TEST LABORATORY

XL17

MONTHLY

PROGRESS REPORT

August 1, 1967 through August 31, 1967

GEORGE C. MARSHALL SPACE FLIGHT CENTER

HUNTSVILLE, ALABAMA

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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SYSTEMS TEST DIVISION

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ADVANCED FACILITIES AND PLANNING OFFICE

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SYSTEMS TEST DIVISION
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I. SATURN IB

A. S-IB Stage

S-IB-11 is tentatively scheduled to arrive at MSFC on October 9, 1967.

B. H-1 Engine

A test program was initiated at the Power Plant Test Stand to investigate the combustion stability of the present 205K H-1 Engine. A series of nine tests, five with bomb induced instability, was performed on Engine H-4067 as listed below:

TEST NO.	DATE	DURATION (SEC.)	REMARKS
P1-498	8-9-67	140	Calibration test
P1-499	8-18-67	40	Calibration test
P1-500	8-21-67	15	Bomb test
P1-501	8-23-67	15	Bomb test
P1-502	8-24-67	40	Bomb test
P1-503	8-25-67	15	Calibration test
P1-504	8-28-67	15	Bomb test
P1-505	8-29-67	15	Calibration test
P1-506	8-30-67	15	Bomb test

Although the artificially induced instability dampened within specification limits during the five tests, two periods of instability occurred during test P1-506. A thorough review of the data and an inspection of the engine hardware will precede any additional testing of Engine H-4067.

An experimental (R&D) H-1 engine, which exhibited combustion instability during tests performed by Rocketdyne, is expected to arrive at MSFC on September 5, 1967.

C. S-IVB Stage

S-IVB-209 was placed into storage in the Manufacturing Services Building at Sacramento Test Center. The deferred post-static firing checkout will be resumed in March, 1968.

II. SATURN V

A. S-IC Stage

1. S-IC-T

Static firing tests S-IC-20, S-IC-21, and S-IC-22 were conducted on the S-IC-T stage for mainstage durations of 2.15, 3.60, and 41.74 seconds, respectively. Re-activation of the MSFC S-IC Test Stand and associated GSE was accomplished with this series of tests.

A series of LOX loading tests was also conducted on the S-IC-T stage during this period. The test objectives to determine the conditions causing a negative LOX tank pressure during the early phases of LOX loading and methods to prevent tank pressure decay below ambient were accomplished. As a result of these investigations a revised LOX loading procedure was successfully used for the static firing of S-IC-5 at MTF.

2. S-IC-5

A propellant load test was conducted on S-IC-5 at MTF on August 10, 1967. The static firing was performed at 6:14 p.m. for 125 seconds mainstage duration on August 25, 1967. Preliminary review of the data indicates satisfactory performance of the stage.

B. F-1 Engine

Test FW-068 was conducted with F-1 Engine S/N F-5038-1 at the West Area F-1 Test Stand for a mainstage duration of 41 seconds on August 16, 1967. Primary purpose of this test was to establish engine baseline performance for the LOX depletion test series.

C. S-II Stage

1. S-II-1 (KSC)

Major modifications to the S-II-1 sidewall insulation vent system were accomplished at KSC during this report period. Blowdown tests conducted after the modifications were made confirmed that the system would vent within the required time. Improvements were made on the S-II-1 pneumatic GSE on mobile launcher No. 1 which will insure full relief protection in the fluid systems used to service the stage.

2. S-II-3

The S-II-3 stage is positioned in the A-1 test stand at MTF. The V3-300 (checkout) change point has expired and change point V3-400 (initiation of countdown) is in effect. The newly designed propellant prevalves and 3-way solenoids were installed and will be used for the first time on a flight stage. All stage electrical and mechanical checkouts required up to this point are on schedule and progressing without major incidents. A sidewall insulation blowdown test was conducted on the stage under ambient condition to acquire data for inflight venting prediction. A similar blowdown test is to be performed under cryogenic conditions in conjuction with the stage tanking test scheduled for September 2, 1967.

3. S-II Structural Test Program

Facility construction work is progressing on schedule. The concrete pad for the stand proper was poured on August 17, 1967. Delivery of the test specimen to Test Laboratory is tentatively scheduled for February 8, 1968.

D. S-IVB Stage

1. S-IVB-504 (New)

✓ S-IVB stage 504 (New) was satisfactorily acceptance fired on August 26, 1967, after two unsuccessful attempts. The first attempt was scrubbed on August 16, 1967, after propellant loading due to failure of the Beckman digital data acquisition system. The second attempt was aborted on August 22, 1967, at approximately 51 seconds of mainstage due to an erroneous fire indication caused by the fire detection wire coming in contact with the gas generator exhaust mainfold.

2. S-IVB-BS-2000

One LOX tanking test was conducted at the MSFC S-IVB Battleship Test Stand to determine the J-2 engine LOX pump seal leakage under cryogenic conditions.

3. O_2H_2 Burner

A series of tests conducted on the LOX shutdown valve (LSDV) pneumatic controls verified the requirement for the double vent actuation control module, DAC P/N 1B66692-501, for LSDV actuation. Evaluation of test data revealed pneumatic crosstalk during normal valve operation sufficient to unlatch the LSDV open lock when using the single vent module.

III. APOLLO APPLICATIONS

A. Lunar Drill Program

NASA Headquarters has put a freeze on all FY 68 funds for 945 projects which includes the Lunar Drill Funds. This action could possibly eliminate Westinghouse as a prime contractor for a rotary type drill.

In-house testing on the hammer assembly (percussive concept) to determine optimum rotational speed was continued.

A meeting was held with Northrop and their consultant, Dr. Singh, on a redesigned bit and chip removal system. It is anticipated that units will be fabricated according to this configuration and tested in-house.

