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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION



# PROJECT GEMINI [U]

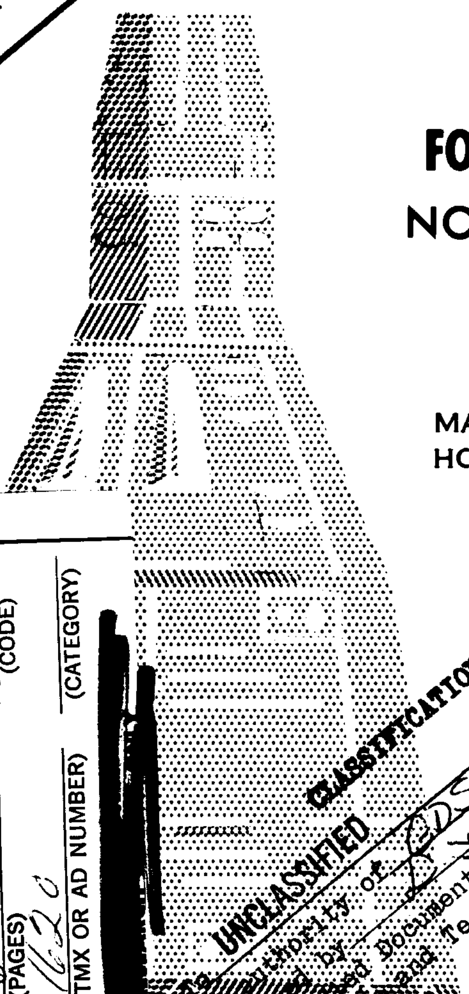
## QUARTERLY STATUS REPORT

NO. 11

## FOR PERIOD ENDING

NOVEMBER 30, 1964

(U)



MANNED SPACECRAFT CENTER
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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION [U]

GEMINI SPACECRAFT PROGRAM

QUARTERLY STATUS REPORT NO. 11

for

PERIOD ENDING NOVEMBER 30, 1964

By Manned Spacecraft Center

## INTRODUCTION

This status report is the eleventh in a series of reports for the second NASA Manned Spacecraft Program Gemini. The reporting period is from August 31, 1964 to November 30, 1964.

## SUMMARY


The major accomplishments of the Gemini spacecraft program during this period are:

Spacecraft 2 was delivered to Cape Kennedy September 21, 1964; Spacecraft 3 is in the final stages of manufacture, Spacecraft 3A completed basic manufacture; cabin section for Spacecraft 4 began modular systems tests; Spacecraft 5 and 6 are being assembled in the white room; Spacecraft 7 is ready to be moved into the white room; and, Spacecraft 8, 9, and 10 are being structurally assembled.

Configurations of Spacecraft 5 and 6 were changed. Weight for the 2-day mission was increased 267 pounds; 14-day mission was increased 31 pounds.

The heat shield for Spacecraft 6 is nearly complete; heat shields for Spacecraft 7 and 8 are in early stages of fabrication.

Modifications to Gemini Launch Vehicle (GLV) No. 3 and subsequent GLV will be made at Baltimore, Maryland before the vehicles are shipped to the Eastern Test Range (ETR); manufacture of GLV No. 4 and subsequent vehicles is on schedule.


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Engines GLV-1006, 2006, 1007, and 2008 were delivered; problems of the malfunction detection thrust chamber pressure switch are solved.

The status for Gemini Launch Vehicles are: GLV-3 in storage; GLV-4 subjected to Subsystems Functional Verification Tests; GLV-5 in horizontal assembly; and GLV-6 in storage.

Examples of tests conducted during this period were tests for the fuel cell, high altitude drogue parachute, environmental control system, and the acquisition aid beacon.

Spacecraft crew training consisted of monitoring and participating in tests of spacecraft; training with the Gemini mission simulator, Gemini part task trainer, and translation and docking trainer; egress, planetarium, parachute, water survival, weightless flight, and centrifuge training.

Tests and deliveries for the Atlas Agena program are on schedule or ahead of schedule.

Spare parts deliveries for Spacecraft 3 and subsequent spacecraft are 88 percent complete; two backup suppliers are being used, or are being considered as suppliers of pyrotechnics; and an incentives contract agreement was reached with McDonnell Aircraft Corporation (MAC).

## MANUFACTURING

### SPACECRAFT

Spacecraft 2 was delivered to Cape Kennedy on September 21, 1964 and was prelaunch tested. The launch is scheduled for the month of December.

Spacecraft 3 is in the final stages of manufacture. After manufacture, the spacecraft will be subjected to simulated flight tests. Delivery of the spacecraft to Cape Kennedy is expected during the latter part of December.

The basic manufacturing of Spacecraft 3A was completed October 15, 1964 and the spacecraft was sent to the laboratory for thermal balance testing. Instruments are being installed and confidence checks are being made. Spacecraft acceptance review is scheduled for December 4, 1964. The first thermal balance test is scheduled for mid-December.

The manufacture of Target Docking Adapter No. 1 was completed and the adapter subjected to a partial system test. On October 16, 1964 the adapter was shipped to Lockheed Missile and Space Company (LMSC) to be used in the hot-fire testing.

Tests on the Spacecraft 4 cabin section modular space systems began November 30, 1964. The adapter module, reentry control system, (RCS) and reentry and recovery (R&R) sections are being manufactured. Spacecraft systems tests are scheduled to start approximately December 17, 1964. The RCS and R&R sections spacecraft systems are scheduled to begin tests at the end of December 1964.

Spacecraft 5 is being assembled in the white room. Examples of work being done include the installation of cabin environmental control system (ECS) and adapter coolant plumbing, water management system, foot and storage boxes, and the trial fitting of the shingles.

Spacecraft 6 is being assembled in the white room. Types of work are the installation of splash curtains, cabin and adapter coolant plumbing, cabin heat exchangers, and fabrication of wire bundles.

Spacecraft 7 is being prepared for moving into the white room. However, the move to the white room is dependent upon the removal of Spacecraft 3.

The Spacecraft 8 structure is being assembled. Assembly work includes installation of the environmental control system module support structures, coldplate and equipment doors, and fitting of conical Rene shingles.

Spacecraft 9 structure is bing assembled. Assembly work includes installation of the structure forward of the small pressure bulkhead, environmental control system module, and coldplates. The splice of the large pressure bulkhead has been completed and the hatch stations have been started.

Spacecraft 10 is in the early stages of structural assembly. The structure of Target Docking Adapter No. 2 has been mounted on the cone fixture for the installation of the external skins.

## GEMINI LAUNCH AND TARGET VEHICLES

Necessary modifications for Gemini Launch Vehicle 3 (GLV-3) are being made at Baltimore before GLV-3 is shipped to the Eastern Test

Range (ETR). To reduce the need for modifications at the ETR, modifications on the Gemini launch vehicles will be made at Baltimore, Maryland.

Manufacture of GLV-4 and subsequent vehicles is on schedule.

Systems test for Gemini Agena Target Vehicle 5001 was completed November 25, 1964. The vehicle was moved to Santa Cruz Test Base for hot-fire tests. After hot-fire tests, the vehicle will be returned to Sunnyvale for radio frequency test, system retest, and delivery to the Air Force.

The schedules for manufacturing and delivery of Atlas and Agena vehicles are being re-evaluated because of the revised Gemini launch and mission schedules. The re-evaluation should be completed by December 1964.

## CONFIGURATION AND WEIGHT

### Configuration

Configuration changes were made for Spacecraft 5 and 6. The configuration for all other spacecrafts remain essentially the same.

The changes to Spacecraft 5 are:

1. Addition of two 45-amp-hours batteries for the IGS, radar, and computer; the fuel cell will supply power to the remaining spacecraft systems

2. Deletion of one pump and power supply from each coolant loop

3. Addition of water tanks to supplement the water being produced by the fuel cell.

The changes to Spacecraft 6 are:

1. Deletion of the fuel cell

2. Addition of two 400-amp-hour batteries in the adapter equipment section for supplying spacecraft electrical power

3. Deletion of one pump and power supply from each coolant loop

4. Addition of water tanks to provide drinking water for the crew

5. Addition of extravehicular activity equipment.

Weights

Weight for the 2-day mission has increased from 7418 to 7685 pounds, an increase of 267 pounds. Weight for the 14-day mission has increased from 7505 to 7536 pounds, an increase of 31 pounds. Weight increases for the 2-day mission, Spacecraft 6, are caused by:

1. Equipment for extravehicular activity + 168 pounds

2. Batteries replacing fuel cells + 28 pounds

3. Additional scientific experiments + 38 pounds

4. Manufacturing variation from Spacecraft 3 weights + 28 pounds.

Weight increases for the 14-day mission, Spacecraft 7, are caused by:

1. Handles and stirrups on adapter for extravehicular activity + 21 pounds

2. Additional experiments + 48 pounds

3. Manufacturing variation from Spacecraft 3 weights + 28 pounds

4. Reduction in quantity of Orbital Attitude Maneuvering System (OAMS) propellant – 51 pounds

5. Remove weight allowance for vibration modification – 8 pounds.

STRUCTURE

Reentry heat was applied to the spacecraft structure. The target docking adapter stiffness was measured and the adapter dynamic response was measured and analyzed. Window temperature cycling at altitude and burst pressure tests were performed and pyrotechnic structural separations were made.

A reentry heating pulse to simulate reentry from an aborted mission was applied to the lower surface of the conical section September 14, and to the hatch area September 23, 1964. The shingle structure expansion and contraction were satisfactory and the redesigned flipper doors did not gap to excess. Data are being analyzed to confirm predictions of heat penetration into the internal structure during reentry.

The target docking adapter stiffness measurements were completed September 23, and the data were transmitted to Lockheed Aircraft Corporation October 6, 1964. The data shows the adapter to be stiffer than the previous estimation of the stiffness. The indication is that the first mode bending frequency for the configuration of the docked spacecraft-Agena is about 3 cps. Lockheed Aircraft Corporation is studying these data. However, for complete evaluation of the orbital maneuvering dynamics and control, Lockheed Aircraft Corporation needs damping and frequency data from the MAC Gemini-Agena dynamic response test. The MAC Gemini-Agena dynamic response test is scheduled for January 1965.

Adapter dynamic response measurements were completed August 27, 1964. These response measurements were used to compute flight dynamic response of the structure, and to determine the subsequent critical stresses. Ten shell modes of the adapter were isolated in the 113.4 to 251.9 cps frequency band. Eight local modes of the environmental control system pumping system were isolated in the 43.0 to 95.6 cps frequency band. Damping was higher for the shell modes than for the local modes. Some shell modes had a ratio of 5 percent, but the most highly damped local mode had a damping ratio of $2\frac{1}{2}$ percent. After analyzing various conditions in the launch trajectory between 64 and 80 seconds after lift-off, MAC found the most critical condition to be 64 seconds after lift-off, Mach 1.0, a $4^{\circ}$ angle of attack, and the pump package on the leeward side. For this condition, the margin of safety is 68 percent.

Window temperature cycling at altitude and burst pressure tests were completed. The design leakage allowance for each hatch is 29.5 cc/min. The test indicated that window leakage was within the allowance for temperatures between $-74^{\circ}$ F and $+300^{\circ}$ F, which encompasses the anticipated orbital temperature range. The burst tests consisted of intentionally breaking the inner pane to test the pressure integrity of the center pane and to test the burst strength of the center and outer panes. All tests were satisfactory. The center pane exhibited a burst pressure strength of 24 psi versus an expected strength of 19 psi; the outer pane burst at 23 psi versus an expected break at 9 psi.

An intensive effort has been made to qualify the pyrotechnic structural separation devices at Z13, Z69, Z100, and Z192 for GT-2. Since the acceptance review for Spacecraft 2, 13 tests of these separation mechanisms have been made. Some problems were encountered and resolved, or are being resolved.

The "jaw bone" coolant tube cutter at Z69 failed to fire during the October 3, 1964, test. It was redesigned and functioned properly for three Z69 firings. The "jaw bone" coolant tube cutter was retrofitted on Spacecraft 2 at Cape Kennedy.

The Z100 firing test split the RTV 90 fairings in such a manner that one edge of the fairing was raised up from the fiberite ring. It is not known whether this is detrimental but it was decided that an attempt should be made to keep the edge of the fairing flat against the fiberite rings. However, there has been difficulty in obtaining a design that will work. Three tests were performed, each test used a different means for keeping the fairings down; but the tests were not successful. A fourth design is being fabricated and will be tested before it is used on Spacecraft 2.

### Heat Shield

Materials and testing.- Several firings of the pyrotechnic joint that separates the reentry module from the adapter were made. All the tests indicated the modification of the pyrotechnic joint prevents damage to the fiberite ring of the heat shield. The flight of GT-2 will be the final demonstration that the heat shield is qualifed for manned flight.

Manufacturing.- The shields for Spacecraft 7 and 8 are in the early stage of fabrication. The shield of Spacecraft 6 is scheduled for completion during January 1965. However, there are problems with the quality acceptance testing of the basic F-120 and pre-pregnated components of the fiber glass. A lack of strength was found in several lots and the reasons are now being studied. None of these lots have been built into heat shields. At the present time, the delay for completing the heat shield for Spacecraft 6 is not critical. This fiber glass problem should be solved during the next quarter.

