REPORT TO THE CONGRESS

Incentive Provisions Of Saturn V Stage Contracts B-161366

National Aeronautics and
Space Administration

NASA - 36

BY THE COMPTROLLER GENERAL OF THE UNITED STATES

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COMPTROLLER GENERAL OF THE UNITED STATES
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B-161366

To the President of the Senate and the
Speaker of the House of Representatives

This is our report on incentive provisions of Saturn V stage contracts awarded by the Marshall Space Flight Center, National Aeronautics and Space Administration.

Our review was made pursuant to the Budget and Accounting Act, 1921 (31 U.S.C. 53), and the Accounting and Auditing Act of 1950 (31 U.S.C. 67).

Copies of this report are being sent to the Director, Bureau of the Budget, and to the Administrator, National Aeronautics and Space Administration.

Comptroller General
of the United States

Contents

ABBREVIATIONS

CPFF	Cost-plus-fixed-fee
CPIF	Cost-plus-incentive-fee
DOD	Department of Defense
GAO	General Accounting Office
IU	Instrument Unit
KSC	Kennedy Space Center
MDAC	McDonnell Douglas Astronautics Company
MSC	Manned Spacecraft Center
MSFC	Marshall Space Flight Center
NASA	National Aeronautics and Space Administration
OMSF	Office of Manned Space Flight
O&M	Organization and Management

COMPTROLLER GENERAL'S REPORT TO THE CONGRESS

INCENTIVE PROVISIONS OF SATURN V STAGE CONTRACTS
National Aeronautics and Space Administration B-161366

D I G E S T

WHY THE REVIEW WAS MADE

In 1963 NASA began incorporating incentive provisions into its contracts as a means of reducing costs, maintaining or accelerating delivery schedules, and obtaining superior hardware. By the end of fiscal year 1969, NASA contracts containing incentive provisions amounted to about $6.7 billion.

The General Accounting Office (GAO) reviewed the contracts for the production of the S-IC and S-IVB launch vehicle stages, the largest contracts containing incentive provisions awarded by NASA's Marshall Space Flight Center (MSFC) to:

--determine if the incentive provisions of the contracts were consistent with the needs of the Apollo Program, and

--evaluate the need for the emphasis placed on schedule incentives in these contracts.

FINDINGS AND CONCLUSIONS

NASA incorporated about $26.2 million in schedule incentives into the S-IC and S-IVB stage contracts to accelerate delivery of these stages. In GAO's opinion the schedule incentives were not needed because

--early delivery of the stages could have been obtained without additional payments to the contractors. (See pp. 9 to 16.)

--adoption of air transportation for the S-IVB stage provided the desired schedule acceleration. (See p. 17.)

--manufacturing of the S-II stage was at least 5 months behind schedule and had thus provided the additional time for testing and solving prelaunch checkout problems on the S-IC and S-IVB stages, which NASA stated it was attempting to obtain through the use of schedule incentives. (See pp. 18 to 20.)

--delivery of the stages for certain vehicles ahead of schedule was not consistent with an earlier decision to delay delivery of these stages. (See pp. 23 to 25.)

NASA did not agree with GAO's findings and conclusions and stated that the early delivery incentives reduced costs, permitted mission

adjustments, and would keep total program costs to the minimum obtainable. According to NASA:

--the decision to use schedule incentives was made concurrent with the decision to stretch out the delivery schedule and the use of these incentives aided in stabilizing the Apollo Program schedule. (See pp. 23 to 25.)

--the behind-schedule position of the S-II stage improved steadily and did not affect the decision to incorporate schedule incentives into the S-IC and S-IVB contracts. (See p. 20.)

--uncertainties associated with air transportation of the S-IVB stage prevented NASA from relying on the potential time to be gained through use of air transportation. (See p. 20.)

