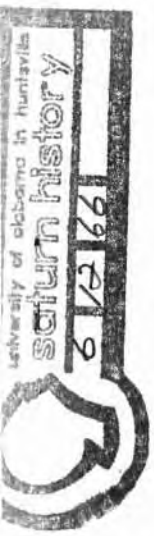

June 1966

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TEST LABORATORY PROGRESS REPORT

MAY 12, 1966 TO JUNE 12, 1966

I SATURN I/IB PROGRAM

A. S-IB-6

S-IB-6 was installed in the static test tower east on Tuesday, May 31, 1966. Rocketdyne personnel replaced the lox pump shaft seals on all eight engines with modified seals with vented housings. The thrust O.K. pressure switches were X-rayed and six switches were replaced due to contamination with soldering balls. Functional checks and sequence test were performed. Leak tests are in progress. No major discrepancies were found to date. The propellant loading test is scheduled for June 16, 1966, and the short duration static firing for June 22,1966.

B. Power Plant Test Stand

Two H-1 engine firings were conducted in conjunction with the H-1 engine special hydraulic system test.

One 40 second duration test was planned to check out the gimbal system and study system contamination. However, test P1-475 conducted May 26, 1966, was erroneously cut off at 2.81 seconds by a redline observer. A second test, P1-476 conducted the same day, was terminated at 20.71 seconds when the engine went hard-over during gimbaling. Post-test investigation revealed the main hydraulic pump quill shaft had been inadvertently omitted during assembly of the system.

Several hot firings are planned for the next report period as well as the continuation of the environmental phase of the special hydraulic system test.

C. 200K H-1 Turbopump Testing

This program supports P&VE in the Saturn IB Vehicle "Pogo" Study. The program is necessary to establish a relationship between suction line resonant frequency and pump suction pressure for the S-IB oxidizer and fuel delivery systems.

Four H-1 "Pogo" tests were successfully conducted, completing the Upstream Pulsing Test Program. The fuel suction system was pulsed at frequencies of 6 to

18 c.p.s. with pump inlet pressures of 30 and 40 p.s.i.a. The data is being prepared for transmittal to P&VE Laboratory for S-IB "Pogo" analysis.

Installation of the downstream pulsing systems continued and is approximately 80% complete. A series of downstream pulsing tests is planned to begin the last of June. The data obtained in these tests will be compared with that of the upstream pulsing tests.

D. Ground Support Equipment

1. Saturn IB Apollo Access Arm

The Apollo Command Module access arm supports an environmentally conditioned cab through which astronauts and service personnel enter the Apollo spacecraft. The arm also provides a support structure for air conditioning and space suit checkout lines.

During the report period all subsystems operation tests were completed with the exception of the environmental chamber pressure regulating system test. Hardware deliveries delayed this test, but the required environmental duct was received and the test is now in progress.

Complete system testing of the access arm is now in progress with completion scheduled for approximately June 17, 1966.

The test program is approximately 80% complete.

2. Saturn IB Lunar Excursion Module (LEM) Swing Arm-Launch Complex 37B

The swing arm will be used on the LC-37 umbilical tower to support electrical, water glycol, and air conditioning service lines to the LEM umbilical connection.

Preparation of the LEM swing arm for umbilical qualification tests was continued. Hydraulic system orifices were varied until the correct swing times were obtained and the umbilical retract rate was established. Extensive tests are being made on the swing arm locking mechanism to determine the linkage

setting required in case of a pneumatic failure. At this time, the performance is not predictable and a new locking mechanism may be installed. A friction clutch for the swing arm boom has been manufactured and will be installed when received. Delivery is scheduled for June 13, 1966.

II SATURN V PROGRAM

A. S-IC-2

The S-IC-2 stage was received and installed in the S-IC Test Stand on May 17, 1966.

A propellant load test was performed on May 27. The main lox flowmeters were removed and the fuel flowmeters modified and reinstalled prior to the load test. Inspection of the lox tank and the screens removed from the suction lines indicated that the lines and tank were relatively clean.

The acceptance firing test was successfully conducted on June 7. The test was terminated by the firing panel operator as planned at 126.3 seconds of mainstage. All major test objectives were achieved. Preliminary data evaluation indicated that all systems performed satisfactorily.

The stage is scheduled for removal from the test stand on June 16, and will be transported to R-ME for refurbishment.

B. F-1 Engine

Tests FW-028 through FW-032 were conducted on the West Area F-1 Test Stand.

Test No.	Date	Duration	Comments
FW-028	5/9/66	150.7	F-1 Engine S/N F-4T2. Cutoff was initiated by the facility panel operator as programed. Primary test objective was to obtain a baseline for determination of performance variations caused by conducting a test on an engine which has not returned to ambient conditions.