Drilling was continued at the Howell, Tennessee Site with the commercial drill rig.

B. LSSM Project

A meeting was held with personnel of P&VE Laboratory, Advanced Systems Office and Test Laboratory to discuss the test program planned for the two mobility test articles. Immediate plans are to initiate work orders to begin construction of the various test tracks.

C. ATM Solar Panel Deployment Tests

Initial hardware has been received and testing will begin early in September. These tests will supply data required by Astrionics Laboratory to finalize their design of the complete test fixture.

IV. VEHICLE STORAGE PROGRAM

The storage status of the S-IB-204 and S-IB-206 fuel additive blender units (FABU), commonly referred to as the Oronite system, was investigated and comments were forwarded to Dr. Rees on August 11, 1967.

Detailed comments of the Stage Storage Working Group's visit to the Michoud Assembly Facility (MAF) were forwarded to I.O. on August 15, 1967.

The I.U. storage procedure (IBM #K82-025) was reviewed and comments were forwarded to I.O. on August 16, 1967.

Guidelines for the storage of Saturn hydraulic systems have been prepared and forwarded to I.O. on August 29, 1967.

The S-II storage specification (MA0208-1027) has been reviewed and comments were forwarded to I.O. on August 30, 1967.

A pre-proposal conference for an industry wide storage study was held on August 30, 1967. The Stage Storage Working Group and eight contractors were represented.

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I. SATURN IB

A. 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 and environmental chamber was recently redesigned to accommodate the new spacecraft hatch design and also incorporates changes that provide more reliable and faster egress routes.

Installation and checkout of instrumentation was accomplished between August 1 and August 12, 1967. Also, pre-test check and subsystem testing was begun, but was interrupted by modifications to the environmental chamber pneumatic systems, and the electrical control test set.

Upon completion of the modifications, subsystems testing was resumed and completed on August 18, 1967.

Final testing (automatic mode) is now in progress and the system is functioning very near operational test requirements.

Present schedule is for the prototype hardware testing to be completed by September 18, 1967, at which time the flight hardware will be received from Cape Kennedy. Testing of the first set of flight hardware is to be completed by October 9, 1967.

II. SATURN V

A. S-IC Stage

1. F-1 Turbopump Testing

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.

The F-1 Turbopump Test Facility is being prepared for testing R&D 6 + 6 Turbopump S/N 4072224. The turbopump has been received and is currently undergoing installation and high pressure duct alignment. Checkout tests are scheduled to begin in September 1967. Nine blowdown tests have been conducted on the F-1 GG LOX feed system to complete this phase of GG checkouts.

S-IC 17-inch LOX Flowmeter S/N WE17-35 is currently being installed and will be tested during September.

2. LOX Depletion Testing

The purpose of this test program is to support R-TEST-SP in a study of the LOX depletion characteristics of the F-1 Engine shutdown sequence. The ultimate goal of the test program is to predict LOX depletion characteristics of the S-IC Ground Stage Engine System.

The facility buildup is in progress. Hydrostatic test of pressure tanks and general cleaning of the LOX system has slipped the test start date to October 15, 1967.

B. S-II Stage

1. S-II Insulation

B-Cell Position 1 - Linde Insulation (70-inch Tank)

The general objective of this test program is to evaluate a Linde pre-evacuated, panel-type insulation system for possible application to liquid hydrogen booster stages.

The test tank is to be returned to M.E. Laboratory for a tank internal fill system correction. Testing will be rescheduled at a later date.

B-Cell Position 1 - Foam Insulation (7 X 7 Calorimeter

This test program was requested by P&VE Laboratory to evaluate the structural integrity and thermal performance of a S&ID, CPR-369-3 foam insulation system.

Although preliminary planning has been initiated, the test plan and start date have not been established due to other priority work.

B-Cell Position 2 - S-II Insulation 24-Inch Calorimeter

This test program was requested by P&VE Laboratory to evaluate the effective conductance of the S-II stage common bulkhead.

The buildup is approximately 30 percent complete. The first series of tests are scheduled for the second week of September.

2. S-II and S-IVB LOX Prevalve Flow Tests

The test objectives for the S-II and S-IVB Prevalves are to determine the acceptability and operating characteristics of the valves under shutoff conditions at various closing rates and lox flowrates.

The initial scope of the program has been changed to include lox flow tests on the S-IVB prevalve. The S-IVB prevalve and its test requirements are to be furnished by R-TEST-SS.

Action has been taken by R-TEST-CV to obtain another S-II lox prevalve through R-TEST-ST. Delivery has been scheduled for mid-September 1967, at which time testing will be resumed.

C. S-IVB Stage

1. J-2X Turbopump Test

Requester: R-P&VE-PAC

This project was requested by P&VE to further the development and also verify performance characteristics of advanced J-2 turbopumps and subsystems. Test Position 501 is being prepared for this testing.

The Test Support Shop, R-TEST-BS, is still working on the piping systems and is about 98 per cent complete. Several vacuum jacketed lines still have some welding to be done to the jackets. The LH_2 sump is being installed but various

problems have caused a considerable delay. The sump installation should be completed by the middle of September. The GH_2 pressurizing line, LH_2 stage tank vent manifold and LH_2 pump return line have not yet been x-rayed. The liquid hydrogen storage facilities are being activated and should be ready to receive hydrogen by September 15. The lox stage tank was reinsulated with peralite on August 24. Tentative target date for completion of buildup on T.P. 501 is November 1, 1967.

2. J-2X and J-2S Thrust Chamber Throttling Tests

Requester: R-P&VE-PA

This program was established to evaluate the throttling characteristics of J-2 thrust chambers. Engine thrust excursions of 5K to 200K (Sea Level) are contemplated. This will be accomplished in a 2-phase program.

