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TEST LABORATORY

MONTHLY

PROGRESS REPORT

December 1, 1967 through December 31, 1967

GEORGE C. MARSHALL SPACE FLIGHT CENTER
HUNTSVILLE, ALABAMA

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

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TEST LABORATORY MONTHLY PROGRESS

REPORT

December 1, 1967 through December 31, 1967

SYSTEMS TEST DIVISION

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ADVANCED FACILITIES PLANNING OFFICE

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

Test SA-48, a 35.4 second test of Stage S-IB-11, was performed at MSFC on December 19, 1967. The test was terminated by the console operator at expiration of the programmed duration.

Functional performance of all systems was satisfactory. Engine thrust levels, with the exception of engine positions No. 2 (H-7095), No. 4 (H-7102), and No. 6 (H-4093), were within specifications. The engines in positions No. 4 and No. 6, being only slightly out of specification, are being left as is. However, the gas generator LOX control orifice of engine position No. 2 is being examined, as recommended by Michoud Operations, prior to making hardware changes.

Test SA-48 was postponed in order to install special strain gage instrumentation on the stage thrust structure. These measurements were made to obtain data required for structural analysis in preparation for the planned series of combustion instability tests to be performed on the stage prior to the duration acceptance test. The combustion instability tests will involve 'bombing' two R&D engines installed in lieu of the flight engines. Five 15-second tests will be conducted on S-IB-11 for this purpose.

B. H-1 Engine

Engine HT6-B was removed from the MSFC Power Plant Test Stand and engine H-4067A (205K) was installed for a stability verification test. Test P1-522 was made on December 8, for a duration of 15 seconds. The test was made with an injector face bomb, and inboard stiff arms installed. The bomb induced instability dampened within specification limits.

C. S-IVB Stage

Stage S-IVB-206 is presently undergoing repeat post-static checkout on Beta III Test Stand at the Sacramento Test Center (STC). Stage S-IVB-206 is scheduled to be removed from the test stand January 5, 1968, and shipment to KSC is expected to be January 30, 1968.

Preventative maintenance operations are being performed on Beta I Test Stand at STC.

II. SATURN V

A. S-IC Stage

1. S-IC-T

One LOX fill and drain test was made at MSFC on December 14, 1967, to obtain data for evaluating and optimizing KSC LOX loading and bubbling procedures. Additional tests are scheduled to be made in early January 1968.

2. S-IC-D

Fuel tank drain tests were conducted at the Mississippi Test Facility (MTF) on the S-IC-D Stage during December 14 through December 29, 1967. These tests were made using water to obtain data for evaluating the re-designed anti-vortex device. The stage is scheduled to be removed from the test stand on February 2, 1968.

B. F-1 Engine

The West Area F-1 Test Stand was secured to a standby status. Future F-1 engine testing will be limited to critical high priority programs that may be generated as a result of anticipated or actual flight malfunctions.

C. S-II Stage

1. S-II-3

S-II-3 was shipped from MTF to KSC on December 21, 1967. New LOX prevalves and new LH_2 feedlines were installed prior to shipment.

2. S-II-4

S-II-4 is presently installed on Test Stand A-2 undergoing preparations for a LOX/LH_2 tanking test. New propellant prevalves were installed and ECP 4539, "Reduction of Maximum LH_2 Tank Pressure", is being incorporated prior to the tanking test. At present the LOX/LH_2 tanking test is scheduled for January 16, 1968, and the acceptance firing is scheduled for January 24, 1968.

3. S-II Structural Test Program

The facility construction is progressing on schedule for receiving the stage (V7-21) on March 25 and for initiating the structural test activity on May 1, 1968.

D. S-IVB Stage

The J-2S engine S/N J108 was instrumented, and the electrical and mechanical checkouts were completed on December 13, 1967. Two hot firings were conducted at the MSFC Battleship Test Stand during this report period as listed below:

Test No.	Date	Duration, Seconds Idle Mode	Duration, Seconds Mainstage	Remarks
SIVB-047S	12-19-67	1	1.43	Test was scheduled for 1 second idle mode and 15 seconds mainstage but was terminated by an erroneous signal from the "stall approach monitor".
SIVB-048S	12-21-67	1	14	All objectives were met and all parameters appeared normal.

