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GEORGE C. MARSHALL SPACE FLIGHT CENTER
HUNTSVILLE, ALABAMA

MSFC
MANNED SPACE FLIGHT
PROGRAM STATUS
FOR
DECEMBER 18, 1962
MANAGEMENT COUNCIL MEETING

Available to NASA Offices and
NASA Centers Only.

National Aeronautics and Space Administration

MSFC

MANNED SPACE FLIGHT

PROGRAM STATUS

FOR

PRESENTATION TO THE

MANAGEMENT COUNCIL

December 18, 1962

December 18, 1962

Note:

This is material prepared in support of Dr. von Braun's presentation for the December 18, 1962, Management Council Meeting - Agenda Item 2, "MSFC Status Report".

Presentation material consists of slides, two film reports and narrative back-up information to support the presentation.

OUTLINE

MSFC MANNED FLIGHT PROGRAMS

		Number of Slides
1.	SATURN	
	C-1 PROJECT	2 (Plus Film, 8 min.)
	C-1B PROJECT	3
	C-5 PROJECT	3
2.	F-1 ENGINE	3 (Plus Film, 8 min.)
3.	INSTITUTIONAL	2

SATURN C-1

SLIDES & FILM

1. Saturn C-1 Dynamic Test Program
2. Saturn C-1/S-IV Battleship Testing
3. Film - SA-3 Launch

SATURN C-1 DYNAMIC TEST PROGRAM

- BLOCK II VEHICLE BEING INSTALLED IN TOWER (MSFC)
- PHASE I TESTING TO BE ACCOMPLISHED JAN-MAR 1963

  PURPOSE

  1. DETERMINE OVERALL VEHICLE DYNAMIC CHARACTERISTICS WITH JUPITER NOSE CONE
  2. DETERMINE OPTIMUM LOCATION FOR CONTROL ACCELEROMETERS
  3. DETERMINE FINAL SETTING FOR CONTROL COMPUTER

- S-I STAGE OF DYNAMIC TEST VEHICLE TO BE SHIPPED TO AMR FOR PAD 37B CHECKOUT MARCH 1963

M-CP-P
DEC. 13, 1962

SATURN C-1 S-IV BATTLESHIP TESTING

- RL-10-A3 ENGINES BEING INSTALLED
- HELIUM BUBBLING TEST TO START WEEK OF DECEMBER 24, 1962
- FIRST HOT FIRING RESCHEDULED FROM MID-DECEMBER TO 1ST WEEK JANUARY

M-CP-P
DEC. 13, 1962

SA-3 LAUNCH FILM

This 8 minute film shows a selection of views from the Engineering Sequential Camera during the SA-3 launch and flight. It should be noted that better camera coverage was accomplished during the SA-3 launch than on previous Saturn launches.

SATURN C-1 PROJECT NARRATIVE

Slide
1. SATURN C-1 DYNAMIC TEST PROGRAM

The current status and objectives of the Saturn C-1 Dynamic Test Program (Phase I) are covered briefly. Phase II of the dynamic test program simulating second stage flight (second stage only) will begin in April, 1962.

Slide
2. SATURN C-1/S-IV BATTLESHIP TESTING

The RL10A-3 engines are being installed on the battleship tank (SACTO). The LOX pump from engine 1802 (one of the six battleship vehicle engines) was returned to P&W for rework because of a LOX seal problem. The problem has now been corrected, the engine returned for installation.

The first testing is scheduled for the week of December 24, 1962. This will be cold helium bubbling tests used for optimizing LOX preconditioning procedure. This preconditioning is necessary in order to achieve a split engine chilldown (10 seconds for LOX and 40 seconds for LH_2).

The first hot firing was rescheduled from mid-December to January to allow adequate time for reorificing of the diffuser water manifold (to eliminate diffuser overheating) and installation of a gas analyzer and additional temperature probes in the LOX tank.

Film
3. SA-3 LAUNCH FILM

This 8 minute film shows a selection of views from the Engineering Sequential Camera during the SA-3 launch and flight. It should be noted that better camera coverage was accomplished during the SA-3 launch than on previous Saturn launches.

