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RELEASE NO: 66-179

PROJECT: GEMINI 10
(To be launched no earlier than July 18, 1966)

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GEMINI 10
LAUNCHES SET
FOR JULY 18

The National Aeronautics and Space Administration will launch the Gemini 10 spacecraft and its Agena Target Vehicle no earlier than July 18 from Cape Kennedy, Fla.

The mission is one of the most complex manned space flights to date. The primary mission objective is successful rendezvous and docking of the Gemini 10 spacecraft with the Agena 10 Target Vehicle. Operational goals, subject to time and propellant expended in rendezvous, include rendezvous with the Agena which was launched March 16 for Gemini 8, two periods of extravehicular activity by the pilot and conduct of 16 experiments.

Command pilot for the three-day Gemini 10 flight is John W. Young. Pilot is Michael Collins. Backup command pilot is Alan L. Bean, and backup pilot is Clifton C. Williams, Jr.

Young was pilot on Gemini 3, the first manned mission in the Gemini program. Collins will make his first space flight on Gemini 10. Bean and Williams have not yet made a flight in space.

Launch of the Agena is scheduled for 4:40 p.m. EDT with the Gemini to lift off at 6:20 p.m. EDT. The late afternoon launch time is determined by orbital characteristics of the passive Gemini 8 target vehicle.

The Agena 10 will be launched into a 185-mile circular orbit by an Atlas Standard Launch Vehicle developing 390,000 pounds of thrust. Gemini 10 will be inserted into an initial 100-by-168 mile orbit after a boosted flight atop a 430,000-pound-thrust Gemini Launch Vehicle.

Based on perfect timing of both launches, the initial rendezvous is scheduled in the fourth revolution, about five hours after liftoff, of the Gemini 10. Computation of maneuvers for rendezvous will be done in the spacecraft and will be compared with calculations on the ground.

After almost an hour of formation flying with the Agena 10, the command pilot will execute the first docking maneuver. During this docking exercise, an electric charge monitor test will be conducted to study the amount of charge that is exchanged between the Gemini and Agena as the TDA probe contacts the Agena.

A bending mode check to study the amount of bending stress between the docked vehicles will begin over Hawaii approximately six hours after the Gemini launch.

About seven hours and 40 minutes into the flight, the crew will use the Agena primary propulsion system to conduct a series of translations (changes of position in orbit). The purpose of the translations is to position the spacecraft for a later rendezvous with Agena 8. The number, magnitude and direction of these translations will be determined by Gemini 10 flight controllers after launch of the spacecraft. The determination will be based on the Agena 8 orbit, Agena 10 liftoff time and orbit, spacecraft launch time and success of the initial rendezvous.

Even with a nominal fourth-revolution rendezvous and successful docking, these first dual rendezvous translations could be conducted to place the docked spacecraft in a circular orbit as low as 138 miles or in an elliptical orbit with an apogee as high as 460 miles.

The former is a "catch-up" orbit in which the spacecraft travels faster than the 246-mile-high Agena 8 and overtakes it from behind. The latter is a "dwell" orbit with the Agena 8 overtaking the slowed-down spacecraft.

Necessary height and phase adjustment and plane change translations done between 19 and 29 hours into the flight will position Gemini 10 about eight miles below the passive target. Then,it gradually will overtake the target for the dual rendezvous terminal phase initiation at 47 hours 10 minutes of elapsed time.

Activities planned between rendezvous maneuvers include two more dockings of Gemini 10 with Agena 10. At 19 hours and 26 minutes over the United States, Command Pilot Young will undock in darkness and move the spacecraft three feet back to conduct an ion wake measurement experiment (S-26).

He then will translate to 60 feet behind the target before moving in at half-a-foot per second to re-dock. Pilot Collins will undock about 30 minutes before daylight, repeat the S-26 experiment and the 60-foot translation, then will re-dock some 20 minutes after sunrise.

About 22 hours and 20 minutes into the mission, the crew will power-down Agena 10 and separate from it at two feet per second. The Agena 10 will remain dormant in a co-elliptic orbit nine miles below Agena 8 until ground controllers reactivate it later in the mission.

Thirty-five minutes later Collins will open his hatch and stand exposed to space for 55 minutes. During this period of stand-up extravehicular activity he will carry out five different photographic experiments.

He will be connected to the spacecraft oxygen supply by short hoses and to the cockpit by a nylon tether. Communications and biomedical instrumentation will be maintained over a short umbilical extension.

For his second extravehicular activity, about 48 hours into the mission, and lasting 55 minutes, Collins will operate from a 50-foot line using a hand-held maneuvering unit (HHMU). During this EVA he will evaluate the extravehicular life support system (ELSS) and the nitorgen gas-fed maneuvering unit. He also will conduct two micrometeoroid experiments.

EVA pilot pickup may be attempted. The command pilot would then translate the spacecraft toward the extravehicular astronaut, allowing the EVA pilot to return to the spacecraft by pulling himself along the umbilical.

An hour after he has returned to the cabin and the spacecraft has moved away from the Agena 8, Collins once more will open the hatch to jettison some EVA equipment that includes the umbilical, the maneuvering unit and the ELSS chest pack, the EVA visor and the standup EVA hoses and tether.

A retrograde height adjust translation will lower the spacecraft's orbit in preparation for reentry. Retrofire will occur at 69 hours 44 minutes between the Canton and Hawaii tracking stations. Splashdown should take place about 33 minutes later in the 44-1 landing zone about 300 miles east of Florida.

(END OF GENERAL RELEASE; BACKGROUND INFORMATION FOLLOWS)

PREFLIGHT ACTIVITIES AND INTEGRATED COUNTDOWN

Gemini flights are developed by the NASA Manned Spacecraft Center (MSC), Houston, Tex., under the direction of the NASA Headquarters Office of Manned Space Flight in Washington, D. C. The NASA John F. Kennedy Space Center (KSC), Fla., has the overall responsibility for preflight testing, checkout and launching of the Gemini and Atlas/Agena vehicles for the Gemini missions. After launch, control of the flight is the responsibility of the Mission Control Center, MSC.

Gemini 10 Timetable at Kennedy Space Center:

Gemini launch vehicle (GLV) arrived May 18 (first stage) and May 21 (second stage).

GLV erected at Launch Complex 19 on June 7.

Gemini 10 spacecraft arrived May 13 for receiving inspection, ordnance installation, and assembly checks at Merritt Island.

Atlas standard launch vehicle (ASLV) arrived June 10, erected on Launch Complex 14 on June 15.

Gemini Agena target vehicle (GATV) arrived May 15, the target docking adapter preceding it on May 4.

GATV, docking adapter, and spacecraft underwent "timber tower" tests at KSC Radio Frequency Site June 4.

Docking compatability checks conducted June 4-7.

Spacecraft and launch vehicle premate tests conducted June 14-16 at Complex 19 with electrical mating June 20.

Mechanical mating check July 5, simultaneous countdown dry run July 11.

Gemini 10 countdown is a combination of countdowns referenced to the orbiting passive Agena 8 and associated with the Gemini 10 and Agena 10 launch vehicles, the spacecraft and the target vehicle, the crew, Houston Mission Control and the worldwide tracking network, the Eastern Test Range, and the Radio-Command Guidance System.

Liftoff for the target vehicle is scheduled for the 95-minute mark in the simultaneous count. The Gemini spacecraft will be launched approximately 100 minutes and 30 seconds later, depending on the exact location and performance of the orbiting Agena. A built-in hold is scheduled at T-3 minutes to adjust the Gemini liftoff time to coincide with Agena 10's first pass over the Cape. After the launch sequence adjustments are computed, the count will resume.

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LAUNCH VEHICLE COUNTDOWN

Time	Gemini	Atlas-Agena
F-3 days	Start pre-count	Countdown
F-1 day	Start mid-count	
T-720 minutes	GLV propellant loading	
T-615 minutes		Begin terminal count
T-390 minutes	Complete propellant loading	
T-300 minutes	Back-up flight crew reports to the 100-foot level of the White Room to participate in final flight preparation. Begin terminal countdown, Pilots' ready room, 100-foot level of White Room and crew quarters manned and made ready for prime crew.	
T-255 minutes	Medical examination	
T-240 minutes		Start tower removal
T-235 minutes	Eat	
T-195 minutes	Crew leaves quarters	
T-185 minutes	Crew arrives at ready room on Pad 16	
T-135 minutes	Purging of suit begins	
T-125 minutes	Crew leaves ready room	
T-120 minutes	Flight crew to Complex 19	
T-119 minutes	Crew arrives at 100-foot level	
T-115 minutes	Crew enters spacecraft	
T-100 minutes	Close spacecraft hatches	
T-95 minutes		Lift off
T-86 minutes		Insertion into orbit
T-70 minutes	White Room evacuation	
T-55 minutes	Begin erector lowering	
T-20 minutes	Spacecraft OAMS static firing	
T-3 min.,1 sec.	Built-in hold	
T-04 seconds	GLV ignition	
T-0 seconds	Lift off	
T+2 minutes 36 seconds	Booster engine cutoff (BECO)	
T+5:36	Second stage engine cutoff (SECO)	
T+5:56	Spacecraft-launch vehicle separation	
T+6:09	Insertion into orbit	

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REENTRY

(Elapsed Time from Gemini Lift-Off)

Time	
69:44	Retrofire
69:45	Jettison retrograde section
70:03:04	400,000 feet altitude
70:05:12	Communications blackout
70:05:19	Initiate guidance
70:10:06	Blackout ended
70:11:49	Drogue chute deployed (50,000 feet)
70:13:23	Main chute fully deployed (11,000 ft.)
70:17:48	Spacecraft landing

MISSION DESCRIPTION

Information presented in this section is based on a normal mission. Several alternatives exist through which flight objectives can be achieved. The complexity of the mission increases the possibility of modifications or deletions to the flight plan even as the flight progresses.

Many maneuvers included in the flight plan will be used only as necessary to place the vehicles involved in the proper positions. Components of these maneuvers will be determined during the mission. Therefore, velocity increments and orbital values are not available for this preflight description in many cases.

(All orbital parameters are given in statute miles. To convert to nautical miles, multiply by .87; to kilometers, multiply by 1.61.)

LAUNCH

Launch Times -- Atlas-Agena: 4:40 pm, EDT, Launch Complex 14.
Gemini 10: 6:20 pm, EDT, Launch Complex 19.

Launch Window -- Agena launch window lasts about 20 minutes. Gemini 10 window opens about 100 minutes and 30 seconds after Agena liftoff. The window opens at the M=4 pane -- the opportunity to achieve rendezvous in the fourth revolution. This pane lasts approximately 35 seconds. Opportunity to rendezvous in later revolutions, through M=20 (the 20th revolution) exists for about 30 minutes. However, only the 35 second M=4 pane will be used for the first launch attempt. A decision on use of the extended window and whether to recycle 48 hours will be made when and if the originally scheduled launch is postponed.

Azimuth -- Atlas-Agena will be launched along an 84.4 degree azimuth east of north into a near-circular orbit of 185 miles with an inclination of 28.87 degrees. Gemini 10 launch azimuth will be biased from 96.6 to about 98.7 degrees so that a small amount of launch vehicle yaw steering will place the spacecraft in the Agena 10 target plane at the beginning of rendezvous terminal phase, thus eliminating necessity of a plane change.

INITIAL RENDEZVOUS

Orbits -- Agena 10 at near-circular 185 miles. Gemini 10 initially in elliptical 100-168 miles. Gemini trails Agena 10 by 1160 miles.

Incremental Velocity Adjustment Routine (IVAR) -- Spacecraft thrusters used at insertion to correct in-plane velocity errors of 3 to 200 feet per second.

