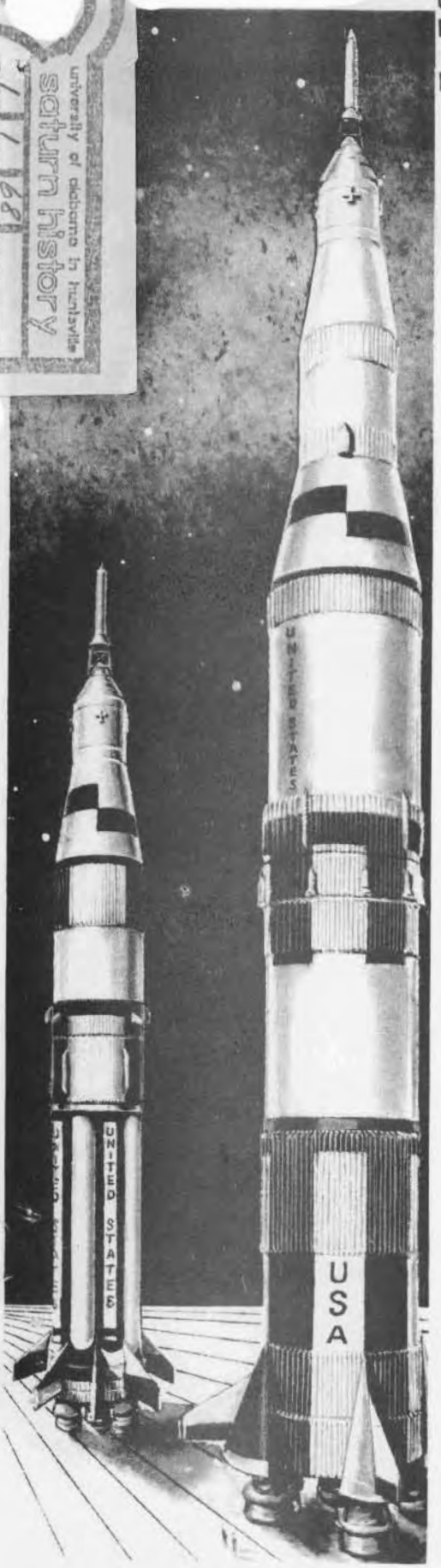

GEORGE C. MARSHALL SPACE FLIGHT CENTER

SATURN

MPR-SAT-67-4

SATURN V SEMI-ANNUAL PROGRESS REPORT

JULY 1, 1967 – DECEMBER 31, 1967

PREPARED BY I-V-P

NASA

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

MSFC - Form 774 (Rev October 1967)

GEORGE C. MARSHALL SPACE FLIGHT CENTER

MA 001-005-2H
MPR-SAT-67-4

SATURN V SEMI-ANNUAL PROGRESS REPORT

(July 1, 1967 - December 31, 1967)

ABSTRACT

This Saturn V Semi-Annual Progress Report describes progress and major achievements from July 1, 1967 in the Saturn V Program.

1. The AS-501 was successfully launched from KSC on November 9.

2. The SA-502 Launch Vehicle was erected at KSC in July. The 502 Spacecraft - CSM-020 - arrived KSC November 23. Spacecraft erection occurred December 9.

3. There were three captive firings of the S-IC-T in August.

   Testing of the S-IC-D on the DTV Program was concluded in July.

   The S-IC-3 Stage arrived KSC December 27.

   Post-Static checkout of the S-IC-4 was completed in December.

   Acceptance test firing of S-IC-5 was completed at MTF August 25.

   Post Manufacturing Checkout of the S-IC-6 was completed in August.

S-IC-7 completed post-manufacturing checkout in November.

Buildup of S-IC-8, S-IC-9, and S-IC-10 Stages, at Michoud, progressed during the report period.

4. Fabrication of S-II Test Structures A & B was completed.

Condition I testing of S-II-TS-C began at MSFC in November.

S-II-3 arrived KSC December 26.

S-II-4 arrived MTF November 26; preparations for captive firing continue.

S-II-5 systems checkout was completed at MTF on December 26.

Systems installations on S-II-6 continued at Seal Beach.

S-II-7 through S-II-10 were undergoing fabrication and stage buildup.

5. One S-IVB Battleship firing was conducted at MSFC.

S-IVB-503N completed Acceptance Testing at SACTO in July, S-IVB-504N in August, and S-IVB-505N in October.

Fabrication of S-IVB-506N was completed in September.

S-IVB-507 through S-IVB-510 Stages were undergoing manufacturing and checkout at the Space Systems Center.

6. S-IU-503 was waiting shipment to KSC as report period ended.

S-IU-504 was accepted by NASA on November 14.

S-IU-505 and S-IU-506 were undergoing component assembly and fabrication.

7. A damage assessment of LVGSE, utilized in the November launch of AS-501, was made. Refurbishment and recertification activity began immediately.

8. LVGSE deliveries and installations actively supported Saturn V Program activities.

GEORGE C. MARSHALL SPACE FLIGHT CENTER

MA 001-005-2H

MPR-SAT-67-4

SATURN V SEMI-ANNUAL PROGRESS REPORT

(July 1, 1967 - December 31, 1967)

by

SATURN V PROGRAM CONTROL OFFICE

(I-V-P)

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GEORGE C. MARSHALL SPACE FLIGHT CENTER

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SATURN V SEMI-ANNUAL PROGRESS REPORT

(July 1, 1967 - December 31, 1967)

SECTION I. SUMMARY

AS-501 was launched from Launch Complex 39, Pad A, at Kennedy Space Center, at 7:00 A. M., November 9, 1967. Based on an evaluation of flight data, the performance of AS-501 was perfect.

An inspection of launch facilities, utilized in the launch of AS-501, was made to assess damage to those facilities as a result of the launch. Refurbishment and recertification began immediately.

SA-502 was erected in High Bay 3 during July. The AS-502 Spacecraft, CSM-020, arrived KSC November 23; spacecraft erection occurred December 9.

The Dynamic Test Vehicle Program was completed in July with the completion of S-IC DTV tests.

There were three captive firing tests of the S-IC-T at the Mississippi Test Facility during August.

Post (static) firing modifications to the S-IC-3 Stage were completed, and the stage was shipped to KSC, arriving in late December.

The S-IC-4 Stage was formally accepted by NASA on August 28. The stage was placed in storage at Michoud due to work priorities.

Acceptance test firing of S-IC-5 was successfully accomplished at MTF on August 25.

Post manufacturing checkout of S-IC-6 was completed at Michoud in August. The stage was placed in storage in the Michoud Factory area on September 12.

Post manufacturing checkout of S-IC-7 was completed at Michoud in November.

Fabrication and buildup of S-IC-8, S-IC-9, and S-IC-10 continued at Michoud during the report period.

Fabrication of S-II Test Structures A & B was completed at Seal Beach, and the structures were shipped to MSFC and Santa Susana, respectively. Condition I testing of S-II-TS-C began at MSFC in November and continued through the report period.

S-II-3 acceptance captive firing was accomplished September 27. Following post fire checkout and modifications, the stage was shipped to KSC, arriving December 26.

S-II-4 systems checkouts were completed at Seal Beach, and the stage was shipped to MTF, arriving November 26. Preparations for captive firing were active as the report period closed.

Integrated systems checkout of S-II-5 was completed at MTF on December 26.

Systems installations on S-II-6 continued at Seal Beach.

S-II-7 through S-II-10 Stages were undergoing fabrication and stage buildup at Seal Beach.

There was one S-IVB Battleship firing at MSFC on July 6.

Rebuilding of the Beta III Test Stand, at the Sacramento Test Center, continued through most of the report period. Testing was resumed on November 22.

Acceptance testing of Stages S-IVB-503N, -504N, and -505N was accomplished in July, August, and October, respectively.

Fabrication of the S-IVB-506N Stage was completed in September, checkout and modification activity continued through December.

Stages S-IVB-507 through S-IVB-510 were undergoing various phases of manufacturing and checkout at the Space Systems Center.

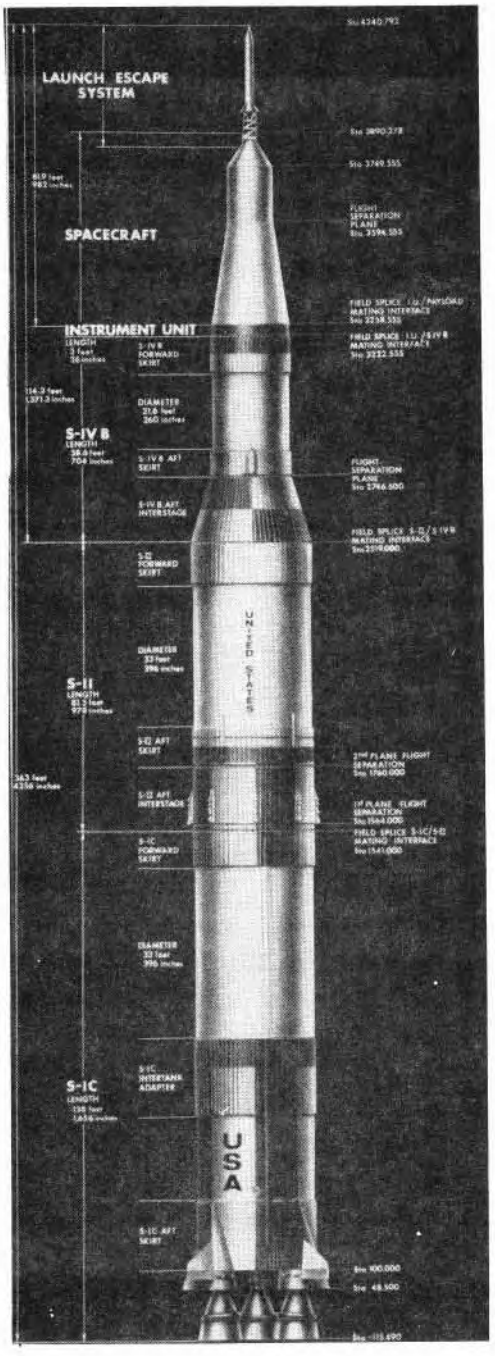
S-IU-503 completed Systems Checkout in November; however, it was decided to perform random retest in some problem areas. Retesting was completed, and the unit was awaiting shipment to KSC at the close of the report period.

S-IU-504 was accepted by NASA on November 14.

S-IU-505 and -506 were undergoing component assembly and fabrication throughout the period.

LVGSE actively supported the AS-501 launch and SA-502 processing at KSC.

SECTION II



SATURN V CONFIGURATION

A. AS-501 LAUNCH VEHICLE

1. PRE-LAUNCH OPERATIONS

Work on the AS-501 was in progress at the beginning of July, 1967. An inverter in the S-II recirculation system that failed during the last report period, was replaced on July 1. Checkout of the new inverter was accomplished on a non-interference basis, and was completed July 3.

Preparations for launch vehicle Overall Test (OAT) #2, were in process during the first half of July. Problems encountered during S-IC Electrical Support Equipment (ESE) distributor modification checkout, and terminal countdown sequences circuit checkout caused OAT #2 to be delayed several times. On July 13, launch vehicle OAT #2 was accomplished.

The launch vehicle Mission Control Center - Houston (MCC-H) interface test was conducted on July 11 and 12. Preparations were then made to conduct the Spacecraft MCC-H interface command test on July 14.

On July 17, the S-II LOX and LH_2 fill disconnects, and aft carrier plate ejections were finished. Visual observance indicated clean separation. The aft carrier plate was re-installed to support stage power up. The propellant fill disconnects were re-installed to support the Service Arm # 4 integrated test.

The Frequency Response test, and Vibration Transducer Calibrations test were completed on the Instrument Unit on July 19. Guidance and Navigation tests, and the Launch Escape System Aborts test were also completed on July 19.

The space vehicle electrical mate, and the Emergency Detection System (EDS) tests were completed on July 24. On July 25, the installation of a cold helium dump module, and the installation of a rain baffle module on the S-IVB were accomplished.

Preparations for space vehicle OAT #1 Plugs-in test were completed July 26, with the test beginning the following day. The test was divided into two parts, part one being Abort Run and part two being Mission Run. An evaluation of the test results

PRE-LAUNCH OPERATIONS (Continued)

indicated the necessity of re-running the test. Plugs-in testing was resumed on July 31.

Space Vehicle OAT #1 was discontinued on July 31, due to ground computer problems, and was begun again on August 1. The same day, antenna modifications and engine sequence tests on the S-II stage were completed. Also, antenna sealant, chill-down inverter installation, and lab checkout of the propellant utilization inverter were accomplished on the S-IVB.

The Hazardous Gas Detection System test was started on August 2, and completed on August 10.

The Space Vehicle OAT #2 Plugs-out test, originally run on August 3, was re-run due to a launch vehicle internal power problem, and was completed on August 4. Installation of the S-II ullage motor ignition system was completed August 6. On August 7, the Propellant Interface test was successfully accom lished. Engine valve timing and sequence was completed on the S-II on August 10.

On August 14, the Instrument Unit ground support cooling unit was found to have a faulty regulator valve. The valve was re-placed and checked out the same day.

The Space Vehicle Simulated Flight test began on August 16; testing was suspended due to a power transfer problem. The test was successfully concluded the following day.

Engine gimball checks, and dynamic feedback tests on the S- were completed on August 16. Also on August 16, the LUT LH_2 Leak test was completed. The Mobile Service Struct damping system checkout, which had been scheduled for the was scrubbed due to a leaking regulator.

The Launch Control Center Holddown Arm Integ ration test successfully completed August 17. Auxiliary propulsion s fairing rework and engine bolt changes were concluded on August 21. S-IVB J-2 engine instrumentation line remov

completed the same day. Installation of the ullage rocket and stage separation ordnance was completed the following day.

On August 26, the AS-501 was transferred to Pad A (Figure 1). Launch Vehicle power was applied on August 29. The following day, the Control Computer Functional test and the RP-1 Simulated Loading test were accomplished. The LOX Simulated Loading test was concluded August 31.

The LH_2 Simulated Loading Test was completed on September 1, and the LOX/LH_2 Simulated Loading test the following day. On September 3, the LUT water tests were completed. S-II stage and GSE electrical mechanical end to end hardware checks were satisfactorily conducted on September 5.

The Flight Control Computer was installed in the Instrument Unit on September 8. Guidance and control checks for the Simulated Flight test were conducted September 11.

The holddown arm load modification and the tail service mast cylinder modification were completed September 10. The same day, hazardous gas detection system leak checks of all stages were satisfactorily completed. The system was then returned to flight configuration to support the LH_2 Cold Flow test.

On September 11, S-IC flight control checks were concluded, and the Base Heat Shield was re-installed. After checking the instrumentation cable routing, re-installation of actuator thermal insulation began.

LH_2 pre-pressurization, LOX pre-pressurization, and engine start bottle orifice installation were completed September 14.

The S-IC LOX tank pressure switch checkout and re-installation of an engine purge line were accomplished on September 19. An engine cocoon purge was conducted following the installation of engine thermal insulation.

A Telemetry Operational Readiness test was successfully conducted on September 21. Insulation GN_2 purge functional

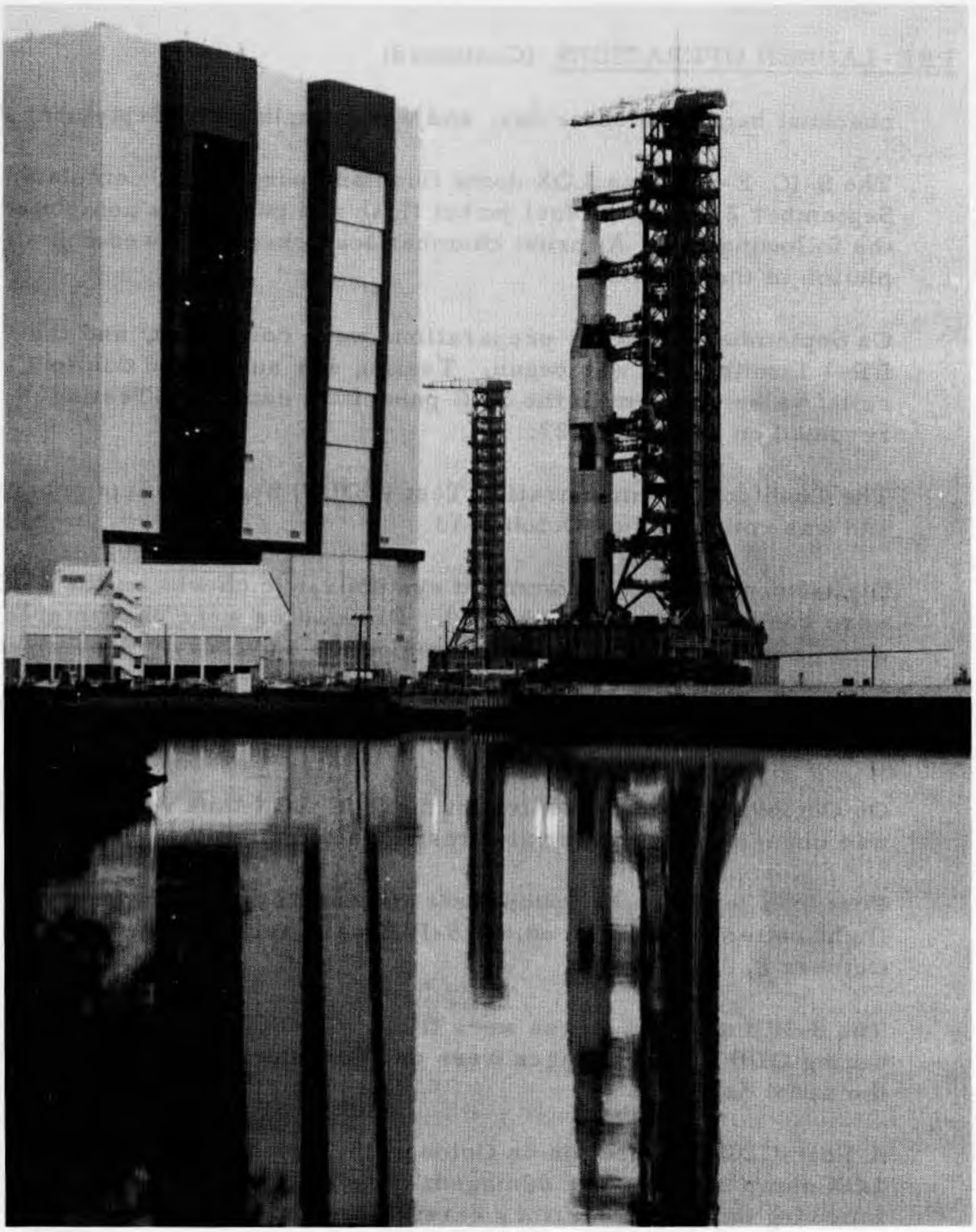


Figure 1. AS-501 In Transit From the VAB to Launch Complex 39, Pad A at KSC.

checkout began the same day, and was completed on September 23.

The S-IC F-1 engine LOX dome flush and purge were completed September 21, and the fuel jacket flush and purge was completed the following day. A thrust chamber leak check followed completion of these tests.

On September 25, RP-1 preparations were completed, and the RP-1 Loading test was begun. Testing was suspended due to a relief valve problem in the S-IC pneumatic console. Testing resumed on September 27.

The Countdown Demonstration Test (CDDT) began on September 27, and was completed on October 13.

Digital range safety - command system range checks on the S-IC were conducted on September 29. Difficulties were encountered with Coder # 2, but were corrected on the same day. A crimped connector was found in the thrust structure during S-IC gimbal checks on October 2. Reconnection was made on October 3, and the gimbal checks were resumed.

On October 7, a microswitch on the S-IC LOX tank vent valve #2 was changed out and the valve tested satisfactorily.

Post load leak checks, propellant utilization calibration and flight battery activation on the S-IVB were accomplished on October 8.

The S-IVB and S-II stages were filled with LOX on October 11, during CDDT. Both stages were drained, during a hold in CDDT, the same day.

A Post-CDDT inspection on October 15, revealed that all S-II LOX sump baffles were damaged. The baffles were removed the following day. A laboratory reassembly showed three pieces missing. A search was started for the missing pieces. All feed ducts were boroscoped, fuel ducts to the engines were disconnected to permit checking the LOX pump inducer/impeller area, and the upper LOX tank slosh baffle was inspected. One

PRE-LAUNCH OPERATIONS (Continued)

0.8 x 0.2 inch piece of LOX sump baffle was found in pump #5, under the impeller, on October 20. During the inspection, the LOX pump bearing retainer nut was found to be loose on all S-II engines. The nuts were torqued to the proper specifications and the engines re-assembled. The search for the two missing S-II LOX tank sump baffle pieces was concluded October 24. It was determined that one piece had apparently broken into minute fragments which could not be located. The remaining piece probably disintegrated in a like manner.

On October 25, during Safety and Arm (S&A) checks on the S-IC, the S&A device failed to go from safe to arm. The S&A device was changed out the same day. Laboratory analysis revealed binding between the plunger shaft and inert detonators, preventing rotation on the faulty device. Safe and Arm load checks were run and verified on October 30.

The S-IVB Auxiliary Propulsion System (APS) module #1 tank assembly was changed out on October 30 because of excessive differential pressure across the bladder assembly noted during APS preparations.

As of November 1, testing of the helium control valve #4 was in progress, battery X-raying was continuing on the S-II, and APS oxidizer loading was nearing completion on the S-IVB Stage.

APS fuel and oxidizer loading on the S-IVB was completed November 2. A leak developed in a fuel level cutoff transducer during S-IC/F-1 engine ordnance installation on November 6. The leak was stopped by applying epoxy compound, aluminum plate, and a clamp. X-raying of the S-II flight batteries was completed on November 6.

2. LAUNCH

The AS-501 launch countdown was initiated at 10:30 P. M. (EST) on November 6. The 49 hour countdown went relatively smooth with no major problems being encountered. Three holds were built into the countdown to be used as catch up time for technicians.

On November 8, the S-IC was engaged in launch countdown operations with no significant problems to report. The functional test

of the S-II LOX regulator was satisfactorily concluded. MSFC approved a waiver request on the skin reflectivity measurement and spare APS leakage of the S-IVB.