SATURN C-1B

SLIDES

1. Saturn C-1B Project Status (S-I Stage)
2. Saturn C-1B Project Status (S-IVB Stage)
3. Saturn C-1B Project Status (S-IVB Stage - Cont'd)

SATURN C-1B PROJECT STATUS

S-I STAGE

- MSFC PREPARING REQUEST TO CCSD TO PROPOSE ON MODIFYING CURRENT CONTRACT TO INCLUDE PARTIAL RE-DESIGN OF S-I STAGE CAPABLE OF MEETING PAYLOAD AND INTERSTAGE COMPATIBILITY REQUIREMENTS.

M-CP-P
DEC. 13, 1962

SATURN C-1B PROJECT STATUS

S-IVB STAGE

- DAC PREPARING SCOPE CHANGE TO INCLUDE FOUR DEVELOPMENT FLIGHT S-IVB STAGES FOR C-1B PROGRAM

  PRESENT CONTRACT INCLUDES SIX S-IVB DEVELOPMENT STAGES FOR C-5; NONE ON C-1B

- PRESENT CONTRACT TO BE EXTENDED 90 DAYS TO COVER LEVEL OF EFFORT UNTIL DEFINITIVE CONTRACT NEGOTIATED

M-CP-P
DEC. 13, 1962

SATURN C-IB PROJECT STATUS

S-IVB (CONT'D)

- PLANNED HOT TEST PROGRAM

	LOCATION	INITIAL HOT TEST
BATTLESHIP	SACTO	MAY '64
ALL SYSTEMS	SACTO	NOV '64
ACCEPTANCE 201	SACTO	APR '65

- THREE TEST POSITIONS TO BE BUILT AT SACTO. THE THIRD POSITION WILL SUPPORT C-IB AND WILL REQUIRE FUNDING IN FY-64

M-CP-P
DEC. 13, 1962

SATURN C-1B PROJECT NARRATIVE

Slide
1. C-1B PROJECT STATUS (S-I STAGE)

MSFC is currently studying payload and interstage compatibility criteria to determine the extent of S-I Stage re-design that will be required. CCSD will use these requirements as a basis for a subsequent proposal on a modified contract.

Primary objectives of the re-design will be to reduce S-I Stage weight to be consistent with the payload requirements and to match the S-IVB Stage interface. It is anticipated that weight reduction will be accomplished by resizing the propellant containers and tail section assembly, and by reducing propulsion system pressurization equipment.

Slide
2. C-1B PROJECT STATUS (S-IVB STAGE)

Changes in scope of current S-IVB Stage contract are discussed briefly.

Slide
3. C-1B PROJECT STATUS (S-IVB STAGE - CONT'D)

This slide presents the current schedule for the S-IVB Hot Test Program at SACTO.

SATURN C-5

SLIDES

1. Saturn C-5 Project Status (S-IC Stage)
2. Saturn C-5 Project Status (S-II Stage)
3. Saturn C-5 Project Status (S-IVB Stage)

SATURN C-5 PROJECT STATUS

S-IC STAGE

- BASED ON RECENT DISCUSSIONS WITH BOEING, RESOLUTION OF CONTRACT APPEARS LIKELY AFTER SOME ADDITIONAL NEGOTIATIONS

  IDENTIFICATION OF AREA OF WORK NOT REQUIRED WILL PERMIT REDUCTION IN MANPOWER REQUIREMENTS TO A MORE NEARLY ACCEPTABLE LEVEL

- INITIAL INSTALLATION OF MAJOR COMPONENT ASSEMBLY TOOLING HAS COMMENCED AT MSFC

M-CP-P
DEC. 13, 1962

SATURN C-5 PROJECT STATUS

S-II STAGE

- LH_2 SPILL PROGRAM STARTED THIS MONTH
- CONSTRUCTION OF VERTICAL CHECKOUT BUILDING DEFERRED

  POST STATIC EVALUATION, CHECKOUT AND REFURBISHMENT AT MTF WILL BE PERFORMED IN TEST STAND UNTIL S-II STAGE STATIC TESTS REQUIRE FULL USE OF STAND. (CY-1966)
- STAGE TRANSPORTERS WILL BE MANUFACTURED AT NAA-TULSA