## SOLID PROPELLANT ROCKET SYSTEMS

### Schedules

All qualification tests of motors, initiators, and pyrogens were completed. MAC has received the qualification test report and should have their review of the testing complete by the end of the next reporting period.

## Qualification Tests

All tests were completed as required with no anomalies reported that have not been discussed in previous reports. Upon completion of MAC review, NASA will review copies of the qualification test report. No further qualification test data will be presented in this report.

# LIQUID PROPELLANT ROCKET SYSTEMS

## Schedules

R and D Test Program.- Only miscellaneous component testing is being performed to investigate problem areas. Reaction Control System (RCS) system test unit S/N 004 was completed; RCS system test unit S/N 003 was delayed because of a test facility conflict with the Orbital Attitude Maneuvering System (OAMS) system S/N 003. Minor tests of the OAMS should complete testing on this unit by early December 1964, at which time this system will be removed from the altitude chamber and RCS S/N 003 will be installed. Tests of this system should be completed by February 1965. Tests on an R and D OAMS system built to the Spacecraft 6 configuration were eliminated.

Qualification Test Program.- Inadequate design of the propellant tank flanges caused failures, which with tank hardware unavailability will extend the completion of the component qualification program into May 1965. System qualification of both OAMS Spacecraft 2-5 configuration and RCS should be complete by February 1965. Testing of the OAMS Spacecraft 6 configuration will be delayed until there is a further clarification of the test program and hardware is available. Testing of the Spacecraft 4 configuration "B" package and Spacecraft 6 TCA component will extend into April 1965. Hardware unavailability of the OAMS 22-inch oxidizer tank has caused it to be the constraint upon completion of the Spacecraft 2 through 5 program. All other Spacecraft 2 through 5 qualification testing was initiated.

Reliability Test Program.- The program should be complete by May 1965 exclusive of tank testing. Rocketdyne supplied no schedule for the tank program, the initiation of which is dependent upon qualification completion. The only unapproved test procedure specifications are the four of five tank configurations. The undelivered hardware consists of three spare bladders; "E" package, and "B" package. Exclusive of tanks, the constraint upon the completion of this program has been hardware availability and the cause of some slippage during the last quarter.

Production Hardware Deliveries. - Spacecraft 3 and 3A OAMS and RCS deliveries were completed during this quarter. Undelivered equipment for Spacecraft 4 OAMS and RCS consists of all three "B" packages, two 22-inch OAMS fuel tanks, and all cartridges for delivery to Cape Kennedy. For Spacecraft 5 three "B" packages, two RCS fuel tanks, two 20-inch OAMS oxidizer tanks, two 22-inch OAMS fuel tanks, eleven RCS TCA three 25-pound OAMS TCA, and all cartridges are to be delivered. For Spacecraft 6, 30 of 62 items have been delivered and 7 of 62 pieces have been delivered for Spacecraft 7.

## Research and Development Test Program

Components and Thrust Chamber Assemblies. - All formal testing on the components and TCA is complete. Miscellaneous testing is continuing on hardware, which is a problem on an "as required" basis.

RCS Screening Tests. - A testing criteria has been established by which production RCS injectors can be accepted. Effectivity of the screening criteria is Spacecraft 8. The technique is similar to the 100-pound OAMS which employs a stainless steel chamber and throat fabricated to the same dimensions as production units. The acceptance criteria is based upon chamber wall burn through by the combustion gases within eight seconds of steady state operation.

Systems. -

RCS S/N 003: Acceleration testing is completed and the only remaining testing is skin heating tests at altitude.

RCS S/N 004: All testing is complete.

OAMS S/N 003: Tests conducted include manual regulation, fill-drain-clean procedures, and skin heating.

## Qualification Test Program

Components. -

"A" Package: Testing is complete for both units. The manual valve leakages discussed in the previous report resulted from a test procedure error, however, some hardware improvements were incorporated. During endurance testing of the pressure transducer the unit became inoperative because the Bourdon tube had a hole in it.

"B" Package: The two qualification units have been plagued with problems and further testing has been terminated. The check valves and relief valves, which were exposed to liquid fuel and oxidizer failed the leak tests. One of the functions of this package is the prevention of fuel and oxidizer from intermixing in the event a bladder ruptures. This test is not an overly servere test. The releif valve on Spacecraft 3 and 4 should be exposed to propellant vapors and some lesser amount of liquid due to condensation. If a burst diaphragm is ruptured the valves on subsequent spacecraft should be tested. The test requirements will be revised to incorporate concentrated propellant vapors, which will be temperature cycled throughout the temperature limits of $+15^{\circ}$ F to $+160^{\circ}$ F and no redesign will be performed. The revised testing will be picked up on the Spacecraft 4 configuration, which contains the redesigned burst diaphragm. However, satisfactory completion of testing on this package is now a constraint on Spacecraft 3.

"C" Package: Testing is complete on this unit. Manual valve difficulties were experienced similar to those on the "A" package.

"D" Package: Testing is complete with manual valve difficulties experienced as on the "A" package.

"E" Package: Testing is complete except for final disassembly and inspection. A major weld defect was revealed by activation of a cartridge valve. Consequently, changes to the weld are to be incorporated. Other problems encountered include manual valve leakage, high pressure switch activation at the low temperature range, and excessive contamination.

Propellant Tanks.- An inadequate tank flange design is being revealed by tests on almost all designs. The R and D program did not adequately investigate this potential problem and schedules are in jeopardy because of this and because the hardware has been delivered late. Currently, NASA does not have the OAMS 22-inch oxidizer tank, which will be flown on Spacecraft 3 and 4. Testing has been initiated on all other tanks. Flange leakage has not been observed on the OAMS 20-inch and 22-inch fuel tanks. However, the 22-inch fuel tank suffered a bladder leak after vibration which permitted over 40 pounds of fuel (25% of capacity) to be entrapped between the plys of the Teflon bladder. The fuel could not be expelled with the application of full system pressure of 295 psi.

Some design changes will have to be incorporated to prevent further flange leakage. Test procedures will be reviewed to establish if the bladder leakage occurred under a realistic set of conditions and a determination will be made if a redesign is required.

Pressurant Tanks. - All testing is complete.

Pressure Regulator. - Considerable problems are being encountered on this component. The two units in test are called type T-4 and are to be installed in Spacecraft 4 and subsequent spacecraft. The system qualification tests of the OAMS and RCS are to qualify the type T-2, which is installed on Spacecraft 3. Basically, the units are similar. The problems encountered with the T-4 are overpressurization during initial system pressurization, excessive regulator creep or internal leakage, and excessive external leakage. NASA has requested investigation of the application of pad pressures to the spacecraft systems prior to launch which,also, has other beneficial effects. This will eliminate design changes if satisfactorily incorporated and in addition, MAC and Rocketdyne are investigating other approaches.

Motor Shutoff Valve (MOSOV). - Testing of Unit 1 is complete and no failures were reported. Unit 2 failed vibration test and was replaced. Its replacement failed activation tests after oxidizer resistance testing was completed. This failure is being attributed to application of excessive grease, which prevented the micro-switch contacts from fully closing. The unit is to be repaired and the vibration tests are to be repeated. Testing of the unit will then continue as originally planned.

Pressure-Temperature Indicator. - Testing was initiated on this unit and completion of the test is scheduled for December 1964.

Cartridge. - All cartridge testing is complete and no problems were reported.

Cartridge Valves. - Cartridge valve testing is nearly complete with the exception of some vibration and low temperature altitude tests. Two failures were reported during leakage and dielectric strength tests. However, the failures do not appear to be serious because these failures appear to be more of a procedural problem.

TCA. -

RCS. - All testing is complete. Problems were experienced with the propellant valves after explosive atmosphere testing and with excessive skin temperatures after completion of mission duty cycle hot-firing tests. The excessive skin temperature is believed to be caused by the recirculation of exhaust gases in the Tri-Mod altitude facility.

OAMS. -

25-pound thrust TCA: All testing is complete except propellant compatibility testing with fuel and oxidizer, impulse signal width tests, and a mission duty cycle to guaranteed life.

85-pound thrust TCA: All testing is complete and a similar excessive skin temperature problem was experienced.

100-pound thrust TCA: All testing is complete. However, some failures were experienced with the propellant valves and with an inlet tube after vibration, which was reworked and retested.

Systems.-

RCS: The vibration testing is complete and the system is being prepared for hot-fire testing at altitude (CTL IV Cell 38). The major problem resulting from vibration was the failure of the "A" package pressure transducer, which failed leakage tests. Chamber pressure tube stubs, which are installed for test purposes only, cracked and were replaced. The major tests that remain are the altitude tests at temperature extremes.

In view of the difficulties encountered with servicing, deservicing, and cleaning of Spacecraft 2, it appears that some additional tests to explore these problems should be reinitiated.

OAMS modular vibration testing, without TCA installed, was completed with slightly excessive fuel bladder leakage occurring. Final assembly of the tank module to the adapter frame and TCA is complete and the system is now in acceptance testing. The major tests consist of mission duty cycles performed at 160° F which should be complete by the next report. Storage tests should also be added to investigate the system cleaning problem.

Additional Qualification Tests for Spacecraft 6 Components.- Due to TCA configuration change, tests will be conducted on the "B" package with burst diaphragms, burst diaphragms at a component level, OAMS 25-pound, 85-pound, and 100-pound thrust TCA and propellant valves, RCS 25-pound TCA and OAMS system. This was necessary to meet the Gemini life requirements, and due to "B" package problems. In addition, there shall probably be some additional propellant tank tests.

## Reliability Assurance Testing (RAT)

Reliability Assurance Testing (RAT) has commenced on almost all component assemblies and is progressing on schedule much better than the qualification test program and fewer failures are being encountered although test levels are more severe. With the exception of the "B" and "E" packages, 25-pound RCS TCA, and propellant tanks, all tests should be complete by the next report.

"A" Package - Complete except for disassembly and inspection

"B" Package - Spacecraft 4 configuration testing has not commenced due to hardware unavailability.

"E" Package - Testing has not commenced because hardware was unavailable.

Regulator - Functional checkout has been initiated.

25-pound Propellant Valve - Testing is complete.

100-pound Propellant Valve - Testing is complete.

25-pound RCS TCA - The unit is proceeding into vibration testing.

100-pound OAMS TCA - The unit is proceeding into vibration testing.

Motor Shutoff Valve (MOSOV) - The unit is being prepared for test.

Propellant Tanks - These tests are delayed pending completion of the qualification tests, thus a schedule is unavailable.

## Production Spacecraft

Spacecraft 2.- Considerable problems with the propellant valves have required a constant check of valve opening responses. This check is being performed every four days. Considerable problems were encountered in cleaning the system after exposure to propellants.

Spacecraft 3.- Modular and integrated systems tests are complete. Specification deviations were accepted on bladder leakage and propellant valve leakage for two TCA. The first introduction of propellant will be at Cape Kennedy prior to static firing. However, a suitable method to clean the system must be developed to prevent similar problems as were experienced with Spacecraft 2.

## AGE

This effort is almost complete except for some minor rework and a new order for some additional spares that are needed to bring all units to a fully operational status.

## PYROTECHNICS

Quality control procedures at Ordnance Associates have been brought within acceptable levels by the efforts of the prime contractors and NASA. However, production still is not at a satisfactory rate. MAC is currently assisting Ordnance Associates by producing some of the metal parts. Backup efforts to procure cartridges for Ordnance Associates devices were initiated with Central Technology Incorporated and the Naval Ordnance Plant at Macon, Georgia. Qualification of seat devices will be performed by Weber Aircraft Corporation. Northrup Corporation's Ventura Division has also initiated procurement of pyrotechnics for the landing system from other suppliers.

The previously reported design modification, staking of the support disc, to preclude vibration breaking of the bridge wires in Ordnance Associates initiators proved to be detrimental rather than beneficial. To meet the earliest possible Spacecraft 2 flight date, it was decided to use available dual bridge wire cartridges in all Ordnance Associates devices. Jumper bundles were fabricated for Spacecraft 2 to supply power to all bridge wires. The bridge wire problem was caused by poor welding techniques as well as the increased stresses induced by disc staking.

Although qualification of all pyrotechnaics is required prior to the flight of Spacecraft 3, this constraint has not been placed on Spacecraft 2. Acceptance of all Ordnance Associates cartridges includes specification vibration and conditioning at $130^\circ$ F for 30 minutes. Bridge wire resistance readings and dielectric testing were performed before and after each of these conditionings. In addition, lot sampling tests included conditioning at $200^\circ$ F for 30 minutes followed by the no-fire and all-fire tests. Selection of cartridges for Spacecraft 3 and up will await completion of the qualification programs at Ordnance Associates and the backup sources of supply.

