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**SATURN V
DYNAMIC TEST VEHICLE
TEST PROJECT
PLAN**



**SATURN V
TEST
OFFICE**

**SATURN V
MASTER TEST PLAN
SERIES**

National Aeronautics and Space Administration



GEORGE C. MARSHALL SPACE FLIGHT CENTER

I-V-TD No. 3

Date Effective: April 16, 1965

SATURN V
DYNAMIC TEST VEHICLE
TEST PROJECT
PLAN

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SATURN V MASTER TEST PLAN SERIES

SATURN V TEST OFFICE

REV. A

SATURN V MASTER TEST PLAN SERIES

SATURN V DYNAMIC TEST VEHICLE TEST PROJECT PLAN

FOREWORD

The SATURN V MASTER TEST PLAN SERIES establishes the Saturn V Program level test plans which control the Saturn V Test Program. The series is in consonance with the Apollo Test Requirements, NPC 500-10, and is in accordance with Saturn V Program Directive Number 3, subject: Saturn V Master Test Plan.

The SATURN V MASTER TEST PLAN SERIES consists of:

A. The program document entitled the Saturn V Master Test Plan (MTP),

B. A series of master ground test plans:

Saturn V Master Ground Test Plan,

Saturn V Dynamic Test Vehicle Test Project Plan,

Saturn V Ground Wind Loads Test Project Plan,

Saturn V Launch Facility Checkout Plan (SA-500F),

Saturn V Prelaunch Checkout and Launch Operations Plan,

C. Saturn V Mission Directives for each launch vehicle.



SATURN V MASTER TEST PLAN SERIES

SATURN V DYNAMIC TEST VEHICLE TEST PROJECT PLAN

REVISION RECORD

REV SYM	DESCRIPTION	DATE	APPROVED
	<p><u>ORIGINAL RELEASE</u> of 14 pages, distributed as Section III. A of <u>Saturn V Master Test Plan.</u></p>	4-16-65	
A	<p>Revision A consists of 19 pages:</p> <p style="padding-left: 40px;">i through iv 1 through 9 A-1 through A-6</p> <p>Changes made in Revision A are shown below:</p> <ol style="list-style-type: none"> (1) Incorporated MASTER TEST PLAN SERIES page format throughout document and added pages ii, iii, iv and A-1 to complete the document (2) Changed "DTV Test Program" to "DTV Test Project" throughout document. (3) page 1: Clarified test objective, para. 2. e. (4) page 4: Revised tests for support of SA-501, para. 5; changed test management responsibility, para. 6. (5) page 6: Changed test schedule. 	8-30-65	<p>APPROVAL: <i>JHR</i></p> <p><i>Ralph E. Roberts</i> PROJECT MANAGER, SATURN V DYNAMIC TEST</p>

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SATURN V MASTER TEST PLAN SERIES

SATURN V DYNAMIC TEST VEHICLE TEST PROJECT PLAN

1. Introduction. A detailed knowledge of the space vehicle dynamic flight characteristics is necessary for structural, guidance, and flight control system design. Design criteria for these elements were based on analytical data which have not been substantiated by test. The Dynamic Test Vehicle (DTV) test project is planned to determine the dynamic characteristics of the space vehicle and to verify the earlier analyses.
2. Test Objectives. The objectives of dynamic tests are to:
 - a. Determine the space vehicle structural dynamic characteristics under conditions simulating flight configuration and environment insofar as practicable.
 - b. Determine the optimum location for flight sensors and obtain experimental transfer functions for the control system.
 - c. Determine the physical mating compatibility of stages and modules.
 - d. Compare dynamic test results with subsequent flight test results for continuous development of dynamic test techniques and facilities to assure the highest possible degree of accuracy in the development of future vehicle structures prior to flight.
 - e. Determine the space vehicle dynamic characteristics under conditions simulating space vehicle transport from the Vehicle Assembly Building to the launch pad insofar as practicable.
3. Test Requirements. As a minimum the objectives must be accomplished within the following test requirements:
 - a. The test environments shall simulate the mission configuration and environment to the maximum extent practicable.
 - b. The restraints of the test fixture shall have a minimum of undefinable influence on the test environment and measured results.