Phase I consists of facility design, facility activation, and initial testing. The facility utilizes pressurized propellant tanks and throttle valves to control the engine thrust level. The activation test firings include ignition, partial transition, full transition, and mainstage of a tubular wall J-2 thrust chamber with a ceramic coating to increase combustion zone durability.

Initial testing utilizes a J-2 thrust chamber with tapoff capability. The thrust chamber will be evaluated at steady state conditions, four to six mixture ratios, and between 5K to 200K SL thrust levels (no dynamic throttling).

Phase II will consist of dynamic throttling of a J-2 thrust chamber with and without hot gas tapoff capabilities, at four to six mixture ratios, and between 5K and 200K SL thrust. These tests will define engine and facility operating capabilities and will permit thrust chamber and tapoff optimization.

No tests were conducted during this reporting period.

The linear plug for the lox throttle valve has been completed, installed, and LN_2 blowdowns were conducted.

The facility fuel (LH_2) run tank pressurizing media is being changed from gaseous helium to gaseous hydrogen. Static throttling tests will begin when this changeover has been completed, tentatively scheduled for the week of September 18, 1967.

3. J-2 Engine Telescoping Nozzle

Requester: R-P&VE-PA

The test objective is to evaluate the feasibility of the proposed J-2 Engine Telescoping Nozzle design. This proposal consists of a retractable engine nozzle skirt which will stow in the existing stage interface envelope. After stage separation, the nozzle can be extended to obtain optimum engine expansion ratio. The project utilizes a working mockup (non-flight hardware) to evaluate the design proposal.

The test system has been installed and preliminary checkout of test hardware and test fixtures has been completed. Five (5) checkouts were conducted to study preliminary performance of J-2 telescoping nozzle using motion picture coverage. Six (6) additional checkouts were conducted recording the deployment time. The checkouts indicated a non-symmetrical deployment of the nozzle extension. Investigation revealed that the counter-weights were not per specification, and were not equalized. Corrective action has been taken and testing continues.

4. LH_2 Slosh Testing

This program supports P&VE and Test Laboratory in areas of LH_2 propellant feed system studies and lox studies in an ellipsoidal tank.

No tests were conducted during this report period. The facility is being modified for tests of the Parker S-IC lox vent and relief valve which are scheduled for the latter part of September.

5. S-IVB Auxiliary Propulsion System Testing

The S-IVB Auxiliary Propulsion System Test Program was requested by P&VE Laboratory for conducting tests on upper stage ullage and attitude control engines and systems at simulated vacuum environments.

Two Douglas gas removal tank assemblies, designed to remove the gas bubbles from the APS propellant bladders on the Saturn 501 vehicle, were tested at the Storable Propellant Test Facility during the week of August 6 - 12. The DAC launch operations crew, and NASA/KSC representatives, were present for

the subject tests. The GSE functioned adequately, removing the gas with a minimum of propellant off-load.

Following the verification of the gas removal GSE, an additional test was conducted to further evaluate the benefit of 100 psig ullage pressure compared to 50 psig in reducing the gas accumulation. Test results indicated a minimum bubble reduction of 20 per cent with the 100 psig hold pressure.

A technical memorandum (R-TEST-CT-74-67) has been prepared on the tests described herein and will go out to distribution in mid-September, 1967.

At present the Tapco engines are being installed in the Saturn V/S-IVB APS Module along with propellant valve inlet accumulators designed to damp the extreme pressure oscillations obtained during engine pulsing. Testing is scheduled during the next reporting period.

D. Ground Support Equipment

Ground Support Equipment testing includes development and acceptance test programs of Saturn V launch vehicle support hardware under the design cognizance of both MSFC and KSC. Launch environments are simulated as closely as possible for both types of test programs although launch support equipment to be installed later at the launch complex is used for acceptance test programs only.

For vehicle service arm tests, the swing arms are mounted in a tower which duplicates the launch umbilical tower at KSC. The ground umbilical is connected to the vehicle umbilical plate that is mounted in a simulated vehicle skin panel. This panel is mounted on a random motion simulator which simulates the relative motions between the launch vehicle and launch tower. For inflight disconnect arms, the panel is connected to the random motion simulators through an elevator system so vehicle lift-off accelerations can be duplicated. In addition, the equipment is exposed to wind, rain, and cryogenic temperatures to include worst case design conditions.

In the test programs, component checkout tests are conducted after installation of the test hardware in the test facility. This phase of the program is followed by subsystem checkouts and subsequently, complete systems tests

simulating launch environments. A description of hardware undergoing tests and the results of these tests follows:

1. LC-39 Service Arms

a. S-IC Intertank (Set III) - This preflight arm supplies the vehicle S-IC stage with lox fill and drain service as well as personnel access to the vehicle. The arm has capabilities to allow automatic reconnection in case of a mission hold or abort.

System tests wet and tracking tests were completed satisfactorily except for tracking a high, dry vehicle. Reliability tests have been started and are approximately 50% completed. At present the reliability tests are suspended for a special series of tests for P&VE to determine the maximum lox line pressure that the carrier can have and still be retracted using an 825 to 850 p.s.i.g. supply to the retract cylinder.

b. S-IC Forward (Set III) - This preflight arm supplies the forward end of the S-IC stage with electrical, pneumatic, air-conditioning services, and personnel access.

All testing is completed and the arm is to remain in the area until all modifications are completed and AS-501 is launched.

c. S-II Intermediate (Set III) - This inflight service arm provides air conditioning, electrical, pneumatic, LH_2 and lox services to the S-II stage. The lox and LH_2 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 AA-04-02 arm was modified at MSFC by installing a lanyard withdrawal system for the main umbilical to replace the dual cylinder withdrawal system used on AA-04-01 and AA-04-03. R&D tests on the lanyard withdrawal system are now underway. At the conclusion of the R&D testing on the lanyard system, it is planned to retrofit the lanyard system on AA-04-01 and AA-04-03.