Failure to initiate one of the test Z70 tubing cutters has led to redesign of the tube of that assembly. Only one explosive interconnect Mild Detonating Fuse (MDF) line will be used. The detonator block was redesigned to accept an electrical detonator and the single interconnects. The redundant tubing cutter shaped charge strands will now be independently end ignited.

In qualification testing of the catapult rocket, its thrust was approximately 5 percent above specification levels. However, attenuation through the seat-man mass brought its acceleration within acceptable levels.

Switches delivered for flight usage continue to have high contact resistances. Modified design approaches have been initiated.

Failure to ignite a harness release actuator has led to utilization of PA101 instead of M42 primers. The mix used in the PA101 is less subject to aging.

Tests were performed by MAC to determine the vulnerability of Gemini pyrotechnics to electromagnetic radiation. Analyses of these tests indicated a minimum of 28 dB attenuation of the power reaching the critical devices.

## FUEL CELL

Two section-life tests were performed. The coolant inlet temperature for both tests was $75^{\circ}$ F.

The first section, 1516, simulated a rendezvous evaluation pod mission, followed by a powered-down parking orbit. The flight portion of the test was preceded by simulation of limited prelaunch spacecraft systems testing. Throughout the test, peak loads were limited to 28.5A per section at 24V to simulate use of batteries to supply guidance and control power. The life of 1516 was over 1100 hours on load.

The second section, 1519, simulated a rendezvous evaluation pod, followed by full parking orbit loads. The flight portion of the test as well as the simulated prelaunch spacecraft systems tests was based upon best estimates of maximum expected fuel cell loads without using the spacecraft batteries. Section 1519 lasted over 800 hours on load. Both sections showed a gradual decay in performance at parking orbit loads and failed shortly after a repeat of rendezvous load levels was attempted.

The encouraging results of sections 1516 and 1519 were amplified by test results of individual stacks. These stack tests covered various load and coolant conditions at normal and overstress levels. However, the life test results were clouded by other problem areas.

The water produced by the fuel cells continues to be considered unacceptable as an exclusive source of drinking water for long-term use. Acidity odor, color, taste, organic, and total solids were out of limit of the specifications. Efforts to bring all of these characteristics within acceptable limits by passing the water through ion-exchange resins were partially successful. To preclude the clogging of fliters by fungi growing in the water during storage of the sections the water valve filters will be removed in future production sections.

To prevent clogging of other water line components, it is expected that larger area filters will be used as part of the ion-exchange assembly.

During the hydrogen purge operation, evaporation of water was leaving a deposit of organic chemicals on the valve seats, which eventually resulted in sticking valves. Redesign of the valves is expected to overcome this problem. However, procurement of the redesigned valves has delayed section production.

Additional production delays have been caused by operator error in testing, aerospace ground equipment (AGE) design, and leaking plumbing within the section container. P-3 sections have been produced for testing in power systems, temperature-vacuum, dynamic qualification, and additional development tests of repeated rendezvous load profile and storage degradation.

Determination of the ability of the fuel cells to withstand long-term storage is being done at the section and stack levels. Section tests will be performed on a real time basis including simulated Spacecraft 5 load profiles. At the stack level, life tests will be periodically performed on cold stored stacks as well as control stacks for comparison of cold storage effectiveness. Revised startup and shutdown procedures are expected to reduce prelaunch degradation of the fuel cells.

## LANDING AND RECOVERY SYSTEMS

### Gemini Water Suitability Program

After the hardware was reviewed, Static Article No. 5 was reassembled September 9, 1964. The weighing and balancing, fresh water tank checkout, and drying of the vehicle in the pressure chamber were completed September 16, 1964. Final system checkouts aboard the NASA motor vehicle "Retriever" were completed. A favorable sea for conducting test was predicted for the week of September 28, 1964.

The manned at-sea tests were conducted September 30 and October 1, 1964 in the gulf of Mexico. Waves during the tests ranged from 3 to 5 feet in height and James A. Lovell and Alan L. Bean were the astronauts in the sea test vehicle. The spacecraft post-landing systems performed satisfactorily. However, there was difficulty in maintaining adequate crew comfort for the astronauts while wearing the Gemini pressure suits during the first 3 hours. Removal of the suits improved the comfort level of the test subjects, but, the heat and humidity levels in the cabin were high. The test was stopped after 17 hours because of the approach of hurricane Hilda.

The post-test inspection of the vehicle was held at Ellington Air Force Base on October 2, 1964, and debriefing of the test results on October 5, 1964.

An at-sea test to determine if opening the hatch would alleviate the heat and humidity problem was conducted November 13, 1964. The opening of the hatch to an intermediate position lowered the temperature in the cabin and improved the comfort level of the test subjects.

An at-sea test to demonstrate the water egress procedure was conducted November 16, 1964. The astronauts were able to egress through the left hatch in the prescribed manner. It is significant to note that as the astronaut egressed, he was able to close and latch the hatch. This would allow recovery of the reentry vehicle in the event the crew had to evacuate because of propellant fumes and the vehicle was not taking on water.

## Spacecraft 2 Postflight Evaluation

A meeting was held at MSC on October 27, 1964 between representatives from Cape Kennedy and MSC. Cape Kennedy SEDR F498-2 "Project Gemini Postflight Evaluation – Spacecraft 2" and the MSC evaluation requirements were reviewed. The revised SEDR F498-2 was submitted to the Gemini Program Office on November 10, 1964.

## Parachute Recovery System

Static Article No. 7 and No. 4A are at the El Centro, California test site. Preparations for testing the recovery system using the high altitude drogue is complete for Static Article No. 7, except for the drogue parachute riser cable guillotine cartridges. The first drop for the series of tests will be completed within a few days after receiving the riser cable guillotine cartridges. Preparations for testing Static Article No. 4A are proceeding. Static Article No. 4A will be used for drop No. 2.

The high altitude drogue development program completed seven tests. These tests make a total of 15 tests conducted. The reefing ratio was reduced to 43 percent of 8.3 $D_o$. This was done to reduce the opening shock loads to acceptable limits when the spacecraft is exposed to the maximum dynamic pressure expected during an abort. These tests have shown that a 43 percent reefing ratio will limit the reefed opening shock loads and the disreef opening shock load to acceptable limits. This is considered the final drogue configuration and is now qualified for complete system testing.

## EJECTION SEAT SYSTEM

The delivery rate of pyrotechnics governs the speed of the ejection seat qualification program. Two ejection tests, tower drops of the harness, and six parachute drops of a dummy from a helicopter were completed. One of the ejection tests was from a rocket sled. The second ejection test was from an F-106 airplane while the airplane was on the ground.

### Sled Test

Sled ejection test No. 8 was completed at China Lake, California, November 5, 1964. The test was made to simulate abort during maximum dynamic pressure (q) conditions. Two dummies, 15 and 75 percentile, were ejected at a $q$ of 940 psf. The feet of the 75 percentile dummy (left seat) came out of the stirrups and caused the seat to pitch over and yaw to the left. The left side panel became overloaded and structurally failed. The panel, which is the mounting location of the harness release actuator broke off and seat/dummy separation never occurred. The seat with the 15 percentile dummy (right seat) performed as designed and the seat and dummy were recovered.

The structural design deficiency uncovered during the test has been corrected. A new foot stirrup design was completed and separation tests were conducted at Weber Aircraft Corporation. The two changes will be incorporated prior to sled test No. 9, which will be made at $15^{\circ}$ yaw and a dynamic pressure of 820 psf.

### Parachute Deflation Pockets

A decision was made to study the effect of installing deflation pockets on the personnel recovery parachute. The pockets consist of nylon panels sewn across the radial seams on alternate gores around the exterior surface of the canopy skirt. The opening in the pocket faces the parachute apex so they trap water and will automatically collapse the canopy on water impact.

A test program consisting of six dummy drops was conducted at the Naval Parachute Facility at El Centro, California, from November 9 to November 17, 1964. The tests were conducted under conditions which simulated dynamic pressures encountered during an off-the-pad abort. The tests duplicated previous tests conducted without pockets in order to compare parachute opening times.

Parachute opening times obtained from these tests show an increase of 1 to 3 seconds when compared with opening times without pockets. Present limitations of horizontal distance from the launch vehicle and height above ground level at parachute full open during an off-the-pad abort show that the increase in parachute opening time is not acceptable. The deflation pockets will not be used.

### High Altitude Ejection Tests

The static ground level ejection test was completed at the Naval Parachute Test Facility at El Centro, California, October 15, 1964. The purpose of the test was to prove escape system and aircraft compatibility in preparation for the airborne tests. All test objectives were successful.

The two airborne tests are scheduled for the weeks of January 4 and January 11, 1965. Pyrotechnics should be available for the tests during the weeks of January 4 and January 11, 1965.

## ENVIRONMENTAL CONTROL SYSTEM

Qualification testing is nearly complete and reliability testing has started at AiResearch. Minor failures have delayed completion of the qualification tests. Qualification testing required to support Spacecraft 3 is considered to be complete.

Manned altitude chamber tests on Spacecraft 3, SEDR H 383-3, were conducted on November 16, 17, and 18, 1964. The ECS operated satisfactorily and provided adequate cooling for the crew during the tests.

### $CO_2$ Sensor

Consideration is being given to changing the radioactive source material from Tritium to Americium 241. Development testing has shown Americium will reduce the pressure sensitivity of the sensor to within the ±2 mm Hg specification requirement.

[redacted]

## GEMINI SPACE SUIT

The primary space suits for both GT-3 flight crews were checked out satisfactorily during the manned altitude chamber tests of Spacecraft 3 November 15, 17, 18, and 19, 1964. No significant suit problems occurred in these tests. Interim pre-installation acceptance tests, (PIA) procedures will be finalized on the basis of the tests conducted in St. Louis. Flight crew suiting procedures were validated, and representative time schedules were established.

Procedures for flight crew suiting and spacecraft ingress were practiced during the Wet Mock Simulated Launch of Spacecraft 2 at Cape Kennedy on November 24, 1964. The primary GT-3 flight crew donned training suits and full biomedical instrumentation. The crew was assisted by the space suit bioinstrumentation and aeromedical personnel who are to participate in the GT-3 launch operation. As a result of this practice operation, it was established that all physical examinations, bioinstrumentation sensoring, and suit donning would be done in the Pilots' Ready Room at Complex 16.

One set of the space suit AGE of two sets fabricated by the NASA Manned Spacecraft Center Technical Services Division was installed in St. Louis, and the other set was installed in the Pilots' Ready Room at Cape Kennedy. This AGE is now operational.

An incentive contract for the remaining flight suits was awarded to the David Clark Company. This contract covers the procurement of G3C or G4C space suits for Spacecraft 5 through 12.

## EXTRAVEHICULAR OPERATION

Progress was made in the detailed design of the extravehicular life support system (ELSS). The mounting attachments and stowage provisions for the chest pack have been defined. The umbilical design and performance requirements have been established. Oxygen flow rates through the umbilical have been optimized for thermal considerations at 7.8 lb/hr normal and 13.5 lb/hr emergency. An Interface Specification Control Document (ISCD-3) is being prepared to describe and formalize the ELSS/Spacecraft interface. The first qualification systems are scheduled for completion and delivery during January 1965.

McDonnell Aircraft Corporation was completing the zero gravity mock-up at the end of the reporting period in preparation for full-scale weightless tests which are to be conducted during January 1965.

[redacted]

The compatibility test unit (CTU) is being converted to a flight configuration crew station mock-up using realistic spacecraft seats, hatches, hatch sills, and actuators. The tests, to be conducted in the KC-135 aircraft at Wright-Patterson Air Force Base, will include evaluation and validation of extravehicular egress, ingress, hatch closing techniques, and chest pack and umbilical handling procedures.

The design of the extravehicular space suit has been defined. Micrometeoroid and thermal protection will be integrated in the outer cover layer of the suit. Prototypes of this outer cover layer have been evaluated with satisfactory results. A redundant pressure sealing closure made up of one sealing zipper and one structural zipper has been approved for prototype and qualification suits. The helmet over-visor design has been defined and prototypes are presently being manufactured. The prototype extravehicular space suit is scheduled for delivery during mid-January 1965 for use in the zero-gravity flight tests.

## CREW STATION INTEGRATION

A flight-crew inspection of the crew station stowage provisions for Spacecraft 4 was held at McDonnell Aircraft Corporation on September 2 and 3, 1964. The basic stowage concepts for long-duration missions were established and approved by the GT-3 and GT-4 flight crews. Most of the photographic equipment will be stowed in molded fiber glass containers which are designed to fit in the large center stowage box. These fiber glass containers have the advantage of being readily adaptable to objects of any shape. In addition, stowage flexibility is obtained without changing the configuration of the box or mounting structure. The actual stowage configuration for Spacecraft 4 is being modified slightly to include the stadimeter of experiment D-9, which was recently approved for this spacecraft. The same stowage concept will be used. Loose items not stowed in the center stowage box will be packed in individual canvas bags and packed in the side or aft food boxes.

An evaluation of the crew station stowage provisions for Spacecraft 5 is scheduled for mid-January 1965. Some delays have been encountered because of the lack of definition of photographic and experiment equipment configuration. Outline drawings on all items for stowage in Spacecraft 5 and 6 are being prepared.