III. APOLLO APPLICATIONS

A. Lunar Drill Program

The Northrop contract (Percussive Concept) has been extended at no cost to the government, for $2\frac{1}{2}$ months. This became necessary to permit Northrop to support the testing and evaluation of components which were delayed in fabrication. The MSFC, which is responsible for the fabrication of these components, has been unable to meet the schedules due to shortage of funds.

B. Mobility Test Article (MTA)

The MTA test courses are approximately completed but due to the weather and program priorities no test activity is expected in the near future.

C. S-IVB Orbital Workshop

Test Laboratory has agreed to conduct tests on the S-IVB Workshop solar panels utilizing the test fixture which is being designed and fabricated for the Apollo Telescope Mount panels.

IV. VEHICLE STORAGE PROGRAM

F&DO has promised completion of the prototype stage storage cover in Building 4708 by January 15, 1968.

R-TEST-ST participated with I-V-SII in a stage storage review at Seal Beach on December 12, 1967, during which the R&DO proposal, to eliminate $4,000,000 of storage costs, was discussed. Space Division (SD) of North American Rockwell Corporation is expected to provide a new proposal based on concepts expressed at this meeting.

The Stage Storage Committee held two meetings this month:

a. On December 18, 1967, to review SD comments on proposed MSFC storage standard.

b. On December 20, 1967, to close out action items generated by December 18 meeting.

The major problem areas developing this month were as follows:

a. Completion of a full scale prototype cover for the S-IB stage -- scheduled for January 15, 1968.

b. Development of a design specification for vehicle desiccant systems for the S-II stage. Areas currently under investigation are the S-IB and S-IVB stage desiccant systems, but there apparently are no MSFC designs or specifications available, and the committee will have to develop them.

Comments on MSFC storage standards have been received from the S-II, S-IVB and S-IB stage contractors; the latter two are under evaluation by the committee at this time.

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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.

The test facility has been prepared for testing the LC-37 configuration access arm. Included in the rework was the relocation of the tower pedestal and rerouting hydraulic and pneumatic lines.

Meanwhile, work was initiated on the environmental chamber to bring it up to the latest configuration. This includes installation of modification to the Adaptor positioning Device (APD) centering and lifting mechanisms and installation of new rollers on the extension platform. Some of the required hardware from KSC has not arrived as yet and therefore, the mod kit completion will be delayed until receipt of this hardware.

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.

There were no tests conducted this report period. Testing of the R&D 6+6 impeller F-1 turbopump S/N 4072224 will resume in January 1968.

The S-IC 17-inch LOX flowmeter S/N WE17-35 will be tested when a Whittaker prevalve is available.

2. LOX Depletion Testing

The purpose of this test program is to support R-TEST-SP and P&VE 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 set at the first of February.

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 p.s.i.g. (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, was used for this program.

The burst test was conducted December 15, 1967, with an approximate burst pressure of 6176 p.s.i. The data are being evaluated and a report will be issued.

B. S-II Stage

1. S-II Insulation

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

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

Testing is complete and the memorandum report for this test program is scheduled for completion on January 5, 1968. This program will not appear in following progress reports.

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

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

Testing is complete and the memorandum report was completed on December 21, 1967. This program will not appear in following progress reports.

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.

Cold Flow Calibration tests were completed during this reported period, and the data obtained is being evaluated. Testing will continue in January 1968.

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, still has several mandatory items to finish but could not work on T.P. 501 during this month. The pump and reworked section of the pump discharge line are now installed. Also the GG control valve and bleeds were installed but not plumbed to the facility or gas generator. The upper section of the S-IVB fuel suction line was collapsed by the cleaning contractor and damaged beyond repair. Another section was obtained from the S-IVB test stand to replace it. Due to the reduction in test stand personnel and lack of shop support, the completion date cannot be predicted at this time.

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 1 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 tap-off 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 tap-off

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 tap-off optimization.

Two static throttling tests at Pc of 250 p.s.i. and 675 p.s.i. were successfully conducted during this reporting period. Static throttling is accomplished by pressurizing the propellant tanks to full mainstage pressures (LOX - 1395 p.s.i., LH_2 - 1460 p.s.i.) and prepositioning throttle valves in the main propellant lines to achieve the desired chamber pressure and mixture ratio.