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SATURN V DYNAMIC TEST VEHICLE TEST PROJECT PLAN

3. Test Requirements (Continued)

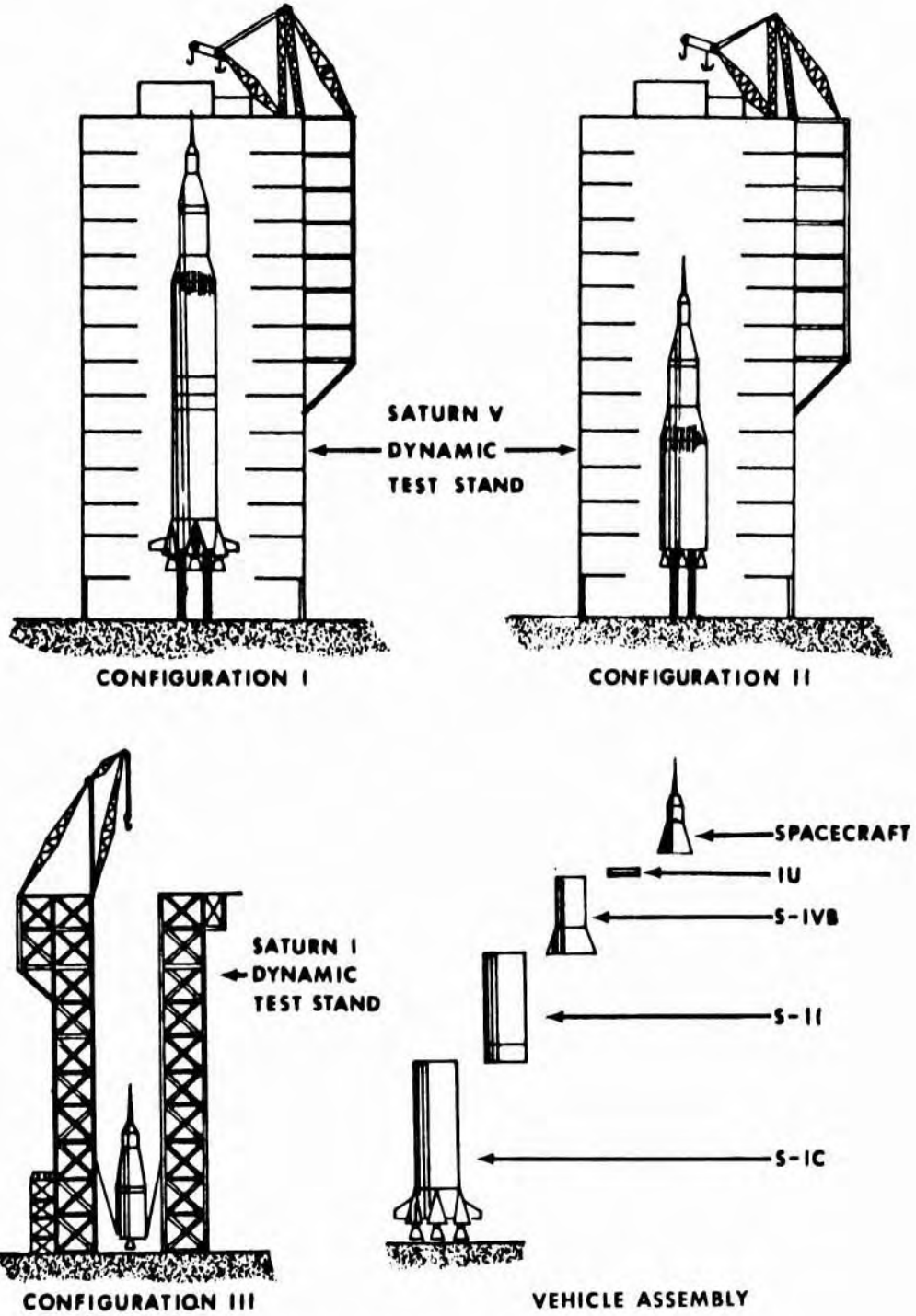
- c. Specific tests or measurements that may be associated with vehicle physical compatibility or vehicle handling and assembly procedures, but which do not relate directly to fulfilling dynamic test objectives above shall be performed only on a non-interference basis with dynamic tests. Test results affecting other contractors and agencies shall be made available on a timely basis.
- d. The test approach shall be compatible with other Saturn dynamic testing to enable exchange and correlation of test results.
- e. Saturn IB dynamic test hardware and facilities shall be used to the maximum extent practicable.

4. Test Specimen Configuration Requirements. See DTV test configurations shown in Figure 1.

- a. The test specimen shall be a complete full scale space vehicle configuration. Vehicle and stage systems of the test vehicle will be largely non-functional except as needed for testing. Non-functional components are to be selectively omitted or simulated depending upon their masses and their expected dynamic effect. Test vehicle weight and center of gravity shall simulate flight vehicle characteristics, and dummy components installed shall simulate flight hardware weight, stiffness and center of gravity.
- b. The test specimen, except dummy components, shall be flight type hardware. Qualified hardware is desirable; however, this requirement is waived if use in dynamic tests is scheduled before qualification is achieved.
- c. The configuration of the launch vehicle shall be in accordance with the requirements established in Saturn V Dynamic Test Vehicle Description, prepared by R-P&VE, dated May 8, 1964.
- d. Boilerplate spacecraft BP-027 has been assigned for use in these tests.