M-CP-P
DEC. 13, 1962

SATURN C-5 PROJECT STATUS

S-IV B STAGE

- DAC HAS BEEN INSTRUCTED TO PREPARE SPECIFICATION AND SCOPE CHANGE FOR DEVELOPMENT OF S-IV B HYDRAULIC ACTUATORS

M-CP-P
DEC. 13, 1962

SATURN C-5 PROJECT NARRATIVE

Slide
1. SATURN C-5 PROJECT STATUS (S-IC STAGE)

Negotiations on a long term contract (NAS8-5608) have progressed through the "fact-finding" stage. Based on these findings, the P&C negotiator requested the Boeing Company to revaluate their manhour requirements. The result was a reduction in direct labor manhours; however, MSFC considered even the revised figure to be unrealistic. Further discussions with Boeing Company on December 12 led to the identification and elimination of another unrequired work area in the program. As a result, it was possible to reduce the direct labor manhour requirement to approximately 33.5 million. Final resolution should be obtainable through additional negotiations.

Major assembly tooling is in fabrication and initial installation has commenced at MSFC. The first hardware delivery to MSFC ("Y" ring for the test fuel tank) is scheduled for January 1963.

Boeing Company has indicated that they can deliver documentation for all ground test stages in time to meet Plan V schedule requirements.

Slide
2. SATURN C-5 PROJECT STATUS (S-II STAGE)

A purchase request was initiated in late November to begin the LH_2 spill test program. The purpose of the program is to evaluate the explosive hazard associated with cryogenics used on the C-5 vehicle. Particular emphasis will be placed to justify the conduct of the full duration clustered engine tests on the S-II All Systems vehicle at Santa Susana. The test program is scheduled for completion by December 15, 1963.

Based on the limited funding of facilities at MTF, it was judged that the construction of the S-II Vertical Checkout Building at that facility could be postponed until calendar year 1966. The purpose of this building is to facilitate a post-static firing quality control evaluation of the vehicle under a sheltered environment. This building will be required when the delivery schedule dictates the presence of three S-II vehicles at MTF during one calendar month. Until the Vertical Checkout Building b ecomes available, the post-static quality control evaluation of the S-II vehicle will be performed with the missile mounted in the static test stand.

SATURN C-5 PROJECT STATUS (S-II STAGE) (CONT'D)

To date NAA has been authorized to perform certain component manufacturing at Tulsa for the S-II vehicle in conjunction with the fabrication of particular elements of the ground handling equipment. The largest single component for the S-II program being fabricated at the Tulsa facility is an S-II transporter, three of which will be used for land transportation of the S-II vehicle from Seal Beach to the AKD docking facility and from Port Hueneme to the NAA/S&ID test facilities at Santa Susana. The principal mission of the Tulsa facility is fabrication. The establishment of a comprehensive engineering design capability at this location is being discouraged by MSFC. During the week of December 3, 1962, Mr. Lingle, Special Assistant to Mr. Webb, conducted private conferences with management personnel from S&ID regarding the expansion of the NAA/S&ID activities at the Tulsa facility. The impact of these conferences has not been made known to MSFC as of this date.

Slide
3. SATURN C-5 PROJECT STATUS (S-IVB STAGE)

This action was taken as it became increasingly apparent that the S-II actuators previously specified for use also on the S-IVB stage were considerably overdesigned when compared to S-IVB requirements. Separate design would result in a simpler, lighter, and less costly actuator.

F-1 ENGINE

SLIDES & FILM

1. F-1 Engine Testing
2. Film - F-1 Engine Status Report
3. F-1 Engine Major Problems
4. F-1 Engine Combustion Stability Actions

F-1 ENGINE TESTING

	TO DATE
• TOTAL TESTS	213
• TOTAL DURATION	4400 SEC
RATED THRUST TESTS	60
RATED THRUST DURATION	2500 SEC
FULL DURATION TESTS AT RATED THRUST	5

M-CP-P
DEC. 19, 1962

F-1 ENGINE STATUS FILM

This 8 minute film is a status report for the F-1 engine. Depicted are aspects of the development, fabrication, assembly, transportation, and test firings. It is believed the solutions to the problems confronting the development of the F-1 engine are now in sight and that production schedules will be met.