Phase Adjustment (NC1) -- Near spacecraft second apogee, 2:18 GET, a posigrade horizontal burn of 54.7 fps raises perigee to 134 miles and reduces catch-up rate to 4.4 degrees per orbit. Spacecraft trails by 440 miles. (Over Tananarive)

Coelliptical Maneuver (NSR) -- Near third apogee, 3:48 GET, a posigrade burn, mainly horizontal with the spacecraft pitched up about 4 degrees, will add a velocity of 51.2 fps and circularize the orbit to 168 miles. Gemini trails by 126 miles, is catching up at 2.3 degrees per orbit, should have radar lock-on. (Over Tananarive)

Terminal Phase Initiation (TPI) -- Near the end of the third revolution, 4:36 GET or about three minutes before darkness, a posigrade burn with the spacecraft pitched up along the line of sight to the target puts the spacecraft on an intercept trajectory with Agena 10, which it trails by 38 miles. (Over Hawaii)

Intermediate Corrections -- During terminal phase the target will travel 130 degrees. Two spacecraft trajectory corrections may be made. They are at 12 and 24 minutes after TPI, 82 and 34 degrees of orbital travel from the target, respectively.

Terminal Phase Final (TPF) -- Velocity matching maneuver of about 45 fps excluding any additional requirements due to semioptical techniques used for final approach, executed to complete rendezvous at 5:08 GET or about seven minutes from daylight. (Southeast of Ascension)

FIRST DOCKING

After the velocity matching maneuver to complete rendezvous, the spacecraft will fly in station-keeping formation with Agena 10 until the first docking is performed by the command pilot at 5:50 to 6:00 GET. Agena 10 will be positioned at a 90-degree yaw with the target docking adapter facing north; the spacecraft, also at a 90-degree yaw, will point south. This configuration gives optimum lighting conditions on the target. (West of Hawaii)

BENDING MODE CHECK

At 6:00 GET the spacecraft, in docked configuration, will be given a three second pitch-down thrust immediately followed by three seconds of pitch-up thrust. After two minutes of stabilization, the spacecraft will be given a three second yaw left thrust then a three second yaw right thrust. After ten seconds of stabilization, the spacecraft will swing the docked unit back into the direction of flight, Agena 10 target docking adapter forward.

DUAL RENDEZVOUS MANEUVERS

Height Adjust Translation -- At 7:38 GET, an orbit adjusting maneuver to be determined on establishment of relative positions of Gemini 10 and Agena 8. Agena 10 primary propulsion system will be used.

Phase Adjust Translation -- At 8:25 GET, a phase adjusting maneuver or maneuvers to be determined. This and the previous maneuver could result in a circular orbit as low as 138 miles or an elliptical orbit about 185 by 460 miles. Agena PPS will be used.

Plane Change Translations -- At 19:10 GET, a plane change maneuver or maneuvers as necessary to bring the spacecraft/target docked configuration into the Agena 8 plane. Agena 10 secondary propulsion system will be used.

FIRST UNDOCKING, SECOND & THIRD DOCKINGS

At 19:25 GET the command pilot will undock from Agena 10 and translate to three feet from the target docking adapter at one-half foot per second. He will conduct the ion wake measurement experiment (S-26), translate 60 feet from Agena 10, then translate back toward the target at one-half foot per second. He will dock at sunset over the west coast of Africa.

From 20:05 to 20:10 the pilot will undock, translate three feet from the TDA, conduct the S-26 experiment, translate to 60 feet and back to dock at one-half fps. Docking will occur at 20:55 in daylight over the Pacific Ocean.

FURTHER DUAL RENDEZVOUS MANEUVERS

Height Adjust Translation -- At 21:22 GET, or 14th perigee, a maneuver based on updated ground values will refine the docked unit's apogee to eight miles below the Agena 8 orbit. (Over Canary Islands)

Coelliptical Maneuver -- At 22:08 GET, 15th spacecraft apogee, a ground updated maneuver will circularize Gemini 10's orbit eight miles below the Agena 8 orbit. This is the final of the docked configuration burns. Following a posigrade OAMS translation to separate the spacecraft from Agena 10, the pilot will command shutdown of Agena 10 systems. The target vehicle will remain in its 238-circular orbit until reactivated by the ground.

STANDUP EVA

Near the Canary Islands at 22:55 GET, the pilot will open the right-hand spacecraft hatch and stand erect. The oxygen inlet on his suit will be connected to the spacecraft environmental control system (ECS) by an 18-inch extension, his suit outlet by a 24-inch extension hose. A similar communications and bio-instrumentation electrical extension interconnects those systems; a nylon tether restrains the pilot in the cabin.

After sunset at 23:02 GET, the pilot begins the ultra-violet astronomical camera experiment (S-13), which continues through 36 minutes, 14 seconds of darkness. At sunrise he transfers the 70 mm Maurer camera and bracket to the command pilot, receives the MSC-8 Maurer camera and extension rod, and photographs the slate holding color patches of red, yellow, blue and gray. Assembly of the color patch photography experiment and the photography together take about nine minutes. He hands the slate to the command pilot, jettisons the extension rod, and conducts the synoptic terrain and synoptic weather experiments (S-5 and -6) using the 70 mm Maurer camera and the remaining film in the magazine.

Ingress and hatch closing at 24:10 GET, terminate the standup EVA west of the Canton tracking station.

AS NEEDED DUAL RENDEZVOUS MANEUVERS

To minimize dispersions in position, velocity, and time of arrival at dual rendezvous TPI, a series of maneuvers based on updated values from ground tracking stations is allowed in the flight plan. Under nominal conditions, the values of these maneuvers are zero in each case. True values from the ground updates will be applied and the maneuvers made if required.

The maneuvers scheduled are:

Phase adjustment	28:45 GET
Height adjustment	40:15 GET
Phase adjustment	41:00 GET
Corrective combination	45:00 GET
Co-elliptical	45:30 GET

DUAL RENDEZVOUS

Terminal Phase Initiation (TPI) -- Certain ground rules and constraints have been established for dual rendezvous TPI. They include:

Spacecraft on-board radar not available for rendezvous;

Visual acquisition of target;

Target must be continuously illuminated by the Sun (since target has no acquisition lights);

Sun should be overhead at TPI, and five to ten minutes from setting at TPF; thus establishing a requirement for an 80-degree terminal phase travel angle.

At 47:10 GET, terminal phase will be initiated by a translation, posigrade and pitched up, of a magnitude to be computed by the crew using the spacecraft reticle bore-sighted on the target. If the target has not been visually acquired at the time of TPI, updated ground values will be applied to determine the maneuver. Mid-course corrections also will be computed from the optical tracking technique. The pilot, using the Gemini sextant, will determine time of arrival 2.3 miles from the target, then will calculate the braking maneuver necessary to reduce the closing rate to 30 fps. At 47:31 GET, the spacecraft should be in a formation-flying position 60 feet from Agena 8.

UMBILICAL-EVA

The pilot will begin umbilical-EVA by opening the spacecraft hatch at 48:08 GET, over the Indian Ocean west of Carnarvon some five minutes before sunrise. He will stand in the hatch and, with help from the command pilot, feed the umbilical out of the hatch. At sunrise he will move from the cabin and move along the handrail to the nitrogen fitting on the external adapter section surface. Inserting the quick-disconnect fitting on the nitrogen hose into the spacecraft fitting and opening the nitrogen valve to activate flow of propellant to the HHMU, he will move back to the cabin area, collect the micrometeoroid experiment (S-12) and hand it to the command pilot.

He will take the EVA motion picture camera from the cabin, install in on the spacecraft adapter just behind the pilot's hatch, and turn it on at one frame per second. Then he will fire the HHMU to check its flow.

Ten minutes into the extravehicular activity, the pilot translates to the Agena 8 to attach a new S-10 micrometeoroid collection package and return the old S-10 package to the command pilot. From 30 to 40 minutes into the EVA, the pilot uses the hand-held maneuvering unit to translate to 30 feet in front of the spacecraft, stop his translation rates, then move along the line of sight to the Agena.

Following the HHMU evaluation, the pilot will drift at nulled rates until the command pilot translates the spacecraft to him for the EVA pilot pickup maneuver. The final 10 minutes of EVA will be used for evaluation of the umbilical dynamics. Before ingress, the pilot will turn off the nitrogen valve on the spacecraft adapter. He will bleed the HHMU of remaining propellant by holding on to the adapter handrails and firing the maneuvering unit in short bursts. He will unplug the nitrogen umbilical, return to the hatch, retrieve the EVA camera, and close the hatch. EVA will end at sunset over the Atlantic southeast of the United States.

Following a four fps retrograde separation from Agena 8, the pilot will reopen the hatch and jettison a bundle of EVA equipment.

RETROFIRE

Retrofire will occur at 69:44 GET between Canton and Hawaii, with splashdown in the West Atlantic 44-1 landing area some 300 miles east of Florida at 70 hours 17 minutes ground elapsed time.

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AGENA MANEUVERS FOLLOWING SPLASHDOWN

Agena 10 will be maneuvered into a parking orbit of about 250 miles after Gemini 10 splashes down. The target vehicle will be in such an orbit that it can be used as a rendezvous target for the later missions.

ORBITS - REVOLUTIONS

The spacecraft's course is measured in revolutions about the Earth. A revolution is completed each time the spacecraft passes over 80 degrees west longitude, or at Gemini altitude about once every 96 minutes.

Orbits are referenced to space and in Gemini take about 90 minutes.

The longer time for revolutions is caused by the Earth's rotation. As the spacecraft circles the Earth, the Earth moves some 22.5 degrees in the same direction. Although the spacecraft completes an orbit in about 90 minutes it takes another six minutes for the spacecraft to reach 80 degrees west longitude and complete a revolution.

Gemini completes 16 orbits per day, but in 24 hours crosses the 80th meridian of longitude 15 times -- hence 15 revolutions per day.

EXPERIMENTS

Sixteen experiments are scheduled for Gemini 10. Eight have been flown on previous flights. The experiments are divided into three categories: scientific, seven experiments; technological, eight experiments; and medical, one experiment.

SCIENTIFIC

S-1 Zodiacal Light Photography

Purpose - To obtain photographs of the zodiacal light at sunset, and to obtain photographs of the airglow covering the entire horizon during the night.

Equipment - Modified 35mm Widelux camera, Model F VI/Field of view 50 degrees. Lens opening is f/1. Focal length 20mm. Weight 3.5 pounds. Film -Eastman Tri-X 35mm, ASA 400, B & W, 18 exposures.

Procedure - The pilot will mount the camera on the right hand window. The command pilot will orient the spacecraft attitude with the reticle, using celestial references. The pilot will then perform photography and record the times. When not in use, the camera is stowed in the left hand aft food box.

Experimenter - Dr. E. P. Ney, University of Minnesota.

Note: Also flown on Gemini 5, 8, 9.

S-10 Micrometeorite Cratering

Purpose - To collect craters of micrometeoroid impacts on different types of materials and return them for laboratory analysis.

Equipment - Micrometeorite impact package is mounted on the target docking adapter of the Agena before liftoff. The rectangular package is hinged to fold open and expose eight plates, but will not be opened for this experiment.

Procedure - The package will be launched onboard the Agena in the closed position. It will be retrieved by another EVA pilot on a later rendezvous flight and analyzed for meteoroid impact and cratering.

Experimenter - Dr. Curtis Hemenway and Royce Coon, Dudley Observatory, Albany, New York.

Note: Also flown on Gemini 8 and 9. Not fully activated on Gemini 8, but the package is expected to be recovered during the umbilical EVA on this flight.

