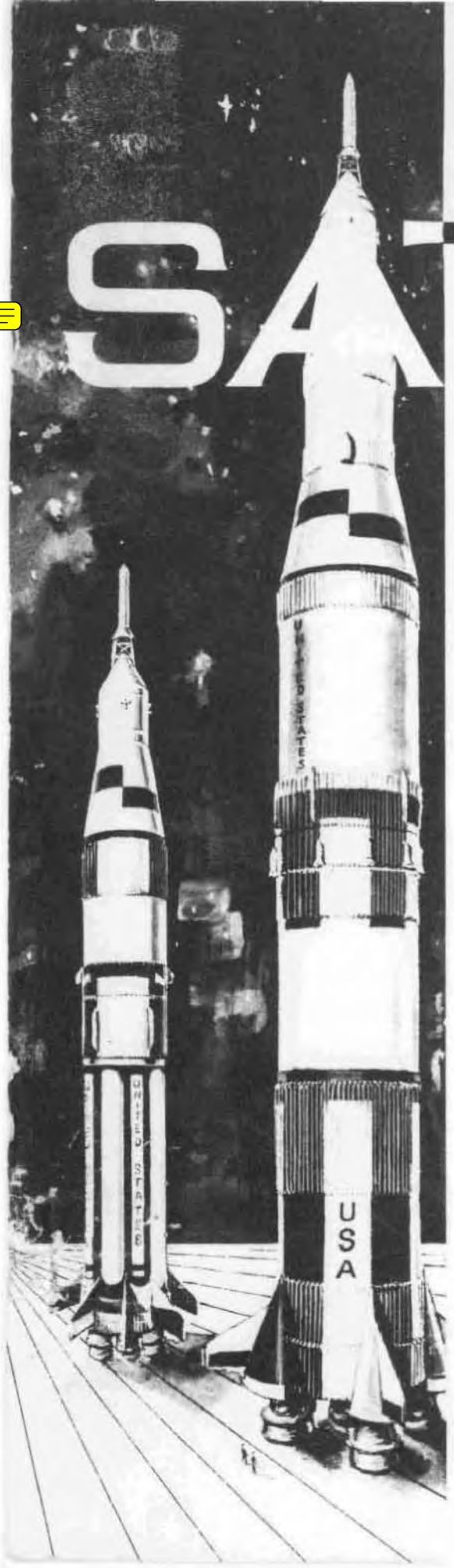
MA 001-002-2H
IMPR-SAT V 66-3)

MARSHALL SPACE FLIGHT CENTER

HUNTSVILLE, ALABAMA



SATURN

SATURN V SEMI-ANNUAL PROGRESS REPORT

JULY 1, 1966 - DECEMBER 31, 1966

PREPARED BY I-V-P

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

MSFC - Form 774 (Rev May 1966)

GEORGE C. MARSHALL SPACE FLIGHT CENTER

MA-001-002-2H
(MPR-SAT V 66-3)

SATURN V SEMI-ANNUAL PROGRESS REPORT

(July 1, 1966 - December 31, 1966)

ABSTRACT

This Saturn V Semi-Annual Progress Report describes progress and major achievements from July 1, 1966, through December 31, 1966, in the Saturn V Program.

1. Stacking of the SA-500D Vehicle was completed on December 3.

2. Processing of the SA-500F Vehicle was completed on October 15 at KSC.

3. All SA-501 Stages have been stacked at KSC with the exception of the S-II-1.

4. The S-IC-T has been erected in the B-2 Test Stand at MTF.

   The S-IC-1 arrived at KSC on September 12.

   Refurbishment of the S-IC-2 was completed on August 10.

   The S-IC-3 was successfully acceptance fired at MSFC on November 15.

5. The ultimate pressure test to destruction of the S-II CBTT was conducted on December 1.

   Two successful test firings of the S-II-1 were conducted durin December at MTF.

   The S-II-2 Systems Checkout was completed on October 2.

   The S-II-3 LH_2 Forward Bulkhead was damaged by a falling access ladder.

6. The S-IVB-500FS Test Article Environmental Test Program was completed August 9.

   The S-IVB-501 arrived at KSC on August 14.

   Acceptance firing of the S-IVB-502 was accomplished on July 28.

   Prestatic Checkout of the S-IVB-503 is underway in the Beta III Test Stand.

7. F-1 Engine Qual II Testing is complete.

   The F-1 Engine Program has conducted 1, 692 R&D engine systems tests.

   J-2 engines have undergone 2, 750 tests as of the end of this report period.

   The J-2 Engine Program Contract NAS8-19 was approved in July.

8. The S-IU-501 arrived at KSC on August 24.

   Systems Checkout of the S-IU-502 was completed on November 3.

   Component Assembly of the S-IU-503 is nearing completion.

9. LVGSE deliveries are supporting the Saturn V Program activities.

10. Saturn V major facilities are either complete or in the final stages of completion.

MA-001-002-2H
(MPR-SAT V 66-3)

SATURN V SEMI-ANNUAL PROGRESS REPORT

(July 1, 1966 - December 31, 1966)

by

SATURN V PROGRAM CONTROL OFFICE

(I-V-P)

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SATURN V SEMI-ANNUAL PROGRESS REPORT

(July 1, 1966 - December 31, 1966)

SECTION I. SUMMARY

The SA-500D, Dynamic Test Vehicle, has been stacked in the Test Tower at MSFC and preparations are underway for the start of Configuration I Testing in January, 1967.

Processing of the SA-500F, Facilities Checkout Vehicle, has been completed and all stages are in storage with the exception of the S-II-F/D which is being used in the SA-500D Vehicle at MSFC.

The S-IC-1, S-IVB-501 and S-IU-501 arrived at KSC and have been stacked in the Vehicle Assembly Building, with the H7-17 fit-up fixture being used as a spacer for the S-II-1.

The S-IC-T was shipped from MSFC to MTF and has been installed in the B-2 Test Stand for static firing in February, 1967.

Refurbishment of the S-IC-2 has been completed. Post Static Checkout has also been accomplished with the exception of verification of the modifications which are now being installed at MSFC.

The S-IC-3 underwent a successful acceptance firing at MSFC and was returned to Michoud where refurbishment was completed. Post Captive Checkout was begun in mid-December.

The S-II-1 was placed in the A-2 Test Stand at MTF. After completion of Pre-Static Checkout, together with modification and repairs, the stage underwent two successful full duration firings.

Post Manufacturing Checkout of the S-II-2 was completed in October. Stage modifications and preparations for shipment to MTF are currently underway.

Vertical build-up of the S-II-3 Stage was completed during July. During stage systems installations, a section of an access ladder fell and damaged the LH_2 forward bulkhead, necessitating removal of the bulkhead. Installation of stage systems is continuing.

The S-IVB Battleship underwent thirteen test firings at MSFC. A successful simulation of the S-IVB-503 Acceptance Test was included in the testing accomplishments.

Acceptance firing of the S-IVB-502 was accomplished in the Beta 1 Test Stand at Sacramento during July. Post Static Checkout was completed in September. Modification and stage storage are continuing.

Factory Checkout of the S-IVB-503 was completed during September. The stage was transported to Sacramento and installed in the Beta III Test Stand where Post Static Checkout is underway.

The F-1 Engine Oualification II Testing was completed during September. The Endurance Test Engine accumulated 2,284 seconds firing time during 20 test firings.

Twenty J-2 production engines were accepted during this period. This makes a total of ninety-five J-2 engines delivered by Rocketdyne.

The final scheduled tests utilizing the S-IU-500FS have been completed and the unit has been reallocated to the MSFC Systems Development System as the S-IU-500ST-2 to be updated to the S-IU-504 configuration.

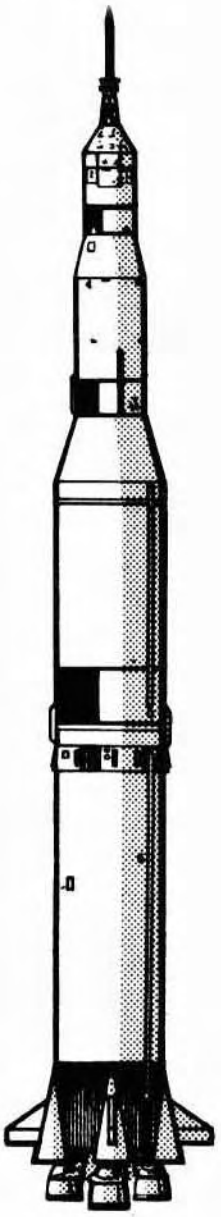
Systems Checkout of the S-IU-502 has been completed and the stage is now undergoing post acceptance engineering changes and installation of Modification Kits.

Structural fabrication has been completed and component assembly of the S-IU-503 is currently in process.

LVGSE deliveries and activations have successfully supported completion of SA-500F processing and initial processing of the available SA-501 stages.

Saturn V major facilities are either complete or in the final stages of completion.

SECTION II



SATURN V CONFIGURATION

A. SA-500D DYNAMIC TEST VEHICLE

Overall progress continued to be good at the Dynamic Test Stand at MSFC. Problems which had become evident during the initial phase of Vehicle-Site Integration testing were being resolved during early July. Primary efforts were directed at correcting noise and distorted wave shape problems on the shaker system in preparation for S-IC-D Longitudinal testing; however, late resolution of these problems required that the test plan be altered to allow for Thrust Vector Control testing and Engine Lateral Mode testing while problems relative to the S-IC-D Longitudinal testing were being resolved.

S-IC-D Thrust Vector Control (TVC) tests began on August 11. The S-IC-D was ballasted with a full fuel tank, and the LOX tank was filled to the lower "Y" ring level. The TVC tests could not be completed due to the discovery of two defective actuators. While the actuator problem was being resolved, Engine Lateral Modes (ELM) tests were initiated. TVC and ELM tests were performed incrementally when possible while modifications were being made to the shaker system. Testing of the shaker system was further delayed due to a burned out water pump in the cooling system. The instrumentation trailer was set up for continuation of ELM testing using the live engine with engine gimballing locks not operating. This test was completed on September 9. An ELM test with the gimballing locks operating was attempted on September 12, but was stopped when four lead weights used to simulate standard engine weight came loose. Testing was delayed until the necessary repairs could be made.

Shaker testing and evaluation was reinstituted on September 13 and continued until September 27. ELM testing was resumed on September 27 with mechanical locking of the engine gimballing actuators and was completed on September 28. The Fin and Fairing test was begun on September 29 and was completed on October 3. S-IC-D Longitudinal test preparations began immediately thereafter.

Prior to starting the Longitudinal test, cracked brackets on the upper thrust ring splice fitting were discovered and had to be replaced. In addition, the 30,000 pound load cells monitoring device was calibrated; trouble shooting and rework of the shaker low frequency amplifier and servo drawer in the instrument trailer were performed, and five accelerometers in the LOX tank area, which were rejected due to water seepage, were replaced. Stage ballasting was completed on October 17 and Longitudinal testing began the following day.

Longitudinal testing was suspended from October 25 to October 28 to correct flexure problems and to perform scheduled maintenance. Longitudinal testing was again suspended until November 7 to repeat Engine Lateral Modes testing using a simulated engine. The test rerun was necessary because the quality of previous test data was unsatisfactory. A facility checkout and support evaluation for the roll condition was completed on November 5. Longitudinal testing resumed on November 7 and was completed on November 12. A facility checkout was performed to increase the confidence level in the fit, form and function of the shaker system when hooked up to the S-IC-D Stage.

The S-II-F/D was shipped from KSC on October 29 and arrived at MSFC on November 10. The stage was moved to the Manufacturing Engineering Laboratory where dye penetrant inspection tests were performed. Rib and stringer cracks discovered during the inspection were repaired. The S-II-F/D was moved to the test tower on November 19 and the forward skirt was attached the next day. The stacking of the S-II-F/D on the S-IC-D was completed on November 22 without any problems being encountered.

S-IVB-D Aft Interstage stacking began on November 23 and was completed on November 28. The S-IVB-D Stage stacking operations began on November 29 and were completed on November 30. The Lower LEM Adapter, LEM and Upper Space LEM Adapter were stacked on December 1. Vehicle assembly was completed with the stacking of the Command Module, Service Module and Launch Escape System on December 3 (Figure 1).

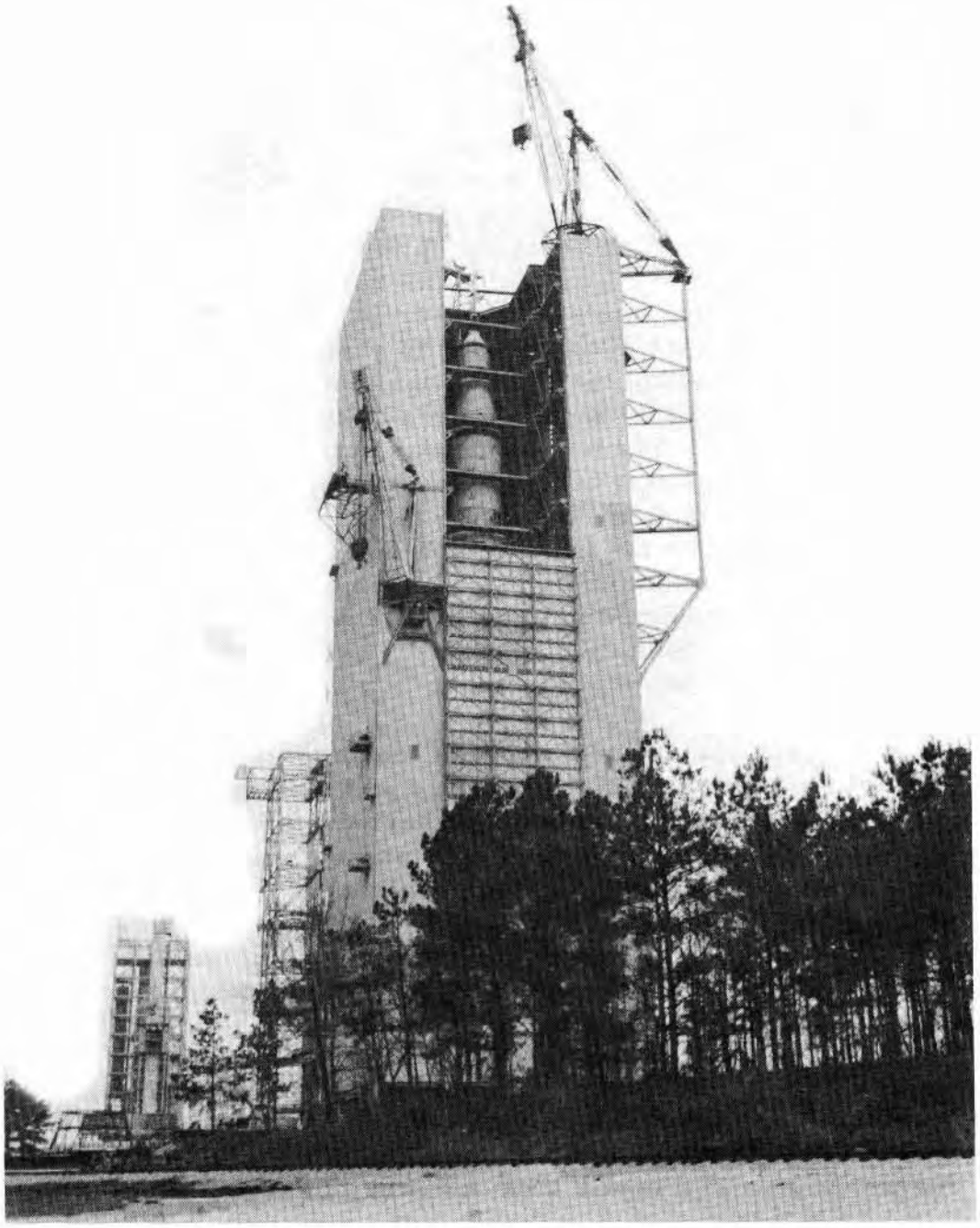


Figure 1 - Dynamic Vehicle Stacked In The Dynamic Test Tower At MSFC

Vehicle test preparations began immediately. Some delays were incurred due to S-II-F/D repairs, a requirement to substitute the smaller 219L shakers for 350 shakers for Roll test, and an added requirement to monitor the structural interface between the Command Module and Service Module. Damage occurred to the common bulkhead of the S-II-F/D on December 8 when a worker dropped an air hose during painting of the inside of the liquid hydrogen tank. The resulting dent was found to be minor and was burnished out. Also, some minor cracks were discovered and repaired near the circulating pump in the fuel tank.

Beef-up of the DTV tower was completed on December 13. This involved strengthening the structure from the ground to the twenty-four foot level and was designed to eliminate shaker induced tower resonance vibrations.

Vehicle test preparation and site integration continued until late December. During this time, checkout of the TV system, pneumatic system and ballast system was accomplished. Strain gauges were installed at the Command Module/Service Module interface. Brush recorders and power supplies were installed at the fifteenth level.

Configuration I Testing will begin with the Roll test in early January, 1967. The Roll test consists of two parts: Time Point 2 (which simulates lift off) and Time Point 10 (which simulates burnout). The Pitch test will follow and in turn will be followed by Yaw and Longitudinal tests. Completion of Configuration I Testing is planned for mid-February, 1967.

B. SA-500F FACILITIES CHECKOUT VEHICLE

General

The SA-500F Vehicle completed the Flow 1 facilities checko mission during this report period. The vehicle stages were transported to KSC using the available transportation faciliti and verified environmental protection and handling technique At Launch Complex 39, KSC, the stages were processed thrc the facility in a normal sequence of stage receiving inspectio stacking and transporting of the stacked vehicle to and from Launch Pad A. Checkout of the propellant loading procedures pneumatic servicing equipment and vehicle-to-facilities compatibility was accomplished. Stage and vehicle activities for this period were as follows:

STAGE ACTIVITIES

S-IC Stage: The automatic loading of RP-1 in the S-IC-F planned for early July was hampered by a problem with the RCA-110A computer in obtaining a readout of the vehicle status while in RP-1 loading configuration. Checkout of the S-IC-F hydraulic supply and checkout unit was accomplished while the computer problem was being solved. RP-1 automatic loading began August 12 and testing was successfully completed August 24. Prior to detanking the RP-1, the level adjust and replenish cycles were successfully performed.

Cleaning of the contaminated LOX facility supply lines continued into this report period, necessitating delays in the start of LOX tanking tests. Initial S-IC-F manual LOX loading sequence tests were scrubbed August 19 due to the rupture of an 18 inch flex line at the LOX storage tank. The line rupture resulted in the loss of the entire LOX load in the storage tank and some damage to the tank itself. Subsequent NASA inspection revealed that approximately 800,000 gallons of LOX were lost and that the inner shell of the LOX storage tank had collapsed inward about sixteen feet in one area. The damage was studied and NASA decided to attempt to return the shell to its original form by means of hydrostatic pressure. This method produced satisfactory results, and repair of the facility system was begun. Repairs to

the LOX supply system were completed and subsequent S-IC manual LOX loading was completed on September 20. S-IC-F automatic LOX loading was completed October 3.

S-II Stage: Inspection of the LH_2 tank recirculation-line boss on the S-II-F was made during late June. The inspection disclosed three cracks which were corrected by grinding out the defective areas. This effort was accomplished at the beginning of the report period. As a result of cracks being found in the flight stages at Seal Beach, a complete inspection of the S-II-F LH_2 tank was conducted during July. Bosses, brackets, fill-and-drain valve areas, and various other points were inspected with dye. Two cracks were discovered on a stringer and were ground out. A small crack was found in a ring frame stiffener. The stiffener was removed and replaced. Pressure systems leak and functional checkout progressed concurrently with the inspection on a non-interference basis with tank entry.

LOX fill systems interface leak checks were in progress during mid July and resulted in the replacement of the seals on the LOX fill-and-drain valves. Both valves were retorqued to a higher value. Subsequent leak checks of the valves were successful.

Structural inspection of the LOX tank began on July 26. Three cracks were discovered on the stringers that blend with the purge-port bosses. The cracks were ground out, and LOX tank closeout was completed on July 28.

The structural defects in the interior of the LH_2 tank were repaired and closeout of the tank was completed on August 3.

The S-II-F full pressure test was conducted successfully on August 12 in conjunction with the S-IC-F fuel loading test. The engine compartment conditioning system diaphram was installed and flow checks of the engine compartment conditioning system were completed on August 16. On August 17, the engine compartment platform was removed and the bobtail instrumentation was placed in operation for the S-IC-F LOX loading test. During this test, failure of the facility LOX system occurred, causing resulting delays in the S-II-F tanking schedule.

The facility LH_2 system cold-flow test was successfully performed on September 19. This test involved checking the flow of LH_2 from the LH_2 storage tank through the LUT transfer lines, the loading skids, the S-II LH_2 fill-and-drain valve, and the S-II and S-IVB heat exchangers. The propellant utilization procedure was successfully completed on September 20. Automatic programs and Launch Vehicle and GSE measurement scans were also successfully completed on September 20.

The S-II bobtail environmental test, without thrust chamber chill, was accomplished on September 21 during the S-IC LOX loading test.

The S-II-F LOX and LH_2 manual-loading test was successfully accomplished on 23 September. The S-II-F LOX and LH_2 automatic loading was attempted on October 3. The test was interrupted with 40 percent of the LOX loaded, due to sluggish operation of the LOX fill-and-drain valve. It was decided to terminate the test, as all test objectives could be met during the Launch Vehicle automatic loading test at a later date.

S-IVB Stage: Power and control switching tests were performed during July in order to revalidate S-IVB-F systems following the breaking of distributor connectors for the rerouting of cables.

Point level sensor calibrations were completed in early August. Attempts to calibrate the Propellant/Utilization System were delayed by electrical problems. It was necessary to pull the Propellant/Utilization electronics assembly for lab checks. The Pneumatic Console Leak and functional checks were completed August 8 and revalidation of the console and ESE Patch Distributors was accomplished the following day. Necessary propellant tank purges were completed prior to the successful completion of the Propellant/Utilization System calibration on August 19.