On November 9, 1967, at 7:00 A.M., the AS-501 was launched from Launch Complex 39, Pad A, at Kennedy Space Center (Figure 2). At T-minus 8 seconds the S-IC's 5 F-1 engines ignited in a planned 1-2-2 start sequence with an engine position starting order of 5, 3-1, and 4-2. Upon first motion of the vehicle, the last remaining stage to ground support equipment interfaces were disjoined. Vertical alignment of the vehicle was maintained by means of a thrust vector control system which gimballed the four outboard F-1 engines. At 11.7 seconds after launch the vehicle executed a programmed tilt-over and roll maneuver to a flight azimuth of 72 degrees East of North. Dynamic pressure caused maximum structural loading at 78 seconds after launch. S-IC VHF telemetry data was lost and other radio frequency systems on the vehicle were interrupted between 136.5 and 138.5 seconds after launch. These problems followed within one second the S-IC inboard engine cutoff and may have been related to engine cutoff. The engine cutoff was initiated by a signal from the Launch Vehicle Digital Computer (LVDC). At 150.8 seconds after launch the four S-IC Stage outboard engines were cut off by a signal from the LOX depletion sensors. A linear shaped cutting charge was then used to separate the S-IC from the S-II.

At S-IC separation, eight ullage rockets on the S-II were ignited for 3.7 seconds to provide propellant settling. The S-II main engines were ignited prior to cutoff of the ullage rockets.

Following S-II ullage ignition and S-IC retro motor ignition, S-IC/S-II first plane separation occurred. Second plane separation occurred 30 seconds later at 181.4 seconds. The S-IC Stage broke up before impact approximately 332 nautical miles downstream.

Thirty-five seconds after S-IC Stage separation the Launch Escape Tower was jettisoned from the Command and Service Module. The S-II Aft cameras were jettisoned at 37.8 seconds after S-IC separation or at 189.8 seconds after launch.

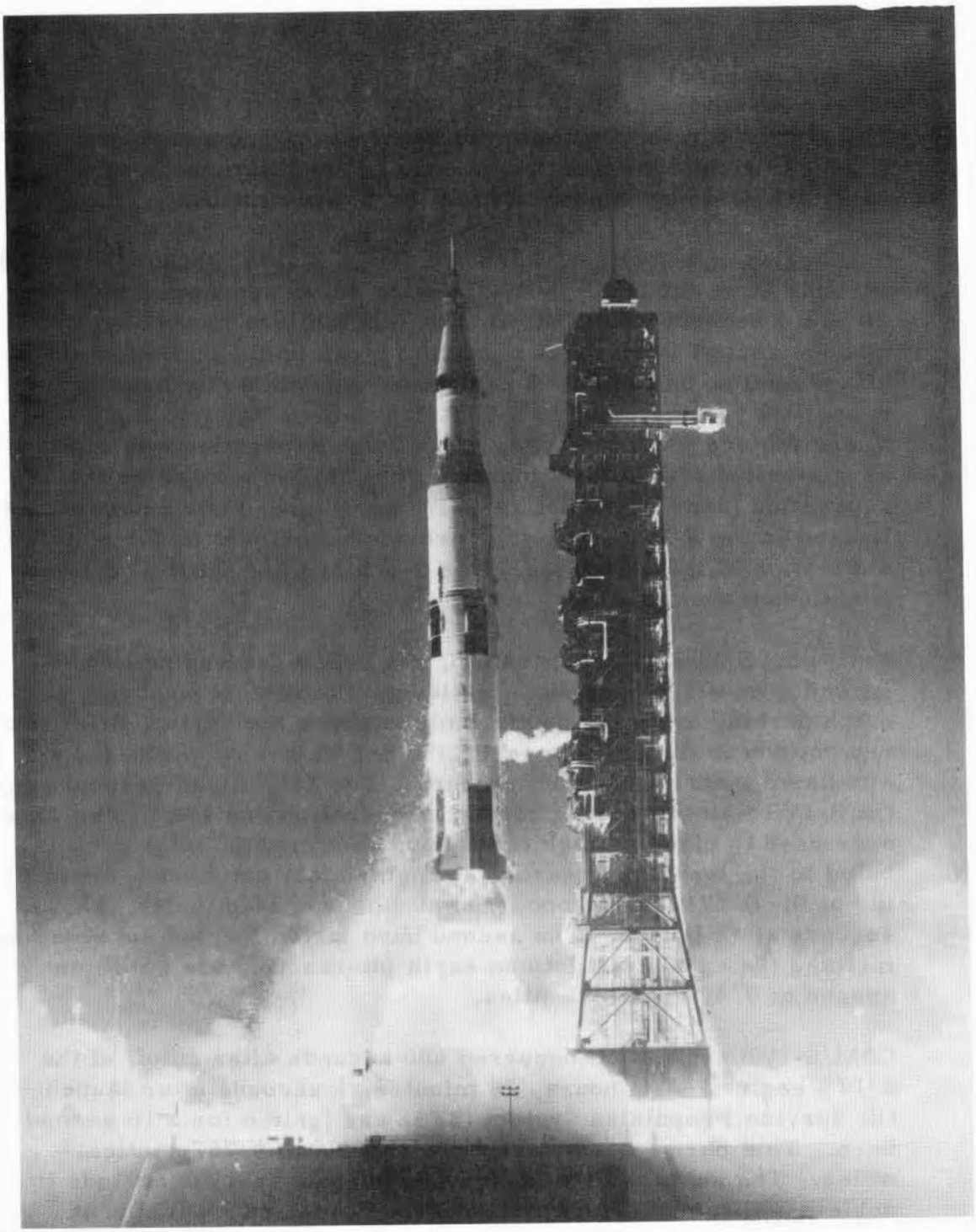


Figure 2. AS-501 Launch From KSC November 9, 1967.

LAUNCH (Continued)

The duration of the S-II powered flight was 378.5 seconds. During this time steering commands to the S-II thrust vector control system were generated in the Instrument Unit.

S-II engine cutoff was initiated by the LOX level sensors at 519.8 seconds after lift off. The S-II engine cutoff sequence was 5-0. At 520.4 seconds after lift off, the S-IVB ullage motors ignited and one second later the S-II retro motors ignited. Both solid ullage motors on the S-IVB performed satisfactorily maintaining propellant seating prior to S-IVB first burn. After firing, both ullage motors jettisoned properly. Stage separation was effected by activation of a Mild Detonating Fuse (MDF) located on the separation plane of the S-II/S-IVB interstage. Four retro-rockets located in the S-IVB interstage provided deceleration for positive separation of the S-II Stage. The S-II Stage and the S-IVB interstage separated as a unit.

Following S-II/S-IVB separation, the S-IVB J-2 engine was ignited. At 675.6 seconds after launch the vehicle went into an earth parking orbit 100 nautical miles above the earth. After two revolutions in the parking orbit, the S-IVB was reignited for a simulated translunar injection burn. The LH_2 ullage pressure on the S-IVB was low during restart preparation and start. The pressure used to close a stuck continuous vent module valve contributed to the low tank pressure at engine start command. Restarting of the S-IVB engine occurred at 3 hours, 11 minutes, 27 seconds after launch. The second burn lasted for 300 seconds and injected the spacecraft into an earth intersecting orbit with an apogee of 9,301 nautical miles.

CSM/S-IVB separation occurred 600 seconds after cutoff of the S-IVB engine. At 3 hours, 28 minutes, 6 seconds after launch the Service Propulsion System (SPS) was ignited for a 16 second burn. This burn raised the apogee altitude to 9,767 nautical miles. The spacecraft was then aligned to a specific attitude to achieve a thermal gradient across the Command Module heat shield. This spacecraft thermal orientation attitude with the Command Module hatch window directly toward the sun so that the conical surface of the crew compartment was perpendicular to the sun rays, was maintained for approximately 4 - 1/2 hours. The

LAUNCH (Continued)

Service Propulsion System was then reignited to accelerate the spacecraft to the most severe reentry conditions that could be achieved from a lunar return trajectory. Following Service Propulsion System cutoff the Command Module and Service Module were separated.

The Command Module was maneuvered away from the Service Module, and the Command Module was then oriented into the proper reentry attitude. Reentry occurred at 400,000 feet, at a flight path angle of -7.077 degrees with an internal velocity of 36,537 feet per second. The Command Module landed upright within 9 nautical miles of the planned landing point in the Pacific Ocean, 8 hours, 37 minutes, 8 seconds after launch.

The carrier USS Bennington was within 6 nautical miles of the Command Module point of impact. Thirteen minutes after landing swimmers had reached the Command Module. The recovery flashing light was observed to be erected and flashing, the sea dye marker was deployed but sheared from the swimmer umbilical before hoisting aboard the carrier. The HF antenna was erect, but damaged during recovery. The VHF antennas were erect, but one did not lock in the up position. Divers installed and inflated the flotation collar around the module within ten minutes after locating the Command Module. The Command Module, Apex Cover, and one of the three main parachutes were recovered by the USS Bennington 2 hours and 14 minutes after splashdown.

3. POST-LAUNCH

An examination of the Command Module indicated that the aft heat shield was heavily charred. The crew compartment heat shield charring was less than expected. The spacecraft windows were undamaged. There was moisture between the micrometeroid and heat shield panels of the rendezvous windows. Inside the spacecraft was approximately two quarts of sea water taken in through the relief valve.

Based on an evaluation of extensive data covering the full flight, the performance of the AS-501 was perfect. The time of the AS-501 mission from liftoff to recovery of the Command Module was 10 hours, 51 minutes, 8 seconds.

B. AS-502 LAUNCH VEHICLE

At the end of June, SA-502 Launch Vehicle had been de-stacked in preparation for erection of S-II-2. On July 6, S-II-2 LH_2 tank cleaning and Low Bay Checkout were completed; S-II-2 Stage was erected in High Bay 3 on July 11. S-IVB stage erection followed on July 13, and IU on July 14.

S-IC Stage power was successfully applied on July 14. S-IVB engine thrust chamber purge was completed July 19, along with J-2 engine actuation systems servicing. S-IC hydraulic leak and functional tests were also completed July 19.

Cold helium dump module installation, switch selector functional tests, launch vehicle electrical mate, and launch vehicle Power On had all been accomplished by July 24.

S-II switch selector automatic checkout, engine actuation system electrical checkout, and propellant dispersion system checkout were accomplished by July 27.

S-IVB Digital Data Acquisition System (DDAS) sub-system test, Power Distribution and Control Switch, and Switch Selector Function tests were completed July 27.

The IU Azusa Transponder Closed-loop test was also completed July 27.

Control System Checks, and Instrumentation and Measurement System tests were performed before the end of July.

During the first week of August, S-II engine actuator system functional checkout, TM airborne tape recorder checkout, and the power transfer portion of Stage Power application was accomplished. The IU Flight Control Computer (SN 507) was installed during this week.

Launch Vehicle Emergency Detection System (EDS) test was completed August 8.

AS-502 LAUNCH VEHICLE (Continued)

Power Transfer & Launch Vehicle Propellant Dispersion tests were accomplished on August 16.

S-IVB Propulsion Sub-system checks were completed, and Launch Vehicle Overall Test #1 (LVOAT #1) rerun was accomplished August 31.

S-IC Fuel Jacket Leak and Functional tests were run September 23.

S-II LOX tank closeout occurred October 2.

The S-II-2 Stage was certified flight worthy (COFW) on November 15, the S-IU-2 on December 6, the S-IC-2, and S-IVB-502 on December 21.

The AS-502 spacecraft, CSM-020, arrived on dock KSC November 23; spacecraft erection occurred December 9, and AS-502 SC/GSE Complex Setups were completed December 16.

As a result of the flight evaluation of S-IVB-501 LH_2 tank continuous vent valve, a decision was made to relocate 2 pressure transducers to provide optimum thermal enviornment. This change will be effective for S-IVB-502 and subsequent.

At the close of this report period, AS-502 was located in High Bay 3 (Figure 3), and the following work was in process, with no significant problems forseen: Korotherm rework, doubler installation on main and auxiliary tunnel clips, flight control and guidance checks, and propulsion subsystem checks.

AS-502 Transfer to Pad is scheduled for the first quarter of 1968.

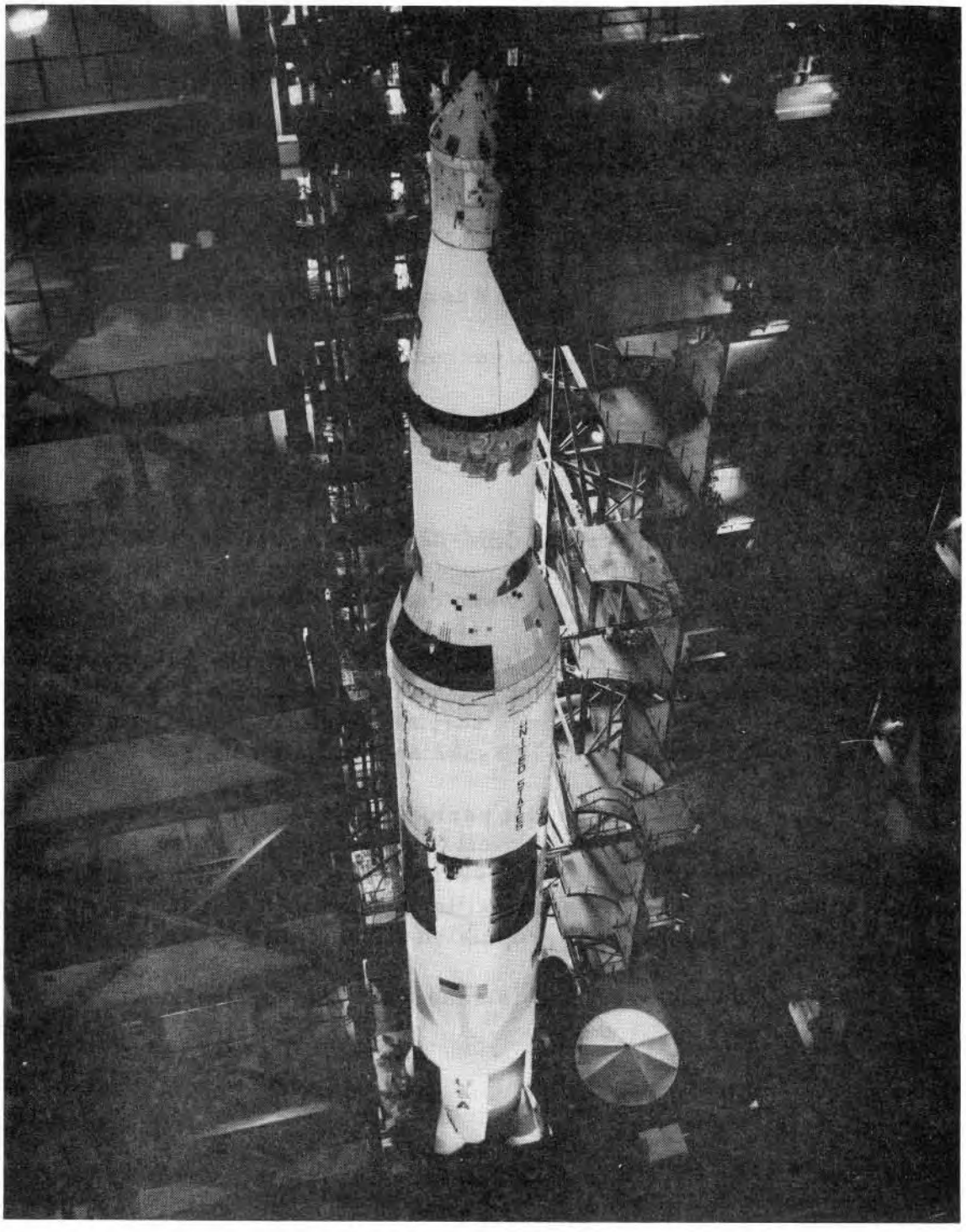
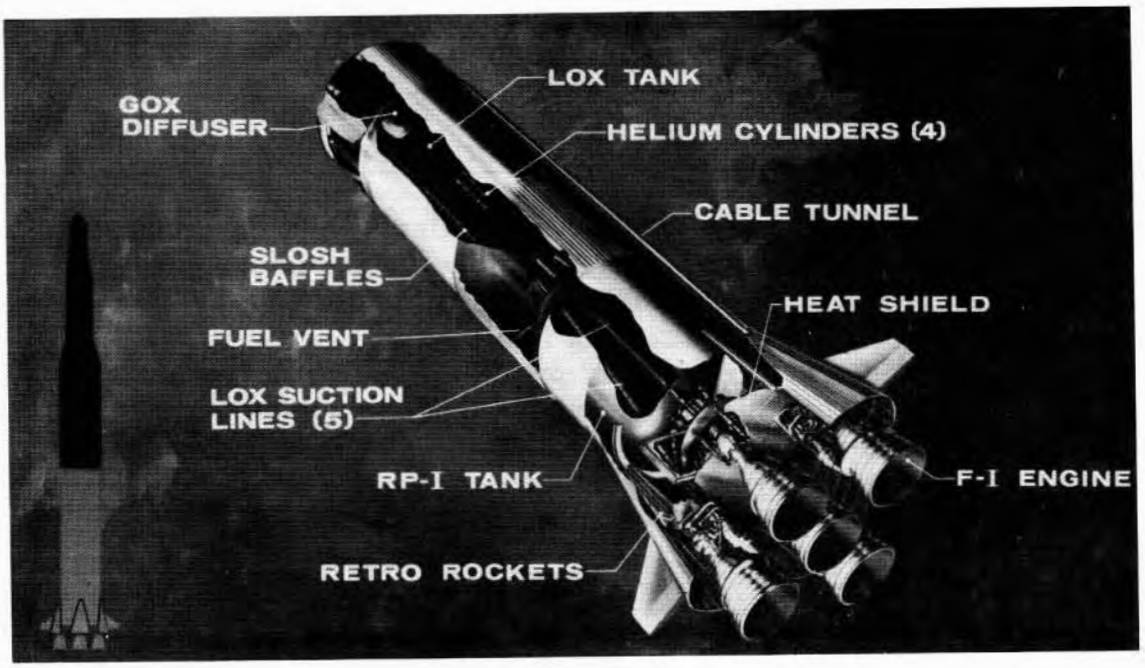


Figure 3. Top View of AS-502 In High Bay 3



SATURN V S-IC STAGE

C. S-IC STAGES

General

Formal testing of the S-IC-D on the DTV Program was concluded in July. The S-IC-3 was delivered to KSC in December. Post-Static Checkout was completed on the S-IC-4 and pre-delivery modifications were underway in December. The S-IC-5, S-IC-6, and S-IC-7 were placed in storage at Michoud due to work priorities at KSC and Michoud. Buildup of the S-IC-8 and S-IC-9 was accomplished during this report period. Buildup work was underway during this report period on the S-IC-10 through S-IC-13.

1. S-IC SUPPLEMENTAL STRUCTURAL TESTING

Test D-47, Apex Gore Assemblies:
The Apex Gore Test, D-47, previously interrupted by a flash fire which destroyed the tarpaulin roof and much of the wiring in the testing facility, was resumed in early July. Testing of the simulated hold repair was satisfactorily completed on July 10, at 225% of designed load. On July 31, the testing of the plug-nut configuration hole repair was successfully accomplished at 225% of designed load. No additional Apex Gore tests are anticipated.

2. S-IC-T BATTLESHIP/ALL SYSTEMS STAGE

Captive firing test number 20 on the S-IC-T was conducted at Marshall Space Flight Center on August 1. The test scheduled to last 40 seconds was ended after 2.15 seconds. The objectives of the test were to demonstrate the operational readiness of the S-IC test complex, S-IC-T Stage, and ground support equipment; to provide training for Kennedy Space Center launch crews; and to demonstrate the launch integrity of the Saturn V liftoff switch. The test was terminated prematurely by an engine redline observer. The engine position # 2 turbine temperature monitor inadvertantly signaled an engine cutoff condition. To correct this problem and prevent its recurrence 5 of the 10 chamber pressure channels were changed completely for test number 21.

S-IC-T BATTLESHIP/ALL SYSTEMS STAGE (Continued)

Captive firing test number 21 on the S-IC-T was conducted on August 3. This test scheduled for 40 seconds was terminated after 3.6 seconds. The objectives of the test were the same as for the previous test. The test was terminated prematurely by an engine redline observer. Cutoff was initiated by the engine 5 fuel pump inlet pressure monitor. The cutoff signal was given inadvertently. A check of the transducers after the test revealed that the original 5 chamber measurements were discrepant. The 5 transducers changed after test number 21 were in their normal range. To further isolate the problem, one of the original chamber pressure transducers was changed prior to test 22.

On August 3, stage captive firing test number 22 was conducted. The test which was scheduled for 40 seconds lasted 41.74 seconds. The test was conducted to demonstrate the operational readiness of the S-IC test complex, the S-IC-T Stage, and ground support equipment; to provide training for Kennedy Space Center launch crews; and to demonstrate the launch integrity of the Saturn V liftoff switch. All test objectives were met, no deviations were noted. The test was terminated automatically by the terminal countdown sequencer.

