TEST LABORATORY

MONTHLY

PROGRESS REPORT

July 1, 1967 through July 31, 1967

GEORGE C. MARSHALL SPACE FLIGHT CENTER
HUNTSVILLE, ALABAMA

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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TEST LABORATORY MONTHLY PROGRESS REPORT

July 1, 1967 through July 31, 1967

SYSTEMS TEST DIVISION

FOR INTERNAL USE ONLY

COMPONENTS AND SUBSYSTEMS DIVISION

TECHNICAL SUPPORT DIVISION

ADVANCED FACILITIES PLANNING OFFICE

I. FACILITIES

GEORGE C. MARSHALL SPACE FLIGHT CENTER
TEST LABORATORY
MONTHLY PROGRESS REPORT
SYSTEMS TEST DIVISION
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I. SATURN IB

A. S-IB Stage

1. S-IB-11

Test procedures are being updated and the test stand refurbished in preparation for acceptance static testing of stage S-IB-11. A firm schedule has not been determined, however, the stage is expected to be tested during the fourth quarter of 1967.

2. S-IB-MM

A plan for static testing the proposed Saturn IB/Minuteman first stage and associated ground support equipment was completed and forwarded to the Technical Systems Office.

B. H-1 Engine

H-1 engine S/N H-6067 was removed from the test stand for rework of the injector in preparation for chamber stability verification tests. This series of tests will begin the second week of August 1967.

C. S-IVB Stage

1. S-IVB-209

S-IVB-209 was removed from the Beta I Test Stand on July 6, 1967, and transported to the Vertical Checkout Laboratory for continuation of post-static checkout.

II. SATURN V

A. S-IC Stage

1. S-IC-T

The S-IC-T and associated ground support equipment were still being prepared for static firing. The test is presently scheduled for August 1, 1967, for a duration of 40 seconds.

2. S-IC-5

S-IC-5 is being prepared for acceptance firing in early August 1967. During propellant load test preparations on July 25, 1967,

the stage fuel emergency drain duct collapsed. The stage duct has been replaced and the propellant load test is presently scheduled for August 7 and 8, 1967.

B. F-1 Engine

Test FW-067 was successfully conducted with F-1 engine S/N F-3TI on the West Area F-1 Test Stand for a mainstage duration of 41 seconds on July 12, 1967. The primary purpose of this test was to calibrate the engine for the S-IC-T. The engine was re-orificed for the S-IC-T firing.

C. S-II Stage

1. S-II-3

The S-II-3 stage was shipped from Seal Beach to the Mississippi Test Facility (MTF) on July 11, 1967, aboard the Point Barrow. S-II-3 arrived at MTF on July 27, 1967. The stage was positioned and tied down in the A-1 Test Stand on July 28, 1967, with no problems.

The S-II-3 Processing Plan Review meeting was conducted at MTF on July 26, 1967. At present 5,663 manhours of known work consisting of TAR's, CNC's, and MCR's are scheduled to be performed at MTF resulting in three day schedule slip in applying power to the stage for pre-static checkouts.

2. S-II Structural Test Program

Facility construction work is progressing on schedule. Stage delivery to Test Laboratory is presently scheduled for February 8, 1968.

D. S-IVB Stage

1. S-IVB-504 (New)

The stage was installed on the Beta I Test Stand on July 7, 1967. McDonnell Douglas Corporation foresees no constraints to an August 16, 1967, acceptance firing. The O_2/H_2 burner system and the ambient re-pressurization system will be functionally checked out prior to the stage firing.

2. S-IVB-BS-2000

One hot firing on the J-2 engine was conducted at the MSFC S-IVB Battleship Test Stand during this report period. Test S-IVB-046 was conducted on July 6, 1967, for a duration of 435.4 seconds using engine J-2060. Performance was satisfactory and all test objectives were met satisfactorily.

3. O_2H_2 Burner

Test S-IVB-H05 was conducted on July 25, 1967, for a duration of 166.4 seconds. Cutoff occurred automatically when open talkback

was lost from LOX shutdown valve. Investigation of this malfunction is continuing.