At this point planned tanking tests were delayed by the failure of the facility LOX supply system. Subsequent to repairs to the system, S-IVB-F manual LOX and LH_2 loading tests were accomplished on September 28. During LH_2 fast fill, loading was stopped at 52 percent because of a leak in the swing arm no. 6 umbilical connection. Rerunning of the test was

unnecessary since all major test objectives were satisfied. LH_2 slow fill and replenish test were deleted. The defective LH_2 fill disconnect was reworked before the automatic loading test.

VEHICLE ACTIVITIES

Launch Vehicle Automatic LOX and LH_2 loading was attempted on October 8. However, when the S-II fill-and-drain valve was commanded open at the beginning of the S-II LOX fast fill operation (from 40 percent to 96 percent sequence) the valve did not open and the LOX System reverted. Subsequent re-initiation of the open command to the valve was unsuccessful. The decision was made to terminate the test, due to the malfunctioning valve. Subsequently, the S-IVB and S-II LOX drain and the S-IC LOX drain operation were accomplished.

Launch Vehicle Automatic LOX and LH_2 loading was satisfactorily accomplished on the next attempt on October 12, 1966.

The following tests were satisfactorily accomplished:

a) LOX chilldown of the main and replenish lines with tank pressure through the vehicle and umbilical vent.
b) S-II LOX slow fill to 5 percent.
c) S-II LOX fast fill to 40 percent.
d) S-IVB LOX cool down and slow fill to 5 percent.
e) S-II LOX tank leak check.
f) S-II LH_2 tank preconditioning to maintain -50 Deg. F.
g) S-IVB LOX fast fill to 95 percent.
h) S-IVB LOX slow fill to 99 percent.
i) S-IVB LOX auto replenishing.
j) S-II LOX fast fill from 40 percent to 96 percent.
k) S-II LOX slow fill from 96 percent to 99 percent.
l) S-II LOX replenish.
m) S-IC LOX slow fill to 5.5 percent.
n) S-IC LOX fast fill to 93 percent.
o) S-IC LOX slow fill to 100 percent.
p) S-II LH_2 preconditioning below -150 Deg. F.
q) S-II LH_2 chill down and slow fill to 5 percent.
r) S-II LH_2 fast fill to 98 percent.

s) S-II LH_2 slow fill to 100 percent.
t) S-II LH_2 automatic replenish.
u) S-IVB LH_2 chill down and slow fill to 5 percent.
v) S-IVB LH_2 fast fill to 98 percent.
w) S-IVB LH_2 slow fill to 100 percent.
x) S-IVB LH_2 automatic replenish.
y) The S-II forward facing sheet leak check.
z) S-II thrust chamber chill down (one cycle).

During the S-IVB automatic replenish, a leak in the 18 inch GH_2 vehicle vent line on the Mobile Launcher developed into a fire. The fire was extinguished by closing the vehicle LH_2 vents and applying a GN_2 purge of the vehicle venting. The fire caused no damage to the vehicle or the facility. The leak was caused by a ruptured flex bellows in the line.

The S-IVB thrust chamber chill down and the terminal count were not accomplished due to LH_2 leak and fire. The launch vehicle drain was satisfactorily accomplished as follows: LOX drain preparations, simultaneous manual S-IVB LH_2 and S-II LH_2 drain, simultaneous automatic S-IVB and S-II LOX drain and S-IC LOX drain. At this point, SA-500F-1 wet tests were considered complete.

Roll back of the SA-500F from Pad A to the VAB began the morning of October 14 and was completed that afternoon. A minor bearing overheating problem on the Crawler Transporter was encountered during the move. The Command Service Module and Instrument Unit were de-erected October 15. De-erection of the S-IVB and S-II was accomplished on September 16 and followed by de-erection of the S-IC on October 21.

Both the S-IU-F and the S-IVB-F were stored at KSC. The S-II-F was converted to the S-II-D configuration and was shipped from KSC to MSFC on October 29. The stage arrived at MSFC on November 10. The S-IC-F was shipped to Michoud for storage. It arrived at Michoud on December 10 aboard the barge Poseidon.

C. SA-501 FLIGHT VEHICLE

Buildup of the first Saturn V Flight Vehicle, the SA-501, began during this report period.

The S-IC-1 stage was received at KSC September 12. The stage was moved to the Vehicle Assembly Building (VAB) Transfer Aisle. No processing of the stage was accomplished until the stage was stacked, with the exception of the installation of handling fixtures and positioning for erection.

In order to minimize the impact by the late delivery of the S-II-1 stage, due to problems at MTF, it was decided to use the H7-17 fit-up fixture as a spacer in the SA-501 launch vehicle until the S-II-1 stage is available. Studies were implemented to determine H7-17 structural modifications necessary to support the S-II payload stack in the VAB. The H7-17 fit-up fixture arrived at KSC on August 16 from MTF. The fixture was unloaded and placed in the VAB high-bay transfer aisle the next day. Modifications were performed on the fixture to provide additional strength and attachments that would be necessary for stacking and supporting the required load. Spacer modifications, including installation of GFE electrical cables were complete August 24. The Spacer was erected on the S-IC/S-II adapter and placed in the S-II Checkout Cell.

The S-IVB-501 arrived at KSC and was moved into the Low Bay of the VAB August 15. Receiving inspection was completed and power was applied to the stage August 25 in the S-IVB Checkout Cell. Extensionmeter, fill and drain valve and LOX duct modification installations were accomplished concurrently with stage checkout.

The S-IU-501 was received at KSC August 26. Receiving inspection and visual inspection of the stage were completed. Checkout and modifications to the stage continued through the end of October.

Prior to the erection of the SA-501, it was necessary to remove and replace all but four of the Swing Arms, used for SA-500F checkout, on Launch Umbilical Tower (LUT) No. 1. Change-out of the Swing Arms was completed on October 24. The S-IC-1 was erected on LUT No. 1 on October 27. The handling fixtures were removed and access platforms and bulkhead protectors were installed. The S-II Spacer was erected on the S-IC-1 on October 31 (Figure 2). Erection of the S-IVB-1 was accomplished on November 1 and was followed by the erection of the S-IU-501 the next day (Figure 3). Checkout of the stages and GSE began as soon as the stages were stacked. Launch Vehicle "Power On" was accomplished on November 22. Launch Vehicle Checkout will continue until the S-II-1 stage is available, at which time the S-II Spacer will be de-erected and will be replaced by the S-II-1. Checkout of the complete Launch Vehicle should be finished during the first quarter of 1967.

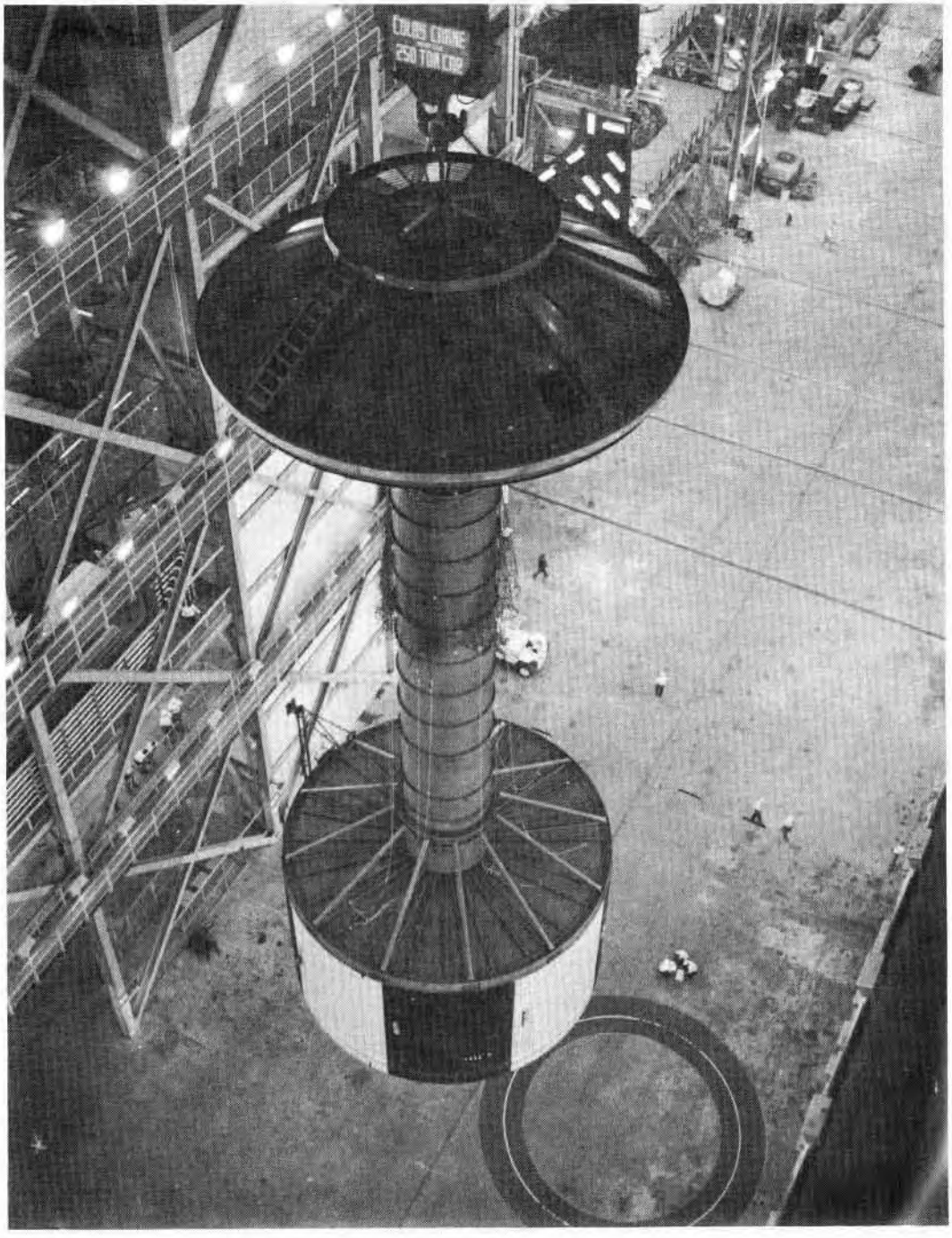


Figure 2 - H7-17 Fit-Up Fixture Being Erected In The VAB At KSC As A Spacer For S-II-1

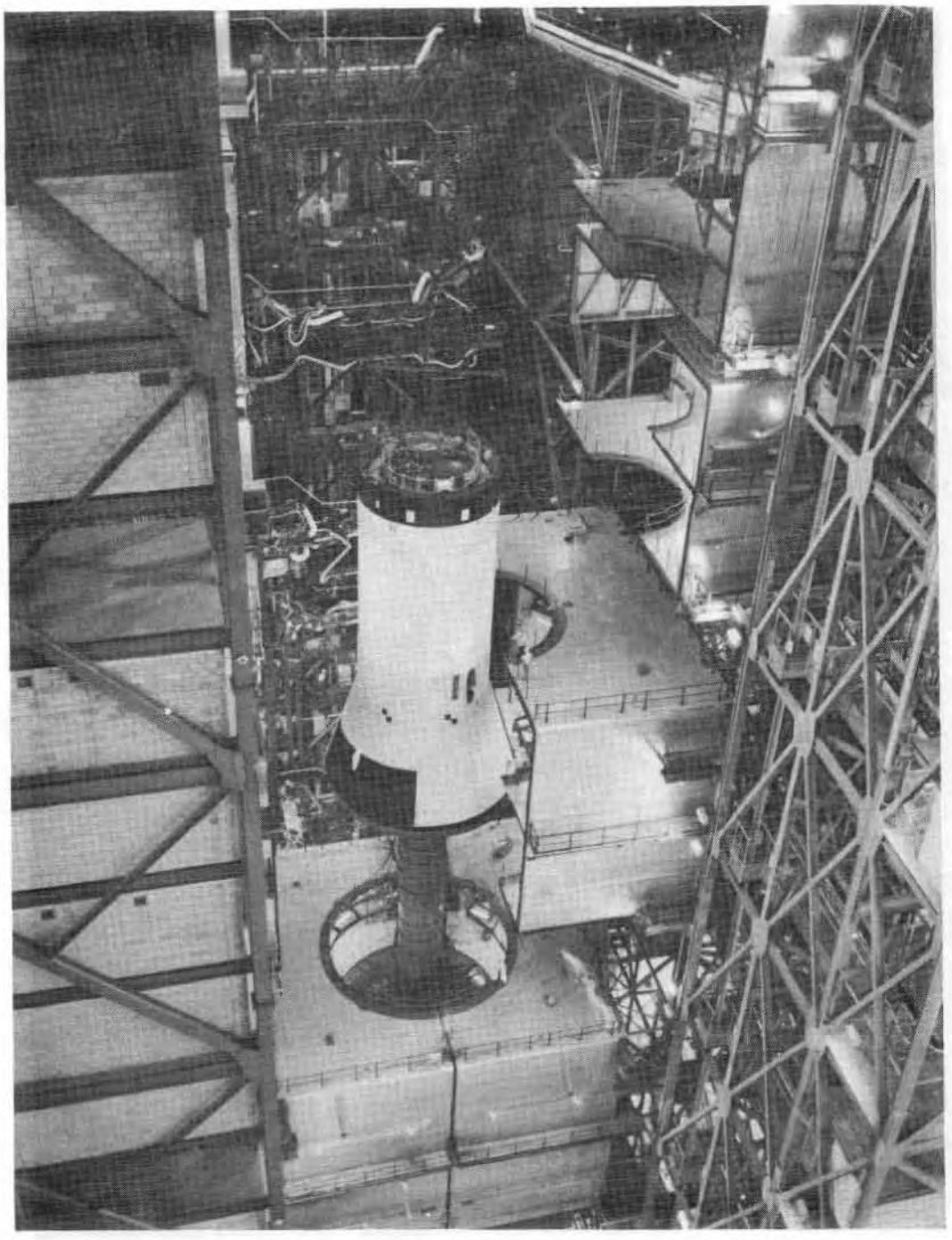
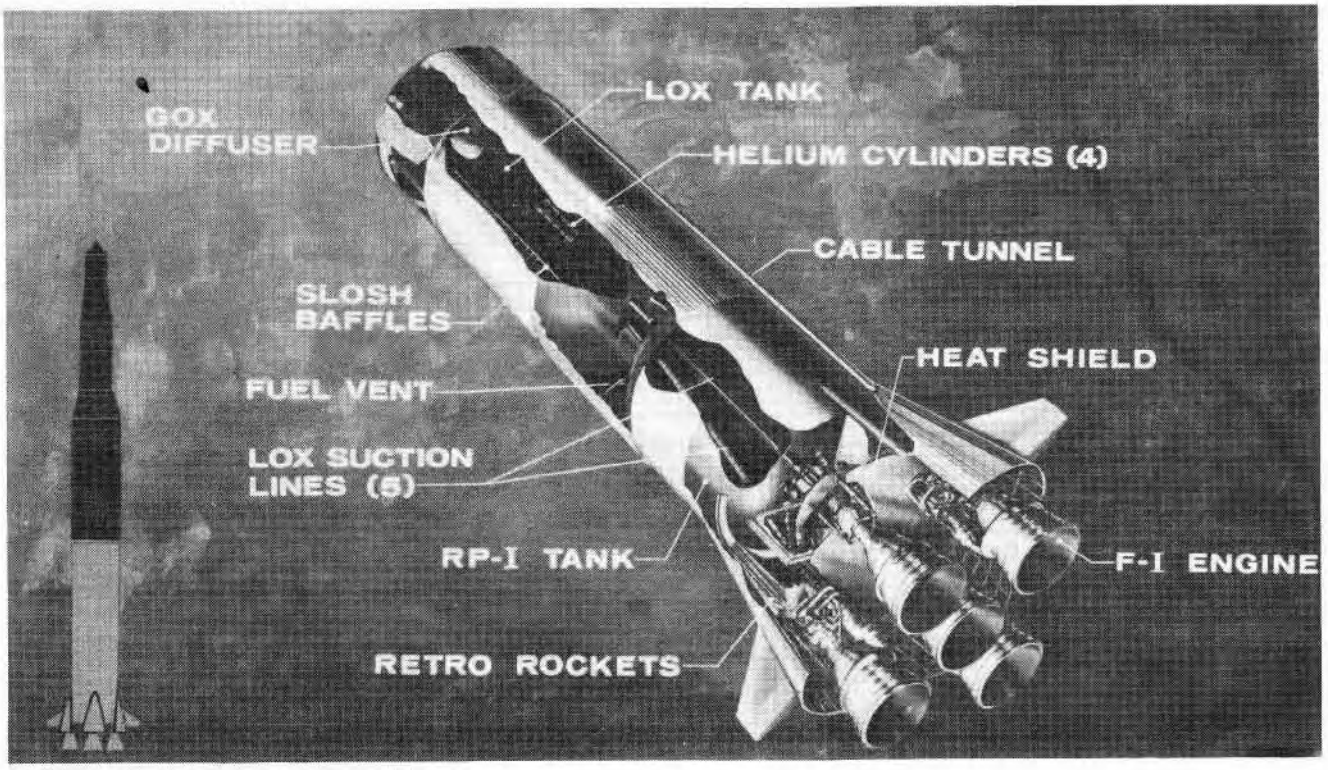


Figure 3 - Buildup Of The SA-501 Vehicle Using The H7-17 Fit-Up Fixture As A Spacer To Replace The S-II-1 At KSC



SATURN V S-IC STAGE

D. S-IC STAGES

General

The S-II interstage portion of S-IC/S-II interface test specimen failed during design limit loading at 127 percent design limit load. The S-IC-T was shipped to MTF and has been installed in the B-2 Test Stand. The S-IC-1 arrived at KSC September 12 and has been stacked in the Vehicle Assembly Building. The S-IC-2 has completed Post Static Checkout and is undergoing modifications at MSFC. The S-IC-3 completed captive firing at MSFC and has been returned to Michoud for Post Static Checkout.

1. S-IC STRUCTURAL TEST PROGRAM

Test D-31, S-IC-5 Oxidizer Tank Assembly: The first test condition, Cut-Off Empty, was successfully conducted July 12 to the desired load limit of 140 percent. Intertank modifications were completed during late July and testing resumed on July 28. The second and third test conditions, Cut-Off Full and Launch Rebound were completed successfully and all objectives of Test D-31 were considered met in early August.

Test D-34, Oxidizer Tank Assembly:
Preparation of the test set-up for the Oxidizer Tank Assembly continued during July, August and September. The Oxidizer Tank specimen was moved into the Load Test Annex August 17 from the Vertical Assembly Building to facilitate a new requirement to add more test gauges. Mechanical and structural systems for the tests were completed and checked out by the end of September. Checkout of the instrumentation system was completed during the first of October. The first seven of nine test conditions of the D-34 Oxidizer Tank began October 5 and were completed October 7. Set up activity for the Inertial Loads Test began immediately and will extend into mid-February 1967, with the test planned for the last part of that month. The final test

condition, Burst test, is planned for May 1967.

Test D-35, S-IC-5 Fuel Tank Burst Test:
During October, the start date for the preparation of the tank for Burst test was rescheduled for the end of December. At the end of the report period, plans were being made to use the Vertical Assembly Building to obtain controlled environmental conditions during strain gauge installation on the D-35 S-IC-5 Fuel Tank. The Burst testing is scheduled to be complete by the end of March, 1967 in support of the S-IC-4 on dock delivery to KSC. According to present plans, the specimen will be in the VAB for two months and then would be moved to the Static Test Stand for Burst test.

Test D-38, Center Engine Alignment Struct:
Set-up for Test D-38 began September 1. The Strut Specimen was installed in the Baldwin Test Fixture and tension and compression loading was successfully carried to 140 percent of design limits. All test requirements were considered complete by September 29.

Test D-47, Apex Gore Assemblies:
Testing began in July on the first of five Apex Gore specimens. Testing was completed July 20 on the Upper LOX Bulkhead Gore with integral LOX vent fittings and a load distribution adapter. The second specimen, a fuel lower bulkhead segment with four milled fittings, began checkout September 19, and by September 29 all ten test conditions had been successfully conducted. The test set-up for the third specimen was initiated during October on the West test pad. This third test uses a fuel lower bulkhead three fitting gore. Set-up activity included bolting the specimen to the fixture and modifying the tie-down. Installation of reaction fixtures and instrumentation continued throughout the period. Completion of the test was delayed until January, 1967, due to a conflict in the scheduling availability of data interface equipment with other programs.

Test D-48, Fairing to Stage Fittings:
Testing was successfully completed July 21. The test load was applied in increments to design limit load and until failure occurred at 253 percent of design limit load by tear-out around the bolt at frame Station 115.

Test D-109, Base Air Scoop:
Delivery of the Base Air Scoop Specimen was delayed due to design and manufacturing problems. The specimen was shipped from Michoud on November 8. Immediately upon receipt of the specimen at MSFC, Configuration Change incorporation began. Fabrication of the test set-up began in the Load Test Annex in early December. Testing is planned for the last two weeks of February, 1967.

S-IC/S-II Interface Test:
This test is conducted to simulate loads during S-IC burn-out. The S-IC forward skirt mating with the Aft Adapter from the S-II makes up the test specimen. The specimen was constructed and stacked in the Vertical Assembly Building of the Manufacturing Engineering Division. Stacking of the components began September 23 and the completed specimen was delivered to the Load Test Annex October 12 for instrumentation and set-up. Test Systems Checkout was completed and the S-IC/S-II interface test began on December 13. The test consisted of five conditions:

a) 100 percent design limit load at ambient temperature
b) heat influence with no load
c) 130 percent design limit load with heat applied
d) ullage motor fitting load test, and
e) axial load to failure at ambient temperature.

The first two conditions were completed successfully on December 13. On December 15, during the third test condition, the S-II interstage portion of the specimen failed. The failure occurred at about 127 percent design limit load. The specimen was compressed about four inches and no further testing is possible unless a new

condition, Burst test, is planned for May 1967.

Test D-35, S-IC-5 Fuel Tank Burst Test:
During October, the start date for the preparation of the tank for Burst test was rescheduled for the end of December. At the end of the report period, plans were being made to use the Vertical Assembly Building to obtain controlled environmental conditions during strain gauge installation on the D-35 S-IC-5 Fuel Tank. The Burst testing is scheduled to be complete by the end of March, 1967 in support of the S-IC-4 on dock delivery to KSC. According to present plans, the specimen will be in the VAB for two months and then would be moved to the Static Test Stand for Burst test.