3. S-IC-3 FLIGHT STAGE

At the start of the report period, the S-IC-3 Stage was in the Stage Test Building at Michoud undergoing helium bottle changeout. Specially designed tooling, proof load tested in the Manufacturing Building and checked out with the S-IC-F Stage, was used for this operation. Contamination and safety control were given prime consideration. A contamination barrier was set up, and a clean-as-you-go operation was effected. On July 17, the first helium bottle was winched from the LOX tank. Changeout of the helium bottles was completed during the first week in August.(Figure 4). On August 9, the final phase of the operation was underway with the replacement of the Liquid Oxygen Level probe and the re-installation of the forward handling ring lifting eye and hub. Upon completion of this work, the stage was moved to the Manufacturing Building on August 22. On September 12,

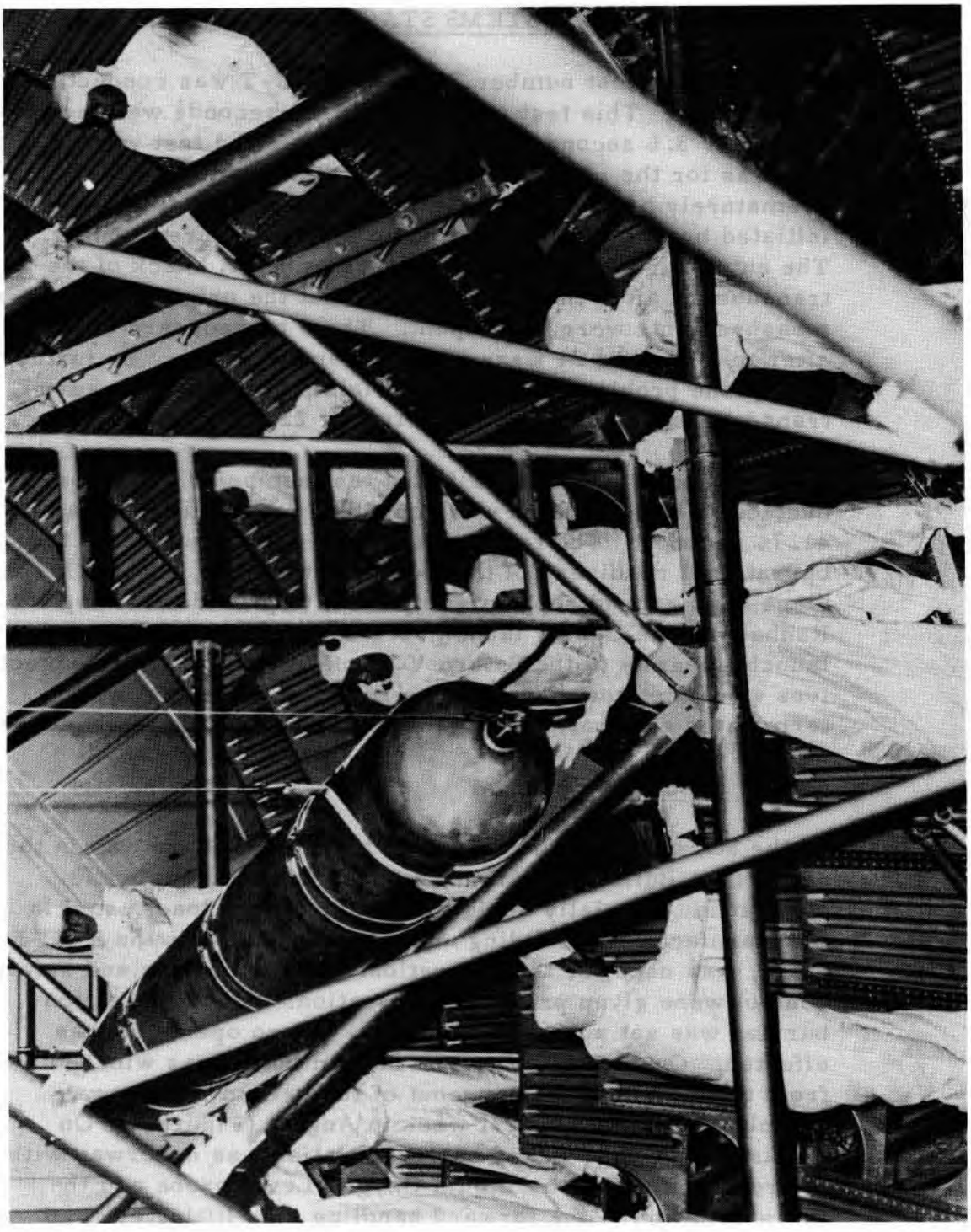


Figure 4. Removal of Helium Bottle From S-IC-3 LOX Tank

S-IC-3 FLIGHT STAGE (Continued)

the stage was transferred from storage to the Stage Test area for Post Delivery Storage modifications.

Retest activity began on November 13, on the S-IC-3 at the request of NASA. This testing was required because of the long post-acceptance storage period, and modifications made at Michoud which were originally scheduled for KSC. Retest activities on the S-IC-3 were completed on December 5, with the Simulated Flight test. Power-On testing of the stage was delayed on December 5, due to a power outage. All Power-On testing was completed on December 6.

Due to troubles with the servoactuators in the S-IC-5, a decision was made to rework all of the servoactuators on the S-IC-3.

Weighing of the S-IC-3 was conducted on December 14, in Test Cell # 1 of the Stage Test Building. Three load cells were placed under the stage, to determine the weight of the stage minus liquid propellant. Atmospheric conditions and other conditions were monitored and controlled to prevent upsetting the sensitivity of the load cells. The weight of the stage was recorded at 311,970 pounds.

The Sequence and Control Distributor was removed from the S-IC-3 for incorporation of several changes. The changes were made to eliminate single point failures which could result in mission or crew loss.

On December 21, the stage was loaded onto the barge Point Barrow at Michoud for shipment to KSC. The barge departed from Michoud on December 23, and arrived at KSC on December 27.

4. S-IC-4 FLIGHT STAGE

On July 1, the S-IC-4 Stage was in the Stage Test Building undergoing post static checkout and refurbishment. Work was proceeding slightly behind schedule due to an electrical outage which occurred during the previous report period, and necessary rework of connectors in the electrical distributors.

S-IC-4 FLIGHT STAGE (Continued)

The deletion of base heat shield vapor barriers was completed during July.

An inspection of the LOX tank ring, during the second half of July, revealed a broken segment. The segment was removed for rework, and a subsequent study indicated a fatique type failure. A decision was made to replace the segment with a thicker segment as used on the first three Saturn V vehicles.

During a quality and reliability inspection, it was revealed that the welds on the engine actuator return ducts, which are a part of the engine gimballing system, were marginal. The ducts were removed and returned to the supplier for rework. Additional ducts, which were available at Michoud, were installed on the S-IC-4 Stage to avoid impacting the S-IC-4 Stage delivery date.

On August 21, the stage was weighed in Test Cell #1 of the Stage Test Building. This 16 hour continuous operation determined the actual weight of the stage minus liquid propellant. The stage was prepared for weighing by positioning two load cells under the aft end and one under the forward end.

After completion of post static checkout and weighing, the S-IC-4 Stage was transported, on August 22, to the Manufacturing Building.

The stage was formally accepted (on-dock Michoud) by NASA on August 28. On September 12, the S-IC-4 Stage was placed in Storage at Michoud due to work priorities to support activities on the S-IC-1 and S-IC-2 at KSC, and the S-IC-3 at Midhoud. The S-IC-4 was moved from post-acceptance storage in the manufacturing area to the Stage Test Building on December 27, to begin Predelivery Modification and retest activities.

5. S-IC-5 FLIGHT STAGE

At the beginning of the report period (July 1), the S-IC-5 was located in the MTF/S-IC test stand. A significant amount of work on the splice angles, the distributor, and the Proof Load

S-IC-5 FLIGHT STAGE (Continued)

Handling Ring remained to be completed before static firing of the S-IC-5 could be accomplished. Also, work was continuing on the changeout of Intertank Bolts.

The Propellant Load test of the S-IC-5, conducted on July 25, was interrupted due to the collapse of the fuel tank emergency drain duct. The collapse occurred when a vacuum was created in the emergency drain line by the recirculation of fuel through the line. The fule tank emergency drain duct, drain valve, and fuel fill and drain line were replaced.

An inspection of the LOX pre-pressurization filter revealed that an "O" ring was missing from the filter element. No evidence of "O" ring material was found in either the LOX tank filter screens or the GSE facility filter screens. A decision was made to use the filter "as is" during LOX loading.

The Propellant Load test was successfully completed on August 10. No significant problems were experienced during the test.

During pre-static firing checkout of the S-IC-5 Stage, it was discovered that the actuators were not operating properly. An inspection revealed broken cam follower spiral springs in one of the actuators. The failures were due to hydrogen embrittlement, together with austenitic deposits on the surface areas due to improper cleaning prior to heat treating. All of the actuators were replaced.

A full duration acceptance firing test on the S-IC-5 was conducted August 25 (Figure 5). The prime objective of the test was to demonstrate satisfactory performance of the stage and its systems. Cutoff was initiated automatically by terminal countdown sequencer. Test operations were satisfactory and all major objectives were achieved. The 3-2 engine cutoff sequence was satisfactory, but the 1-2-2 engine start sequence was not achieved. The thrust of engine 4 was not within the engine internal thrust pressure of $\pm$ 15 kips of the predicted sea level thrust values. Fuel loading probe voltages did not meet engine thrust pressure requirements,

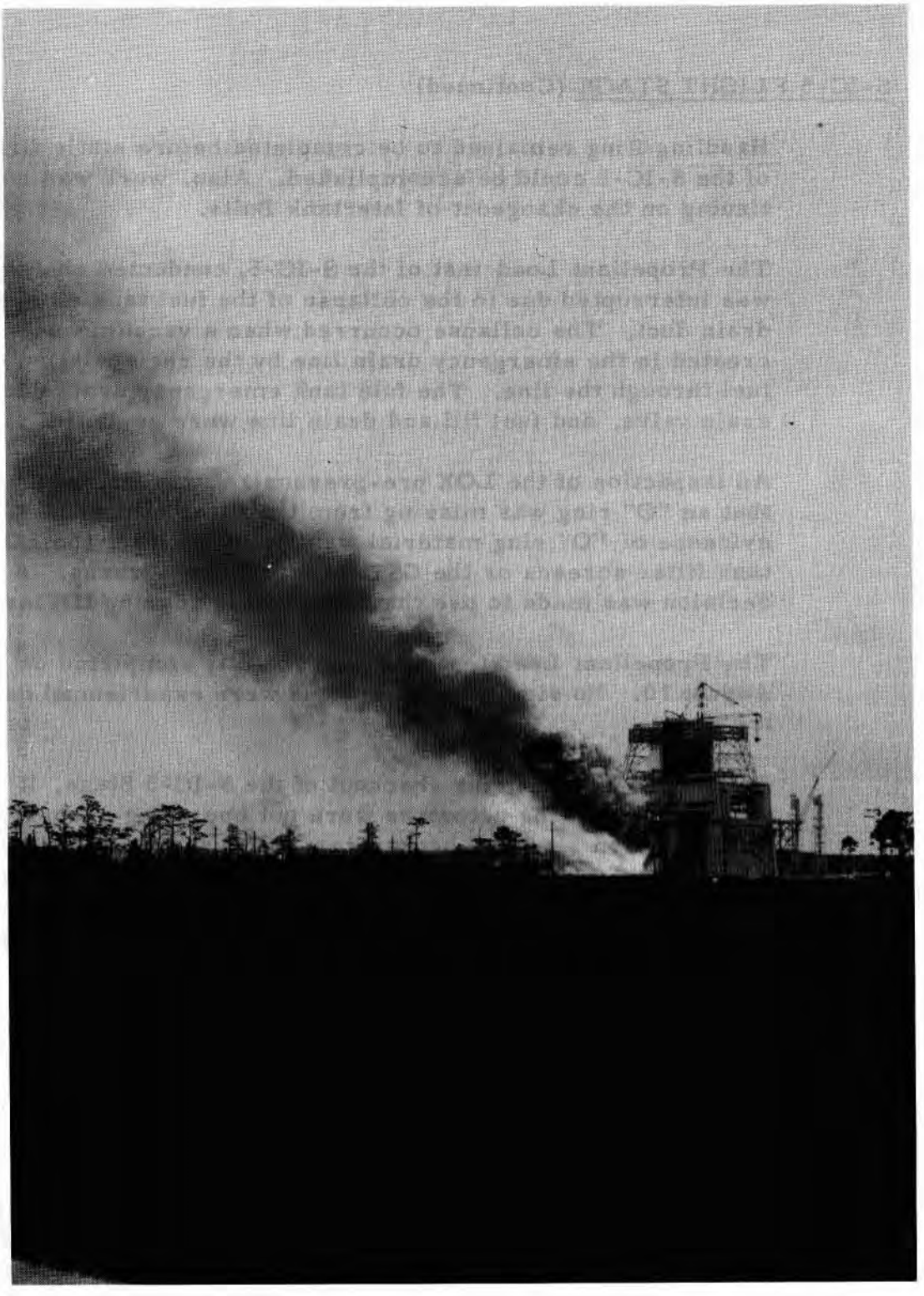


Figure 5. S-IC-5 Undergoing Acceptance Firing At MTF

S-IC-5 FLIGHT STAGE (Continued)

and the engine 4 heat exchanger effectiveness was below the minimum requirement at one data point sampled. Another test deviation noted was that Range Safety System 1 did not receive the command signal from the ground support equipment. Despite several problems the test was considered satisfactory with all major objectives being achieved.

During the removal of static firing test hardware, the turbine inlet transducer of Engine 2 was found to be broken, and a thermocouple missing. The missing thermocouple was located two days later in the throat area of the engine. The inspection caused a three day delay in removing the stage from the test stand. Removal of the stage was accomplished on September 11. The stage was returned to Michoud on September 12 for refurbishment and post-static checkout. Included in the refurbishment was a change in the paint configuration. On October 19, as part of the forward skirt refurbishment, the instrumentation wiring was wrapped with an adhesive-type tape, which has both sides covered by a thin sheet of protective cellophane. On the same day, the United States flag was installed on the S-IC-5 LOX tank. The flag was composed of silk screen printed decal material, and was installed in three sections. Retest procedures were continued through October. Following retest procedures, the stage was placed in storage.

6. S-IC-6 FLIGHT STAGE

The S-IC-6 Stage was in the Stage Test Building on July 1, with post-manufacturing checkout slightly behind schedule due to problems with the new Methode Connectors used in the electrical distributors. The electrical distributor rework was completed, and the distributors were reinstalled on the stage. On July 13, a checkout of the electrical distributors was made using a circuit analyzer. It was determined that the resistance and continuity in the distributors was correct. A checkout of telemetry equipment was the last acceptance test to be conducted prior to stage shipment to Mississippi Test Facility. Post-manufacturing checkout was completed on July 24, and NASA formally accepted the test results on July 26. The stage remained in the Stage Test Building

S-IC-6 FLIGHT STAGE (Continued)

after post-manufacturing checkout undergoing preparations for shipment to Mississippi Test Facility for static firing. On August 14, the stage was moved from the Stage Test Building to the factory area. Final pre-firing modifications were completed, and the stage was placed in storage in the Stage Test Building on August 22. Instrumentation was installed on the stage at this time. On September 1, NASA requested that the S-IC-6 Stage be held in storage at Michoud due to work priorities to support activities on the S-IC-1 and S-IC-2 at KSC, and the S-IC-3 Stage at Michoud. Work on the fin and fairing assembly continued through the month of October. Modifications on the S-IC-6 were in progress during December. The 101 F-1 engine was disconnected from the stage for replacement of the oxidizer seal in the oxidizer pump. Following changeout of the seal, modifications and Systems A (hardware instrumentation for static firing purposes only) installation began.

7. S-IC-7 FLIGHT STAGE

The S-IC-7 Stage was in the horizontal installation position of the Michoud manufacturing building on July 1. On July 18, the stage electrical systems were checked with a circuit analyzer to determine if there were any fabrication errors, broken wires, or errors in hook-up. Horizontal installation of stage hardware was completed on August 11. On August 14, the stage was transported from horizontal assembly to Test Cell 2, in the Stage Test Building for Post-Manufacturing Checkout (PMC). The final PMC test (simulated static firing) was successfully conducted on November 10. Upon completion of PMC, the stage was placed in storage at Michoud due to work priorities at KSC and Michoud.

8. S-IC-8 FLIGHT STAGE

The S-IC-8 thrust structure was moved onto the four pylons of the Vertical Assembly Tower on July 14, to begin vertical assembly.

During the first half of July, the Material Review Board, which had been investigating cracks in the fuel tank, released

S-IC-8 FLIGHT STAGE (Continued)

the fuel tank for return to production. After release by the Material Review Board, a stringer was removed from the fuel tank because of discoloration. Laboratory analyses were performed, and the stringer passed the tests and was returned to the fuel tank. On July 21, the fuel tank was transported to the Vertical Assembly Building and mated to the thrust structure.

The intertank was moved into the vertical assembly tower over the fuel tank and mated on July 25.

On August 14, the LOX tank was moved into the Vertical Assembly Building and mated to the intertank. The forward skirt was positioned on August 15. Vertical assembly of the S-IC-8 Stage was structurally completed on September 16. The stage was then removed from the assembly tower, lowered onto a transporter, and prepared for transportation to Horizontal Assembly Position # 1 in the Manufacturing Building (Figure 6) .

The five F-1 engines for the S-IC-8 were installed on the stage during horizontal assembly. On September 25, the first engine was moved into position and attached to the stage. The fifth engine was mated on October 10. During December, work continued on the S-IC-8 Stage in horizontal assembly position # 1, in the Manufacturing Building.

9. S-IC-9 FLIGHT STAGE

On July 1, the S-IC-9 fuel tank was in storage in the Manufacturing Building at Michoud. The fuel tank was removed from storage and transported to the Vertical Assembly Building (VAB) July 26. The tank was then moved with a crane to Pit # 3 for a shakedown operation, prior to being moved into the Hydrostatic Test Facility.

The S-IC-9 LOX tank was removed from storage in the Manufacturing Building on August 18, and transported to the Vertical Assembly Building. In the VAB, final internal wiring and minor hardware were installed on the LOX Tank.

Figure 6. S-IC-8, S-IC-4 and S-IC-6 in Manufacturing Building at Michoud, Louisiana

S-IC-9 FLIGHT STAGE (Continued)

Following completion of this work, a complete inspection of the LOX tank was conducted. After the inspection, the LOX tank was moved into the Hydrostatic Test Facility. Following hydrostatic testing, the stage was moved into the Manufacturing Building.

On September 25, the S-IC-9 intertank was removed from the painting and storage area in Michoud's Manufacturing Building and trasported to the Vertical Assembly Building where it was lifted by a crane into the assembly tower and mated with the fuel tank.

The five LOX suction ducts were installed on the LOX tank during the first half of October. On October 16, the LOX tank was moved into the vertical assembly tower and mated to the intertank.

The last major component, the forward skirt, was lifted to installation position on October 18, completing the S-IC-9 Stage vertical assembly.

10. S-IC-10 FLIGHT STAGE

Work on the S-IC-10 forward skirt was in progress during August. Technicians were mechanically tightening titanium coated steel fasteners and fitting interior wire supports in position.

On September 21, the S-IC-10 intertank was nearing structural completion, and preparations were begun to transport the intertank to the paint area in the Manufacturing Building.

On October 17, after the application of electrolytic leak detection tape to the lower bulkhead weld seams, the S-IC-10 fuel tank was removed from the production dolly and lowered into the Hydrostatic Test Facility. Inside the tower, the tank rested on a leveling ring which corrected its position to within $\pm$ .5 inches of vertical. The tank was then tested, inspected, and cleaned prior to removal to the paint area. The LOX tank was completed in December, in the Vertical

S-IC-10 FLIGHT STAGE (Continued)

Assembly Building. Minor pick-up work and quality inspection was conducted on the tank in preparation for hydrostatic testing.

11. S-IC-11 FLIGHT STAGE

Thrust structure assembly for the S-IC-11 Stage was in process during July. By the end of July, the center engine support, four holddown posts, the lower thrust rings, and auxiliary shear webs had been installed. Work was in process on the installation of the outboard engine adapter fittings. During August, technicians were installing intermediate ring segments by securing them to corresponding thrust and holddown posts.

Work was continuing on the S-IC-11 intertank during September. Technicians were installing gussets, stiffeners, rings, and securing doublers and strengtheners at primary stress points on the structure.

Etching and dye penetrant inspection of the S-IC-11 lower LOX bulkhead welded fittings was conducted on October 19. Acid was applied to the fittings to remove 0.0004 inches of metal. A penetrating dye was applied for 15 minutes and then washed off. A developer was applied and the welded area was inspected for scratches, porosity, cracks, and traces of lack of fusion.

On December 18, the S-IC-11 lower LOX bulkhead and skin ring was moved over the top of tank assembly position # 1 and lowered into position on the second tank skin ring. After alignment the two tank skin rings were joined by welding.

12. S-IC-12 FLIGHT STAGE

During July, components for the S-IC-12 LOX and fuel cruciform baffle assemblies were being joined at Michoud. The components were installed in an assembly fixture and joined with revets and lockbolts. After removal from the fixture, the assemblies underwent a cleaning operation.

S-IC-12 FLIGHT STAGE (Continued)

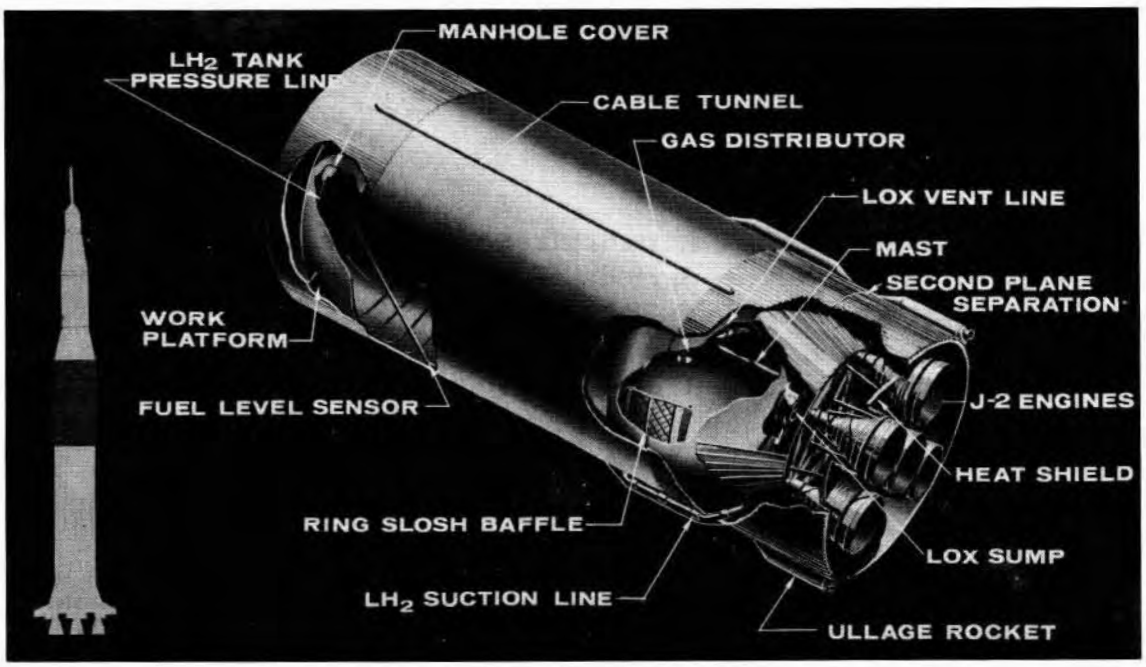
The gore segments were structurely completed in September. They were inspected for correct thickness, proper overall diminsions, and following this inspection, the segments were placed in storage awaiting bulkhead welding.

An actuator rod support assembly was completed on December 14, in the Minor Assembly Environmental Controlled area. This was accomplished by welding two assembly components together.

13. S-IC-13 FLIGHT STAGE

Component parts for the S-IC-13 were arriving at Michoud during this report period. On October 18, in the non-destructive test area, a gore base for the S-IC-13 Stage was inspected for surface discontinuities. A dye solution was applied to the part with the excess dye being washed off with deionized water. Developer was applied and the component was then moved to a drying tank. After drying, an ultra-violet light inspection was conducted on the gore base.

In December, hardware for the S-IC-13 was cleaned in the Minor Component Clean Facility at Michoud. A tank skin segment was processed through the aluminum clean line. The skin was subjected to a vapor degrease process, an alkaline clean, hot water rinse, a deoxidize bath, a taping, and an irridite or conversion coating process. After drying, the skin was ready for tank assembly.