GAO contends that (1) the objectives of the schedule stretchout and the use of delivery incentives were incompatible (see pp. 23 to 25), (2) there was little, if any, evidence to indicate improvement in the S-II stage behind-schedule position at the time the S-IC and S-IVB stage contracts were being negotiated (see p. 18), and (3) the uncertainties of using air transportation for the S-IVB stage had been cleared up before the S-IVB stage contract was modified. (See p. 29.) GAO further noted that, despite the advantages that NASA said resulted from the use of schedule incentives, the contracts for the follow-on production of S-IC and S-IVB stages provided only for the assessment of a penalty against the contractors if the stages were not delivered on time (See p 26.) GAO believes that NASA could have avoided using schedule incentives to obtain the early delivery of the first group of stages without adversely affecting the Apollo Program.

RECOMMENDATIONS OR SUGGESTIONS

In view of the apparent change in policy with respect to the use of schedule incentives as discussed below, GAO is making no recommendation.

AGENCY ACTIONS AND UNRESOLVED ISSUES

In October 1969, NASA and the Department of Defense issued a joint incentive contracting guide that describes improved incentive contracting techniques With respect to schedule incentives, the new guide suggests that, usually, it is not advisable to provide rewards in order to advance delivery schedules and that, generally, penalty-only incentives are the most appropriate means of ensuring delivery on schedule. GAO believes that the new guidelines, if properly implemented, should preclude a recurrence of the situations described in this report. (See pp. 33 and 34.)

MATTERS FOR CONSIDERATION BY THE CONGRESS

GAO believes that the matters discussed in this report will be of interest to the Congress in its continuing assessment of Government procurement policies and procedures and in overseeing NASA's management of the Space Program.

CHAPTER 1

INTRODUCTION

The General Accounting Office has reviewed the policies, procedures, and practices followed by the National Aeronautics and Space Administration in the development of incentive provisions for selected Saturn V stage contracts awarded by the George C. Marshall Space Flight Center, Huntsville, Alabama.

Our review was directed primarily toward (1) determining whether the incentive arrangements of the contracts for the production of launch vehicle stages were consistent with the needs of the Apollo Program and (2) evaluating the need for the emphasis placed on schedule incentives in the contracts. We did not attempt to evaluate the overall effectiveness of incentive-fee type contracts. The scope of our review is described on page 35.

The principal NASA officials responsible for the administration of the activities discussed in this report are listed in appendix IV.

The Office of Manned Space Flight (OMSF) at NASA Headquarters has primary responsibility for the management of all manned space flight programs approved by the NASA Administrator. In carrying out this responsibility, OMSF has three field centers under its direction: MSFC, the Manned Spacecraft Center (MSC), and the John F. Kennedy Space Center (KSC). MSFC is responsible for the design, development, and test of launch vehicles and space transportation systems for manned space flights. MSC's primary mission is the development of spacecraft for manned space flights and the conduct of manned space flight operations. KSC serves as the primary center within NASA for the checkout and launch of space vehicles.

The ultimate objective of the Apollo Program--the third of NASA's manned space flight programs--was the landing of men on the moon for limited observation and exploration and returning them safely to earth. For this mission and subsequent lunar missions, MSFC developed the Saturn V