Test D-38, Center Engine Alignment Struct:
Set-up for Test D-38 began September 1. The Strut Specimen was installed in the Baldwin Test Fixture and tension and compression loading was successfully carried to 140 percent of design limits. All test requirements were considered complete by September 29.

Test D-47, Apex Gore Assemblies:
Testing began in July on the first of five Apex Gore specimens. Testing was completed July 20 on the Upper LOX Bulkhead Gore with integral LOX vent fittings and a load distribution adapter. The second specimen, a fuel lower bulkhead segment with four milled fittings, began checkout September 19, and by September 29 all ten test conditions had been successfully conducted. The test set-up for the third specimen was initiated during October on the West test pad. This third test uses a fuel lower bulkhead three fitting gore. Set-up activity included bolting the specimen to the fixture and modifying the tie-down. Installation of reaction fixtures and instrumentation continued throughout the period. Completion of the test was delayed until January, 1967, due to a conflict in the scheduling availability of data interface equipment with other programs.

Test D-48, Fairing to Stage Fittings:
Testing was successfully completed July 21. The test load was applied in increments to design limit load and until failure occurred at 253 percent of design limit load by tear-out around the bolt at frame Station 115.

Test D-109, Base Air Scoop:
Delivery of the Base Air Scoop Specimen was delayed due to design and manufacturing problems. The specimen was shipped from Michoud on November 8. Immediately upon receipt of the specimen at MSFC, Configuration Change incorporation began. Fabrication of the test set-up began in the Load Test Annex in early December. Testing is planned for the last two weeks of February, 1967.

S-IC/S-II Interface Test:
This test is conducted to simulate loads during S-IC burn-out. The S-IC forward skirt mating with the Aft Adapter from the S-II makes up the test specimen. The specimen was constructed and stacked in the Vertical Assembly Building of the Manufacturing Engineering Division. Stacking of the components began September 23 and the completed specimen was delivered to the Load Test Annex October 12 for instrumentation and set-up. Test Systems Checkout was completed and the S-IC/S-II interface test began on December 13. The test consisted of five conditions:

a) 100 percent design limit load at ambient temperature
b) heat influence with no load
c) 130 percent design limit load with heat applied
d) ullage motor fitting load test, and
e) axial load to failure at ambient temperature.

The first two conditions were completed successfully on December 13. On December 15, during the third test condition, the S-II interstage portion of the specimen failed. The failure occurred at about 127 percent design limit load. The specimen was compressed about four inches and no further testing is possible unless a new

S-II interstage can be located. The investigation of the failure was continuing at the end of the report period.

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

The S-IC-T Stage was installed in the S-IC Test Stand July 7 for additional static firings. Tentative plans called for a 40 second test firing and some fuel and LOX loading tests. Buildup of the stage to the firing configuration was initiated. Three outboard engines and the inboard engine were installed on the S-IC-T stage. The LOX suction duct at Engine Position No. 4 was lowered approximately 25 feet for inspection of the line and three sets of roller brackets. No discrepancies were found. The flowmeters were removed from the LOX prevalves. However, the tests were cancelled in order to expedite shipment of the stage to MTF and the stage was removed from the stand.

Modification work to incorporate the S-IC-4 functional provisions into the S-IC-T continued through August and September. Faulty LOX prevalves and minor parts shortages hampered some modification efforts, but had ceased to be a problem by mid-September.

The stage turnover meeting was held at MSFC on October 7. The stage was shipped October 17 from MSFC to Mississippi Test Facility (MTF). There was some travelled work yet to be done on the stage, but these were mostly minor items. The stage arrived at MTF on October 23. The stage was stored until December 16, waiting for the completion of the B-2 Test Stand and subsequent facility demonstration.

The S-IC-T was placed in the B-2 Test Stand on December 17. Stage electrical and mechanical hookup to the test stand began immediately. Static firing is planned for early 1967 to demonstrate the facility checkout system.

3. S-IC-1 FLIGHT STAGE

Post Static Checkout of the S-IC-1 was in process at the Reliability and Quality Division at MSFC at the beginning of the report period. July activities included replacement of the pitch actuator on Engine No. 4, a simulated flight test and instrument testing. Post Static Checkout was completed August 10 after those subsystems which had hardware modifications had been reverified and stage weighing had been accomplished. The stage was turned over to Manufacturing Engineering August 10 where it was prepared for shipment to KSC. The S-IC-1 was loaded on the barge Poseidon and departed MSFC for KSC in the afternoon of August 26. The shipment was delayed at New Orleans due to a strike between the Towing Sub-contractor and the Union. The shipment was resumed on September 7 and arrival at the KSC dock occurred September 12 (Figure 4). The stage was off loaded and moved to the Vehicle Assembly Building transfer aisle where receiving inspection was initiated.

4. S-IC-2 FLIGHT STAGE

Refurbishment of the S-IC-2 by the Manufacturing Engineering Division at MSFC was completed on August 10. The stage was moved to the Reliability and Quality Test and Checkout Station to commence Post Static Checkout. The engine in the No. 1 position was removed from the stage for two static test firings which were completed on August 24 because the engine had produced higher thrust than desired during previous static firing tests. The high thrust problem was corrected and the engine was reinstalled August 27. The stage underwent mechanical pressurization; functional test; instrumentation and measurement systems tests. Defective DDAS and F-1 Telemetry Assemblies were repaired and reinstalled. TV and film camera equipment was tested in the functional laboratory and installation began September 8 and was completed September 15. Completion of Post Static Checkout was hampered by

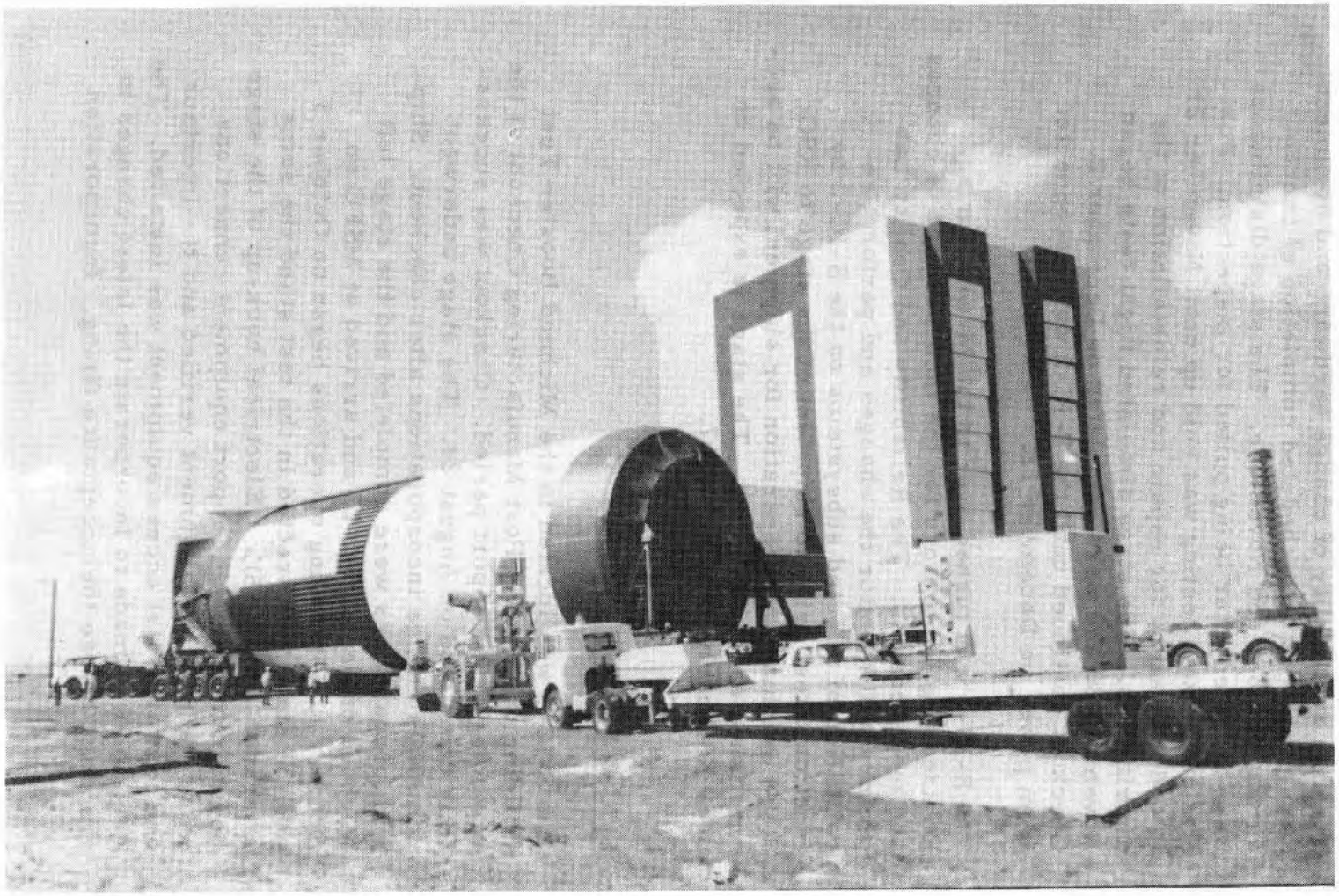


Figure 4 - Arrival Of The S-IC-1 At KSC

GSE and other stage and equipment problems.

The late availability of change hardware and documentation prolonged the scheduled completion of checkout during October and November. The stage distributors were rejected after being pulled for inspection. Post Static Checkout testing was held up until November 21 in order to allow for repair and reinstallation of the distributors. The stage simulated flight tests began November 30 and were completed on December 2. Checkout continued until the S-IC-2 was disconnected from power on December 12.

The S-IC-2 was turned over to the Manufacturing Engineering Laboratory for the incorporation of changes and modifications. The Reliability and Quality Laboratory will monitor the changes and perform revalidation of affected subsystems on the S-IC-2 by functional test prior to shipment of the stage to KSC. Stage weighing and preparation for shipment will be accomplished early next year. The stage is expected on dock KSC early in March,1967.

5. S-IC-3 FLIGHT STAGE

The S-IC-3 was located in the Michoud Booster Test Building undergoing Post Manufacturing Checkout at the beginning of the report period. Checkout was successfully completed on August 24. The stage underwent numerous change incorporations after checkout. Shipping preparations were completed and the stage left Michoud on September 23 and arrived at MSFC on October 1. Unloading operations began on October 3 and the stage was erected in the test stand the same afternoon (Figure 5). Electrical hook-up of the stage began immediately. Support equipment connections were made, stage alignment verified and the intertank and forward skirt access equipment was installed. The decision was made to incorporate the latest changes in the stage before the acceptance firing. Incorporation

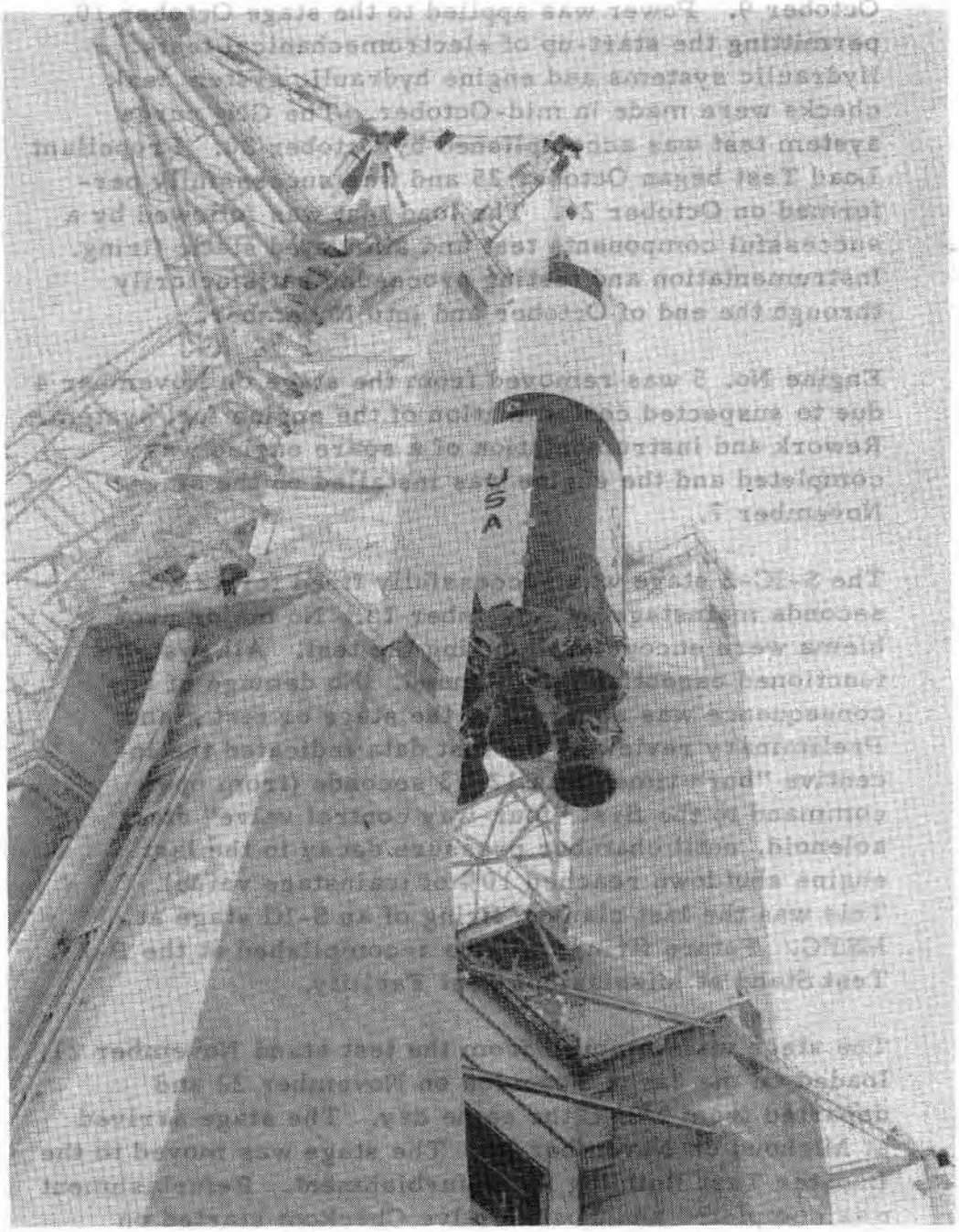


Figure 5 - S-IC-3 Being Erected In The Static Test Stand At MSFC For Acceptance Firing

of the changes began October 5 and were completed October 9. Power was applied to the stage October 10, permitting the start-up of electromechanical tests. Hydraulic systems and engine hydraulic system leak checks were made in mid-October. The GN_2 purge system test was accomplished by October 20. Propellant Load Test began October 25 and was successfully performed on October 26. The load test was followed by a successful components test and simulated static firing. Instrumentation and testing proceeded satisfactorily through the end of October and into November.

Engine No. 5 was removed from the stage on November 4 due to suspected contamination of the engine fuel system. Rework and instrumentation of a spare engine was completed and the engine was installed on the stage November 7.

The S-IC-3 stage was successfully fired for 121.5 seconds mainstage on November 15. No major problems were encountered during the test. All systems functioned essentially as planned. No damage of any consequence was apparent to the stage or test stand. Preliminary review of the test data indicated the incentive "burn time" was 127.3 seconds (from open command to the first "four-way control valve" start solenoid, until chamber pressure decay in the last engine shutdown reached 10% of mainstage value). This was the last planned firing of an S-IC stage at MSFC. Future firings will be accomplished at the B-2 Test Stand at Mississippi Test Facility.

The stage was removed from the test stand November 21, loaded on the barge Poseidon on November 22 and departed from MSFC the same day. The stage arrived at Michoud on November 27. The stage was moved to the Booster Test Building for refurbishment. Refurbishment was completed and Post Captive Checkout started on December 17. Checkout is expected to be complete by late February, 1967.

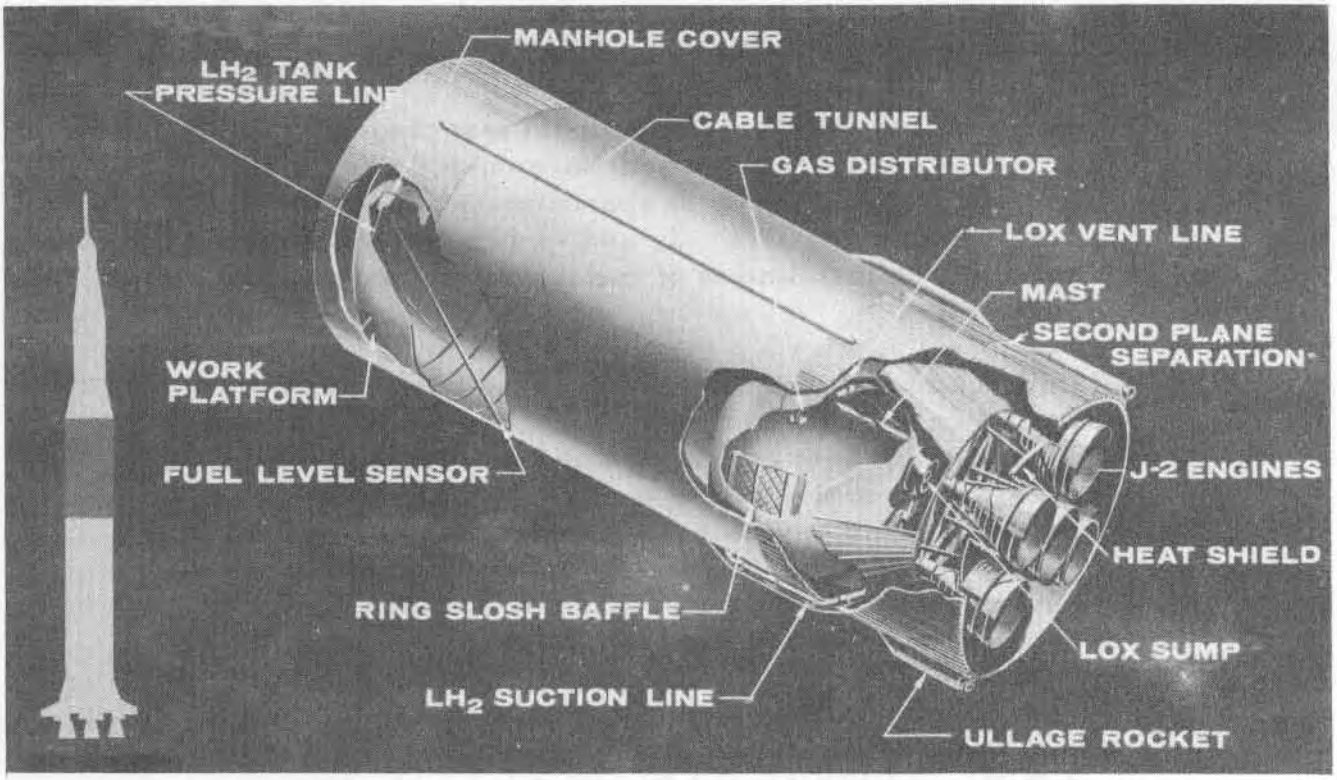
6. S-IC-4 FLIGHT STAGE

Horizontal assembly of the S-IC-4 stage was completed in early August. The stage was moved from the Manufacturing Building, Michoud, for Post Manufacturing Checkout in the Booster Test Building August 5. Checkout was successfully completed December 1. The stage is in storage at Michoud, where it will remain until it is shipped to Mississippi Test Facility in February, 1967.

7. S-IC-5 FLIGHT STAGE

The S-IC-5 fuel tank completed hydrostatic test, cleaning and painting during July. After stage hardware had been installed in the thrust structure, which was placed in the vertical assembly tower on June 30th, the S-IC-5 fuel tank was moved into the position on August 10. The following day the intertank was mated to the fuel tank. On August 17, after the installation of the five LOX suction ducts, the liquid oxygen tank was mated to the intertank. The last major component of the "stack-up", the forward skirt, was raised to installation position on August 19 to complete the S-IC-5 stage "stack-up." Vertical assembly of the S-IC-5 stage was completed on the 12th of September. The stage was removed from the tower and moved to the Manufacturing Building.

Installation of the five F-1 engines began on October 24 and was completed November 18. After the installation of the various stage systems, the stage was transported to the Stage Test Building, where post manufacturing checkout began on December 21.



SATURN V S-II STAGE

E. S-II STAGES

General

The Common Bulkhead Test Tank ultimate pressure test to destruction has been completed. The Battleship stage boattail environmental testing began in October. Two successful full-duration static firings of the S-II-1 stage were accomplished at MTF during December. The S-II-2 checkout and modifications have been completed. Damage caused by a falling ladder necessitated replacement of the S-II-3 LH_2 forward bulkhead.

1. COMMON BULKHEAD TEST TANK (CBTT)

Preparations for the CBTT biaxial test program were in progress during October and November. The CBTT underwent modification to approximate the structural condition of the S-II-1, -2, and -3 LH_2 tanks. Modification included the installation of metal doubler plates on the LH_2 tank wall.

On December 1, the Common Bulkhead Test Tank failed during an ultimate pressure test. The liquid hydrogen tank portion of the test article was under 38.4 psi hydrostatic pressure when the failure occurred. The common bulkhead and liquid oxygen portion of the test article remained intact. The hydrogen tank portion of the CBTT was removed from the CBTT test stand by a contractor. The portion consisted primarily of the pieces of the collapsed forward LH_2 bulkhead, and the LH_2 tank wall. The parts were laid out on a grid in a Rocketdyne building at Santa Susana. Some sections of the tank wall were taken to the metallurgy laboratory at Downey for examination.

An investigating committee examined CBTT data, CBTT parts, and film of the CBTT failure. The investigating committee concluded from the available information that the failure initiated at a prior crack in a recirculation pump fitting castellation on LH_2 tank cylinder 2.