III. APOLLO APPLICATIONS

A. Lunar Drill Program

Joy Manufacturing Company began working on Contract No. NAS8-20839. The contract duration is ten months for a total cost of $107,615.

The Westinghouse contract on the Rotary Concept of the drill is waiting for approval of the D&F from Headquarters procurement.

Compressor drawings have been supplied to R-TEST-SP from Northrop (Percussive Concept). The completion date for this hardware is the middle of August 1967.

A meeting was held on July 18, 1967, to discuss the scope of a presentation to Dr. von Braun planned for August 1967.

In-house testing on the hammer (Percussive Concept) to determine optimum rotational speed has been initiated.

Drilling at the Howell, Tennessee Site has been discontinued until after test S-IC-20.

B. LSSM Project

The Bendix Mobility Test Article (MTA) underwent repairs on the steering control circuits, wheels, and electronic duty cycle control board. All functional systems are now performing satisfactorily. Half of the steering tests have been concluded on this vehicle and the remainder are scheduled for August 14, 1967.

The General Motors MTA wheels were received and installed. Three flexsplines were machined and installed in the wheel drive units. Minor repairs to the brake system and wheel drive units were completed, and all functional systems are now performing satisfactorily. The MTA was moved to R-P&VE on July 28, 1967, for moment of inertia and related measurements.

IV. VEHICLE STORAGE PROGRAM

Publication of the initial guideline document for stage storage was achieved on July 10, 1967.

The S-IVB storage plan (DAC-56572) has been reviewed and comments supplied to Industrial Operations on July 24, 1967.

The S-II storage specification was reviewed and comments are in preparation.

A visit was made to Michoud Assembly Facility (MAF) for facility evaluation and for a presentation by Chrysler of their plans for storage of the S-IB; detailed comments on this item are currently being prepared.

The I.U. storage procedure has been received and is in review.

The November 1966, general storage plan prepared by Boeing for the S-IC system is currently being reassessed for its applicability to current program requirements.

Additional items under consideration include:

a. A general storage document for all vehicle hydraulic systems that use MIL-5606 hydraulic oil.

b. Special preparations that may be required of the vehicle due to structural considerations.

c. A survey of industry wide storage techniques, the Mueller concept of stacked storage at Cape Kennedy.

d. Vehicle contamination due to long term purge techniques.

e. Resolution of differences of responsibility between Industrial Operations and Research & Development Operations.

f. Definition of additional general guidelines for Industrial Operations.

g. Facilities requirements generated as a function of the visits to Seal Beach, Sacramento and MAF.

Responses are required to specific requirements developed by Industrial Operations, such as the current outstanding item requesting an evaluation and recommendations of Research & Development Operations with respect to scheduling of manufacturing checkout, static acceptance firing, post-static checkout, storage, etc., (I-V-Q-192a-67) and a document requesting four stage storage spaces for I.U.'s effective August 15, 1967, (I-V-IU-1359-67).

Daniel H. Driscoll, Jr.

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COMPONENTS & SUBSYSTEMS DIVISION
July 1, 1967 through July 31, 1967

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.

A test program is being conducted for KSC for determining the acceptability of the redesigned Environmental Chamber (EC) and the arm actuating assembly. The first EC to be tested will be a prototype model, to which changes can be made if so desired. The second and third units will be flight hardware for use on LC-34 and LC-37 during Saturn IB manned vehicle launches.

The prototype hardware was received during the month of July and installation on the test stand was completed on July 31. All instrumentation has been installed and the tower plumbing and wiring is now being connected to the arm system.

Checkout of subsystems will begin on August 7, followed by operation of subsystems and systems test.

The procedure was prepared during July.

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. Checkout tests are scheduled to begin in September 1967. Fifteen blowdown tests have been conducted on the F-1 GG fuel feed system. Blowdown testing of the GG lox feed system is scheduled for the first two weeks of August 1967.

S-IC 17-inch Lox Flowmeter S/N WE17-35 is scheduled to be tested during August 1967.