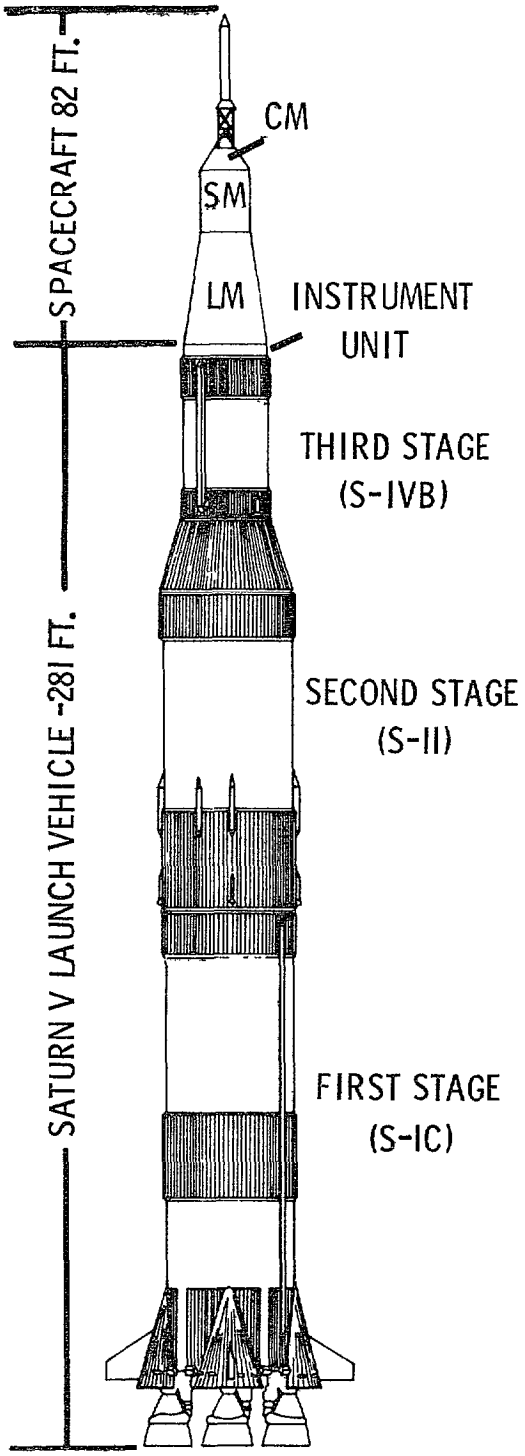
launch vehicle which consists of four major components: the S-IC first stage or booster, the S-II second stage, the S-IVB third stage--also used as the second stage of the Saturn IB launch vehicle--and the instrument unit (IU). A picture of the Saturn V launch vehicle appears on the next page. A total of 15 Saturn V flights are planned for the Apollo Program and the vehicles for these flights are numbered consecutively from 501 to 515. The stages corresponding to these vehicles are also numbered consecutively, beginning with S-IC-1, S-II-1, and S-IVB-501. Thus the Saturn 501 vehicle includes the S-IC-1, the S-II-1, and the S-IVB-501 stages and an IU.

The successful lunar landing mission in July 1969 was launched by Saturn V-506. NASA plans to utilize the remaining launch vehicles for additional lunar exploration missions. As of September 1969 nine Saturn V vehicles had been delivered, two additional vehicles were being tested prior to acceptance by NASA, and the stages for the remaining four vehicles were being assembled. The stages for the last vehicle, Saturn V-515, were scheduled to be delivered in December 1970

The first two S-IC flight stages were fabricated in-house by MSFC; the remaining 13 S-IC flight stages were contracted for in groups of eight and five. The S-IVB flight stages for the Saturn V vehicle were contracted for in groups of six and nine, and the 15 S-II flight stages were procured in groups of 10 and five. In each case the initial contract for the first group of stages was awarded on a cost-plus-fixed-fee (CPFF) basis. Under a CPFF contract the Government reimburses the contractor for actual costs incurred and, in addition, pays the contractor a predetermined fixed fee.

Although no precise date can be fixed as the time when NASA decided to utilize incentive-fee type contracts, it was NASA's policy as early as September 1962 to include incentive provisions in its contracts. In a letter to the directors of NASA field centers, dated February 25, 1963, the NASA Associate Administrator encouraged the field centers to use incentive provisions in their contracts as a means of reducing costs, maintaining schedules, and obtaining superior hardware.