2. S-II BATTLESHIP STAGE

Five test firings of the S-II Battleship were initiated during July and August. Test results were as follows:

Test No. 035 was conducted on July 22. The duration of the test was 300 milliseconds with an automatic cutoff being initiated from the Gas Generator Over Temperature (GGOT) Sensing Unit on Engine No. 1. Investigation showed that the cutoff was a low temperature cutoff due to a miscalibration. Examination of data indicated that the fuel pump on Engine No. 3 experienced a stall. Further examination and a teardown of the LH_2 turbine revealed that the first stage turbine wheel had been installed backwards during replacement of the honeycomb seal which had occurred the day before the test.

Test No. 036 was conducted on July 29. The duration of the test was 40 seconds of mainstage with automatic cutoff initiated from the GGOT Sensing Unit on Engine No. 5. Data revealed that the cutoff was erroneous. The probe and associate connectors on the Engine No. 5 GGOT Sensing Unit were replaced.

Test No. 037 was conducted on July 30. The duration of the test was 365 seconds of mainstage operation with cutoff being initiated by the LH_2 low level cutoff (ECO) system. A 3.1 second time delay was used in conjunction with the LH_2 low level cutoff sensors in simulating sensor location on flight stages.

Test No. 38 was conducted on August 11. The duration of the test was 365 seconds of mainstage operation with automatic cutoff being initiated by the LH_2 low level cutoff (ECO) system.

Test No. 39 was conducted on August 31. The duration of the test was 233 seconds of mainstage operation with automatic cutoff being initiated from the Engine No. 4 electrical control system. Preliminary indications are that an intermittent power failure to the helium control solenoid within the electrical control package caused the premature cutoff.

Upon completion of Test No. 39, major modifications were begun to the test stand in preparation for boattail environmental test programs. Primary modifications made during September for this test program consisted of: Replacement of the static-firing fragmentation and heat shield with a flight-type heat shield; removal of LOX facility prevalves and LOX facility recirculation valves; replacement of the static-firing engine compartment purge manifold with a flight-type manifold; installation of the S7-40 purge unit, and installation of a simulated interstage enclosure. Two special LOX recirculation return-line valve-mounting plates were installed on the bottom of the LOX tank at positions 1 and 3. Specially designed LOX recirculation lines with a different helium-injection configuration were also installed at these positions for the boattail environmental testing.

Battleship stage boattail environmental testing was begun on October 10 with the tanking of liquid oxygen in the test stage's LOX tank. Boattail environmental tests were conducted throughout October, November and December. The purpose of the test program is to evaluate the S-II stage LOX recirculation system in an environment simulating the boattail condition from Saturn V prelaunch countdown through first stage boost. Engine compartment conditioning is performed with the purge and thermal control unit (S7-40), a nitrogen servicing unit.

3. S-II-1 FLIGHT STAGE

The S-II-1 was in Station VIII at Seal Beach at the beginning of the report period. Final painting and marking of the stage were completed on July 2. The acceptance run of the integrated systems automatic checkout program was started on July 10. Stage systems performance was satisfactory, but GSE malfunctions and programming discrepancies developed and forced termination of the run. After the discrepancies had been corrected, an engineering evaluation run was conducted on July 11, to determine system readiness. The run was made to the point of umbilical drop, and no problems were encountered. The acceptance run was started again on July 14. Some NO-GO conditions were encountered; however, they could

be accounted for and were resolved. On July 22,a special standing-wave test was made with the stage removed from the station. Acceptance of the test data later that day completed the S-II-1 stage systems checkout milestones.

Immediately following completion of the systems checkout acceptance run on July 14, the LOX tank was purged and the common bulkhead was inspected for cracks. It was suspected that cracks might exist on some of the welded closeout plates that were used to cover manufacturing purge ports. One crack was detected in one of the fillet welds. Repair was made by drilling out the small plate and plugging the hole with a threaded, sealed bolt. The LOX tank was closed, and the necessary leak and functional tests were conducted.

The S-II-1 stage was moved from Station VIII to Station VII on the night of July 22. The LH_2 tank was entered on July 23, and dye-penetrant inspections were made to determine whether structural cracks were present. Twenty-four cracks were found; all were repaired by scarfing (grinding). In cases where grinding into the parent metal was required, doublers were bonded to the outside skin surface; two doublers were installed on Cylinder Five and one on Cylinder Four. The doubler locations were established by X-Rays, and bonding integrity was verified by ultrasonic inspection. Repairs were completed on July 29.

The AKD Point Barrow was positioned at the Navy dock on July 27. All tiedown equipment was tested, and placement of all tiedowns and associated equipment required for the S-II-1 shipment was completed on July 28.

The S-II-1 stage, on a Type II transporter, was removed from Station VII on July 30, convoyed to the Navy dock, and loaded aboard the AKD Point Barrow. Tiedown was accomplished, and monitoring and conditioning units were connected to the stage. The S-II-1 departed July 31, and arrived on dock at Mississippi Test Facility on August 13 (Figure 6).

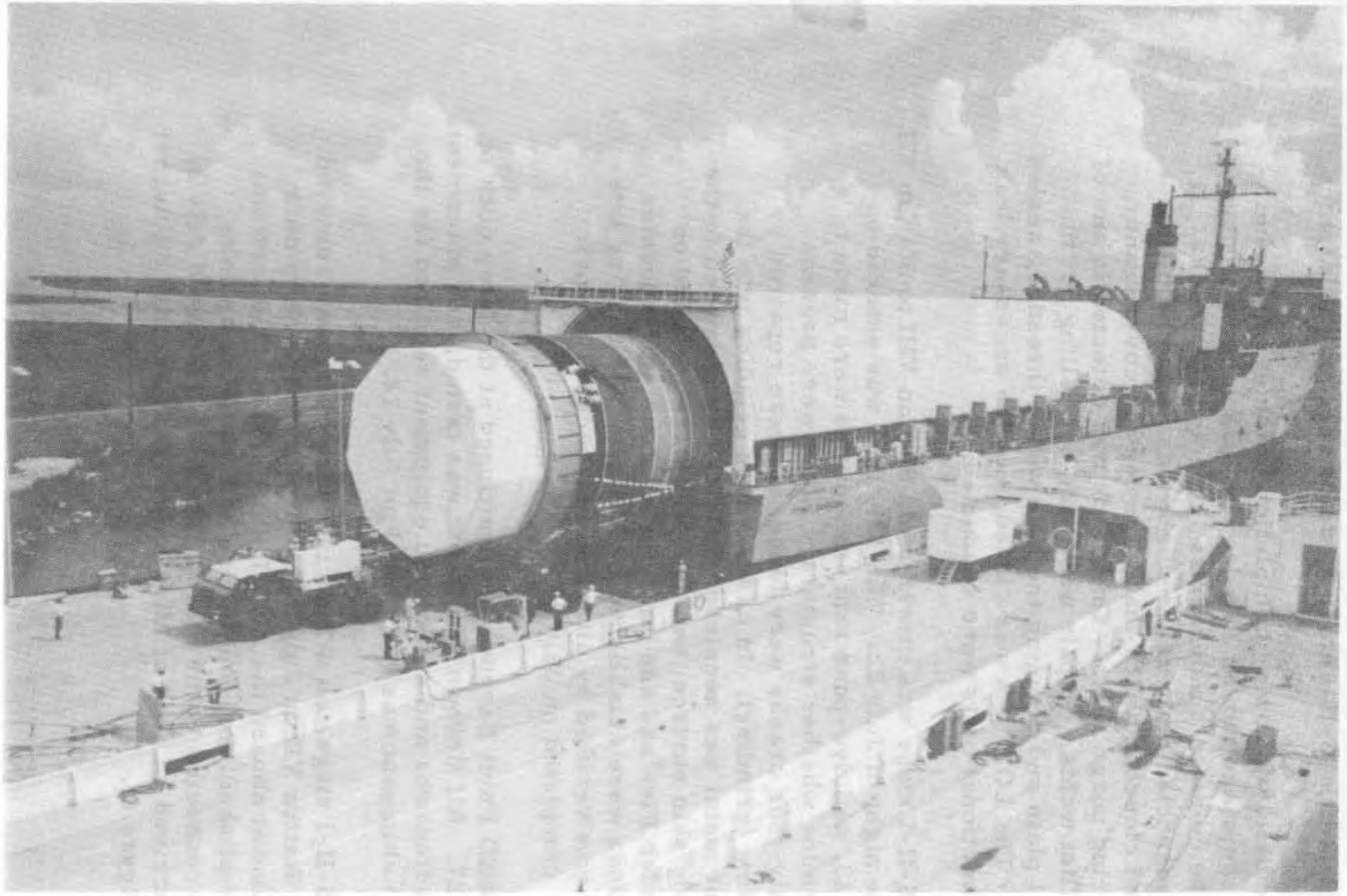


Figure 6 - Transfer Of The S-II-1 From The "Point Barrow" To The "Pearl River" At Michoud Enroute To MTF

At MTF, the S-II-1 was moved into the S-II service building where receiving inspection was performed. No major discrepancies were recorded. A complete inspection was then conducted inside the LH_2 tank to examine for cracks at the propellant feed-line outlets and at the rib and stringer ends; no cracks were found. After completion of this inspection, a decision was made to replace one of the LH_2 cylinder doublers bonded to the external surface of the tank because a poor bond was suspected. The doubler was removed by grinding, and a new one was bonded on. This activity was completed; the remaining receiving inspections were performed, and the stage was installed on Test Stand A-2 on August 19 (Figure 7).

A structural study of the bonded doublers was still underway at Downey during this time. It was decided from this study to remove the bonded doublers and to replace them with mechanically fastened doublers. Preparations for this effort began on August 27. Doubler replacement was started on August 29 with the stage remaining in the test stand. The work was completed on September 3. Meanwhile, the stage/GSE interface connections were made, and preliminary checkouts were performed. Power was applied to the stage on August 26.

Prestatic checkout activities were greatly limited and impacted by rework and modification efforts during September and October. The mandatory installation of mechanical fasteners on the LH_2 feedline duct outlets during September constituted one of the restraints. The requirement during October to re-enter the LOX tank for inspection of the aluminum foil seal on the Aft LOX bulkhead dollar weld doubler, together with the subsequent decision that a new sealing method must be used, further delayed test activities into November.

A successful full duration firing was completed on December 1. After 384 seconds of mainstage operation was accomplished, a manual cutoff was initiated at two percent liquid oxygen depletion. During the test the number 2 and 4 engine SLAM arms did not drop, resulting in the successful gimballing of engines 1 and 3 only.

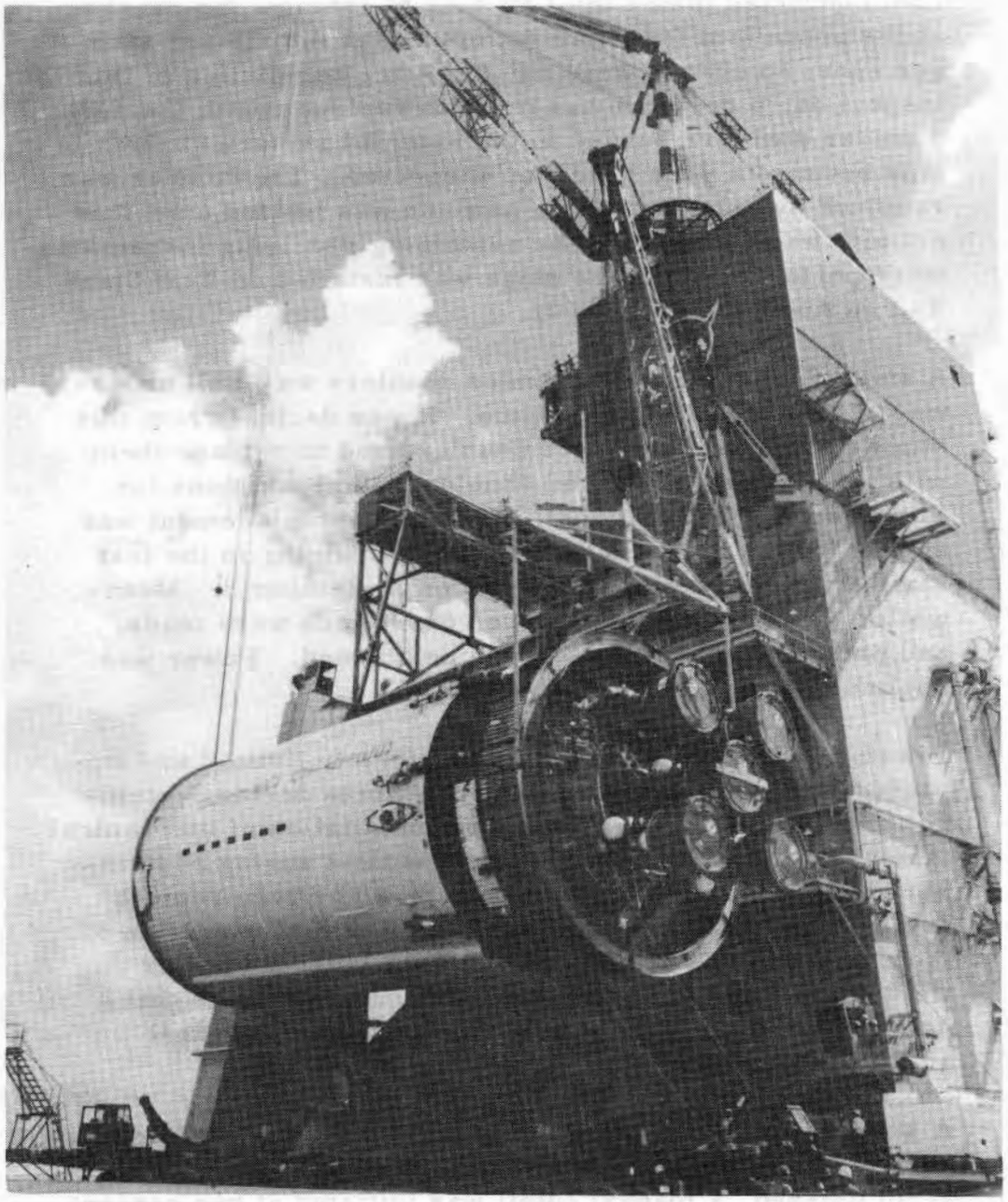


Figure 7 - S-II-1 Erection In The A-2 Test Stand At MTF

The S-II-1 stage underwent its second successful full duration acceptance test on December 30, 1966. It will now proceed through post-static checkout prior to delivery to the Kennedy Space Center where it will be installed in the 501 launch vehicle stack.

4. S-II-2 FLIGHT STAGE

The S-II-2 mechanical and bracket installations for the thrust structure were completed on July 1 in Station VII. The 12 cracks detected in the LH_2 tank stringers were repaired while the stage was horizontal in Station VII; eight of the cracks were spot drilled and grooved out; the other four were determined to be in the parent metal and were grooved out and blended.

Since transfer of the stage to Station VIII had been detained by lengthy test operations on the S-II-1 stage, the S-II-2 was transferred from Station VII to Station IV on July 8. This dwell time in Station IV was used to accomplish insulation repairs, insulation tests, and engineering changes. Electrical and mechanical system shortages were also installed as they were received. The S-II-2 stage was transferred from Station IV to Station VIII on July 23, and checkout of the stage systems was started on the next day.

The control-room/stage/station interface checkout was completed on July 28, and power was applied to the stage. An evaluation run of the automatic checkout program for the electrical power system was made on July 30. Some problems occurred during this run; all were resolved. After correction of the problems, an acceptance run on the electrical power system test was conducted successfully on August 1. Manual and automatic checkout of the S-II-2 stage systems progressed on schedule through August and September.

During an X-Ray Inspection in September, it was noted that the bolts in the splice area of the forward skirt appeared to be loose. The insulation was removed from the splice areas. It was determined that the bolts fit too

tightly in the bolt holes to be torqued properly. The holes were reamed and new bolts were installed and properly torqued. Replacement of the insulation completed the resolution of the problem, and checkout of the S-II-2 stage systems was completed on October 2.

Due to contamination, the stage LH_2 feedlines were removed and replaced on October 8 and 9. LH_2 prevalves were also replaced as a result of contamination. The stage was then transferred from Station VIII to Station VII on October 14.

In Station VII, the stage underwent LH_2 tank inspection, installation of metal doublers on the LH_2 tank wall, and rework of LH_2 feedline elbows. On October 26, the stage was moved back to Station VIII, where it is undergoing modifications prior to painting and packaging for shipment to the Mississippi Test Facility. The S-II-2 is scheduled to be shipped to MTF during late January, 1967.

5. S-II-3 FLIGHT STAGE

Vertical buildup of the S-II-3 was completed with the final major-structure weld joining of Cylinder Two to Cylinder Three on July 8. Final installation of the engine activation systems was completed on July 11. During the week of July 29, installation of systems into the Thrust Structure was accomplished and the structure was moved to Station IV in the vertical assembly building.

Inspection of the LOX tank structure during early July revealed cracks in the manufacturing purge-port closeout-plate welds in the common bulkhead. The plates were removed; and threaded, sealed bolts were installed. Additional dye-penetrant inspections of the LH_2 tank ribs and stringers were made. Seventeen cracks were found in the ribs, 25 in the stringers. Repair of the cracks by grinding resulted in a significant reduction in wall thickness in five locations. Doublers were bonded to the exterior surface of the skin at these locations. Laboratory testing of the bonded-doubler repair technique was accomplished, and the S-II-3 LH_2 tank was instrumented with

strain gauges to sense doubler deflection and vertical weld deflection during the hydrostatic test of this stage.

On July 29, the S-II-3 stage was hydrostatically tested. Instrumentation attendant to cracks in the LH_2 tank was operative, and readings were taken at all planned points. A leak developed through a crack in the weld joining the Engine 2 feedline elbow to its mounting ring and the test was terminated. X-Ray inspection revealed cracks in the Engine 3 and Engine 5 feedline elbow welds. Repair was effected by grooving and rewelding. Verification of the repair was made by performing a second hydrostatic test and by X-Ray inspection of the welds after the test. No discrepancies were noted at this time. Subsequent to the second hydrostatic test, inspection of the bonded doublers on the LH_2 cylinder revealed propagation of a void area in the doubler material. This doubler was removed and replaced, and strain-gauge instrumentation was installed for pneumostatic testing.

The first pneumostatic test was terminated at 30 psig when the doubler instrumentation indicated separation of the doubler from the tank wall. In Station VII, all five doublers were removed, and mechanically fastened doublers were installed and sealed internally with aluminum foil.

X-Ray inspection of the feedline elbows after the first pneumostatic test revealed a 2.5 inch crack in the Engine 3 feedline elbow weld. Repair was again made by grinding, rewelding, and X-Ray verification. No defects were noted. The second pneumostatic test went to full pressure (LOX tank - 20 psig, LH_2 tank - 35 psig). X-Ray inspection of the welds revealed a 2.5 inch crack in the Engine 5 feedline elbow weld. Studies and testing were begun to determine an effective repair for this type of crack.

The stage was moved to Station V on August 31 for LOX tank cleaning and for LH_2 tank helium soaking in preparation for systems installation.

During the week ending September 9,thrust-structure mating operations were in process. At this time, water was discovered in one set of common bulkhead purge lines. Subsequent inspections determined the water had entered the bulkhead through the seal of two of the six purge plugs during hydrostatic test. Bulkhead drying operations were begun on September 14 and continued on a non-interference basis into October.

A decision to pneumostatic test the stage for the third time was made on September 2. However, prior to the test, two vertical stringers were repaired. In addition, the LH_2 feedline elbows were reworked by adding 22 bolts per elbow. The rework was started on September 14 and was completed on September 25; the third pneumostatic test was successfully completed on the following day. The stage was moved into Station VII after the pneumostatic test. Dye-penetrant inspection of the stringers and ribs, and X-Ray inspection of the LH_2 feedline elbows were accomplished with no discrepancies noted. The stage was moved to Station V on September 29 for LH_2 tank cleaning.

Stage systems installation resumed October 3 and continued throughout the month. The forward skirt was installed on the stage on October 13. By mid-November, the five J-2 engines had been installed (Figure 8). Insulation closeouts had been completed and the forward skirt and thrust structure major instrumentation containers had been installed. On November 23, the stage was moved from Station IV to Station VII for LH_2 in-tank installations.