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SATURN V DYNAMIC TEST VEHICLE TEST PROJECT PLAN



SATURN V DYNAMIC TEST CONFIGURATIONS

FIGURE 1

SATURN V MASTER TEST PLAN SERIES

SATURN V DYNAMIC TEST VEHICLE TEST PROJECT PLAN

4. Test Specimen Configuration Requirements (Continued)

- e. Three test configurations are required:

Configuration I simulates the flight vehicle configuration during S-IC boost phase and is made up of the S-IC-D, the S-II-S/D, the S-IVB-D stages, the S-IU-200D/500D instrument unit and the BP-027 spacecraft.

Configuration II simulates the flight vehicle configuration during S-II boost phase and is made up of the S-II-S/D, the S-IVB-D, the S-IU-200D/500D and the BP-027.

Configuration III simulates the flight vehicle configuration during the S-IVB boost phase and is made up of the S-IVB-D, the S-IU-200D/500D and the BP-027.

5. Relationship of Dynamic Test to Overall Saturn V Program. The start of Saturn V dynamic tests is dependent on the progress of earlier testing. The S-IVB-D, the S-IU-200D/500D and the BP-027 are used for Saturn IB dynamic tests, then are modified for use in Saturn V dynamic tests. The S-II-S/D is used for Saturn V structural tests, then is refurbished for use in dynamic tests.

In order to support design release of the control computer by April 4, 1966, engine lateral modes and thrust vector control tests on Configuration I must be completed by March 15, 1966. All Configuration III testing will also have been completed by this time.

6. Test Program Management. The Saturn V Program Manager discharges his responsibility for the Saturn V DTV Test Project in accordance with the agreements reached between General O'Connor, I-DIR, and Mr. Wiedner, R-DIR. Mr. R. E. Robertson continues as the Project Manager, Saturn V Dynamic Test; Mr. J. O. Lysaght has been appointed to replace Lt. Col. Brouns as the R&DO Technical Manager for Saturn V Dynamic Tests; Mr. C. E. Watson has been appointed as his alternate.

The management agreements reached for the Saturn V Dynamic Test Project are included in the memorandum to Dr. von Braun, DIR, from Gen. O'Connor, I-DIR, and Mr. Weidner, R-DIR, subject: Management of Saturn IB and Saturn V Dynamic Tests, dated February 3, 1965. To the extent of defining these agreements, a copy of this letter forms a part of this document and is included as the Appendix.