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 tests of pressure tanks and general cleaning of the lox system has slipped the test start date to October 1, 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 start date has slipped to the week of August 7, 1967, due to a lower bulkhead panel failure prior to testing.

B-Cell Position 1 - Foam Insulation

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

Testing on the 7 x 7 calorimeter is scheduled ahead of the foam insulated 70" tank, and will be initiated at the completion of testing with the Linde insulation.

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

This test program was requested by P&VE Laboratory to evaluate the thermal performance of the S-II stage interior common bulkhead insulation.

Preliminary planning has been initiated; however, no firm test start date has been established.

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

Requestor: R-TEST-SS

The test objectives for the S-II and the S-IVB lox 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 expanded 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.

Final analysis of the valve malfunction during Test 204-3 indicated that a repair of the galled valve housing would not be feasible and a spare housing cannot be obtained. R-TEST-SS is attempting to secure another S-II lox prevalve which is presently used by P&VE for testing. If successful, the test program as requested by R-TEST-SS will be completed as soon as possible.

C. S-IVB Stage

1. J-2X Turbopump Test

Requestor: 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 shop is still working on the piping systems which is about 95% complete. The LH_2 sump has not been able to pass X-ray inspection and will probably delay the completion date until the second week in August. The liquid hydrogen

100,000-gallon storage tank and piping system has been reassembled and is ready for activation. Activation should be completed during the month of August. Tentative completion date for T.P. 501 buildup and start of check-out tests is the first week in October.

2. J-2X Thrust Chamber Throttling Tests

Requestor: 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 J-2X testing. The facility utilizes pressurized propellant tanks and throttle valves to control the engine thrust level. The activation test firings will 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.

The initial J-2X testing will utilize 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 and 200K SL thrust levels (no dynamic throttling).

Phase II will consist of dynamic throttling of 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.

During this reporting period, six mainstage tests were conducted as follows:

a. Two tests at 700 p.s.i. chamber pressure and 4.5 and 5.5 mixture ratios.

b. Two tests at 785 p.s.i. chamber pressure and 5.0 and 5.5 mixture ratios.

c. Two tests at 70 p.s.i. chamber pressure and 5.5 mixture ratio.

The total mainstage test time was 76 seconds. The two tests at 70 p.s.i. chambers pressure exhibited very low

frequency instability (1.5 cycles/sec), however, there was no hardware damage.

At present, a new linear plug for the lox throttle valve is being manufactured. In approximately two weeks, this modification should be completed and static throttling tests will begin.

3. J-2 Engine Telescoping Nozzle

Requestor: 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 will utilize a working mock-up (non-flight hardware) to evaluate the design proposal.

The assembly of the pneumatic actuation system has been completed.

Preliminary checkout of the test hardware, test fixture, and test procedure will be with motion picture film coverage only. Preliminary checkouts should be completed by 8/18/67. Testing will follow immediately.

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.

Two tests, C-004-12 and C004-13, were conducted during this period. The tests were performed to evaluate the Giannini and E.O.S. mass gages. The Whittaker, S-IC lox vent valve was tested concurrently with the mass gages. This valve was tested in support of the S-II structural test. The valve operated properly at liquid hydrogen temperatures. Although the closed microswitch operated at ambient temperatures during pretest checks it would not operate at low temperatures. A Parker S-IC lox vent valve will be tested in the same location (LH_2 slosh tank venturi vent line). One or two more tests will be required in this series and will be conducted in August.

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.

A series of tests were conducted on the Phase IV, Saturn V/S-IVB APS module oxidizer bladder during the period of July 11 - 24 to determine the effect of various tank ullage pressures on gas bubble formation in the bladder. Blanket pressures of 80, 100, and 150 p.s.i.a. were utilized. X-rays of the tank assembly indicated a small amount of gas accumulation at the 100 and 150 p.s.i.a. pressure levels, and a considerably larger amount at the 80 p.s.i.a. level. The subject module is now being modified to facilitate gas removal using Douglas ground support equipment. Gas removal tests are scheduled during the month of August.