System tests are being conducted on the further revised umbilical lanyard withdrawal system. These tests have revealed two problems, the umbilical withdrawal cable becomes damaged, and the left umbilical leg impacts the arm structure

during some test conditions. With the resolution of these two problems, the lanyard withdrawal system can be committed to hardware for AS-502. The necessary hardware to modify the S-II intermediate arm to a lanyard withdrawal system for AS-502 will be shipped to KSC on September 15, 1967.

The modified lox line, reported in last month's progress report, has passed the cold shock test, and flex cycling tests. It is presently under vibration tests by an outside contractor.

d. S-II Forward (Set I) - This inflight service 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.

Modifications to the S-II forward arm and the installation of the production unit of the carrier plate-arresting bungee cord assembly have been completed.

R&D testing of the lanyard withdrawal system has been completed and hardware to modify the S-II forward arm to a lanyard system for AS-502 has been shipped to KSC.

Acceptance testing of the lanyard withdrawal system and associated hardware has been started.

e. S-IVB Aft (AA-06-01) - This inflight service arm provides LO_2 and LH_2 fill and drain services to the S-IVB stage. AA-06-01 was returned to MSFC after being used at KSC in the Saturn V 500F wet test. The service arm was modified to a lanyard withdrawal system, which replaced the dual cylinder withdrawal system tested on AA-06-02 and AA-06-03.

After completion of the 50-hour water flow test (reference May Progress Report), the arm was reinstalled in the test area on June 14, 1967. Arm rotation tests were rerun at a primary supply pressure of 2,300-2,450 p.s.i.g. to increase the retraction time to 4.0-4.1 seconds, in accordance with design criteria.

Spike loads of up to 5,000 pounds in the primary lanyard during disconnect and withdrawal were traced to air in the hydraulic system.

Eight strain gauges were installed on the umbilical carrier disconnect lever stops at the request of P&VE/DAC. Several tests were conducted to determine if excessive loads were being applied to the umbilical carrier during disconnect. The maximum primary lanyard load during this series of tests was approximately 2,200 pounds, and the maximum strain recorded was 647 microinches per inch. Plots of the strain gauge data were delivered to P&VE/DAC for analysis.

R&D testing on the primary lanyard system was completed on August 18, 1967, and the hardware to modify the S-IVB aft arm to a lanyard system for AS-502 has been shipped to KSC. Acceptance testing according to the SK75M24639 (revision B) test criteria was begun on August 21, 1967. These tests are now in progress.

f. S-IVB Forward (AA-07-01) - This inflight service arm provides air conditioning, electrical, pneumatic, water glycol, and LH2 venting services to the S-IVB stage and to the instrument unit (IU). The arm also supports the Lunar Excursion Module (LEM) umbilical carrier.

Disconnect and withdrawal tests were completed during this report period. LEM disconnect and withdrawal tests were conducted both with and without the 3/4-inch check valve installed downstream of the LEM air motor. The check valve increases withdrawal time by approximately 0.15±.05 seconds. The equivalent orifice size of the check valve was determined to be 0.474 inches.

Systems tests dry are underway. Occasionally, the LH_2 vent line will hang on the L/O 1206 platform as the arm decelerates during retraction. KSC is designing a bumper which should correct this problem.

System test wet should commence approximately 9-6-67.

g. Service Module - The service module arm is an inflight arm which provides air conditioning, electrical, GH_2 venting, and water-glycol cooling services to the Apollo service module umbilical connection.

During this report period, carrier withdrawal tests with and without lift-off were conducted. It was determined that withdrawal times without lift-off are 1.5 to

1.57 seconds, and times with lift-off are 1.21 to 1.35 seconds (design criteria calls for 1.25 to 1.5 seconds). Special tests are being conducted to determine the minimum pressure required to retract the arm in 9.2 seconds, and the minimum pressures required to kickoff and withdraw the carrier in 1.25 to 1.5 seconds.

h. 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.

Extensive redesign of the entire command module access arm system is in work at KSC. It is anticipated that the arm now in the test area will be re-worked to the new configuration and tested. The period of testing is not known at the present time. Special testing relevant to the anticipated modification was performed during the period of August 18 through August 23, 1967. A switch was installed in the lower hinge in the arm extend retract circuit. The arm was extended and retracted permitting this switch to stop rotation at various angles. Also the arm was extended from various park angles to the extended and locked position. The tests were successfully completed with the conclusion that a park position switch can be made functional.

2. Saturn V Damping, Retract, and Reconnect System (DRRS)

The DRRS is a system for the primary purpose of damping the Saturn V vehicle oscillation due to vortex shedding. The system has the capability of automatic extension, connection, disconnect, and retraction as well as damping oscillations. The test program is being conducted for P&VE Lab to qualify the system prior to its use on LC-39.

Due to hardware delivery delays, testing of the ML-3 arm has not been resumed. No new delivery date has been established by ME Lab.

3. LC-39 Tail Service Masts (Set 1)

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. Mast retraction is initiated by vehicle lift-off.

Testing has been completed to test plan Section III.D Test Procedure and buildup are in progress for special tests to be conducted for KSC and R-P&VE.

These special tests will be conducted prior to the installation of flight hardware and flight hardware testing. The purpose of these tests is to further evaluate the TSMs. These tests will be conducted August 30, 1967, to September 30, 1967. A delay in the special test program has been due to necessary evaluation and test planning of added special tests.