SATURN V LAUNCH VEHICLE



FIRST STAGE (S-IC)

DIAMETER	33 FEET
HEIGHT	138 FEET
WEIGHT	5,022,674 LBS. FUELED 288,750 LBS. DRY
ENGINES	FIVE F-I
PROPELLANTS	LIQUID OXYGEN (3,307,855 LBS., 346,372 GALS.) RP-I (KEROSENE) - (1,426,069 LBS , 212,846 GALS.)
THRUST	7,653.854 LBS AT LIFTOFF

SECOND STAGE (S-II)

DIAMETER	33 FEET
HEIGHT	81.5 FEET
WEIGHT	1,059,171 LBS. FUELED 79,918 LBS. DRY
ENGINES	FIVE J-2
PROPELLANTS	LIQUID OXYGEN (821,022 LBS , 85,973 GALS) LIQUID HYDROGEN (158,221 LBS., 282,555 GALS)
THRUST	1,120,216 TO 1,157,707 LBS.
INTERSTAGE	1,353 (SMALL) 8,750 (LARGE)

THIRD STAGE (S-IVB)

DIAMETER	21 7 FEET
HEIGHT	58.3 FEET
WEIGHT	260,523 LBS FUELED 25,000 LBS. DRY
ENGINES	ONE J-2
PROPELLANTS	LIQUID OXYGEN (192,023 LBS., 20,107 GALS.) LIQUID HYDROGEN (43,500 LBS., 77,680 GALS.)
THRUST	178,161 TO 203,779 LBS
INTERSTAGE	8,081 LBS.

INSTRUMENT UNIT

DIAMETER	21.7 FEET
HEIGHT	3 FEET
WEIGHT	4,306 LBS.

This report deals with the conversion of the CPFF contracts for the first group of S-1C and S-IVB stages to cost-plus-incentive-fee (CPIF) contracts and with the incentive provisions incorporated into these contracts by NASA. Although MSFC planned to convert the S-II stage contract to a CPIF contract, because of a number of problems, the initial and the follow-on S-II stage contracts have remained on a CPFF basis. The second group of S-1C and S-IVB stages were procured by MSFC on a CPIF basis, and the contract for the 15 IUs was awarded in March 1965 on a CPIF basis.

A CPIF contract is a cost-reimbursement-type contract that specifies a target fee and typically provides for increasing or decreasing this fee, depending upon the degree to which the contractor meets or exceeds a combination of predetermined cost, schedule, and performance targets. CPIF contracts typically contain the following types of incentive provisions.

Cost incentives--The contract establishes a target cost and provides that the target fee will be increased by a specified percentage of any cost underruns and decreased by a specified percentage of any cost overruns experienced by the contractor.

Schedule incentives--Schedule incentives can be in the form of bonuses, penalties, or a combination of both. The contract specifies a target delivery date and generally provides for an increase in fee if the end item is delivered on or ahead of schedule and/or provides for a decrease in fee if the end item is delivered late. Bonuses and penalties can also be applied to interim milestones in addition to end-item deliveries.

Performance incentives--Performance incentives are intended to motivate the contractor to strive for outstanding technical achievement. "Performance" can refer to the performance characteristics of the item being procured or the technical performance of the contractor. The contract establishes performance targets and provides for the payment of additional or less fee, depending upon whether the contractor exceeds or fails to meet the performance targets.

CHAPTER 2

CONVERSION OF S-IC AND S-IVB CONTRACTS

PAYMENT OF SCHEDULE INCENTIVES NOT NEEDED TO ACHIEVE INTENDED OBJECTIVES

Our review showed that NASA included schedule incentives amounting to about $26.2 million in the S-IC and S-IVB stage contracts in order to accelerate delivery of these stages although, in our view, (1) the delivery of certain stages ahead of schedule did not appear to be compatible with an earlier decision to delay delivery of the stages, (2) early delivery of the stages, had it been desirable, could have been obtained without the additional payments to the contractors, and (3) the additional time for testing and solving prelaunch checkout problems, which NASA was attempting to obtain through the use of schedule incentives, was already available to it.