C-1 engine S/N 812 was tested in the small altitude cell during the week of July 24 - 28 to ascertain the size of the inlet orifices used in the C-1 engines previously tested in the Saturn V/S-IVB APS module. Test data indicated that the proper size orifices were used.

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 sybsystem 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 under the normal test program were resumed on July 10, 1967. The vehicle simulator was modified to allow these tests to be conducted under the new stacking tolerances. It was found that the umbilical carrier would not connect to the vehicle when the simulator was in the "high" vehicle condition. Connection can be accomplished with all other conditions. These tests are still in progress.

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.

During this reporting period the prototype lanyard guide was tested and found to be satisfactory. All flight umbilicals were tested and the test program was completed on July 24, 1967.

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 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.

Preliminary umbilical withdrawal tests are being conducted on a further revised lanyard withdrawal system. These tests are to determine the operating pressures and cable adjustments required for the system operation. A revised lox coupler withdrawal system has been installed and preliminary tests are being conducted. This system is designed to reduce the withdrawal cable loads.

The modified lox line, reported in last months progress report, failed the cold shock test. The inner bellows was permanently distorted during this test. The probable cause was the line was restrained at both ends and did not allow the line to properly expand during the pressurization.

Another line is presently being modified and will be subjected to the hydrostat and cold shock tests; however, only one end of the line will be restrained for these tests. For further information concerning this lox line failure, see memorandum R-TEST-CF-55-67.

After the lox line has completed the cold shock, it will be delivered to P&VE Laboratory for vibration and flex cycling tests.

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 to correct the problems reported in the last report have been accomplished with prototype carrier plate arresting bungee cord and foot control lanyard. Production type hardware is expected from KSC Design in the near future. Kickoff and withdrawal tests were resumed July 17, 1967, and continued through July 31, 1967.

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. The arm rotation tests were rerun

at a primary pressure of 2,300-2,450 p.s.i.g. and the retraction time under no-wind conditions was increased to 4.0-4.1 seconds, in accordance wtih design criteria.

Umbilical carrier disconnect and withdrawal tests were continued, but the spike loads in the primary lanyard were higher than had been encountered before. A 75M08416-1 Parker-Hannifin shock accumulator was teed into the rod-end supply to the hydraulic withdrawal cylinder, and the spike load was reduced considerably with a 1,000 p.s.i.g. precharge in the accumulator. The accumulator was replaced by a Greer 30A one-quart accumulator, which was precharged to 1,200 p.s.i.g. The initial results looked promising, but continued testing revealed that the spike load was still reaching higher values than the 2,500 pound allowable load.

The hydraulic cylinder was then bled again, and this operation revealed that there was still air in the system. After the bleeding operation, test results showed the initial spike load had almost disappeared. Approximately 54 disconnect and withdrawal tests have since been conducted, and the highest load so far has been 2,250 pounds.

In conformance with a DAC/P&VE request, eight strain gauges were installed on the umbilical carrier disconnect lever stops to determine the loads being induced in the carrier during disconnect. Initial tests have indicated that the loads are not large enough to cause concern; 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 LH_2 venting services to the S-IVB stage and to the instrument unit (IU). The arm also supports the Lunar Excursion Module (LEM) umbilical carrier.

The "T" head tracking tests have been successfull completed, with only minor problems (see June Progress Report).

A GN_2 purge of approximately 1 p.s.i.g. was applied to the LEM withdrawal air motor, and six disconnects of the LEM carrier were conducted to check out the system. These tests showed the system to operate satisfactorily with the purge in operation.

Disconnect and withdrawal tests are presently in progress, with full systems tests scheduled to begin the first week of August.

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 reporting period, arm retraction tests, with and without wind, and tracking tests at 99.9% wind were completed.

It was determined during slow vehicle simulator lift-offs that the primary withdrawal lanyard was too long to permit cam-off of the umbilical carrier. The necessary lanyard length was determined by tracking tests. However, the electrical cables on slow lift-off became taut before the primary withdrawal lanyard. This problem is being investigated.