On Tuesday, November 29, 1966, the forward bulkhead of the LH_2 tank was damaged while the stage was in the horizontal position in Station VII for in-tank systems installations operation. In-tank systems installation operations were completed and the personnel entrance ladder mechanism was being retracted from the LH_2 tank through the access part in the forward LH_2 bulkhead. During the access ladder removal operation,a weld in the retracting mechanism failed causing an estimated ten-foot section of the ladder to fall against the inside of the LH_2 forward

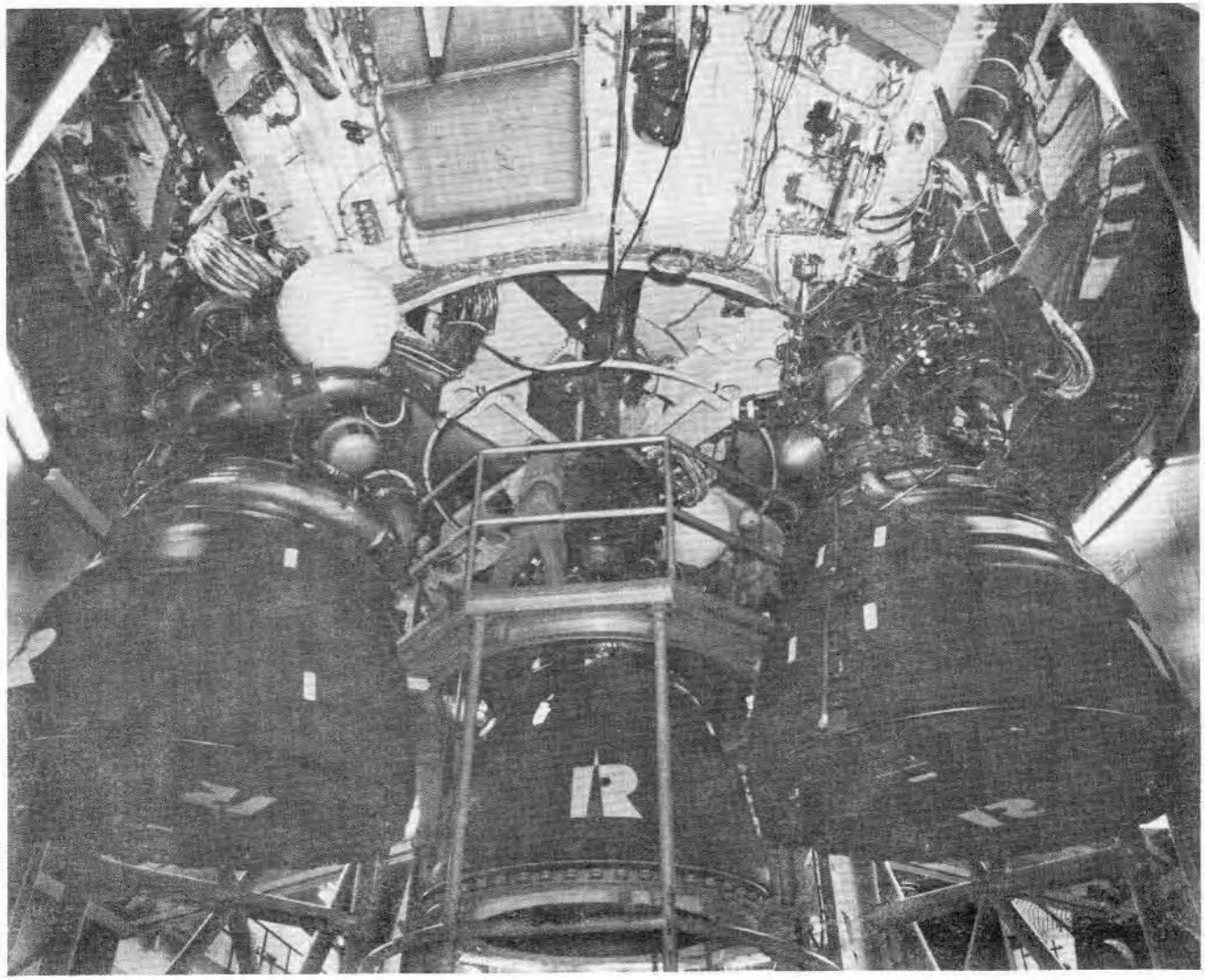


Figure 8 - Installation Of Three Of The Five J-2 Engines On The S-II-3

bulkhead from a height of about fifteen feet. One of the twelve gores of LH_2 bulkhead was damaged by the impact of the ladder. Three cracks through the bulkhead gore were found, the longest of which was about 52 inches in length. Subsequently, the stage was moved to Station IV where the LH_2 damaged bulkhead was removed. During January, the bulkhead formerly scheduled for use on the S-II-5 will be welded to the LH_2 tank cylinder.

6. S-II-4 FLIGHT STAGE

The forward bulkhead for the S-II-4 was completed on July 8 and vertical buildup began. Welding of Cylinder 3 to Cylinder 4 was begun on July 13 and was completed on July 18. Meanwhile, in another station, Cylinder 1 was welded to Cylinder 2; the joint was completed on July 27. Also, the weld joining Cylinder 6 to the forward bulkhead was made and completed on July 29.

During hydrostatic testing of the Cylinder 6/forward-bulkhead assembly on August 9 (Figure 2), a leak developed in Cylinder 6. Subsequent investigation revealed cracks at Tank Splice No. 1, Station 774. A method of repair was developed; and repair of the cylinder, with the use of mechanically attached doublers, was completed on August 22. The assembly was moved to Station V. Hydrostatic testing to 27 psig was completed successfully on August 25. The assembly was moved to Station I, where the Cylinders 5 to 6 weld was completed on August 28.

Welding of the common bulkhead to the Cylinders 1 and 2 assembly was completed on August 12. Inspection revealed a questionable area in the J-weld. A method of repair was selected, and the repair was completed on August 22. Acceptance was withheld until August 30 when the laboratory test of the weld was returned. Installation of the bolting ring was completed on August 30. The common-bulkhead/cylinders 1 and 2 assembly was moved to Station VI on August 30 for hydrostatic testing.

Hydrostatic testing of the aft bulkhead was completed on August 3. Painting was completed on August 18. The bulkhead was moved into Station III, positioned, leveled, and trimmed for the girth weld. The girth weld was completed on September 4, but was not accepted. Three major discrepancies existed: offset, height, and inclusions or porosity. On September 28, the primary material review board made the decision to cut the girth weld apart. The S-II-5 aft bulkhead was used to replace the S-II-4 aft bulkhead.

The Aft LOX bulkhead was cut off on October 12 due to a a faulty girth weld. The Aft LOX bulkhead from the S-II-5 was used as a replacement and welding was completed on December 5. Preparations were underway during late December to cut and reweld the forward LH_2 bulkhead.

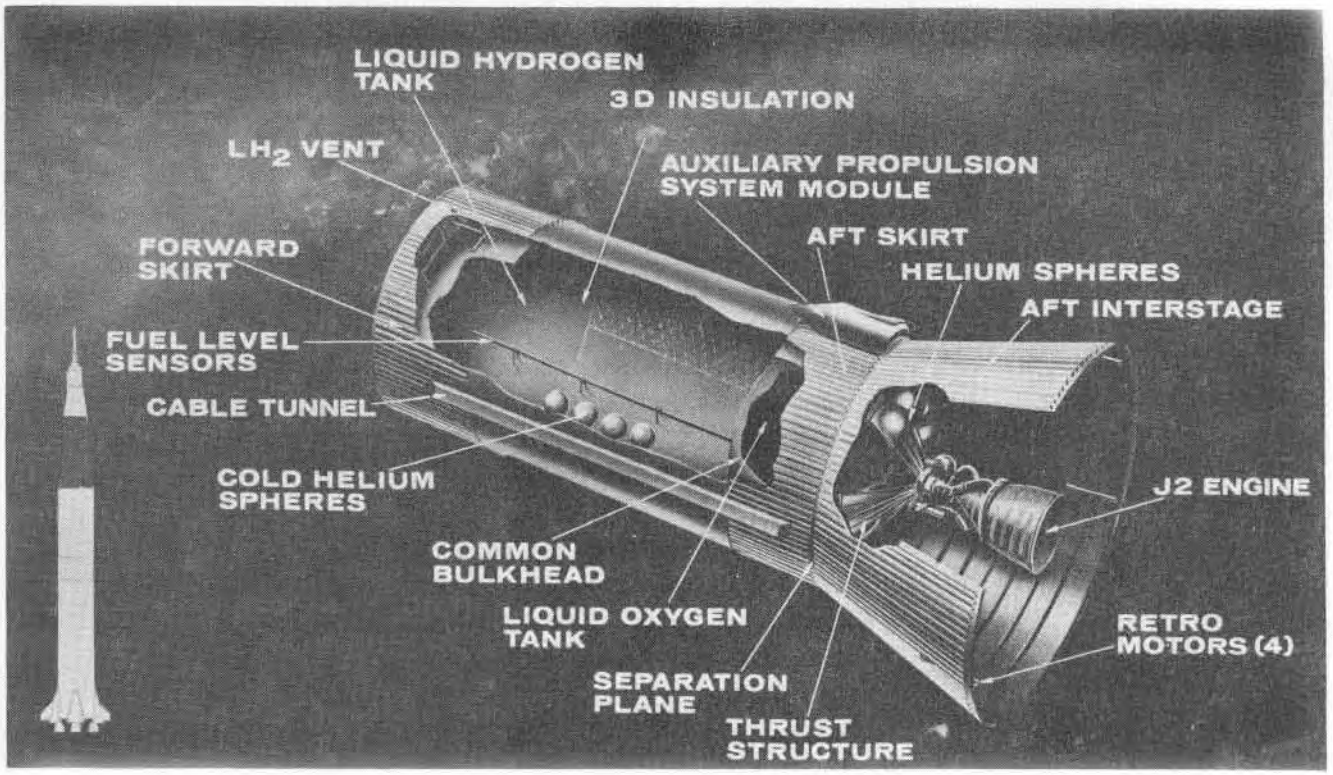
7. S-II-5 FLIGHT STAGE

Structural fabrication of the major tankage components was underway at the beginning of the report period. A damaged gore segment in the forward bulkhead was replaced. The dollar weld and machining operations were begun on July 12 and completed the same day. The second insulation-layup-and-bond operation was completed on August 16, and final bonding was completed on August 18. During ultrasonic testing, voids were detected in the insulation. Insulation repair was begun. Stud welding was accomplished concurrently with the insulation repair.

Early in August, corrosion pitting was observed on the aft facing sheet of the common bulkhead. To eliminate schedule impact, the S-II-6 aft facing sheet was designated for use on the S-II-5 stage (The corroded aft facing sheet was burnished and prepared for hydrostatic test. The sheet will be used on either stage S-II-6 or S-II-7). The aft facing sheet (from the S-II-6 stage) was prepared for core layup. The dollar weld on the forward facing sheet was completed on August 5. Tracing operations and helium leak check were also completed. Bonding, processing, and ultrasonic inspection of the bulkhead were completed by September 28.

...structure assembly was in progress during August. Assembly of the four aft skirt panels to the thrust cone was completed on August 19. The center-engine beam was installed on August 29. Completion ... fabrication and assembly of the thrust structure and a... skirt were achieved on September 1. Bracket and syst... installations began on September 30.

Vertical buildup of the stage began on September 20 wit... the weld joining of Cylinder 3 to Cylinder 4. Buildup by joining tankage components was hindered by welding problems. The S-II-5 stage LH_2 tank forward bulkhead was welded to cylinder 6 in October, 1966. An over-tolerance offset resulted in the welded assembly being rejected by inspectors. The offset was the result of bulk-head growth during welding. In December, the bulkhead was cut off and used to replace the damaged LH_2 tank for-ward bulkhead on the S-II-3 stage. Excessive porosity and oxide in the "J" ring weld necessitated the cutting of the common bulkhead from Cylinder 1. Rewelding of the bulkhead should be accomplished during January.



SATURN V S-IVB STAGE

F. S-IVB STAGES

General

The Environmental Test Program utilizing the S-IVB-500FS has been successfully concluded. The S-IVB-501 has been delivered to KSC and erected in the Vehicle Assembly Building. Acceptance firing of the S-IVB-502 was accomplished during July. The S-IVB-503 is in position for acceptance firing in the Beta 1 Test Stand at Sacramento. Factory Checkout of the S-IVB-504 was completed in December. Major S-IVB-505 components are nearing completion.

1. S-IVB BATTLESHIP STAGE (MSFC)

Thirteen test firings of the S-IVB Battleship Stage were conducted at MSFC during this report period. Major test objectives achieved during the period were:

a) Duplication of conditions under which rough combustion had previously been experienced (Test 030, 031).
b) First S-IVB hot gimbaling program performed at MSFC.
c) LOX depletion cut-off test (035, 036, 037).
d) Fuel depletion cut-off test (038, 039, 040).
e) Simulation of S-IVB-503 Acceptance Test consisting of first burn, two hour coast period, restart and run to fuel depletion (041A, 041B)

Test No.	Date	Duration	Remarks
S-IVB-030	7-26-6	6.0 sec.	No evidence of rough combustion
S-IVB-031	7-26-6	200.5 sec.	No evidence of rough combustion

Test No.	Date	Duration	Remarks
S-IVB-032	8-11-6	31.0 sec.	Cut by observer because of fire in the fuel turbo-pump area
S-IVB-033	8-24-6	20.0 sec.	Cutoff resulted when LOX pump inlet pressure exceeded redline limit.
S-IVB-034	8-26-6	279.0 sec.	Cutoff by LOX depletion-hydraulic system operation successful.
S-IVB-035	9- 9-6	1.5 sec.	"Ignition Detected" signal not received. Test terminated by engine control package - due to faulty ignition probe.
S-IVB-036	9- 9-6	3.5 sec.	Test terminated by automatic vibration safety cutoff device.
S-IVB-037	10- 5-6	285.3 sec.	Cutoff initiated by LOX Depletion System as planned.
S-IVB-038	10-12-6	234.0 sec.	Cutoff by Fuel Depletion Cutoff System. All test objectives were met.
S-IVB-039	11-14-6	288.4 sec.	Cutoff was initiated by fuel level chart observer.
S-IVB-040	12-13-6	2.15 sec.	Cutoff was initiated by automatic gas generator over temperature device because of erroneous indication due to faulty "drag in" instrumentation cable.

Test No.	Date	Duration	Remarks
S-IVB-041A	12-20-6	153.01 sec.	Cutoff was initiated by control after successful run for intended first burn duration.
S-IVB-041B	12-20-6	281.14	Fuel mass observer initiated depletion cutoff.

2. S-IVB-500FS FLIGHT SYSTEMS TEST ARTICLE

The three final scheduled tests utilizing the S-IVB-500FS test article were completed during July and August. The fifth of the seven planned tests(consisting of simulated countdown, launch, orbit and translunar flight with temperatures simulating the maximum condition) was completed on July 29. The sixth test, completed on August 2, simulated the maximum temperature condition experienced during launch, earth orbit, and translunar injection. The final test (simulating a combination of the worst conditions, selected failures, and changed test parameters) was successfully completed on August 9. This final test concluded the S-IVB/IU environmental test program at the Space Systems Center, Space Simulation Laboratory in California.

3. S-IVB/V STRUCTURAL TEST

Destacking of the S-II/S-IVB Interface Specimen was accomplished in early July after the successful completion of all parameter influence tests (except elevated temperature) and subsequent data review.

The S-IVB/V Aft Skirt Specimen A-47A was moved to a separate test pad for build-up for its structural test. The Specimen was damaged slightly during preparations and required some rework. The bending moment parameter test was completed on September 14, with satis-

factory results. On September 20, data anomalies forced postponement of the maximum ultimate load test until September 23, at which time it was successfully completed. Preparations began immediately for the elevated temperature parameter test which was successfully concluded on October 4. The Main Engine Cutoff Ultimate load test was conducted on October 14. The failure test of the specimen was conducted on October 19 with satisfactory results. The design limit load was approximately 221 percent when the dummy aft interstage buckled in the vicinity of the maximum compression stringer and the aft skirt tore in the area of the maximum tension stringer.

The S-IVB/V Forward Skirt for Test Plan A-1 was being prepared for the ultimate test under maximum conditions at the beginning of the report period. The test was successfully conducted on July 19. Failure occurred in bending under approximately 250 percent design limit load with axial load held constant at 100 percent design limit.

The elevated temperature parameter test of the S-II/S-IVB Interface Joint Specimen Test Plan Item A-47 was successfully concluded on August 26. Necessary preparations were made for the combined load test under Main Engine Cutoff Conditions (MECO) of the Interface Joint. Problems with the facility valve and lack of data printouts, due to computer programming errors, caused delays in the test. On September 12, during the ultimate axial load/elevated temperature test under MECO conditions, the Interface Joint Specimen failed. Data indications were that the axial load at the time of failure was about 140.5 percent of design limit while the temperature was approximately 520 degrees F. At last report,it was doubtful that additional testing could be accomplished without extensive rework of the Aft Interstage.

Testing of the first specimen of the S-II/S-IVB Interface Bolt Tension Test, Test Plan Item A-66, was

completed on November 11. Two separate sets of bolts were used in the test with failure occurring at approximately 210 percent and 260 percent of design limits.

4. S-IVB-501 FLIGHT STAGE

At the beginning of the report period, the decision was made to change the shipping date of the S-IVB-501 to KSC from Sacramento from August 2 to August 12. This date would meet the KSC required date and allow additional time to be utilized to close out all possible open work prior to shipment to KSC. During early July the stage was in the Vertical Checkout Lab at Sacramento undergoing post fire subsystem checkout and modification work. The all-systems test began on July 21, but it was necessary to repeat the test on July 27 after replacement of the stage switch selector. The stage was removed from the checkout position of the Vertical Checkout Laboratory on July 29. The stage was placed in the horizontal position and modification work and active preparations for stage shipment continued through the end of July. Stage turnover to NASA was conducted at Sacramento on August 9.

The installation of flight vehicle instrumentation and the tank purge operations were completed on August 11. The stage was loaded aboard the Super Guppy aircraft and departed Sacramento on August 12, as planned. The stage arrived at KSC on August 14 (Figure 9), with a one day delay due to weather. At KSC the stage was moved into the Vehicle Assembly Building low bay and receiving inspection began immediately.

5. S-IVB-502 FLIGHT STAGE

Pre-static firing checkout of the S-IVB-502 was in process in the Beta 1 Test Stand at Sacramento during early July. Subsystem checkout and modification work continued as planned. Proofing of the loading and firing tapes was initiated during the first week in

Figure 9 - Arrival Of The S-IVB-501 At KSC

July. All subsystem checkouts, including the integrated systems test, were completed on July 13. The simulated static test began on July 21 and paved the way for acceptance firing of the stage on July 28 (Figure 10).

Acceptance firing of the S-IVB-502 was accomplished on the first attempt with no major discrepancies. The test countdown proceeded very smoothly and no flight hardware problems were encountered. Duration of the burn was 150.7 seconds. After a 91 minute simulated orbital coast period, stage restart and a successful 291.2 second burn were accomplished.

Stage post firing activities continued at the test stand throughout July. The stage was removed from the test stand on August 10 and placed in the Vehicle Checkout Laboratory. At the lab, the common bulkhead and post fire internal LH_2 tank inspections were completed. Power was applied to the stage on August 17 for post fire checkout. Systems test continued through August. The engineering run of the all systems test started on August 31 and the final run was made on September 12, signifying the completion of post static checkout activity. The stage turnover acceptance meeting was held at Sacramento on September 20 as planned. After acceptance of the stage, it was turned back to the contractor for post acceptance modification work and storage. Modification and storage of the stage will continue until early next year when the stage will be shipped to KSC.

6. S-IVB-503 FLIGHT STAGE

Preparations at Huntington Beach for S-IVB-503 stage joining operations were active at the beginning of July. The stage tanks were cleaned and LH_2 tank installations were made. The skirts and thrust structure were installed in Tower # 2 and LOX tank installations and stage interconnections were made. Stage joining operations were complete by mid-July. The stage was

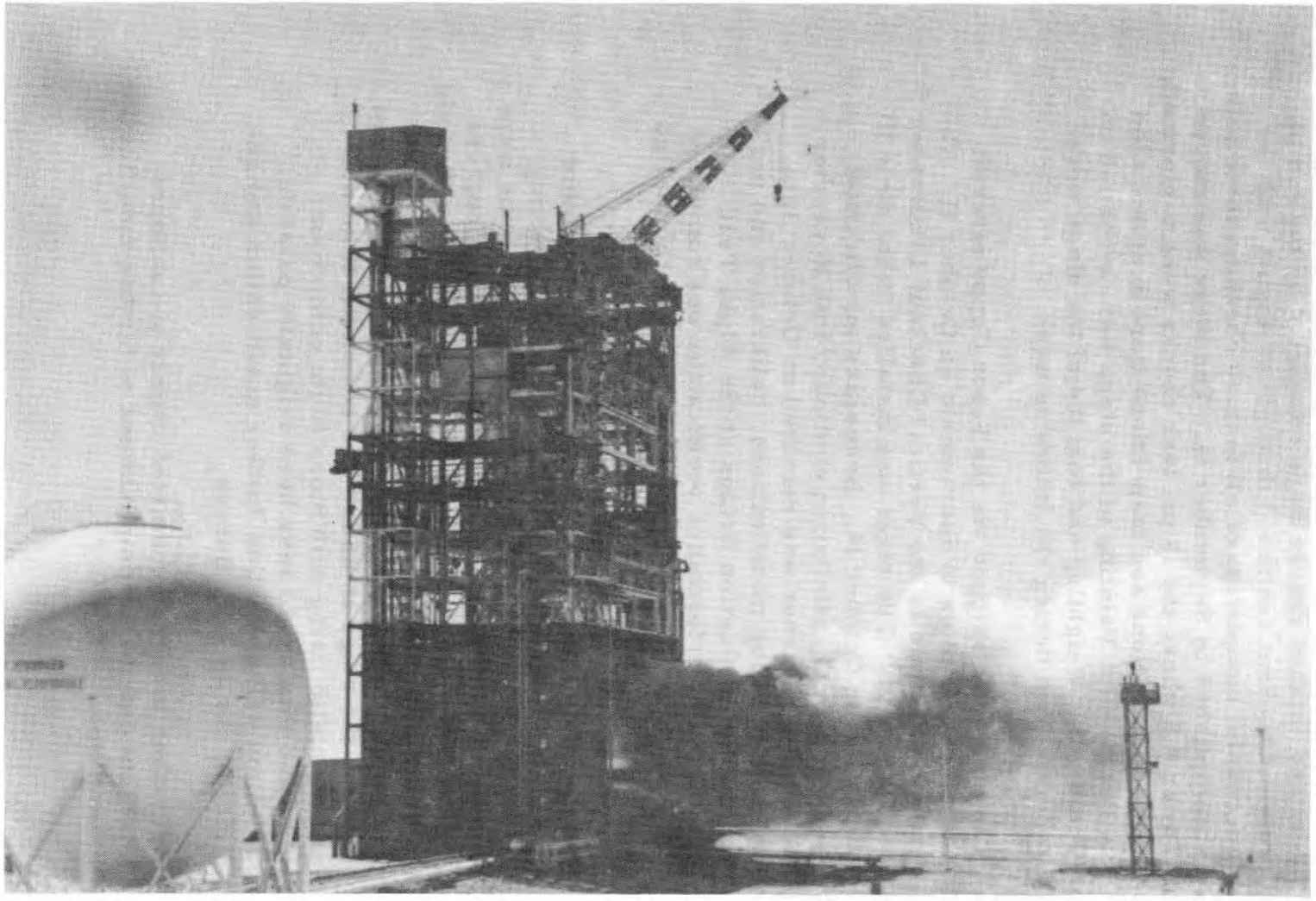


Figure 10 - Acceptance Firing Of The S-IVB-502 At Sacramento

moved to Tower # 6 and the J-2 Engine was installed. Megger checks and continuity testing were accomplished to begin post manufacturing checkout. Engine alignment test and antenna checks were completed by the end of July. Checkout continued throughout August with the successful completion of all factory checkout tests being accomplished by September 14. The stage was moved to Tower # 8 where the 10 psi leak checks were performed. Final installations and inspections were accomplished in Tower # 7. Painting of the stage was completed on October 3. Weighting and balance of the stage were accomplished during the following week.