S-12 Micrometeorite Collection

Purpose - (1) To collect ultra-small meteoroids in near Earth space to study the nature and frequency of hyperballistic impacts under in-flight conditions, (2) to expose microbiological specimens to the space environment to determine their ability to survive the vacuum, extreme temperatures, and radiation, and (3) to search for any organisms capable of living on micrometeoroids in space.

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Equipment - Aluminum collection box, 11 inches long by 5.5 inches wide by 1.25 inches deep, weighing 7 pounds, 6 ounces. The device has two collection compartments and an internal electric motor and thermally insulated batteries. The collection compartment materials are aluminum-shadowed 200 Angstrom thick nitrocellulose and formvar mounted on 200-mesh copper screening. They are the same collection materials used by the experimenters in previous rocket, balloon and aircraft sampling experiments.

Procedure - The experiment will be mounted in the retro adapter directly behind the pilot's hatch. The hinged lid can be opened and closed electrically from inside the spacecraft. It is planned to open the experiment only during the first eight-hour sleep period of the crew when the spacecraft is in drifting flight in order to avoid contamination by the OAMS system. One of the compartments will be sterilized to determine the presence or absence of microorganisms in the micrometeorites collected. When returned to the laboratory, cultures designed for non-terrestrial organisms will be prepared to determine if any types of life are present in the sample. A set of representative Earth microorganisms such as bacteria, molds, and spores will be placed in the non-sterile compartment. They will be quantitively assayed after the flight exposure to determine the fractions which survive. During the first portion of EVA, the pilot will lock the collection box and return it to the spacecraft cabin.

Experimenter: Dr. C. Hemenway, Dudley Observatory, Albany, N. Y.

Note: Also flown on Gemini 9.

S-6 Synoptic Weather Photography

Purpose - To make use of man's ability to photograph cloud systems selectively -- in color and in greater detail than can be obtained from the current meteorological satellites.

Equipment - A 70mm Maurer camera with 80mm Zeiss F2.8 lens; two magazines of color film with 65 exposures each.

Procedure - Any system which the pilot recognizes as being significant should be photographed. Such areas would include squall line clouds, thunderstorm activity not associated with squall lines, frontal clouds and views of fronts, jetstream cirrus clouds, tropical and extratropical cyclones, wave clouds and broad banking of clouds in the trade winds or other regions.

Experimenter: K.M. Nagler, U. S. Weather Bureau.

Note: Also flown on Gemini 4, 5, 6, 7.

S-5 Synoptic Terrain Photography

Purpose - The purpose of this experiment is to get high quality, small scale photographs of selected parts of the earth's surface for use in research in geology, geophysics, geography, oceanography, and other fields.

Procedure - The experiment will consist of taking pictures of certain areas and features along the flight path with a 70 mm camera, hand-held or mounted, using panchromatic, infrared or color film. Precise attitude control is not required, but moderately high camera depression angles (angle between the horizontal and the camera axis), preferably between 45 degrees and 90 degrees, are desired.

Equipment - Camera will be the 70mm Maurer with 80mm focal length standard lens.

Experimenter - Dr. Paul D. Lowman, NASA Goddard.

Note: Also flown on Gemini 4, 5, 6, 7.

S-13 UV Astronomical Camera

Purpose - Primarily to devise and test the techniques for ultraviolet photography and spectroscopy under vacuum conditions. To investigate the distribution of light intensity in the ultraviolet portions of stellar spectra down to a limit of 200 QA. Also to explore the ultraviolet spectra of O and B stars and some of the planets.

Equipment - 70mm Maurer camera with 73mm f3.3 UV Mauer lens.

Procedure - The spacecraft is oriented toward the star field to be photographed. The cabin will be depressurized and the hatch opened. The camera will be positioned manually and guided by the pilot. A defraction grating will be used to obtain spectrograms of the desired stars and planets.

Experimenter - Dr. Karl Henize, Dearborn Observatory.

S-26 Ion Wake Measurement

Purpose - To investigate the ionosphere wake of an orbiting spacecraft; i.e. to measure charged particle densities and temperatures within the wake relative to those of the ambient plasma. To evaluate the possibility of using this ionosphere wake as a guidance mechanism to facilitate rendezvous. Additional data generated in performance of the experiment will include measurement of the electrical potential difference between the vehicle and surrounding medium.

Equipment - Using a five-element retarding potential analyzer with a simple electronic switching arrangement, measurements will be made of positive ion density, electron density, ion temperature or energy distribution function and vehicle potential with respect to the surrounding ambient. The three sensors and preamplifiers are connected to an electronics package consisting of a power conditioner, signal generator and data conditioner. A key component is the master clock used to generate the carrier in the phase coherent system and to sequence the modes and biases applied to the sensor electrodes.

Procedure - The analyzers are mounted on the outside but flush with the front furface of the docking cone of the Agena target docking adapter. The instrument system will be activated by ground command at a time sufficiently in advance of the actual rendezvous and docking to insure a suitable sample is made of the ambient plasma characteristics. Continuous sampling of ion density and electron density and energy during the rendezvous maneuver would provide profiles through the wake behind Gemini 10. The actual traverse of the detectors would be determined by analysis of the rendezvous operation after the flight. In addition to making measurements during the rendezvous maneuver, it is desireable to have the Gemini spacecraft maneuver laterally with respect to the Agena axis and "sweep" the wake across the detectors and to map it in a transverse manner. This maneuver is repeated with several separations between the spacecraft at distances of a few feet.

Experimenter - Dr. D. Medved, Electro Optics Systems, Inc.

MEDICAL

M-5 Bioassay of Body Fluids

Purpose - To collect body fluids before, during and immediately after flight for analysis of hormones, electrolytes, proteins, amino acids and enzymes which might result from space flight.

Procedure - Urine will be collected in a special bag for each elimination. A specified amount of tritiated water will be added automatically. The water has a tracer amount of radio-active tritium. By comparing the amount of tritium in the sample with the known amount of tritium placed in it, biochemists can measure the total volume. Twenty-four 75 cc capacity sample bags will be carried. A sample will be drawn for each elimination. The remaining urine will be transferred into the urine dump system of the spacecraft.

Experimenter - Dr. L. F. Dietlein, MSC.

Note: Also flown on Gemini 7, 8, 9.

TECHNOLOGICAL

D-5 Star Occultation Navigation

Purpose - To determine the feasibility and operational value of star occulting measurements in the development of a simple, accurate and self-contained orbital navigational capability.

Equipment - As much of the existing Gemini onboard equipment as is possible will be used for the recording of photometric sensor output signal intensity and time. A photoelectric sensor also is necessary for performance of the navigational studies. The photoelectric sensor consists of a telescope, eyepiece, reticle, partially silvered mirror, iris, chopper, optical filters, photomultiplier, pre-amplifier and associated electronics. The instrument is hand-held to the astronaut's eye for viewing out the spacecraft window.

-more-

Procedure - As the astronaut views the horizon, he looks for bright stars about to be occulted. He then points the telescope at one and centers the star within a reticle circle. A portion of the radiation is then diverted to a photomultiplier. With a hand-held switch, the astronaut initiates a calibration mode in which the intensity of the star is measured automatically. He then tracks the star within the reticles as the star passes into the atmosphere and behind the edge of the earth. The tracking period for each star is approximately 100 seconds.

Experimenter - Capt. H. Kozuma, U. S. Air Force

Note: Also flown on Gemini 7.

D-10 Ion Sensing Attitude Control

Purpose - A navigation system which can sense vehicle attitude (yaw, pitch, roll) by utilizing the flow variations of the space environment on a specially designed system.

Equipment - Two experimental packages or booms (one for yaw, one for pitch) located in the adapter section of the vehicle. The unit weighs 10 pounds, require 10 watts and are approximately 5x6x13 inches in size. There are seven computated data points and the packages operate at an angle of plus or minus 15 degrees.

Procedure - The deployment of the two booms, followed by the firing of the flap-releasing pyrotechnics, is accomplished by one of the astronauts via a set of switches in the cabin. An additional switch, also in the cabin, applies and removes the main power input to each unit. Both yaw and pitch operations are simultaneous and the boom deployment, followed by flap release, are one-time operations.

Experimenter - Capt. E. Vallerie, U. S. Air Force

MSC-3 Tri-Axis Magnetometer

Purpose - To monitor the direction and amplitude of the Earth's magnetic field with respect to an orbiting spacecraft.

Equipment - An adapter mounted tri-axis fluxgate magnetometer.

Procedure - The astronaut will operate the experiment as the spacecraft passes through the South Atlantic Geomagnetic Anomaly. The magnitude of the three directions of the Earth's magnetic field will be measured with respect to the spacecraft.

Experimenter - W. D. Womack, MSC

Note: Also flown on Gemini 4, 7

MSC-6 Beta Spectrometer

Purpose - Prior to the Apollo missions it will be necessary to predict, as accurately as possible, the radiation doses to which the astronauts will be subjected so that the degree of hazard can be assessed for each mission and preventive measures taken. The Beta Spectrometer experiments will provide accurate data on the electron source term. This source term data will be an input to computer calculations for dose due to secondary x-ray emission.

Equipment - The spectrometer must be mounted in the adapter equipment section. The mounting is such that the axis of the electron cone is normal to the plane of the outward face of the bremsstrahlung spectrometer detector. The electron acceptance cone must have an unobstructed view of the environment external to the spacecraft. The spectrometer will be wired to power from the spacecraft power supply.

Procedures - A bremsstrahlung spectrometer will be carried on the Beta Spectrometer. The bremsstrahlung will measure x-rays produced by electrons impinging on the spacecraft. The bremsstrahlung readings will be compared with the results of electron computer calculations to verify or adjust the computer code.

Experimenter - J. Marbach, MSC

MSC-7 Bremsstrahlung Spectrometer

Purpose - When a spacecraft passes through a region of high free electron concentration an interaction takes place between the vehicle structure and the electrons, producing a continuous x-ray spectrum. This experiment is designed to measure the bremsstrahlung flux as a function of energy immediately behind the vehicle when the vehicle passes through the South Atlantic anomaly.

Equipment - The bremsstrahlung spectrometer will consist of an x-ray detection system. It will be mounted on the inner wall of the pressurized cabin. The only modifications required will be those allowing for mounting, power and telemetry connections.

Procedure - After the spectrometer is mounted and checked out, the only experimental procedure will be turning the spectrometer on and off at the correct time.

Experimenter - R. Lindsey, MSC.

MSC-8 Color Patch Photography

Purpose - What effect the environment of space will have upon the color photography taken in cislunar space and on the lunar surface during the Apollo mission is not known. If optimum photography is to be obtained during an Apollo mission, the influence of the UV energy transmitted by the Apollo camera lens must be known. This experiment will show that.

Equipment - Equipment will consist of the 70mm Maurer still camera with 80mm f2.8 standard lens and back, color film similar to that which will be used used during an Apollo mission and a slate 4¼ x 4¼ x ¼ inches in dimension supporting four color patches.

Procedure - Prior to launch, a slate holding four National Bureau of Standards color patches will be photographed under controlled lighting conditions with the camera loaded with film similar to that which will be used during a Apollo landing mission. After insertion into orbit the pilot will photograph the slate from outside the spacecraft and oriented to receive the maximum solar illumination.

Experimenter - J. R. Brinkman, MSC.

MSC-12 Landmark Contrast Measurement

Purpose - To acquire reference data for Apollo guidance and navigation system design. Principally, to measure visual contrast of land-sea boundaries and other types of terrain to be used as navigation landmarks.

Equipment - Same as that used on D-5 plus 16mm movie camera and the addition of two optical filters which fit over the objective lens of the experiment photometer. Filters are each two inches in diameter and about ¼ inch thick.