Test No.	Date	Duration	Comments
FW-029	5/9/66	52.1	F-1 Engine S/N F-4T2. Cutoff was initiated by the S-IC lox depletion cutoff sensor. Primary test objective was to determine performance variations caused by conducting a test on an engine which has not returned to ambient conditions.
FW-030	5/11/66	150.1	F-1 Engine S/N F-4T2. Cutoff was initiated by an observer when the opening control line to the number two main lox sequence valve failed permitting a high pressure fuel leak. Primary test objective was the same as for Test FW-028.
FW-031	5/18/66	150.5	F-1 Engine S/N F-4T2. Cutoff was initiated by the facility panel operator as planned. Primary test objective was the same as for Test FW-028.
FW-032	5/18/66	59.8	F-1 Engine S/N F-4T2. Cutoff was initiated by the thrust OK cutoff system as programed. Primary test objective was the same as for Test FW-029.

C. SIVB Test Stand (MSFC)

Three hot firings were conducted as shown in the table below:

Test No.	Date	Duration	Remarks
SIVB-025	5/13/66	--	Ignition test only. First attempt was aborted at X-8 seconds when the lox prevalve failed to open.
SIVB-026	5/18/66	5.9	Redline observer cutoff when the PU valve was commanded toward the closed position at X+4.5 seconds. Previous redline value was X+6 seconds and observer was not informed of change.
SIVB-027	5/18/66	11.0	Cutoff was by the vibration safety cutoff device (VSC).

The main objective of test SIVB-025 was to obtain additional data on pump inlet conditions by starting the engine with a 300 second hot duct chilldown and a one second fuel lead.

Tests SIVB-026 and SIVB-027 were to have been conducted to simulate vehicle SIVB-501 flight sequence with approximately a 90 minute hold period between the

two starts. However, after the VSC on test SIVB-027, the test was cancelled to investigate why VSC occurred and for possible damage to the engine.

Four hot duct chilldown tests were conducted during this report period in addition to the one on test SIVB-025. These tests were conducted on the fuel feed system only. The engine fuel pump was insulated to keep the frost buildup on the pump to a minimum. Evaluation of the test data is now in progress.

D. F-1 Heat Exchanger Development Tests

The purpose of this program is to establish reliability and to verify the design of the F-1 Heat Exchanger.

One test was conducted for a duration of 150 seconds. The post-test inspection revealed numerous weld cracks in the water injector and 90° elbow turning vanes which required shop welding. Repairs are now completed and the water injector is being installed.

One more full duration test is being planned with a heat exchanger lox flow of four lb/sec before starting the next phase of testing where the lox flow will be increased to six lb/sec.

E. F-1 Turbopump Seal Tests

This program is being conducted to develop and improve lox turbopump seals. This will be accomplished by comparing wear characteristics of various materials and configurations in the seal test fixture at simulated turbopump operating conditions.

Minor changes to instrumentation were completed. A second rotational checkout of the fixture was attempted, but aborted, due to a leak in a facility LN_2 line. During chilldown, the fixture had high internal leakage of cryogenic fluid. After the test abort, R-TEST-CVS and P&VE jointly elected to inspect the

internal parts (bearings, seals, and mating ring). The fixture is being re-assembled with new bearings, mating ring, and seal.

F. F-1 Gas Generator Scale Model Injector

This program is being conducted to investigate scale model F-1 gas generator injectors of various designs to determine their suitability for full scale evaluation. Each candidate injector is subjected to a two-part test program. Part I consists of water flow tests to determine discharge coefficients and pattern characteristics. Part II consists of hot firings with various propellant mixture ratios and flowrates.

No tests were conducted. The personnel and test facility have been occupied by higher priority work. A scale model of a Block II doublet injector is presently being evaluated. The evaluation will be continued in June.

G. F-1 Gas Generator Development Test

A project was established to conduct tests on an F-1 gas generator with different injector configurations. The objectives of the program are to alleviate detrimental pressure oscillations, reduce continued combustion in the turbine manifold, and increase gas generator performance.

The evaluation of the Rocketdyne experimental doublet injector was completed.

The first two tests of the P&VE double swirl-cup injector were also conducted during this reporting period. The evaluation of this injector will continue during June.

A report covering the P&VE concentric-tube injector has been issued, and the report covering the Rocketdyne experimental doublet injector evaluation is being prepared.

H. Carbon Deposition Studies

This program is to determine what effect variables such as accumulated test time heat exchanger surface temperature and water injection rates have upon the prediction of carbon film resistance on the F-1 heat exchanger. A test apparatus is being used which provides the capability to measure the thickness of carbon deposited on a tabular heat transfer section in cross flow.

New hot gas seals have been fitted to the heat exchanger and tests at low flowrates are currently being conducted.

I. Pump Inducer Development

This project has been requested by P&VE in an effort to develop the hubless inducer for use on future turbopumps.

The hubless inducer/impeller performance phase of the program has been completed. The strobe light system for taking synchronized movies of the inducer during cavitation runs proved satisfactory. The memorandum report for this phase is being prepared.

At the present time, the test facility is being modified to permit recirculation of the test fluid. The suction line is being redesigned to accommodate a quality meter, which will measure the vapor content of the test liquid.

The next phase of testing will be performance mapping of the impeller without an inducer.

J. MTF Components

Thirteen cryogenic facility valves were tested this month in accordance with requirements outlined by MTF. Nine of the valves were acceptable and four were returned to the Valve Laboratory for servicing. The latter four will be retested.

K. J-2 Turbopump Test

This project was requested by P&VE in an effort to verify performance

of present and advanced lox and LH_2 turbopump systems on the J-2 rocket engine.