The new carrier withdrawal air motor that was installed would not function properly. It was determined that the rotor end-plates were seizing the rotor. By grinding 0.010 inches off of the rotor, the problem was alleviated and the air motor is now functioning properly. Withdrawal times will be checked during the next reporting period.

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 reworked to the new configuration and tested. The period of testing is not known at the present time. Currently the arm is in standby condition.

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 Laboratory to qualify the system prior to its use on LC-39.

The local control console, winch control console, and the kickoff panel were received by Test Laboratory on July 7, 1967. The kickoff cylinders were received on July 11, 1967. Each item was installed on the day that it was received.

All testing, which is necessary prior to use of the local control console and redundant hoist at KSC, was completed on July 20, 1967. The assemblies were removed and transferred to ME Laboratory for refurbishment on July 24 and 25, 1967.

In addition to the above mentioned tests, special impact tests were run in order to determine the effects of motion and position of the LES tower on loading. A modification to the hydraulic extend system which consisted of a 300-p.s.i. relief valve upstream of the damping circuit, was installed and tested. Test results showed only a slight decrease in loads on the LES tower because of the mod. R-P&VE has decided to remove this modification.

Delivery of the ML-2 redundant hoist and console to Test Laboratory is presently scheduled for August 14, 1967. Testing will resume at that time.

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

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 now in progress for special tests to be conducted for KSC and for 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 TSM's. These tests will be conducted August 10, 1967 to August 28, 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 prepared and 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: "Nondestructive Testing of Saturn V Holddown Arm Base Castings, 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 will be completed during the next report period and will entail reboring the upper link pivot hole for matched alighment. Load testing of arms 004 and 006 will be continued when they are released by R-ME.

Present plans for further testing of the holddown arms include installation (on arm 003) and testing of a hood for vehicle engine exhaust blast protection. Hood installation is 90% completed; instrumentation will commence July 31, and testing will be completed during the next reporting period. Subsequent to this test, arm 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 liftoff switch actuator arms can signal initiation

of the umbilical disconnect and service arm rotation at the required vertical distance of vehicle lift-off.

Testing on a modified primary actuator assembly was completed 7-14-67. A report is being prepared.

6. 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. A report is being written to cover the original valve.

(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-SS with two pipe sections to determine the strength of welding in relationship to pipe. Testing was completed July 19, 1967. The report has been written and submitted for approval.

c. Von Accumulator Test - This test was conducted with two accumulators (for KSC (MG) and R-TEST-RT) to determine if they could withstand a 24-hour pneumatic and hydraulic pressurization test. Testing was completed June 7, 1967. Test report has been written and submitted for approval.

7. S-IVB Aft Withdrawal Cylinder Life Cycle Test

The purpose of this test program, for KSC, is 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, has successfully completed 1,282,000 cycles including a 72-hour continuous period. The life cycle test report is being prepared. Test reports for cylinders S/N 1, 2, and 3, and S/N 4, 5, and 6 were approved. The report on S/N 7, 8, and 9 has been submitted for approval.

8. Flush and Purge Truck

This test program is being conducted (for P&VE) to ensure that the truck will 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 has requested additional testing with minor modifications to the unit to determine if increased outputs can be achieved.

The additional testing is completed with one exception. An environmental test is to be performed on the 35-gallon unit by August 25, 1967. Refurbishment of the unit is in progress and the truck will be released to P&VE (less the 35-gallon unit) by August 8, 1967.

9. Hydrogen Embrittlement Test

The purpose of this test program is to determine the hydrogen embrittlement effects of gaseous hydrogen on the yeild 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 nilductility transition temperature,elongation of the material, change in cross-sectional area, and radiographic and fractographic analysis of the fracture surfaces.

Buildup for this test is 98% complete. The test procedure is being reviewed. Tail service mast priority has delayed testing. Testing is scheduled to begin during the next report period.

10. 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 a one LH_2, were to be hydrostatically proof tested and therm shock tested.

One line (S/N 6) was completed 7-15-67. Perma deformation occurred, it is believed, because the end flan were restrained. Another line is being fabricated and wil be tested by 8-11-67 without restraining the end flanges. test report for line S/N 6 has been submitted for approval.

