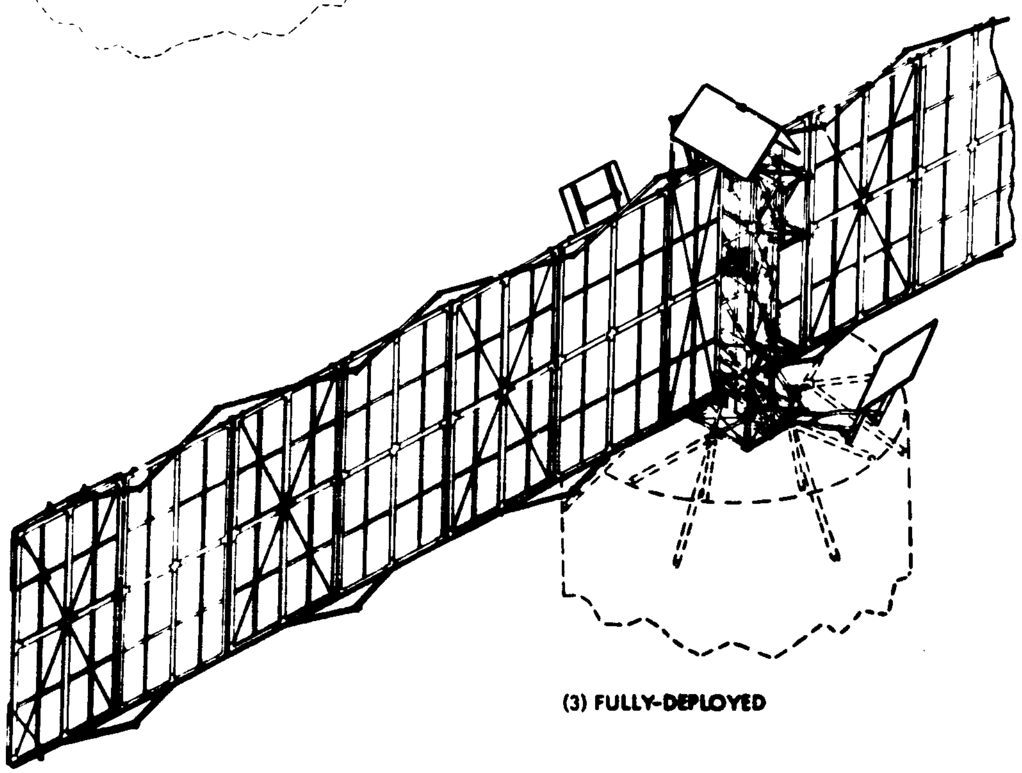


(1) STORED



(2) SEMI-DEPLOYED



(3) FULLY-DEPLOYED

Various levels of impact energy will be differentiated through the use of the capacitor panels of three different thicknesses. Directional information will be gained by using a combined solar sensor-Earth sensor system.

The Pegasus electronic system registers meteoroid penetrations of panels and stores a record of panel thickness, panel number and time of penetration. Pegasus attitude and certain temperatures are recorded on a timed schedule.

Upon ground command, all recorded information is read out of the Pegasus memory system and telemetered to the ground. A second beacon telemeter transmits "housekeeping" and total meteoroid count data continuously throughout the mission. The spacecraft has two telemetry links with a total of 179 measurements.

A digital command system provides for on-off control of various system components, circuit replacement, certain in-flight tests and other control functions. A solar cell (nickel-cadmium) battery power supply provides all power for Pegasus for its one year life. The batteries are recharged by energy from the solar cells.

Other Industrial Participants

Solar aspect sensor development was under subcontract to Adcole Corp., Cambridge, Mass. Five of these digital solar aspect sensors determine the solar vector with respect to the axes of the satellite body. Also used is a "shift register" unit which selects the sensor illuminated by the Sun.