4. LC-39 Mobile Launcher Holddown Arms

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. Twelve holddown arms have been structurally tested and shipped to KSC. Structural testing of the final set of arms (fourth set) began August 11, 1966, and was successfully completed November 2, 1966.

This fourth set of arms is a spare set and is being retained at MSFC to serve as test bed for development of the holddown arm secondary release system and blast shield.

Concept evaluation of a secondary (explosive) release system (to be used as a back-up release to the normal, pneumatic release system) was successfully conducted between April 3, and April 14, 1967. A test report, Internal Note-Test-14-67, has been released.

During testing of the secondary (explosive) release system, cracks were discovered in the base castings (in the general area of the upper arm pivot point) of arms 002, 003, 004, and 006. Subsequent dye-penetrant and ultrasonic inspections of the arms revealed that crack depth was significant (reference Memorandum R-QUAL-AVP-2469-67, Subject: "Non-destructive Testing of Saturn V Holddown Arm Base Casting, P/N 75M05793, S/Nos 002, 003, 004, and 006"). At the request of KSC Design, R-ME is repairing the cracks in accordance with document 76K02512, "Holddown Arm Repair Procedure for Launch Complex 39". Weld repair of arms 003 and 002 is complete. Load testing of the repaired holddown arms, requested by KSC Design, is being conducted. Load testing of arm 002 is complete. Repair of arms 004 and 006 was to have been completed during this report period but, due to the magnitude of the problem, repair and/or final resolution of the crack problem is not complete.

The protective hood system was installed on Holddown Arm 003 and testing was initiated when, on August 10, 1967, an AVO (HDA 865) requesting removal of the hood hydraulic-pneumatic assembly for shipment to the Martin-Denver Corporation, Denver, Colorado was received. Results of the limited testing of the holddown arm indicated that the solenoid valves located in the hydraulic-pneumatic assembly may be inadequate for the intended use. A flash report has been written to document results to date. Further testing is planned for the protective hood when the hydraulic-pneumatic assembly is returned. Subsequent to this test, HDA 003 will be load tested to validate crack repair.

5. Saturn V Lift-off Switches

This program is being conducted for KSC to ensure that the lift-off switch actuator arms can signal initiation of the umbilical disconnect at vehicle lift-off.

Testing on a modified primary actuator assembly was completed 7-14-67. The test report is 70% complete.

6. Q-Ball Cover Removal System

The purpose of the test program was to demonstrate operational reliability of the system for removing the cone cover from the vehicle nose.

Tests were conducted in conjunction with the Primary Damper System to verify that a KSC modification would eliminate an interference problem between the damper arm and the Q-ball cover pneumatic line. The modification was satisfactory. The final report has been submitted.

7. High Pressure Test Facility

a. Anderson Greenwood and Company Relief Valves -

The purpose of this testing is to evaluate the operating characteristics of two pneumatic pressure relief valves for the Mississippi Test Facility (I-MT-EF).

(1) P/N 3518G23-S - Testing was completed April 7, 1967, on this valve which had pulsating flow characteristics. MTF will send MSFC an identical valve, except for enlarged ports, for evaluation. Testing will be conducted on this valve and a report will be written to cover the original and modified valves.

(2) P/N 81C68-4 - Testing is complete on this valve. During the cycle test, galling was encountered between the valve spindle, guide, and nozzle. The report has been written and submitted for approval.

b. Pipe Burst Test - This test was conducted for R-TEST-BS with two pipe sections to determine the strength of welding in relationship to pipe. Testing was completed July 19, 1967. The report has been released.

c. Von Accumulator Test - This test was conducted for KSC (MG) and R-TEST-RT to determine if two accumulators could withstand a 24-hour pneumatic and hydraulic pressurization test.

Testing was completed June 7, 1967. The test report has been released.

8. S-IVB Aft Withdrawal Cylinder Life Cycle Test

The purpose of this test program, for KSC, was to determine the ability of one withdrawal mechanism to "track" vehicle motion for 1,100,000 cycles. Testing began November 22, 1966, and was completed June 9, 1967. Nine (9) additional cylinders were functionally tested for use on LC-39. A 72-hour continuous-cycle test was added and completed.

Cycling of the pneumatic withdrawal cylinder continued through June 9, 1967. The cylinder, to the latest design configuration, successfully completed 1,282,000 cycles including a 72-hour continuous period. The life cycle test report is being prepared. The report for cylinders S/Nos. 1 through 6 has been approved. The report for cylinders S/Nos 7, 8, and 9 has been submitted for approval.

9. Flush and Purge Truck

This test program was conducted (for P&VE) to ensure that the truck would service the F-1 engine as required.

Testing was initiated December 16, 1966, and the tests have been completed according to the original test procedure. P&VE requested additional testing, with minor modifications to the unit, to determine if increased outputs could be achieved.

Testing has been successfully completed and the truck released to P&VE on 8-8-67. The 35-gallon unit, held for additional testing, was released to P&VE on 8-24-67. The report is in progress.

10. Hydrogen Embrittlement Test

The purpose of this test program is to determine the hydrogen embrittlement effects of gaseous hydrogen on the yield point and ultimate strength of various materials being used in high pressure hydrogen containers; to provide comparative data to enable R-P&VE-MM to study the material nil-ductility transition temperature, elongation of the material, change in cross-sectional area, and radiographic and fractographic analysis of the fracture surfaces.

Buildup of this test is 98% complete. The PAP was submitted 8-31-67. Tail service mast priority has delayed testing. Testing is now scheduled to begin 9-4-67.

11. Straza Duct Proof-Tests

These flexible, vacuum-jacketed propellant transfer lines are used to transfer lox and LH_2 to the S-II stage via the S-II intermediate service arm.

Three lines, two lox and one LH_2, were to be hydrostatically proof tested and thermal shock tested.