The stage was shipped via the Super Guppy aircraft from Los Alamitos to Sacramento on October 11. The stage was moved to the Vertical Checkout Laboratory on October 12. The stage was installed in the Beta III test stand on October 14. Necessary modification work and parts installation continued into November. The 0_2 - H_2 Burner was removed on October 31 to undergo updating modifications, calibration and performance verification firings at the Alpha Test Facilities. Performance verification was completed on November 8. The 0_2 - H_2 Burner was reinstalled on the stage on November 10.

"Power-On" was accomplished on November 8 and subsystem checkout was begun. Prior to applying power to the stage, several GSE power problems were resolved. While pre-firing checkout was in progress during November and December, the decision was made to delay acceptance firing until January of next year. The delay was possible due to a change in the required date for the stage at KSC. The additional time will permit static firing with more flight components installed than would have been originally possible. The time will also allow further qualification and re-firing of the 0_2 - H_2 Burner.

December progress consisted mainly of continued checkout and the accomplishment of further modification

work. Proofing of the integrated test tape was initiated in mid-December and debugging of all tapes was completed by the end of the month.

7. S-IVB-504 FLIGHT STAGE

All tankage for the stage had been assembled and hydrostatically tested by mid-July. Leak and dye checks were performed and the LH_2 tank was moved to the insulation chamber for insulation installation. Installations on the forward and aft skirts began on July 25. LH_2 tank insulation work was completed and the stage was removed from the Insulation Chamber on July 29. Installation in the LOX and LH_2 tanks was in progress at the beginning of August. All major sections (aft skirt, forward skirt, thrust structure and tankage) were located in Tower # 2 and stage joining operation began in late August. Some delays in the joining and installation operations were encountered due to hardware shortages. The stage was erected in Tower # 6 on September 22 for Megger checks and final installations, prior to J-2 Engine installation. Engine installation was then accomplished on September 30. Systems installations continued through October.

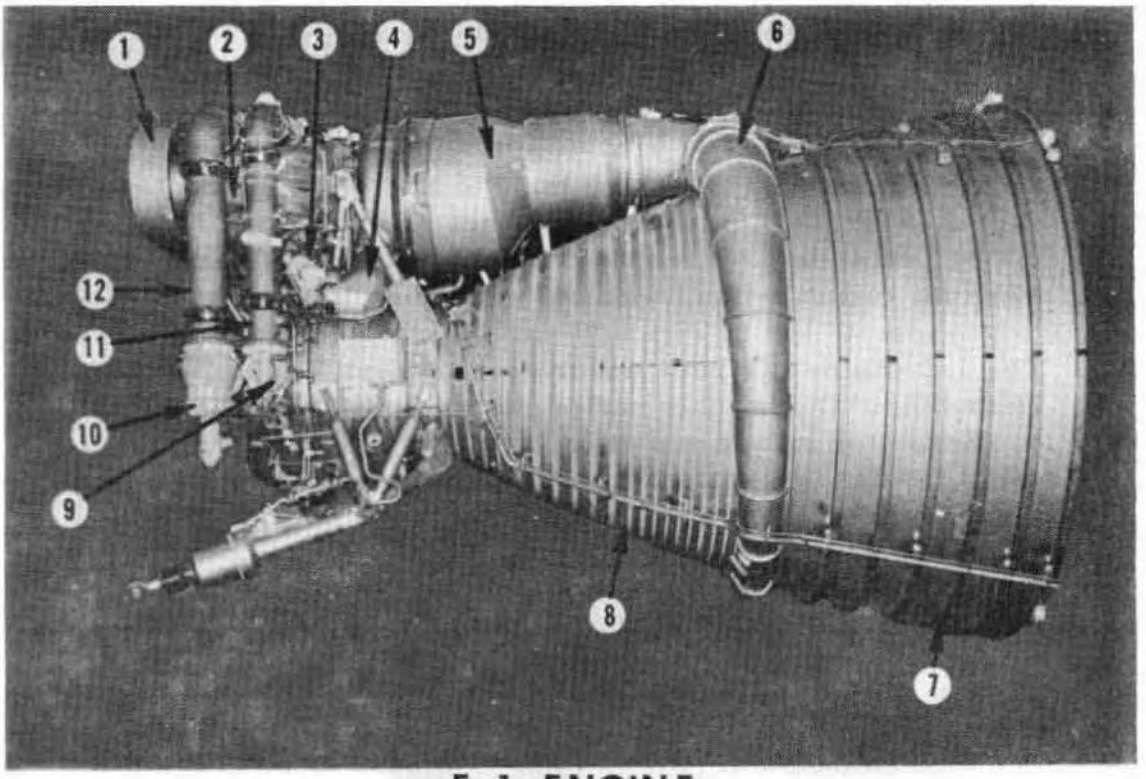
Factory checkout of the stage began on October 4, with the activation of Continuity, Antenna and Cold Plate tests. Factory Checkout was completed on December 9. Data review of the all System Test indicated the tests were successful.

The stage was moved to Tower # 6 for a post checkout modification period prior to the high pressure leak checks. Leak checks were completed in Tower #8 on December 29 and the stage was moved to Tower # 7 for final installations. Shipment of the stage to Sacramento is planned for late January, 1967.

8. S-IVB-505 FLIGHT STAGE

The S-IVB-505 common bulkhead was completed in early August at Santa Monica. The Liquid Oxygen Tank and forward dome assembly were in process at the end of August. Welding of the LH_2 cylinder to the LOX tank began in Tower # 1 in mid-September. Tank assembly and proof testing were completed in September. X-Ray and dye-check inspection of the joining tank welds were completed early in October. The tankage was placed in the Insulation Chamber and a special bulkhead drying test was performed. The test was performed to establish the criterion for allowable bulkhead moisture content. Hydrostatic testing of the tankage was performed on October 10. The 10 psi leak check was completed on October 24, and the stage was moved to the Insulation Chamber for processing. Insulation installation continued through November to successful completion on December 5. LH_2 installations began with the installation of the Cold Helium Bottle.

At the end of the period the Aft Skirt was 70 percent complete; the Forward Skirt was 55 percent complete; and the Thrust Structure was 50 percent complete. Stage component joining is scheduled to start on January 11, 1967.



F-1 ENGINE

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

SATURN V ENGINES

G. ENGINES

General

Through December 31, 1966, the F-1 Engine Program has conducted 1,692 R&D engine systems tests
131,240 seconds. Six hundred and sev
were for full duration, with 247 excee

The J-2 engine has been under development for approximately 76 months. During this period nearly 2,750 tests have been conducted for an accumulation in excess of 267,000 seconds using 130 development and production engines. This includes a total of 97 full duration tests.

ENGINE SYSTEM TESTING

1. F-1 Engines (EFL)

Developmental test activity continued at Edwards Field Laboratory (EFL) on the four R&D test positions. Seventy-five R&D engine tests were conducted for an accumulated duration of 10,154 seconds; of these, 51 were full duration runs (150 seconds or more).

Forty production engine tests were conducted at EFL during this period. Total duration for the tests was 3,470 seconds. Fourteen of the tests were for full duration (150 seconds or more).

2. F-1 Engines (MSFC)

West Area

A total of fourteen F-1 engine tests were conducted at the West Area F-1 Test Stand during this report period. Four different engines were used. Test objectives were as follows:

a) Evaluation of the first qualification configuration of engine S/N F-5038.

b) Calibration of engine F-4017 for S-IC-2 stage.

c) Calibration of engine F-2010 for S-IC-T.

d) Calibration of engine F-3014 for S-IC-1 spare.

e) Evaluation of modifications to the static firing instrumentation system.

f) Evaluation of Resistoflex Flight Supply to the gimbal filter manifold duct assembly.

g) Establishment of a baseline for the thermal insulation test program.

Engine S/N F-5038 accumulated 2065.8 seconds with eighteen starts prior to being moved from the stand.

East Area

Two tests were conducted during this period using engine S/N F-1002-3. The first test was for 41 seconds duration with the objective of determining baseline performance for prevalve shutdown test. The second test was the first of a series of tests to investigate possible prevalve control system failure and emergency engine shutdown with prevalves. Cutoff was given after seven seconds by the thrust OK system after the LOX prevalve had been signalled to close. A LOX turbopump explosion occurred during engine shutdown. The engine test data and hardware are being analyzed to determine the cause of the explosion.

3. Engine Qualification Test

F-1 Engine Qualification II Testing started in August as planned and was completed in mid-September. Engine F-5039 was successfully subjected to thirty-two safety limits and eleven malfunction tests. The endurance

engine F-5037 was successfully subjected to 20 tests for a total duration of 2,284 seconds, which included 10 full-duration runs. Some delay occurred during endurance testing due to injector baffle erosion which required injector change-out after the third duration test. The formal Qual II Test Engine Teardown Inspection Review was held at Conoga Park, California, on November 29. The discrepancies found were anticipated and none were considered sufficiently serious to require corrective action of a retrofit nature. A final report, giving results of the Qual II Engine testing and teardown inspection, will be forthcoming from the contractor early in 1967.

4. J-2 Engines (SS-FL)

During this report period, 313 R&D tests were conducted at the Santa Susana Field Laboratory (SS-FL) for a total of 38,250 seconds.

5. AEDC

Modification of the J-4 Test Cell at Arnold Engineering Development Center, Tullahoma, Tennessee (which included installation of the S-IVB Battleship stage) was completed and the facility activated during this report period. An engine environmental verification program, including engine re-start modes, was conducted for an accumulation of 231 seconds during this report period.

6. J-2 Qual II Test

The Qual II (qualification of the 205/230 K thrust engine) test series was completed on August 22. During this series, engine J-2072 was subjected to 30 tests for a total of 3807 seconds. All tests were for programmed duration. There were 1504 seconds accumulated at maximum mixture ratio.

ENGINE PRODUCTION AND DELIVERIES

1. F-1 Engines

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

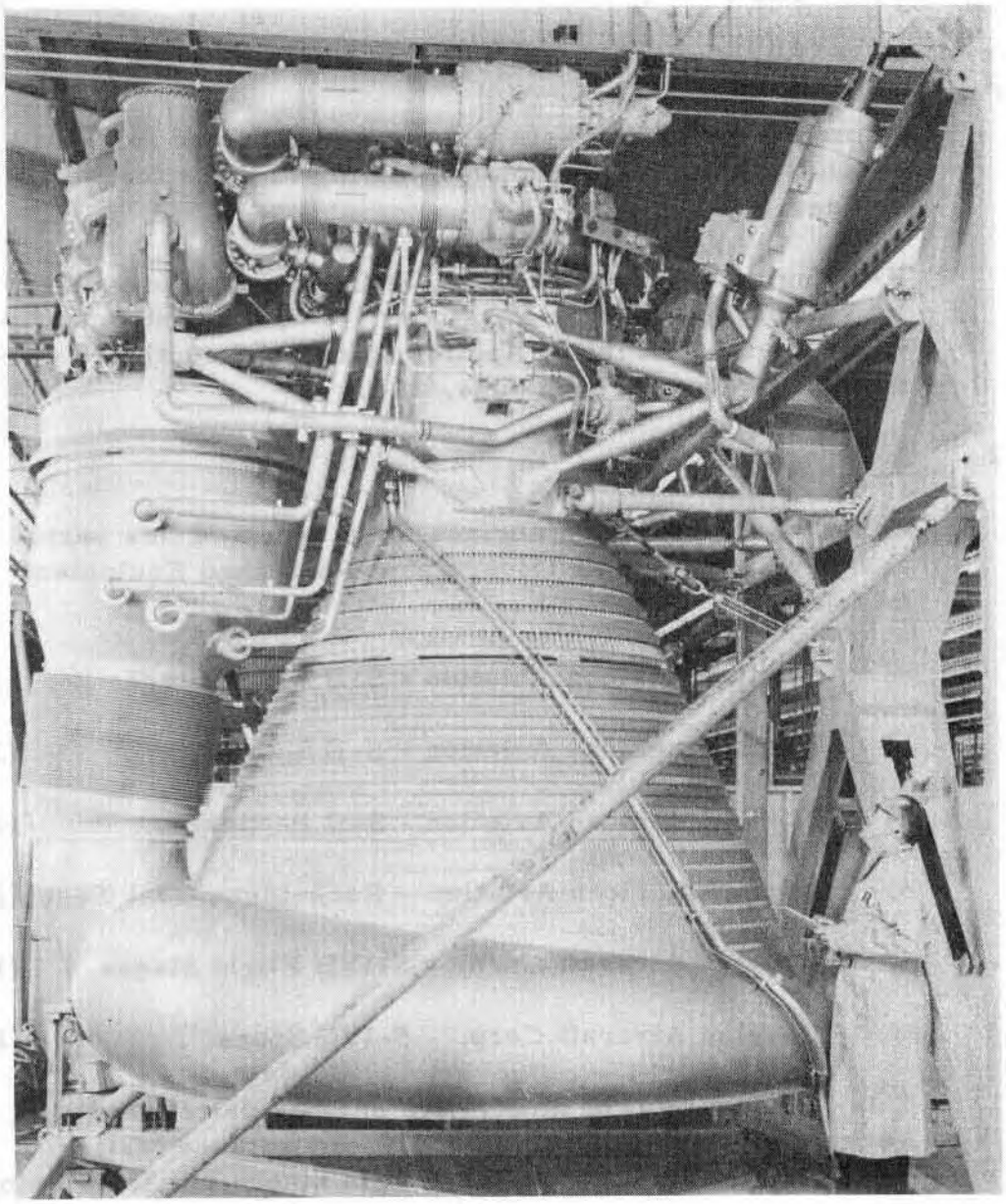


Figure 11 - F-1 Engine Checkout

a) The Boeing Co. S-IC-5 Flight Stage (2)

b) The Boeing Co. S-IC-6 Flight Stage (5)

c) The Boeing Co. S-IC-7 Flight Stage (3)

d) The Boeing Co. S-IC Flight Stage (Spare) (1)

e) Marshall Space Flight Center-Ground Test (1)

Approximately thirty-six tests were conducted for 3,040 seconds during the acceptance testing of these twelve engines.

F-1 Engine Contract NAS8-18734 CPIF was approved by NASA Headquarters on November 18. This contract provides for the last thirty Apollo engines and continued production support through June, 1970.

2. J-2 Engines

Twenty 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 (11)

b) North American Aviation - S-II Spares (3)

c) North American Aviation - S-II Battleship (2)

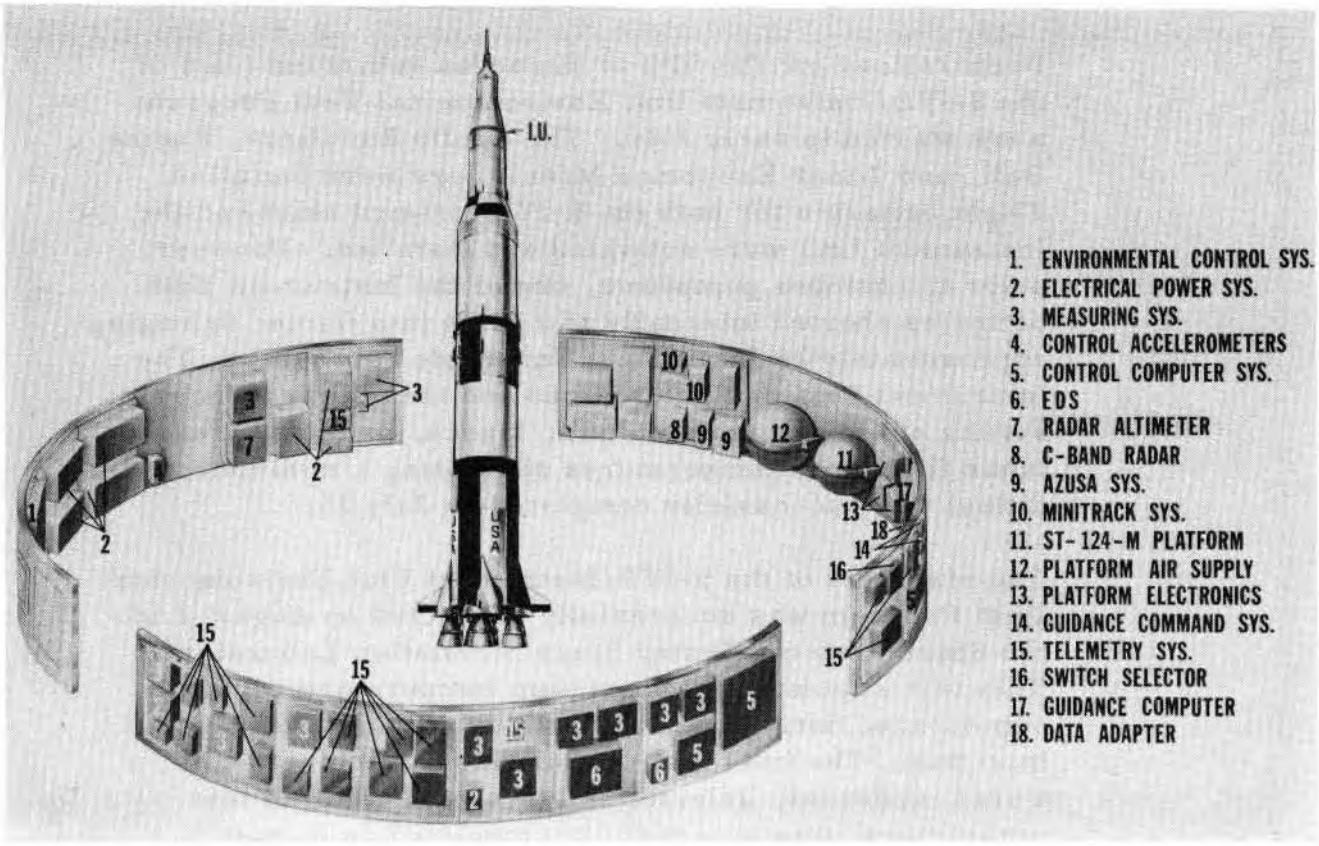
d) North American Aviation - Rocketdyne Qual Test (2)

e) Douglas Aircraft Corp. - S-IVB Flight Stages (1)

f) Douglas Aircraft Corp. - S-IVB Spare (1)

This makes a total of ninety-five engines delivered by Rocketdyne through December 31. Acceptance testing during this report period resulted in ninety-one tests being conducted for an accumulated total of 11,822 seconds.

J-2 Engine Program Contract NAS8-19 was unconditionally approved by NASA Headquarters in Washington on July 29. This contract establishes the provisions for production support effort through December, 1968, and for the 155 J-2 engines required in the Apollo Program. The contract also combines the J-2 engine production and production support effort.



SATURN V INSTRUMENT UNIT

H. INSTRUMENT UNITS

General

Environmental Tests utilizing the S-IU-500FS have been successfully completed. S-IU-200S/500S-III Structural Testing was completed during this period. The S-IU-501 was delivered to KSC during August. The S-IU-502 has completed Systems Checkout.

1. S-IU-500FS FLIGHT SYSTEMS TEST UNIT

Preparations for the fifth of the seven scheduled tests of the S-IVB/Instrument Unit Environmental Test Program were started in early July. The Apollo Simulator, Engine Bell, and Lunar Excursion Module legs were installed. Flight batteries for both the S-IVB forward skirt and the Instrument Unit were activated and installed. However, prior to chamber pumpdown, one of the Instrument Unit batteries shorted internally and burst into flame, damaging approximately 20 Instrument Unit cable harnesses. The Instrument Unit was refurbished and the fifth test (consisting of simulated countdown, launch, orbit and translunar flight with temperatures simulating a minimum condition) was successfully completed on July 29.

The sixth test of the S-IVB/Instrument Unit Environmental Test Program was successfully conducted on August 2 in the Space Systems Center Space Simulation Laboratory. This test simulated the maximum temperature condition experienced during launch, earth orbit, and translunar injection. The final test, simulating a combination of worst conditions, selected failures, and changed test parameters, was successfully completed on August 9. In addition, an unscheduled corona investigation test was accomplished as requested by MSFC to determine whether significant electrical discharge occurs in the Instrument Unit or S-IVB stage electronics during the critical pressure range.

The Instrument Unit used in the test program was returned to MSFC on the Super Guppy aircraft on August 20. The S-IU-500FS has been reallocated to the Saturn V Systems Development Facility. The unit will be updated to the S-IU-504 configuration and redesignated S-IU-500ST-2.

2. S-IU-200S/500S-III STRUCTURAL TEST UNIT

Preparations for testing to qualify the SA-506 structure were in progress at the beginning of the report period. During July, all strain gauges and photo stress were installed on the IU segments. The IU was inserted in the test setup and the test stack configuration of the lower load ring of the S-IVB forward skirt.

Cold plates were removed from S-IU-200/500V for use in the structural test and were proof loaded to 1.4 limit loads. They withstood these loads satisfactorily, and were installed in the structural test unit. Cabling from the strain gauge bridge completion blocks to digital data system together with other test preparations were accomplished in early August. Testing was delayed several days in order to resolve problems with instrumentation.

All test conditions were completed by September 15. The last test condition for the 200/500S-III IU was the application of 140% maximum limit compression load on centerline of the ST-124. The 200/500-II IU failed while this load was being held and before data could be acquired. Although the IU was considered qualified for this load condition, the test was repeated on the 200/500S-III IU to provide data at the 140 percent limit load. The S-IU-200/500S-III has successfully withstood nominal 140 percent limit loadings at the access door and battery locations and is considered qualified for both manned and unmanned Saturn IB and V vehicles.

3. S-IU-501 FLIGHT INSTRUMENT UNIT

System tests of the S-IU-501 were in progress at the beginning of the report period. Emergency Detection System tests and Simulated Plug Drop tests were completed by

July 28. The Simulated Flight test was attempted on July 29, but had to be run again after rework since four switch selector operations did not function at the end of the test.