Procedure - The photometer will be mounted to the right-hand window as in the star occultation experiment. Several minutes before the landmark is expected to appear over the horizon, the observer turns on the power supply. The spacecraft is then turned so that the photometer points normally toward the expected landmark direction, and then rotated to put the sun at the observer's back, thus shading the window from direct sunlight.

Experimenter - C. E. Manry, MSC

Note: Also flown on Gemini 7

MSC-5 Lunar UV Spectral Reflectance

Purpose - To determine the ultraviolet spectral reflectance of the lunar surface between 2,000 and 3,200 angstrom.

Equipment - The 70mm Maurer still camera and UV lens will be used for this experiment. An objective grating attachment for the camera will be used for spectrograms, and interference filters will be used for side band photography.

Procedure - Several spectrograms will be made of the solar radiation reflected from the lunar surface. The spectrograph is similar to a camera in operation. Thus the procedure is similar to photographing the moon. Exposure times will vary from one to 50 seconds. The spectrograph will be swivel mounted so that the pilot can guide the spectrograph during the longer exposures. The command pilot will keep the spacecraft oriented toward the moon.

Experimenter - R. C. Stokes, MSC.

CREW PROVISIONS AND TRAINING

CREW TRAINING BACKGROUND

In addition to the extensive general training received prior to flight assignment, the following preparations have or will be accomplished prior to launch:

1. Launch abort training in the Gemini Mission Simulator and the Dynamic Crew Procedures Simulator.

2. Egress and recovery activities using a crew procedures development trainer, spacecraft boilerplate model and actual recovery equipment and personnel. Pad emergency egress training using elevator and slide wire, and breathing apparatus.

3. Celestial pattern recognition in the University of North Carolina's Morehead Planetarium at Chapel Hill.

4. Zero gravity training in KC-135 aircraft to practice EVA. Stowage and donning of EVA equipment is done in aircraft and crew procedures trainer.

Additional EVA training is performed in 20-foot chamber at vacuum conditions.

5. Suit, seat and harness fittings.

6. Training sessions totaling approximately 15 hours per crew member on the Gemini translation and docking simulator.

7. Detailed Agena and Gemini systems briefing; detailed experiment briefings; flight plans and mission rules reviews.

8. Participation in mock-up reviews, systems review, subsystem tests, and spacecraft acceptance review.

9. Ejection seat training.

During final preparation for flight, the crew particpates in network launch abort simulations, joint combined systems test, and the final simulated flight tests. At T-2 days, the major flight crew medical examinations will be administered to confirm readiness for flight and obtain data for comparison with post flight medical examination results.

GEMINI 10 SUITS

The pressure suit worn by the command pilot will be similar to suits worn on Gemini 4, 5, 6, 8, and 9. The pilot will wear a suit with special thermal protective cover layers for EVA activities.

COMMAND PILOT SUIT

The Gemini command pilot's suit has five layers and weighs 23 pounds. The layers are, starting inside the suit:

1. White cotton constant wear undergarment with pockets around the waist to hold biomedical instrumentation equipment

2. Blue nylon comfort layer

3. Black neoprene-coated nylon pressure garment

4. Restraint layer of nylon link net to restrain pressure garment and maintain its shape

5. White HI-1 nylon outer layer

PILOT SUIT

The pressure suit worn by the Gemini 10 pilot weighs 33 pounds and is identical to the Gemini 4 and Gemini 8 pilot suit with the following exceptions:

1. No extravehicular thermal over-gloves will be worn. Thermal protection for the hands is now integrated in a basic suit glove.

2. The material is now a layer-up of neoprene-coated nylon, the same material as the pressure retention layer.

3. The inner visor is a polycarbonate material which provides impact and micrometeoroid protection.

The Gemini extravehicular suit has seven layers: 1-4 and 7 are identical to the command pilot's suit.

5. Thermal protective layer of seven layers of aluminized mylar with spacers between each layer.

6. Micrometeoroid protective layer.

For extravehicular activity, the pilot will wear a detachable overvisor which has attach points on both sides of the helmet and can be swiveled into position over the face-plate. The overvisor is gold-coated and provides protection for the eyes from solar glare.

When the cabin is depressurized, the suits automatically pressurize to 3.7 pounds per square inch to provide pressure and breathing oxygen for both crew members.

EXTRAVEHICULAR LIFE SUPPORT SYSTEM (ELSS)

It is a 42-pound rectangular box which is worn on the chest. It provides electrical, mechanical and life support connections between the EVA astronaut and the spacecraft. System is 18 inches high, 10 inches wide and six inches deep. It contains ejector pump for circulation, a heat exchanger for cooling air, a 30 minute emergency oxygen supply. Controls and a warning system for the emergency oxygen supply are mounted on the top of the unit. Used in combination with the AMU, the ELSS functions as a suit pressurization and air supply system during EVA.

HAND-HELD MANEUVERING UNIT (HHMU)

This unit is similar to the unit used by Ed White on Gemini 4 and scheduled for use by Dave Scott on Gemini 8. A minor modification has been added since the Gemini 8 mission as well as a different fuel and fuel source location. A handle has been added providing a forward and reverse. The unit is used to provide the extravehicular astronaut with positive control of his attitude and to propel him from point to point in the zero gravity environment of free space. Nitrogen fuel bottles are now located in the adapter section. The fuel is fed to the HHMU through the umbilical. Major components of the gun, in addition to the two handles, include two spring loaded poppet valves, foldable tubes, two one-pound nozzles, and one two-pound nozzle. It weighs about three and a half pounds and is stored in the cabin during launch. The unit is 12 inches long by $4\frac{1}{2}$ inches, and 15 inches retracted. Tractor and braking thrust ranges up to two pounds, and the total delta velocity of the gun is 84 feet per second.

UMBILICAL TETHER

The umbilical tether for Gemini 10 EVA is a "Siamese umbilical" manufactured by McDonnell Aircraft Corp. It includes two fluid transmission hoses, one for oxygen and one for the nitrogen HHMU fuel. The nitrogen hose, 3/8-inch inside diameter, is about 60 feet long; the oxygen hose, 1/4-inch inside diameter, is 54 feet; the 1,000-pound test nylon tether which governs the distance away from the spacecraft the EVA astronaut can move, is 50 feet long. When snubbed into the restraint eye at the nose of the spacecraft, the umbilical tether will permit movement to about 40 feet from the spacecraft. Electrical power, communications and bio-instrumentation hardlines also are contained in the umbilical. The hoses are protected from temperature extremes by a wrapping of aluminized mylar. Hoses, hardlines and tether are encased in a sleeve of white nylon. Outside diameter of the sleeve-covered unit is 2 inches.

MEDICAL CHECKS

At least one medical check a day will be made by each crew member. Performed over a convenient ground station, a check will consist of oral temperature and food and water intake evaluation.

BODY WASTE DISPOSAL

Solid Wastes -- Plastic bag with adhesive lip to provide secure attachment to the body. Contains germicide which prevents formation of bacteria and gas. Adhesive lip also used to form seal for bag after use and bag is stowed in empty food container box and brought back for analysis.

Urine -- Voided into fitted receptacle connected by hose to either a collection device or overboard dump.

WATER MEASURING SYSTEM

A mechanical measuring system has been added to water gun. It consists of a neoprene bellows housed in a small metal cylinder mounted at base of gun. The bellows holds one-half ounce of water. When plunger of gun is depressed, a spring pushes water out of bellows and through gun. A counter in right side of gun registers number of times bellows is activated. Each crewman will record how much he drinks by noting numbers at beginning and end of each use of gun.

FOOD

Number of Meals -- Nine per astronaut for mission.

Type -- Bite-sized and rehydratable. Water is placed in rehydratables with the water gun. Bite-sized items need no rehydration.

Storage -- Meals individually wrapped in aluminum foil and polyethelene, polyamide laminate. All meals are stored in the right aft food box over the pilot's right shoulder.

GEMINI 10 FOOD MENU
(THREE-DAY MENU CYCLE)

DAY 1: Meal C	Calories
(R) Beef pot roast	119
(R) Potato salad	143
(B) Cinnamon toast	56
(R) Chocolate pudding	307
(B) Brownies	241
(R) Tea	32
	898

DAY 2: Meal A	
(R) Applesauce	139
(R) Sugar coated flakes	139
(B) Bacon squares (double)	180
(B) Cinnamon toast	56
(R) Cocoa	190
(R) Orange drink	83
	787

DAY 2: Meal B	
(R) Pea Soup	220
(R) Tuna salad	214
(B) Cinnamon toast	56
(B) Fruitcake (date)	262
(R) Pineapple grapefruit drink	83
	835

DAY 2: Meal C	
(R) Beef and vegetables	98
(R) Meat and spaghetti	70
(B) Cheese sandwiches	158
(R) Apricot pudding	300
(B) Gingerbread cubes	183
(R) Grapefruit drink	83
	892

DAY 3: Meal A	
(R) Peaches	98
(B) Strawberry cereal cubes	171
(R) Sausage patties (2)	223
(B) Cinnamon toast	56
(R) Orange drink	83
(R) Grapefruit drink	83
	714

DAY 3: Meal B	Calories
(R) Shrimp cocktail	119
(R) Beef and gravy	160
(R) Corn	105
(B) Toasted bread cubes	161
(B) Fruitcake (Pineapple)	253
(R) Orange grapefruit drink	83
	881

DAY 3: Meal C	
(R) Potato soup	220
(R) Chicken salad	237
(B) Beef sandwiches	268
(R) Butterscotch pudding	311
(R) Tea	32
	1068

SUPPLEMENTARY FOOD: Meal A	
(R) Fruit cocktail	87
(R) Toasted oat cereal	91
(B) Bacon squares (double)	180
(R) Ham and applesauce	127
(B) Cinnamon toast	56
(R) Orange drink	83
(R) Pineapple grapefruit drink	83
	707

SUPPLEMENTARY FOOD: Meal B	
(R) Shrimp cocktail	119
(R) Chicken and gravy	92
(B) Toasted bread cubes	161
(B) Fruitcake (Pineapple)	253
(R) Orange grapefruit drink	83
(B) Coconut cubes	175
	883

(R) Rehydratable
(B) Bite-size

CAMERAS

Still Cameras

One 70 mm Hasselblad wide-angle camera using a 38 mm lens and haze filter. Capable of time exposures and speeds up to 1/500 second using f4.5 to f22.0 aperture settings. The field of view is 63° X 63°, the resolution is 125 lines per mm; and the camera can be focused from one foot to infinity. Magnification is approximately 1.5 times. Used during EVA.

Two Maurer 70 mm cameras using 80 mm lens with a field of view of 37° X 37° can be focused from one foot to infinity. Aperture settings are from f2.8 to f22 and the resolution is 200 lines per mm. Experiment lens such as the UV lens will be used with these cameras.

Sequence Camera

Two 16 mm Maurer Sequence cameras using 18 and 75 mm lenses and 5, 18 and 75 mm lenses are available. The 5 mm lens will be used for EVA photography. Fields of view of the 5, 18 and 75 mm lenses are 118° X 78°, 40° X 30° and 8° X 5° respectively. Time exposures and single exposures can be taken as well as adjusting the frame rate at either 1 or 6 frames per second. Resolution is 40 lines per mm and the shutter speeds are 1/50, 1/100, 1/200, and 1/250 seconds. Nine magazines of Kodak S.O. 207 color film approximately 80 feet each in length will be carried during the mission.

MANNED SPACE FLIGHT TRACKING NETWORK
GEMINI 10 MISSION REQUIREMENTS

NASA operates the Manned Space Flight Tracking Network by using its own facilities and those of the Department of Defense for mission information and control.