One line (S/N 6) was completed 7-15-67. Permanent deformation occurred, it is believed, because the end-flanges were restrained. The report has been released. Another line (S/N 4) was tested with the end-flanges un-restrained. No failure occurred. The report has been submitted for approval.

12. Safety Gate

The purpose of this test program was to determine if the modified stop mount and lock pin on the Saturn V service arm safety gate assembly would maintain the service arm in the extended position should a system failure result in maximum hydraulic pressure being applied to the arm retraction cylinders.

The report has been released.

III. SUPPORTING RESEARCH AND TECHNOLOGY

A. 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.

Three tests were conducted during this report period. These tests are the first of a series to evaluate the effectiveness of perforated baffles. Testing is curtailed due to facility modifications which will be performed through September 1967.

B. S-IC Model Drop

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.

There was no test activity during this report period. A data transmittal report covering tests 39 through 60 is presently being prepared.

C. Liquid Hydrogen Super Insulation

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.

30-Inch Calorimeter: A pin hole leak has been found on the bottom of the calorimeter. The calorimeter will be repaired, hydrostated, and re-insulated for additional testing to start the latter part of September.

D. Storable Propellant Space Engine Testing

This program was requested by R-P&VE-P to provide support for testing (1) engines to be used on Project Thermo, and (2) advanced technology engines.

The two 40-pound thrust engines remain at Kidde Company for repacking of the catalyst. Expected delivery is late September 1967.

E. Jet Impingement on Water (½K Cluster Phase)

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

Six tests (C-002-29C through 34C) were accomplished during this report period. Scheduled test completion date is September 22, 1967.

F. Combustion Dynamics

Requester: R-P&VE-PA

This 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.

No tests were conducted with the 30K thrust level engine during this reporting period. Approximately seven tests with an existing solid copper injector will be conducted when scheduling permits.

P&VE has requested that testing at high chamber pressure levels with the 15K engine be temporarily suspended in order that a few research tests with liquid hydrogen at low chamber pressure levels might be conducted. All of the fuel (LH_2) is to be injected through the transpiration-cooled wafers and the LOX will be injected through a slightly modified injector. The purpose of the test is to measure the temperature at the combustion chamber wall, near the injector, so that the phase of the combustion products might be determined.

The tests scheduled for this effort were discussed with P&VE and R-TEST-C representatives in May, and it was agreed that three to five additional tests would be conducted with a new injector face. This injector face will impinge LOX on LOX in an attempt to improve the combustion efficiency of the engine. The injector face has been received, but no testing will be performed until Test Position 115 becomes operational. It is estimated that testing will resume by November 1, 1967.

G. Pump Inducer Development Project

Requester: R-P&VE-PAC

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

The program has been cancelled by the requestor and a final memorandum report is in progress. The memorandum report will cover both the hubless inducer with impeller and the LH_2 high-speed inducer test phases. The rough draft copy of the memorandum report is to be completed by September 15, 1967.

H. Acoustic Studies

Requester: R-P&VE-SVR and AERO-AU

Acoustic studies currently being performed at AMTF are to investigate, analyze, and evaluate the noise generating mechanisms and the resultant acoustic fields of aerodynamic flows, i.e., rocket exhaust flows. These flow fields are generated by launch vehicle propulsion systems which are large in size and power; consequently, very severe acoustic environments are created. Techniques for estimating these adverse environments in many instances are very crude or non-existent. Therefore, it is necessary that prediction techniques be developed and verified that will adequately define the associated acoustic environment.

These test programs cannot be conducted using full-scale flow fields, but by careful consideration of dynamic similarity principles and valid scaling procedures, scale model test programs of these flow fields can be successfully performed, to accomplish the above stated objectives.

Specific programs now planned at the AMTF are:

(1) Comparison of acoustic environmental characteristics of a cone and bell-shaped engine nozzle with duplicate exit diameters.

(2) Acoustic environmental variations due to nozzle exit pressure variations for a single engine.

(3) Ground plane acoustic environment (amplitude) for static and flight operation of a 1/20th scale Saturn V vehicle configuration.

(4) Vehicle acoustic environment (phase and amplitude) for the launch condition of a 1/20th scale Saturn V vehicle configuration.

(5) Acoustic source location study of a single, undeflected, rocket exhaust flow.

(6) Saturn V. MLV acoustic environmental definition for strap-on configurations.

(7) Supplementary study of cluster effects as a function of engine separation distance and cluster diameter.

(8) Study of the three dimensional acoustic field developed by a rocket exhaust flow impingement on a deflector (uni- and bi-directional flow).

Six tests were conducted at the AMTF during this reporting period to complete the pressure ratio study. All reduced data has been forwarded to R-AERO-AU for their immediate use.

Test stand modifications are underway and testing to determine cluster effects as a function of engine separation distance and cluster diameter (No. (7) above) will begin September 12, 1967.

I. Flame Study

Requester: R-TEST-C

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.

Testing on this project has been temporarily suspended. A report on this program will be completed in October.

J. Improved Saturn V Launch Facilities (VLF-39) Model Study

Requester: KSC

This program is a specific study of existing facility capabilities (VLF-39) necessitated by the proposed use of improved Saturn V Boosters which will use five uprated F-1 engines and 4-each "Strap-Ons" 120-inch Solid Rocket Motors. This study will be used to establish the extent of launch facility (VLF-39) capability and/or modifications required when using the improved Saturn V Booster Configuration.

The test program, utilizing 1/58 scale model facilities has the following objectives:

a. Determine the environment of vehicle base and facility elements during holddown and initial liftoff.

b. Determine the environment of the mobile launcher and umbilical tower for maximum vehicle drift.

c. Determine the extent of facility modification necessary for compatibility with improved Saturn V vehicles.