Other industrial firms involved in significant aspects of Pegasus development and their contributions include: Aluminum Co. of America, Pittsburgh, structural extrusions; Di/An Controls, Boston, system clock, core memory; Space Craft, Inc., Huntsville, beacon transmitter; United Electrodynamics Corp., Pasadena, Calif., temperature sensor; United Shoe Machinery Corp., Beverly, Mass., harmonic drive; G. T. Schjeldahl Co., Northfield, Minn., detector panels; Bulova Watch Co., Flushing, N.Y., off system timer; Norden Division, United Aircraft Corp., Norwalk, Conn., shaft encoder; Keltec Industries, Alexandria, Va., antenna, batteries, battery controller, zener pack; Motorola, Scottsdale, Ariz., diplexer, hybrid ring, low pass filter; RCA, Montreal, Canada, FM transmitter; AVCO Corp., Cincinnati, command receiver; Consolidated Systems Corp., Monrovia, Calif., command decoder; Applied Electronics Corp., Metuchin, N.J., PCM and PAM commutators; Space Technology Labs, Redondo Beach, Calif., electron spectrometer; General Electric Co., Philadelphia, RTV-11 sealant and environmental testing; Corning Glass Works,

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Electronic Products Division, New York, glass resistors; Vinson Engineering, Van Nuys, Calif., actuator (back-up for the motor gearbox; Eastern Air Devices, Dover, N.H., drive motor. Ion Physics Corp., Burlington, Mass., design assurance radiation testing; Washington Video Productions, Washington, D.C., technical documentation films; Hayes International Corp., Birmingham, Ala., design assurance particle impact testing; Dynatronics, Orlando, Fla., specialized PCM Data Readout Units (GSE).

SA-9 LAUNCH VEHICLE

The first stage (S-1) of this vehicle is the last of eight to be produced at the NASA-Marshall Center. The remaining two S-I stages, S-I-8 and S-I-10, were built by the Chrysler Corp. at the Marshall Center's Michoud Operations, New Orleans. Both have been static tested at Marshall and are undergoing post static firing checkout. The second (S-IV) stages of all the Saturn I's were made by Douglas Aircraft Co., Santa Monica, Calif. and static tested at Sacramento.

The SA-9 has a redesigned instrument unit. The unit, shorter and more compact than the instrument unit used on the preceding three two-stage flights, weighs about half as much as the one on SA-7.

Weight was reduced by switching to an unpressurized instrument unit similar to the one to be used on the Saturn IB and Saturn V. A center hub, designed to carry the pressurized gases, was eliminated allowing IU components to be relocated for easier access. This also eliminates the necessity of carrying pressurizing purge gas on board the rocket.

The redesigned IU is a 154-inch diameter cylinder 34 inches high and weighing about 2,600 pounds. (The SA-7 IU weighed some 5,400 pounds.) Components are mounted on the inside perimeter of the IU "wafer."

The instrument unit houses the main guidance and control tracking, telemetry, measuring, and electrical power and control instruments.

The SA-9 vehicle has an auxiliary non-propulsive vent system added to the S-IV stage hydrogen tank. Earlier S-IV stages had a residual hydrogen venting system but the small thrust created by the venting caused the orbiting stages to tumble in space. Excessive tumbling in orbit could damage the structure of the Pegasus. Telemetered data received from SA-7 indicated that the non-propulsive vent system on that flight held the tumble rate to within acceptable limits but the additional system will give added assurance that the Pegasus will not tumble excessively.

SA-9 will be the fourth Saturn I vehicle to fly with a "live" S-IV second stage. The SA-6 and SA-7 flights carried instrumented Apollo boilerplate spacecraft to obtain launch environment data. The first four Saturn I flights, SA-I through SA-4, were suborbital booster tests. These vehicles carried "dummy" upper stages and payloads. SA-5, the first test of the second stage, carried a "dummy" payload.

The first stage, S-I, is powered by eight Rocketdyne H-1 engines, each producing 188,000 pounds of thrust. The engines will run at the maximum rated thrust of 1,500,000 pounds (32,000,000 horsepower).

The S-I is 21.4 feet in diameter and 80.3 feet long and will weigh nearly a million pounds including 880,000 pounds of propellant.

The eight engines are attached to an eight-legged thrust frame and arranged in two square patterns. The four inboard engines are rigidly attached at a three-degree angle outward from the long axis of the booster. The outboard engines, placed at an outward angle of six degrees, are mounted on gimbals for control of the vehicle during first stage powered flight.

The propellants, liquid oxygen and kerosene, are contained in nine pressurized tanks. Eight 70-inch-diameter tanks are clustered around a 105-inch-diameter center tank. The center and four outer tanks contain liquid oxygen. The remaining four (alternating) tanks hold kerosene.

