TEST LABORATORY

MONTHLY

PROGRESS REPORT

October 1, 1967 through October 31, 1967

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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Karl L. Heimburg

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

A. S-1B Stage

Stage S-1B-11 arrived at Redstone dock on October 27, 1967. Installation in the test stand was postponed (through October 31, 1967), by adverse weather conditions. Test procedures have been updated for stage S-1B-11 and refurbishment of the MSFC Static Test Tower East was accomplished.

A special test was conducted with a flight configuration fill and drain valve installed in the RP-1 transfer system. The purpose of the test was to determine if unintentional valve closure under full flow condition could have dislodged the liner of a similar valve during loading of S-1B-9 at the Static Test Tower East. The test simulated the most severe conditions a similar stage valve could experience in a loading operation. The valve passed the test in all respects.

B. H-1 Engine

On October 2, 1967, test P1-518 was performed at the Power Plant Test Stand, completing the bomb instability test series at MSFC. Engine H-4067 was removed from the test stand on October 3, 1967, and shipped to Neosho (Rocketdyne) for continued testing on their facilities.

C. S-IVB Stage

Due to contractor slippage in refurbishment of the Beta III Test Stand at the Sacramento Test Center (SACTO), installation of S-IVB-206 for stand/stage interface checks was rescheduled from mid-October to about mid-November 1967.

II. SATURN V

A. S-1C Stage

The Byron Jackson LOX pump seal test, requested by Kennedy Space Center (KSC), was completed on October 9, 1967. The purpose of the test was to qualify the seal for the 1000 g.p.m. LOX transfer pumps used at KSC.

The prevalve timing test, requested by Boeing, was conducted at ambient and cryogenic conditions, with and without accumulators, on October 10 and 13, 1967. The purpose of the test was to see if the

accumulator bottles could be completely eliminated. The test results revealed that the S-IC-T valve timing was insignificantly slower without the accumulators.

The delivery of the S-IC-6 stage to the Mississippi Test Facility (MTF) has been delayed indefinitely due to schedule changes. Preparations are being made to install S-IC-D in the MTF Test Stand, Position B-2, for full-scale fuel drain tests to evaluate the redesigned anti-vortex assembly.

B. F-1 Engine

Tests FW-071 and FW-072 were conducted at the MSFC West Area F-1 Test Stand with F-1 engine S/N F-5038-1 on October 19 and October 26, 1967, respectively. Both tests were terminated by the S-IC LOX low level cutoff sensors as planned. Primary purpose of these tests was to evaluate engine performance during LOX depletion utilizing GOX pressurization. An evaluation is also being conducted on the thrust vector control system with modified Hydraulic Research actuator springs.

C. S-II Stage

1. S-II-3

The S-II-3 flight stage remains in the A-1 Test Stand at MTF undergoing post-static checkout and modifications. The certificate of acceptance has been signed off following a data review of the September 27, 1967, acceptance static firing. Resulting squawks are being evaluated and worked off by the contractor.

Completion of insulation repairs is being impacted by recently approved modifications which are being made on the LH_2 recirculation system insulation (ECP 4631) and the LH_2 elbow feed duct purge system (ECP 4960). Installation of additional vent manifolds in the sidewall insulation (ECP 4897) will be performed in the MTF Vertical Checkout Building, which will delay the scheduled November 20, 1967, ship date to KSC.

The S-II stage manager decided to retain the present LH_2 prevalves on the stage in lieu of changing to a slightly modified version.

2. S-II Structural Test Program

All facets of the S-II Structural Test Program are progressing on schedule.

Stage structural test specimen delivery to R-TEST is scheduled for March 25, 1968.

D. S-IVB Stage

1. S-IVB-505 (New)

A satisfactory acceptance test of S-IVB-505N occurred at SACTO on October 12, 1967. The duration of the test was 448 seconds mainstage. The O_2/H_2 burner also performed satisfactorily as exhibited by a 191 seconds duration firing. S-IVB-505N will undergo an abbreviated post-static checkout and then be placed in storage at SACTO.