SATURN V S-II STAGE

D. S-II STAGES

General

S-II-Test Structures A & B fabrication was completed at Seal Beach, California, and were shipped to MSFC, and Santa Susana respectively. S-II-TS-C was at MSFC, undergoing Condition I testing. The S-II-3 Stage was delivered to KSC. The S-II-4 Stage was delivered to MTF and was being prepared for static firing. The S-II-5 completed systems checkout, and the S-II-6 Stage was undergoing systems installations. S-II-7, 8, 9, and 10 were in varying stages of fabrication.

1. S-II TEST STRUCTURES

Fabrication of test structures was continuing at the start of this reporting period. S-II-TS-A and B were located at Seal Beach while S-II-TS-C was at MSFC. During the reporting period, the test structures have been referred to as S-II-mini-stage structures, also as Light Weight Structures. The alphabetical indications "A", "B", and "C" have been retained, and are used in this report.

a) STRUCTURE "A":

The circumferential weld joining cylinders 1 and 2 was completed in July, and during the following month, the J-weld joining the common bulkhead to cylinders 1-2 was accomplished. The J-weld was found to contain excessive porosity, and was subsequently cut apart and re-welded. The new J-weld was accepted on August 30.

Installation of bolting ring segments was completed on September 16. By the end of September, mating of the simulated thrust structure and aft static-firing skirt assembly had been completed, and placed in storage. During the same period, the LOX bulkhead was in station III, and preparations were underway for girth welding. The girth weld was completed during the first week in

STRUCTURE "A" (Continued)

October, and was followed by an X-ray inspection and review. Of 124 X-rays taken, 121 were held up for review, and it was finally determined that 53 of the areas would require rework. On October 11, about half of the rework had been completed. The following week, all weld repair were completed, and the assembly was waiting to be joined to the aft skirt.

Aft-skirt and LOX tank mating was achieved during the first week in November. The total assembly (cylinders 1-2, common bulkhead, LOX bulkhead, aft skirt, and simulated thrust structure) was shipped from Seal Beach, California on November 12. The "A" Structure remained in transit until December 6, at which time it arrived at MSFC docks. It was then moved to the Manufacturing Engineering (ME) laboratory at MSFC, and during the following week it was prepared for welding to the S-IC forward bulkhead.

At the close of the reporting period, the "A" Structure remained in the ME laboratory. The weld was complete, and inspection revealed no discrepancies.

b) STRUCTURE "B":

At the start of the report period, fabrication of this structure was in progress. Completion of meridian and dollar welding of the forward bulkhead took place on August 4, and the assembly was then joined with cylinder 6 on September 12.

During this period, fabrication of the forward skirt was completed at Downey, California. This assembly, along with the membrane structural closeout and wagon wheel, were delivered to NAA/SD, Seal Beach, on September 26. The wagon wheel is a fixture welded to the "B"

STRUCTURE "B" (Continued)

Structure for support purposes, and the membrane is a cover, welded to the bottom of cylinder 6 making, in effect, a short LH_2 tank.

Welding of the membrane to cylinder 6 was accomplished on October 9. At this same time, the forward skirt had been positioned and preparations were underway for mating it to cylinder 6. Mating took place on October 12. Mating of the wagon wheel to closeout was completed on October 24.

The total assembly (forward skirt, forward bulkhead, cylinder 6, membrane, and wagon wheel), was shipped from Seal Beach to Santa Susana, on October 31.

During the first week in November, the "B" Structure arrived at Santa Susana and was installed in the test facility (Figure 7). Instrument installation occupied the remainder of the month, along with preparations for testing.

The "B" Structure was placed in the test stand at Santa Susana during the week of December 6. Preparations for testing continued through the remainder of December, with no significant problems being encountered.

c) STRUCTURE "C":

At the start of this reporting period, the "C" Structure was located at MSFC. Scheduled testing was being delayed due to hardware shortages in the heat control system -- this problem was resolved during the month of September by a "work-around" hook-up, and checkout was in process by the last week in September.

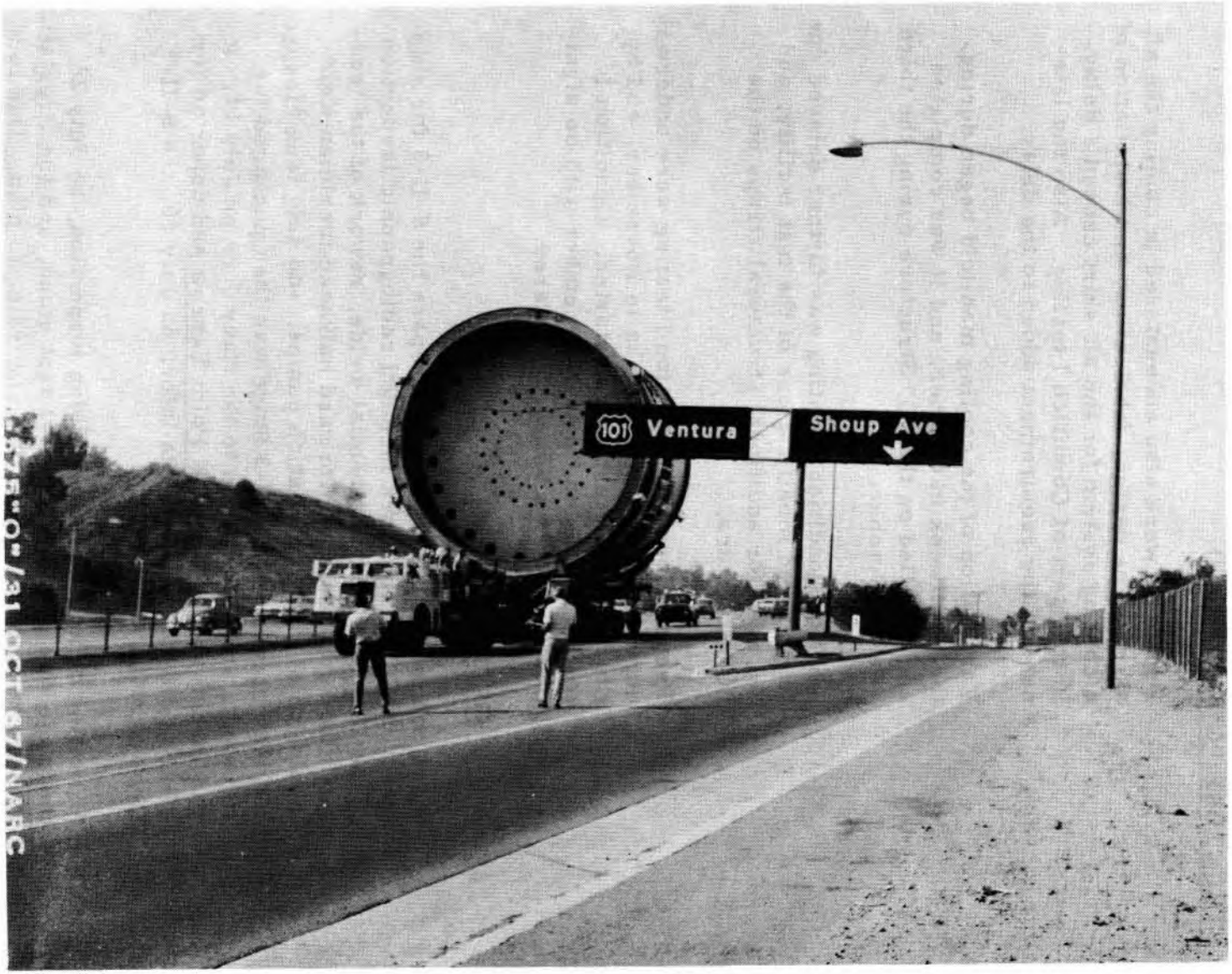


Figure 7. Test Structure "B" Enroute To Santa Susana

STRUCTURE "C" (Continued)

Problems were also encountered in cooling the aft skirt. The design, fabrication, and installation of a cooling system for the aft skirt caused a delay in the start of Condition I testing. Also the lateness of the requirement added to the delay.

Fabrication of the cooling manifold began during the first week in October, and it was completed and installed on the "C" Structure during the third week in October.

Start of Condition I testing was further delayed due to required modifications of the test facility, and the need for additional structural straps on the "C" Structure.

Preparations for Condition I testing were underway during the first three weeks in November, and by the final week testing had started. Condition I testing continued through December with no significant problems being encountered.

2. S-II-3 FLIGHT STAGE

Work continued in early July to prepare the S-II-3 for shipment to MTF. The work included radiographic inspection of the LH_2 tank circumferential welds, rework of the feedline elbow foil seals and forward bulkhead meridian welds, insulation of the recirculation pumps, and LH_2 tank closure and leak check. The S-II-3 Stage was then packaged for shipment, and transferred to the Navy dock on July 11. It was loaded aboard the ADK Point Barrow and departed for MTF on July 12. Two weeks later, on July 26, the S-II-3 Stage arrived at MTF.

Following completion of receiving inspection, on July 28, the stage was positioned in A-1 test stand, and the Prestatic Firing checkout was conducted according to plan. Due to a delayed delivery of LOX prevalves, the electrical and engine sequence control checkout was constrained; engine

S-II-3 FLIGHT STAGE (Continued)

leak and functional tests, and pressurization checks were conducted earlier in the sequence than planned. All prevalves were received and installed on August 25, and all remaining prestatic checks were complete in preparation for the tanking test.

Cryogenic tanking was conducted on September 7, the primary objective was to verify correct operation of LOX and LH_2 shutoff and overfill sensors, A-1/C-1 test complex with stage connected, A7-71 heat exchanger, and start tank and thrust chamber chilldown. During chilldown of the LH_2 tank, delamination of cylinder 2 insulation occurred between feed lines 2 and 3. The delaminated area was temporarily covered with a plastic film, LH_2 propellant was loaded to the 10 percent level, and the Automatic Sequence test was conducted. Except for the Sidewall Insulation Pressure Decay test, all major test objectives were achieved with only minor problems encountered. Engine 1 did not gimbal, and due to a procedural problem the auxiliary hydraulic pump for that engine did not start. During securing operations, a problem with the Air Servicing Unit occurred which required replacement of the compressor and coupling unit. Repair of the delaminated sidewall insulation was accomplished, and pressure testing was conducted on September 17.

The S-II-3 was static fired, for approximately 65 seconds, for the first time on September 19, with ignition occurring at 8:10 P. M. The primary test objectives were to qualify the A-1 test stand flame bucket and demonstrate stage, stand, and control room compatibility. Special objectives were: (1) to evaluate the slow chill of the LH_2 tank, (2) to achieve a 3800 gpm maximum LOX fill rate in the fast-fill mode, (3) to perform a Sidewall Insulation test at cryogenic temperature, and (4) to verify operation of the LH_2 fastfill and over-fill sensors.

The test was terminated, as planned, by manual cutoff. All primary and special test objectives were successfully accomplished with the exception of the Sidewall Insulation

S-II-3 FLIGHT STAGE (Continued)

test. Only one of three vent covers could be actuated for test because of icing. Post-test inspection revealed several minor pinhold leaks in the sidewall insulation. The leaks were evaluated by an empirical method of cutting slots, taping, and conducting flow tests. The repairs were completed successfully.

While preparing the S-II-3 for acceptance static firing, a LOX leak occurred early in the loading sequence. The pump discharge check valve flanges were tightened, and no further LOX leakage occurred.

Full duration acceptance static firing of the S-II-3 Stage was conducted on September 27, ignition occurring at 3:23 P. M. S-II-3 mainstage burn time was 358 seconds, termination was automatically initiated, as planned, by LOX depletion. Primary objectives of the test were to: (1) demonstrate the functional integrity of the stage under static firing conditions and (2) verify that the stage met the specified acceptance test requirements. Special objectives were to: (1) evaluate the slow chill of the LH_2 tank and (2) perform a Sidewall Insulation test. All test objectives were accomplished. The flight control system performed the complete gimbaling program, and initial data indicated satisfactory performance.

Formation of ice between the spring loaded vent cover and the in-flight vent prevented its being pulled during the test. Prior to the test, one vent cover was found to be loose and was replaced by a rubber stopper. The stopper functioned satisfactorily during the test.

Following cutoff, the LOX prevalves were slow to respond, requiring 45 seconds to open. The engine system performed satisfactorily, and all parameters were within specified limits. Engine 5 thrust chamber took longer to chill than the other four engines, and at engine start time it was -160 degrees F. LH_2 tank pressurization occurred at +250 seconds as programmed.

S-II-3 FLIGHT STAGE (Continued)

There were no significant problems encountered in the propellant management system. Propellant Utilization (PU) computer readouts compared favorably with the point sensor locations. The PU high mixture ratio occurred at approximately +284 seconds, 14 seconds later than planned. However, the test was considered successful.

Prior to the Sidewall Insulation test, the insulation leak detection and purge system performed satisfactorily. Following the test; however, sidewall insulation pressure could not be maintained, and the backflow purge had to be used. Small leaks which required repair were discovered in the Cylinder I bolting ring area insulation. All electrical power and thermal control systems operated normally throughout the test.

Modification work was accomplished in parallel with post static firing checkout operations. These activities took place during the first two weeks in October.

S-II-3 Stage detailed leak checks were completed during the last two weeks in October, and at the same time, engine detailed leak checks were started. The completion of these checks were delayed, due to required rework of the Augmented Spark Ignitor (ASI) line on engine 3.

Stage Flight System automatic checkout was completed, and Simulated Flight automatic checkout started on November 9. During the following week, the Simulated Flight automatic checkout was completed, and the stage removed from test stand.

Modification work continued through the end of November with no significant problems being encountered.

Installation of redesigned LH_2 feedlines was completed during the week of December 13.

S-II-3 FLIGHT STAGE (Continued)

During the third week in December, after modification work was complete, the S-II-3 Stage was shipped to KSC. The stage arrived on December 24, and was "off loaded" December 26.

3. S-II-4 FLIGHT STAGE

At the start of this reporting period, the S-II-4 Stage was undergoing special tests on the effectiveness of foam insulation. During a proof test at 6.8 psig, a large section of the common bulkhead insulation facing sheet separated from the honeycomb core. Repair was accomplished by the addition of rubber doublers, and a subsequent test proved the repair to be completely satisfactory.

During this same period, the stage was moved to Station IX (systems checkout) where systems installation continued (Figure 8). Three LH_2 feedlines were removed and returned to the vendor for rework due to weld deficiencies. Problems which could delay the S-II-4 shipment from Seal Beach were late delivery of welded lines, electrical harness changes, and requirements for re-inspection of LH_2 tank welds.

Fit checks made on the umbilical carrier plates pointed out the need to correct one of the forward plates to eliminate an interference problem. Vacuum checks were made on the vacuum - jacketed lines, and a Single-Point Ground test was conducted.

Systems checkout and subsequent shipment of the stage to MTF was delayed due to:

1) Rework of the electrical harness.
2) Antenna rework.
3) Installation of blanking plates.
4) Late delivery of replacement welded lines from the vendor.

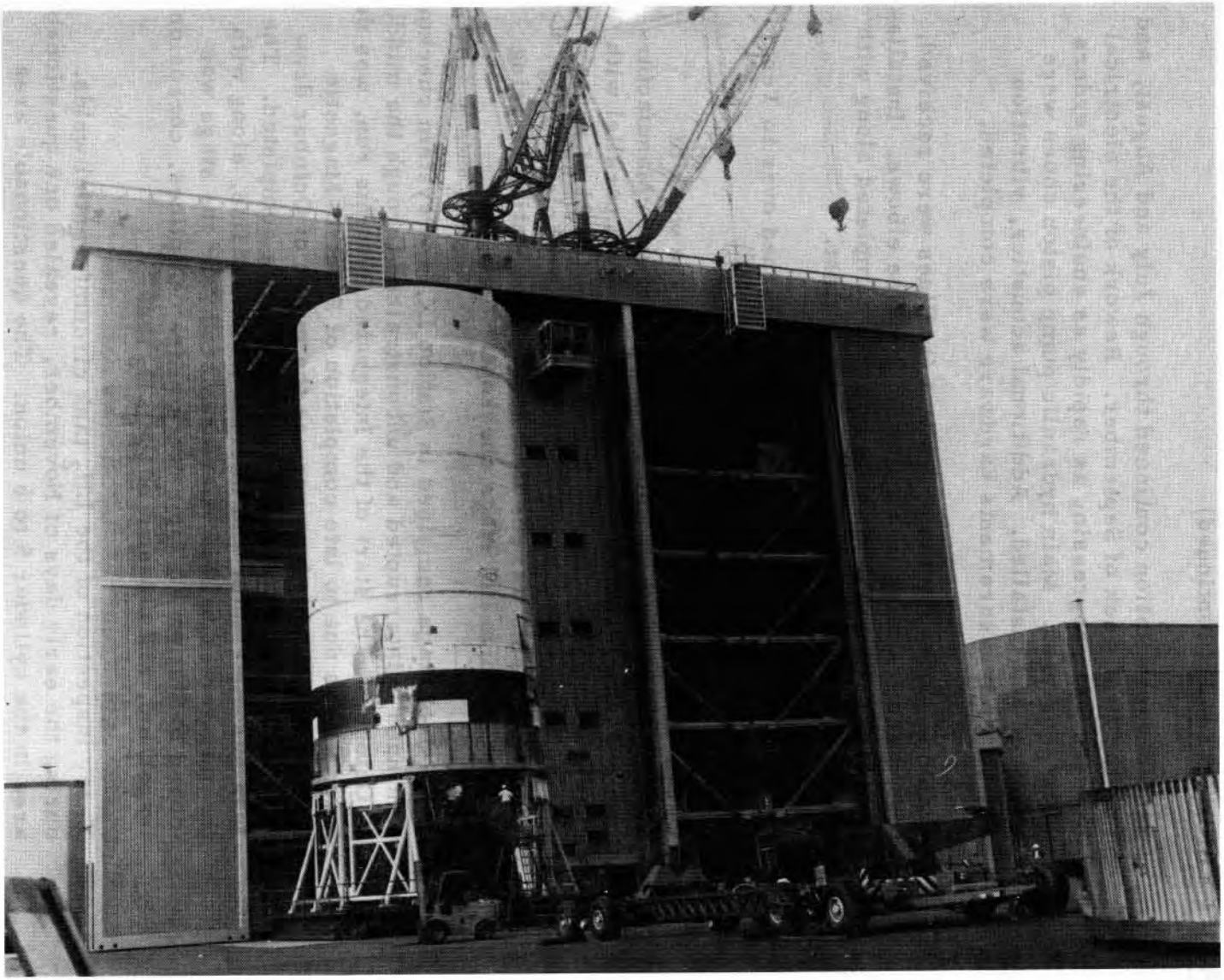


Figure 8. S-II-4 Being Moved Into Station IX

S-II-4 FLIGHT STAGE (Continued)

Systems installation continued through July and August, and into the first week of September. Rework of the electrical harness was progressing as rapidly as engineering orders were generated. Main hydraulic pump piston shoes were received and installed. Additional acoustics, vibration and strain measurements hardware were completed.

Blanking plates for the propellant feedlines were received, tested and installed on all five (5) feedline elbows. Installation of the fill and drain manifold was completed along with the Bolting Ring Insulation Purge Flow test.

On September 9, the S-II-4 Stage was turned over to Test Operations for systems checkout.

Checkout of the stage continued through the week of September 20, with no constraints or delays. Manufacturing personnel worked stage modifications in parallel with checkout activity. By the end of September, 21 of approximately 33 checkout procedures had been completed and accepted. (This was the first instance of Station IX being used to perform full stage checkout.)

The S-II-4 Stage remained in Station IX, and system checkout continued uninterrupted and unconstrained through the middle of October. The start of the Integrated Systems run, was delayed 4 days due to late completion of Electro-Magnetic Compatibility test; however, as the month of October drew to a close, the Integrated Systems run was completed. The LOX gas distributor and internal LOX vent line, along with the anti-vortex baffles, were replaced, and the stage was moved to Station VII for rework of frame splices, corrosion inspection, and closeout of the LH_2 tank.

X-ray inspection of the LH_2 tank circumferential welds, during the early days of November, revealed one questionable area in the cylinder 5 to 6 union. The questionable area was deemed acceptable, and on November 11, the S-II-4 Stage was loaded aboard the AKD Point Barrow, and

S-II-4 FLIGHT STAGE (Continued)

departed from Seal Beach, California for MTF on November 12.

The Point Barrow, with the S-II-4 Stage, cleared the Panama Canal on November 21, and the stage arrived at MTF on November 26. The following day the stage was positioned in the A-2 test stand and the LOX tank welds underwent inspection. Stage hookup was also in process.

During the week of December 6, LOX tank inspection was completed after some minor discrepancies were found, and cleared. The LOX tank was closed, and power-up preparations were in process.

Preparations for captive firing were proceeding uninterrupted at the close of the reporting period.

4. S-II-5 FLIGHT STAGE

At the beginning of the report period, the S-II-5 Stage was in system installation undergoing insulation closeouts. The LOX tank was complete except for installing the LOX vent line, gas distributor, and support mast.

During the second week in July, the LOX tank was entered and installation of the LOX vent line and gas distributor began. Brackets for the addition of acoustic and strain measurement hardware were installed.

Systems checkout and shipment to MTF was delayed due to:

1) Rework of electrical harness.
2) Antenna rework.
3) Late delivery of replacement welded lines from the vendor.

On the 28th of July, S-II-5 was removed from Station IV and positioned in Station VII for frame splice modifications

S-II-5 FLIGHT STAGE (Continued)

of the LH_2 tank. Satisfactory reinspection of the tank followed.

By the end of July, membrane seal leak checks had been successfully completed. Replacement of the hydraulic pump piston shoes was in process and the main oxidizer valves had been received. Installation of vibration, acoustic and strain measurement hardware was delayed due to utilization of skilled personnel on the S-II-4.

As of the first week in August, systems installation and insulation closeouts were suspended, pending completion of propellant tank inspection.

The following week, the S-II-5 was temporarily moved to Station II, to complete LH_2 tank closeout. The stage was positioned in Station VI on August 13, for the remainder of systems installation work.

During the week of August 23, inspection of propellant tank installation took place. The main oxidizer valve and LH_2 pressure line installations was completed, and a prefit of the fill and drain fairing was conducted.

Early in September, skilled personnel became available, and the addition of vibration, acoustic and strain measurement hardware, which had been delayed, was completed and accepted by NASA. At this time, systems installation and modification work was proceeding slowly due to S-II-4 priority on specialized personnel.