In late 1964 and early 1965, when NASA was planning to convert the S-IC and S-IVB CPFF contracts to incentive-fee contracts, with emphasis on schedule incentives, it was also implementing a plan to stretch out the Saturn V delivery schedule. The delivery schedule stretch-out was intended to provide more time to make modifications to undelivered stages during the early phases of the program as a result of the experience gained from the ground test program and the initial launches of the Saturn V vehicles. The schedule incentives included in the S-IC and S-IVB stage contracts subsequent to the schedule stretch-out were intended to provide additional time as a hedge against unforeseen test and checkout problems by motivating the contractors to deliver the stages in advance of the scheduled dates. The schedule stretch-out and later acceleration therefore appear to be contradictory.

NASA records indicate that, at the time the contract conversions were being negotiated with the contractors in late 1965, NASA adhered to its decision to emphasize schedule incentives although the then available information showed that the behind-schedule status of the S-II stage and the use of air transportation to deliver the S-IVB

stages would probably provide the additional time to solve unforeseen test and checkout problems. As a result of this decision, NASA paid substantial schedule incentives to the S-IC and S-IVB stage contractors, and we believe that these payments could have been avoided without adversely affecting the Apollo Program.

Agency regulations and guidance relating to incentive objectives

In March 1964 OMSF issued instructions requiring, in part, that its three field centers present proposed incentive arrangements for selected procurements to OMSF for approval prior to negotiating incentive provisions for inclusion in the contracts. The purpose of the prenegotiation review and approval by OMSF was to provide contract negotiators with well-defined guidelines that would ensure adequate recognition of important program considerations bearing upon or affected by the procurement.

In December 1964 the Associate Administrator, OMSF, (1) requested that MSC and MSFC make certain that they had identified all contracts that should include incentive provisions and (2) established the goal of incorporating incentive provisions in these contracts by the end of calendar year 1965. Also, MSC and MSFC were requested to establish timetables to accomplish this goal and to advise OMSF of their plans. In accordance with this request, MSC and MSFC developed plans which ultimately encompassed the conversion of all the major Apollo CPFF hardware contracts to incentive-fee contracts.

With respect to the use of incentive-fee contracts, the NASA Procurement Regulation cautions that, without proper balancing of incentive objectives, the Government may receive, at unwarranted expense, a product of greater quality than desired or delivery of the product before it is needed. The regulation states further that particular care and judgment is required in framing the specific incentive terms of a given procurement. The NASA Incentive Contracting Guide, which was issued to provide authoritative guidance and sound precepts to NASA personnel concerned with incentive contracts, recognizes that, in many cases, early delivery of hardware may be of no use to NASA

and recommends the elimination of rewards for early delivery when delivery in advance of the target date is of no value.

In our opinion both the procurement regulation and the incentive contracting guide contemplate, as a prerequisite to the effective application of incentive provisions, a comparison of the benefits to be derived from the use of incentives with the costs to be incurred.

Decision to emphasize schedule incentives coincided with stretch-out in Apollo delivery schedule

On December 4, 1964, OMSF provided MSFC and MSC with guidelines to be used in developing incentive arrangements for the Apollo CPFF hardware contracts that were to be converted to incentive-fee contracts during the ensuing year. These guidelines provided for the use of multiple incentive arrangements with greater emphasis on cost and schedule incentives than on performance.

At about the same time, plans for a stretch-out in the Apollo delivery and launch schedule were in the final stages of formulation, and on January 2, 1965, the Apollo Program Director provided the three field centers with a proposed delivery and launch schedule revision for their comments and recommendations. On January 15, 1965, MSFC advised the Apollo Program Director of its general agreement with the proposed schedule changes, and on February 16, 1965, he furnished the field centers with a new Apollo Program delivery and launch schedule, designated as the MA-2 schedule.