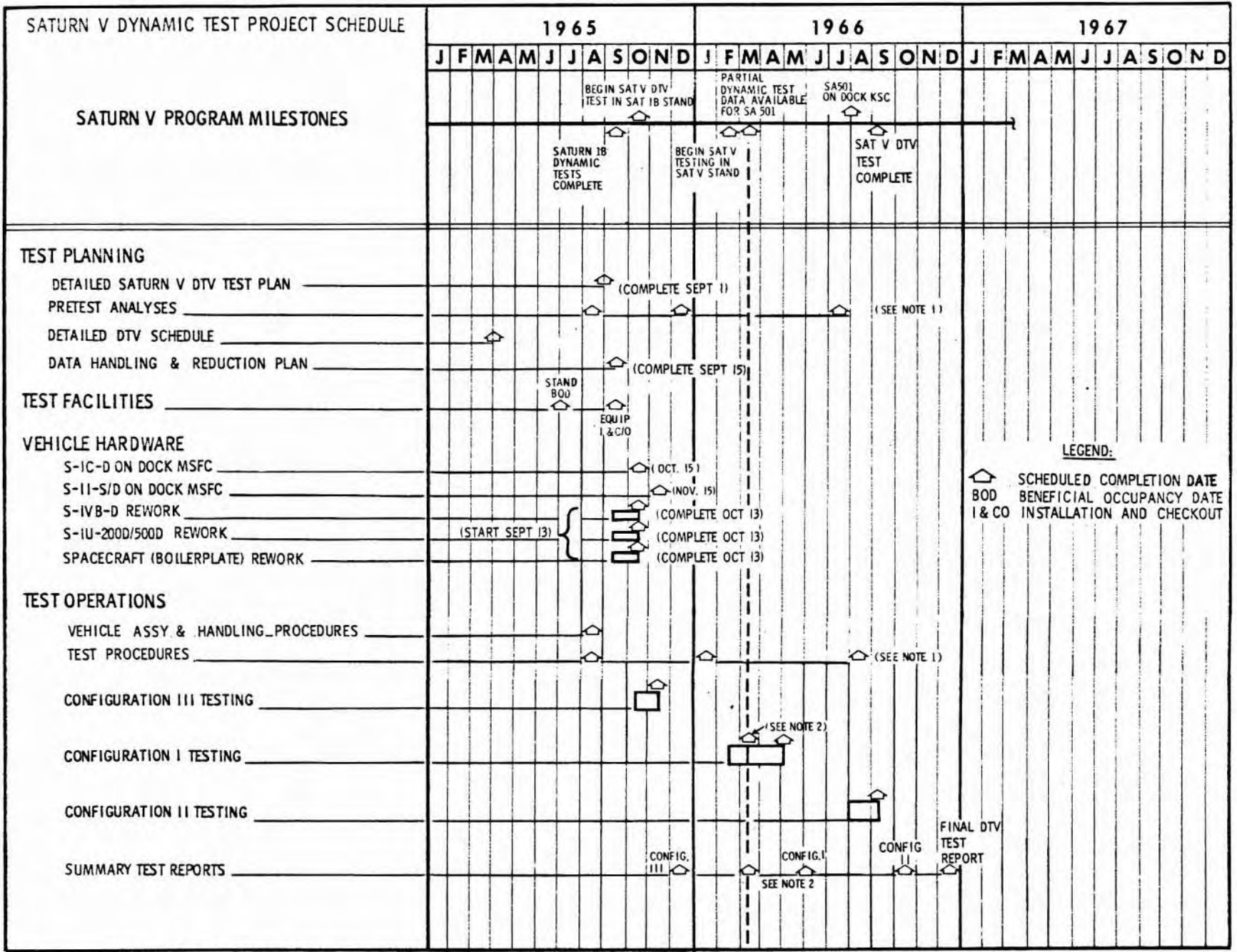
7. Test Description. Dynamic testing will examine the vehicle response to lateral, longitudinal and torsional excitation that simulates the flight vibration spectrum. Also, engine cantilever modes, control system response and performance, fin and fairing modes, and miscellaneous transmissibilities will be investigated. Restraints imposed on the vehicle by the support system will be evaluated and used to obtain free-free modal data.

The vehicle will be mounted on a hydrodynamic support system made up of four hydraulic/pneumatic pedestals to permit a simulated unrestrained reaction. For each test configuration, the vehicle will be set up for vibration in a single plane and excited at various ballast loadings that simulate the vehicle fuel load at critical time points in the flight trajectory. This sequence will be performed, in succession, for longitudinal, pitch, yaw, and torsional external vibration. An engine gimbal test, using a ground servo system and flight actuators, will be run to explore thrust structure compliance and to obtain experimental transfer functions for the control system.

A mathematical model using digital computer techniques is being developed for use in analyzing characteristics and in analyzing test data.

Sequence of testing will be:

- (1) Configuration III will be tested in the Saturn IB Dynamic Test Facility.
 - (2) Configuration I will be tested at the Saturn V Dynamic Test Facility.
 - (3) Configuration II will be tested in the Saturn V Dynamic Test Facility.
8. Test Schedule. The Saturn V DTV Test Project will be implemented in accordance with the schedule of Figure 2.



NOTES: 1. THESE DOCUMENTS TO BE RELEASED FOR EACH OF THE TEST CONFIGURATIONS III, I, AND II, IN SEQUENCE
 2. PITCH, CANTILEVER AND YAW TESTS TO BE COMPLETED PRIOR TO MARCH 18, 1966 TO SUPPORT DESIGN RELEASE OF CONTROL COMPUTER BY APRIL 4, 1966.

SATURN V TEST PROJECT SCHEDULE
 FIGURE 2

9. Subsidiary Test Plans. The Technical Manager shall be responsible for subsidiary test planning and shall include the following as a minimum.
- a. Test contractor statement of work, or proposed revisions, shall be prepared to define the work package to be contracted. The statement of work shall be forwarded through the Project Manager, Dynamic Test, for coordination and contractual action.
 - b. Saturn V DTV test plan shall be prepared in accordance with the project schedule, Figure 2, to establish detailed test objectives and requirements and shall include vehicle configuration requirements, data measurements, instrumentation system requirements, tests to be conducted, and pretest analyses required. After approval by the Technical Manager, three copies shall be submitted to the Saturn V Test Office for review and comment.
 - c. A pretest dynamic analysis shall be performed for each test configuration. This analysis, together with predicted test results, shall be completed in accordance with the project schedule, Figure 2.
 - d. A detailed test project schedule shall be prepared in accordance with the project schedule, Figure 2, to accomplish test objectives within the project milestone requirements shown in paragraphs 5 and 8. After approval by the Technical Manager, three copies shall be forwarded to the Project Manager.
 - e. Test procedures shall be prepared for each test configuration and released in accordance with the project schedule, Figure 2.
 - f. DTV assembly and handling procedures shall be prepared in accordance with the project schedule, Figure 2. The DTV assembly and handling operations will provide the earliest opportunity to evaluate Saturn V vehicle handling and assembly methods, and particular care shall be used to ensure that, during preparation, these procedures are fully coordinated with all organizations involved in planning stage and vehicle handling and assembly.