Design of the test setup is 95% complete and should be finished in June. Facility activation is 30% complete. The GN_2 system modifications and cleaning are complete, the air system cleaning is 75% complete and GH_2 system modifications are 25% complete. The lox transfer system, lox dump lines and lox return line have been cold shocked with LN_2 and are scheduled for chemical cleaning in June. The LH_2 storage area is being readied for cold shock tests which are scheduled June 15, for the vacuum jacketed transfer lines using LN_2. The 23,000 gallon lox stage tank was shipped from Oklahoma the last week in May and should arrive the second week in June.

To date, the buildup is on schedule. Serious slippage is not expected providing material is available when needed.

L. F-1 Gas Generator Throttling by Helium Injection

At the request of the Booster Engine Test Section, R-TEST-SA, this program was established to determine the feasibility and operating limits of F-1 gas generator throttling by helium gas injection into the lox bootstrap line.

Five tests were conducted using a Blcok II F-1 GG assembly. This completes the helium injection evaluation for this gas generator configuration. A data transmittal is now pending which will complete this project.

M. Lox Slosh Facility

The Lox Slosh Facility, a 40% scale model of the Saturn V, S-IC Stage, lox tank and suction lines, was established to support R-P&VE studies of tank pressurization, propellant geysering, sloshing, and tanking phenomena.

The final report for this program is scheduled to be completed for submittal on August 1, 1966.

N. LH_2 Slosh Testing

This program supports P&VE in the areas of LH_2 propellant feed system

studies and studies of lox propellant feed systems in an ellipsoidal tank.

Test C-004-6 was conducted May 11, 1966, to study pressure decay of the S-IVB fuel tank experienced in the 201 flight as related to flight 203. The test established the base line to compare pressurization requirements with and without slosh. The tank was not sloshed for this test. In conjunction with the pressurized drain, tests were conducted to evaluate the Giannini and ORTEC Mass Measuring Systems. These systems utilize radio active elements to determine the density of liquid hydrogen.

Testing of the S-IVB chilldown pump turbine drive system has resumed. Problems associated with the LH_2 pump after it was emersed in LH_2 prevented completion of the tests. The pump inducer rubbed the housing and the pump bearings were binding, thus preventing the inducer from turning.

O. S-IVB Auxiliary Propulsion System Testing

The S-IVB Auxiliary Propulsion System Test Program was requested by P&VE Laboratory and is an in-house capability for conducting tests on upper stage ullage and attitude control motors.

Five tests were conducted at altitude on the Saturn IB/S-IVB APS Module on May 26, 1966. These tests utilized "green" N_2O_4 containing 0.67% nitric oxide. The purpose of the tests was to obtain performance data to be compared to data from the previous tests conducted on this module utilizing "white" N_2O_4 containing less than 0.10% NO. Preliminary review of the data indicated no change in performance.

Testing of the Saturn V/S-IVB APS Module is scheduled for late June 1966.

P. 40,000 GPM Flowbench

This facility will support the Instrument Development Branch of Test Laboratory by providing a high flow water calibration capability.

The Brooks velocity probe failed by bearing fracture. A flow technology "Flow-Probe" was installed for volumetric calibration. Decreasing valve actuation time has necessitated a minor modification for the prevention of "water hammer". A facility shutdown is scheduled for July 1, 1966, for weighing system modification.

Q. Liquid Hydrogen Super Insulation Program

This program, requested by P&VE, consists of studying the effectiveness of "super insulated" LH_2 tanks in a simulated space environment of 10^{-6} torr pressure.

No tests were conducted during this period. Test Tank No. 3 with Linde SI is at ME Laboratory and has been pumped as low as 250 microns. Delivery of the tank to Test Laboratory is dependent upon delivery of the 3-axis scanner to MSFC.

Buildup of the 30" calorimeter facility continues. The calorimeter is at ME Laboratory for wrapping.

R. F-1 Turbopump Facility

The F-1 Turbopump Facility provides the capability to perform checkout, calibration, qualification, and development tests on S-IC/F-1 Turbopump propellant feed systems. This facility contains a gas generator driven F-1 Turbopump which is mounted on a thrust chamber and simulates the S-IC flow system from the suction duct inlets to the main shutoff valves of the engine.

Four F-1 Turbopump Tests were conducted during this report period. The purpose of these tests was to change the operating conditions of the F-1 Turbopump from auxiliary supplied GG propellants to bootstrap operation. The desired operating conditions were obtained and preparations are being made to remove the presently installed turbopump and install the turbopump from F-1 Engine No. 2010. This turbopump will be green run to assure its integrity. This pump is scheduled to be tested during the next reporting period.

Four flow tests were conducted on the Whittaker S-IC Fuel Prevalve to obtain slower closing times than had been experienced in previous tests. The valves were timed to close in 5.6 seconds. This concludes all scheduled testing on this prevalve.

Two lox flowline tests were also conducted at the F-1 Turbopump Test Stand. Tests C-015-19 and C-015-20 were run to obtain data on a S-IC lox flowmeter and an Arrowhead Lox Inboard PVC. The lox flowmeter was of a new design utilizing a Molybdenum Disulfide lubricant with greater bearing tolerance. Flows ranged from 15,000 GPM to 25,000 GPM. A Flexonics S-IC Lox Outboard PVC will be tested as soon as it is received.