By the end of September, the LOX tank vent line had been installed and the tank was closed. Sidewall Insulation Proof Pressure test of cylinder 2 through cylinder 6 was started. Insulation leak checks of the cylinder bolting ring area were in process, and as of the 4th of October, the Sidewall Insulation Proof Pressure test was completed. All recirculation valves were installed and a second Proof Pressure test of cylinders 2 through 6 was successfully accomplished.

S-II-5 FLIGHT STAGE (Continued)

Midway through the month of October, the S-II-5 Shakedown test was completed and subsequent inspection revealed no significant problems.

On October 24, the S-II-5 stage was transferred to Test Operations. Systems installations had been completed, and the stage was in systems checkout Station VIII. Stage hook-up and preparations for checkout were in process. No significant problems were encountered.

The stage continued in systems checkout through the month of November, no constraining problems were encountered. Modification work was accomplished in parallel with systems checkout.

Systems checkout continued into December. The S-II-5 remained in Station VIII and all tests were conducted satisfactorily. On December 26, the Integrated Systems checkout was successfully completed, and as the report period closed, disconnecting of the stage from checkout equipment was in process.

5. S-II-6 FLIGHT STAGE

In July, as this report period opened, the S-II-6 Flight Stage was positioned in Station VI, at Seal Beach, California.

Preparations were underway to start systems installation, although fabrication was not yet complete.

On July 12, a special team was formed to evaluate electrical harness problems and issue on-the-spot engineering orders for rework and/or modifications. Prior to the end of July, the propellant leak detection equipment and purge lines had been installed.

During the final week of August the thrust structure was mated to the remainder of the stage, and insulating foam was applied to the cylinder 1/bolting ring assembly. The

stage was removed from Station VI, positioned in Station VII, and systems installation proceeded satisfactorily.

LH_2 in-tank installations were completed, but rework and closeout of the lower organic seal was delayed due to employment of skilled personnel on flight stages 4 and 5. Rework of eleven cylinder frame splices was required because a substitute material was used which later proved unsatisfactory during laboratory tests.

During the week of August 9, LOX tank installations were in process and six upper slosh baffles had been installed. Rework of the lower organic seal was again in process.

By the end of August, rework of the girth weld had been completed and accepted by NASA. The main oxidizer valves had been received but installation was delayed pending a decision on the need for "black-light" inspection prior to installing the valves.

Lower organic seal installation had been completed, but inspection revealed the existence of eight leaks in the edge of the seal. These were repaired and closeout was complete.

During the first half of September, systems installations and insulation closeouts continued. Modification work was accomplished along with systems installation. While machining the foam insulation on the S-II-6 cylinder 1/bolting ring, an area of insulation approximately 2' x 4' debonded. The debonded insulating material was removed and the area resprayed, after which it was hand-sanded and re-machined. Sonic brush and product quality verification tests were successfully completed on the repaired area.

By the end of September, the LOX tank gas distributor, and pump installations had been completed. Rework of the electrical harness was continuing.

S-II-6 FLIGHT STAGE (Continued)

On October 4, all five J-2 engines had completed checkout, and were ready for installation. Throughout the remainder of October systems installation continued without significant problems. Some minor problems were encountered with insulation leaks in the feedline elbow purge springs and elbow cavities. The installation of J-2 engines was completed on October 28.

During the month of November, systems installation proceeded without interruption or significant problems.

The Sidewall Insulation Proof Pressure test was successfully completed during the first week in December. The LOX feedline was attached to LOX prevalve on December 13.

Modification work was being accomplished in parallel with systems installations, and propellant tank inspection was being conducted at the close of the reporting period.

6. S-II-7 FLIGHT STAGE

At the beginning of this reporting period, the S-II-7 Stage was in vertical buildup. The LH_2 bulkhead had been completed, and was in storage. By the middle of July, it had been removed from storage and welding of Cylinder 6 to the forward bulkhead had been completed. Inspection of the weld revealed the need of repairs. These repairs were made, and the weld was accepted by NASA on July 21.

To accomodate this weld, a turntable system was utilized which rotated the LH_2 bulkhead/cylinder 6 past the welding head as opposed to the "skate," where the welding head itself moved while the assembly remained stationary. No significant improvements were noted in the weld; however, the following advantages were evidenced:

1) Reduced set-up time.
2) Improved welder head control.
3) Operator remains at one spot and observes the welding.

S-II-7 FLIGHT STAGE (Continued)

4) Long cables used with the "skate" no longer required.

The LH_2 bulkhead/cylinder 6 weld was completed July 23, and accepted on July 28.

Common bulkhead cylinders 1-2 assembly was prepared for internal contour check during the first week in July. Subsequent to this check, the aft LOX bulkhead to common bulkhead girth weld was completed. X-rays and dye penetrant inspections were satisfactory, and the assembly was accepted on July 24.

Welding problems were encountered in developing weld parameters for thick to thin areas on cylinders 3-4. Inspection of the cylinder 3 to 4 weld during the second week in August revealed a need to rework the weld, this was completed on August 15, and accepted on August 23.

LOX tank cleaning started during the last week of August, and was completed during the first week of September.

The weld joining cylinder 4 to 5 was completed on September 5. The weld x-rays and dye penetrant tests proved satisfactory, and the assembly was accepted on September 7.

The stage closeout weld, joining cylinders 2 to 3 was made on September 12, and accepted on September 17. This weld completed vertical buildup of the S-II-7 Stage, and on September 18, it was pneumostatically tested (Figure 9). The test revealed several discrepancies which required repair by rewelding. The significant discrepancies were two cracks which penetrated the weld. The two cracks were reworked and since both were in machine stress areas, a plan of action was initiated to:

1) Establish repair parameters and certification requirements for S-II-7 weld repairs.

2) Test weld repairs designed for cylinders 3 to 4 and 5 to 6 weld defects.

Figure 9. Pneumostatic Testing of The S-II-7 At The Remote Test Site

S-II-7 FLIGHT STAGE (Continued)

3) Measure the S-II-7 in the weld defect area, by use of a strain gauge, prior to re-pneumostat.

4) Determine minimum metal thickness on the S-II-7 in stress relieved areas.

5) Conduct a stress evaluation to assess the seriousness of this type of defect on the present design.

6) X-ray the S-II-4, -5, and -6 Stages in the stress relieved areas.

Rework of the discrepancies proceeded without delay. The stage was transferred to Station VII for systems installation.

Rework of the weld defects continued during the first two weeks of October, and by the third week of the month the cylinder 3 to 4 and 5 to 6 weld repairs were completed and accepted by NASA.

During the final week of October, the stage was moved to Station IV for LH_2 tank doubler installation. The decision to install the doublers was postponed until the results of laboratory tests could be reviewed. During the week of November 15, the tests of the laboratory speciment proved satisfactory. The decision was made to proceed with the installation of doublers on the stress relieved machined areas of the LH_2 tank.

By the end of November, the S-II-7 Stage had been returned to the horizontal position in Station VII. LH_2 tank doubler installation proceeded without problem, and was completed the following week. During the first week in December pneumostatic testing of the tank was successfully completed, and the tank weld inspection was in process. By the end of December, post-pneumostat inspection and cleaning of the LH_2 tank were completed, and as the report period closed, preparations were again being made to begin systems installations.

S-II FLIGHT STAGES (Continued)

7. S-II-8 FLIGHT STAGE

At the beginning of the reporting period, the S-II-8 Stage was in fabrication and assembly of structural components.

Foam insulation was applied to the forward bulkhead on July 25. On August 2, trimming and sealing operations were completed and the assembly was accepted by NASA on August 19.

The forward facing sheet of the common bulkhead was welded and hydro statically tested during July, meanwhile the honeycomb core was bonded to the aft facing sheet. The forward facing sheet was bonded to the core late in July, and the sandwiched structure was completed on August 2.

Foam insulation was applied to LH_2 cylinder 3 on July 17, in Station VI. This was the first time foam had been applied to a cylinder forward of the number one cylinder. After a cure period of 48 hours, the foam was trimmed to a thickness of 3/4 inch, and depressed areas were resprayed. Final machining took place on July 26, after which, cylinder 3 foam insulation was complete. Vertical welding and splicing of cylinders 2, 4, 5, and 6, was completed in July, and all cylinders were covered with a heavy aluminum foil to seal out moisture until application of a suitable moisture-proof material.

Assembly of all non-pressurized structures had been completed by the end of September. The vertical buildup phase for the S-II-8 Stage started by accelerating the welding schedule for the LH_2 tank cylinders, thereby taking full advantage of station availability. Welding cylinder 3 to 4 took place in Station 1A on August 25, and was accepted on September 5.

S-II-8 FLIGHT STAGE (Continued)

The forward bulkhead and cylinder 6 were placed in Station 1A, and on September 20, the weld was started using Tungsten Electrode with Inert Gas (TIG) welding equipment. The weld was accepted by NASA September 30. Cylinder 1 to 2 weld also started September 20; completion took place during the first week in October and was accepted by NASA.

The cylinder 1-2 assembly, and the common bulkhead were placed in Station 1B during the second week of October. The weld joining the two structures was completed during the week of October 18. Cylinder 5 to 6 weld was completed and accepted by NASA during this same period.

By the end of October, the cylinder 4 to 5 weld had been completed and accepted by NASA. Inspection of the cylinder 1-2 assembly - common bulkhead weld revealed some minor discrepancies; these were repaired, and the assembly was accepted by NASA.

During the first half of November, the S-II-8 Stage remained in vertical buildup; work continued on schedule with no significant problems (Figure 10). The girth weld was completed on November 13, and the final two weeks in November marked the completion of the closeout weld and its acceptance by NASA on November 28.

Vertical assembly was completed during the week of December 6; strain gauge wires were installed on the stage in preparation for pneumostatic testing. At the close of the reporting period, the Pneumostatic test had been completed, and a post-pneumostatic tank inspection was in process.

8. S-II-9 FLIGHT STAGE

Major structural fabrication of the S-II-9 Flight Stage continued at the start of the report period.

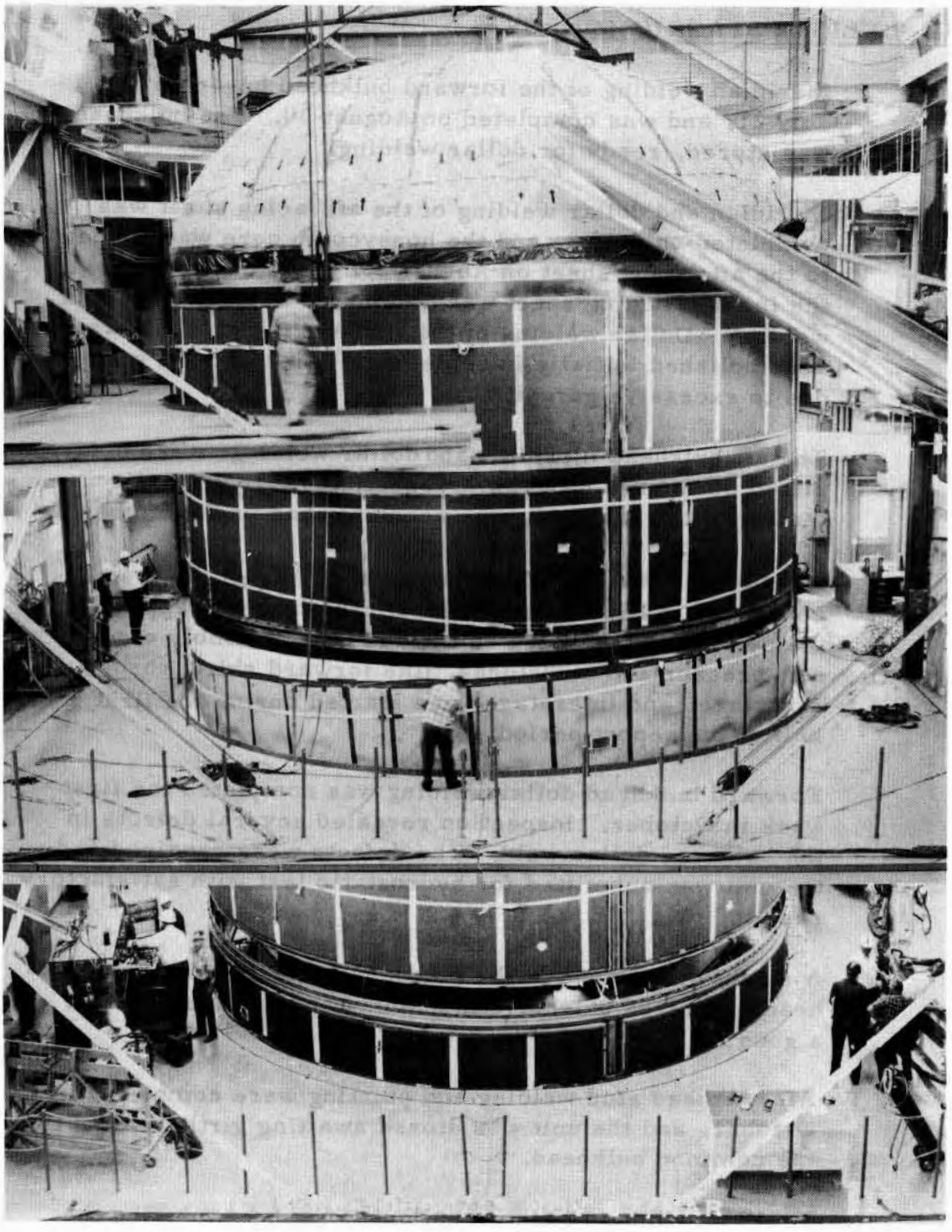


Figure 10. Vertical Buildup Of The S-II-8 Structural Components

S-II-9 FLIGHT STAGE (Continued)

Meridian welding of the forward bulkhead began on July 21, and was completed on August 30. The bulkhead was stored, ready for dollar welding.

Meridian and dollar welding of the aft facing sheet was completed on July 5, and the honeycomb core was bonded to the aft facing sheet on August 30. Also during August, the forward facing sheet was completed through meridian welding. Dollar welding of the forward facing sheet was accomplished initially in September, but had to be cut apart due to excessive porosity.

The aft bulkhead meridian and dollar weldings were completed on August 7 and 22, respectively. Hydrostatic testing of the assembly was accomplished on September 8.

Welding of the LH_2 cylinders began in August and was completed in September. Foam insulation was applied to the cylinders during the same period. Assembly of the non-pressurized structures, (the forward skirt, thrust structure, and interstage) was started during the first half of the report period.

Forward bulkhead dollar welding was completed the first week in October. Inspection revealed several defects in the bulkhead dollar weld. The defects were repaired and the unit was submitted for hydrostatic test with satisfactory results.

A defect discovered in the components of the common bulkhead, required extensive machining and buildup to effect a good fit.

Aft bulkhead stud welding and painting were completed in October, and the unit was stored awaiting girth welding to the common bulkhead.

Vertical buildup of the propellant tanks began during the first week in November. Cylinders 4-5 weld was accepted on November 20. Cylinder 3 was joined to cylinders 4-5

S-II-9 FLIGHT STAGE (Continued)

on December 1. Vertical buildup of the tanks continued as the reporting period closed.

9. S-II-10 FLIGHT STAGE

Major structural fabrication of the S-II-10 Flight Stage was underway at the start of the reporting period. The gores for the aft facing sheet of the common bulkhead were situated in the weld fixture, and all meridain welding was completed on August 21. Gores for the forward bulkhead were loaded into the fixture on September 8, and by September 30, three of the meridian welds had been completed and certified.

During October, cylinders 4 and 6 were welded, spliced and made ready for spray-on foam insulation application. Cylinder 3 was foam-insulated in November and cylinders 4, 5, and 6 in December. Assembly of cylinder 2 began during the first week in December.

All meridian welds, on the forward bulkhead, were completed and accepted by December 1, and the bulkhead was stored to await the dollar weld.

On October 22, the final meridian weld on the forward facing sheet of the common bulkhead was completed and the unit was placed in storage, ready for common bulkhead buildup.

Aft bulkhead dollar welding was completed and accepted in December, and as the period closed, the bulkhead was being prepared for hydrostatic testing.

10. S-II-11 FLIGHT STAGE

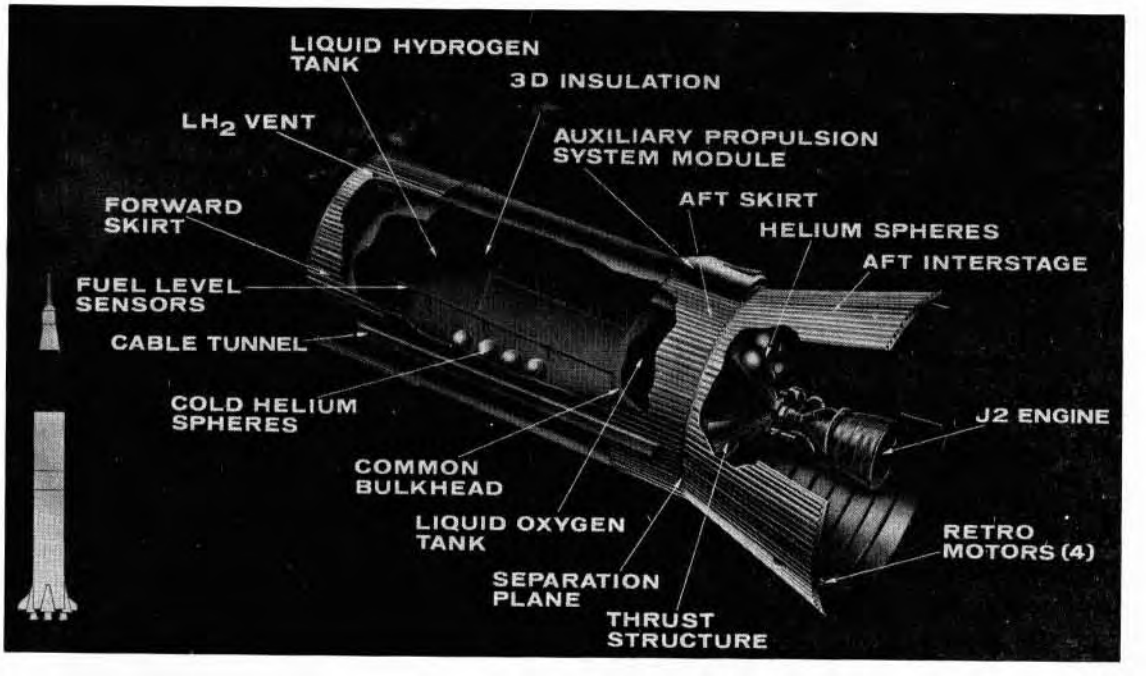
Forward bulkhead gore sections, and forward and aft facing sheets, were delivered to Seal Beach during the latter half of the reporting period.

Stage assembly activity began on October 6, with loading

S-II-11 FLIGHT STAGE (Continued)

of aft facing sheet gores on the weld tool. The final meridian weld was completed on December 5, and the bulkhead was placed in storage pending availability of the dollar weld fixture.

By December 18, the seventh meridian weld of the forward facing sheet was complete, and as the report period ended vertical welding of cylinders 3 and 4 was complete.



SATURN V S-IVB STAGE

E. S-IVB STAGES

General

There was one S-IVB Battleship Stage test conducted at MSFC during this report period. Rebuilding of the Beta III Test Stand at the Sacramento Test Center continued through most of the period--testing was resumed in the Beta III Stand with the installation of the S-IVB-206 Stage on November 22. The 503N Stage completed Acceptance Testing, and was placed in storage at SACTO in July. Shipment of the S-IVB 503N to KSC was accomplished on December 29, and arrived the following day. The 504N Stage completed Acceptance Testing, and was placed in storage at SACTO in August. Shipment to KSC is planned for April, 1968. S-IVB-505N Stage fabrication was completed early in the report period and the stage was delivered to SACTO August 18. Following completion of Acceptance Testing, the stage was placed in storage, at SACTO, in October. Fabrication of the 506N Stage was completed in September. Checkout and modification activity continued through December.

The S-IVB-507 through 510 Stages were undergoing various phases of manufacturing and checkout at the Space Systems Center at the end of the report period.

1. S-IVB BATTLESHIP STAGE (MSFC)

There was one test firing of an S-IVB Battleship Stage during this report period:

Test No.	Date	Duration	Remarks
S-IVB-046	7/6/67	436.39 Sec.	All parameters appeared normal. All planned objectives were met.

This test was conducted with the following prime objectives:

a) Evaluation of J-2060 engine performance with P. U. valve from J-2048 engine.

b) Measurement of bending loads in downstream portion of LOX ASI line.
c) Evaluation of LH_2 and LOX pressurization systems.
d) Investigation of fuel tank low level vortex.
e) Testing of contractor supplied instrumentation.

2. BETA III REBUILD

Refurbishment of the Beta III Test Stand shop was completed the first week of August, and all structural subcontract work was completed by mid-August.

The installation of the rebuilt Dummy Aft Interstage Kit was begun August 23, and completed October 1. Jib crane installations were structurally complete by the end of the month.

Rebuilt Blockhouse and Terminal Room GSE was calibrated early in September.

Test Stand electrical cable installations were completed by the end of August, and electrical "end-item" checkout was performed early in October.

Refabricated vacuum jacket lines were installed, and proof leak testing of cryogenic lines between pneumatic consoles and interface plates were performed early in October.

Pneumatic Consoles A & B were in place on the test stand and were connected at the beginning of October.

The engineering run of the Ground Support Equipment Test Set (GETS) was performed the week of October 12-18, after which the sell run of the DDAS was run. The sell run of the GETS was completed November 8. GSE checkout was complete by mid-November. The LN_2 Cold Flow of the LOX and LH_2 Transfer Systems was completed November 14, and the LH_2 Cold Flow test was successfully completed November 20. The S-IVB-206 Stage was installed in Beta III on November 22, and Power On was accomplished November 29.

S-IVB STAGES (Continued)

3. S-IVB-503N FLIGHT STAGE

The S-IVB-503N was at Sacramento, in the Vertical Checkout Lab, for post firing modifications and checkout at the beginning of this report period. The All Systems Test (AST) was begun the first week of July, and completed July 14. A meeting, held July 18, accepted the data from the AST, and the Turnover Meeting was held July 27. The stage was placed on a roll dolly in the South Tower for modification work. Anti-flutter kit modifications began July 31. The stage was placed in the horizontal storage position in the North Bay early in August, where flutter-kit mods continued. September found the stage again in the South Tower, with mods continuing. A NASA inspection team was at SACTO September 18 to 21 to perform a special electrical inspection. Checkout of stage GSE was initiated September 26. Electrical connectors on the 0_2 - H_2 burner propellant valves were found to have the same defect as had been noted on S-IVB-503 -- the Micarta wafers in the connectors were cracked.