2. S-IVB-BS-2000

Two prevalve response time tests were conducted at the MSFC S-IVB Battleship Test Stand. These tests are being conducted because of excessively long prevalve opening times noted during flight stage S-IVB acceptance testing. Existing conditions and dates for these tests are given in the table below:

Date Of Test	Conditions
October 6, 1967	The Sterer actuation control module and flight length lines were used. Vent port check valves were installed in the actuation control module and prevalve restrictors were installed in the prevalves. Actuation pressure was supplied by the stage pneumatic system. Response times were obtained under ambient and cryogenic conditions.
October 25, 1967	The conditions were the same as in the above test except that the actuation pressure was supplied by a facility source. This was done to get a high actuation pressure of 600 p.s.i.g. Response times were obtained under ambient and cryogenic conditions.

The following tests of the O_2/H_2 burner system were conducted at the MSFC S-IVB Battleship Test Stand:

Test No.	Date	Duration	Remarks
SIVB-H06	Oct. 4, 1967	250 Sec.	Normal mission profile repressurization.
SIVB-H07	Oct. 6, 1967	249 Sec.	Start with high LOX supply pressure.
SIVB-H08	Oct. 10, 1967	250 Sec.	Simulated LOX tank pressurization control module regulator failure.
SIVB-H09	Oct. 20, 1967	250 Sec.	One igniter start, propellant supply conditions in middle of start box.

Test No.	Date	Duration	Remarks
SIVB-H10	Oct. 30, 1967	250 Sec.	One igniter start, propellant supply conditions in cold corner of start box.

In all tests the O_2/H_2 burner re-pressurization systems were used to pressurize the S-IVB Battleship propellant tanks. All objectives were met and operation of the burner systems was satisfactory.

III. APOLLO APPLICATIONS

A. Lunar Drill Program

1. Rotary Concept

The status of this concept is the same as reported last month. The funding situation has not permitted awarding of a contract with Westinghouse Electric Corporation.

2. Percussive Concept

Testing was initiated on the nitrogen compressor designed by Northrop under the present contract. The hammer design by Northrop has been released to the shop with a scheduled delivery date of November 20, 1967. Testing was also initiated on a drill string specimen supplied by Avico Corporation.

B. Mobility Test Article (MTA)

The Brown Engineering Company vehicle was received in Test Laboratory and is being stored in Building 4649. The vehicle requires refurbishment which will be accomplished by Brown Engineering Company personnel under the direction of R-P&VE. This vehicle will be subjected to the same tests as the General Motors (GM) and Bendix vehicles. The GM and Bendix vehicles were operated from the Chase vehicle power supply. R-TEST-F has initiated action for the test course construction west of the West Area Blockhouse.

C. Apollo Telescope Mount (ATM)

No test activity. R-ASTR is presently redesigning the solar panels and test fixtures to meet new requirements.

D. S-IVB Orbital Workshop

A cost estimate and preliminary schedule for use of the S-IVB-500F stage as a ground test article was prepared as requested by R-P&VE-X. The general test plan prepared by McDonnel Douglas Corporation is being revised by the contractor as directed by R-P&VE-X.

IV VEHICLE STORAGE PROGRAM

Five meetings of the R&DO Stage Storage Committee were held o resolve and discuss outstanding action items.

The following stage contractor storage plans were reviewed, valuated, and comments were forwarded to the respective Industrial perations stage offices.

a. S-IB Storage Plan dated August 31, 1967.

b. S-IVB Storage Plan dated August 1967.

c. I.U. Storage Plan No. 7915953 dated October 5, 1967.

Rough drafts of MSFC Standards for storage of each Saturn stage were distributed to the committee for review and comments. Updated drafts of these standards are being prepared at this time.

Daniel H. Driscoll, Jr.