The flight crew countdown for the wet mock simulated launch for GT-2 was prepared and published as Cape Kennedy SEDR 640-2. This SEDR will be used as the basis for the flight crew countdowns during the GT-3 wet mock simulated launch, simulated flight and launch countdown.

The Flight Crew Support Division, Crew Systems Division, and Cape Kennedy Medical Operations Office are supporting the preparation of the flight crew countdown.

## FOOD, WATER, AND WASTE SYSTEM

Several discrepancies in the food and waste system components were discovered during the zero gravity and GT-3 altitude chamber tests. The primary problems were leakage of the food bags, crumbling of the snack-type food, and excessive urine transfer times; these and other minor discrepancies are being corrected. A review of the fixes with the flight crew representatives indicates the corrective action is satisfactory. Flight food will be delivered in early January for flight crew evaluation and for use in training.

## GUIDANCE AND CONTROL SYSTEMS

The Spacecraft 2 Guidance and Control System (G&C) was subjected to a complete series of launch pad tests; Phase I and II SST testing was conducted on Spacecraft 3 G&C System; and Phase I SST testing was conducted on Spacecraft 4 G&C System. A review of this testing indicates that cabin testing (Phase I) of the G&C systems can be deleted. All testing that affects systems operations or determines accuracies is repeated during Phase II testing. This repeat of tests is due to the elapsed time between cabin and mated testing, work periods required to complete spacecraft assembly, and the addition of the Adapter Module and RCS section wires and components that must be exercised as a complete system with the cabin components. The elimination of Phase I testing reduces the testing time on flight hardware without reducing confidence in the systems. In the future, one series of detailed systems test followed by a combined systems simulated flight test will be conducted on the G&C systems after the mated spacecraft assembly and work periods have been completed. This should reduce the number of revalidation tests required. The majority of equipment malfunctions that have occurred in the G&C hardware have resulted from:

1. Operator error

2. AGE failure

3. Spacecraft installation design

4. Spacecraft common ground design, inadequate shields, and shield ground control

5. Component handling procedures at Cape Kennedy and MAC.

Steps have been and are being taken to reduce the problems in these areas, however, many problems still exist and a continued effort to improve the situation is required.

Engineering simulations are continuing to verify the G&C systems behavior with automatic and man-in-the-loop operations with emphasis on the reentry, orbit maneuvering, and insertion correction modes of operation. To determine the safest methods of operation, simulations have been conducted with a range of failure modes of thruster valves, control systems electronics, computer erroneous outputs, platform drifts, and attitude indicator failures, et cetera. Wind-tunnel testing at MAC has indicated effects of Reynolds number on moment forces, which would adversely affect the control systems dynamic performance and the spacecraft trim lift characteristics, would affect the performance of the reentry modes upon G&C commands. A review of these conditions indicates that the safest reentry technique is to use the rate command with each ring of RCS operation selected and that the present systems design provides adequate capability under practical circumstances to conduct insertions, adjusting, and orbit thrusting maneuvers. During the next reporting period, emphasis will be concentrated on rendezvous mode studies. Late in this quarter, the Mission Simulators became operational although many checks remain to confirm the validity of the spacecraft simulation; however, crew training on G&C systems in mission simulators is in progress.

Closed loop operation of the Mission Simulator, Mission Control Center (MCC) launch guidance monitoring, and Burrough/GE radio guidance was not attempted during this quarter. However, the required equipment has been brought to a status that debugging runs and operational status should be achieved in the next quarter.

Emphasis has been placed on preparing for postflight analysis of the G&C systems. An organization for system analysis was established and the required support material and computer programs are being developed.

## INERTIAL GUIDANCE SYSTEM (IGS)

During testing of Spacecraft 3 at MAC the computer output modules (ladder) supplying steering signals to the Gemini Launch Vehicle (GLV) were burned out. Failure analysis revealed that a high voltage low impedance (greater than one ampere of current) source had been applied across the computer outputs when the computer was turned off, causing the failure of the modules. The GLV simulator is the most probable source of these voltages since it is connected to the ladder output and testing on it was being conducted during the time the failure occurred. This is the second time that a flight computer has been damaged during spacecraft testing at MAC. Isolation resistors and protective devices are required in the Computer-AGE interface lines for the spacecraft productions testing at MAC and at Cape Kennedy. Isolation resistors were installed for electronic systems test unit and compatibility test unit testing at MAC and no failures occurred.

A number of computer malfunctions occurred during testing of the Spacecraft 2 IGS at MAC and at Cape Kennedy and during the Spacecraft 3 Phase I SST. During a special EEI test conducted at Cape Kennedy using a spacecraft simulator, IGS simulator, and the GLV, large transients appeared on the computer ladder output lines of the IGS simulator. The test setup was reviewed and determined to be different than the flight configuration, therefore, special tests were conducted on the Spacecraft-GLV in the mated configuration to determine the size and source of any transients on the computer ladder output interface lines. These tests indicated that the transients occurring during the Spacecraft-GLV mated configuration were smaller than one volt peak-to-peak and it was determined from IBM and MAC testing that the computer can tolerate greater than 8 volts without problems. This result indicated that no GLV-Spacecraft computer line filters were required. However, during these tests the computer signal return-to-chassis-ground signals were monitored and determined to be much larger than the MAC estimates; values of one to six volts were observed and recorded on scopes. The computer is designed to be highly insensitive to interface voltage transients. However, electrical noise between the signal return-to-chassis-ground can cause the memory read amplifiers to malfunction. The grounding arrangement in the spacecraft contains long common ground leads in many systems which allows significant noise pickup between computer chassis ground and signal return. As a result of these investigations, a grounding strip has been installed in Spacecraft 3 to connect the computer signal return to the spacecraft structure at the computer. Spacecraft 3 final simulated flight test at MAC was conducted satisfactorily with this configuration.

Using both Spacecraft 2 and 3 flight configuration power supplies, the IGS integration testing was completed on the spare flight system. The Spacecraft 4 IGS integration tests were, also, completed during this period. During the tests of the spare and Spacecraft 4 systems, design errors were found in the IMU status power supply, system electronics, and the IGS auxiliary computer power unit.

## Computer

Computer systems for Spacecraft 4, 5, 6, and a second spare have completed predelivery acceptance during this period. The qualification program is complete on the computer and the manual data insertion unit. The Incremental Velocity Indicator (IVI) is expected to complete tests by February 27, 1965. The computer operational program check has been completed. Math Flow 3 – Mode One and Math Flow 3 – Mode two for Spacecraft 3 and 4 and the Launch Pad Requirements Document were delivered.

## Inertial Measurement Unit

The inertial measurement unit (IMU) platform for Spacecraft 2 was removed during Cape Kennedy testing due to intermittent slip-ring operations. While testing at the vendor to confirm the fault and determine which segment of the rings were faulty, the failure disappeared. The suspected slip rings were removed and the failure analysis was conducted. The rings were tested for contamination, concentricity, alinement, and brush pressure and no significant defects were found. An improved slip ring wiping procedure was developed which provides monitoring of the operation of all slip-ring segments during the wiping as well as increasing the frequency and number of rotations during a wiping operation. Arrangements are being made to use these procedures during the testing operations.

The Qualification Test Unit No. 2 has completed acceleration testing; the unit was accelerated to 15g. During the early part of the testing, acceleration errors occurred which were traced to an incorrectly selected gain resistor used in the accelerometer preamplifier. When resistors are selected using the correct procedure, the unit performs within the required accuracies. Spacecraft 3 and subsequent spacecraft platforms will be retrofitted with the correct resistors.

During this period, the vibration testing was started twice and was interrupted each time due to failures of the stiffeners used to reduce resonant vibration amplification and rocking which causes excessive gyro drift. The bonding procedure for installing stiffeners has been improved and all platforms will be checked using a 1g sine sweep to confirm the resonant frequency of the gimbals with proper bonding of stiffeners. During this period, three IMU systems have been delivered.

## Control System

During testing at MAC, two major control systems problem areas were isolated. They are concerned with the attitude display group and the attitude and maneuver hand controllers. Attitude Display Group (ADG) units were removed from Spacecraft 2 and 3 after preinstallation tests were conducted and spacecraft testing was in progress. Integration testing of the ADG may be desirable to assure compatible system components and reduce rejections in spacecraft testing. Improved calibration fixtures and procedures are being developed for use with the hand controllers. Diodes were installed in the attitude hand controller leads to prevent sneak circuit operation of jets.

Attitude Control and Maneuvering Electronics.- Five attitude control and maneuvering electronics (ACME) systems were delivered between September 1 and November 30, 1964. Spacecraft testing of the ACME has indicated it is a highly reliable system.

Horizon Sensor.- The Qualification Test Unit No. 1 completed temperature, humidity, and salt spray tests. Five systems were delivered during this period. To increase the emissivity characteristics, MAC has directed the paint on the horizon sensor be changed to white. The paint supplied by MAC during testing flaked and exhibited unsatisfactory bonding characteristics. All units must be stripped and repainted with the new improved paint and will delay the availability of flight units.

During SST, the horizon sensor exhibited many unexplained unlock operations. A review of the spacecraft grounding, shield control design, and procedures revealed that engineering changes had not been incorporated in Spacecraft 2 and 3. These modifications have now been installed and will be tested during the next quarter. The handling procedures of units returned to the vendor have been defective which indicates the need for better quality control and inspection at MAC and Cape Kennedy. Procedures are being developed to improve this situation for handling of units.

## Radar Systems

The White Sands radar fly-over program to confirm dynamic tracking errors has been completed. A transponder was installed in an aircraft which was flown on fixed headings over a vertically bore-sighted radar. The radar and transponder performed reliably during the test. The data from the test are currently being evaluated to determine system accuracy.

Rendezvous Radar.- The radar for Spacecraft 5 was delivered December 15, 1964. The Qualification Unit completed temperature, EEI, and temperature-altitude tests. Qualification Unit No. 2 radar completed humidity testing during which the RF absorption material on the harp absorbed water. Testing has shown that the bore sight slippage produced is eliminated when the harp material is dried in an altitude chamber. At Cape Kennedy the humidity values are not considered a problem.

Transponder. - The Qualification Unit has completed humidity, salt fog, and explosion testing. The target docking adapter unit transponder was delivered in September 1964.

Rendezvous Evaluation Pod. - The first Rendezvous Evaluation Pod (REP) is scheduled for delivery during January 1965, and an environmental test qualification program has been established to be conducted on the second REP unit.

## RADAR TRANSPONDERS

Radar transponders that are using C- and S-bands continues to be unsatisfactory. A program is under way to procure improved transponders and delivery of the radar transponders will be later than expected. Delivery of the improved transponders is expected about February 1, 1965, and if the schedule permits, the transponders will be installed in Spacecraft 3.

## DIGITAL COMMAND SYSTEM

Cracked teflon insulation on one wire of a twisted shielded pair used in several places in the digital command system has been discovered. Effective with Spacecraft 3 all digital command systems will be reworked to replace this wire. At the same time a design change is being considered to correct a fault in the decoder. This change will require wiring changes at terminal boards and the effect on qualification status will have to be determined. The change will improve the worst case of the probability of accepting an improper command. The package for Spacecraft 3 is expected December 28, 1964.

## UHF RECOVERY BEACON

The design change for the recovery beacon voltage regulator is complete. Delivery of the regulator for Spacecraft 3 is expected December 11, 1964, and deliveries will be made as needed after December 11, 1964.

## ACQUISITION AID BEACON

Qualification testing was satisfactorily completed. Deliveries of equipment are normal.

## ANTENNA SYSTEMS

The latest configuration of UHF descent antenna and reentry stub will be effective for Spacecraft 3. The HF antenna on Spacecraft 3 will not be extended during orbit. Effective for Spacecraft 4, an additional HF antenna will be installed in the adapter. These changes were necessary because of thermal problems during reentry if the HF antenna failed to retract. Deliveries of equipment are satisfactory.

## TIME REFERENCE SYSTEM

Equipment deliveries are on schedule for the electronic and event timers. Systems tests are very satisfactory. The G.m.t. clock qualification test units failed. New units with design changes are being tested; the new unit design change tests should be completed by December 24, 1964, and the latest design will be flown on Spacecraft 3.

## VOICE COMMUNICATIONS

The transmitter-receiver failed the simulated mission test, which consists of temperature cycling at altitude for an extended period followed by cold water immersion. The cases leaked after immersion. The manufacturer designed a new case which is being tested. The new design, if successful will be effective with Spacecraft 3. Delivery of the astronaut's lightweight headset was delayed but delivery is expected during December 1964.

## INSTRUMENTATION SYSTEM

During the salt water immersion qualification test at Electro-Mechanical Research (EMR) water leaked into the Pulse Code Modulation (PCM) programer through the breather relief valve. The leaks were corrected, and the PCM programer successfully passed the salt water immersion test.

All components of the instrumentation system have successfully passed their qualification tests except Instrumentation Package No. 2, which failed the salt water immersion test. This test is scheduled to be rerun on December 20, 1964. Instrumentation Package No. 2, has passed all other portions of the qualification tests.