9. Subsidiary Test Plans (Continued)

- g. A data handling and reduction plan shall be prepared in accordance with the project schedule, Figure 2, to define data distribution and data reduction requirements for stage contractors, for MSFC and for other interested NASA organizations. After preparation and approval by the Technical Manager, three copies of the plan shall be submitted to the Project Manager.

10. Test Resources. Availability dates for the test resources below are shown in Figure 2.

- a. Dynamic test stages are provided by each of the stage contractors through the respective Stage Managers.
- b. The dynamic test spacecraft is provided by MSC. The Project Manager will provide coordination with MSC.
- c. The Saturn V and Saturn IB Dynamic Test Facilities will be used for testing.
- d. The Technical Manager shall take action as necessary to design or acquire test equipment for use in the Saturn V DTV Test Project.

11. Test Instrumentation. The test instrumentation shall be held to the minimum required to fulfill the Saturn V dynamic test plan as approved by the DTV Technical Manager. Saturn IB dynamic test vehicle and flight instrumentation shall be used to the maximum extent practicable.

12. Test Operations. Test operations shall be completed in accordance with the detailed test project schedule and shall fulfill the Saturn V dynamic test plan.

All test operations shall be accomplished under the cognizance of the Technical Manager. Participation of MSFC organizations in these operations will be handled through the Technical Manager.

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SATURN V DYNAMIC TEST VEHICLE TEST PROJECT PLAN

12. Test Operations (Continued)

The Boeing Company will perform the operations associated with testing in the Saturn V Dynamic Test Facility. The Chrysler Corporation will perform operations associated with testing in the Saturn IB Dynamic Test Facility.

13. Data Handling, Reduction and Analysis. The Technical Manager shall establish the responsibilities for data handling, reduction, analysis, retention and distribution.

14. Test Reporting.

- a. Progress reports shall be prepared monthly to describe the status of the test project. They shall be submitted by Boeing to the Technical Manager with five copies to the Project Manager.
- b. Interim test reports shall be prepared for the testing in each plane within the three test configurations and for each of the component tests. These reports are to be submitted to the Technical Manager within one week after each test and will include data taken during the test, correlation of predicted results to actual results and a resume of the test operations.
- c. A summary test report shall be prepared for each test configuration and shall be submitted within 30 days after completion of testing for the configuration.
- d. A final report covering the overall Saturn V DTV Test Project shall be submitted within three months after completion of testing.

APPENDIX

**MANAGEMENT OF
SATURN V DYNAMIC TESTS**

GEORGE C. MARSHALL SPACE FLIGHT CENTER
HUNTSVILLE, ALABAMA

Memorandum

TO Dr. von Braun, DIR DATE FEB 3 1965

FROM Director, Industrial Operations, I-DIR
Director, Research & Development Operations, R-DIR

SUBJECT, Management of Saturn IB and Saturn V Dynamic Tests

1. The recent briefing by the Control Dynamics and Structural Feedback Committee (CD & SFC) on dynamic testing indicated several potential management problems. Since this meeting, several discussions have been held between Industrial Operations and Research & Development Operations personnel to establish a definitive management plan.

2. Enclosures 1 and 2 present the Saturn IB and Saturn V plan for Program Management of the dynamic tests, respectively. These plans improve the management structure and are in accordance with the guidelines established by you in the CD & SFC presentation.

3. A systematic plan has been devised for maintaining coordination among MSFC and contractor elements for the timely implementation and completion of the dynamic test program through the establishment of project and technical management.

The project management will be headed by a project manager who will specifically perform management responsibilities and duties, which will primarily be as follows:

- a. Dynamic test program control.
- b. Assuring the Saturn I/IB and Saturn V Program Managers that the test program is maintained within established schedules and costs.
- c. Program control and redirection of contractor efforts through the Technical Manager, R&DO.
- d. Evaluation and assessment of contractor proposals and proposed scope changes.