GEORGE C. MARSHALL SPACE FLIGHT CENTER
TEST LABORATORY
MONTHLY PROGRESS REPORT
COMPONENTS & SUBSYSTEMS DIVISION
October 1, 1967 through October 31, 1967

I. SATURN IB

A. Ground Support Equipment

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

During testing of the LC-34 access arm, modifications were incorporated on the Environmental Chamber Adaptor Positioning Device (APD) to improve the functional capabilities of the APD centering and lifting operations. The mods were performed from Oct. 11 to Oct. 16, 1967.

Final systems tests were completed after incorporation of the mod kits. These tests were run between October 16 and October 20, 1967, and the equipment proved satisfactory in its operation. The access arm is capable of performing its intended function on LC-34 as prescribed by the Test Plan (CF-28-67). The access arm environmental chamber (EC) was shipped to KSC on October 23, 1967. The arm truss and actuator has not been shipped as yet because of funding limitations. However, this equipment will be shipped as soon as funds are available.

The test facility is now being reworked to test the LC-37 access arm. This involves relocating the tower pedestal and re-routing hydraulic and pneumatic lines.

Prior to installation of the LC-37 hardware in the test facility, the same mod kits that were installed on the LC-34 EC must be installed on the LC-37 EC. The mod kits have not been received from KSC as yet, however.

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.

R&D 6+6 Turbopump S/N 4072224 has been installed and instrumented. Testing is scheduled to start approximately the middle of November.

S-IC 17-inch Whittaker LOX prevalve S/N 104 has been removed from the test stand and sent to P&VE for vibrational tests. S-IC 17-inch lox flowmeter S/N WE17-35 will be tested when another prevalve is made available or when this prevalve is returned.

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 and Saturn V flight vehicle.

Facility buildup is in progress. The planned test start date is January 8, 1968. Program completion date has been set at April 5, 1968.

3. S-IC Helium Bottle Proof and Burst Test

Requester: R-P&VE-PMD

This program was requested by P&VE to determine if age has any effect on the He bottle structure after repeated cycles of pressurizing have been recorded. The general objectives of the test program are to determine the permanent volumetric increase of the bottle after pressurizing to 3940

psig (ambient proof) and to determine the ambient burst pressure of the bottle.

An S-IC helium storage bottle, 20M02008, S/N 0003, which has been in service in Test Position 114, CTL since 1963, will be used for this program. At present, a structure to curtain the helium bottle is being fabricated and it is expected that tests will begin during the week of November 20, 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.

Corrections to internal fill system have been completed. The test tank is scheduled to be returned to the test facility November 4, 1967. Testing is scheduled for the week of November 9, 1967.

B-Cell Position 1 - Foam Insulation (7x7 calori

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

Due to program priorities, testing on 7x7 cal meter is not anticipated in the near future. Therefore th program reporting will be discontinued.

B-Cell Position 2 - S-II Insulation 24-inch (rimeter

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

Six tests (C-447-5 through 10) were accompl during this report period. Data analysis indicates a r(of basic performance required.

2. J-2 Engine Ignition - Model Study

Requester: R-P&VE-PAB

To more clearly define potential no-ignition hazard, a series of model tests will be conducted in an altitude chamber during which the J-2 start transient nozzle pressures and the potential ignition sources will be simulated. The plan is to establish supersonic flow of a predetermined mixture of gaseous hydrogen and oxygen in the chamber nozzle and then attempt to ignite it at a location where the turbine exhaust gas enters the J-2 nozzle.

The tests will then be repeated with the ignition source outside the nozzle to simulate an ignition source from the exhaust of an adjacent engine on the S-II stage.

The vacuum pumps were serviced and have been reinstalled and checked out. Facility buildup is underway and the first test will be conducted in mid-November.

C. S-IVB Stage

1. J-2 Turbopump Test

Requester: R-P&VE-PAC

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

The shop, R-TEST-BS, is essentially finished except for a few miscellaneous items to be completed during the buildup phase. The LH_2 stage tank and piping system has been chemically cleaned and reinstallation of the various systems has started. The stage tank vent line is the last item to be cleaned in the LH_2 system and will be completed the first week in November. The stage tank liquid level probe has been installed and is being connected electrically.