Rework and incorporation of changes continued until mid-August. During rework, the defective manifolds discovered during June were replaced. Retest began on August 10 with the rerunning of power distribution and control.

Checkout of the IU-501 was completed on August 18 with all test requirements satisfied. The unit left the manufacturing and checkout facility on August 24 and was delivered to KSC on the Super Guppy aircraft (Figure 12). The unit was placed in the IU receiving section of the VAB for receiving inspection and processing. Necessary MOD kits were installed on the unit. The ST-124M Inertial Guidance System was returned to MSFC in order to incorporate engineering changes and subsequently shipped back to KSC.

The S-IU-501 was stacked on the S-IVB-501 on November 2. Subsequent progress is reported in the SA-501 vehicle section of this report.

4. S-IU-502 FLIGHT INSTRUMENT UNIT

Component assembly of the S-IU-502 was in progress at the beginning of the report period. Late availability of good manifolds hampered the completion of assembly. The manufacturing assembly phase continued during July with the installation of cables, electrical assemblies, and GN_2 assemblies. FACT testing of cables began in early August. Assembly progress was constrained during mid-August by the unavailability of the LVDA/LVDC mounting structure, ST-124 support ring, gas bearing panel, water methanol, manifolds and gas bearing supply heat exchanger.

Assembly was completed on September 3. The unit was then moved to the checkout station and testing began immediately. The high pressure test of the GN_2 system was performed on September 6 and nine leaks were

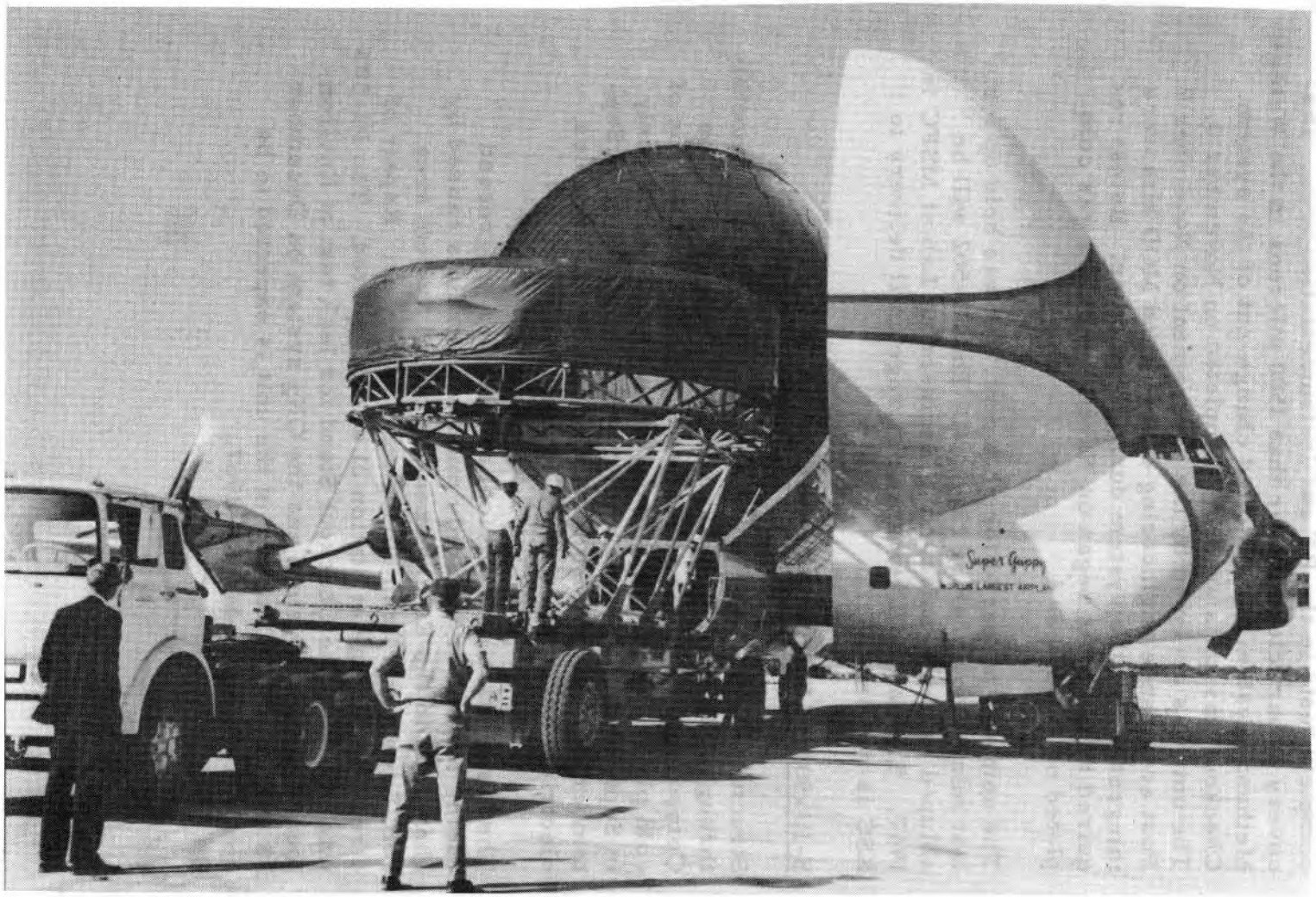


Figure 12 - IU-501 Arrival At KSC

detected. These leaks were repaired immediately. The ST-124M was returned to MSFC on September 13 to allow installation of an accelerometer for vibration measurement. Minor cable problems were resolved in order to complete tests in the RF and Instrumentation area. Discovery of particles greater than 1500 microns in the Water-Methanol system necessitated change-out of the system. Checkout was satisfactorily completed on November 3. The unit was accepted by the government on November 7. Post acceptance engineering changes and MOD kits were integrated into the system during November. Retest required by mod kits began on November 21 and was completed on December 1.

The unit was prepared for shipment, but was held up for last minute engineering changes. The IU-502 will be shipped to the Manufacturing Engineering Lab at MSFC in 1967. The unit will remain in storage until delivery to KSC is required.

5. S-IU-503 FLIGHT INSTRUMENT UNIT

Structural fabrication of the S-IU-503 progressed smoothly through July to an early completion on August 8. The Component Assembly phase began with the installation of cold plates. Cable tray installation was complete early in September. Assembly efforts for the duration of September and October involved the installation of cables, electrical assemblies and GN_2 assemblies.

The installation of electrical assemblies progressed during November with only minor constraints caused by shortages in the Environmental Control System area. FACT tests were run during mid-December. Repair of structure damage at Station 21 was completed. The IU-503 was moved to the Checkout Stand for leak test of Environmental Control System and the GN_2 system on December 28 (Figure 13). Checkout of the unit is expected to be complete in early March, 1967.

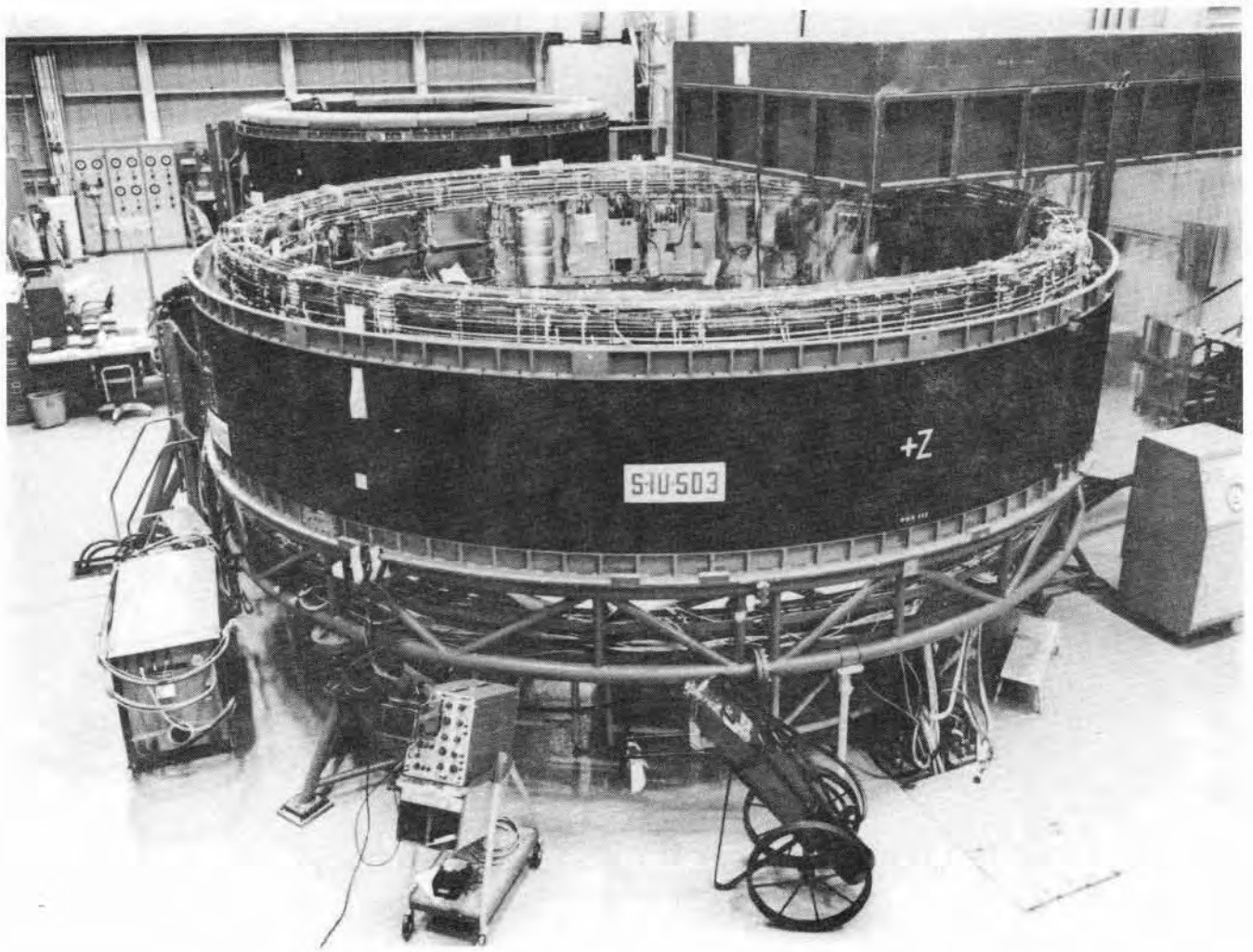
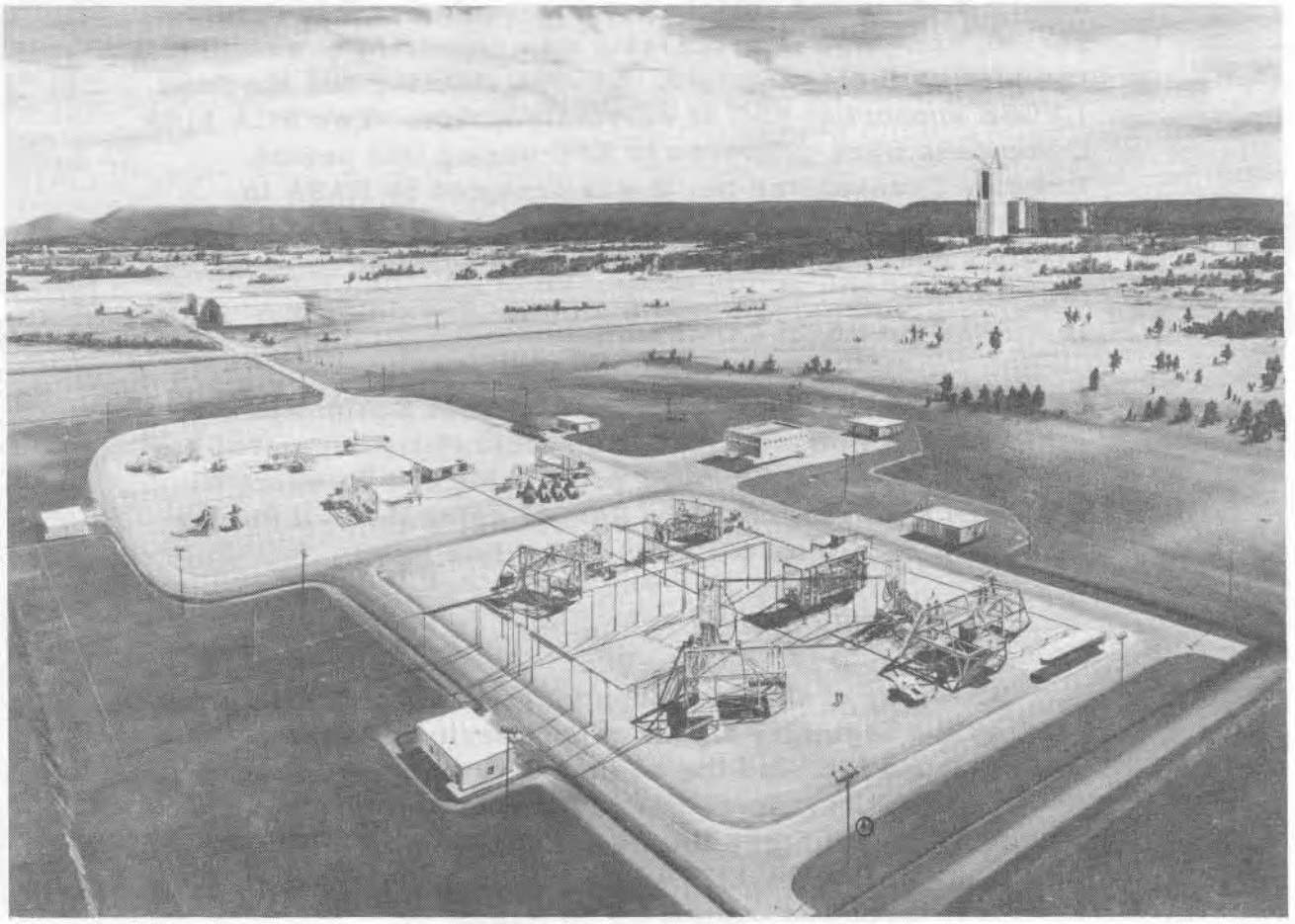


Figure 13 - IU-503 On The Saturn V Checkout Stand

6. S-IU-504 FLIGHT INSTRUMENT UNIT

Structural fabrication of the S-IU-504 began on August 25. This effort should be completed during the last part of January 1967, followed by component assembly completion in April, 1967.



SATURN V LAUNCH VEHICLE GSE

I. LAUNCH VEHICLE GROUND SUPPORT EQUIPMENT (LVGSE)

General

LVGSE deliveries and activations have successfully supported Saturn V stage and vehicle processing during this report period. SA-500F-1 processing was supported to successful completion during October. SA-501 stacking and checkout LVGSE support at KSC is currently active. Two RCA 110A Computers were delivered to KSC during this period. Crawler Transporter No. 2 was accepted by NASA in September. Progress in all areas of LVGSE indicates timely support for all Program requirements.

1. KSC LAUNCH COMPLEX 39

The Launch Vehicle Ground Support Equipment at Launch Complex 39-1 has successfully supported the completion of SA-500F processing and de-erection and the erection of the SA-501 using the S-II Spacer as a substitute for the S-II-1 flight stage.

LOX Supply System

Cleaning of the LOX Supply System was still in process at the beginning of this report period. Lines being cleaned included the 14 inch cross-country line, the 6 inch VJ cross-country line and the 6 inch dump line. Cleaning of these lines was completed on July 10. Cleaning of the LUT spool pieces up through the 200 foot level was completed on August 7.

During S-IC-F LOX loading on August 19, an 18 inch flex line at the LOX storage tank ruptured, resulting in the loss of the entire LOX supply and damage to the LOX storage tank. Modifications and repair of the LOX tank, the 18" transfer line, and associated systems were completed on September 19. Support of SA-500F LOX loading resumed on September 20.

Launch Umbilical Tower No. 1 (LUT 1)

Tail Service Masts (TSM) 1, 2 and 3 utilized on LUT 1 in support of the 500F-1 were considered unqualified and were replaced with qualified TSM's to support SA-501 on October 18. The qualified TSM's are currently undergoing functional checkout. The unqualified TSM's were returned to MSFC for modification and qualification testing prior to LUT 3 utilization. Service Arms 1, 2, 3 and 9, utilized on LUT 1 in support of 500F-1, were considered qualified and relacement of the arms to support SA-501 was not required. However, arms 4, 5, 6, 7 and 8 had never been subjected to the required qualification tests at MSFC and replacement of these arms was required to support SA-501. Change-out of the unqualified arms 4 through 8 was accomplished between September 17 and October 24. The unqualified arms were returned to MSFC for modification and qualification tests prior to LUT 3 use. The hydraulic and pneumatic distribution systems installation work for Arms 1 through 9 has been accomplished and the arms are currently undergoing validation.

Pad A

The number of Pad A GH_2 storage vessels was increased from four to eight. The eight pressure vessels were on board at LC-39 on October 27. Installation of the facility began on November 3 and will be completed during January, 1967. The primary Flame Deflector for Pad A was completed and tested by mid-November. The spare deflector is scheduled for completion in late April, 1967.

Mobile Service Structure (MSS)

The Mobile Service Structure (MSS) Ramp test and Launch Vehicle Mate test were completed during August. BOD for the MSS was accomplished on August 15. Completion of the basic construction

contract was scheduled for September 1. However, labor problems extended the completion date to October 3. The original work scope for RF transmission installations was completed on July 15. However, interference with the follow-on air conditioning contractor necessitated removal of a portion of the waveguide. The waveguide was reinstalled on a non-interference basis. Validation and acceptance of the MSS 01S equipment was satisfactorily completed on September 8.

Launch Umbilical Tower 2 (LUT 2)

The LUT 2 Tail Service Masts were received at KSC on December 2. The installation date for the TSM's has not yet been determined. Service Arms 1, 2, 3 and 9 were delivered to KSC on October 15. Installation of Arm 1 was accomplished on October 21; Arms 2 and 3 were installed on October 26. Arm 8 was received at KSC on November 8 and installed on December 6. Installation of Arm 9 has been delayed until early next year due to the use of a "Chicago Boom" on the 320 foot level used in lifting the required GSE equipment to the various levels on LUT 2. Necessary piping, tubing and hydraulic and pneumatic systems installations used in direct support of the arms are in process. Service Arms 4 through 7 are expected on dock KSC by mid-February, 1967.

Crawler Transporter 2 (C/T 2)

Unloaded test of the C/T 2 began on August 8. A problem with a bent hydraulic steering cylinder shaft delayed the test completion. A steering cylinder was transferred from C/T 1 and the Unloaded Test was completed on August 16. The Unloaded Ramp Test was accomplished the following day. LUT 2 was used to perform the Jack test. Testing, using a new steering cylinder and final bearing break-in, was completed by September 20. C/T 2 was accepted from the contractor on September 23. As a result of the long lead delivery

of electronic relays, the automatic JEL system is not expected to be installed and operational on C/T 2 until early January, 1967.

Pad B

The RP-1 system has been completed with the exception of the pneumatic console and miscellaneous electrical equipment. The mechanical testing was completed on December 17. LOX and LH_2 systems are nearing completion. The firebrick installation on the Flame Trench was completed on November 18. The structural steel erection of the Flame Deflector was begun on October 3 and is now 99 percent complete. The painting of the Flame Deflector has begun. The gunite covering is the only other erection remaining.

RCA 110A Computer

The RCA 110A Computer for Launch Control Center, Firing Room 2 was installed on September 20.

The RCA 110A Computer for Launcher Umbilical Tower No. 2 was delivered to KSC on September 30 and installed in LUT No. 2 on October 3.

2. SYSTEMS DEVELOPMENT FACILITY (SDF)

The five F-1 engine simulators for the Hydraulic Load Simulator arrived on dock Huntsville on September 26. Installation of the mechanical interconnects, supports, and the five simulated engines required about three weeks. Checkout of the Hydraulic Load Simulator was delayed due to the discovery of a cracked fitting on the main return line between the pumping unit and the simulated engines and to improper functioning of the three pumps on the Greer Hydraulic Unit. These problems were corrected and final functional checkout began on October 26. A technical demonstration of the Hydraulic Load Simulators was

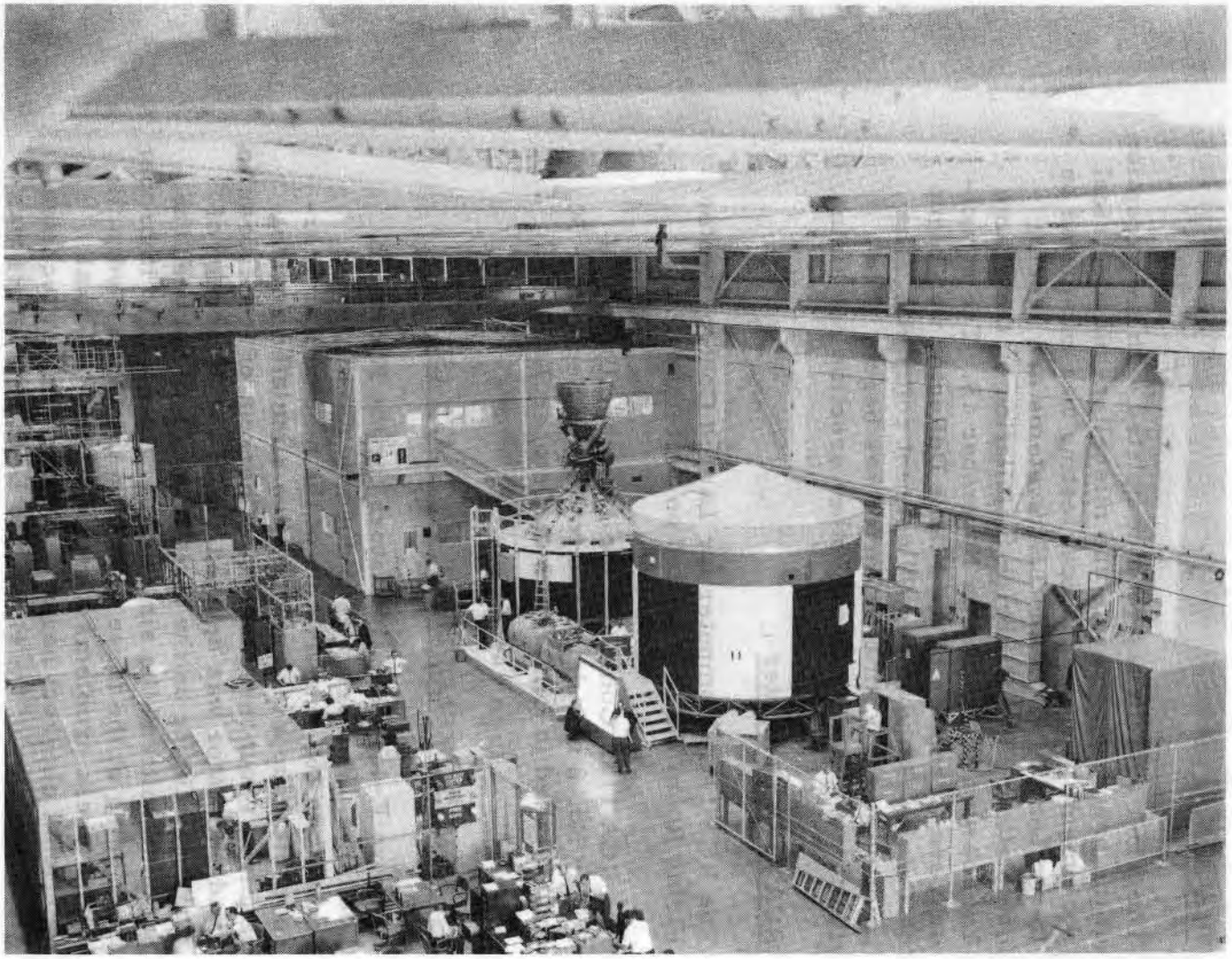


Figure 14 - Overall View Of The Saturn V Systems Development Facility At MSFC

satisfactorily performed on November 30. Efforts were made during December to clear up several minor shortages in the system.