The MA-2 schedule was the result of an overall assessment of the status of the Apollo Program, made in August and September 1964. The assessment, which NASA called the most comprehensive review of the Apollo Program ever conducted, was undertaken at the direction of the NASA Associate Administrator and included assessments by the program managers at the three field centers, by the major hardware contractors, and by the senior Apollo Program Office officials. The results of this assessment were presented to OMSF top management in September 1964 and to the NASA Associate Administrator in October 1964. The chart presented

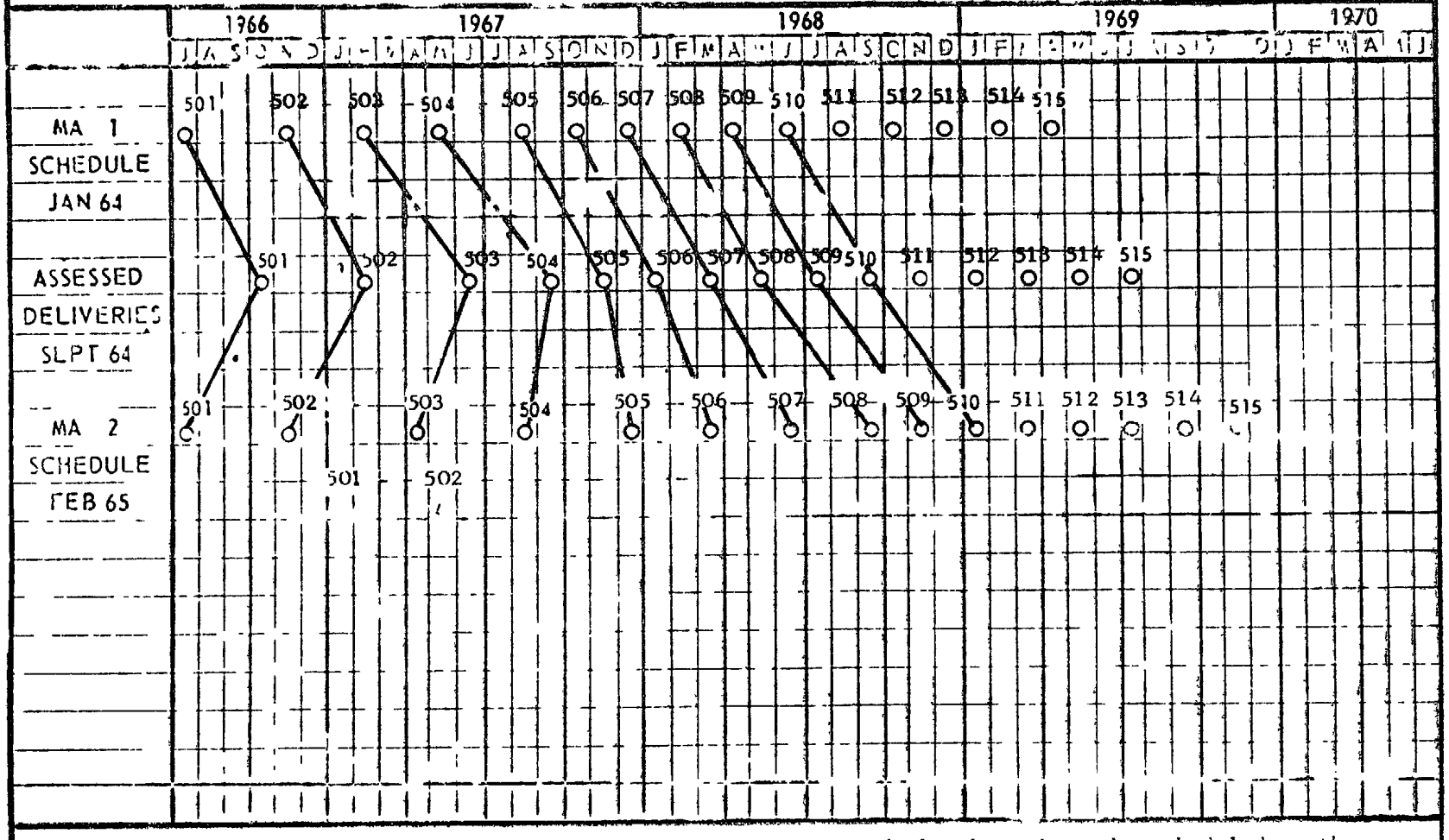
on the next page compares the preexisting MA-1 schedule with NASA's September 1964 delivery schedule assessment and with the MA-2 schedule which resulted from the program assessment.