For Gemini 10, the network will provide flight controllers:

(1) Radar tracking, command control, voice and telemetry data are available from launch through Gemini spacecraft splashdown in recovery area. Except for voice communications, the network provides the same functions for the Agena Target Vehicle as long as electrical power is available.

(2) Verification of the proper operation of the systems onboard the Gemini and Agena target.

REAL TIME COMPUTER COMPLEX (RTCC)

The RTCC at the Manned Spacecraft Center, Houston, will be the primary computer center utilized in the control of the entire mission. The RTCC receives, stores, processes, sends, and drives displays of the necessary mission critical information required by the flight controllers at the Mission Control Center (MCC-Houston).

During the launch (powered flight) phase, the RTCC receives launch trajectory data from the Air Force Eastern Test Range (AFETR) radars via the Cape Kennedy CDC-3600 Real Time Computing Facility (RTCF) and from the Bermuda tracking station.

During all phases of the mission, the RTCC receives trajectory and telemetry data from the various sites and stores and processes this information for use by flight controllers in the command and control of the mission. This telemetered information consists of bio-medical, environmental, electrical, command maneuvering and other spacecraft and target vehicle systems parameters. This information is displayed at the various flight controllers consoles in the MCC where necessary decisions are made for the conduct of the mission. The flight controllers use the displayed information to assist them in the determination and generation of required voice and command updates to be sent to the spacecraft and target vehicle.

TRACKING

The Gemini 10 mission will require separate tracking of five space vehicles: the Gemini spacecraft, the Gemini 8 and Gemini 10 Agena Target Vehicles (ATV), the Gemini Launch Vehicle (GLV-a modified Titan II), and as required, the Atlas Booster called SLV-3. The Agena Target Vehicle will carry one C-band and one S-band beacon, while the spacecraft carries two C-band beacons. Skin tracking (radar signal bounce) off the spacecraft, Agena target vehicles, and Gemini launch vehicle throughout orbital lifetime is a mission requirement. The MSFN and various facilities of the North American Air Defense Command (NORAD) will be used for this mission. However, NORAD will not track during the rendezvous phase.

For Gemini 10, various combinations of spacecraft tracking assignments will be carried out according to individual station capability. Some sites have radar systems capable of providing space position information on both the Gemini and one Agena vehicle simultaneously through their Verlort (S-band) and FPS-16 or FPQ-6 (C-band) radars. Most of the data transmission links, however, have only a single system capability; therefore, transmission scheduling priority will be established by the Flight Director or Flight Dynamics Officer according to the mission requirements.

During the first revolution of the Agena 10 (prior to Gemini spacecraft liftoff, as a general rule, the C-band radars will track the Gemini spacecraft while the S-band radars will track the Agena 10 Target Vehicle. The sites with dual-tracking capability will track both vehicles simultaneously. Tracking of the Agena 8 will be done by selected C-band stations just prior to the mission and during the mission as assigned by the MCC-H.

NETWORK CONFIGURATION

Stations / Systems	C-Band Radar	S-Band Radar	Telemetry Receive & Record	Telemetry Real Time Display	Low Speed (TTY) Telemetry Data Transmission	Wide Band Data	High Speed Data	On Site Data Process & Summary	Gemini Launch Vehicle Telemetry	Gemini Launch Vehicle Command	Digital Command System	Voice - Transmit & Receive	Teletype - Transmit & Receive	Flight Control Team Manned	Spacecraft Acquisition Aid System	Skin Track
Mission Control, Houston (MCC-H)				X				X			X	X	X	X		
Mission Control, Kennedy (MCC-K)			X	X		X			X	X	X	X	X		X	
Merritt Island, Fla. (MLA)	X															X
Cape Kennedy, Fla. (CNV)	X	X	X			X			X	X	X	X	X		X	
Patrick AFB, Fla. (PAT)	X												X			X
Grand Bahama Island (GBI)	X	X	X			X			X	X	X	X	X		X	X
Grand Turk Island (GTI)	X	X	X			X			X	X	X	X	X		X	X
Bermuda (BDA)	X	X	X				X				X	X	X		X	
Grand Canary Island (CYI)	X	X	X	X	X			X			X	X	X	X	X	
Kano, Nigeria (KNO)			X									X	X		X	
Tananarive, Malagasy (TAN)			X									X	X		X	
Pretoria, South Africa (PRE)	X												X			
Carnarvon, Australia (CRO)	X	X	X	X	X			X			X	X	X	X	X	X
Woomera, Australia (WOM)	X												X			
Canton Island (CTN)			X									X	X		X	
Kauai, Hawaii (HAW)	X	X	X	X	X			X			X	X	X	X	X	
Guaymas, Mexico (GYM)		X	X	X	X			X				X	X	X	X	
Pt. Arguello, Calif. (CAL)	X	X	1									X	X		X	
White Sands, N. M. (WHS)	X												X		X	X
Eglin, Fla. (EGL)	X												X		X	X
Antigua Island (ANT)	X		X			X			X	X	X	X	X		X	X
Ascension Island (ASC)	X		X									X	X		X	X
Coastal Sentry Quebec (CSQ)			X	X	X			X			X	X	X	X	X	
Rose Knot Victor (RKV)			X	X	X			X			X	X	X	X	X	
Range Tracker (RTK)	X											X	X			X

1. Last two passes prior to reentry.

Goddard Space Flight Center Computer Support

NASA's Goddard Space Flight Center, Greenbelt, Md., real time computing support for Gemini 10 includes the processing of real time tracking information obtained from the spacecraft, target vehicle, and GLV beginning with mission simulations through Gemini spacecraft recovery and Agena lifetime.

Goddard's computer also will certify the worldwide network's readiness to support Gemini 10 through a system-by-system, station-by-station, computer-programmed checkout method called CADFISS (Computation and Data Flow Integrated Subsystem). Checkout of network facilities also will be performed by Goddard during postlaunch periods when the spacecraft are not electronically "visible" by some stations and continue until the vehicles are again within acquisition range.

Gemini Spacecraft

The spacecraft has two C-band tracking beacons. The model ACF beacon (spacecraft) will be installed in the reentry module and the DPN-66 model beacon in the adapter section.

The ACF beacon will be prime for launch, insertion, and reentry phase, using the DPN-66 as a backup for these periods.

Gemini 10 Agena Target Vehicle

The Agena target vehicle will contain one C-band and one S-band beacon. The C-band beacon will be a modified DPN-66. The C-band beacon will be prime for Agena Target Vehicle before the Gemini launch. The Gemini spacecraft will be the prime target for C-band tracking following launch.

Gemini 8 Agena Target Vehicle

Since the main batteries and propulsion systems on the Agena 8 were depleted shortly after termination of the Gemini 8 mission, beacon tracking or maneuvering of the Agena 8 Target Vehicle will not be possible. During this inactive period, the NORAD facilities have provided most of the tracking information necessary for mission planning purposes. During the mission, skin tracking of the Agena 8 will be accomplished by selected stations.

Acquisition Systems

All the sites in the network will receive real time acquisition messages (pointing data) from the Real Time Computing Center at MSC, Houston. This information will be used to position the telemetry and radar antennas at the proper azimuth for acquisition of the RF signals from the spacecraft at the time they appear over the horizon. Most sites are also equipped with an acquisition aid system which permits "slaving" the radar antennas to the telemetry antennas or vice versa. Since the telemetry antennas have a much broader beamwidth than the radar antennas, they may acquire the spacecraft RF signal first, making it possible to point the radar antennas in the general vicinity of the spacecraft to insure a rapid radar acquisition.

Mission Message Requirements

Low speed telemetry data (onsite teletype summaries) from flight controller manned stations will be sent to the Houston Mission Control Center.

Bermuda and Corpus Christi transmit Gemini spacecraft or Agena target vehicle PCM telemetry via high-speed digital data to Houston Mission Control Center in computer format. MCC-K/TEL III, Grand Bahama Island, Grand Turk Island, and Antigua will remote Gemini spacecraft and Agena wide-band data to the Houston Mission Control Center in the same manner.

Spacecraft Command System

The prime ground system in effecting rendezvous is the Digital Command System (DCS) located at key stations throughout the worldwide network. Command control of the mission from launch through recovery will as always be provided by the Flight Director at Houston Mission Control Center. Maximum command coverage is required throughout the mission.

Grand Canary Island; Carnarvon, Australia; Hawaii, and the two ships, USNS Coastal Sentry and USNS Rose Knot; are DCS equipped and manned by flight controllers who will initiate all uplink data command transmissions.

Following astronaut recovery, further commands will be required for the Agena target vehicle. Network Digital Command System support will be continued throughout the Agena target vehicle battery lifetime.

Cape Kennedy, Grand Bahama, Grand Turk, Antigua and Bermuda sites will not be manned by flight controllers. All uplink data command transmissions through these sites will be remoted in real time from Houston Control Center.

In addition to real time commands and onboard clock update commands, the following digital instructions may be sent:

a. Gemini spacecraft

1. Preretro with maneuver
2. Preretro without maneuver
3. Orbital navigation
4. Maneuver
5. Rendezvous
6. Accelerometer error corrections

b. Agena Target Vehicle

1. Maneuver
2. Ephemeris
3. Engine burn time

Spacecraft Communications

All MSFN stations having both HF and UHF spacecraft communications can be controlled either by the station or by remote (tone) keying from Houston Mission Control Center and from Goddard.

The following sites are not scheduled to have a capsule communicator (Cap Com) and will be remoted to Houston Mission Control Center:

Cape Kennedy, Grand Bahama Island; Tananarive, Malagasy Republic; Kano, Nigeria; Bermuda; Grand Turk Island; Pt. Arguello, Calif.; Antigua Island; Ascension Island; Canton Island; USNS Range Tracker, and the voice relay aircraft.

Spacecraft Systems Support

The Gemini spacecraft communications systems (antennas, beacons, voice communications, telemetry transmitters, recovery light, and digital command system) allow radar tracking of the spacecraft, two-way voice communications between the ground and the spacecraft and from astronaut to astronaut; ground command of the spacecraft; TM systems data transmission, and postlanding and recovery data transmission. The sole link between the ground and the Gemini spacecraft is provided by these systems.

The Agena target vehicle communications systems (antennas, beacons, telemetry transmitters, and digital command system) allow radar tracking of the vehicle from both the ground and the Gemini spacecraft. Ground station and Gemini spacecraft command to the Agena also are accomplished through this system.

Agena Target Vehicle Onboard Systems supported by Network Stations	Gemini Spacecraft Onboard Systems supported by Network Stations
Telemetry (Real Time)	Reentry Module UHF (Voice) Transmit-Receive
Telemetry (Dump)	Reentry Module HF (Voice) Transmit-Receive
L-Band Transponder	Reentry Module Telemetry (Real Time)
S-Band Transponder	Reentry Module Telemetry (Dump)
C-Band Transponder	Reentry Module Telemetry (Backup)
Command Receiver (Range Safety)	Adapter Package L-Band Radar (Telemetry Readouts)
Command Receiver (Command Control)	Reentry Module C-Band Transponder
	Adapter Package C-Band Transponder
	Adapter Package Acquisition Aid Beacon
	Adapter Package Digital Command System
	Reentry Module UHF Recovery Beacon

Ground Communications

The NASA Communications Network (NASCOM) used for Gemini 9 will be used for Gemini 10. Shore stations for USNS Rose Knot and USNS Coastal Sentry Ship support will be based upon the mission-designated ship positions and predicted HF radio propagation conditions.

Network Responsibility

Manned Spacecraft Center (MSC). The direction and mission control of the Network immediately preceding and during a mission simulation or an actual mission is responsibility of the MSC.