S. S-II Insulation

This test program was requested by P&VE Laboratory to study the effectiveness of the LH_2 Insulation currently planned for use on the S-II Stage of the Saturn V Vehicle. The objectives of the program are (1) to determine the heat transfer coefficient of the insulation, and (2) to determine what effect, if any, fill and drain cycles have upon the adhesive.

Testing is complete on 7 x 7 calorimeter. Calorimeter sent to Materials Laboratory for visual inspection for possible debonding. Seventy inch tank to be installed for testing on completion of repair patching being accomplished by Materials Laboratory.

T. Zero Gravity Test Facility

The Zero Gravity Drop Tower is utilized to assist P&VE in the study of low gravity fluid mechanics and thermodynamics phenomena. The facility is located in the Saturn V Dynamic Stand.

Eight tests were conducted during this period. All tests were performed with the LH_2 impulse package incorporating impulse before and after drop.

Work has begun to install a telemetry data acquisition system in the drop facility. It is expected that this system will be operational by mid-July.

U. Fluid Correlation Tests

These tests were requested by Astrionics Laboratory to evaluate the performance of F-1 servoactuators with 5606, RP-1, and RJ-1 fluids.

Testing has been completed. Report scheduled for submittal June 24,1966.

V. S-IC Model Drop Tests

This test program was requested by R-AS to evaluate the S-IC booster recovery concept as proposed by the Boeing Company. Testing is to be accomplished on scale models impacting on water.

The corrections and design work are scheduled to be completed June 13, 1966. The fabrication of long lead time items and test stand preparation is in progress. Checkout tests scheduled to begin about August 1, 1966.

W. Ground Support Equipment

1. High Pressure Fluid Tests

The following tests are being conducted to qualify high pressure pneumatic components in the High Pressure Fluid Test Facility:

a. Grayloc 10,000 p.s.i.g. Coupling Test This program for KSC is to qualify Grayloc 10,000 p.s.i.g. couplings for use with pipe larger than 1 - 3/4" in diameter. All testing is complete with the exception of one test which will be repeated. The hardware for this repeat test is being fabricated. The final report is being reviewed. The couplings have performed satisfactorily.

b. Vacco Regulator Test This test for the Mississippi Test Facility is to evaluate the facility regulator (PCV-A) purchased for the pneumatic system at MTF. The regulator has been replaced at MTF and the test program terminated.

c. Pacific Pressure Regulator Test procedure is being reviewed and testing is scheduled to start July 1, 1966.

This test is being conducted for Launch Support Equipment Engineering Division, KSC. The purpose of this test is to qualify a 10,000 p.s.i.g. Pacific pressure regulator to be used in a high pressure system by the Launch Support Equipment Engineering Division, KSC.

d. Grayloc Secondary Seal The purpose of this test program is to verify the physical and functional integrity of the Grayloc Secondary Seal. The test procedure has been completed and testing will start as soon as the support hardware needed for testing is received from manufacturing (R-TEST-RT).

e. Grayloc Socket Weld Coupling These couplings are attached to the pipe with a socket weld rather than the more commonly used butt-weld. The couplings are to be used in a 6,000 p.s.i.g. pneumatic system at KSC. The procedure is being reviewed; testing will be complete by June 10, 1966, and the report will be completed on July 1, 1966.

f. ITT-Hammel Dahl Shut-off Valve A one inch valve has been tested and the results have been published. A one and one half inch unit is ready for testing and a four inch valve is being repaired. Testing should resume June 15, 1966.

This test is being conducted for Mississippi Test Facility (I-MT-EF), to evaluate the valve's performance because of failures encountered in its usage at MTF.

g. Ladwig Relief Valve The test procedure is being prepared and testing is scheduled to begin June 6, 1966.

This test is being conducted for Mississippi Test Facility (I-MT-EF) because of failures in its application at MTF.

2. LC-39 Mobile Launcher Holddown Arm Test

The purpose of this test program for KSC is to verify the physical and functional integrity of the Saturn V holddown arms prior to installation on the mobile launcher. All four holddown arms of the second set with forged links have been tested and shipped to KSC. The test program for the third set was completed May 5, 1966, and the report is being prepared. Preparations are in progress for the final set of arms.

3. Pressure Vessel Testing

This is a portion of a research program being conducted by Test Laboratory to determine the effect of hydrogen embrittlement in steel and the effect of pressure on a new nozzle design.

Planning and buildup are now in progress preparing for the remaining portions of this test program, i.e., cycling and then storing 8,800 p.s.i.g. hydrogen in three laminated wall pressure bottles and final hydrostatic burst testing. Testing is now scheduled to begin June 20, 1966.

4. Cable Retract Assemblies

The cable retract assemblies provide primary hydraulic power to the service arm cylinders and provide a redundant cable to rotate the arms in the event of hydraulic failure.

Acceptance tests began on March 15, 1966, and have been conducted on three cable retract assemblies, which proved satisfactory. Testing delayed because of repeated failures of console No. 2 main pneumatic supply solenoid valves. KSC is currently obtaining a satisfactory valve.