After an additional static throttling test, dynamic throttling will begin in January 1968.

3. S-IVB LOX Fill and Drain Valve

Requester: R-P&VE-PM

A potential problem for the S-IVB LOX fill and drain system, which can result due to loss of electrical power to the pneumatic solenoid control valves is to be investigated. Fast closure of the fill and drain valve at high flow (1000 gpm) may generate surge pressures that could cause failure of the fill and drain system.

Test Position 114 at CTL is being utilized for this program, because it can be adapted with a minimum of modifications to meet the test requirements.

The test stand modification has been completed, all hardware is available. The S-IVB LOX fill and drain valve has been modified to provide analog data on the valve butterfly position. The completed system has been cleaned and final installation is now in progress. Testing is scheduled to begin in January 1968.

4. LH_2 Slosh Testing

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

No tests were conducted during this period.

D. Instrument Unit

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

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 hrs) and gas bearing regulator (1500 hrs).

The first stage regulator has not been delivered by P&VE. Testing will start when test hardware is available.

To date, 750 hours of test time have been logged for the gas bearing regulator. Testing will continue for the planned total of 1500 hours.

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 lift-off accelerations can be duplicated. In addition, the equipment is exposed to wind, rain, and cryogenic temperatures to include worst case design conditions.

In the test programs, component checkout tests are conducted after installation of the test hardware in the test facility. This phase of the program is followed by subsystem checkouts and subsequently, complete systems tests simulating launch environments. A description of hardware undergoing tests and the results of these tests follows:

1. LC-39 Service Arms

a. S-IC Intertank (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.

The arm was turned over to KSC at MSFC for modifications and refurbishment on December 8, 1967. The test report is now in process.

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.

The arm was turned over to KSC at MSFC for modifications and refurbishment on December 8, 1967. The test report is now in process.

c. S-II Intermediate (AA-04-02) - This inflight service arm provides air conditioning, electrical, pneumatic, LH_2 and lox services to the S-II stage. The lox and LH_2 lines have independent connections to the stage while the remainder of the service lines in the arm are connected to the stage through one common carrier. The AA-04-02 arm was modified at MSFC by installing a lanyard withdrawal system for the main umbilical to replace the dual cylinder withdrawal system used on AA-04-01 and AA-04-03. R&D tests on the lanyard withdrawal system have been completed and acceptance tests are now in process to verify the operation of the AA-04-0 arm to support vehicle launch. It is planned to retrofit the 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 to KSC. 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, KSC directed that the remaining test program be reduced to allow a test completion date of 12-15-67. It is apparent that these problems will remain unresolved when the arm is shipped to KSC for launch support.

Systems test wet is complete. The test program, as defined by the latest KSC direction was completed on December 15, 1967. The arm was removed from the test area on December 19, 1967. The arm is being prepared to be turned over to KSC at MSFC for modifications and refurbishment on January 15, 1968.

The last test condition was a test to check the shear out capability of the ball-lock sockets of the main umbilical and the shear out of the collets on the lox and LH_2 couplings. Because of possible damage to the hardware in running this test each system was run separately. The main umbilical sheared without difficulty. On running the lox coupling shear out test the vehicle skin panel was ripped from the simulator. The load cells between the skin panel and the vehicle simulator, which took most of the load, failed in tension at a force estimated in excess of 20,000 lbs. The LH_2 coupling was tested in a like manner but using a slow lift-off and it was determined that the same thing could happen. P&VE is investigating the problem and additional testing will be done at a later date.

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

Testing of the lanyard withdrawal system and associated hardware is complete. The arm was removed from the test area on November 21, 1967. The arm is being prepared to be turned over to KSC at MSFC for modifications and refurbishment on January 26, 1968. The test report is now in progress.

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.

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.

A series of tests to determine the causes of the arm creep problem was completed on November 28, 1967. This problem, which is associated with the secondary retraction system bleed-down operation, is common to all arms.

The arm was removed from the test area on December 5, 1967. The arm is being prepared to be turned over to KSC at MSFC for modifications and refurbishment on January 15, 1968.

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.

Flight carrier tests were completed on two flight carriers during this report period.