The fuel and oxidizer tanks are interconnected at the base to maintain equal levels in all tanks. In case one engine malfunctions and is cut off during flight, the remaining seven engines consume the fuel and oxygen intended for the dead engine. Burning time of the other seven engines would be increased, in case this happened, to reduce the loss in overall booster performance.

The S-I was developed at the Marshall Center and the boosters have been static fired successfully at MSFC more than 50 times, including many full duration runs of about 140 seconds.

S-IV STAGE

Second stage of the Saturn I vehicle, the S-IV, is powered by six RL-10 engines, each having 15,000 pounds thrust for a combined output of 90,000 pounds thrust. The engines burn liquid hydrogen and liquid oxygen, a high-energy combination which produces more than one-third additional thrust per pound of propellants than conventional combinations.

S-IV is 18.5 feet in diameter, 41.5 feet long and weighs some 14,000 pounds empty. It carries about 100,000 pounds of propellant for about eight minutes of propelled flight.

A new paint has been used on the S-IV stage and IU to provide thermal protection for the Pegasus payload. The paint, especially developed for this application by the Illinois Institute of Technology, Chicago, is designed to keep the S-IV stage and Instrument Unit surfaces from absorbing heat from the sun. If the surfaces should heat excessively, the heat could be conducted to the Pegasus and interfere or endanger the satellite's mission.

The second stage is basically a two-section tank structure with an insulated common bulkhead dividing it into a forward liquid hydrogen tank and an aft liquid oxygen tank. The common bulkhead minimizes heat losses from the liquid oxygen (-297 degrees F) to the liquid hydrogen (-423 degrees F).

The RL-10 engine, built by Pratt and Whitney Division of United Aircraft Corp., is the country's pioneer LH2 power plant. It underwent its first in-space operation serving as the Centaur propulsion system late in 1963. The engines functioned well in Saturn flights SA-5, 6, and 7.

Previous Saturn I rockets were launched Oct. 27, 1961; April 25 and Nov. 16, 1962; March 28, 1963; and Jan. 29, May 28, and Sept. 18, 1964. All flights were successful.

LAUNCHING THE SA-9

SA-9 will be the fourth Saturn launched from Complex 37, Pad B, at Cape Kennedy, Fla.

Complex 37, the northernmost launch facility on the Cape, covers 120 acres. It has two launch pads, designated A and B, located 1,200 feet apart. A launch control center serves both pads as does a 310 foot tall 10-million pound service structure.

Complex 37's launch control center, located 1,000 feet from the pad, will be manned by some 250 NASA and contractor personnel.

SA-9 will lift off from a 47-foot square metal pedestal, which in its center has a 12-sided, 32-foot-diameter opening to allow the escape of rocket exhaust.

The rocket exhaust will be dissipated by a twin-sloped flame deflector directly beneath the launch pedestal. The metal deflector is wheeled into position on rails. The surface of the deflector is coated with a concrete-like heat-resistant material which minimizes damage to the surface, over which the exhaust flames pass.

Other facilities on Complex 37 include fuel storage tanks and transfer systems for both liquid oxygen/RP-1 and liquid oxygen/liquid hydrogen engines.

Launch Preparations

The SA-9's booster arrived by barge at Cape Kennedy Oct. 30, 1964. The second stage was flown Oct. 22.

The Pegasus satellite arrived at the Cape Dec. 29 and was placed inside the boilerplate Apollo in an operation beginning Jan. 10.

The first and second stages of the SA-9 were mated Nov. 19 and a series of tests on the integrated launch vehicle were begun. These included radio frequency checks, tanking procedures and a simulated flight test.

Pegasus underwent systems tests for a period of several days before it was placed inside the Apollo. These included wing deployment tests of the huge, 96-foot-long satellite. The Apollo boilerplate, carrying the folded Pegasus inside, was mated with the launch vehicle Jan. 14.

Countdown for the launch will begin at T-1 day. It will cover a period of 16-1/2 hours. The first part of the countdown will last about six hours, the second part, 10-1/2 hours.

The final phase of the countdown begins at T-70 minutes and includes:

T-35 minutes -- S-IV liquid hydrogen loading complete.

T-25 minutes -- Radio frequency systems on.

T-24 minutes -- Telemeters on.

T-20 minutes -- C-Band, MISTRAM and ODOP on.

T-15 minutes -- Range safety command transmitter on.

T-13 minutes -- Final phase internal power tests begin.

T-10 minutes -- Telemetry calibration.

T- 5 minutes -- Ignition arming on.