F-1 ENGINE MAJOR PROBLEMS

- COMBUSTION INSTABILITY
- NOZZLE EXTENSION
- HEAT EXCHANGER
- EXHAUSTERATOR

M-CP-P
DEC. 13, 1962

F-1 ENGINE
COMBUSTION STABILITY ACTIONS

- AD HOC COMMITTEE ORGANIZED JULY 1962
- A DYNAMICALLY STABLE ENGINE SYSTEM WAS MADE A CONTRACTURAL REQUIREMENT IN FOLLOW ON OF THE R&D CONTRACT
- ROCKETDYNE COMBUSTION STABILITY COUNCIL ESTABLISHED
- TWO PHASE R&D APPROACH UNDERTAKEN
- PERSONAL SERVICES CONTRACT NEGOTIATED

M-CP-P
DEC. 13, 1962

F-1 ENGINE PROJECT NARRATIVE

Slide

1. F-1 ENGINE TESTING

Fourteen engines are to be utilized in the F-1 R&D program. Through November 28, 1962, 213 separate firing tests had been conducted for a cumulative firing duration of 1,400 seconds. Included in this series were 33 ignition-only tests.

The first four F-1 engines were rated at 1,000K thrust. They were fired 60 times for a total duration of 2,500 seconds at rated thrust.

Six 1,500K thrust engines have now been completed. Five of these are operational and one was damaged because of rough combustion. Five tests at rated thrust and duration have been completed.

Film

2. F-1 ENGINE STATUS FILM

This 8 minute film is a status report for the F-1 engine. Depicted are aspects of the development, fabrication, assembly, transportation, and test firings. It is believed the solutions to the problems confronting the development of the F-1 engine are now in sight and that production schedules will be met.

Slide

3. F-1 ENGINE MAJOR PROBLEMS

Combustion instability has been a persistent problem since inception of the F-1 program and was quite severe earlier in the initial injector development. However, by mid 1961 when engine system testing began, considerable strides had been made and combustion instability appeared no longer a problem of major significance. The injector was by no means completely developed; much work remained to be done, but engine system testing continued and was not paced by the injector or combustion instability.

This problem assumed new proportions on June 28, 1962, when the fifth engine, serial number 008, in the program, was severely damaged due to combustion instability after 106 seconds of a scheduled full duration test. Thus, engine testing had been in progress for one full year prior to any serious instance of combustion instability. Following this incident an Ad Hoc Committee was formed at MSFC to deal with combustion instability in the F-1 program. The committee is composed of four engine specialists from MSFC and one combustion specialist from each: Lewis Research Center, Princeton University and the Air Force. It is felt that the committee as presently composed represents a considerably high degree of technical talent in this field.

F-1 ENGINE MAJOR PROBLEMS (CONT'D)

Since its inception the MSFC Combustion Stability Ad Hoc Committee has been actively reviewing Rocketdyne's past efforts, searching for new injector concepts, making recommendations and monitoring Rocketdyne's present effort. The committee has held two official meetings with Rocketdyne to date. During the first meeting at MSFC on July 16, 1962 the injector development effort and the loss of engine 008 were reviewed. During the second meeting at Rocketdyne on October 2 and 3, 1962 the committee proposed a plan for stabilizing F-1 combustion within the time frame of the PFRT and engine qualification schedule, suggested several injector concepts and made several recommendations. Rocketdyne was asked to develop a stability improvement program in accordance with the Ad Hoc Committee's suggestions. A three phase approach was proposed to meet the relatively short term requirements for PFRT, the longer term engine qualification requirements and a research and technology program. In addition to these two official meetings, several members of the committee have visited Rocketdyne on numerous occasions for the purpose of evaluating progress and making further recommendations.

Also, members of the committee from the Propulsion and Mechanics Branch of MSFC have closely monitored Rocketdyne's effort on almost a daily basis through numerous telecons. These same members have also been in continuous communication with Dr. Priem of the Lewis Research Center and Mr. Harrje of Princeton University. The thoughts and suggestions of these individuals have been made available to Rocketdyne.