Goddard Space Flight Center. The NASA Office of Tracking and Data Acquisition has centralized the responsibility for the planning, implementation, and technical operations of Goddard Space Flight Center. Technical operation is defined as the operation, maintenance, modification, and augmentation of tracking and data acquisition facilities to function as an instrumentation network in response to mission requirements. About 370 persons directly support the network at Goddard; contractor personnel bring the total network level to some 1500.

Department of Supply, Australia. The Department of Supply, Commonwealth of Australia, is responsible for the maintenance and operation of the NASA station at Carnarvon, Australia. Contractual arrangements and agreements define this cooperative effort.

Department of Defense (DOD). The DOD is responsible for the maintenance and operational control of those DOD assets and facilities required to support Project Gemini. These include network stations at the Eastern Test Range, Western Test Range, White Sands Missile Range, the Air Proving Ground Center, and the tracking and telemetry ships.

ABORT AND RECOVERY

Crew Safety

Every Gemini system affecting crew safety has a backup feature. The Malfunction Detection System aboard the launch vehicle warns the crew of a malfunction in time for escape.

There are three modes of escape:

MODE I — Ejection seats, and personal parachutes, used at ground level and during first 50 seconds of powered flight, or during descent after reentry.

MODE II — Retrorockets salvo fired after engine shutdown is commanded.

MODE III — Normal separation from launch vehicle, using OAMS thrusters, then making normal reentry, using computer.

Except for Mode I, spacecraft separates from Gemini Launch Vehicle, turns blunt-end forward, then completes reentry and landing with crew aboard.

Survival Package

Survival gear, mounted on each ejection seat and attached to the astronaut's parachute harnesses by nylon line, weighs 23 pounds.

Each astronaut has:

3.5 pounds of drinking water

Machete

One-man life raft, $5\frac{1}{2}$ by 3 feet, with CO_2 bottle for inflation, sea anchor, dye markers, nylon sun bonnet.

Survival light (strobe), with flashlight, signal mirror, compass, sewing kit, 14 feet of nylon line, cotton balls and striker, halazone tablets, a whistle, and batteries for power.

Survival radio, with homing beacon and voice transmission and reception.

Sunglasses

Desalter kit, with enough brickettes to desalt eight pints of seawater.

Medical kit, containing stimulant, pain, motion sickness and antibiotic tablets and aspirin, plus injectors for pain and motion sickness.

PLANNED AND CONTINGENCY LANDING AREAS

There are two types of landing areas for Gemini 10, planned--where recovery forces are pre-positioned to recover spacecraft and crew within a short time--and contingency, requiring special search and rescue techniques and a longer recovery period.

Planned Landing Areas

PRIMARY	West Atlantic (44-1) where the USS Guadalcanal landing platform helicopter ship is pre-positioned.
SECONDARY	East Atlantic, West Pacific and Mid-Pacific areas where destroyers are deployed.
LAUNCH SITE	Off-the-pad abort or abort during early phase of flight, includes an area about 41 miles seaward from Cape Kennedy, three miles toward Banana River from Complex 19.
LAUNCH ABORT	Abort during powered flight, extending from 41 miles at sea from Cape Kennedy to west coast of Africa.

Contingency Landing Areas

All the areas beneath the spacecraft's ground track except those designated Planned Landing Areas are Contingency Landing Areas, requiring aircraft and pararescue support for recovery within a period of 18 hours from splashdown.

Recovery forces are provided by the military services under the operational control of the Department of Defense Manager for Manned Space Flight Support Operations.

GEMINI SPACECRAFT

The Gemini spacecraft is conical, 18 feet, 5 inches long, 10 feet in diameter at its base and 39 inches in diameter at the top. Its two major sections are the reentry module and the adapter section.

Reentry Module

The reentry module is 11 feet high and 7½ feet in diameter at its base. It has three main sections: (1) rendezvous and recovery (R&R), (2) reentry control (RCS), and (3) cabin.

Rendezvous and recovery section is the forward (small) end of the spacecraft, containing drogue, pilot and main parachutes and radar.

Reentry control section is between R&R and cabin sections and contains fuel and oxidizer tanks, valves, tubing and two rings of eight attitude control thrusters each for control during reentry. A parachute adapter assembly is included for main parachute attachment.

Cabin section between RCS and adapter section, houses the crew seated side-by-side, their instruments and controls. Above each seat is a hatch. Crew compartment is pressurized titanium hull. Equipment not requiring pressurized environment is located between pressure hull and outer beryllium shell which is corrugated and shingled to provide aerodynamic and heat protection. Dish-shaped heat shield forms the large end of cabin section.

Adapter Section

The adapter is 7½ feet high and 10 feet in diameter at its base, containing retrograde and equipment sections.

Retrograde section contains four solid retrograde rockets and part of the radiator for the cooling system.

Equipment section contains fuel cells for electrical power, fuel for the orbit attitude and maneuver system (OAMS), primary oxygen for the environmental control system (ECS), cryogenic oxygen and hydrogen for fuel cell system. It also serves as a radiator for the cooling system, also contained in the equipment section.

NOTE: The equipment section is jettisoned immediately before retrorockets are fired for reentry. The retrograde section is jettisoned after retros are fired.

ELECTRICAL POWER SYSTEM

Gemini 10 will carry two fuel cells for the primary power supply during launch and orbit. The cells consist of three stacks of 32 individual cells. Oxygen and hydrogen react to produce electrical energy.

Four 45 amp-hour batteries will also be carried in the spacecraft to insure a continuous power supply during reentry and landing. They will also be used during prelaunch and launch, in conjunction with the fuel cells.

Three 15 amp-hour squib batteries will be used in the reentry section for all squib-actuated pryotechnic separating during the mission.

OAMS PROPELLANT

Useable -- 940 pounds

A fifth propellant tank has been added to the spacecraft to increase available propellant. Also, the auxiliary (Volkswagon) tank will hold 23.6 pounds of oxidizer.

RENDEZVOUS RADAR

Purpose -- To measure range, range rate, and bearing angle to Agena so crew can determine maneuvers necessary for rendezvous.

Operation -- Transponder on Agena receives radar impulses and returns them to spacecraft at a specific frequency and pulse width. Radar accepts only signals processed by transponder.

Location -- small end of spacecraft on forward face of rendezvous and recovery section.

Size -- less than two cubic feet

Weight -- less than 70 pounds

Power Requirement -- less than 80 watts

Auxiliary Tape Memory (ATM) -- The Auxiliary Tape Memory is a 15-track magnetic tape recorder which stores 835,000 bits on each track resulting in a total storage of 12,500,000 bits. Data parity, clocking, and computer processing bits are recorded in triplicate. The ATM provides triple redundant storage for approximately 1,170,000 bits that can be used for external storage of computer programs. The present computer has provided onboard computer program capbility for launch, rendezvous, and reentry and has 156,000 bits of program storage.

The ATM is a hermetically-sealed unit which contains a mechanical transport assembly mounted on vibration isolators, an an electronic assembly containing the power supply, control logic, record logic, and playback logic.

The tape transport is a flangeless reel, peripheral drive unit which contains 525 feet of one-inch wide magnetic tape. The magnetic tape is driven by an endless, seamless 3/4-inch wide mylar belt called the peripheral drive belt. The peripheral drive belt is in turn driven by two drive capstans which are coupled by smaller endless, seamless mylar belts. By not exposing the magnetic tape to drive stresses, its useful life is extended.

The unit weighs 26 pounds, contains 700 cubic inches, and uses approximately 18 watts. The ATM is built by Raymond Engineering Laboratories, Middletown, Conn., under contract to the International Business Machines, Electronics Systems Division, Owego, N. Y., for the prime Gemini contractor, McDonnell Aircraft Corp.

GEMINI LAUNCH VEHICLE

The Gemini Launch Vehicle (GLV 10) is a modified U. S. Air Force Titan II intercontinental ballistic missile consisting of two stages, identical to the launch vehicles used in previous Gemini flights.

	FIRST STAGE	SECOND STAGE
HEIGHT	63 feet	27 feet
DIAMETER	10 feet	10 feet
THRUST	430,000 pounds (two engines)	100,000 pounds (one engine)
FUEL	50-50 blend of monomethyl hydrazine and unsymmetrical-dimethyl hydrazine	
OXIDIZER	Nitrogen tetroxide propellants are hypergolic, ignite spontaneously upon contact with oxidizer).	

Overall height of launch vehicle and spacecraft is 109 feet. Combined weight is about 340,000 pounds.

Modifications to Titan II for use as the Gemini Launch Vehicle include: (NOTE: GLV-10 same as GLV 1 through 9)

1. Malfunction detection system added to detect and transmit booster performance information to the crew.

2. Back-up flight control system added to provide a secondary system if primary system fails.

3. Radio guidance substituted for inertial guidance.

4. Retro and vernier rockets deleted.

5. New second stage equipment truss added.

6. New second stage forward oxidizer skirt assembly added.

7. Trajectory tracking requirements simplified.

8. Electrical hydraulic and instrument systems modified.

Gemini Launch Vehicle program management for NASA is under the direction of the Space Systems Division of the Air Force System Command.

AGENA TARGET VEHICLE

The Agena target vehicle for Gemini 10 is a modification of the U. S. Air Force Agena D upper stage, similar to the space vehicles which helped propel Ranger and Mariner spacecraft to the Moon and planets.

It acts as a separate stage of the Atlas/Agena launch vehicle, placing itself into orbit with its main propulsion, and can be maneuvered either by ground control or the Gemini 10 crew, using two propulsion systems.

Height (Liftoff)	36.3 feet	Including shroud
Length (Orbit)	26 feet	Minus shroud and adapter
Diameter	5 feet	
Weight	7,000 pounds	In orbit, Fueled
Thrust	16,000 pounds	Primary Propulsion System (PPS)
	400 pounds	Secondary Propulsion System (SPS) Unit II
	32 pounds	Secondary Propulsion System (SPS) Unit I
Fuel	UDMH (Unsymmetrical Dimethyl Hydrazine)	
Oxidizer	IRFNA (inhibited Red Fuming Nitric Acid) in primary propulsion system; MON (Mixed Oxides of Nitrogen) in secondary propulsion system.	
Combustion	IRFNA and UDMH are hypergolic, ignite on contact	

Primary and secondary propulsion systems are restartable. Main engine places Agena into orbit and is used for large orbit changes. Secondary system, two 200-pound-thrust, aft-firing engines, are for small velocity changes. Two 16-pound-thrust, aft-firing thrusters are for ullage orientation and vernier adjustments. Attitude control (roll, pitch, yaw) is accomplished by six nitrogen jets mounted on Agena aft end.

Modifications to Agena for use as Gemini rendezvous target vehicle include:

1. Docking adapter and equipment to permit mechanical connection with Gemini during flight.

2. Radar transponder compatible with Gemini radar.

3. Displays and instrumentation, plus acquision lights for visually locating and inspecting Agena before docking.

4. Secondary propulsion system for small orbital changes.

5. Auxiliary equipment rack for special rendezvous equipment and telemetry.

6. Command control equipment to allow control by Gemini 10 crew or ground controllers.

7. Multi-restart engines to provide in-orbit maneuver capability

Agena program management for NASA is under the direction of the Space Systems Division of the Air Force Systems Command.

STATIC CHARGE DEVICE

Three protruding flexible copper fingers are installed on the Agena docking cone to make first contact with the spacecraft. Any charge will be carried to a ground in the Agena and dissipated at a controlled rate. An electrostatic charge monitoring device is also installed in the target docking adapter to measure the potential or difference in charge between the two vehicles.

ATLAS LAUNCH VEHICLE

The Atlas Standard Launch Vehicle is a refinement of the modified U. S. Air Force Atlas intercontinental ballistic missile, similar to the launch vehicle which placed Project Mercury astronauts into orbit.