The telemetry transmitters completed the reliability overstress tests. The PCM recorder is being tested. PCM System 11 was acceptance tested, PIA tested, and installed in Spacecraft 4. PCM System 12, alocated as a Cape Kennedy spare, is being PIA tested by MAC at St. Louis. The last PCM telemetry ground checkout station arrived at the Manned Spacecraft Operations Building, MILA, November 7, 1964.

A meeting was held at MSC November 5, 1964, to discuss the results of tests conducted by MAC, EMR, RCA, and NASA-Goddard concerning the PCM tape playback loss of ground synchronization. The loss of synchronization is due to the combined effects of cumulative bit-to-bit bit jitter and the low transition density inherent in the dump format. The Gemini dump PCM format bilevel and bilevel pulse word locations will tend to give long strings, eight bits or more, of zeros since the predominant off position of these discretes are zeros. MAC will report to the NASA during December 1964 on action items requiring MAC, EMR, and RCA action.

The instrumentation system equipment delivery status for Spacecraft 3 through 5 is shown in table I.

## GENERAL ELECTRICAL HARDWARE

Continued efforts to qualify an umbilical for the reentry portion of the spacecraft have failed. The present effort involves injection molding refrasil. Spacecraft 2 and 3 will have a pyrotechnic switch added upstream of the umbilical to remove remaining hot pins in the umbilical.

The odors given off in the pressurized area by the etching solution residue left on the teflon wire from the connector potting process, will

TABLE I.- INSTRUMENTATION SYSTEM EQUIPMENT DELIVERY STATUS

Dates given are expected delivery dates

| Item | Spacecraft | | | |
|---|---|---|---|---|
| | 3 | 3A | 4 | 5 |
| Biomed DC-DC Converter | Received | Not required | Received | December 1964 |
| DC-DC Converter | Received | Received | Received | Received |
| Signal Conditioners | Received | Received | Received | December 1964 |
| Accelerometers | Received | Received | Received | Received |
| Pressure Transducers | Received | Received | Received | December 1964 |
| Temperature Sensors | Received | Received | Received | January 1965 |
| Transmitters | Received | Received | Received | Received |
| Tape Recorder | Received | Received | Received | December 1964 |
| PCM Multiplexer Encoder | Received | Received | Received | December 1964 |

be fixed. The fix will eliminate the problem and will be effective for Spacecraft 5 and subsequent spacecraft.

Cabin and suit circuit oxygen samples taken during the Spacecraft 3 unmanned altitude chamber test showed the highest concentrations of napthalene to be 0.34 p.p.m., which is considered safe. Therefore, this is not a problem in Spacecraft 3.

In Spacecraft 4, an odor absorber will be added to the suit loop to minimize any possible problem.

### BATTERIES

The time on the pad in a mated configuration is exceeding the activation stand period of the adapter mounted batteries. Therefore, a test is being conducted to determine the limitations of the batteries after a 30 day activation period.

### RELAY PANELS

Six critical relay panels on Spacecraft 3 passed the vibration tests. The other panels are similar to qualified Spacecraft 2 panels; therefore, all relay panels on Spacecraft 3 are considered to be flight worthy.

## LAUNCH VEHICLES

### GEMINI LAUNCH VEHICLES

The contamination investigation of the Stage I oxidizer tanks for vehicles 2, 3, 4, 5, and 6 was completed. All connections in the upper dome support trusses were removed so that chips and burrs could be removed. Contaminants found might possibly have been loosened when the oxidizer tanks were subjected to vibration but it is doubtful if any effect on the launch would have resulted.

Problems of the MDTCPS are considered to be solved. Test procedures have been revised to prevent simultaneous power application of the V-99 test set and vehicle power to the switch contacts.

To resist corrosion of the switch diaphragm a cleaning procedure was changed; dry nitrogen is blown over the switch for dry cleaning.

Intermittent operation of the command receivers resulted from an improper deviation of the command transmitter. A misinterpretation of program requirements caused a deviation in range signal of 105 KC. When this frequency was reduced to 69 KC, operation of the command receivers was normal.

An acceptable method of remotely adjusting the nitrogen charging gas in the oxidizer standpipe has been proposed by Martin/Baltimore. By eliminating the manual operation, the necessity for opening the oxidizer prevalves can be delayed to lift-off minus 5 minutes. This time improvement, from 155 minutes, eliminates the replacing of prevalves if a hold occurs before lift-off minus 5 minutes and shortens the time required to recycle. Previously, the prevalves were opened at lift-off minus 155 minutes. The remote adjustment for the nitrogen charging gas in the oxidizer standpipe will be effective for GLV-4 and subsequent launch vehicles.

## GLV-2 Status

Progress has been delayed by three incidents which occurred at Cape Kennedy during late August and early September 1964. The vehicle was subjected to at least a 36-volt potential during electrical storm on August 17, 1964. Then, the Florida coast was struck by hurricanes Cleo and Dora. The vehicle was erected after the threat of hurricane Ethel had passed.

Approximately 25 electrical components were replaced and the combined systems tests were completed on October 6, 1964. The GLV-2 design review was held at Space Systems Division in Los Angeles, California, November 2, 1964.

Mechanical mating of the spacecraft to the launch vehicle was completed November 5, 1964; electrical mating was completed November 9, 1964.

## GLV-3 Status

All modifications scheduled for installation at Baltimore were completed. Rerun of the combined systems tests were completed and the vehicle was removed from the Vertical Test Facility on October 12, 1964.

Final rollout inspection was conducted at Baltimore October 28, 1964, and the Space Systems Division was to have accepted the vehicle

November 10, 1964. However, acceptance was rescheduled for November 20, 1964. The delay is not expected to affect the delivery to Cape Kennedy because GLV-3 will be held in storage at Martin/Baltimore until the vehicle is needed.

### GLV-4 Status

The vehicle was completed in horizontal assembly and erected in the Vehicle Test Facility October 27, 1964. Power was turned on the vehicle November 4, 1964 and Subsystems Functional Verification Tests were made.

### GLV-5 Status

The GLV-5 is in horizontal assembly at Martin/Baltimore.

### GLV-6 Status

The GLV-6 is being held in storage at Martin/Baltimore and is scheduled for work in horizontal assembly December 6, 1964.

## PROPULSION SYSTEM

### Engine Status

Two sets of engines for the Gemini Launch Vehicles were delivered. The engine serial numbers and delivery dates are:

| | |
|---|---|
| GLV-1006 | October 2, 1964 |
| GLV-2006 | September 25, 1964 |
| GLV-1007 | October 30, 1964 |
| GLV-2008 | October 14, 1964 |

There were no major engine problems.

Aerojet General Corporation was directed to suspend work on engine 1008 and engines following 1008 for approximately 8 months. The suspension will allow the engine delivery schedule to coincide with the Gemini Stability Improvement Program (GEMSIP) and Augmented Engine Improvement Program (AEIP) programs.

## Augmented Engine Improvement Program (AEIP)

Work concerning the configuration decision of December 1 is proceeding on schedule. Because of unsatisfactory test results, Aerojet General Corporation has recommended the changes and tasks of the Stage I gearbox, dynamic seals, and turbine rotor be suspended and all further Stage I TPA testing be suspended. This recommendation and the previous elimination of the first stage redundant shutdown have lead to the additional Aerojet General Corporation recommendation of eliminating Stage I engine demonstration testing.

The Space Systems Division has combined the Stage II engine testing required under the AEIP and GEMSIP programs. As a result, the start of the AEIP Stage II engine demonstration has been rescheduled to March 1, 1965, from January 1, 1965 to accommodate the GEMSIP schedule. Testing is scheduled for completion May 31, 1965.

## Gemini Stability Improvement Program (GEMSIP)

The Air Force Span Systems Division (AFSSD) has redirected the GEMSIP program to parallel development and comparative testing of tip injecting and regeneratively cooled baffle systems. In addition, approximately 90 percent of the feed system improvement and all of the development research tasks have been suspended.

Fabrication and stability and performance testing of the two-baffle system will continue until January 31, 1965. On January 31, 1965 one of the two configurations will be committed for Gemini use. The engine tests will be combined with the AEIP program; tests will start March 1, 1965.

# GUIDANCE AND CONTROL SYSTEM

## Flight Control

Diodes susceptible to "gold flaking" and used in the critical circuits in the three axis reference system (TARS) and autopilot have been replaced with improved diodes. This change is effective for GLV-3 and subsequent launch vehicles. Special integrity checks will be performed on the TARS and autopilot and on GLV-2.

The first phase of an improvement program for the rate gyro motor bearing system will be incorporated into future production gyros. To extend and improve rate gyro performance, this program will provide motor bearing preload control and torque measurements during the assembly of the gyro. Special integrity checks are being conducted for GLV-2 on the Stage I primary and secondary rate gyros and on the rate gyros within the autopilot. These tests will detect unacceptable changes in gyro bearing characteristics.

Acceptance and production monitoring tests have been successfully completed on the rate switch package which incorporates the new lowered rate switch settings.

### Radio Guidance System

The radio guidance system equations for GLV-2 have been completed. All of the interfaces between the Burroughs A-1 computer and the blockhouse have been installed and are operating satisfactorily. Much of the work by General Electric and Burroughs has been for the support of the ETR launch countdown preparations.

Launch vehicle contractors have been examining GT-1 data and flight records in an attempt to explain the disagreement between the flight path angle values computed from General Electric MOD III trajectory data and the values computed by NASA from orbit data. A report will be prepared after the investigation has been completed.

## MALFUNCTION DETECTION SYSTEM AND ABORT STUDIES

### Malfunction Detection System

The Stage I engine malfunction detection thrust chamber pressure switch (MDTCPS) circuits have been modified to provide a separate indication for each subassembly to the astronauts. This modification deletes the staging indication circuit to provide space on the astronaut's panel for second Stage I engine subassembly light.

Compartment 5 fire protection studies have been completed by Martin and Aerojet. The review of these studies by MSC resulted in the decision to insulate the Compartment 5 malfunction detection system and control harnesses. Insulation presently used to protect against base recirculation of hot gases will be retained.

Stage II pickup for the engine malfunction detection thrust chamber pressure switch has been relocated from the hot gas environment of the engine. It will be located on the liquid side of the injector and redesignated as the malfunction detection fuel injector pressure switch (MDFJPS). Relocation of the switch was necessary to avoid a possible source of pressure pulses that may result from engine instability.

## Abort Studies

Studies of the Mode I/II abort procedures are proceeding as planned for use on GT-3. Martin is updating the vehicle breakup studies and determining the resulting trajectories. McDonnell studies of the delayed Mode II abort procedure, after switchover failure at 10 000 feet, indicates the technique is acceptable with spacecraft 3 equipment.

Slow drift malfunction monitoring has been delegated to Martin during the launch of GT-2. Recommendations to the test conductor for switchover and abort will be derived from the plotboards. Limits of slow drift and plans for prelaunch simulations have been coordinated with all associated organizations.

# QUALIFICATION STATUS

## Launch Vehicle Component Qualification Status

Previously, all launch vehicle airborne components completed qualification procedures except for two assemblies. The test reports were approved by Martin and the Air Force Space Systems Division for the Thiokol destruct initiator, Martin part no. PS601100013-015, and Epsco design instrumentation system multiplexer, Martin part no. PS640900237-039. The assemblies will be used on GLV-2 and subsequent vehicles.

A new problem for the glass fuse used to protect the 115 V ac power output of the static inverter in the instrumentation system was observed and studied. The fuse glass cracked in storage due to thermal expansion between the seal material and glass. The failure did not affect the function of the fuse. However, Martin is changing to a metal microfuse and post manufactured by Littlefuse, Incorporated. Littlefuse also manufactures the glass fuses. Vibration, temperature, and humidity tests of the fuses are being conducted; qualification should be completed by the end of November 1964.

The equipment required for the redundant shutdown system being installed on Stage II GLV-3 and subsequent vehicles is being qualified. The equipment includes a box in which the redundant relays and shutdown and telemetry switches are potted. This box is to be qualified with vibration tests only. Aerojet General Corporation is conducting qualification tests on the squib-operated shutoff valve.

## WIND-INDUCED OSCILLATION PROGRAM

Analyses of wind-tunnel tests on a 7.5 percent scale launch complex model for determining maximum structural loads on the Gemini Launch Vehicle have been completed. Total loads include the effects of wind-induced oscillations on the fully-loaded vehicle and launch transients.

Results of the analysis indicate the total loads for the required 47.5 mph design ground wind of Martin Specification MB-1043 are within the structural capability of the launch vehicle. Ultimate loads for the worst condition are lower than the tested strength, which indicates the vehicle can be safely launched in a wind velocity of 62.5 mph.

Dynamic analyses of the complete vehicle erector, using wind-tunnel data, are complete. Calculated deflections indicate a wind velocity of 70 mph will cause a deflection of the 109-ft platform equal to the 7-in. platform-vehicle clearance.