5. Development Test for LUT Speed Connector

The purpose of this test program is to determine if the LUT speed connector will automatically connect and disconnect electrical cables and also to outline its operating characteristics. Modifications to achieve operation or to improve performance will be incorporated during this test program.

The test procedure has been completed and testing initiated June 1, 1966. This test is being conducted for Launch Support Equipment Engineering Division, KSC.

6. Gallea Gimbal Expansion Joint Test

This program will be conducted for KSC to evaluate the gimbal joint under simulated working conditions.

The joint will provide the flexible joint required in the lox piping system to the LUT at LC-39. Testing will start approximately June 20, 1966, and be completed by June 30, 1966.

7. Service Arms

a. S-IC Intertank (Set II) This preflight arm provides LO_2 fill and drain services to the S-IC stage. It has reconnect capabilities in case of a mission hold or abort.

All subsystems and system tests have been completed. The only test remaining is the flight hardware tests. To date, all systems have functioned properly, withdrawal and retraction occurred faster than the maximum time. Tracking tests proved that the umbilical reconnect unit would reconnect and track properly under the 99% wind conditions.

The flight hardware tests have been delayed pending delivery of seals for the cryogenic lines.

b. S-IC Forward (Set II) This preflight arm provides air conditioning, electrical, and pneumatic services to the S-IC stage as well as personnel access to the forward end of the stage.

All subsystems and system tests have been completed satisfactorily. The arm is now awaiting modifications which are to arrive between June 1 and June 13. After modification is complete, a series of tests to check out the completed arm will be conducted.

c. S-II Aft Service Arm (Set II) Testing of S-II Aft Arm (S/N AA-03-02) per original test plan is complete except for random motion tracking. Design (KSC) is investigating negatory and tangential spring strengthening methods because vehicle tracking problems were experienced.

Additional testing has been requested by KSC on lock boxes and also a modified deceleration valve. The lock box tests were completed on May 31, 1966, and the deceleration valve tests should be complete by June 10,1966.

Random motion tests will be completed upon receipt of modified extension platform springs.

d. S-II Intermediate This inflight service arm provides air conditioning, electrical, pneumatic, LH_2, and lox services to the S-II stage. The LH_2 and lox fill lines have independent connections to the stage while the remainder of the service lines in the arm are connected to the stage through one common carrier.

The primary and secondary umbilical withdrawal systems tests have been satisfactorily completed. These systems release the main umbilical from the vehicle and withdraw it to a stored position on the service arm prior to arm rotation.

General tests were conducted on the LH_2 and lox coupler withdrawal systems in order to obtain satisfactory coupler withdrawal without coupler damage. A revised withdrawal system was installed which provided redundancy and satisfactory performance.

Two full systems tests have been conducted and the test program is considered 45% complete.

e. S-II Forward This inflight arm provides air conditioning, electrical and pneumatic services, plus a GH_2 vent for the S-II stage. All connections to the stage are through a common carrier.

The arm was received April 22, 1966. Arm retracting tests were completed May 27, 1966, and testing was suspended one week to incorporate hardware modifications. Testing is approximately 30% complete and will be resumed June 6, 1966.

f. S-IVB Aft This inflight service arm provides LH_2 and lox fill and drain service to the S-IVB stage.

The service arm was installed on the tower simulator on May 19, 1966. Tracking tests were performed and the resulting data were transmitted to Cape Kennedy where preparations for the Saturn V 500F wet test are under way.

Rotation tests were begun on June 1, 1966. Secondary system retraction tests were successfully performed under no wind and retarding wind conditions. However, problems with the deceleration valve arose when the primary system tests were begun which may necessitate re-running of the secondary system tests.

The power assisted reconnect modifications will be started on June 6. An attempt to do this modification concurrently with arm rotation tests is under way.

g. S-IVB Forward This inflight service arm provides air conditioning, electrical, pneumatic, water glycol, and LH_2 venting services to the S-IVB stage. These services are connected to the vehicle through the S-IVB forward and the instrument unit (IU) carriers, as well as through the lunar excursion module (LEM) carrier.

The S-IVB Forward Arm was received on May 4, 1966. The hinges were installed on the arm on May 6, 1966. The arm was installed on the tower on May 10, 1966. Arm deflection necessitated re-shimming of the lower hinge, which was completed on May 12, 1966. There is an interference problem between the LH_2 vent line, the hinge hydraulic lines, and the LEM flex lines across the hinge.

The hinge hydraulic lines were rerouted through the hinge mounting column and the LEM flex lines were lowered. There is still a possibility of interference between the LH_2 vent line and the LEM lines. The horizontal sheave in the cable retract mechanism could not be installed per drawing. A 75M08190-5 sheave was substituded for the 75M08190-7 and was shimmed to achieve alignment with the cable retract sled.

All vehicle and arm service lines which cross the upper hinge were too short. The arm mounted supports between the interfece brackets were removed to allow installation of these lines.