The 500FS IU arrived at the SDF during late August. It was determined to update the 500FS to the IU 504 configuration. Initial modifications to the unit were performed by the Manufacturing Engineering Laboratory.

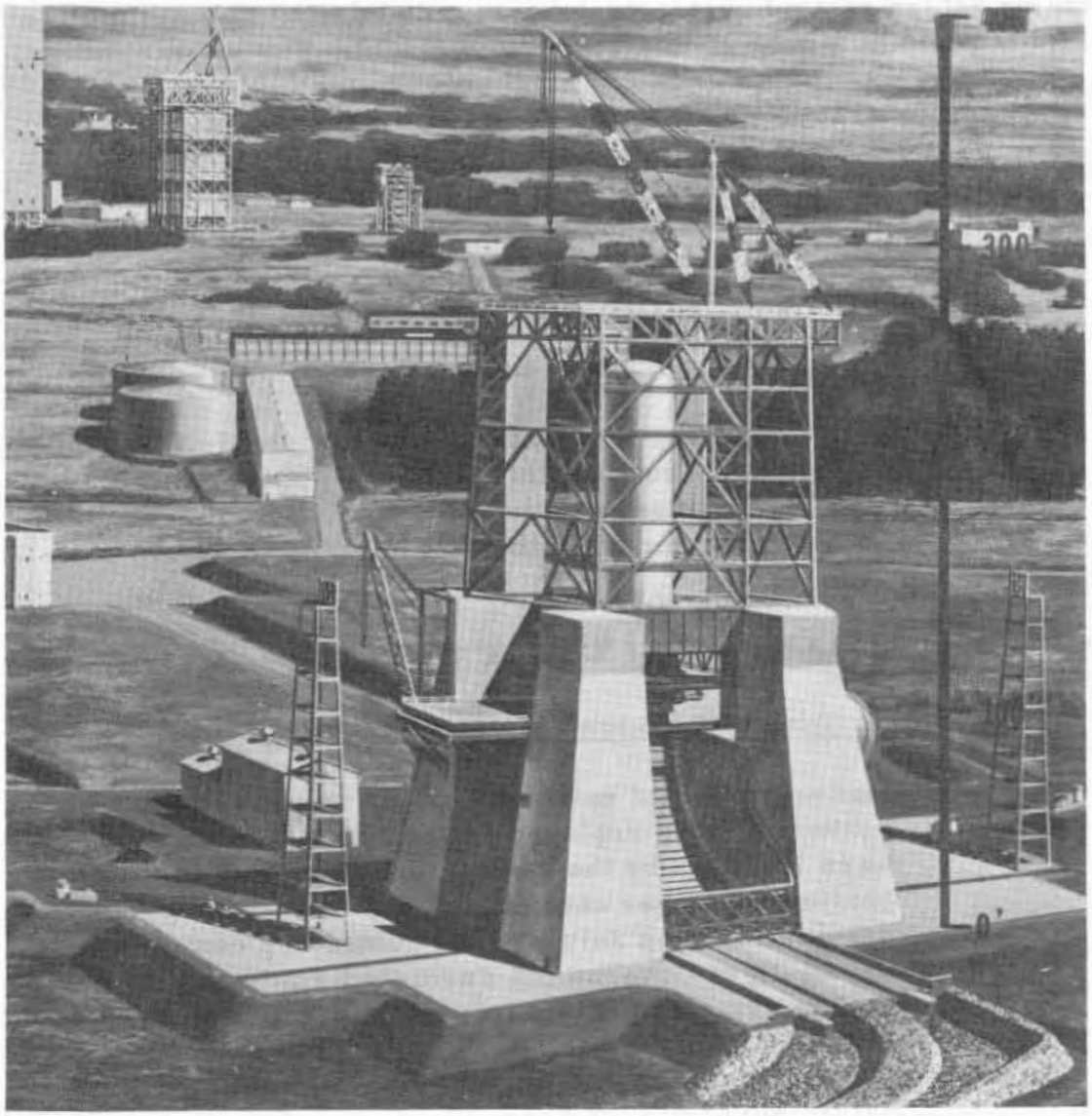
Development and delivery of Program Tapes supported the Saturn V vehicle processing at LC-39. Initial SA-501 Test Program Tapes were delivered to KSC on August 30 with final delivery being accomplished on December 1. Final delivery of the Operating Systems Tapes occurred on October 24. Delivery of the final LVDC Program for SA-501 has been rescheduled to coincide with the delivery of the final Flight Program on March 15, 1967.

3. SERVICE ARM/UMBILICAL DELIVERY AND TEST (SAUDT)

Service Arm/Umbilical testing and deliveries have supported LC-39 vehicle processing requirements. Delivery of the Qualified Service Arms and Tail Service Masts for Launch Umbilical Tower No. 1 was completed on October 12. Change-out of the LUT 1 Service Arms was completed on October 24. Tail Service Masts 1, 2 and 3 and Service Arms 4, 5, 6, 7 and 8, used to support SA-500F-1 processing, were returned to MSFC for modifications and qualification tests for later utilization on LUT 3.

Testing of the three Tail Service Masts for LUT 2 to support SA-502 were completed and delivered to KSC on December 2. Service Arms 1, 2, 3, 8 and 9 were on dock KSC by November 8. Arms 4 through 7 should finish testing and arrive at KSC by the end of February, 1967.

SECTION III



SATURN V FACILITIES

SECTION IV FACILITIES

General

Saturn V facilities are essentially complete at this time. Three major Saturn related contracts were awarded during this six months report period. These contracts were:

a) Rehabilitation of Reservoir site slopes and access road for Project No. 9109 at Edwards Air Force Base, awarded September 8 in the amount of $205,773.

b) Plating and Processing Facility for Project No. 9133 at Neosho, awarded November 30 in the amount of $410,631.

c) Additions to heating system for the S-IC Test Stand Test Position B-2 for Project No. 6403 at Mississippi Test Facility, awarded December 30 in the amount of $137,000.

A. MARSHALL SPACE FLIGHT CENTER

1. Addition to Advanced Saturn GSE Test Facility

Inadequate relief valve seats used on the nitrogen converter were replaced by the manufacturer and were installed by the contractor. The W-K-M quick closing valve was checked out and satisfactorily demonstrated on July 6. The contractor completed the tie-in of Government Furnished Equipment to the helium systems. Final inspection of the facility was held on August 11.

2. Saturn Support Test Area

a) High Pressure Gas and Propellants:
The four Norwalk air compressors were positioned

on the foundations. The units were grouted, bolted and aligned during July. The dryer, which was the last major item of the contract, was received during October and installed by the contractor. The installation of the LOX tank in the East Area was completed during October. Adjusting and checking of the compressor and dryer was accomplished during November. The 48 hour demonstration trial run and final inspection was made. BOD date was November 25. This job is completed except for minor deficiencies noted during the inspection.

b) Cryogenic Type Helium Purifier:
The final test of the unit was accomplished at the manufacturer's plant during July. The unit was knocked down to three major sub-assemblies and was shipped to MSFC on a flat bed trailer during mid-August. The unit was received and reassembled at the job site. Piping design was completed in-house as were piping fabrication and installation. During the week of December 5, the Cryovac Project Engineer completely checked out the unit and demonstrated the operating procedures. The unit was accepted by the government.

3. Engineering Building Extension

Negotiations for early delivery of the motor control center were successful. Final BOD inspection was accomplished on schedule and personnel were moved into the building on August 12.

B. MISSISSIPPI TEST FACILITY (MTF)

During this period, the following contract was completed:

Contract No.	Description	Date Completed
2889	S-II Vehicle Service and Vertical Checkout Building	9-27-66

1. S-II Test Stand A-1

Beneficial occupancy has now been obtained in the following areas: All high-pressure gas piping from the bottle farm to the Pressure Reducing Areas and from the Pressure Reducing Areas to the test stand; the high-pressure industrial water system on the test stand and docks; the flame deflector cooling system; the inside only of service core, sub-basement through tenth level; and the LOX system both on and off stand, including fill, topping, vent, and dump lines, but excluding the dump line from the base of the test stand to the LOX dump pit. Beneficial occupancy of the exterior of the service core, including work platforms and derricks, is scheduled for early January, 1967. Two remaining areas to be turned over by the Corps of Engineers are approximately 98% complete. The target date for having the stand ready to receive a stage for static test is January 27, 1967.

High-pressure gas lines on-stand are about 70% complete. LH_2 fill and vent lines are complete off-stand and about 40% complete on-stand. GSE installation is about 97% complete, with all contractor-furnished end items installed as of December 31, 1966. Check-out of GSE is about 40% complete. Facility operations and checkout is underway. Technical systems installation is nearing completion, with installation about 99% complete and de-bugging and demonstration in progress (Figure 15).

2. S-IC Test Stand Position B-2

Beneficial occupancy of the entire B-2 position and complex off-stand was accomplished in mid-December, with a punch list of discrepancy items which are being

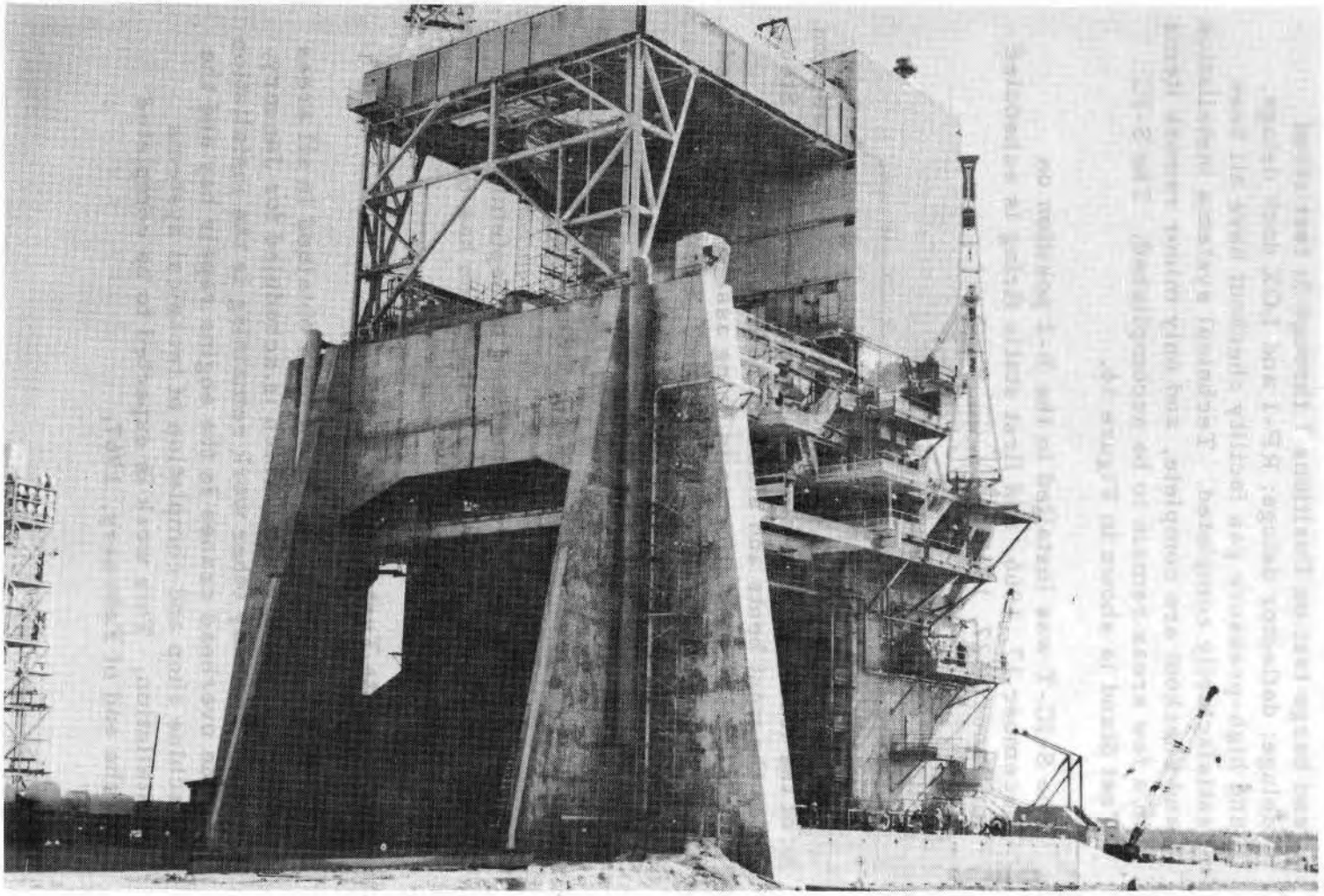


Figure 15 - S-II A-1 Test Stand At MTF

worked off. GSE installation is nearing completion, and all-systems testing and automatic testing is scheduled for January, 1967. The RP-1 system high-flow and low-flow tests; LOX system low-flow test and barge test on Positions 1 through 5; test stand deluge; deflector deluge; RP-1 and LOX dock deluge, and high-pressure gas facility checkout have all been satisfactorily completed. Technical systems installation and checkout are complete, and only minor rework items in a few areas remain to be accomplished. The S-IC Test Stand is shown in Figure 16.

The S-IC-T was installed in the B-2 position on December 17, 1966, and first static firing is scheduled for January 27, 1967.

3. S-IC Test Stand Position B-1

Construction of this position is proceeding on schedule and is expected to be complete by April, 1967. Erection of the load frame on-stand is nearing completion. Steel for the west bents and also for the 17th, 18th, and 19th level work platforms is being assembled and fitted on-ground for installation on-stand. Erection of the flame deflector is about 75% complete, and welding on the flame deflector is in process.

4. S-II Vehicle Service and Vertical Checkout Building

Beneficial occupancy was obtained on September 27, 1966, and technical systems installation has now been completed and accepted.

5. Components Test Facility

Beneficial occupancy has now been obtained in all areas except the clean room, which is scheduled for January, 1967. The only other work remaining is the installation on the overhead cranes in the engine repair bay and the machine shop and completion of technical systems installation. This work is expected to be completed by the end of February, 1967.

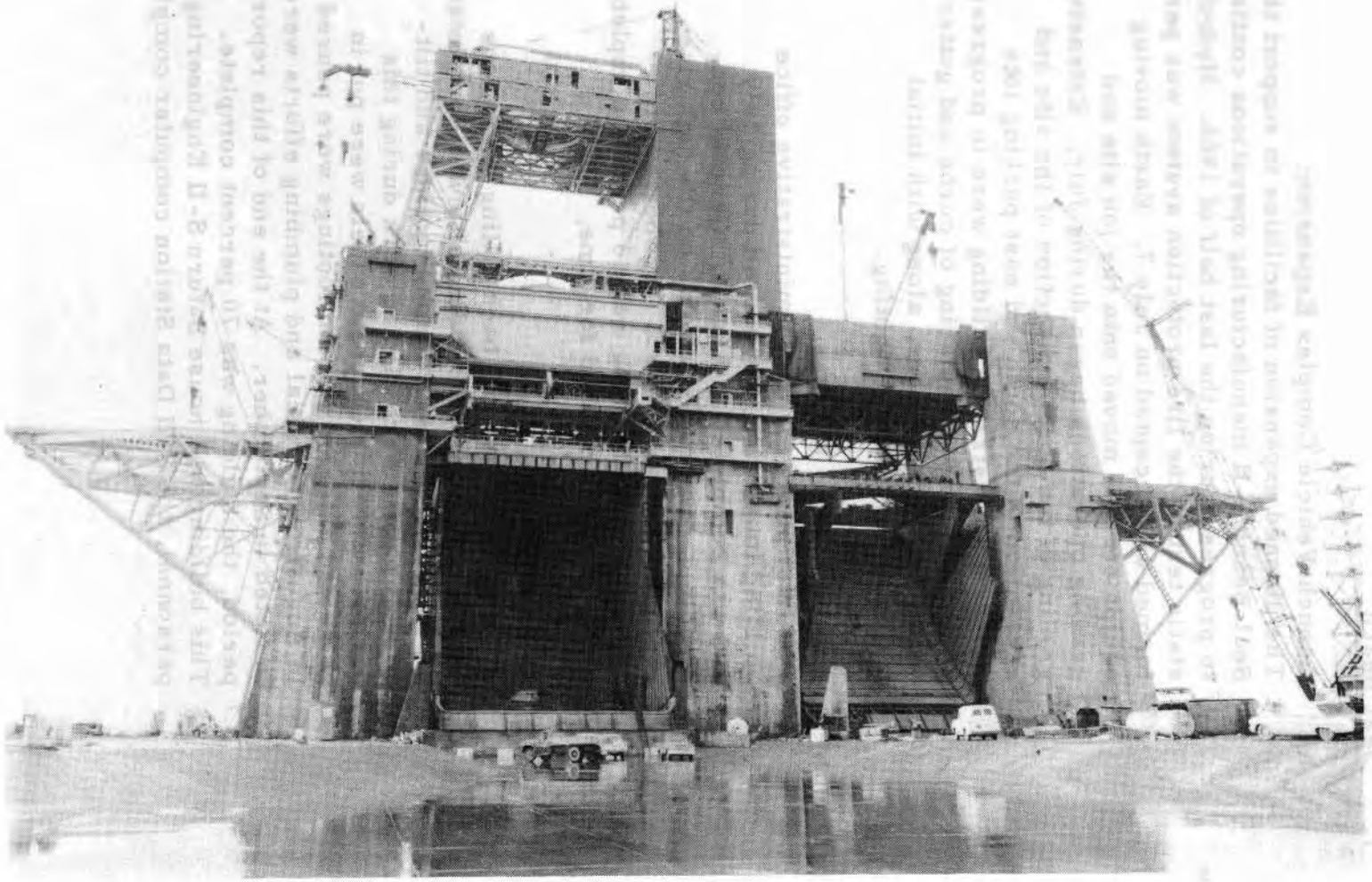


Figure 16 - S-IC Test Stand At MTF

C. CONTRACTOR FACILITIES

1. Seal Beach

a) Launch Vehicle Complex Expansion:
The planned expansion of facilities to support the Seal Beach S-II manufacturing operations continued to progress during the last half of 1966. Hydrostatic test of the fire protection system was performed and accepted on July 7. Earth moving equipment was moved onto the job site and grading operations began during July. Extensive grading of the northern section of the site and excavation of the south and east parking lots for the administration building were in progress during August. The placing of curbs and gutters began during September, along with initial installations for area lighting.

b) Administration Building:
The first piling for the administrative office building foundation was poured during July and was completed in August. General construction, with major efforts on the high rise shell, began on August 5. By the end of December, the building was 43 percent complete with occupancy planned for June, 1967.

c) Multipurpose Building:
Poor soil removal and back-filling operations for the multipurpose building site was completed during July. Slabs, column, footings and tilt-up wall panels were also in work during this period. Exterior concrete panels were put in place and exterior column footings were poured in August. Electrical and plumbing efforts were initiated in September. At the end of this report period, the building was 70 percent complete. This building will house Saturn S-II Engineering personnel, the S-II Data Station computer complex,

and the Computer Program Development Facility. Occupation is to commence in February, 1967.

d) Sub-Assembly Building:
Bolting and touch-up painting of the structural steel continued during July. Also, siding, decking and pipe installation progressed. The main roof decking was completed on July 25. Major efforts during August were placed on air-conditioning, plant-air, sprinkler, and vacuum piping installations. Sheeting installation continued on the west side of the building, and mechanical room cladding began on August 10. Installation of crane rails began in September. Joint occupancy of the thrust structure station took place on September 27.

2. SACTO

Bid packages for the Helium Purification System were sent out in early August, and were followed by on site inspection on August 12. On site construction began on September 22 and was essentially complete by November 2. Leak check of the contractor system was accomplished on November 8. System checkout and tests were accomplished with the system operating at a low pressure and the purification unit being isolated from the system.

APPROVAL

SATURN V SEMI-ANNUAL PROGRESS REPORT

(July 1, 1966 - December 31, 1966)

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 made by MSFC Security Classification Officer. This report has been determined to be UNCLASSIFIED.

for: L. D. Dyke, Dep Prgm Control

ARTHUR RUDOLPH
Manager, Saturn V Program

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