The arm was removed from the test area on December 5, 1967. The arm is being prepared to be turned over to KSC at MSFC for modifications and refurbishment on January 15, 1968.

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.

Testing is completed on the service module arm, S/N AA-08-02, and the final test report is being prepared. The arm was turned over to KSC at MSFC for modifications and refurbishment on December 8, 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. At present Boeing is making modifications to the control system on the arm. The test program will be resumed after these modifications are made.

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.

The control console for the ML-3 damper arm was installed on December 2, 1967. During the adjustment and checkout of the system, an adjustment problem with the

redundant retract system was discovered as follows:

When the redundant retract hoists were adjusted so that the redundant system would fully retract the arm, the fully extended position of the arm was too high; when the carriage was extended to connect to a nominal fueled vehicle, it made contact with the LES tower approximately 12 inches above the stops. This is approximately 8½ inches higher than desired. The adjustment problem was a result of tolerance buildup in the cylinder installation.

By adjusting the redundant hoists for proper arm orientation for first the retract system tests and then the carriage hookup and damping tests, the test program was completed on December 20, 1967. In a meeting on December 21, 1967, attended by R-TEST-C, P&VE, R-QUAL, and ME personnel, it was decided to remove the redundant retract cylinders from the tower, disassemble them, and cut approximately 4 inches off the spacers on the cylinder rod. This would provide enough adjustment to enable the system to function properly from one adjustment. When the redundant retract cylinders are reinstalled in the tower, the full system tests will be repeated to verify system operation.

In addition, the following items will also be installed: (1) a kickoff accumulator, to provide a more positive force to push the retracted arm away from the tower, (2) hook cylinders modified for redundant hook switches, and (3) a replacement winch air motor. These items will be tested during the above series of tests.

The date of test completion will be dependent upon receipt of the modified hook cylinders. Tentative completion date is January 12, 1968.

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 of the set 1, Saturn V TSMs was conducted to assure proper operation of all TSM systems prior to use of the masts in support of vehicle launch at LC-39. Testing was performed under simulated launch conditions.

Testing of the TSMs has been completed with the exception of flight hard-ware testing. Testing of the flight

hardware was discontinued at the request of KSC, 11-22-67, and the TSMs removed from the test area 11-27-67 for refurbishment and shipment to KSC. Shipment was made 12-14-67. A memo report of all special test results has been written and is being reviewed. The final report (internal note) on set 1 testing is being prepared.

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 (explosive) release system (Internal Note-Test-14-67) and protective hood.

During testing of the secondary 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 arms 002, 003, 004, and 006 has been completed. Repair of arm 006 was not accepted by R-QUAL; however, this arm was successfully load tested per KSC AVO HDA-993 and will be ultrasonically and dye-penetrant inspected during the next reporting period. A memo report is being prepared to cover the load tests.

A memorandum report on the protective hood system is in process.

A data transmittal memorandum covering the synchronization drop tests of arms 002, 003, 004, and 006 was released last month.

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. One hundred specimens have been fractured with air, GN_2, or GH_2. The program has been terminated because of the reduction-in-force. A data transmittal memo is being prepared to cover that portion of the program (approximately 20%) which was conducted. This program will be continued if personnel can be made available as other programs are completed.

6. Cryogenic Bottles

The purpose of this test program is to determine if cryoformed 301 stainless steel helium bottles would be suitable for use on Saturn V S-IC stage as possible replacements for the current 2014-T6 aluminum bottles. Four subscale test bottles will be exposed to temperature and pressure requirements specified by R-P&VE.

Facility buildup was in process, and approximately 10% complete, when the program was terminated because of the reduction-in-force.

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 December. Four tests were a continuation of the interface studies of the S-IVB hydrogen tank. The other four tests were to study the effectiveness of screen mesh in preventing vapor pull-through into suction lines as a result of liquid slosh.

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.

Testing is complete. The test data transmittal report and a memorandum report are being prepared. There will be no more reporting of this activity.

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.

Due to the malfunction of the submerged fill and drain valve during Test C-012-31, another series of tests were run to verify or negate the results of this test. Tests C-012-32 through C-012-34 designed to accomplish this were run 18-21 December 1967. However, the fill and drain valve again froze open.