On May 21, 1966, the IU/S-IVB forward carrier was mated to the vehicle simulator, but we found it impossible to mate the electrical cables to the carrier. The vehicle simulator was moved 20.3 inches away from the arm and the electrical cable lengths were adjusted to connect to the carrier at this position. On May 23, 1966, a tracking test was conducted. No problems were noted. The LEM mechanical and electrical modifications are underway, but neither has been completed. Console number one modifications for the reconnect modification are underway.

h. Service Module The service module arm is an inflight arm and provides air conditioning, electrical, hydrogen venting, and water glycol cooling services to the Apollo service module.

Umbilical kickoff and withdrawal tests were continued through the month of May. After having considerable difficulty in this phase of the test plan, several equipment modifications were made and tested. Modifications to the Manned Spacecraft Center (MSC) supplied service module umbilical carrier include: (1) Providing a manifold connection for the GH_2 vent quick disconnect couplings to prevent binding during carrier release, and (2) addition of spacer sleeves over two of the kickoff pistons to prevent interference with the vehicle

half of the electrical connectors. These modifications are being coordinated with MSC GSE management personnel. Modifications to the Kennedy Space Center(KSC) withdrawal equipment include (1) Addition of an extension boom on the end of the swing arm to provide better support for the umbilical carrier and service lines during umbilical withdrawal, and (2) a larger diameter pulley on the withdrawal system air motor to provide faster withdrawal. These modifications were designed by KSC and installed and tested by Test Laboratory.

After the above modifications were made, tests were continued with very good results.

The test program is approximately 70% complete.

i. LC-39 Command Module Access Arm The LC-39 Command Module access arm is a preflight arm which supports an environmentally conditioned chamber through which the astronauts and service personnel can enter the Apollo spacecraft. The arm also provides a support structure for air conditioning and space suit checkout lines.

An abbreviated test program, consisting of a deflection test, a load test, a chamber/simulator (vehicle) fit check, a tracking test and one manual swing test, was completed on the set number one arm on May 13, 1966.

All strains measured during load testing were well below design limits.

Due to excessive arm deflection and a mismatch of 4.5 inches between the first and second element truss centerlines, the chamber was approximately four inches too low to mate with the dry vehicle. The decision was made to raise the arm two holes (10 inches) on the LUT. This condition was simulated by lowering the vehicle simulator 10 inches. Once this was done, the chamber mated satisfactorily with the simulator.

The chamber tracked an amplitude of ± 20 inches at a frequency of .61 cps with no problem.

One semi-automatic retraction and one semi-automatic extension were made using the lower hinge to demonstrate that the arm could be swung using only one hinge. This was necessary because the upper hinge would not hold pressure and there was not time to find the cause and repair it prior to shipment.

The arm was removed from the tower on May 14, 1966, disassembled on May 15, 1966, and shipped to KSC on May 18, 1966.

The set number two arm was received from Hayes on May 20, 1966. The hinges were received on May 23, 1966. The arm was installed on the test tower on June 1, 1966. Testing is scheduled to begin on June 14, 1966.

8. LC-39 Tail Service Masts

The three service masts (lox, fuel, and environmental) are located on the deck of the Mobile Launcher and are used to service the S-IC stage tail section. The masts retract during liftoff.

Mast 3-4 (Lox Service) installation was completed on May 25, 1966, and subsystems checkout began on May 26, and is still in progress. Problems were encountered with leaking valves, which were replaced, and the electrical test set. Checkout of the test set is being accomplished along with the mast.

Mast 1-2 (Fuel Service) was received on May 19, and was erected on May 23, after drilling the mast-umbilical interface plate. The umbilical was installed on the mast and the fluid couplings (quick disconnect) installed. The mast is still in the installation phase.

Mast 3-2 (Environmental Service) was received on May 2, 1966. The mast-umbilical interface holes were drilled and the mast was erected on May 6, 1966. The mast is in the installation phase.

9. Service Arm Control Switch

The seventh service arm control switch will be tested during system test on the S-IVB Fwd service arm which is scheduled to begin approximately June 27, 1966. This switch will be used as a spare for LC-39 and the Saturn V GSE Test Area. All switches (12) have been updated.

III R&D TECHNOLOGY PROGRAMS

A. Jet Impingement on Water

This program was requested by KSC to study the feasibility of launching large flight vehicles on the Saturn V and Nova classes from offshore sites.

Work is in progress on the single engine report. Tentative planning calls for the analytic phase to be completed by June 17, 1966.

B. Jet Impingement on Simulated Lunar Surfaces

This program has been completed and will not appear in this Progress Report in the future.

C. PDS Liquid Destruct System Feasibility Study

Testing has not resumed pending redesign of thermal conditioning system by P&VE Laboratory.

Thermal study of previous tests is in progress. The study should be completed about June 10, 1966.

D. Combustion Dynamics

The project investigates, at an intermediate thrust level, the combustion stability theories which have been developed analytically or at a very small thrust level. The main areas of interest are combustion stability of lox/RP-1 and lox/H_2 systems at the 30K and 15K thrust levels respectively.

A three second test was conducted with the 15K lox/GH_2 transpiration-cooled engine. During this test, mainstage combustion was obtained for two seconds

at a chamber pressure of 2,000 p.s.i. with a nominal O/F ratio of four. During the last one half second of the test, a hotspot developed in the combustion chamber wall, which resulted in some localized chamber wall erosion. A new chamber is being fabricated, utilizing the same basic design, (copper wafers) but with a few improvements incorporated to assure better distribution of the transpiration coolant and to help alleviate thermal expansion stresses. Testing will resume when the new chamber is completed.