The 100,000-gallon LH_2 storage tank activation is complete and is on standby ready for liquid hydrogen.

Target date for checkout tests on T.P. 501 is the third week in December 1967 as reported in the September Progress Report.

2. J-2 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 J-2 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 J-2 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. Contaminated hydraulic fluid caused two tests to be cancelled. Also, Test Position 501 buildup has created a temporary interference.

Testing should resume the first week of November.

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 will utilize a working mockup (non-flight hardware) to evaluate the design proposal.

Testing has verified that counterweight equalization improved nozzle deployment. Tests 202-1 through 202-18 have been completed. Tests 202-10 through 205-15 were unsatisfactory due to data recording tape malfunction. It appears that the frequency of unsatisfactory deployment is increasing. The possible cause is being investigated. Testing will be continued as soon as corrections are made.

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 this report period. Modifications for the S-IC Parker Vent Valve test have been completed and testing is scheduled to begin the first week of November.

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 engine combination pulse mode firings was conducted on the Saturn V/S-IVB APS Module utilizing accumulators at the oxidizer valve inlets of the three Tapco engines. The accumulator bellows were stacked (collapsed) with the application of 225 p.s.i.a. gaseous helium pressure. (Note: The nominal APS system pressure was 195 p.s.i.a.) Even with the completely collapsed bellows, the accumulators damped the system pressure oscillations to ± 20 p.s.i. maximum. In similar tests where accumulators were not used, these oscillations were as high as ± 180 p.s.i. This test series completes the present testing requirements on the APS Module, and no further reporting will be made.

In preparation for the C-1 Engine Acoustic Liner Program, a test was conducted on an unmodified 100-pound thrust engine on October 20. The engine (S/N 774) was fired for 610 pulses of the "most severe" duty cycle. This test supplied engine performance base-line data, and also served to check out the pulsing control network which utilized the RCA 110 computer in the West Area Blockhouse.

Further base-line testing on the unmodified engine, plus testing on an engine with the acoustic liner installed, is scheduled for the month of November.

D. Instrument Unit

1. Extended Life, Qualification Test of IU/ECS First Stage and Gas Bearing Regulators

Requester: R-P&VE-PME

This project was requested by P&VE to perform an extended life, qualification test on IU/ECS first stage regulator (1000 hours) and gas bearing regulator (1500 hours).

At present, the buildup for the first stage regulator is complete, and awaiting availability of test hardware. The buildup for the gas bearing regulator is 95% complete and testing will start during the week of November 15 1967.

E. 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 liftoff 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 (AA-01-03) - This preflight arm supplies the vehicle S-IC stage with lox fill and drain services as well as personnel access to the vehicle. The arm has capabilities to allow automatic reconnection in case of a mission hold or abort.

All reliability tests were completed with satisfactory results. Flight hardware tests were cancelled per instructions from KSC and P&VE. The arm was removed from the tower for refurbishment on October 27, 1967. The test report is now in progress.

b. S-IC Forward (AA-02-03) - This preflight arm supplies the forward end of the S-IC stage with electrical, pneumatic, air conditioning services, and personnel access.

All tests have been completed and the arm removed from the tower on October 30, 1967. Refurbishment is to start immediately.

c. S-II Intermediate (AA-04-02) - This inflig. 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 have been completed and acceptance tests are now in process to verify the operation of the AA-04-02 arm to support vehicle launch. It is planned to retro-fit the lanyard system on AA-04-01 and AA-04-03.

After the R&D phase of testing was completed, a modification kit to retrofit the AS-502 service arm to the lanyard withdrawal system was shipped. There were unresolved problems with the system which were to be corrected during the qualification phase of the test program; however, due to the delivery date, the qualification test program has been reduced.

It appears that these problems will remain unresolved and the service arm may not be qualified to support manned vehicle launches.