Atlas is a 1½ stage vehicle, igniting all three main engines on the pad, then dropping off the two outboard booster engines at staging, allowing the single sustainer engine to continue thrusting at altitude, aided by two small vernier engines.

Height	77 Feet	Minus Agena Payload
Diameter	16 Feet	Lower Booster Section
	10 Feet	Tank Sections
	5 Feet, 10 inches	Tapered Upper End
Weight	260,000 pounds	Fully fueled, minus Agena payload
Thrust	390,000 pounds	Total at liftoff Two booster (outer) engine
	57,000 pounds	One Sustainer (center) engine
	Balance	Two small vernier engines for trajectory and final velocity control
Fuel	RP-1, a hydrocarbon	resembling kerosene
Oxidizer	Liquid oxygen at -297	degrees F.
Combustion	Unlike Titan's hypergolic, spontaneous ignition, Atlas combustion is achieved by forcing propellants to chambers under pressure, burning them in has generators which drive propellant pump turbines.	

Modifications to the Atlas Standard Launch Vehicle for the Gemini 10 mission include:

1. Special autopilot system for rendezvous mission.

2. Improved propellant utilization system to assure simultaneous depletion of both fuel oxidizers.

3. Increased thickness of Atlas structure for support of Agena upper stage.

4. Simplified pneumatic system.

5. Retrorockets moved from exterior equipment pods to upper inter-stage adapter section.

6. Uprated MA-5 propulsion system (used on later Mercury flights).

7. Modular telemetry kit tailored for each mission.

Atlas Standard Launch Vehicle program management for NASA in under the direction of the Space Systems Division of the Air Force Systems Command.

CREW BIOGRAPHIES

NAME: John Watts Young

BIRTHPLACE AND DATE: San Francisco, Calif., Sept. 24, 1930.

EDUCATION: Bachelor of Science degree in aeronautical engineering from Georgia Institute of Technology, 1952.

MARITAL STATUS: Married to the former Barbara V. White of Savannah, Ga.

CHILDREN: Sandy, Apr. 30, 1957; John, Jan. 17, 1959.

PROFESSIONAL SOCIETIES: Member, American Institute of Aeronautics and Astronautics; associate member, Society of Experimental Test Pilots.

EXPERIENCE: Upon graduation from Georgia Tech, Young entered the United States Navy and is now Commander in that service.

From 1959 to 1962 he served as a test pilot, and later program manager of the F4H weapons system project, doing test and evaluation flights and writing technical reports.

He served as maintenance officer for all-weather Fighter Squadron 143 at the Naval Air Station, Miramar, Calif.

In 1962, Young set world time-to-climb records in the 3,000 meter and 25,000 meter altitudes in the F4B Navy fighter.

He was the pilot for the first manned Gemini flight in March 1965 and backup pilot for Gemini 6.

He has logged more than 3,400 hours flying time, including more than 2,900 hours in jet aircraft.

CURRENT ASSIGNMENT: Young was among the group of nine astronauts selected by NASA in September 1962. In addition to participation in the overall astronaut training program he has had specialized duties including monitoring development of the environmental control system, pressure suits, survival and associated pilot equipment, such as spacecraft ejection seats and couches.

NAME: Michael Collins

BIRTHPLACE AND DATE: Rome, Italy, Oct. 31, 1930

EDUCATION: Bachelor of Science degree from the United States Military Academy, West Point, New York.

MARITAL STATUS: Married to the former Patricia M. Finnegan of Boston, Mass.

CHILDREN: Kathleen, May 6, 1959; Ann S., Oct. 31, 1961; Michael L., Feb. 23, 1963.

PROFESSIONAL ORGANIZATIONS: Member, Society of Experimental Test Pilots.

EXPERIENCE: Collins, an Air Force Major, chose an Air Force career following graduation from West Point.

He served as an experimental flight test officer at the Air Force Flight Test Center, Edwards AFB, Calif. In that capacity he tested performance and stability and control characteristics of Air Force aircraft, primarily jet fighters.

He has logged more than 3,500 hours flying time, including more than 3,000 hours in jet aircraft.

CURRENT ASSIGNMENT: Collins was one of the third group of astronauts selected by NASA in October 1963. In addition to participating in the astronaut training program, he concentrates on pressure suits. He was also named as pilot of the backup crew on Gemini 7.

NAME: Alan LaVern Bean

BIRTHPLACE AND DATE: Wheeler, Tex., Mar. 15, 1932.

EDUCATION: Bachelor of Science degree in Aeronautical Engineering, University of Texas.

MARITAL STATUS: Married to the former Sue Ragsdale of Dallas, Tex.

CHILDREN: Clay A., Dec. 18, 1955; Amy Sue, Jan. 21, 1963.

EXPERIENCE: Bean, a Navy ROTC student at Texas, was commissioned upon graduation and received his flight training. He is now a Naval Lieutenant Commander.

He attended the School of Aviation Safety at the University of Southern California.

Bean was assigned to Attack Squadron 44, Jacksonville, Fla., Naval Air Station for four years. He then attended the Navy Test Pilot School at Patuxent River, Md.

He served at Patuxent as project officer on various aircraft for Navy preliminary evaluation, initial trials and final board of inspection and survey trials.

Bean was later assigned with Attack Squadron 172 at Cecil Field, Fla., as a A-4 light jet attack pilot.

He has logged more than 2,600 hours flying time, including more than 2,200 hours in jet aircraft. Bean has flown 24 aircraft, including jet propelled, and helicopter models.

CURRENT ASSIGNMENT: Bean was chosen as an astronaut in the group named by NASA in October 1963. In addition to participating in the astronaut training program. he has specific responsibility in the recovery systems areas.

NAME: Clifton Curtis Williams, Jr.

BIRTHPLACE AND DATE: Mobile, Ala., Sept. 26, 1932.

EDUCATION: Bachelor of Science degree in mechanical engineering from Auburn University.

MARITAL STATUS: Married to the former Jane E. Lansche of New Bern, N. C.

PROFESSIONAL ORGANIZATIONS: Member of Sigma Chi; Pi Tau Sigma, national mechanical honorary; Tau Beta Pi, national engineering society; and associate member of the Society of Experimental Test Pilots.

EXPERIENCE: Williams, a Major in the United States Marine Corps, is a graduate of the Navy Test Pilot School at Patuxent River, Md., and attended the Marine Corps School at Quantico, Va.

He served three years as a test pilot in the Carrier Suitability Branch of the Flight Test Division at Patuxent River. This work included land based and shipboard tests of the F8E, TF8A, F8E (attack), A4E and automatic carrier landing system.

Williams has logged more than 2,400 hours flying time, including more than 1,900 hours in jet aircraft.

CURRENT ASSIGNMENT: Williams was one of the third group of astronauts chosen by NASA in October 1963. In addition to participation in the overall astronaut training program, he has specific responsibilities in the fields of range operations and crew safety and monitoring booster tanks performed on the Gemini 9 flight from the Mission Control Center.

PREVIOUS GEMINI FLIGHTS

Gemini 1, Apr. 8, 1964

Unmanned orbital flight, using first production spacecraft, to test Gemini launch vehicle performance and ability of launch vehicle and spacecraft to withstand launch environment. Spacecraft and second stage launch vehicle orbited for about four days. No recovery attempted.

Gemini 2, Jan. 19, 1965

Unmanned ballistic flight to qualify spacecraft reentry heat protection and spacecraft systems. Delayed three times by adverse weather, including hurricanes Cleo and Dora. December launch attempt terminated after malfunction detection system shut engines down because of hydraulic component failure. Spacecraft recovered after ballistic reentry over Atlantic Ocean.

Gemini 3, Mar. 23, 1965

First manned flight, with Astronauts Virgil I. Grissom and John W. Young as crew. Orbited Earth three times in four hours, 53 minutes. Landed about 50 miles short of planned landing area in Atlantic because spacecraft did not provide expected lift during reentry. First manned spacecraft to maneuver out of plane, alter its own orbit. Grissom, who made suborbital Mercury flight, is first man to fly into space twice.

Gemini 4, June 3-7, 1965

Second manned Gemini flight completed 62 revolutions and landed in primary Atlantic recovery area after 97 hours, 56 minutes of flight. Astronaut James A. McDivitt was command pilot. Astronaut Edward H. White II was pilot, accomplished 21 minutes of Extravehicular Activity (EVA) using a hand-held maneuvering unit for first time in space. Near-rendezvous with GLV second stage was not accomplished after use of pre-planned amount of fuel for the maneuver. Malfunction in Inertial Guidance System required crew to perform zero-lift reentry.

Gemini 5, Aug. 21-29, 1965

Astronauts L. Gordon Cooper and Charles (Pete) Conrad, Jr., circled the Earth 120 times in seven days, 22 hours and 56 minutes. Cooper was first to make two orbital space flights. Failure of oxygen heating system in fuel cell supply system threatened mission during first day of flight, but careful use of electrical power, and excellent operational management of fuel cells by both crew and ground personnel, permitted crew to complete flight successfully. Spacecraft landed about 100 miles from primary Atlantic recovery vessel because of erroneous base-line information programmed into onboard computer, although computer itself performed as planned. Plan to rendezvous with a transponder-bearing pod carried aloft by Gemini 5 was cancelled because of problem with fuel cell oxygen supply.

Gemini 7, Dec. 4-18, 1965

Holds current world record for manned space flight as Command Pilot Frank Borman and Pilot James Lovell completed 206 revolutions of the earth in 13 days, 18 hours, and 35 minutes. On the 12th day of their flight, Gemini 7 served as target for the Gemini 6 spacecraft on the first successful rendezvous in space. In proving man's ability to operate in space for a period up to two weeks, the crew of Gemini 7 carried out an ambitious list of 20 experiments including all medical experiments in the Gemini Program, a test of laser communications from space and visual acuity. The Gemini 7 experienced continuous difficulty with the delta p light on the fuel cell system. However, the system performed for the entire mission. The only other problem encountered was the temporary malfunction of a yaw thruster on the spacecraft. Gemini 7 landed in the Atlantic on Dec. 18, making a controlled reentry which brought it within 10 miles of the recovery carrier.

Gemini 6, Dec. 15-16, 1965

The first spacecraft to rendezvous with another spacecraft in orbit. Command Pilot Walter Schirra and Pilot Thomas Stafford flew their spacecraft from a 100-by-167 mile orbit into a 185-mile circular orbit, rendezvousing with Gemini 7 over the Pacific Ocean at 5 hours, 47 minutes after liftoff. It demonstrated one of the major objectives of the program, and also paved the way for Apollo Lunar Orbit Rendezvous in the accomplishment of the first manned landing on the Moon.

Gemini 6 was launched on its historic rendezvous mission on the third attempt. On the first try, Oct. 25, the Agena Target Vehicle was destroyed by a hard start of its primary propulsion system. On Dec. 12, the Gemini Launch Vehicle failed to liftoff when an electrical plug connecting the rocket with the pad electrical system dropped out prematurely.

Gemini 8, March 16, 1966

Astronaut Neil Armstrong, Command Pilot, and David Scott, Pilot, completed the first rendezvous and docking with an Agena spacecraft launched into orbit approximately 100 minutes earlier. The planned three-day flight was terminated near the end of the seventh revolution after an electrical short circuit in the Gemini spacecraft caused continuous firing of a roll thruster. The crew undocked from the Agena and activated the reentry reaction control system to regain control of the spacecraft. The crew made a guided reentry and landed in the Pacific Ocean 500 miles east of the island of Okinawa, and only approximately five miles from the aiming point. A recovery aircraft was on the scene before splashdown to parachute a recovery team to the spacecraft. The crew and spacecraft were picked up by a Navy destroyer approximately three hours after splashdown.