## ATLAS AGENA

The first Gemini SLV-3 No. 5301, was completed and will be shipped to Cape Kennedy prior to the required date of December 3, 1964. During vehicle sell-off, only minor discrepancies were reported. To date, three SLV-3 vehicles have been successfully launched.

Delivery dates for the first two Gemini Agena Target Vehicles (GATV) are: March 15, 1965 for GATV 5001, and May 15, 1965 for GATV 5002. Vehicle assembly and modifications of the first Agena Target Vehicle and the vehicle Configuration and Record of Transfer (CART) has been completed. Target Docking Adapter (TDA) simulator consoles were received from MAC on schedule and were installed at Complex C-10 for use during systems test.

Vehicles systems tests of vehicle No. 5001 were completed at Complex C-10; there were no major problems. These vehicle systems tests were conducted from September 25 to November 25, 1964. After the tests were completed, the vehicle was prepared for shipment to the Santa Cruz Test Base (SCTB) where hot-fire tests will be conducted.

Qualification testing of all Gemini Agena hardware is nearly complete and the test data are being evaluated. Only minor reruns of tests on the guidance J-box and the PCM telemetry system remain to be done. It is expected all qualification tests will be done before hot-fire tests are started.

Present program plans are that Space Systems Division be given directions to suspend FY 65 work for Agena vehicle 5008 except work required for long lead time items. Long lead time items are identified as items which are time critical and a production delay would increase the cost of the item. This direction includes the booster adapter and the Douglas shroud. Space Systems Division has sent this direction to LMSC. Also, Space Systems Division and General Dynamics/Aeronautics were advised to follow this same policy for the Atlas Launch Vehicle No. 7.

Agena D vehicle no. 82, which will be Gemini Agena Target Vehicle No. 5002, is in the standard Agena mate area at Lockheed Missile and Space Corporation (LMSC). The 8247 engine and the forward and aft equipment rack structures have been attached to the Agena. Agena D systems test and delivery to the Gemini Agena work area will occur during the next quarter.

### Communications and Control Subsystem

All of the Communication and Control (C and C) equipment for vehicle 5001 was completed prior to the start of systems tests. One complete set of C and C equipment (Fly-by No. 1) was shipped to Goddard Space Flight Center.

The early system tests are, primarily, checked for compatibility between components and subsystems. Several minor problems occurred in the C and C subsystems. Programer problems were an absence of a message acceptance pulse that was traced to a shorted transformer and a synchronization problem in the telemetry system that was triggered by a voltage spike caused by capacitance coupling between two wires in the programer. The sync malfunction was corrected by twisting the two wires together. Controller problems were Command 82 engine sequencing circuit not operating properly and the problem was traced to a logic circuit in the controller which was corrected by unsoldering the logic circuit. The emergency reset timer pulse to the controller was not functioning properly because of relay bounce, which was corrected by the addition of an integration circuit. The S-band beacon on-off monitoring circuit required for this program was not connected. As a result, this minor modification is being made to convert the S-band beacon.

All of the C and C equipment has passed qualification testing. To verify earlier test results, a rerun of the pulse code modulation (PCM) telemetry qualification tests at high and low temperature is being made. Component electromagnetic interference (EMI) tests were completed for PCM telemetry, command receiver, controller, and tape recorder.

Memory plane problems have been in the programer. The problems were caused by interchanging good memory planes with memory planes which were out of specification. Amps, Inc., supplied the memory planes and were used as consultants to check the interface between the memory planes and other programer circuits. The check was completed and minor changes to memory plane testing at the factory were recommended. To provide a good programer, LMSC has contracted with Stanford Research Institute (SRI) for a design study of the complete memory section of the programer.

## Propulsion

Disassembly and inspection of primary propulsion system (PPS) components following the propulsion test vehicle assembly (PTVA) tests at SCTB revealed no damage. On the secondary propulsion system (SPS) modules, the exterior of some gas valves were damaged by being exposed to Inhibited Red Fuming Nitric Acid (IRFNA) fumes and a nitric acid atmosphere at SCTB during the PTVA tests. This environment is not normal to a launch or orbit of the Agena. The damage is being evaluated to determine if more protection or more resistant materials are needed.

The verification testing of PPS components at Bell Aerospace Corporation (BAC) to demonstrate design change adequacy has progressed without major problems. The fuel and oxidizer gas generator valves and the fuel dual check valve have completed functional, vibrational, and shock testing. The start tanks have completed shell corrosion testing and are now being dynamically tested. Wet storage testing of the start system was delayed until components for the start tank are available.

A test program was conducted at BAC to determine the cause of SPS Unit II burnthroughs, which occurred during development testing. Although the test results did not provide conclusive data, the tests did give reasonable assurance the failures were caused by a disruption of the combustion pattern in the Unit II. The disrupted combustion pattern was caused by partial vaporization and two phase flows of the oxidizer. This was evident only when the propellants were both above 100° F. Errosion occurs only after the burning time approaches 50 seconds. Certain chambers are more susceptible to corrosion than others because of wall thickness and composition and to the minute differences in the injector pattern. Analysis by LMSC of the SPS indicates the maximum propellant temperature range during orbit will be between 0 to 85° F. The temperature range includes a 30° F tolerance for errors during analysis; nominal range is 30 to 55° F. As a result, the Gemini Program Office thinks no mission problem now exists. As an added precaution, however, Space System Division (SSD) is studying the practicality of acceptance testing all Unit II chambers. The tests will use propellants at high temperatures to check chambers for being susceptible to corrosion.

The SPS modules successfully completed a test of 20 days of dry and 20 days of wet storage. The modules were static fired after storage to demonstrate compatibility with the requirements of the launch site. Bell Aerospace Corporation conducted the tests. The 8250 propulsion systems specification will be updated to show the increased capability of the propulsion system.

## Santa Cruz Test Base

All Aerospace Ground Equipment (AGE) installations at Santa Cruz have been completed. The PCM ground station was completed.

Flight TDA No. 1 was received at the SCTB high-bay building. Checkout of the assembly and the match-mate with the Douglas flight shroud was started. Minor problems with handling equipment and the assemblies were noted during the match-mate. Minor problems were the slight changes for the TDA sling; the difficult access to some of the TDA bolt holes; improper production, nut plates where bolt holes should have been, of the Agena forward auxiliary rack structural simulator; and clearances that were out of tolerance on the mated shroud. All of the problems are being corrected.

The No. 5001 Agena vehicle was delivered to SCTB. Static test firing will be conducted on schedule.

## Electrical System

All Gemini Electrical system components for Vehicle No. 5001 were completed.

The aft power distribution box qualification and electromagnetic interference (EMI) tests were completed.

The forward power distribution box completed qualification tests. During the qualification tests, there was a reduction of insulation resistance at high temperature. The decrease of resistance was corrected by using a higher temperature potting material for all relays and connectors.

The forward signal conditioning junction box completed qualification testing. During the high temperature testing, the output resistance was found to be about 25 percent above tolerances. After an engineering study, it was determined a diode had too high a resistance and a resistor was shifting value during high temperature. The resistor and diode were replaced and the junction box performed satisfactorily.

During system test of Vehicle No. 5001, some noise spikes were detected on the telemetry outputs from the forward signal conditioning junction box. The noise was coming from the vehicle 26-volt power supply. A small resistance capacitor filter was added to the junction box circuits.

The aft signal conditioning junction box completed qualification tests. While Vehicle No. 5001 was in systems test, noise spikes were detected on the output lines from the aft signal conditioning junction box. The noise was caused by the vehicle power supply. Capacitor filtering was added to amplifiers of the junction box.

The qualification testing of the auxiliary forward safe-arm junction box was completed. The EMI testing was completed and there were no significant problems.

## Guidance and Control System and Studies

The modified Agena D flight control and junction boxes and the new Gemini flight command logic chassis for Vehicle No. 5001 were completed.

The EMI testing of the flight command logic circuits was completed.

During system test of Vehicle No. 5001, the flight command logic circuits were responding intermittently to some commands. A recheck revealed a relay wire shorting to the chassis. The wire was replaced and a design change was incorporated to enlarge the wiring hole in the chassis and to reroute the relay wires.

While conducting the attitude gas control system checks on Vehicle No. 5001, the nitrogen gas regulator valve when switched from the solenoid was jumping the reset clock. To correct this, a diode filter network was added to the flight control junction box.

At the beginning of the backup command check of systems test, the output of the velocity meter accelerometer stopped. The guidance system was removed from the vehicle. A retest showed the negative counter circuit was not functioning. This malfunction was traced to three resistors, one of which was probably open. The unit was returned to the manufacturer for failure analysis and repair. The spare unit was placed in the vehicle and the test was successfully completed.

The guidance junction completed qualification testing but a quality control check revealed a damaged resistor and a capacitor. Damage to the resistor and capacitor was done by mechanical interference. The resistor and capacitor are being replaced and relocated. The vibration test of the qualification tests will be rerun.

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The feasibility of controlling the main engine of the Gemini Agena while firing from the spacecraft hand controller was studied by Lockheed. Lockheed determined that three different methods of controlling the main engine were feasible. One method applied the stick signals directly to the gas valves and hydraulic actuator. The others applied the signals to the flight controls electronic package or to the inertial reference package in same manner as present horizon sensor signals. The first method is, essentially, direct control. The second method uses the Agena rate damping and proportional networks. Simulations would have to be run to determine whether the astronaut could control the vehicle adequately in all three modes. For the program to have a direct application to the Apollo program as originally intended, it was determined more extensive modifications to the Agena control system would be required. Therefore, the collective conclusion from engineering and the astronauts was spacecraft control of the Agena thrust vector would not be implemented, but that the control simulations would be completed to obtain engineering data.

The velocity meter heating analysis was completed by LMSC. Lockheed determined the velocity meter could be left on for five days during orbit without the temperature of the velocity meter being outside the controlled range of temperatures. The only change required was the addition of white paint to the electronic control package and accelerometer. Black paint would be used on inside skin of the vehicle. This package is a standard Agena D item and it was decided to add white tape over the box after tests have been completed.

The Target Docking Adapter (TDA) static stiffness tests were completed at MAC during September 1964. These tests were conducted to establish the bending and axial stiffness of the TDA; joint stiffnesses included the effects of the total TDA structure, which included the docking cone from the Agena interface at Agena Station 229.5 to the Gemini nose receptacle at Agena Station 210. The necessary TDA dynamic tests for completing the docked control system stability studies will not be completed until January 1965 because there are higher spacecraft priorities for using test articles. Final Gemini Agena control system parameters for the docked configuration will not be ready until February 1965.

## LAUNCH COMPLEX MODIFICATIONS

### Complex 19

Orders were given for the installation of dual propellant conditioning equipment and ready storage vessels for fuel and oxidizer. This equipment will provide:

1. Increased reliability through redundancy

2. Increased launch contingency time for rendezvous through decreased recycle time

3. Greater possibility of obtaining 24-hour recycle capability.

Surplus equipment from ETR Complex 15 or 16 will be used and the estimated time for installing the equipment is between 6 and 8 months.

The basic requirement for uninterrupted power is fulfilled by the Cape Kennedy critical power generation and transmission system. The system has a high degree of reliability and will have a higher degree of reliability when the new transmission lines are installed. Therefore, the special uninterrupted power system motor-generator sets are not required. Full dependence for power will be placed on Cape Kennedy critical power system.

The Gemini spacecraft, all spacecraft aerospace ground equipment which are transient-sensitive, and all Cape Kennedy facilities required for a Gemini launch use Cape Kennedy critical power. A determination has been made of which Gemini Launch Vehicle (GLV) systems and AGE now powered from commercial power that may cause a hold or a recycle of the countdown in the event of a switching transient. All equipment capable of causing a hold or recycle will be changed to Cape Kennedy critical power before the launch of GT-3.

A decision was made to stop all work in progress on the proposed water valve redundancy. Past experience indicates these valves have a high degree of reliability. The entire complex water distribution and valve system is well maintained, periodically tested, and exercised. Checks and exercises of the water system are a part of the launch countdown.

Installation of the hazardous condition alarm system has been completed. The Spacecraft Test Conductor's Emergency Procedures, MAC Report No. 9881, have been written and coordinated.

A plan has been established to control erector loads. The plan will accomplish the following:

1. Maintain structural integrity of the erector

2. Provide flexibility for performance of the spacecraft tests and checkout.

### Complex 14

Complex 14 activation phasing group meetings were held September 17 and November 19, 1964. Launch Complex 14 detailed integrated activation schedules were reviewed. The schedules are:

1. Completion date for the Atlas-Agena section of the Complex is February 15, 1965.

2. The complex will be turned over to NASA February 15, 1965.

3. The Gemini-Atlas Agena Target Vehicle (AATV) part of the activation has been extended. The scheduled completion date is April 16, 1965. The new date of April 16, 1965 is an economy measure.

## AERODYNAMIC TESTING

The aerodynamic wind-tunnel tests for the Gemini program is complete. Results of the tests will be reported in sections of the report that is reporting on systems affected by wind-tunnel test.