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.

Five tests were conducted this month. These tests completed the series of tests on the residual and boost slosh test packages. Fifty-three tests have been conducted to stud residual slosh and 51 tests have been conducted for the boost slosh program. More drops are scheduled for the month of August.

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 covering tests C-035-21 through C-035-38 was distributed to R-AS on July 21, 1967.

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.

30Inch Calorimeter: The calorimeter is being inspecte for a pin hole leak. Testing will resume the latter part of August.

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 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.

There was no test activity during this report period. Estimated test completion date is November 7, 1967.

F. Combustion Dynamics

Requestor: 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 conducted 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 October 1, 1967. Test Position 115 is undergoing scheduled annual preventive maintenance.

G. Pump Inducer Development Project

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 test facility is in a standby condition, and the project is dormant. A memorandum report, requested by P&VE-PAC, on hubless inducer and LH_2 high-speed inducer tests is being written.

H. Acoustic Studies

Requestor: 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 nonexistent. 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 staged 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).

No tests were conducted at the AMTF during this reporting period. Maintenance of facility components was completed and the facility will be ready for testing during the first week of August, 1967. At this time, testing to complete the pressure ratio study will resume. Four tests remain to complete this phase.

I. Flame Study

Requestor: 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.

The test facility, T.P. 107, is being refurbished and the hardware, valves, filters and flex lines are being cleaned and serviced. The facility should be readied for continued testing by 8-8-67. Test facility schematic is being updated, and test procedure is being reviewed.

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

Requestor: 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 or 156-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 will be 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 will be conducted using the Basic Saturn V Booster scale model and will serve to establish baseline data. Phase II tests will use the same scale model booster but with the uprated F-1 engines. Phase III will utilize 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.

Baseline testing of the lower portion covers liftoff from 0 to 232 feet full scale and the upper portion covers liftoff from 212 feet to 454 feet full scale.

Six tests were conducted during this report period completing Phase I baseline testing. Three tests were conducted simulating the case #5 - 1.25 yaw bias lift off, two tests simulated the maximum drift with minimum tower clearance and one test was conducted simulating Case #5 - 1.25 yaw bias lift off from 342 feet to 574 feet.

The test cell is now being modified for Phase III testing. It is planned to first fire the liquid rockets in the 45° rotated position initially and then insert the solid rocket motors for strap-on testing. Presently, the schedule calls for Phase III checkout tests the week of August 7, 1967.

K. Tektite Study

Requestor: 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.

No tests have been conducted during this reporting period. Testing is scheduled to resume in August 1967, on a non-interference basis.

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.

Eight tests, C-043-19 through C-043-26, were conducted on the condensation model, with the results being within an acceptable range of that calculated from the analytical model. This completes testing in the horizontal position with the condensation model, and testing will resume during August with the model in a vertical position.

Assembly is approximately 40 percent complete on the 1/8 segment, and testing is now scheduled for the latter part of August 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 cyrogenic insulation in a habitation environment.

Four 5-mil and three 3-mil aluminum covered polyurethane insulation samples were tested in a 100 percent gaseous oxygen environment (Tests C-045-23 through 32). A test tank pressure of 5 - 6 p.s.i.a. under flow conditions and a vacuum chamber pressure of 25 mm Hg. were maintained during each test. A velocity at the sample center of 175 ft/min was obtained using an electric blower. Ignition was accomplished using a nichrome wire.

Two inch diameter circular exposures were used on all samples tested. Burn areas approximately 4 and 4.5 inches in diameter were obtained on the 5-mil and 3-mil samples respectively.