By the end of the first week of October, sim-auto, manual control checks, and stage power-on had been completed.

The Aft Interstage Korotherm application was being completely reworked at Huntington Beach prior to shipment to KSC on November 24, to prevent any deterioration such as was experienced on S-IVB-501.

The stage was removed from the South Tower on November 29, and placed on the roll dolly for modifications.

Sell run of the AST was completed on schedule, on November 21.

Modification work proceeded on an accelerated schedule until December 27, when preparations were begun for shipment of the stage to KSC. A Stage Turnover Meeting was held on December 21 to review the open modification work to be transferred to KSC. A total of 596 installation

S-IVB-503N FLIGHT STAGE (Continued)

hours were to be transferred, including: relocation of LH_2 repress check valve, P. U. Over Monitor, LOX non-propulsive vent, and redundant J-2 engine start tank and helium tank pressure transducers. The stage was loaded aboard the Super Guppy on December 27, as scheduled, but the plane crew reported loud popping and rushing air noises after takeoff. The plane returned immediately to MAFB. The stage was unloaded, and no damage was sustained. Investigation of the aircraft indicated a structural problem with one of the nose section latches. Stage was reloaded December 29, and arrived KSC the following day.

4. S-IVB-504N FLIGHT STAGE

The S-IVB-504N arrived at the Sacramento Test Center via the Super Guppy Aircraft on June 16, and was installed in Tower #1 of the Vertical Checkout Laboratory (Figure 11). On July 7, the stage was placed in the Beta I Test Stand, where pre-fire checkout was performed. Ground Equipment Test Setup Automatic Checkout and Auxiliary Propulsion System compatibility were completed during the week of July 6 - 12.

Prefire sub-system checkout was successfully completed with the Integrated Systems Test (IST) on August 4. A simulated static firing countdown was completed without incident on August 9.

The scheduled Acceptance test firing on August 16 was scrubbed due to problems with the Beckman GDAS unit. Countdown had proceeded through LOX and LH_2 loading, 68% levels for the O_2 - H_2 burner firing, and Test Stand Walk-around. Acceptance test firing was rescheduled for August 22.

The Acceptance test firing on August 23 was terminated at 51.23 seconds because of a "FIRE" indication on the J-2 Engine. Post-test investigation revealed no evidence of fire; however, it was discovered that a section of fire

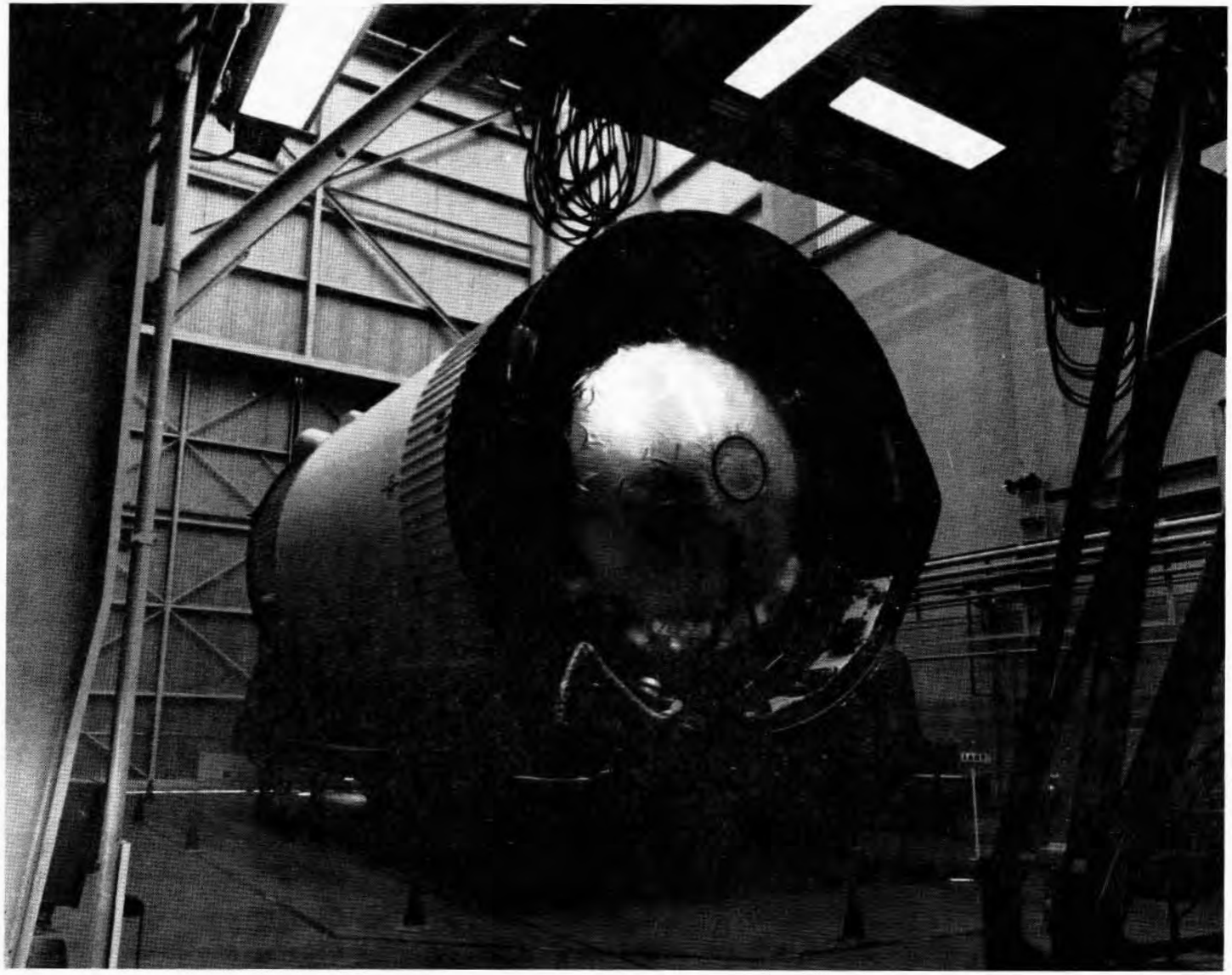


Figure 11. S-IVB-504 In Vertical Checkout Lab - SACTO

S-IVB-504N FLIGHT STAGE (Continued)

detection wiring was improperly positioned touching a fue turbine inlet duct which has an estimated external temper ture of 500-600 degrees Fahrenheit. As the fire-detection wiring is triggered at 170-200 degrees Fahrenheit, a "FI indication was received in the Control Center.

The two-day countdown was relatively problem free. Essentially all planned tasks had been successfully accomplished. These included: Relief Valve Cycle test, continuous vent valve operation, firing of O_2 - H_2 burner (204 second duration), Ambient Repressurization System test, and Critical Component test.

Acceptance firing of the S-IVB-504N was successfully accomplished on August 26. Mainstage duration was approximately 438 seconds. Cut-off was initiated by the propellant utilization system at the planned level of 1 percent liquid oxygen. Liquid O_2 prevalve response was slow during critical components check. The valve was subsequently replaced. The stage was removed from the test stand on August 31, and transported to the South Bay of the Vertical Checkout Laboratory for storage, following the successful completion of an abbreviated post fire checkout. Modification work is scheduled to begin in January, 1968.

5. S-IVB-505N FLIGHT STAGE

At the beginning of this report period, S-IVB-505N was located in Tower #5, Huntington Beach. Systems checkout was completed the first week of July, and the stage was moved to Tower #8 for 10 psi System Leak Checks. These were completed during the second week of July, and Dual System Repressurization installation was begun. This work was completed July 25, and the stage was moved to Tower #7, where the O_2 - H_2 Burner System was installed the last week of July. The stage was then painted and prepared for shipment. The Stage Turnover (Transfer) Meeting was held August 15. The stage was loaded aboard the Super Guppy August 17 (Figure 12), and arrived at Mather AFB

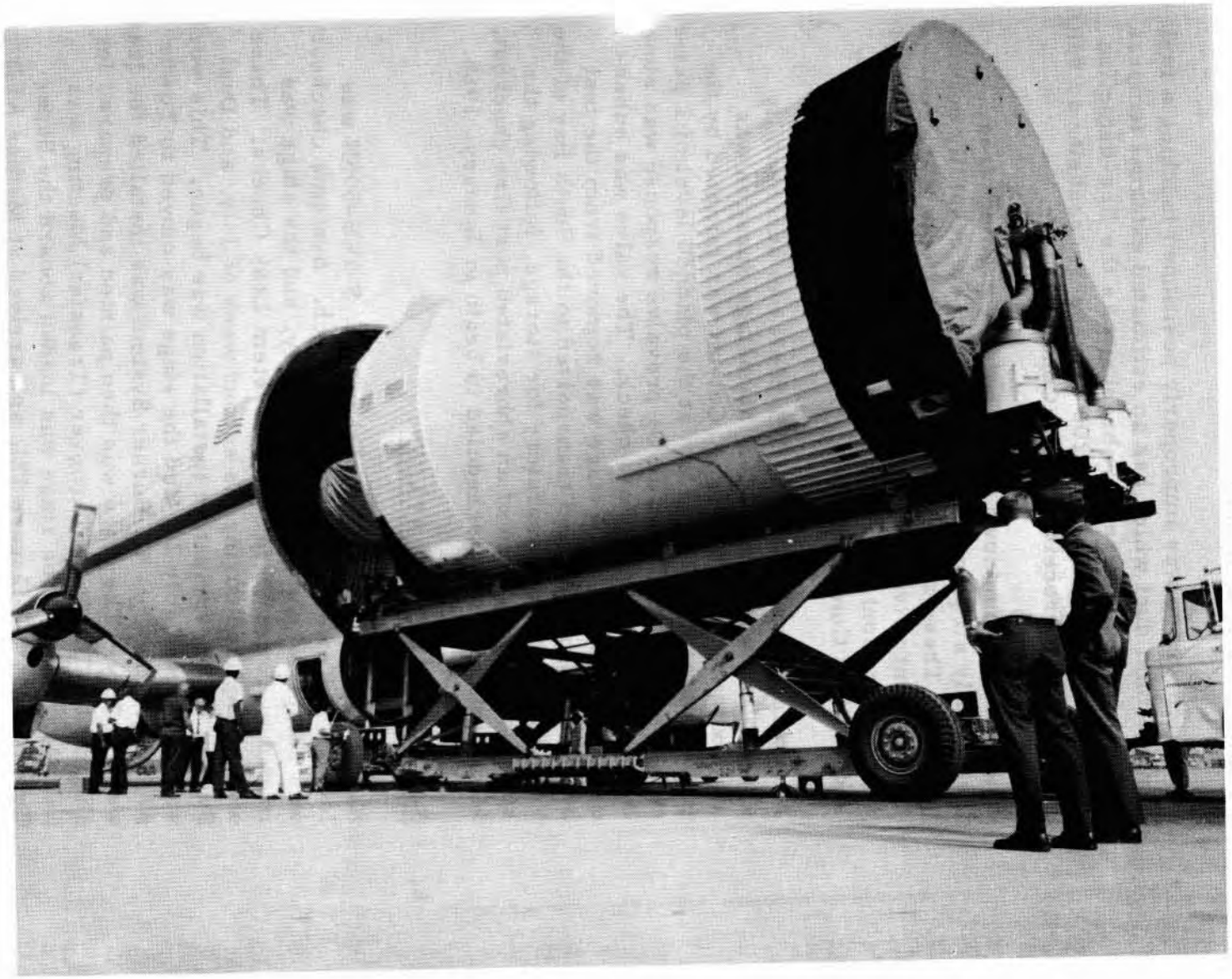


Figure 12. Loading S-IVB-505 Aboard The Super Guppy Aircraft

S-IVB-505N FLIGHT STAGE (Continued)

the same day. Transfer to the South Tower of the Vertical Checkout Laboratory was effected the next day, and mechanical and electrical modifications were accomplished. The stage was installed in the Beta I Test Stand for prefire checkout on September 1. During checkout, the O_2 - H_2 Burner Propellant valves were tagged for replacement.

The micarta wafers in the electrical connectors on the microswitch housing were found to be cracked and were tagged for replacement. It was also decided to replace the existing continuous vent valve with the newer - 507 configuration valve.

Checkout at the sub-system level was completed with the Integrated Systems Test on September 27.

Several modifications were incorporated during the following week:

The LOX shut-down valve was replaced due to erratic operation during checkout.

The 507 configuration continuous vent valve was installed and checked out.

Both O_2 - H_2 burner propellant valves were replaced. (The replacement valves differ from the original in that the rubber silicon material within the connector on the microswitch housing is not bonded to the glass insert.)

Simulated static firing countdown was completed October 5.

Acceptance firing countdown was initiated October 10. A hold was established, due to a defective hydraulic accumulator. The accumulator was replaced, appropriate fill and drain checkout procedures were rerun, and the countdown resumed on October 11.

S-IVB-505N FLIGHT STAGE (Continued)

The acceptance firing was successfully completed on October 12. Mainstage duration was 448 seconds. Propellant utilization cutback time was 152 seconds, with stage cut-off initiated due to LOX depletion. Abbreviated post-fire checkout work completed during the week of October 19 to October 25 included: Integrated Systems test, propellant leak checks, structural inspection, and hydraulic system securing. Hardware removals and post-fire mods began October 19.

Ground structural rework was completed October 24, and the Stage Turnover Meeting was held November 8. The stage was held on the Beta I stand pending removal of S-IVB-206 from the Vertical Checkout Lab.

The S-IVB-505N was placed in the birdcage in the VCL for storage on November 28. Modification work is scheduled to begin at the end of March, 1968.

6. S-IVB-506N FLIGHT STAGE

S-IVB-506N was at Huntington Beach, California, at the opening of this report period. Foil insulation was being installed on the Forward LH_2 Dome. LOX tank cleaning was also being performed at this time. Insulation installation and tank cleaning were completed, and LOX tank installation began on July 24. The stage was moved to Tower 2 for joining of the skirts to the tank assembly on July 27. Joining operations were completed August 21, on schedule, and the stage was moved to Tower 5 for J-2 engine installations (Figure 13). Engine installation was completed by the end of August, and stage checkout began in Tower 5 on September 6. Testing was suspended for a week during the middle of September for rework of a multiplexer test cable, but checkout activity was completed ahead of schedule on November 2. An insulation liner inspection was made the following week, and the stage was placed in Tower 8 for leak checks. Final inspection began in Tower 5 on November 15. Shipment to SACTO is planned for January, 1968.

Figure 13. J-2 Engine Installed In The S-IVB-506.

7. S-IVB-507 FLIGHT STAGE

At the beginning of the report period, the tank assembly (LH_2 tank, LOX tank, and forward dome) was in the Insulation Chamber at Huntington Beach for insulation installation. This was completed August 16, and the stage was installed in Tower 4 the third week of August; J-2 engine installation was completed by the end of August. During hardware installation in the LH_2 tank, a "blister" effect was noted on the liner of the internal insulation. It was determined that this was due to a number of tiles having passed inspection (in April) with an improper mix ratio of polyurethane ingredients. It was decided to replace the liner over the affected areas. Further investigation of the problem is to be made on stored stages at SACTO.

Tank liner rework was completed September 30, and LH_2 installations were resumed. Installations were complete by mid-November, and system checkout began. Completion of checkout is expected early in January.

8. S-IVB-508 FLIGHT STAGE

As this report period opened, the LH_2 cylinder and the LOX tank were being joined in Tower 1. Forward Dome-to-LH_2 tank welding operations began the first week in August. Welding was accomplished, and the tank assembly was placed in the Hydrostatic Test Tank in Tower 8 for leak checks. The stage was moved to the Insulation Chamber August 15. Insulation installation was completed, and inspections began the middle of September. Inspection revealed the same problem as had been encountered on S-IVB-507: a "blister" effect on tank internal insulation lining. Rework of 26 tiles was required. This work had to await the completion of S-IVB-507 rework, but was completed by the end of the first week of October. LH_2 tank hardware installations began October 15, and LOX tank installations followed early in November. LOX tank installations and cleaning were completed November 15.

S-IVB-508 FLIGHT STAGE (Continued)

and stage joining began in Tower 2. Stage joining was completed by mid-December, and electrical wiring and plumbing installations were begun.

9. S-IVB-509 FLIGHT STAGE

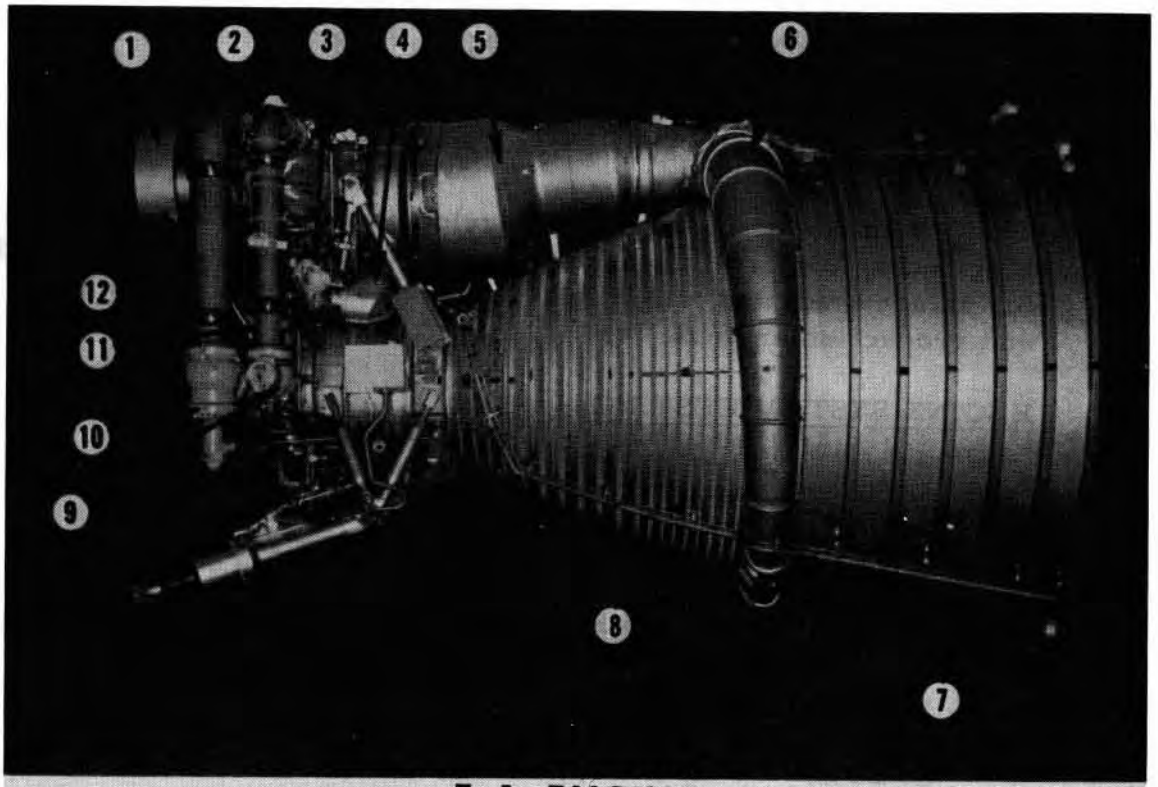
A "growler" check for debonding of the honeycomb insulation of the Aft Common Dome of the S-IVB-509 was completed the first week of July, and the Forward Dome/Aft Dome assembly was prepared for welding. Common Bulkhead seal welding, X-ray, and dye penetration checks were completed and accepted the following week. Welding of the LH_2 tank cylinder segments was also completed by the end of July. An out-of-contour area on the Aft LOX Dome was determined to be too serious to be reworked. The Aft Dome of the S-IVB-510 was selected as a replacement. The LH_2 Forward Dome was shipped to Huntington Beach August 8, followed by the LOX tank assembly on August 30. Welding of the LOX tank to the LH_2 cylinder was accomplished during the second and third weeks of September in Tower 1 at Huntington Beach.

Joining of the LH_2 Forward Dome to the LH_2 cylinder began the following week, was completed by the end of the month. The stage was moved to Tower 8 for leak checks. These were completed, and the stage moved to the Insulation Chamber October 8, for insulation installations, which continued through November. LH_2 tank installations followed, and were completed by mid-December. The stage was then moved to Tower 4 for cleaning.

10. S-IVB-510 FLIGHT STAGE

S-IVB-510 Common Bulkhead welding was accomplished at Santa Monica during July. Welding of the LH_2 Tank Cylinder quarter panels was completed at Huntington Beach during the same period. Fabrication of the LH_2 Forward Dome

(at Santa Monica) was accomplished, and the assembly was shipped to Huntington Beach September 19. The S-IVB-510 Aft LOX Dome was re-assigned to the 509 Stage, and was replaced by the S-IVB-511 assembly. This new Dome was joined to the 510 Common Bulkhead, and the completed LOX Tank Assembly was shipped to Huntington Beach October 3. Joining of the LOX tank to the LH_2 Cylinder began in Tower 1 during the first week of November. Tank assembly was completed by mid-November and was moved to Tower 3 for proof testing. Proof testing was completed December 6, and the stage was moved to the Insulation Chamber where preparations for insulation installations continued through the end of the year.



F-1 ENGINE

1	INTERFACE PANEL	7	THRUST CHAMBER EXTENSION
2	TURBOPUMP	8	THRUST CHAMBER
3	GAS GENERATOR BALL VALVE	9	NO. 1 MAIN FUEL VALVE
4	GAS GENERATOR	10	NO. 1 MAIN LOX VALVE
5	HEAT EXCHANGER	11	NO. 1 HIGH-PRESSURE FUEL DUCT
6	TURBINE EXHAUST MANIFOLD	12	NO. 1 HIGH-PRESSURE LOX DUCT

SATURN V ENGINES

F. ENGINES

General

Through December 31, the F-1 Engine Program has conducted 1,960 R&D engine systems tests for a total of about 162,737 seconds. Eight hundred fifty-two of these tests were for full duration, with 328 exceeding 160 seconds.

The J-2 engine has been under development for approximately 88 months. During this period, 3,256 tests have been conducted for an accumulation of 338,642 seconds using 162 development and production engines.

ENGINE SYSTEM TESTING

1. F-1 ENGINES (EFL)

Developmental test activity continued at Edwards Field Laboratory (EFL) on the four R&D test positions. One hundred twenty-two R&D engine tests were conducted for an accumulated duration of 13,254 seconds; of these, 69 were full duration runs (150 seconds or more). This makes a total of 1,960 R&D tests of this type conducted at EFL.