Gemini 9, June 3-6, 1966

Three separate rendezvous with the Augmented Target Docking Adapter and a two-hour and 10-minute extravehicular activity were the primary accomplishments of the seventh manned Gemini flight. Col. Thomas P. Stafford, a veteran of the first US rendezvous mission in Gemini 6, was command pilot for the three-day flight. Eugene Cernan was pilot and performed the EVA. The flight, originally scheduled for May 17, was postponed two weeks when the Atlas booster which was launching the Agena Target Vehicle developed an electrical short circuit which caused its engines to gimbal hard over and abort the flight. The ATDA was substituted for the Agena and was launched on June 1. Gemini 9 did not launch on June 1 when a malfunction in the computer transmitting data to the spacecraft caused an automatic hold at T-3 minutes. Gemini 9 was launched two days later, and although the shroud had failed to separate from the ATDA which prevented any docking exercises, an initial third orbit rendezvous was achieved, followed by an equi-period rendezvous, and a lunar abort or rendezvous from above on the following day. The EVA was postponed one day because of crew fatigue. Cernan spent more than one orbit outside the spacecraft before visor fogging in his helmet forced termination of the EVA before the Astronaut Maneuvering Unit experiment could be performed. Gemini 9 made the most accurate landing to date in the program, splashing down approximately three and one half miles from the recovery carrier in the West Atlantic after 44 revolutions of the Earth.

U.S. MANNED SPACE FLIGHTS

MISSION	SPACECRAFT HRS.			REVS.	MANNED HOURS IN MISSION			TOTAL MANNED HRS. CUMULATIVE		
	HRS.	MIN.	SEC.		HRS.	MIN.	SEC.	HRS.	MIN.	SEC.
MR-3 (Shepard)		15	22	SO		15	22		15	22
MR-4 (Grissom)		15	37	SO		15	37		30	59
MA-6 (Glenn)	4	55	23	3	4	55	23	5	26	22
MA-7 (Carpenter)	4	56	05	3	4	56	05	10	22	27
MA-8 (Schirra)	9	13	11	6	9	13	11	19	35	38
MA-9 (Cooper)	34	19	49	22	34	19	49	53	55	27
Gemini 3 (Grissom & Young)	4	53	00	3	9	46	00	63	41	27
Gemini 4 (McDivitt & White	97	56	11	62	195	52	22	259	33	49
Gemini 5 (Cooper & Conrad)	190	56	01	120	381	52	02	641	25	51
Gemini 7 (Borman & Lovell	330	35	13	206	661	10	26	1302	36	17
Gemini 6 (Schirra & Stafford)	25	51	24	15	51	42	48	1354	19	05
Gemini 8 (Armstrong & Scott	10	42	06	6.6	21	24	12	1375	43	17
Gemini 9 (Stafford & Cernan)	72	20	56	44	144	41	52	1520	25	09

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PROJECT OFFICIALS

Dr. George E. Mueller	Associate Administrator, Office of Manned Space Flight, NASA Headquarters; Acting Director, Gemini Program
John A. Edwards	Acting Deputy Director, Gemini Program, Office of Manned Space Flight, NASA Headquarters
William C. Schneider	Gemini 10 Mission Director, Deputy Director, Mission Operations, Office of Manned Space Flight, NASA Headquarters
Dr. Robert R. Gilruth	Director, NASA Manned Spacecraft Center, Houston, Texas
Charles W. Mathews	Gemini Program Manager, Manned Spacecraft Center, Houston
Christopher C. Kraft	Assistant Director for Flight Operations, Manned Spacecraft Center, Houston
Dr. Kurt H. Debus	Director, John F. Kennedy Space Center, NASA, Kennedy Space Center, Florida
G. Merritt Preston	Deputy Mission Director for Launch Operations, John F. Kennedy Space Center, NASA, Kennedy Space Center, Florida
Lt. Gen. Leighton I. Davis	USAF, National Range Division, Command and DOD Manager of Manned Space Flight Support Operations
Maj. Gen. V. G. Huston	USAF, Deputy DOD Manager of Manned Space Flight Support Operations; Commander of Air Force Eastern Test Range
Col. Robert R. Hull	USAF, Director, Directorate, Gemini Launch Vehicles, Space Systems Division, Air Force Systems Command
Col. Otto C. Ledford	USAF, Commander 6555th Aerospace Test Wing, Space Systems Division at Air Force Eastern Test Range

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Col. John G. Albert	USAF, Chief, Gemini Launch Division, 6555th Aerospace Test Wing, Space Systems Division at Air Force Eastern Test Range
Lt. Col. L. E. Allen, Jr.	USAF, Chief, Atlas Division, 6555th Aerospace Test Wing, Space Systems Division at Air Force Eastern Test Range
R. Adm. William C. Abhau	USN, Commander Task Force 140 Primary Recovery Area
R. Adm. William P. Mack	USN, Commander Task Force 140.3 Onboard prime recovery carrier
R. Adm. Henry S. Persons	USN, Commander Task Force 130 Pacific Recovery Area

SPACECRAFT CONTRACTORS

McDonnell Aircraft Corp., St. Louis, Mo., is prime contractor for the Gemini spacecraft. Others include:

AIResearch Manufacturing Co. Los Angeles, Calif.	Environmental Control System
IBM Federal Systems Division Electronic Systems Center Owego, N. Y.	Onboard Computer
General Electric Co. West Lynn, Mass	Fuel Cells
The Eagle Pitcher Co. Joplin, Mo.	Batteries
Northrop Corp. Newbury Park, Calif.	Parachutes
Rocketdyne Division, North American Aviation, Inc. Canoga Park, Calif.	OAMS, RCS
Thiokol Chemical Corp. Elkton, Md.	Retrorocket System
Weber Aircraft Corp. Burbank, Calif.	Ejection Seats
Westinghouse Electric Corp. Baltimore, Md.	Rendezvous Radar System

Atlas contractors include:

General Dynamics, Convair Div. San Diego, Calif.	Airframe and Systems Integration
Rocketdyne Div., North American Aviation, Inc., Canoga Park, Calif.	Propulsion Systems
General Electric Co. Syracuse, N. Y.	Guidance

Titan II contractors include:

Martin Co., Baltimore Div., Baltimore, Md.	Airframe and Systems Integration
Aerojet-General Corp. Sacramento, Calif.	Propulsion System
General Electric Co. Syracuse, N. Y.	Radio Command Guidance System
Burroughs Corp. Paoli, Pa.	Ground Guidance Computer
Aerospace Corp. El Segundo, Calif.	Systems Engineering and Technical Direction

Agena D contractors include:

Lockheed Missiles and Space Co. Sunnyvale, Calif.	Airframe and Systems Integration
Bell Aerosystems Co. Niagara Falls, N. Y.	Propulsion Systems
McDonnell Aircraft Corp. St. Louis, Mo.	Target Docking Adapter

Food contractors:

U. S. Army Laboratories Natick, Mass.	Food Formulation Concept
Whirlpool Corp. St. Joseph, Mich.	Procurement, Processing, Packaging
Swift and Co., Chicago Pillsbury Co., Minneapolis	Principal Food Contractors

Suit contractor:

The David R. Clark Co.
Worcester, Mass

ABBREVIATIONS AND SYMBOLS FREQUENTLY USED

AMU	Astronaut Maneuvering Unit
ASCO	Auxiliary Sustainer Cut Off
CGLVTC	Chief Gemini Launch Vehicle Test Conductor
ECS	Environmental Control System
ETR	Eastern Test Range
EVA	Extravehicular Activity
ELSS	Extravehicular Life Support System
FLT	Flight Director (Houston)
GAATV	Gemini Atlas Agena target vehicle
GATV	Gemini Agena target vehicle
GEN	General information
GLV	Gemini launch vehicle
GN2	Gaseous Nitrogen
GT	Gemini Titan
IMU	Inertial measuring unit
IRFNA	Inhibited Red Fuming Nitric Acid
LC (14)	Launch Conductor - Complex 14
LD (14)	Launch Director - Complex 14
LD (19)	Launch Director - Complex 19
LMD	Launch Mission Director

LN2	Liquid Nitrogen
LO2	Liquid Oxygen
LTC	Lockheed Test Conductor
MCC	Mission Control Center (Defined with the word Houston or Cape)
MD	Mission Director (Houston)
OAMS	Orbit Attitude Maneuvering System
PCM	Pulse Code Modulation
S/C	(Gemini) spacecraft
SPCFT	Chief Spacecraft test conductor
SLD	Simultaneous Launch Demonstration
SLV	Standard (Atlas) launch vehicle
STC	SLV test conductor
SRO	Superintendent of range operations
TDA	Target docking adapter
UDMH	Unsymmetrical Dimethlhydrazine

Approximate Times of Major Events
In Nominal Gemini 10 Mission

GET Hours	Event
00	Launch
01	
	Synoptic terrain photos (S-5)
02	
03	
04	
05	Rendezvous with Agena 10
06	First dock, bending mode check
07	
	Dual rendezvous height adjust.(PPS)
08	Eat period
	Dual rend. height adjust. (PPS)
	End eat period
09	Begin sleep period
10	
11	
12	

GET Hours	Event
13	
14	
15	
16	
17	End sleep period
18	
19	
	Dual rendezvous plate change
	Undock
	Ion wake experiment (S-26)
20	Dock
	Undock
	Ion wake Experiment (S-26)
	Dock
21	
	Dual rendezvous height adjust.
22	Undock, dual rendezvous co-elliptical
	Ion wake experiment
23	Begin stand-up EVA (S-13)
	Color patch photography
	Synoptic weather (S-6) and terrain photos
24	End stand-up EVA
	Begin eat period
25	
	End eat period
	Landmark contrast experiment (MSC-12)
	Synoptic terrain photo (S05) as possible

GET Hours	Event
26	
	Star occultation nav (D-5)
	Synoptic weather photo (S-6)
27	
	Landmark contrast (MSC-12)
	Star occultation nav (D-5)
28	
	Synoptic weather (S 6)
29	Synoptic weather (S-6)
	Star occultation nav (D-5)
30	Begin eat period
	Synoptic weather (S-6)
31	End eat period
	Begin sleep period
32	
33	
34	
35	
36	
37	
38	

GET Hours	Event
39	End sleep period, begin eat period
40	End eat period
	Dual rendezvous height adjust.
41	Dual rend. catch-up adjust
	Landmark contrast (MSC-12)
	Star occultation nav (D-5)
42	
43	
44	
	Begin eat period
45	
	End eat period
46	
47	
	Dual rendezvous
48	
	Umbilical EVA
	Evaluate extravehicular life support
	system, hand-held maneuvering unit,
49	retrieve S-12, S-10 experiments
	End umbilical EVA
50	
	Open hatch, jettison equipment
51	
	Begin eat period

GET Hours	Event
52	
	End eat period
	Zodiacal light photo (S-1)
53	Ion sensing attitude cont (D-10)
54	Begin sleep period
55	
56	
57	
58	
59	
60	
61	
62	End sleep, begin eat period
63	End eat period
	Ion sensing attitude cont. (D-10)
64	

GET Hours	Event
65	
66	
67	Begin eat period
	End eat period
68	
69	
	Retrofire (69:44)
70	
	Landing (70:17)
71	
72	
73	
74	
75	
76	
77	

LOCAL TIME A.M.	LOCAL TIME P.M.
12:00	12:00
01	01
02	02
03	03
04	04
05	05
06	06
07	07
08	08
09	09
10	10
11	11
12	12

NOTE: Clip the time scales at left and slide them along the scales showing the approximate ground elapsed time of a nominal mission. Place the local time of liftoff opposite the 00 on the GET scale and you will be able to read off the approximate local times of major events.

-end-