E. LH_2 Seal Evaluation Tests

This program was initiated to test various static seals for special manhole covers on a liquid hydrogen test tank. Testing will resume with LH_2 to determine the location of the leak in the lower part of the tank when LH_2 becomes available.

F. Flame Study

This project is to obtain free stream and disturbed stream calorimetric, temperature, and pressure data, from existing Test Laboratory model rocket engines, which will be useful in predicting full scale rocket engine plume environments.

Five tests were conducted with a copper heat sink total calorimeter located in the plume at 30, 25, 20, 15 and 12 exit diameters from the engine. The sensor unit of the calorimeter failed during the test at 12 exit diameters. Two tests were conducted measuring the total plume pressure at 15 exit diameters. Testing will continue measuring pressure and temperature.

G. Acoustic Studies

Testing to acoustically map the sound field of the Acoustic Model Test Facility (AMTF) is presently in progress. During this reporting period, all efforts were directed toward determining affects of changing the sound source-receiver relationship. Eighteen tests were conducted and the data from these

tests has been partially evaluated. Testing will continue.

H. Solid Motor Contamination Test Program

This project was initiated to make several experiments involving the plume from solid propellant rocket engines fired at a simulated altitude up to 130,000 feet. These engines contain propellants proposed for retro-rockets for future space vehicles. The experiments are to determine the following:

1. Size and velocity of solid particles exhausted from the engine.
2. Contamination from the engine deposited on adjacent paint samples.
3. Attenuation of laser beams through the exhaust plume.
4. Temperature environment on an adjacent test panel which simulates a space vehicle's body.

The test program, of ten solid motor firings, was concluded on June 2, 1966. Five tests were successfully conducted during this reporting period. Two of the tests were conducted with Rocket Power Incorporated motors and one test each with Thiokol, United Technology Corporation and Atlantic Research Corporation motors. Test reports are in preparation.

I. Solid Motor Particle Study

This test program is to be conducted to obtain information concerning solid particle distribution and heat transfer characteristics of plumes, from solid propellant rocket motors.

Facility buildup will begin apprximately June 10, 1966. Twenty Thiokol TX-11 motors are scheduled for delivery June 30, 1966. Buildup is presently underway to support the particle collector and engine.

IV FACILITIES

A. Extension to Components Test Facility Instrumentation (FY-65)

Technical Systems The contractor completed the installation and checkout phase and departed site on May 25, 1966. As-built drawings and final documentation

are due within 60 days after completion of installation and checkout. Contract Phase I, NAS8-12065 - $1,308,318; Phase II contract NAS8-17126 - $126,000. This is the final report on this item.

B. Saturn Support Test Area

1. Transportation Hangar and Addition to Building S-4653

The building is complete and occupied. A second 25-ton bridge crane is under contract and will be installed in early July.

2. High Pressure Gas and Propellants

Three Norwalk compressors have been received. Installation has not started. The second high pressure gas bottle has been set. Helium tanks are now being set. Crane in Compressor Building has been installed. Construction is about 65% complete. Contractor is abour four months behind schedule.

3. Cryogenic Type Helium Purifier

Due to the leakage of eight high pressure valves which had to be returned to vendor for repairs, the pneumatic pressure test had to be postponed to the week of June 12. The flow test has slipped to mid-July with a shipping date set for July 20. Cost is $126,500.

C. Addition to Advanced Saturn GSE Test Facility (FY-65)

1. Brick and Mortar

This project is practically complete. The high pressure test cell piping and equipment has been installed and is in final checkout phase. There is some work and adjusting yet to be done on the air conditioning equipment.

2. Technical Systems

The contractor completed the installation and checkout phase and departed job site on May 25, 1966. As-built drawings and contract documentation

are due within 60 days after completion of installation and checkout phase. Phase I contract NAS8-12087 - $969,618. Phase II contract NAS8-17125 - $130,000. This is the final report on Technical Systems.

D. Engineering Building Extension (FY-66)

Interior partitions have been installed along with about 80% of the light fixtures. It appears that the job can be completed by late July except for a delay in the electrical switch gear. R-TEST-F requested expediting assistance by F&D some three months ago, but it may have come too late to accomplish an early completion. The contractor may request an inspection of the building by July 15, regardless of the delay of the electrical equipment. Telephone equipment can be installed after the inspection. The contract completion date is October 1, 1966.

E. Helium Line to GSE and S-IB Dynamic Test Stand

No problems exist. Contractor is on schedule and is about 65% complete. Contract cost is $62,000.

F. S-IC Sound Suppressors

Test Laboratory personnel visited Washington State University for the purpose of inspecting the scale model's operation and progress to date. Some additional data was requested to be obtained from the super-critical Hydraulic Analogy Model. Testing of the Syphon Inlet model has been completed. Excellent performance of both these models was observed. Some minor leakage problems were noted during the performance of the Supersonic Gas Jet Model. This will be corrected and testing will then proceed over the next four to six weeks. An over-run of $2,500 is anticipated due to delays by P&C in processing a change in scope. A request for these additional funds is being processed. The contract will terminate in mid-August and its costs if $77,075.