Current plans are to return tank No. 3 to ME Laboratory in January. After removal of this test tank, work will begin on installation of the cold wall in the vacuum chamber.

This completes the present testing requirements on this test tank, and no further reporting will be made.

D. Storable Propellant Space Engine Testing

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

An unmodified C-1 engine was fired through three pulsing cycles totaling 1763 engine starts utilizing gaseous helium saturated propellants at temperatures ranging from 100 to 140°F. Fifteen cases of combustion instability (17,500 cps, ± g rms) were encountered.

A C-1 engine with the acoustic liner (Helmholz resonator) installed was tested through two pulsing sequences of 660 pulses each utilizing saturated propellants at temperatures of 120°F and 140°F. There was no occurrence of the high frequency combustion instability. Further testing is scheduled on the modified engine in which the entire duty cycle of 7028 pulses (814.6 seconds engine burn time) will be conducted.

The standard firing cycle of 21 pulsing steps and one steady state step was conducted on Hamilton Standard 25 pound thrust monopropellant engine (S/N 002) on December 1, 1967. This was the second of two such cycles conducted on this engine, with a resultant total engine burn time of 863.64 seconds. There was no apparent degradation in engine performance, and

the maximum Pc oscillations were of the order of 4-5%. Extended steady state firings are scheduled on this engine in January to determine life burn characteristics.

Each of the tests described herein was conducted at a simulated altitude of 100,000+ feet.

E. 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 nonexistant. Therefore, it is necessary that prediction techniques be developed and verified that will adequately define the associated acoustic environment.

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

Specific programs now planned at the AMTF are:

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

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

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

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

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

(6) Saturn V, 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. Due to the low priority assigned this test program, test schedules cannot be determined. Therefore, this program will not be included in future progress reports until testing is resumed.

F. Improved Saturn V Launch Facilities (VLF-39) Model Stud

Requester: KSC

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

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

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

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

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

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

The first phase was conducted using the Basic Saturn V Booster scale model and has established baseline data. Phase II tests will use the same scale model booster but with the uprated F-1 engines. Phase III is utilizing the basic Saturn V scale model with 120-inch simulated solid motor strap-ons. Phase IV will use the basic Saturn V model with 157-inch simulated Solid Motor Strap-Ons.

No tests were conducted during this report period. Presently a report covering Phase I testing is being compiled and preparations are being made for future tests. The next planned test as part of Phase III will be a maximum drift condition (0-232 ft.), utilizing the existing VLF-39 flame deflector modified by the addition of canted 10-foot side walls, 6° cant angle nozzles on the four solid rockets and a simulation of the booster holddown arms. Tests are to continue in January 1968.

G. 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 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.

The 1/8 segment has been received from M.E. Laboratory and has been installed in the vacuum chamber. Build-up is progressing and testing is scheduled to start the latter part of January 1968.

2. Insulation Flammability Study

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

Thirteen insulation flammability tests (C-045-54 through 66) were conducted at the Redstone vacuum drying facility during this reporting period. Five tests were conducted on the standard 3-foot diameter samples, with 2 and 3 mil aluminum coverings, coated with the thermal coating (potassium silicate - Zinc oxide). Various size circular and semi-circular cuts (2 inches to 6 inches diameter) were made in the covering and the insulation ignited with the test tank pressure maintained at 5/5 p.s.i.a. with 100% GO_2 under flow conditions (9.5 SCFM). In all cases the polyurethane foam insulation burned out approximately one inch past the exposed area.

The other eight tests consisted of burning various size pieces (0.5 in^3 to 10.0 in^3) of the polyurethane foam insulation material in the 35.3 ft^3 tank which was pressurized to approximately 5.5 p.s.i.a. with gaseous oxygen, with the vacuum chamber evacuated to 0.5 p.s.i.a. The typical test procedure for these tests was as follows: (1) Test tank vent valve opened and chamber and test tank evacuated to 0.5 p.s.i.a.; (2) vent valve closed, tank fill valve opened, tank pressurized to 5.5 p.s.i.a. with GO_2, and fill valve closed; (3) cameras and mechanical blower supplying velocity at center of 36-inch flange = 175 ft/min, turned on; (4) nichrome wire igniter, touching foam, turned on until ignition occurred and then turned off. The increase in test tank pressure and temperature due to the known quantity of foam burned was recorded.