A list of NASA and Defense Department contracts with universities and private research institutions in the field of rocket combustion was made available to the F-1 Engine contractor. A list of names of the specialists conducting this work was also provided. Rocketdyne has been encouraged to invite these people for consultations. MSFC has offered to assist in making arrangements for these visits where desirable. Rocketdyne has consulted with Dr. Priem of the Lewis Research Center and Mr. Harrje of Princeton University and Dr. Reardon of Aerojet-General to date. It is our understanding that Mr. Bartz and Mr. Rupe of the Jet Propulsion Laboratory and Dr. Zukrow of Purdue University will be contacted next.

F-1 ENGINE MAJOR PROBLEMS (CONT'D)

At the October 2 and 3 meeting it was announced that a Stability Council was being formed within Rocketdyne to deal solely with F-1 combustion instability. This Council was formed in compliance with a request by MSFC that a separate group be organized to deal full time with this problem. The Stability Council consists of five members and is headed by Dr. Klute and Mr. Castenholz. These two individuals have been very successful in the past at Rocketdyne in completing difficult assignments. This Center is pleased with the leadership and organizational ability they have demonstrated to date. Representatives of the Stability Council met with MSFC representatives on December 4, 1962, to report progress to date and present future plans.

While combustion instability is currently the most urgent problem in the F-1 development program, it has not affected the program to the extent which might be imagined. Two engines have been severely damaged and the injectors of two other engines. No significant test stand damage was experienced. All other engine instability cases occurred in transition or shutdown and have been associated with significant changes in valve opening and closing sequencing or human error in engine preparation. The majority of the instability cases occurred on the thrust chamber component stand in the course of injector development and checkout. Many times the instability was purposely triggered with a powder charge to observe the response of the chamber to a finite disturbance.

Other engine system problems were encountered concurrent with combustion instability. Therefore, it is impossible to evaluate the sole impact of this one particular problem on the overall program. An examination of the full range of problems affecting engine system testing does not reveal combustion instability as an outstanding problem which is hindering the program.

Our intense concern in this area is not primarily because of any past delays; rather we recognize combustion instability to be a problem which cannot be solved alone by application of straight forward engineering principles. This problem is very complex and fundamental in nature and has been present in one form or another in our past development programs. Although combustion research has been in progress at several institutions over the past decade a satisfactory understanding

F-1 ENGINE MAJOR PROBLEMS (CONT'D)

of the combustion process has not been obtained. This has prevented the establishment of suitable injector and combustor design criteria which would enable the designer to avoid combustion instability in the initial design. The industry has been looking to these institutions for these criteria to no avail. We at MSFC feel these institutions could have placed more emphasis in this area in the past and should do so now. Lack of suitable design criteria has forced the industry to adopt almost a completely empirical approach to injector and combustor development. This has proved costly and time consuming. Furthermore, this empirical approach does not add to our understanding because a solution suitable for one engine system is usually not applicable to another. The problem of combustion instability is significant because it is extremely difficult to estimate how far or close we are from a solution.

The first two nozzle extensions have been damaged beyond repair in tests. Design revisions are presently in process.

Tests performed on the heat exchanger have thus far failed to validate theoretical performance figures.

The exhausterator has developed thermal cracks. A new design is being developed which should solve this deficiency.

Slide
4. F-1 ENGINE COMBUSTION STABILITY ACTIONS

The Ad Hoc Committee was formed during July 1962 with experts from Lewis Research Center, Air Force, Princeton University, MSFC, and Rocketdyne.

A dynamically stable engine system is a contractual requirement of the F-1 R&D contract (NASw-16).

Rocketdyne has formed a Combustion Stability Council. Staffed with its own experts in the field, Rocketdyne has organized this group for the purpose of devoting full time to the F-1 engine combustion stability problem.

F-1 ENGINE COMBUSTION STABILITY ACTIONS (CONT'D)

The details for a two phase approach to this problem are being worked out by Rocketdyne in conjunction with the Combustion Stability Ad Hoc Committee. The plan will consider a short range program aimed at meeting the relatively short term requirements for PFRT and a long range program aimed at developing a dynamically stable engine system, commensurate with the qualification phase of the F-1 R&D. An integral part of both phases will be an applied research program aimed at supporting and guiding both the short and long range phases of the work.