## NETWORK COORDINATION

Revision 13 of Program Requirements Document, PRD 3600, was distributed. Additional information has been sent to the Operations Support, Plans and Program Office (OSPPO) at the Eastern Test Range to be incorporated into Revision 14 of the Program Requirements Document.

The Manned Spacecraft Center (MSC) conducted a study to determine the capabilities of the launch area tracking systems and the requirements for Gemini metric launch data. One set of data, with accuracies within the capabilities of the existing systems, was derived to meet all requirements. The updated requirements were sent to OSPPO with instructions to revise applicable Department of Defense (DOD) requirements documents.

### Ground Network

Not all ground network sites were able to meet the scheduled overall readiness date of October 8, 1964. Most of the implementation was completed but the systems at several sites have to be checked out and defective parts replaced. All sites supporting GT-2 are ready except for the implementation of the digital command recorders. Goddard Space Flight Center (GSFC) is working on this problem and completion is expected prior to the GT-2 launch. At present, no problems are anticipated for getting all sites ready for GT-3. Information for the FPS-85 radar was received from the Department of Defense. This is an additional Space Detection and Tracking System (SPADATS) radar which was not included in the original radio interference study. Specifications for this radar were forwarded to Lockheed Missiles and Space Company and McDonnell Aircraft Corporation for study. A decision allowing this radar to track Gemini vehicles will not be made until these studies are completed and reviewed by the MSC.

An MSC plan to skin track expended stages of the Gemini launch vehicle and spacecraft adapter was presented to NASA Headquarters. It was suggested this technique be used instead of using the Minitrack system, which was directed by Headquarters. NASA Headquarters gave tentative approval for the plan pending the outcome of GT-3. If the skin tracking technique does not prove adequate, a further analysis will be made and other techniques will be considered.

The Department of Defense and NASA have been conducting detailed discussions about the use of the $3\frac{1}{2}$-second delay between arm cut-off and destruct, either on the ground or as a part of the airborne vehicle. It was agreed NASA will use the airborne time delay in the delayed mode for all manned launches. Thus, $3\frac{1}{2}$-seconds of protection in the airborne system will be provided.

The GPO has been considering methods of relieving the present GE MOD III/GLV constraints on negative pitch look angles. A relaxation of these constraints would provide relief where the present $3\sigma$ dispersion line just touches the "0" pitch look angle, and would allow optimizing the trajectory for a potential payload gain. In order to determine if negative pitch look angles will be acceptable, it is necessary to know the characteristics of the GLV antenna. Space Systems Division (SSD) was directed to conduct tests for determining the antenna pattern in the anticipated area of negative look angles.

## CREW TRAINING

### Spacecraft Tests

The GT-3 flight crew spent several hours participating in the tests of Spacecraft No. 3. Frequently, briefings were given to the flight crews prior to the major spacecraft tests. Crew participation in the tests were extensive subsequent to the beginning of the combined systems tests. The GT-3 flight crew spent approximately 25 hours per crew in Spacecraft 3, and several times this amount of time reviewing and monitoring tests as an outside observer.

The GT-3 crew participated in the final tests of the GT-2 spacecraft and launch vehicle after the spacecraft was mated to the launch vehicle. Close monitoring by Gemini flight crews is planned.

The crew of GT-4 spent some time in monitoring the separate module tests of their spacecraft. Participation in the tests will not be extensive until the combined modular systems tests start.

## Gemini Mission Simulator

Crews for GT-3 and GT-4 resumed training on the Gemini Mission Simulators. The GT-3 crew is using the GMS No. 1, which has the configuration of Spacecraft 3 and is located at Cape Kennedy. The GT-4 crew is using the GMS No. 2, which has the same configuration of Spacecraft 4 and is located at Houston, Texas. The GT-3 training with the mission simulator has consisted, primarily, of learning the detailed flight plan and the normal launch and reentry procedures and control tasks. The GT-4 activities with the mission simulator at Houston have consisted, primarily, of tasks such as retrofire, reentry, and familiarization with checklists for manned flight situations. The GT-3 crew accumulated approximately 20 hours with the GMS No. 1. The GT-4 crew accumulated approximately 10 hours with GMS No. 2.

## Gemini Part Task Trainer

Several astronauts including the GT-3 and GT-4 flight crews have spent several hours with the Gemini Part Task Trainer controlling simulated retrofire and reentry tasks using the flight direction indicators (FDI) and the out-the-window display. In addition, many of the astronauts practiced rendezvous and docking using a TV Agena display. This trainer was used approximately 40 hours by crew members.

## Translation and Docking Trainer

The Translation and Docking Trainer was used by crew members for approximately 20 hours. The majority of this use was for evaluating the various lighting schemes for the Agena vehicle prior to commencing a formalized crew training program with this trainer.

Egress Training

The GT-3 crew reviewed egress procedures using the Gemini mock-up at McDonnell Aircraft. The full-scale egress and recovery exercise for the GT-3 crew is scheduled for February 1965.

The GT-4 crew and part of the GT-3 crew completed a one-day series of briefings on egress and recovery procedures; plus egress from Boilerplate No. 201 in the Ellington AFB flotation tank.

Planetarium

The GT-3 crew completed a 2-day session, approximately 10 hours, at Morehead Planetarium, Chapel Hill, North Carolina. They reviewed the celestial sphere and the part of the celestial sphere which will be observed through the Gemini window at a predicted launch date. The GT-3 crew participated for 6 hours in the general familiarization sessions at the Burke Baker Planetarium, Houston, Texas.

Network and Launch Simulations

Several astronauts, including the GT-3 and GT-4 flight crews, participated in the NS-1 simulations and mission rules reviews held at Cape Kennedy. The GT-3 crew participated in the GT-2 network and launch simulations.

Systems and Operations Briefing

The first two scheduled flight crews participated (more than 100 each) in systems briefings, flight plan, experiment, and spacecraft operations reviews.

Parachute Training

The Group III astronauts completed their parachute training. Each astronaut received five towed runs with free descents. Several flights used the para-commander parachute and touchdown was controlled by riser manipulation. The water parachute training consisted of briefings and supervised practice in proper water entry body position, parachute release, and parachute drag escape. The Ellington flotation tank was used for this training.

### Water Survival

A condensed water survival program was completed at the School of Preflight, Pensacola, Florida, by the Group III astronauts and training consisted of ground school in parachute water landing, water survival techniques, and under water egress from the "Dilbert Dunker."

### Weightless Flights

Several Group III and some of the GT-3 crew received weightless training at Wright-Patterson Air Force Base, Dayton, Ohio, in a KC-135 aircraft. Strap in, egress, ingress, as well as several other inflight tasks were practiced.

### Centrifuge

The Gemini II Centrifuge Training Program is now in progress at the Aviation Medical Acceleration Laboratory, N.A.D.C., Johnsville, Pennsylvania. This program will serve as the refresher training for the GT-3 and GT-4 flight crews and familiarization training for the remaining astronauts. The GT-4 crew completed their centrifuge training of 10 runs. However, the GT-3 crew, as well as several Group III astronauts, will not receive their training until December 1964. The GT-3 and GT-4 crews will complete their training wearing the Gemini pressure suit and utilizing individual contours. The Group III astronauts will train in a shirt-sleeve condition and use the universal contours and pelvic block.

## SIMULATORS AND TRAINERS

### Mission Simulators

Gemini Mission Simulator No. 1 at Cape Kennedy has been checked out. The GT-3 computer program and Spacecraft 3 hardware update program is complete. The simulator has been used for flight-crew training for an average of 24 hours per week since November 9, 1964. Prior to the start of the flight-crew training, flight controller training tape for the GT-2 and GT-3 missions were recorded for use with GMS. Only spacecraft telemetry was supplied for the GT-2 mission but all the data were supplied by the GMS for the GT-3 tapes.

In addition, approximately 6 hours per week have been allocated to checkout of the ground interface with Goddard Space Flight Center. The interface is in the final stages of checkout and will be ready for integrated flight-ground crew launch abort training in mid-January 1965.

Gemini Mission Simulator No. 2 is ready to start the GT-4 flight crew training. The training will start December 1, 1964. The preliminary integration of the GMS No. 2 and the MSCC simulation system has been completed. Nonoperational dynamic data in the operational format has been successfully used to check the data links successfully. Operational integration of GMS No. 1 and Manned Spacecraft Control Center (MSCC) will be started during December 1964.

No checkout of the interface between GMS No. 1 at Cape Kennedy has been scheduled. However, the checkout should be started in the near future.

The visual display mechanical interface has been installed at Houston, Texas on GMS No. 2. The first out-the-window display should arrive in Houston about January 1, 1965.

## Flight Controller Training

The GT-2 simulations of flight controller training for the GT-2 mission are scheduled for December 1964. These simulations will use the 20 launch vehicle and trajectory training tapes supplied by Martin and G. E. and spacecraft telemetry tapes from GMS No. 1. To check out the ground network team and provide flight controller training, a full network simulation was held. This simulation was conducted using GMS data.

The scheduled launch-abort simulations will provide additional training for the launch controller teams.

## Translation and Docking Trainer (TDT)

The TDT has not been accepted because of a docking stability problem. However, several weeks of engineering tests have been made by engineers of MAC and MSC. This data has been helpful for evaluating the performance of the docking trainer; acceptance is expected before January 1, 1965.

## Centrifuge Follow-On Program

All of the MAC supplied equipment has been delivered to Johnsville and the follow-on centrifuge program is proceeding.

# MISSION PLANNING

## Flight Missions

Information for 12 assigned Gemini missions has been published in MSC Internal Note GV-4-1, "Gemini Program Mission Planning Report," dated October 19, 1964. This report is being updated and will be reissued as a Gemini Program Working Paper.

## Advanced Missions

Several advanced mission concepts were reported to NASA Headquarters Office of Manned Space Flight for consideration. Follow-on Gemini flights are being considered for support of inflight space experiements and for continued development of a landing system to be tested on land.

# OPERATIONS, CHECKOUT, AND AEROSPACE GROUND EQUIPMENT

## Spacecrafts 2, 3, and 3A Checkout

Spacecraft 2 completed system testing at MAC and was shipped to Cape Kennedy. Industrial area tests were satisfactorily completed and the spacecraft was moved to the launch pad. Mechanical mating to the launch vehicle was completed. The spacecraft and launch vehicle had satisfactorily completed all testing.

Spacecraft 3 completed modular tests and was mated. The spacecraft had satisfactorily progressed through all assembled spacecraft system tests. A Spacecraft Acceptance Review Meeting was held November 30. Spacecraft 3 is scheduled for shipment to Cape Kennedy December 12, 1964.

Spacecraft 3A, thermal qualification test unit, completed modular tests and was mated. Assembled spacecraft system tests in building 101 were completed, and the spacecraft was moved to building 103A. Spacecraft 3A was installed in the altitude chamber and the remaining system functional tests were conducted. The spacecraft has started the Altitude Chamber Dry Run Test and the Spacecraft Readiness Review Meeting, and the Thermal Qualification Test No. 1 is scheduled.

## Compatibility Test Unit (CTU)

The following tests were conducted on the CTU:

1. A 24-mile mobility test was conducted on the adapter with tanks loaded with inert fluids in quantities simulating Spacecraft 2 pad loading. No visible evidence of damage was noted during the test and bladder permeability checks conducted after the test were satisfactory

2. The CTU cabin was used in the altitude chamber dry run operations prior to the tests of Spacecraft 3

3. The RCS module was static fired after the first and second 30-day wet storage periods

4. The RCS module is being used to check out and perform a first article demonstration on the post-recovery equipment

5. The CTU cabin section will be used for zero g testing in the KC-135 aircraft.

## Aerospace Ground Equipment (AGE)

Delivery of end items for Spacecraft 2 and 3 AGE to the Cape Kennedy hangar and launch pads are sufficient for launch operations. Replacement equipment for the AGE will become available during December and January 1965. Interim maintenance of AGE may use hangar equipment components for replacement of launch pad equipment.

McDonnell Aircraft validated the West Test Station of building 101 control room for the checkout of Spacecraft 3. Modifications and readiness tests of the East Test Station were also made for supporting the checkout of Spacecraft 4.

## Logistics

There are 2446 spacecraft and/or adapter components and parts required at Cape Kennedy for support of Spacecraft 3. This figure includes 2194 components and parts effective for Spacecraft 3 and subsequent spacecraft as well as 252 components and parts effective for Spacecraft 3.

The spare parts delivered for Spacecraft 3 and subsequent spacecraft are 88 percent (1928 items) complete. Parts delivered for Spacecraft 3 are 74 percent (185 items) complete.

It is anticipated that before delivery of Spacecraft 3 to Cape Kennedy, 95 percent of the spare parts for Spacecraft 3 will be delivered. Spare part deliveries to Cape Kennedy for Spacecraft 3, 4, 5, 6, 7, and 8 will be 85 percent complete.