The test program is being conducted in four phases. A 1:58 scale model of the Saturn V Booster will be utilized for all four phases of the test program.

The first phase was conducted using the Basic Saturn V Booster scale model and has established baseline data. Phase I tests will use the same scale model booster but with the uprated F-1 engines. Phase III is utilizing the basic Saturn V scale model with 120-inch simulated solid motor strap-ons. Phase IV will use the basic Saturn V model with 156-inch simulated solid motor strap-ons.

Three tests of the Phase III program were conducted during this report period. All three tests were lower portion (0-232 feet) vertical lift-off tests. Two were conducted using only the LOX/RP-1 F-1 scale model engines in the 45° rotated position and the third was the first test using both the liquid model engines and the four strap-on 120-inch scale model solid rocket motors with 0° cant. Preliminary results indicate that the solid strap-on tests were successful and apparently will work without major modifications of the VLF-39.

Phase III testing is continuing.

K. Tektite Study

Requester: R-AERO-AT

This project was initiated to support Goddard Space Flight Center through R-AERO-AT on an experimental and theoretical program involving a study of Tektites. Tektites are black rocks that have been found in localized deposits in several parts of the world. Markings on the tektites appear to have been caused by ablation as might occur upon entry through the earth's atmosphere.

This program was initiated to see if the markings can be duplicated on synthetic tektites using a lox/hydrogen engine to simulate entry temperatures and velocities.

Two tests have been conducted during this report period using 2-inch diameter tektite samples. The thermal expansion problem previously encountered, which caused the tektites to

drop off its mount during tests has apparently been overcome.

Camera coverage is improving, although mechanical difficulties with the Milliken movie cameras are still being encountered. Infrared coverage has been deleted due to poor results since test number 5. Television coverage with video-tape instant replay has been added.

Lockheed personnel are designing a calorimeter for use in the program. It should be ready for testing by October 1, 1967.

IV. APOLLO APPLICATION

A. S-IVB Workshop

1. S-IVB Workshop Environmental Control System

This program, requested by R-P&VE-P, is required to support the thermal design of the S-IVB Orbital Workshop environmental control system. Tests are scheduled for a condensation model and a 1/8 segment of the workshop compartment liner. The condensation model tests will be used to confirm the analytical model being used to investigate condensation effects. Results from the 1/8 segment will provide data on heat transfer coefficients, fan performance, wall temperature, condensation rates, and curtain temperatures.

Thirteen tests, C-043-27 through C-043-39, were conducted on the condensation model in the vertical position, and testing will continue through September.

Assembly is approximately 70 per cent complete on the 1/8 segment, and testing is now scheduled to start the latter part of September in a 5 p.s.i.a. atmosphere.

2. Insulation Flammability Study

This program was requested by R-P&VE-M to define and study the fire retardency of the S-IVB internal cryogenic insulation in a habitation environment.

Three-mil and four-mil aluminum covered polyurethane samples, in addition to several two fold, two-mil samples, are to be furnished by R-P&VE-MC shortly. Testing of the subject samples will continue during the next reporting period.

W. L. Grafton

GEORGE C. MARSHALL SPACE FLIGHT CENTER
TEST LABORATORY
MONTHLY PROGRESS REPORT
TECHNICAL SUPPORT DIVISION
AUGUST 1, 1967 through AUGUST 31, 1967

I. SATURN IB

a. Supported testing with high pressure water and propellants at the H-1 Power Plant Test Stand.

b. Continued miscellaneous shop support for S-IB Test Facility.

II. SATURN V

a. Design was started on a GN_2 purge loop system for the J-2 engine thrust chamber at the S-IVB Test Stand also on the F-1 Turbo-Pump Manifolding Restraint System.

b. Design reached 90% completion on all phases of the S-II Stage Aft Structural Test Assembly. Final design completion is being held up pending all load strap locations on the LOX Tank Bulkhead. Fabrication of all test equipment is proceeding as fast as possible. Furnished test hardware is receiving inspection and repair prior to installation in the test position.

c. Design continued on the 501 position emergency escape system, pipe supports and access to critical piping points, support for the S-IVB Aft Swing Arm Tip Assembly, 25000 gallon cryogenic storage tanks vacuum system, the S-II Forward Swing Arm Umbilical Panel and the Vehicle Random Motion Simulator.

d. Design was completed on tiedown points of the LH_2 dump system to the 500 position burn pond.

e. Fabricated/modified vent trap water storage tank, zero gravity drop tube access platforms, Paul GH_2 recharger at test stand #500, S-1C handling ring, super-insulation test facility, 501 test facility, 36' x 48' vacuum chamber, helium compressor piping, removable top and access platform on vertical tank at Cell 112, and gaseous hydrogen pressure vessels.

f. The S-1C Forward Handling Ring for S-1CD and F vehicles has been completed. The second S-1C Flight Stage Forward Handling Ring being fabricated by Progressive Welders, Inc. is due to arrive about September 23 to be mated to the S-1C Jig Fixture.

g. A new contract for two additional S-1C Flight Stage Forward Handling Rings with an option for a third has been awarded to the Brown Engineering Co.

h. Technical monitoring of the modifications to the Barge "Orion" by the Diamond Manufacturing Company in Savannah, Georgia. Completion is scheduled for September 3, 1967. Sea trial shakedown from Savannah to New Orleans is to begin immediately after shakedown.

i. Design, documentation and checking continued on other projects such as: (a) MTF Shuttle Barges; (b) S-1C Engine Extension Trailers; (c) Marine tie-down for empty S-1C transporter; (d) Revisions to S-1C transporter documentation and manual.

j. The "A"-Frame Boom Modification Kit for the barge "Poseidon" was completed, also design and documentation for the Saturn V Damper System to be shipped aboard the Super Guppy Aircraft was completed.

k. Supported testing with high pressure water, propellants and gases at the S-1C Stand, West Area F-1 Engine Test Stand, and GSE Test Area.

l. Modified straza ducts.

m. Continued miscellaneous machine work.

n. Continuing fabrication on S-II Tower Structure, forward load assembly, foundation base plates, burn stack tower, high pressure GH_2 storage system, firex system, specimen support system (fabrication by BECO) and in-board loading assembly.