Thirty-six production engine tests were conducted at EFL during this report period. Total duration of these tests was 2,983 seconds. Twelve of these tests were for full duration (150 seconds or more). This makes a total of 279 tests of this type conducted at EFL.

2. F-1 ENGINES (MSFC)

WEST AREA

A total of eight F-1 engine tests were conducted at the West Area F-1 Test Stand during this report period. Two different engines were used. Total duration for the tests was approximately 340 seconds. Test objectives were as follows:

F-1 ENGINES (MSFC) (Continued)

a) Calibrate F-1 engine for S-IC-T use.
b) Establish a baseline for the LOX depletion test series.
c) Evaluate F-1 engine performance during LOX depletion, utilizing GOX pressurization.
d) Evaluate F-1 engine performance during LOX depletion, utilizing helium pressurization.

The last test to be performed was FW-074, during the month of November. The following month the West Area F-1 Test Stand was secured to a standby status. Future F-1 engine testing will be limited to critical high priority programs that may be generated as the result of anticipated or actual flight malfunctions.

3. F-1 ENGINE LAND TRANSPORT TEST

The mode of shipment of F-1 engines from Canoga Park, California to Michoud, Louisiana has been changed from air transport by Super Guppy to land transport by truck. Some difficulty has been encountered with the engine shipping covers which are made of a textured, rubberized fabric. Difficulties encountered were:

a) Water inside containers on most shipments.
b) One cover damaged en-route, which delayed the shipment until another could be provided.
c) On Engine F-6066, receiving inspection checks revealed 26 discrepancies due to rust.

Various approaches which will protect the engine and not present an excessive investment are being evaluated.

4. J-2 ENGINE (SS-FL)

During this report period, 100 R&D tests were conducted at Santa Susana Field Laboratory for a total of 14,675.0 seconds. Thirty-five production engine tests were conducted and a total duration of 4,449 seconds was accumulated during this period.

ENGINES (Continued)

5. J-2 ENGINE TESTING AT AEDC

The J-2 engine environmental verification program at Arnold Engineering Development Center continued during this report period. Major test objectives accomplished include:

a) Simulation of S-IVB 80-minute orbit restarts.
b) Evaluation of emergency start tank dump procedure.
c) Evaluation of the compatibility of the fuel pump to start at very low engine inlet pressure.
d) S-IVB-500 one-orbit simulation to test turbine hardware condition.
e) Completion of the SA-501 verification program.

Testing resumed at AEDC on July 6, after a four week shut down for annual facility maintenance.

The last S-II-501 test series was run during the early part of the report period. All 501 testing was completed and required modifications were incorporated into the flight vehicle. Engine J-2052 was removed from the J-4 test cell in October and replaced by engine J-2047. The purpose of this engine exchange was to evaluate a second sample of the capability of the engine fuel pump to start under very low inlet pressure.

ENGINE PRODUCTION AND DELIVERIES

1. F-1 ENGINES

Eleven production F-1 engines were accepted during this six month period. Assignment of the engines were:

a)	The Boeing Company	S-IC-9	flight stage	1
b)	The Boeing Company	S-IC-10	flight stage	5
c)	The Boeing Company	S-IC-11	flight stage	3
d)	Unassigned			2

F-1 ENGINES (Continued)

Approximately 35 tests were conducted for 2,815.87 seconds during the acceptance testing of seven engines.

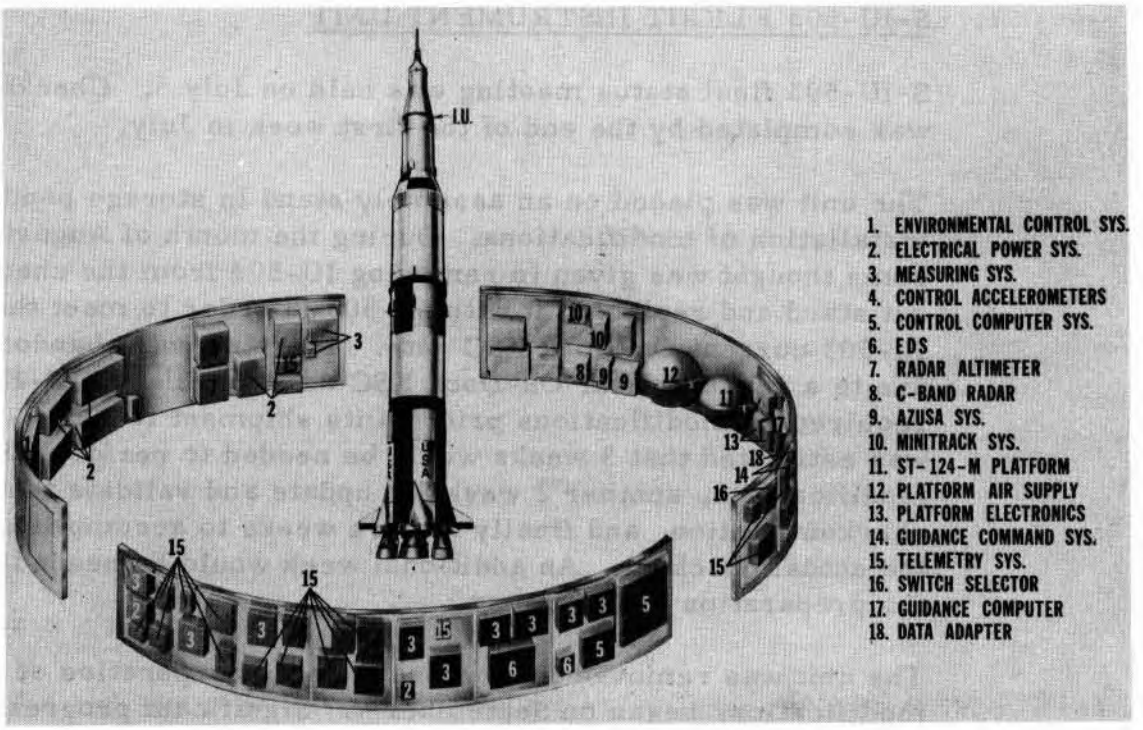
As of December 31, a total of seventy-five F-1 engines had been delivered.

2. J-2 ENGINES

Twelve J-2 production engines were accepted this period, and were allocated as Government Furnished Equipment as follows:

a)	North American Aviation	S-II Flight Stages	9
b)	Douglas Aircraft Corp.	S-IVB Flight Stages	3

This makes a total of one hundred and nine J-2 engines delivered by Rocketdyne through December 31. All of these engines were utilized either on Saturn V vehicles or as Saturn V spares. Acceptance testing during this report period resulted in thirty-five ' being conducted for an accumulated total of 4,449 s



SATURN V INSTRUMENT UNIT

G. INSTRUMENT UNITS

General

S-IU-503 was waiting shipment to KSC at close of the report period. The S-IU-504 was accepted by NASA on November 1 and was undergoing additional modification. The S-IU-505 and 506 were in component assembly and structural fabricati respectively.

1. S-IU-503 FLIGHT INSTRUMENT UNIT

S-IU-503 final status meeting was held on July 5. Checko was completed by the end of the first week in July.

The unit was placed on an assembly stand in storage pendi installation of modifications. During the month of August, some thought was given to removing IU-504 from the check- out stand and replacing it with IU-503 in order to meet the IU-503 current On-Dock KSC date. The plan was abandoned due to a new and later On-Dock KSC date for IU-503. S-IU-5 required 33 modifications prior to its shipment to KSC. It was estimated that 3 weeks would be needed to perform the modifications, another 2 weeks to update and validate the checkout station, and finally 3 more weeks to accomplish the actual checkout. An additional week would be needed for preparation for shipment.

The unit was removed from storage and incorporation of the modifications began on September 7. Significant progress was made through the third week in September. Inspection disclosed a dent in cold plate number 20 which occurred during reinstallation of an electronic assembly; the damaged plate was replaced.

During the final week of September, 12 of the 33 required modifications were completed with a total of 19 modifications in progress. Seven additional modifications were added to the IU-503 modification list, making a new total of 40 modifications required. Work continued to progress, and at the end of the first week in October, all but three modifications had been completed, and S-IU-503 was in the checkout stand.

S-IU-503 FLIGHT INSTRUMENT UNIT (Continued)

Checkout station validation was completed on November 14, and system checkout began the same day. The Power Distribution and Control test (PD&C) was conducted on November 15, but was unsuccessful due to Electrical Support Equipment (ESE) and procedure problems.

S-IU-503 remained in the checkout stand, and retesting of various systems continued through the end of November and into December. By the second week of December, the retest was complete; however, several anomalies were revealed. It was decided that random retest of the problem areas would best facilitate closeout of systems checkout.

At the close of the report period, all retests had been satisfactorily completed, and S-IU-503 was awaiting shipment by Super Guppy to KSC.

2. S-IU-504 FLIGHT INSTRUMENT UNIT

Constraints mentioned in last progress report continued in the early part of this period. Total assembly of S-IU-504 was constrained by the following shortages: Gas Bearing Supply Panel, Water Menthanol Accumulator, Electrical Assemblies, CCS Directional Antenna, C-Band Transponder, S-Band Transponder, CCS Power Amplifier, and RF Assembly.

The Umbilical through End-item test was completed on July 19, and the unit was moved to the checkout stand July 21 (Figure 14). The GN_2 Leak test was satisfactorily completed during week ending July 27, and the S-IU-504 began systems checkout on July 28.

During checkout, the IU-504's 56 volt power supply failed, and was replaced with an alternate unit. Checkout continued, and by the middle of August the sub-system checkout phase began, whereby each system underwent individual testing. Failure of the 270 multiplexer on August 23, plus several other problems, such as parts shortages, brought about a delay in completion of the S-IU-504 checkout.

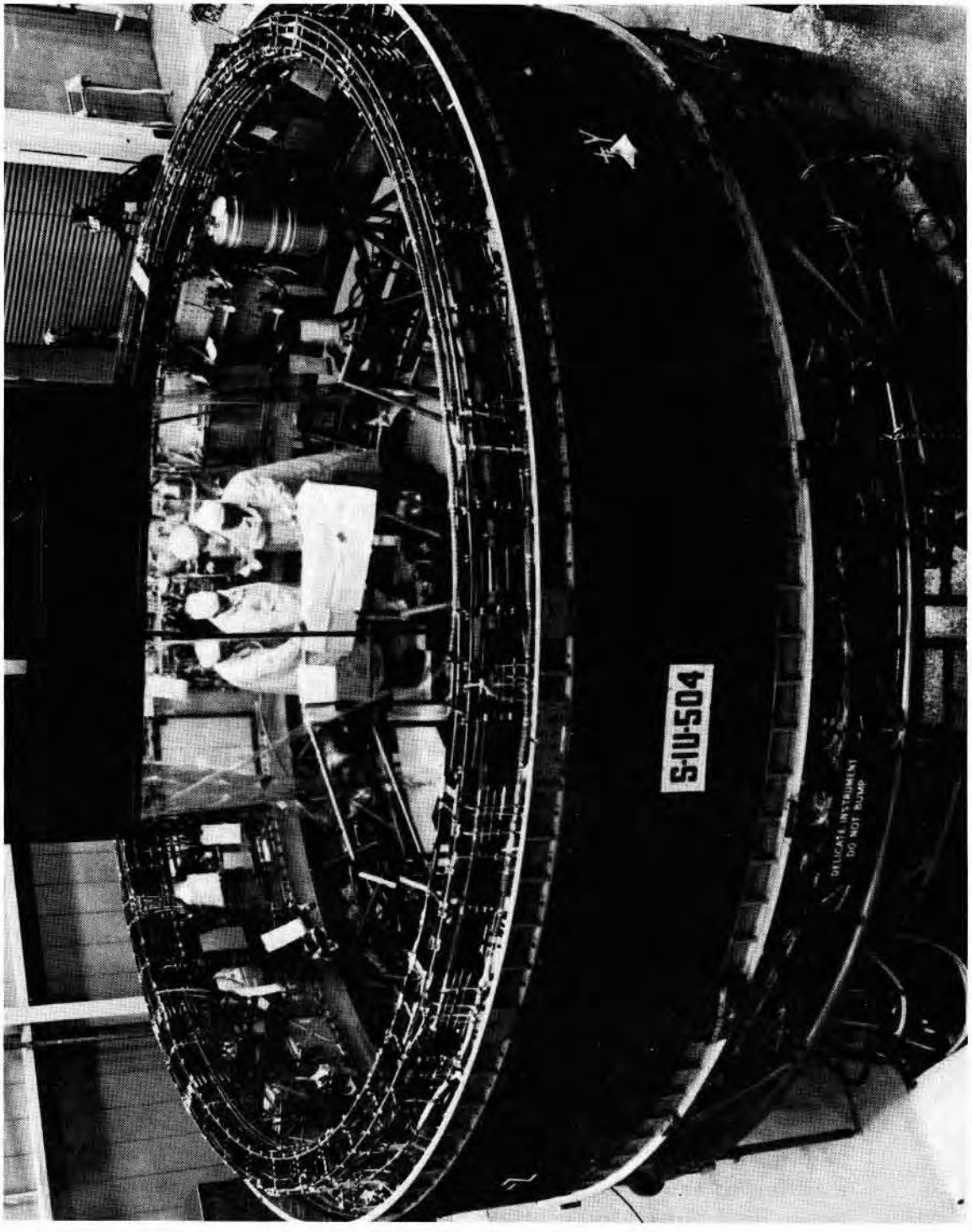


Figure 14. S-IU-504 On The Checkout Stand

S-IU-504 FLIGHT INSTRUMENT UNIT (Continued)

Several parts, previously listed as short, were received and installed together with the Flight Control Computer, during the first week in September. The ESE/Vehicle Compatibility test failed due to a circuit to chassis ground electrical short in the Flight Control Computer. The Computer was removed for repair on September 11, Absence of this assembly was the major problem confronting checkout of the S-IU-504. A Non-Flight Model of the Flight Control Computer was installed, and checkout continued so far as possible.

The first week in October saw the conclusion of the fifth "Simulated Plug Drop test"; all five of these tests were either unsatisfactory or were prematurely terminated. Investigation of these problems and a subsequent test on October 5, proved satisfactory.

A simulated flight test was conducted on October 6. The pre-lift off data was unsatisfactory, and a rerun was scheduled for October 13. Drain, dry and refill operations of the IU were conducted on October 10 and 11. A noise spike on LVDA ladder output was thought to be isolated to relay K41 in 6D3A2 control distributor. The distributor was removed, and the relay was replaced. A rerun of the PD&C test showed the noise spike still existed; however, this spike is no longer a problem. The simulated flight test was rerun on October 18; evaluation of the data proved satisfactory, and the S-IU-504 was removed from the checkout stand on October 30.

During the first week in November, the Instrument Unit underwent final government inspection. Major problems constraining government acceptance involved numerous discrepancies in the documentation reflecting the "as-built" versus the "as-designed" configuration. These differences were corrected The S-IU-504 was accepted by NASA on November 14, and the unit was prepared to undergo modifications.

By the end of the month, all mod kits were ready for installation; however, the checkout station was occupied by the S-IU-503 undergoing re-test. During the week of December 14, the IU-503 completed its retest; but, due to anomalies

the unit remained in the checkout station, thus further delaying final testing of the IU-504.

3. S-IU-505 FLIGHT INSTRUMENT UNIT

The S-IU-505 was installed in the relocated fabrication stand during the latter days of the last reporting period, and fabrication progressed satisfactorily during the month of July (Figure 15). As of the second week in August, fabrication was estimated to be 85% complete.

During the following week, much activity was devoted to installation of inserts for antenna mounting brackets. On August 15, S-IU-505 was lifted from the fabrication stand, and taken to the X-ray bay where each cluster of inserts for the eight antenna mounting brackets were X-rayed.

By the end of August, remaining work necessary to complete fabrication consisted of installation of Vibration Dampeners, Ground Rivets, and Antenna Mounts. The unit required touch-up painting, after which assembly operations began on September 12.

By the end of September, IU-505 assembly status was: 5 cold plates, all hazardous gas tubing, and 5 cable tray support brackets installed. Further manufacture and assembly was constrained due to non-availability of other cold plates that had been rejected because of suspected contamination. MSFC and Contractor personnel met in an attempt to correct the situation. The meeting proved successful, and the cold plate corrosion problem was resolved. By the end of the first week in October, manufacturing and assembly was progressing satisfactorily.

Assembly operations on the S-IU-505 continued into the second week of October; however, these operations were constrained by a shortage of cables, tube assemblies, a vibration isolation assembly, Gas Bearing Supply Panel, and numerous electrical assemblies. Insofar as possible, assembly operations

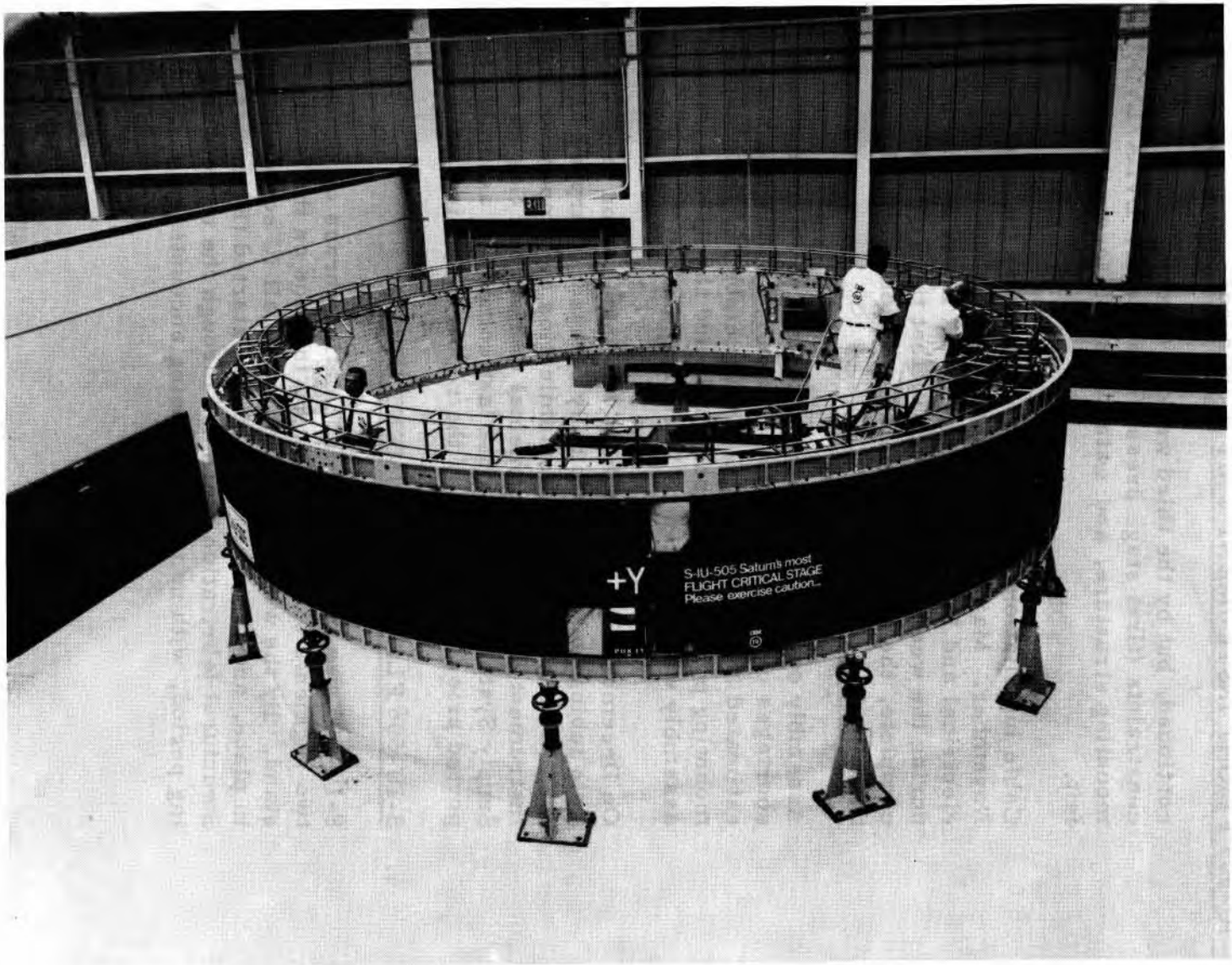


Figure 15. S-IU-505 Undergoing Structural Fabrication

continued, but by the third week of October, additional major constraints (first stage pressure regulator, LVDA/LVDC mounting structure, and water menthol accumulator) were felt.

Cable installations on IU-505 began during the first days of November. Major hardware shortages continued to be electrical and ECS panel assemblies. It was estimated during the week of November 16, that the S-IU-505 was 40% complete, the major constraints previously mentioned continued.

Assembly operations continued during the following week. shortages continued to exist; however, IU-505 was now estimated at 50% complete. On December 7, the antenna mounting points were resurfaced, and the RF transmitter assembly was installed on December 12.

On December 21, flight tubing was installed on the S-IU-505. This tubing had been thoroughly cleaned. Purpose of cleaning was to guard against contamination of components in the Instrument Unit's Environmental Control and Gas Bearing Supply System. This was the last component assembly reported prior to the close of the reporting period.

4. S-IU-506 FLIGHT INSTRUMENT UNIT

S-IU-506 was in the initial fabrication phrase on October 19, two segments of the IU-506 were in place on the fabrication stand. By the week of November 16, all IU segments were in place, and structural fabrication started (Figure 16). Structural fabrication continued through the end of the reporting period, with no problems being encountered.