Further testing of the 3-mil aluminum covered 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
JULY 1, 1967 through JULY 31, 1967

I. SATURN IB

a. Transportation of Stages

It was determined that the instrumentation for ATM land movements will be by R-TEST-ICA and the instrumentation by air will be by specialized testing (Mr. Friezner). Transducers will be compatible for both efforts. A visit was made to Raven Industries, Sioux Falls, South Dakota, to investigate fiberglass as a material for the ATM container. The information gathered is being studied and decision will be reached by August 1, 1967 to determine whether a flexible or rigid material will be used as a cover.

b. S-IB Testing

Fabricated or repaired; flame deflector, thirteen blind flanges, and continued shop support.

c. S-IVB Testing

Supported testing of S-IVB Stage, Saturn V. Dynamic Stand Test, LH_2 Slosh Testing, F-1 Engine Static Firing, J-2x Thrust Chamber with high pressure gases, high pressure industrial water, and recharging of the gaseous hydrogen system. Also continued construction of the hydrogen gas transmission system.

II. SATURN V

a. S-1C Stage Testing

Design modifications were completed on the S-1C Saturn Test Facility prior to firing.

Modified or repaired the following projects, prior to S-1C firing; LOX Vent Piping, Ground Hydraulic System, Lift-off Switch Brackets, Five MPSI Line, Engine Leaks, Deflector, Forward Handling Ring, LOX to LN_2 Conv. Tank #2,

Orifice Plates, S-1C Handling Ring. Tested S-1C Handling Ring and shipped to MTF.

Continued support of Super Insulation Facility, 501 Facility, 36"x 48" Vacuum Chamber, Flanges for machining O' Ring Groove, Gaseous Hydrogen Pressure Vessels, Acoustical Facility, Helium Compressor Piping, Removable Top and Access Platform on Vertical Tank at Cell 112.

b. Component Testing

The Zero Gravity Drop Facility access platform at elevation 351.48 was modified to facilitate installation of instruments in the drop tube.

c. S-II Stage

The design was continued on the buildup for the S-II Structural Test Specimen and reached an overall completion of approximately 90%. The loads for testing the LH_2 fill and drain have not been determined by P&VE. An analysis was made on the vertical GH Bottles and it was determined that 2% TNT explosion blast could be withstood.

An excess property subcooler was checked out for possible use in the S-II Structural Test Program.

Fabrication continued on the S-II Tower structure; foundation base plates, inspection walkway GH_2 storage, saddle adaptors for 28,000 gallon LOX tank, ring "Skirt", and moved the Paul Liquid Hydrogen Recharger from CTL 300 back to Hydrogen Hill.

Modified and fabricated; existing 2500 KG calibrators, electronic chassis, flow meters housing,and installed safety stands for Saturn Instrumentation.

d. GSE Testing

The operational tests were performed on the H7-25 frame assembly aft hoisting equipment designed by NAA.

Design was completed on mounting the Saturn V lift-off control switches in the S-1C stand to check vibration effects under firing conditions.

Continued support for; Straza Duct modification and Arm Weldment lift-off switch for module service arm.

Technical monitoring of the Barge "Orion" modification by Diamond Manufacturing Company in Savannah, Georgia is continuing. The modification is scheduled for completion on September 1, 1967.

Design, documentation and checking is in progress on the following projects: "As built" drawings of the MTF Shuttle Barges, S-1C Engine Extension Trailers, Marine tie down for empty S-1C transporter, and S-1C transporter drawings and manual.

Additional design and documentation is being prepared for Saturn V Damper system shipments on the Super Guppy.

The second S-1C Fin and Fairing Trailer was completed and shipped to Mich. for use by TBC

Supported testing at the GSE Test Area with LN_2 and high pressure gases.

III. SUPPORTING RESEARCH AND TECHNOLOGY

a. In-house applied research and development

Design is continuing on the installation of a LH_2 Mass Flow Calibration System, and up-rating of the J-2 Engine Test Position at Cell 500.

Design has been started on an Ion Gage Calibration System for use in the Instrumentation Development Building, also on the replacement of the Pneumatic Thrust Spheres in the Drop Capsule at the S-1B Dynamic Facility.

Supported tests at Cell "A", Cell 117, and other offices and Labs with high pressure gases, LH_2, RP-1 Fuel, and industrial water pressure.