Further testing on these type samples is scheduled during the next reporting period.

W. L. Grafton

GEORGE C. MARSHALL SPACE FLIGHT CENTER
TEST LABORATORY
TECHNICAL SUPPORT DIVISION
DECEMBER 1, 1967 through DECEMBER 31, 1967

I. SATURN 1-B

A. S-1B Stage

1. Fabrication of the 6' x 9' vacuum chamber progressed to approximately 40% completion.

2. Supported test at STTE and Power Plant Test Stand with GN_2, GHe, RP-1, and high pressure industrial water.

B. S-IVB Stage

Furnished transporter and personnel to move S-IVB stage from Saturn V Dynamic Stand to Douglas Area south of Bldg. 4619.

II. SATURN V

A. S-1C Stage

1. Fabrication of super insulation facility progressed to approximately 80% completion.

2. Continued build-up of 501 test facility progressed to approximately 95% completion.

3. Continuing fabrication of gaseous hydrogen pressure vessels. Blocks are 100% complete, specimens are 85% complete.

4. Fabrication continued on the 36" x 48" vacuum chamber for familiarization effort, approximately 80% complete.

5. Supported LOX Fill and Drain Test on S-1C Stage with high pressure gases and high pressure industrial water.

6. The steel handling ring that was shipped to the Boeing Company will not be used on flight stages and there-

fore will not undergo the rigorous testing planned for it. It will be tested to the same loads as the aluminum handling rings. The actual time scheduled for the test has not been determined.

7. Design and documentation has been completed for the S-1C Stage Forward Protective Cover to be used with the new steel handling rings.

8. The approval of vendor technical documents and the correcting of documentation drawings on the barge "Orion" continued during this period.

9. Design is in progress for the modification of the "Engine Purge System" at the Saturn Static Test Facility

B. S-II Stage

1. S-II structural stand buildup approximately 65% complete.

a. Wagon wheel and skirt fabrication complete.

b. Axial loading system approximately 70% complete.

c. LOX aft bulkhead outboard load assembly (Shop portion 60% complete).

d. LOX aft bulkhead inboard load assembly, fabrication 100% complete, needs insulation.

e. Aft lox bulkhead load ring, approximately 60% complete.

f. Specimen support ring (Fab. by BECO 90%) scheduled for completion 12/18/67.

g. On stand firex 25% complete.

h. Fabrication on access platforms 30% complete.

2. Cryogenic Piping

a. High pressure GH2 system approximately 95% complete.

b. LH2 system complete, fabrication 60% complete.

c. GH2 vent storage and load approximately 85% complete.

d. GH2 vent lines and recharger fabrication 50% complete.

e. Burn stack fabrication 95% complete.

f. Igniter - 100% complete.

g. Defuser, 20% complete.

h. LN2 fill and drain, fabrication 30% complete.

i. LN2 vent system, fabrication 20% complete.

j. LH2 vaporizer system, fabrication 70% complete.

k. Furnished towing equipment and personnel for transporting the S-II Stage to Bldg. 4755.

3. Supported S-II - IV Thrust Structure Test at Bldg. 4619 with high pressure gases and LN2.

4. Work has continued on pulling vacuums on the 12 LH2 storage tanks at the S-II Structural Test Area.

5. The test facility for the S-II Aft Stage Structural Test continued toward completion. Modifications to the various piping systems are being made as testing requirements are revamped. Facility structural changes are being made to accomodate test requirement changes and fabrication tolerances. Design was started on a weather

protection cover for the test specimen when in the test facility.

6. GSE - Continuing shop support.

7. Supported test at the S-IVB Facility, GSE Area, and J-2X (502) with high pressure gases, high pressure industrial water, and recharging of the gaseous hydrogen system.

III. A.A.P.

A. Neutral Buoyancy Facility

Fabrication on the neutral buoyancy facility at M&ME is approximately 100% complete.