III. OTHER PROGRAMS

a. Design continued on the ATM solar panel 15 degree segment to be mounted in our High Vacuum Facility, the ATM

transporter and environmental control capsule. Instrumentation requirements have not been received from R-ASTR. A decision has been made to use a rigid type cover.

b. Fabrication on nitrogen compressor lunar drill concept 1 is approximately 30% complete.

c. Studies were made on new force application techniques in the lunar drill program.

d. A layout and cost estimate was made on providing an ambient Voyager engine test position to be located at the STTE position.

e. A transportation study on shipping the Voyager and Voyager Shroud vertically to KSC has been completed. The findings show that air transportation for this package is not available. Water shipment is recommended.

f. The route survey effort for NGTM was transferred to F&DO because of personnel shortage. The money has been approved for this study. The survey will begin about September 18, 1967.

g. Procurement planning was started for long lead time items to be used on the NGTM Cold Flow Test Facility planned at R-TEST.

h. Two CLT's built at MSFC have been completed and shipped to the users. Orifices were added in the hydraulic jack piping to insure proper functioning of the cylinder lock valves and the new hydra-latch rams. Spare parts are being transferred from R-TEST to I-PL inventory.

i. Design and documentation is nearing completion on the RACK Transportation Equipment.

j. Technical and safety evaluation support for KSC continued through this period.

IV. SUPPORTING RESEARCH AND TECHNOLOGY

a. Component design efforts were expended on: the LH_2 Slush Facility; Hydrogen Mass Flow and Calibration System;

zero gravity electric hoist and drag shield structure; Ion Gage Calibration System; air blower and flexible duct to the vibration-shaker at the Instrumentation Development Building.

b. Supported testing with high pressure gases/propellants/water at: building 4748, Cell "C" and Cell "B"; building 4749, Cell "A"; Cell 116, Acoustic Model Test Facility; Cell 105, building 4583; CTL, Cell 117/Cell 104.

c. Propellant/high pressure gas supported to other Labs by Semi-Trailer:

LN_2	LH_2	LOX	GHe	GN_2	Air
SSL P&VE ME	P&VE	P&VE	P&VE QUAL ME	ASTR P&VE ME QUAL AERO	P&VE MSI Cleaners ME

d. The installation of helium compressor #3 was completed. The machine was run in and put in service.

e. Work has continued on air compressor problems, Bldg. 4647, experienced with the compressor bearings. Two machines are out of service.

f. Six diesel exhaust stacks were sand blasted, painted, and reinstalled.

g. A specification for the purchase of high pressure gaseous hydrogen vessels was written.

Julian S. Hamilton

Julian S. Hamilton

GEORGE C. MARSHALL SPACE FLIGHT CENTER
TEST LABORATORY
MONTHLY PROGRESS REPORT
ADVANCED FACILITIES PLANNING OFFICE
AUGUST 1, 1967 through AUGUST 31, 1967

I. FACILITIES

A. R&A Projects

1. Additions to Cryogenic Storage - Project 7072 - The LH_2 transfer control building was erected and joint occupancy given. Construction of pipe supports and placement of conduits were essentially completed. The project is approximately 75% complete.

2. S-II Structural Test Pad - Project 7076 - The S-II pad was poured and excavation completed for open pipe trench #1. The project is approximately 50% complete.

3. S-II Aft Section Test Assembly Special Requirements - Assembly of materials for the off-stand firex system was complete. Welding of pipe sections and excavation of pipeline A were started. Construction of the project is about 5% complete.

4. Construction is underway on the following projects:

a.	Project 7008 - Additional LOX Storage for All Test Positions, Building 4583	80% complete
b.	Project 7009 - Firex System Addition, Test Stand 115	80% complete
c.	Project 7013 - Elevator for Test Stand 500	34% complete
d.	Project 7021 - GH_2 Transmission System	95% complete
e.	Project 7023 - GN_2 Pipeline System	35% complete
f.	Project 7031 - Modifications to Provide LH_2 Service, TS 300	complete
g.	Project 6742 - GN_2 Connector Line	5% complete
h.	Project 7058 - Extension of Steam Line to S-IV B Test Stand	48% complete
i.	Project 7066 - Timber Clearing, West Area, FY 67 Landscaping, Part II	50% complete
j.	Project for Fire Detection System	0 complete
k.	Project for Landscaping Dodd Road, FY 67	5% complete

1. Improvements in Vicinity of Bldg. 4650 - 97% complete

5. Beneficial occupancy was accepted on Project 7018 - Transformer Substation, Test Stand 500.

B. Environmental Test Complex

Funds were received from Headquarters to initiate further studies on requirements and justifications for the subject facility complex. A Scope of Work has been prepared and preliminary meetings were held on September 7, and 8, with representatives of the Contractor with a target date of September 18, for a firm contract.

C. Propulsion Systems Test Facility

Scope of Work has been completed, reviewed by F&DO and is ready for submission to P&C. A flow diagram and site plan has been completed for modification of east side of static test tower.

D. Nuclear Ground Test Module

Purchase requests for equipment were sent to P&VE for approval but were returned disapproved pending resolution of FY-68 NASA Budget.

J. B. Carrington