The service arm is presently being modified to the documented configuration in preparation for the qualification test phase. The tests should be complete by December 1, 1967.

d. S-II Forward (AA-05-01) - This inflight service arm provides air conditioning, electrical and pneumatic services plus a GH_2 vent system for the S-II stage. All connections to the stage are through a common carrier.

The service arm and associated pneumatic plumbing were modified to accommodate the hardware for the insulation vent cover spring-reel lanyards. Testing of spring-reel lanyard method of removing the insulation vent covers under ambient and icing conditions has been completed. No malfunction in this system was noted.

The tests to determine the minimum pressure needed to retract the service arm in 7.2 seconds under a no wind and a 60 m.p.h. retarding wind condition have been completed.

Qualification testing of the lanyard withdrawal system and associated hardware is still in progress. Systems test dry are completed.

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.

The arm was installed on the tower simulator on March 8, 1967. Testing began on March 16, 1967, and continued until May 15, 1967, at which time the arm was removed from the test area and taken to the S-IC stand for a water flow test.

The arm was reinstalled in the test area on June 15, 1967, and testing was resumed. R&D testing on the lanyard system was completed on August 18, 1967, and the hardware necessary to convert AA-06-02 to the lanyard withdrawal system was then shipped to KSC.

Acceptance testing in accordance with the SK75M24639 (Rev. B) Test Criteria was begun on August 21, 1967. These tests were completed on October 4, 1967.

Eight full systems tests were completed toward the 50 reliability runs before that series was elimi nated by KSC.

The 75M07823-11 hinge line on the LO_2 side of the arm has been replaced, and a new 75M07823-9 LH_2 flex line has been installed in preparation for the system test wet series. These tests are scheduled to begin by November 2, and should be completed by November 8, 1967.

The test program, including two flight hardware series, is scheduled for completion on December 10, 1967.

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.

Testing to determine the effects of various size orifices and lines in two of the charging systems, system test dry, and system test wet were completed during this report period.

Flight carrier tests which were scheduled to start 10-30-67 are being held in abeyance pending delivery of the flight I.U. carrier. Estimated start date for these tests is 11-8-67.

g. Service Module - The service module service 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, full system tests with vehicle oscillation and lift-off, and aiding and retarding wind were conducted and completed. With the completion of full system tests, the arm is considered to be qualified. It was decided by KSC that flight umbilical tests and reliability tests would not be conducted. Since no further testing was required, it was decided in the post-test meeting to remove the arm from the area. This will be accomplished on November 1, 1967.

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.

The environmental chamber was removed on September 20, 1967, and shipped to KSC for modification. The test program will be resumed upon receipt of the modified chamber.

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.

No testing was accomplished during the report period because the DRRS control console was not received from ME Lab. The latest delivery schedule to Test Lab is November 15, 1967.

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. Special tests to obtain data for the AS 501 launch were completed 10-3-67. They included minimum pressure tests, failure mode tests, and change proposals tests.

Additional special tests to determine the ability of the umbilical carrier to disconnect from a four-inch offset were requested 10-6-67. They were completed 10-12-67.

A flash report of the results of special tests is being compiled.

Flight umbilical carrier installation was completed 10-19-67.

A post special tests meeting was held 10-20-67 where KSC decided to delay flight hardware testing until problems were resolved pertaining to HRV-2 (hydraulic return valve number 2) and the lox mast "lox-dome purge" service line.

A special memo (R-TEST-C-69-67) was prepared 10-24-67 and sent to D.D. Buchanan noting HRV-2 problems.

Testing will be resumed after the TSMs are updated to "flight" configuration.

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 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 protective hood.

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. At KSC's request, the cracks were repaired by R-ME and are being load tested by R-TEST-CF. Load testing of arm 002 has been completed and is in progress on Arm 004. Arms 006 and 003 are scheduled for load-test completion during November. Repair of arm 006 was not accepted by R-QUAL; however, this arm is scheduled for load tests per KSC AVO HDA-993.