A contract is currently being initiated by MSFC for the personal services of Mr. D. Harrje of Princeton University for the purpose of obtaining assistance in the solution to the combustion instability problem. Mr. Harrje is a permanent member of the Combustion Stability Ad Hoc Committee and has assisted MSFC/Rocketdyne since July 1962 when the committee was first formed.

INSTITUTIONAL

SLIDES

1. FY-63 Program Summary (C of F)
2. FY-63 Program Summary (Personnal Services & Institutional Support)

FY-63 PROGRAM SUMMARY

CONSTRUCTION OF FACILITIES	CURRENT FUNDING PLAN	ADDITIONAL REQUIREMENTS	
HUNTSVILLE	44.639	3.127	
MICHOUD	21.093	1.500	
MTF	73.020		
VARIOUS LOCATIONS	33.202	3.350	
TOTAL*	171.954M	7.977M	
	179.931 M		

* DOES NOT INCLUDE NRDS FACILITIES

M-CP-P 454
DEC. 10, 1962

FY-63 PROGRAM SUMMARY

PERSONAL SERVICES & INSTITUTIONAL SUPPORT	CURRENT FUNDING PLAN	ADDITIONAL REQUIREMENTS	
SALARIES & BENEFITS	69.922	2.694	
TRAVEL	3.300	.500	
INSTITUTIONAL SUPPORT	36.200	11.369	
TOTAL	109.422M	14.563M	
	123.985M		

M-CP-P 455
DEC. 10, 1962

INSTITUTIONAL NARRATIVE

General

The 3rd Quarter Program Review on December 12, 1962 projected a budgetary deficit for FY-1963 in three specific areas:

AREA	PROJECTED FY-63 DEFICIT
R&D Programs	$43.9 Mil
C of F	8.2 Mil
Personal Services & Inst. Support	14.6 Mil
TOTAL DEFICIT	$66.7 Mil

Shortages in any one of these areas will have a direct impact on the lunar program. Specific effects are currently under study.

The quarterly review dealt mainly with the R&D Program deficit. For this reason, deficits associated with the C of F and Institutional areas were left unresolved.

Slide
1. FY-63 PROGRAM SUMMARY - C of F

This slide shows additional C of F Requirements for FY-63 at various locations. A detailed breakout of the additional requirements are given in TABLE 1.

Slide
2. FY-63 PROGRAM SUMMARY - PERSONAL SERVICES & INSTITUTIONAL SUPPORT

This slide shows additional Personal Services & Institutional support requirements for FY-63. A detailed breakout of the additional requirements in this area are given in Fig. 1.

CONSTRUCTION OF FACILITIES
PROJECTED ADDITIONAL REQUIREMENTS

HUNTSVILLE	
J-2 Engine Power Plant Test Stand	1.168
Load Test Annex	.245
F-1 Engine Test Stand	.428
Utility Installation	1.286
Sub-Total	3.127
MICHOUD	1.500
Modification to Michoud (Chrysler Equipment & Under Estimate)	
VARIOUS	
Facilities F-1 Engine Program (C of F)	1.850
Facilities Saturn S-II Stage (R&D)	1.500
Sub-Total	3.350
TOTAL *	7.977

*Does not include 1.194 for F-1 Test Stand at Huntsville or 1.105 for F-1 Engine Program at EAFB (Various) covered under current Funding Plan but not yet approved.

TABLE 1

PERSONNEL COST AND OPERATION OF INSTALLATIONS FUNDING STATUS

DESCRIPTION	(Dollars In Thousands) FY - 1963		
	Required	Available	Deficit
Salaries and Benefits	72,616	69,922	2,694
Travel	3,800	3,300	500
Transportation of Persons	71	67	4
Transportation of Things	954	643	311
Rents, Communications and Utilities	11,062	10,226	836
Printing and Reproduction	664	600	64
Other Services (Including $2,575,000 required for DOD Quality Control personnel)	21,418	16,414	5,004
Supplies and Materials	8,400	5,400	3,000
Equipment	5,000	2,850	2,150
TOTALS	123,985	109,422	14,563

1. FY-63 Requirements and Deficit based on 7,500 end-of-year personnel strength.

2. Deficit for 7,100 end-of-year personnel strength is $13,257,000.

FIGURE 1