IV. MISCELLANEOUS

a. Apollo Telescope Mount

Design is continuing on the transportation equipment required for ATM and the RACK transportation equipment.

b. 30 M Lunar Drill

Fabrication continued on the nitrogen compressor Lunar Drill Concept 1.

c. Others

Refinished Norwalk Air Compressor Cylinder.

A feasibility study has been started on cold flowing the GTM in the S-II Structural Test Facility.

Facility buildup and modifications continued in the following areas: Helium Compressor Facility, Air Compressor Station bldg. 4647, West Area High Pressure Industrial Water Systems, additions to Cryogenic Storage, S-1C Test Stand Area, Gaseous Hydrogen System.

Julian S. Hamilton

Julian S. Hamilton

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

I. FACILITIES

A. R&A Projects

1. Additions to Cryogenic Storage - Project 7072 - The foundation for the LH_2 transfer control building is complete. Construction of the building is 80% complete. BOD from MSI is scheduled for August 18, 1967.

Installation of electrical, instrumentation and control conduits is progressing on schedule.

Construction of concrete pipe supports is progressing on schedule.

Construction of the entire project is approximately 55% complete.

2. S-II Structural Test Pad - Project 7076 - Excavation for the S-II pad was completed and erection of forms was started. Grading for the site of the terminal building was completed. BOD of pad is scheduled for Sept. 11, 1967.

3. S-II Aft Section Test Assembly Special Requirements - The civil and structural design was completed July 25, 1967.

4. Design is underway for the Installation of Steam Ejector System, Building 4557, Project 8008.

5. Project 8004, Helium Line Extension to Building 4650 has been deferred at the 30% design stage pending resolution of funding.

6. Project 8003 - High Pressure Air Pipeline - F&DO is taking definite steps to obtain funding and is writing new justification.

7. Construction is underway on the following projects:

a.	Project 7008 - Additional LOX Storage for All Test Positions, Building 4583	- 41% complete
b.	Project 7009 - Firex System Addition, Test Stand 115	- 59% complete
c.	Project 7013 - Elevator for Test Stand 500	- 27% complete
d.	Project 7018 - Transformer Substation Test Stand 500	- 75% complete
e.	Project 7021 - GH_2 Transmission System	- 27% complete
f.	Project 7023 - GN_2 Pipeline System	- 27% complete
g.	Project 7031 - Modifications to Provide LH_2 Service, TS 300	- 27% complete
h.	Project 6742 - GN_2 Connector Line	- 0% complete
i.	Project 7058 - Extension of Steam Line to S-IV B Test Stand	- 3% complete
j.	Project 7066 - Timber Clearing, West Area, FY 67 Landscaping, Part II	- 30% complete
k.	Project for Fire Detection System	- 0% complete
l.	Project for Landscaping Dodd Road, FY 67 Part I	- 0% complete

8. Beneficial occupancy was accepted on the following:

Project 6255 - Pavement Addition, Building 4653, July 28, 1967

Project 66-35 - Elevator at Liquid Hydrogen Test Stand, July.

Project 7056 - LOX Trailer Parking Area, July 28.

Cable Trays and Cable Installation, East Test Area

B. ENVIRONMENTAL TEST COMPLEX

Presentation material covering the Preliminary Conceptual Study of Environmental Test Complex is complete.

Funds in the amount of $50,000 have been received at MSFC. Study will be initiated with an A&E firm aimed at solutions to the test facility requirements for the Voyager 1973 mission and providing a stronger justification for large thermo/vacuum facilities at MSFC.

C. STORABLE PROPELLANTS TEST FACILITY

Preparation of budget drawings have been initiated. A Scope of Work for a PER has been completed. A budget write-up has been prepared and is being reviewed. Fifty thousand dollars has been received for a PER.

D. NUCLEAR GROUND TEST MODULE:

Funding requirements for first and third quarters of FY 68 have been forwarded to Mr. Connel of P&VE.

Basic site drawings are being revised to indicate the structural test position in the West Test Area.

A position paper is being prepared for approval by Center Management in order to accomplish the necessary modifications to facilities in the West Test Area.

for J. B. Carrington

Karl L. Heimburg

Karl L. Heimburg

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