Testing of the protective hood was completed during the last reporting period, and data transmittal memos (R-TEST-C-63-67 and R-TEST-CF-81-67) have been released. An internal note is in process.

A data transmittal memorandum is being prepared covering the synchronization drop tests of arms 002, 003, 004, and 006.

5. Hydrogen Embrittlement Test

The purpose of this test program is to determine the hydrogen embrittlement effects of gaseous hydrogen on the ultimate strength of various materials being used in high pressure hydrogen containers; to provide comparative data to enable R-P&VE-MM to determine 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 complete. The PAP was submitted August 31, 1967. The SOP has been approved by Safety. Testing is in progress. Thirty GN2 specimens have been fractured Modifications were necessary for micro-switch actuation. These modifications have been completed and testing with air as the specimen fracture medium is being conducted.

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.

Eight tests were conducted during this report period. These tests were conducted with the lox impulse package to study slosh amplification in the S-IVB Lox tank.

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.

Eight tests (C-035-72 through 79) were conducted with 833 pound model weight during this report period. A data transmittal covering the 701 pound model weight tests (C-035-39 through 63) was transmitted on October 12, 1967. The tests on this model are scheduled to be completed in November 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.

105-Inch Diameter Tank - Tests C-012-29, 30, and 31 were conducted on this test specimen during the reporting period. These tests complete the Linde Si 62 insulation test phase. Raw data will be transmitted to P&VE by the second week in November.

30-Inch Calorimeter - The insulated calorimeter was returned from M.E. Laboratory and is being held until personnel are available for testing. These people are now working on the O.W.S. 1/8 segment.

D. Storable Propellant Space Engine Testing

This program was requested by R-P&VE-P to provide support for testing of advanced technology engines.

Test C-042-4 on the Kidde 40-pound thrust monopropellant engine (S/N 001) was conducted on October 10. This engine, which in testing at MSFC in June 1967, had experienced Pc oscillations of ± 10%, had been repacked with finer catalyst granules by the manufacturer prior to the subject test. Maximum Pc oscillations of ± 3% were experienced in this case.

Further testing on the Kidde engine and on a 25-pound thrust Hamilton Standard monopropellant engine will be performed during the next reporting period.

Two 1-pound thrust and two 5-pound thrust beryllium engines (bi-propellant) were received from Rocketdyne on October 31 and will be tested as scheduling permits.

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.

An internal note covering single engine and cluster testing is scheduled for completion the second week of November 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 program has been terminated and a report will be prepared. Completion of this report is scheduled for November 1967. This project will no longer be included in future progres reports.

G. Acoustic Studies (AMTF - Acoustic Model Test Facility)

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 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, MLF (Modified Launch Vehicle) 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 during this reporting period. Testing to determine cluster effects as a function of engine separation distance and cluster diameter (No. 7 above) will resume when scheduling permits.

H. 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.

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.

One test was conducted during this reporting period with the tektite sample located approximately six inches from the engine exit.

One test, scheduled for early November, remains to be conducted to complete the test program.

J. Dynamics and Stability of Motions of a Cable-Connected Spinning Space Station

The purpose of this test program, requested by R-AERO-DD is to determine the stability area of two bodies connected by a cable spinning in space.

The catapult system has been built and checked out by Test Laboratory. With this catapult system the model will be spun up to a pre-determined speed, and then shot into the air. Data will be recorded using 16 mm motion picture cameras. A net will be erected to catch the model.

There will be approximately 100 missions obtained in 10 test periods. Tests utilizing this facility will commence when specific test requirements and space station models are received from R-AERO-DD.

IV. APOLLO APPLICATIONS

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.

The present series of tests on the condensation model have been completed, and this item will not be reported in future progress reports.

Assembly, by M.E. Laboratory, of the 1/8 segment is approximately 97 percent complete. Delivery of the segment is expected during the second week of November, with testing scheduled to start approximately one month from receipt of the segment.