B. Orbital Workshop - GSE

1. Design modification to the clean room at the S-1B Dynamic Stand Vacuum Facility was completed.

2. Design began on the Space Storage Facility for the Orbital Workshop Auxiliary Attitude Control System. Main effort was directed to the handling equipment and module support frame requirements. Vacuum Chamber and related equipment was held up pending higher level decisions concerning usage of existing equipment advocated in earlier proposals.

C. ATM - Transporter

The ATM Transporter work has been resumed with the Brown Engineering Company. R-ASTR has again delayed the promised firm information on the ATM. The new firm information released date to R-TEST-BD is Jan. 15, 1968. The present effort on the ATM deals with pressurization and cleanliness details.

IV. RESEARCH AND DEVELOPMENT TECHNOLOGY PROGRAMS

A. General

Supported APS Module Test at Bldg. 4750, Super Insulation Test, Helium Liquefication Test, Zero G. Drop Test

and Sat. V Dynamic with high pressure gases and propellants as required.

B. Ion Gage Calibration System

Design was completed on the Ion Gage Calibration System to be used by the Instrumentation Development Branch.

C. 30 M Lunar Drill

Design study continued on the application of "Percussive Energy' to the drill bit of the lunar drill.

D. LH2 Mass Flow Calibration and Slush Hydrogen Facility

Design continued on schedule for phase I (Flow Calibration) at the LH2 Mass Flow Calibration and Slush Hydrogen Facility.

E. High Flow - High Pressure LH2 Test Position 300

Design continued on the various piping systems at the High Flow - High Pressure LH2 Test Position 300.

V. OTHER SIGNIFICANT EFFORT

A. Propellant and Pressurants Support

Supported other Offices and Labs with propellants and high pressure gases. Filled 92 GHe K-Bottles at 200 scf each.

B. Compressors

Compressors numbers 2 and 3 in bldg. 4647, new air station, are operational. Compressor number 1 has failed and is being repaired. Compressor number 4 has not been worked on pending information on the warrantee.

C. Saturn V Dynamic Test Facility

Documentation to an as-built status proceeded to 75% completion on the Saturn V Dynamic Test Facility.

D. LH2 Transfer Line at S-1B Dynamic Test Facility

Design continues on a LH2 transfer line from the LH2 storage to the Super Insulation Vacuum Chamber at the S-1B Dynamic Test Facility.

E. LOX Transfer System at Test Positions 114 & 115

Design continues on a LOX transfer system from LOX storage at CTL Test Position 115 to CTL Test Position 114.

William E Marsalis

William E. Marsalis

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

I. FACILITIES

A. R&A Projects

1. Additions to Cryogenic Storage - Project 7072. Work was continued on conversion of the GN_2 line to a GH_2 line. With that exception, only minor items remain to be completed. The entire project is 85 percent complete.

2. S-II Structural Test Pad - Project 7076. Work was continued on electrical items and site work. The entire project is 80 percent complete.

3. S-II Aft Section Test Assembly. Placement of anchor blocks, pipe piers, and cable tray supports was completed. Cables were pulled into place. Work was continued on off-stand firex and on-stand electrical. This work is 80 percent complete.

4. Construction is underway on the following projects:

a.	Project 7013 - Elevator for Test Stand 500	75% complete
b.	Project 7021 - GH_2 Transmission System	100% complete
c.	Project 7023 - GN_2 Pipeline System	100% complete
d.	Project 7031 - Modifications to Provide LH_2 Service, TS 300	100% complete
e.	Project 6742 - GN_2 Connector Line	100% complete
f.	Project for Landscaping Dodd Road, FY 67	100% complete
g.	Project for Fire Detection System	11% complete

5. Projects 8008 and 8003 - Action is underway to obtain local approval for submission of these two projects to Headquarters for release. These projects are Steam Ejector for Dynamics Test Stand, Building 4557 and High Pressure Air Pipeline.

B. 38' X 60' Vacuum Chamber

Preparation of planning drawings on schedule.

C. Modification of East Side of Static Test Tower

Preliminary drawings on modification of industrial water system and high pressure gas under review. Design of storage tanks for storable propellants completed.

D. C of F, FY 68 Fire Alarm System

Design drawings for review are scheduled to be delivered for review during the week of January 8, 1968. This project will tie in the FY67 fire alarm project and place additional fire detection equipment in the West Test Area.

J. B. Carrington

Karl L. Heimburg

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