## RELIABILITY AND QUALITY ASSURANCE

An accelerated effort has been placed in effect for the Ground Test Program at MAC. The work program will bring the completion of the program in line with the current launch schedule. The major changes that were made to support Spacecraft 2 and 3 launches are:

1. Parachute Landing System - Spacecraft 3. To expedite and provide a backup for the original test program, Static Article 4A test vehicle was shipped to El Centro. This additional test vehicle allows a one-week turnaround for parachute drops instead of the two-week turnaround required when one test vehicle, Spacecraft 7, was available.

2. Hatch Development and Qualification. The functional (100 cycle) test instrumentation was reduced to allow a timely completion of this test while not jeopardizing acquisition of important test data.

3. Pyrotechnic Demonstrations - Spacecraft 2 and 3. After reevaluation of existing test data, the Gemini Program Office established the requirements for three successful pyrotechnic plane separations, Z13, Z69, Z700, as a constraint on Spacecraft 2. One of the successful tests required the pyros to receive expected vibration and temperature prior to testing the pyros. All of these tests have been successfully completed. The remaining two pyro plane separations are a constraint on the launch of Spacecraft 3, with one of the tests requiring a 14-day altitude soak prior to testing.

4. Rendezvous and Recovery Section and Radar Cover Pyro Release Demonstration, Spacecraft 2. Thermal fixes generated as a result of the single drogue configuration reentry heating test were incorporated into the double drogue test vehicle. This allowed continuation of the single drogue structural test without additional manufacturing time. The thermal gradient tests were then conducted on the double drogue configuration to verify effect of thermal fixes made on Spacecraft 2.

5. Rendezvous and Recovery Section Structural Test Double Drogue Configuration of Spacecraft 3. An additional test vehicle (Static Article R&R section) is being utilized in these tests to allow parallel testing time.

6. Static Article 3, Structural Test, Spacecraft 3. The aft hoist loop test was removed from this test article to expedite completion of Phase I and Phase II abort tests. Top priority was given these tests from both MAC manufacturing and test lab, to allow a timely completion. Verification of the aft hoist loop redesign was accomplished by testing at MSC and MAC.

7. Static Article 4, Structural Test – Spacecraft 3. Hatch operation from two-point parachute suspension has been rescheduled for test prior to TDA dynamic response test. This test vehicle has completed modification for TDA tests and can be utilized for the hatch test while awaiting the start of the TDA dynamic response test.

8. Spacecraft 3A Thermal Qualification. GPO assigned a full-time test engineer to this test to expedite manufacturing and testing.

Production and qualification test programs for Gemini pyrotechnic devices have experienced many delays and many quality deficiencies were isolated at Ordnance Associates, Incorporated. The corrective actions taken are:

1. Definitive quality assurance procedures have been established.

2. Backup sources are being established, Central Technology, Inc. has received a purchase request for devices to be qualified and used starting with Spacecraft 4. The Naval Ordnance Plant at Macon, Georgia, is being considered as an additional source.

3. Manufacturing processes used at Ordnance Associates have been evaluated and rigid controls have been established with resident personnel from MAC and itinerant personnel from the Gemini Reliability and Quality Assurance Office maintaining close surveillance over the operations.

The outstanding problem associated with the Gemini pyrotechnics is the ability to produce the required quantities in sufficient time to complete the constraining portions of the ground test program for Spacecraft 3. The program office is conducting a critical analysis to assure the production rate of pyrotechnic devices.

An analysis of the Lockheed target vehicle contract requirements revealed that failure analysis was called for but inadequately defined. GPO has, therefore, defined its requirements to Air Force Space Systems Division (AFSSD) both as to quantity and quality for implementation at Lockheed.

The Quality Program Plan was reviewed and found to be insufficiently definitive. The plan states, in general, what LMSC plans to do but not how much, when, and by whom. LMSC has proposed to rewrite the plan to correct its lack of definition.

4. Corrosion problems on the Saturn Launch Vehicle S-II, has caused concern about potential stress corrosion areas that might exist in the Gemini spacecraft and its systems. An evaluation of MAC's

controls relative to the use of corrosion susceptible material indicates adequate control is exercised to prevent the appearance of corrosion in the Gemini spacecraft. An evaluation of controls used by MAC suppliers is in progress. All information to date indicates supplier controls are adequate. However, there is a potential problem with tube connector "B" nuts since the procuring specification allows 2024, 2014, and 2017 aluminum alloy which are susceptible to stress corrosion. The specification is being changed to allow only 7075-T73 aluminum alloy for "B" nut fabrication. This alloy with a T73 heat treat has a very low susceptibility for stress corrosion. An evaluation of the susceptibility to stress corrosion of the present "B" nuts is in progress.

Effort is being made to improve quality assurance control techniques in quality assurance for GFAE.

All technical monitors for GFE were informed of the NASA quality requirements. Each monitor was requested to take the necessary action to assure the implementation of these requirements for each procuring order in addition to providing the Quality Assurance Plans and the Government Inspection Plans to GPO.

A plan to audit the contractor's quality assurance efforts and establish government inspection agencies has been provided to support the technical monitors. Implementation of the plan will be primarily by the MSC Quality Assurance Office.

Engineering and Development Directorate (E&D) was requested to support the Gemini Program Office with respect to the technical adequacy of all Qualification Test Programs, Qualification Test Procedures, and Qualification Test Reports of Gemini experiments as per the GPO and E&D joint work support agreement. Implementation of the work request is being evaluated by the E&D.

Considerable work has been expended revising and negotiating the Quality Assurance and Reliability statements of work in preparation for the conversion of the present Gemini Cost Plus Fixed Fee (CPFF) contract to a Cost Plus Incentive Fee (CPIF) contract.

MAC was unable to determine a suitable test to be conducted on Spacecraft 3, 4, and 5 for outgassing Teflon shielded wire that was contaminated during the tetra-etch process. Tetra-etch of Teflon wire is required to insure a proper bonding surface, for potting, and due to the use of improper etching procedures, which have been corrected, the tetra-etch solution was allowed to "wick-up" into the shield braid. In an oxygen atmosphere, a naphothalene type odor would outgas from the Teflon shield caused by the tetra-etch solution residue. This odor was considered toxic and MAC had conducted various high temperature outgassing tests. None of the tests could be adapted for purging the spacecraft. It was decided Spacecraft 3 and 4 would be used "as is" because the activated charcoal in the suit can be used to remove the naphothalene odor. Also, it will be necessary to provide additional activated charcoal in the suit circuit for Spacecraft 5 because the mission will be of longer duration.

Correspondence is being transmitted to MAC requesting that they take action to prevent damage to the flat braid on shielded wires located in the Spacecraft Z69 pyrotechnic area and the area between the seats. Indications are the damage is being caused by carelessness and by mishandling the wire and wire bundles during fabrication and installation. The suggested corrective actions to be presented to MAC are:

1. Installation of covers over the wire bundles for protection against personnel traffic. The covers would be removed before flight.

2. All personnel concerned with the handling of shielded wire containing flat braid should be made aware of the deleterious consequences resulting from mishandling.

3. Each inspector and supervisor directly concerned with this type of wire should be cautioned to exert constant vigilance during fabrication and installation to insure that care is being exercised.

Coordination is also tentatively being accomplished by the Gemini Program Office to request MAC to determine the amount of weight increase that would result by using round braid shielded wire. Should the weight increase be negligible, an evaluation will be made to determine the feasibility of round braid shielded wire.

## GEMINI CONTROL ROOMS

Control rooms were activated at MAC and in GPO. Schedule boards were prepared in duplicate and are located in MAC and GPO. The sets include Vendor Summary, Qualification Status, MAC Test Program, Spacecraft System Test Schedules for Spacecraft 3, 4, and 5, Launch Operations for GT-2 and GT-3, Manufacturing Operations for Spacecraft 4 and 5, Equipment Delivery Status for Spacecraft 4 and 5, Production Schedule for Spacecraft 6 through 12, and Aerospace Ground Equipment Status. As equipment is delivered and manufacturing operations, systems tests, and launch operation are completed, successive spacecraft will be tracked and boards will be changed accordingly. Photographs of status boards and copies of backup data will be used as program history and will be recorded. Daily change progress reports and weekly problem action reports are prepared and distributed by the GPO control room. Cost charts are also maintained in the GPO control room. Vehicle schedule boards are being prepared similar to those currently available for spacecraft and will be maintained in the GPO control room.

## CONTRACT CONVERSION

Agreement was reached on all major elements of the Incentive Contract being negotiated with MAC.

During September 1964, preliminary discussions were held with the contractor on the terms and conditions of the contract. Also a fact-finding group was formed of MAC and MSC personnel to establish a realistic cost for the CPIF contract from April 1, 1964 through completion. During this period, an extensive effort was also being put forth in preparing the Contract Schedule and Statement of Work, and its 14 appendices.

Upon completion of the Contract Schedule and Statement of Work contract discussions were begun with MAC on these documents resulting in substantial agreement in a majority of the areas.

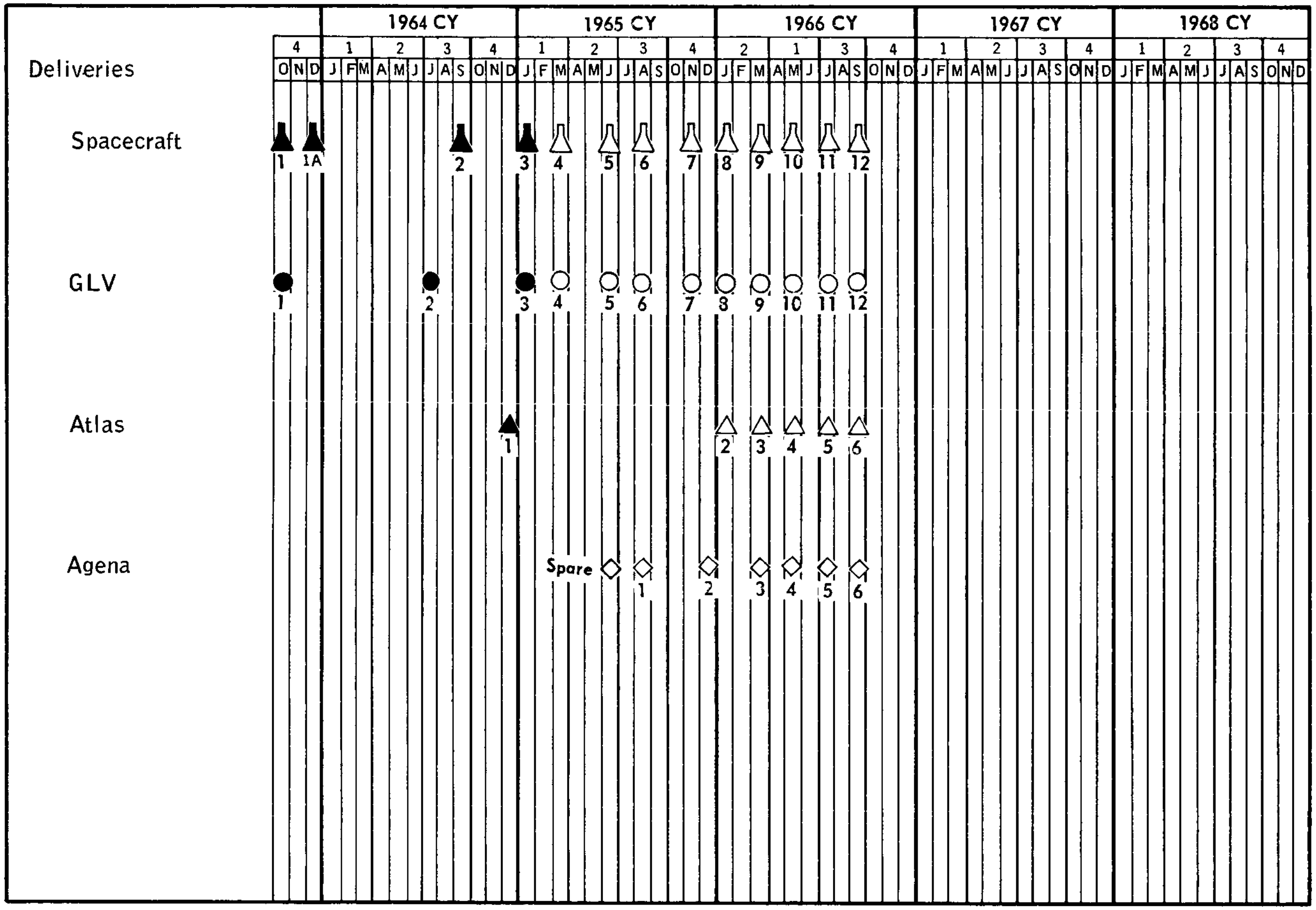
Other discussions were held with MAC which resulted in agreements on the estimated cost and fee for the changes to the CPFF contract, plus actual costs of the overall CPFF contract through March 31, 1964. Concurrent with the agreement on the costs discussed above, NASA and MAC also reach agreement on the physical percentage of the CPFF contract completed and the fee earned.

The performance criteria were also discussed and, in general, agreement between NASA and MAC was reached. It is expected that the entire contract should be completed during the early part of the next reporting period.

[redacted]

NASA-S-65-2865

Gemini Delivery Schedule

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