2. Insulation Flammability Study

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

New insulation test samples have been received from R-P&VE-MCA and will be tested during the next reporting period.

W. L. Grafton

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

I. SATURN 1-B

A. S-1B Stage

1. Supported static testing at the Power Plant Test Stand with propellants, high pressure gases and industrial water.

2. Continued miscellaneous shop support for S-1B Test Facility.

3. Design was completed on a modification to the fuel storage for the STTE test position.

4. Design, documentation and checking continues on the S-1B stage tie-down aboard the barge "Orion".

II. SATURN V

A. S-1C Stage

1. Design was started on a modification for a new high pressure bypass arrangement of valves and orifices for the GN2 and H_e systems at the S-1C Test Stand.

2. Supported static testing at the West Area F-1 Engine Test Stand with propellants, high pressure gases and industrial water.

3. A design study to improve the thrust measuring system of the F-1 Engine Test Stand was cancelled. Static checkout of measuring accuracy after correction of an instrumentation wiring discrepancy indicated an accuracy within less than one percent. Subsequent firings have verified this accuracy and therefore the thrust measuring system modification was unnecessary.

B. Transportation

1. The second S-1C forward handling ring manufactured by Progressive Welders, Inc., has been completed except for modifications resulting from the Boeing Company study. These modifications will be made by R-TEST-BS rather than modifying Progressive Welders contract. The other S-1C forward handling rings being manufactured by the Brown Engineering Company are progressing on schedule and should meet delivery schedules easily.

2. Installation of the GN2 pressurization system for the barge "Orion" progressed to 75 percent completion.

3. Work has been started on up-dating of the design drawings on the barge "Orion" to provide "As-built" drawings.

4. Design continued on tie down arrangements for S-1C, S-II and S-1B stages on the barge "Orion".

5. Checking of contractor furnished documentation, manuals and instructions for the barge continues.

C. S-II Stage

1. Modification of the S-II test specimen support and loading system was completed during the month.

2. Design of test fixtures for the LH2 fill and drain system was completed.

3. Design continues on instrumentation junction enclosures for P&VE and it's related environmental control requirements.

4. Design was completed on internal access equipment and hydraulic loading systems.

5. Vacuums have been pulled on three of the twelve LH2 storage tanks at the S-II Structural Test Stand Area.

6. Fabrication continued on the following projects: Forward Load Ring Assembly - 100%; GH2 Storage System - 40%; LH2 Storage System - 20%; Umbilical Panel - 80%; In-board Loading Assembly - 85%; Aft LOX Bulkhead Loading Ring - 40% complete.

D. S-IVB Stage & Aft Interstage

1. Design continued on the requirements for converting the East Area S-IVB Test Position to Flight Stage Testing.

2. Design was completed on the protective covers for the LH2 fill valves and the extension and heat radiation shielding of the emergency escape firepoles at the S-IVB test position.

3. Supported testing with propellants, high pressure gases, and industrial water for the following projects: S-IVB Stage; Auxilliary Propulsion System; LH2 Slosh Testing; J-2X Thrust Chamber; Test Position 502; and the Dynamic Test Stand.

E. G.S.E.

1. Fabricated duct for filter blower, and continued shop support for miscellaneous machine work.

2. Design was completed on the structural support for the S-IVB Aft Swing Arm Tip Assembly to be used to test the new automatic re-connect umbilical system.

3. Supported testing at the GSE test area with LN2 and high pressure gases.

F. Component Testing

1. Design continued on the emergency escape system and critical cryogenic pipe supports at test position 501.

2. Design continued for a full length J-2 engine combustion chamber at test position 501.

G. Other

The following projects progressed to: Vent enclosure for water storage tanks - 95%; Pyro drop tank bulkhead, fabrication due 12-29-67; Build-up of super insulation facility - 75%; Build-up of 501 facility - 95%; Gaseous hydrogen vessels, blocks - 100%, specimens - 70%; Access platforms for Cell 112 & Cell 501 - 100%; Acoustical Test Facility - booster scale model - 95%, complex umbilical tower - 100%, launcher - 75%, deflector & piping - 50%.