T- 4 minutes -- Range clearance.

T- 3 minutes -- Arm destruct system.

T- 2 minutes, 43 seconds -- Launch sequence starts.

T- 3 seconds -- Ignition

T- 0 -- Liftoff.

PEGASUS TRACKING AND DATA ACQUISITION

The Pegasus mission requires extensive ground tracking and data acquisition support. To meet this requirement the Manned Space Flight Tracking Network along with certain elements of the Department of Defense Gulf and Eastern Test Ranges will support the Pegasus spacecraft through its first five orbits, after which Goddard Space Flight Center's STADAN (Space Tracking and Data Acquisition Network) will assume responsibility for monitoring and tracking the satellite.

On-board instrumentation will include a telemetry transmitter scheduled to last about 90 minutes and a C-Band radar beacon scheduled for a 20-minute life. The instrument unit and the Pegasus each have two 136-mc telemetry transmitters, one set to automatically close down after 18 months of continuous operation and one to remain dormant until interrogated. An interrogation will activate the transmitter for 90 seconds. Performing only on command, this transmitter will not be shut down after a specified time. A TV camera will observe the Pegasus deployment.

Radar tracking will be accomplished by stations of NASA's Manned Space Flight Tracking Network while the C-Band beacon is active. During the first orbit, acquisition aid antennas associated with the C-Band radars will be used while the UHF telemetry beacon is active. After the C-Band beacon ceases to transmit, the radars will employ "skin" tracking (beam-bouncing) techniques until the end of the fifth orbit.

The STADAN will then track Pegasus for the full 18 month lifetime of the 136-mc telemetry transmitters if it orbits that long. (Actually, the payload may orbit three or more years, but data is sought for at least a one-year period.) Upon beginning of reentry or 136-mc transmitter decline, orbital data responsibility will be shifted from Goddard's Data Systems Division (STADAN) to its Manned Space Flight Tracking Network computers. The MSFN will simultaneously resume tracking and data acquisition responsibility throughout reentry.

Optical tracking coverage will be provided by the Smithsonian Astrophysical Observatory's Optical Tracking Network (SAO) whenever visibility conditions permit. MOTS (Minitrack Optical Tracking System) will also be utilized.

Operational control of the Pegasus will be through the Pegasus Operations Control Center, Goddard Space Flight Center, Greenbelt, Md. Command functions required by the Marshall Space Flight Center will be accomplished through STADAN command facilities.

NASCOM (NASA Communications Network) will utilize its SCAMA (Station Conferencing and Monitoring Arrangement) capability to interconnect the STADAN Control Center with network stations, Marshall Space Flight Center and Kennedy Space Flight Center. Located within the Goddard Space Flight Center, SCAMA is a redundant, manually operated, switching console that instantaneously connects, disconnects or brings together any combination of STADAN and/or MSFN Tracking stations throughout the world. It is "Home Office" and operational nerve center of NASA's worldwide voice communications network.

Goddard's MSFN real-time computing system will determine orbital insertion conditions, provide the network with acquisition information during early phase of the mission. During reentry period the real-time system will be used for predictions and impact determination. For the Pegasus during deployment phase, GSFC Data Systems Division will provide the network with orbital and prediction data utilizing Minitrack tracking data.

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Network Configuration and Control

MSFN		STADAN		SAO	
Cape Kennedy	T	Fort Myers	MON	Organ Pass	B
Patrick AFB	R	Johannesburg	MON	Jupiter	B
Merritt Island	R	Woomera	MON	Curacao	B
Bermuda	RT	Goldstone	MON	Villa Dolores	B
Grand Turk Island	RT	Santiago	MON	San Fernando	B
Antigua	NRT	Quito	MON	Shiraz	B
Ascension	NRT	Lima	MON	Olifantsfon-tein	B
Pretoria	NRT			Naini Tal	B
Tananarive	T			Tokyo	B
Carnarvon	RT			Maui	B
Hawaii	RT			Island Lagoon	B
California	RT			Arequipa	B
Guaymas	T				
White Sands	R				
Texas	T				
Eglin	RT				

Legend:

R - C-Band Radar
T - UHF Telemetry (225-260 mc)
M - Minitrack Tracking (136 mc)
B - Baker-Nunn Optical Tracking
O - STADAN Optical Tracking System
N - Pegasus Spacecraft Telemetry (136 mc)

- End -