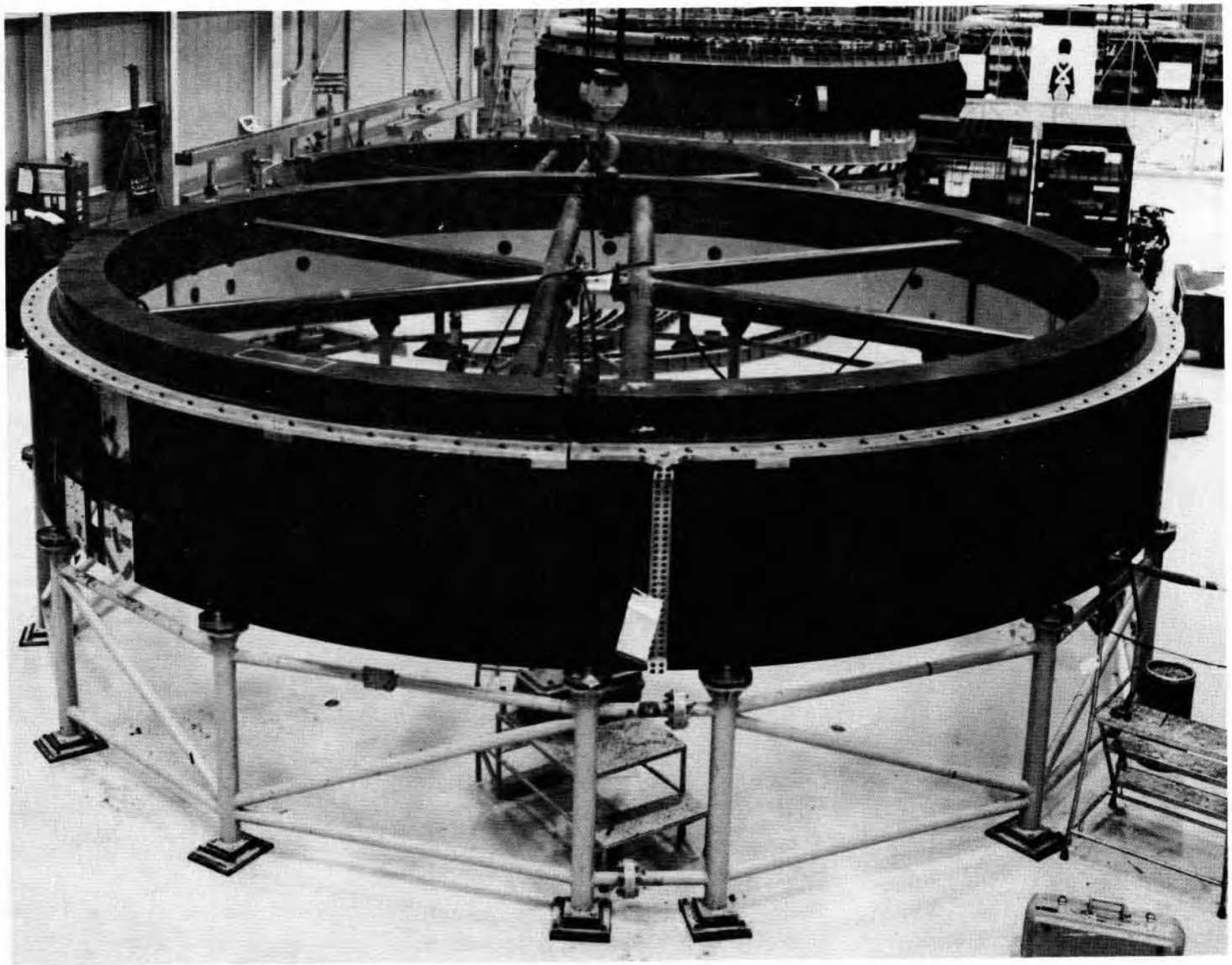


Figure 16. S-IU-506 Situated On The Fabrication Stand

SATURN V LAUNCH VEHICLE GSE

H. LAUNCH VEHICLE GROUND SUPPORT EQUIPMENT (LVGSE)

General

LH_2 Burn Pond modifications for Pad A were completed during this report period. The replacement on both Pad A and Pad B, of a 6" LOX vent line with 10" lines, and of 10" LOX fill lines with 14" lines was also completed during the period. Pad A and LUT 1 sustained some damage in support of the AS-501 launch, a damage assessment was made, and repairs and refurbishment began immediately. Modification and validation of LUT 1 and 2 service arms was completed. Spacecraft automatic checkout equipment for Firing Room 3 arrived in September.

1. PAD A

This report opened with the completion of the Pad Terminal Control Room (PTCR)/LCC Integrated test on July 3.

Environmental Control System (ECS) control panel mods were completed the last of July, and Environmental Control System Air-to-GN_2 Changeover tests were run early in August. Environmental Control System GN_2 functional testing was performed the third week of August, and integrated testing was completed by August 28, after AS-501's transfer to Pad.

LH_2 Storage Area leak testing was completed July 12, and integrated testing on August 28. LH_2 vacuum jacket line evacuation and leak testing was also completed this date.

Cold alignment of LOX pump 126 was accomplished on August 8, of pump 106 on August 14, and of pump 107 on August 15. Warm alignment of pump 107 also occurred August 15. Cross-country LOX line cleaning revealed four cracked lap welds which were replaced with forged flanges. LOX pump cold alignments were completed by August 18, and sub-system tests were successfully performed. LOX storage filling was accomplished August 24.

LOX prepressurization lines, which had arrived August 3, were cleaned on August 24, and subsequently installed on Pad A.

PAD A (Continued)

RP-1 Fuel Circulation testing was completed August 24.

LOX Simulated Loading test was successfully accomplished August 31.

GSE electrical/mechanical end-to-end and hardware checks were completed September 6.

The LOX storage facility was used to store LH_2 for AS-501. Tank filling began July 24, was completed July 28, with system functional checkout completed by September 25.

Replacement of the 6" LOX vent lines with 10" lines, to relieve overpressurization problems, was completed during the second week of August. All the 10" vent line system installations were completed by November 7.

Pad A supported the launch of AS-501 on November 9. Blast damage was sustained by the Engine Service Cart and Platforms. The resilient Crawlerway surface on the Pad was severly damaged, and the flame deflector surface cracked. The RP-1 interface mast was distorted by heat, and the Mobile Service Structure mounts sustained severe heat and blast damage.

All rework and replacement must be completed in early 1968, to support AS-502 transfer to the Pad.

2. LAUNCH UMBILICAL TOWER NO. 1 (LUT 1)

The RP-1 fuel system flush was completed the first week of July, and RP-1 transfer system leak checks were accomplished July 28. All aluminum LOX valves were replaced with stainless steel valves and changeout was completed August 9. LH_2 baseline tests were run the second week of July, and LH_2 leak checks were run August 12-16.

The RP-1 LCC/PTCR integrated test run was completed August 14. S-IVB propellant/vehicle interface was effected and verified August 15. S-IC propellant/vehicle interface

followed on August 17. LOX and propellant pre-pressurization checkout were accomplished September 10.

A Marotta valve inspection on August 17-18 revealed 6 discrepant valves. These were removed and replaced. Forty valves were inaccessible, and could not be inspected. A decision was made, on August 22, to cover the inaccessible valves with potting compound to prevent potential internal water damage.

Operational Readiness requirements were met with AS-501 being moved to Pad A on August 26.

LUT interface leak checks were completed September 6. Spacecraft Power-on was accomplished September 7, and Spacecraft Vehicle Cut-off and Malfunction test was run September 13. The LH_2 coldflow test occurred September 20.

The installation of a Helium purge to the LH_2 valves on LUT 1 and pad facilities was completed September 8. ECS/LCC - Vehicle Interface tests (Part III) were completed early in September, and Hazardous Gas Detection System leak checks of all stages were satisfactorily completed September 10.

LUT level fogging system tests were run September 12. Two faulty valves were found, and broken diaphrams were suspected. The valves were replaced, the system repressurized, and tests were rerun on September 16.

A Q-ball removal system was installed the first week of September. Visual inspection and pressurization checks of the system were performed September 16. The system was damaged during testing by the LUT hammerhead crane, and was subsequently replaced by the Apollo 6 system. The new system allowed completed Cover Retract and LCC integrated tests by the end of the month.

The ECS GN_2 Moisture Level test was performed early in October. LH_2 storage tanks were filled and topped off October 17, and LUT inert prefill units and cryogenic propellant storage tanks on October 24.

LVGSE (Continued)

SERVICE ARMS LUT 1

Service Arm (SA) activity was restricted largely to modification and checkout.

SA 1 - Carrier assembly modifications and instrument functional tests were completed the first week in August. LOX debris valves were reworked to reduce pressure during disconnect; this was accomplished by the end of September. LOX fill and drain lines were successfully leak checked October 8. SA-8 reconnect mechanism was installed and leak checked October 24, and a new (replacement) stag bearing plate was installed and bonded October 30. A crack was discovered in the original plate.

SA 2 - A discrepant indicator switch was replaced on August 17.

SA 3 - Service-arm pressurization, damper-arm switc and retraction was successfully accomplished August 10. A new stage bearing plate was insta and bonded August 30.

SA 4 - A propellant pneumatic withdrawal cylinder an latch-back cylinder were installed and tested i Storage duct jib hoist installations were compl August. LOX pre-pressurization, fill and dr lines, and the NAA J-ring purge line at the b were installed in September; however, the L and drain line subsequently developed a leak changed out in October.

SA 5 - A kinked fuel standby prepressurization line placed October 6, and GN_2 vent lines were fully leak checked October 8.

SA 6 - Straza duct installations were completed ir LH_2 fill and drain lines were successfully October 24.

SERVICE ARMS LUT 1 (Continued)

SA 7 - A leaking LH_2 vent line was found to be kinked; the line was straightened and successfully leak checked in September. Cryogenic leaks developed during testing in early October, and resulted in the replacement of a GN_2 vent line flex hose. Service arm external platform locking mechanism installations were completed October 25.

SA 8 - In August, an interface problem between the service arm filter box and the Mobile Service Structure (MSS) "clamshell", preventing the closure of the MSS platform, was resolved by the relocation of the filter box.

Permanent weatherproofings, and emergency egress modifications were completed in early September. An interface problem between the service arm extension platform and the Spacecraft was resolved, early in November, by the modification of the service arm extension tip.

SA 9 - Cryogenic fill and bleed tests were completed late in July. SA functional testing in manual, automatic, and and remote manual modes was successfully completed in August. SA integrated testing was also completed in August, following shear-door installation.

Permanent weatherproofing and fire hose installations were accomplished in September, also environmental chamber control lines were pressurized. Service arm pressurization, damper arm switchover and retract were successfully accomplished early in October.

Tail Service Mast (TSM) Cryogenic Line Fill and Bleed tests were completed early in August. A leak was discovered in the cylinder supply and control valve of TSM 3-4 during slow-retract tests in August. The cylinder was replaced, and slow-retract was subsequently accomplished. A manual

SERVICE ARMS LUT 1 (Continued)

bleed valve on TSM 3-2 leaked during SA testing and was replaced August 11. TSM modification functional testing was completed September 20.

Hold Down Arm (HDA) / LCC integration testing using ordnance, was completed August 15, and integration testing was fully completed August 18. Control release modifications were completed by the end of August. On October 24, it was discovered that the stage bearing plate on HDA 1 was cracked, and the epoxy bonding on HDA 3 bearing plate was sheared; these were replaced before the end of the month. HDA lanyard modifications were completed October 30.

3. LAUNCH UMBILICAL TOWER NO. 2 (LUT 2)

On August 18, a valve on the LUT 6,000 psig GN_2 system was inadvertently opened resulting in several seal leaks. As a result, IU Pneumatic Console Remote checkout was delayed 3 days.

Launch Control Center/Firing Room 2 guidance console modifications, calibrations, and checkout were completed August 25.

Initial blowdown of all SA control consoles was accomplished September 13.

The LCC ground computer remote control panel was installed September 16.

LUT Hydraulic Charging Unit Supply and Return Line Pressure test was run September 16.

MSS/LH_2 Disconnect test was completed September 18. Damper Retract and Reconnect (DDRS) winch, winch control panel, and control console were installed during the week of October 6. Reinstallation of an LH_2 18 inch vent line,

previously removed for modification, was also accomplished during this week. The main LOX discharge line was installed during the week of October 20. The LOX propellant control console, and the LOX by-pass system control console were installed the first week of November. All 14 inch main LOX fill lines were installed by November 10. Damper arm installations began November 20 -- completion is expected early in January, 1968. The industrial water main deluge riser was erected November 6.

SERVICE ARMS LUT 2

All SA modifications, required prior to SA validation, were completed October 30.

SA 1 - Retract Component Pressure and Bleed tests were completed October 31.

SA 2 - Withdrawal Subsystem functional test was accomplished December 1.

SA 3 - Withdrawal Subsystem functional test was accomplished December 1.

SA 4 - Retract Pressure and Bleed test was performed December 1, Withdrawal Component test December 6, and LCC integrated tests on December 8.

SA 5 - Manual Withdrawal and Withdrawal functional tests were completed the first two days of December, and LCC integrated tests December 5.

SA 6 - Retract Pressure and Bleed test was performed November 19, Subsystem functional test the following day, and LCC integrated tests November 28.

SA 7 - Component Pressure and Bleed tests were performed October 31, Withdrawal Subsystem functional test November 24, and LCC integrated tests November 28.

SERVICE ARMS LUT 2 (Continued)

SA 8 - Withdrawal Subsystem functional tests were completed October 31, and LCC integrated tests November 16. SA 8 validation was completed November 20.

SA 9 - Withdrawal Subsystem functional tests were performed December 6.

TSM - Slow Retract tests of TSM 3-4 were successfully completed November 28, and TSM 1-2 Subsystem functional tests December 1. TSM/LCC integrated test was run December 2.

HDA - HDA/LCC integrated test was successfully completed during the week of December 7-14.

LUT 2 supported the Launch Vehicle Over All Test (LV/OAT) Plugs-in on December 21.

6. PAD B

Functional testing of Pad B RP-1 Propellant System was accomplished August 16.

LH_2 System functional testing was completed September 12, with LH_2 System fill following on September 17.

Phase 2 of Pad B Burn Pond modifications were completed November 3.

LOX Propellant and By-pass System Consoles were installed November 2, along with the LOX Purge Panel.

Installation of all 14" LOX fill lines, and 10" vent lines were completed November 10. Cold Shock testing of these cross-country lines was accomplished November 30.

7. LAUNCH UMBILICAL TOWER NO. 3 (LUT 3)

Spacecraft automatic checkout equipment for Firing Room 3 arrived KSC September 15.

Rust and scale removal and repainting of LUT 3 was accomplished November 13, and the LUT was moved to Pad B on November 21, for Interface Compatibility tests.

8. LCC/RCA 110A COMPUTER

A new Operational System (OPS) tape, containing the Automatic Checkout Equipment (ACE) portion of the Emergency Detection System (EDS) program for the 110A, arrived on July 22; verification was completed two days later.

Two modules that had caused a memory disparity during LV/OAT 2 rerun were replaced August 14.

Checkout of LCC computer power supply, and installation of a new 110A computer drum were accomplished August 21.

LCC Count Clock modifications were completed August 24.

Service Module Deluge Panel/LCC integrated tests were completed September 12.

LCC completed requirements for remote re-initialization on September 18.

Calibration of the LCC Digital Events Evaluation magnetic tape unit was completed October 26.

Checkout of the LCC Display Console was accomplished early in November, and with the installation and checkout of the new OPS program on November 11, the LCC was ready to support SA/LCC integration testing.

A flight control computer failed during checkout, on December 4, this required returning the computer to the vendor. The repaired unit was returned to KSC, and reinstalled before the end of December.

9. POST AS-501 LAUNCH DAMAGE ASSESSMENT

An inspection of launch facilities, utilized in the November 9, launch of AS-501, was made to assess damage to those facilities. The assessment was limited to a visual inspection to determine the extent of damage. Only limited testing was accomplished during this inspection. Following is a brief assessment of major damage sustained by the facilities.

PAD A LUT 1 - Refurbishment and validation of Tail Service Masts and Holddown Arms is scheduled for completion by January 17, 1968. Completion of Service Arm refurbishment and validation is anticipated by the end of January.

a) Propellant Systems - Recertification testing began December 29.

LOX System - There was contamination of LOX Systems lines.

RP-1 - Damage consisted of burned and bent piping in the disconnect tower.

LH_2 - Most significant damage was a crack in the burn panel which allowed water to leak in.

Propellant Loading Networks - Overall damage to propellant electrical systems was minimal; however, water was found in propellant consoles and distributors - this had not been anticipated. Some cables showed heat and fire damage.

b) Pre-Flight Service Arms, Damper Retract & Reconnect Systems

Auxiliary Damping Systems - Service Arm 1, S-IC Intertank - All the LOX lines were contaminated and the Hinge Cylinder Bleed Valve connections came loose allowing

leakage of hydraulic oil in hinge area, causing undetermined damage to lower hinge. Control console number 1 doors were blown open, damaging latches. Service Arm 1 does not have to be removed from tower for rework but the LOX lines must be removed and cleaned.

Service Arm 2 - S-IC Forward - Hinge Cylinder Bleed Valve connections came loose allowing leakage of hydraulic oil in hinge area. The oil burned, causing undetermined damage to upper and lower hinges, environmental control system flex hose, vehicle service line flex hose, and associated tubing. Control console doors blew open, damaging latches. The Arm does not have to be removed from tower. Recertification began December 14 and Service Arm 2 was available for vehicle processing December 28.

Service Arm 3 - S-II Aft - Same as Service Arm 2. Recertification was accomplished December 14 to 18.

Damper Retract and Reconnect System - The only visible damage was a cracked weld at a local console door hinge. This resulted from an excessive negative pressure outside the console. This Arm does not have to be removed from Tower. Recertification was accomplished December 11 to 19.

Service Arm 9 - Command Module - The Environment Chamber door was bent and twisted and the Environment Chamber over-pressure vent was broken. Control console door latches were broken.

All damage resulted from excessive negative pressure outside of enclosed areas. All damaged parts will be replaced. This Arm does not have to be removed from Tower.

c) Service Arm and Tail Service Mast Electrical Systems

Tail Service Mast - Cables in the lower part of Tail Service Mast appeared to be undamaged; however, it

Service Arm and Tail Service Mast Electrical Systems (Continued)

is assumed that all Tail Service Mast umbilicals were damaged and all will be replaced.

Hold Down Arms - Cabling and J boxes internal to Hold Down Arms 1, 3, and 4 were damaged by flame.

Service Arm 1 - This arm (at 60' level) sustained heaviest cable damage.

Service Arms 2, 3, 4 - Cables at hinge points sustained damage due to hydraulic oil fire -- positioned indicator cables internal to the hinges were probably destroyed.

Service Arms 5, 6, 7, 8 - Only minor damage was sustained.

d) In-Flight Service Arms

Service Arm 4 - S-II Intermediate - The control console doors blew open, damaging latches; extensive hinge area damage was due to hydraulic oil fires; hinge - end LOX LH_2 flexhoses were exposed to high temperature due to hydraulic oil fires; the "Arm Extended" switch was burned by hydraulic oil fires; hinge cover (aluminum) on lower hinge melted, hydraulic hoses inside were burned, and the hinge cylinder and bearings were exposed to high temperature.

Service Arm 5 - S-II Forward - The control console doors blew open and the door latch was damaged. Deceleration bleed valve assemblies leaked hydraulic fluid and a LH_2 vent line convolute section was damaged. This Arm does not have to be removed from Tower.

Service Arm 6 - S-IVB Aft - The secondary separation lanyard was broken and the insulation on cables was damaged. This Arm does not have to be removed from Tower.

Service Arm 7 - S-IVB Forward - The insulation of Water Methanol line was pulled loose and the door latch assembly on control console was sheared off. This Arm does not have to be removed from Tower.

In-Flight Service Arms (Continued)

Tail Service Mast - The lower hood of Tail Service Mast 1-2 was blown away but the upper hood remained attached - both hoods on Tail Service Mast 3-2 and 3-4 were blown away. All hood actuators were in the open position.

Aft Umbilical Carriers - All Umbilical Carriers sustained major damage due to being exposed to direct heat and engine blast when Tail Service Mast hoods did not close during launch.

Engine Service Lines - The silicone canvas Environmental Control System (ECS) duct was burned completely through at the aft umbilical carrier.

Tail Service Mast Base - The dynatherm covering performed well in protecting the mast structure from high temperatures. Operational plumbing and components in all masts appeared to be in good condition, excluding discoloration from the severe environment.

Hold Down Arms - All the paint was burned off, but no discernable damage was noted to casings themselves. Hold Down Arm protective hoods were warped due to heat, but were repairable.

e) S-IC Electric Supply Equipment Mechanical Systems

S-IC Ground Umbilical Carriers - The umbilical carriers for the Tail Service Masts suffered considerable damage - complete refurbishment required.

Intertank and Forward Skirt Access Equipment Storage Containers - The storage containers suffered considerable damage; bulkhead protective equipment was also damaged.

f) S-IC Ground Support Equipment Electrical Systems

Forward Umbilical Service Unit (FUSU) on 100' level sustained major damage when the doors blew off. FUSU components and cables were subjected to water and fire damage.

LVGSE (Continued)

g) Access Equipment, and High Pressure Industrial Water Systems

Platform and Transponder System - LUT level zero platform was dislodged from its secured position atop the Engine Service platform, and totally destroyed. Debris was strewn over a 800' x 600' area on the south side of the Pad.

The Engine Service Platform was dislodged from its secured position atop the Platform Transporter; however, it remained on the Transporter. Several sections of grating are missing or bent. The bolts securing two guide assemblies were sheared off.

The Platform Transporter was pushed off the end of the rails, taking with it the rail stops and the south Transporter winches. The Transporter sustained damage to the outer structural I-beam on the south side. The handrail was missing. The wheel truck bolts, which secure the truck to the I-beam of the Transporter were sheared off. It has been recommended that the Transporter storage area be relocated for subsequent launches.

The Southwest Transporter winch cover was smashed by the Transporter, and the winch was torn from its mounting pad. The winch received extensive damage to most components, such as: spring frame, shaft bearing, gear covers, motor housing, gear damage. The electrical control box was dislodged, and other electrical damage was sustained.

The Southeast winch cover was smashed by the Transporter, and the winch was torn from its mounting pad. The damaged cover was jammed in place, preventing assessment of damage to the winch. It has been recommended that winches be buried below Pad level. The rail stops were torn from their mounting pads by the Transporter.

Access Equipment, and High Pressure Industrial Water Systems
(Continued)

LUT Level Zero Winches - Winch A received minor damage from an unknown flying object. The covers on winches B & C were blown off, and both winches received extensive damage approaching total destruction. It has been recommended that winches be removed during launch.

Emergency Access Platform - The Emergency Access Platform cover was blown off. The interior of the Emergency Access Platform was not accessible for inspection.

Industrial Water System - Damage to the Industrial Water Systems was confined to two nozzles in the flame trench, and slightly burned cables on the LUT tower feeding the LUT Level Fogging Control valves.

Environmental Control System (ECS) - Damage was sustained by the ECS ducts on the LUT Zero Level, and the vertical run between the Zero Level and the 30' Level. All duct assemblies, flex joints, and elbows in this area require replacement. All ECS/ LUT interface flex ducts and horizontal ducts on the Pad ECS Tower also require replacement.

APPROVAL

SATURN V SEMI-ANNUAL PROGRESS REPORT

(July 1, 1967 - December 31, 1967)

The information in this report has been reviewed for security classification. Review of any information concerning the Department of Defense or Atomic Energy Commission programs has been determined to be UNCLASSIFIED.

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ARTHUR RUDOLPH
Manager, Saturn V Program

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