H. MTF Support

1. A design study for the conversion of the B-1 test position for the S-1C stage to an acceptance test position for the F-1 engine was completed.

2. Design studies for converting the A-2 position, S-II static test facility to accommodate acceptance test of S-IVB stages were completed.

III. A.A.P.

A. Neutral Buoyancy Facility

Fabrication on the neutral buoyancy facility at ME Lab is 35% complete.

IV. RESERACH AND DEVELOPMENT TECHNOLOGY PROGRAMS

A. LH2 Mass Flow Calibration Facility

Design of the LH2 mass flow calibration was suspended until a final conceptual location could be determined.

B. High Pressure Engine Combustion Facility - Position 300

Design continued on the high flow, high pressure LH2 system for test position 300-CTL.

C. Instrumentation Research & Development

1. Design reached 90% completion on an adapter for the 5 million pound Gilmore Calibrator. Adapter is to be used for tensile testing.

2. Design reached 95% completion on the Ion gage calibration system for use in the Instrumentation Development Building.

D. Low Gravity Test Facility

1. Design was completed on an access platform for inspection and maintenance of the Drag Shield Capsule.

2. Design was begun on an access ladder and catwalk for inspection of the lighting system and guide rails.

3. Design was begun for mounting 3 cubic feet 3,000 psi titanium spheres and accompanying blast protection in the Drag Shield Capsule.

4. Supported the following projects with propellants, high pressure gases and industrial water: Tektite studies (simulated metorite re-entry); Acoustic studies; Improved Saturn V launch facilities.

V. OTHER SIGNIFICANT EFFORT

A. Apollo Telescope Mount

Design was temporarily suspended on the ATM Environmental Capsule and Transporter. Information is lacking from R-ASTR and R-P&VE that would allow reliable procedure.

B. 30 M Lunar Drill

1. Design studies continued on different concepts to apply "percussive energy" to the drill bit. Design was started on the adaptation of a new tungsten carbinde percussive bit to the present drill string drive assemb

2. Continuing shop support for the nitrogen compressor.

C. Multiple Docking Assembly

Transportation requirement studies and preliminary design studies concerning the Multiple Docking Assembly have slowed because of lack of information. An orientation trip was made by two employees to McDonnell at St. Louis for problem and interface clarification.

D. Misc. Design Support

1. Design was completed on a vent system modification for the LH2 trailers.

2. Design was started on: Line from the storage area to the super insulation vacuum chamber at the S-1B Dynamic Test Stand; LOX transfer system from the storage tank at CTL test position 115 to CTL test position 114.

E. Air compressor Station

Work has continued on the problems experienced with the Norwalk compressors in the New Air Compressor Facility. Two compressors are presently in operation.

F. Hydrogen Systems

1. A project was initiated to tie the S-II Structural Gaseous Hydrogen System into the main GH2 Transmission System. An existing GN2 line from the S-IVB Stand to the West Area will be converted to GH2 service.

2. Preparations for the conduct of boil off tests on liquid hydrogen trailers for the Logistics Branch were completed. A successful trail test was conducted on one of the Test Lab's trailers.

3. The Paul Chemical Company hydrogen recharger has been moved from Test Position 500 to the S-IVB Area.

4. The gaseous hydrogen transmission line in the East Area has been completed and is now in service.

5. Specifications were completed for the procurement of seamless high pressure gas storage vessels for hydrogen service.

G. Propellants and Pressurants Support

Supported the following Labs and projects, as required with, propellants, high pressure gases and industrial water: P&VE, ASTR, ME, P&VE Sparkman Drive, AS, QUAL, Test at Cell "B", Super Insulation Testing at Dynamic Test Stand, Helium Liquefication Testing.

J. L. Hamilton

for William E. Marsalis