G. Minor Construction and R&A Projects

Construction is in progress on the following projects:

Project	Scheduled Completion Date
Improvements to Dodd Road	June 1966
Additional Paving at Building 4650	September 1966
Modifications to Elevator at Dynamic Test Stand	June 1966
Additional Electrical Power Building 4748	August 1966
Addition to Steam Plant, Building 4567	December 1966
Elevator at Liquid Hydrogen Test Stand	December 1966
Modifications to Helium System West Area	September 1966

Construction has been completed on the following projects:

Repairs to Concrete at S-IC

Addition to Deionized Water, Building S-4549

Steam Line for Hydrogen Recharger

Roof Repairs, Building 4583

Mororize Large Valves, Test Area

Projects currently under design:

Firex System Addition, Test Stand 115

Additional Lox Storage for all Test Positions - Building 4583

The following is a status summary of the R&A Projects starting with FY-65:

Projects submitted for approval---------- 8

Projects pending criteria---------- ---------- 8

Projects pending start of design---------- 0

Projects approved for accomplishment----------18

Projects in criteria preparation---------- 3

Projects in design preparation---------- 3

Projects pending construction contract---------- 1

Projects in construction---------- 8

Projects completed----------19

Projects to be submitted for approval---------- 1

V MISSISSIPPI TEST FACILITY

During this period, Test Laboratory had 55 personnel supporting MTF. Fifteen were on TDY status; forty were directly supporting MTF within Test Laboratory.

VI CONTRACTOR ACTIVITIES

A. S-IVB Stage

1. S-IVB-501

Vehicle 501 is undergoing post static checkout at the SACTO VCL following a successful restart acceptance firing on May 26. The two burn firing was accomplished on the second attempt with no problems. First burn duration was 153 seconds with an approximate 90 minute simulated coast period followed by a second burn duration of 305 seconds. During the second burn, a successful gimbal program was conducted. The vehicle was removed from Test Stand Beta I on June 3 and transferred to the VCL.

2. S-IVB-502

Vehicle 502 arrived at SACTO via the Super Guppy on June 1, and was installed in Test Stand Beta 1, on June 6. The acceptance firing date is scheduled for approximately August 1, although DAC may be ready to acceptance fire by mid-July.

3. S-IVB-204

Vehicle 204 is currently in storage at the VCL and is scheduled to be shipped to KSC on July 11, 1966.

4. S-IVB-205

Vehicle 205 underwent a successful 437.5 second duration acceptance firing on June 2, 1966. There were no significant problems arising from the firing, although data evaluation is incomplete. The firing was delayed one week due to the slip in the acceptance firing of Vehicle 501. Post static checkout of Vehicle 205 will be done on the Beta 3 test stand.

B. MTF (S-II-T)

Tests A2-509-TB-66 through A2-517-TA-66 were conducted at the MTF A-2 Test Stand.

Test No.	Date	Duration	Cutoff
A2-509-TB-66	5/10/66	9	Cutoff was initiated by redline observer monitoring the helium control bottle pressure on Engine No. 3. Cutoff was believed erroneous since the system appeared to be satisfactory and an instrumentation connector was found to be loose.
A2-512-TA-66	5/11/66	46	Cutoff was initiated by the gas generator over temperature cutoff system (GGOT) on Engine No. 3. The cutoff was believed to be erroneous since the measurement was erratic from T+5 seconds.
A2-513-TA-66	5/16/66	7.8	Cutoff was initiated by the vibration safety cutoff (VSC) on Engine No. 3. The cutoff appeared to be due to a malfunction in VSC system since Engine No. 3 was operating within acceptable limits. The VSC accelerometer was replaced.

A2-514-TA-66	5/17/66	150	Cutoff was initiated manually by test conductor. All primary objectives were achieved except that Engine No. 4 SLAM restrainers did not release. A manual command had to be typed in so engines 1, 2, and 3 could be gimballed.
A2-515-TA-66	5/2/66	354	Cutoff was initiated by the LO_2 low level cutoff system. All systems operated satisfactorily.
A2-516-TA-66	5/25/66	1.9	Cutoff was initiated during transition by a faulty VSC on Engine No. 3. The VSC was moved to another channel and countdown was recycled.
A7-517-TA-66	5/25/66	195	Cutoff was initiated when the Engine No. 5 Lox ASI line broke loose and burned the instrumentation cable to the thrust O.K. pressure switch which automatically cutoff the engines.

The S-II-T vehicle was destroyed on May 28, 1966, at 4:17 p.m. CST. The LH_2 tank was ruptured when the second shift crew attempted to pressurize the tank. The crew, not knowing the LH_2 pressure sensors and switches had been disconnected and believing the LH_2 vent valve was leaking, closed the facility blocking valves which caused the vehicle tank to become over-pressurized and to burst.

Karl L. Heimburg

DISTRIBUTION

I-V-P, Sid Johnston (3)
I-I/IB/C, Mr. Ladner
I-RM-D, Mr. Butlington
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