Under the MA-2 schedule, the delivery dates for the stages for the first two Saturn V vehicles remained the same as those under the MA-1 schedule. The launch date for the first vehicle also remained the same, but the launch date for the second vehicle was extended 1 month. The delivery date for the third Saturn V vehicle (503) was extended 2 months and for each succeeding vehicle the delivery date was extended for increasingly longer periods up to a maximum of 7 months for the delivery of the eighth and all subsequent Saturn V vehicles. As had been the case under the prior MA-1 schedule, the three stages for each Saturn V vehicle were required to be delivered to KSC at about the same time.

During our discussions with Apollo Program officials, they indicated to us that one of the major objectives of the MA-2 schedule was to lengthen the intervals between deliveries of the stages and between launches of the vehicles to provide additional time to make modifications to the vehicles as a result of the experience gained or problems encountered in the ground test program or from the initial Saturn V flights. In his comments on the MA-2 schedule, the Director, MSFC, indicated that another benefit of the stretch-out was that it would enable MSFC to defer incurring costs on stages to be delivered later in the program, and thus would reduce the funding requirements of the Apollo Program during its peak years.

During February to April 1965, MSFC took action to incorporate the MA-2 delivery schedule into the various hardware contracts. At about the same time, OMSF developed refined incentive guidelines. By letter dated April 8, 1965, and at a conference on incentive contracts held at MSFC on April 9, 1965, OMSF officials furnished guidelines to MSFC which provided that, when incentive arrangements for the Apollo contracts were being developed, emphasis should be placed on schedule, cost, and performance, in that order. OMSF also advised MSFC that prenegotiation conferences with OMSF would be required for each of the major system

MA-1/MA-2 DELIVERY AND LAUNCH SCHEDULE COMPARISON



contracts to be converted to an incentive-fee type contract before negotiations with the contractors were undertaken.

In April and May 1965, subsequent to the issuance of the refined incentive guidelines providing for emphasis on schedule incentives, MSFC approved the amendments to the three stage contracts that incorporated the stretched-out delivery dates of the MA-2 schedule.

Our review of the S-IC and S-IVB contract files showed that, prior to negotiating the MA-2 schedule changes with the contractors, MSFC had estimated that the cost of delaying delivery of these two stages would be about $22 million. The total of the contractors' estimates of the cost of delaying delivery of the stages was about $33 million. However, the amendments to the S-IC and S-IVB stage contracts incorporating the MA-2 schedule revision were negotiated as part of lump-sum settlements of a number of outstanding contract change orders to each contract. Therefore, we could not determine the exact increase in the target cost of each contract attributable to the MA-2 schedule revision. However, on the basis of the cost estimates of MSFC and the contractors prior to negotiation of the contract amendments and on the basis of the negotiated amount of the lump-sum settlements, it appears to us that the increases in the target costs for extending the S-IC and S-IVB delivery schedules were agreed to at an amount between $22 million and $33 million.

On April 20, 1965, at a meeting of top-management officials from NASA Headquarters and the field centers, the forthcoming contract conversion of the CPFF contracts to incentive-fee contracts and the guidelines to be followed were discussed further and the Associate Administrator, OMSF, reiterated that emphasis should be placed on schedule, cost, and performance incentives, in that order.

The MSFC records we reviewed indicated that a number of MSFC officials had reservations with respect to placing emphasis on schedule incentives and also that MSFC had difficulty in formulating incentive arrangements which were responsive to the needs of the Apollo Program and, at the same time, were within the guidelines established by OMSF. However, we found no evidence to indicate that the

difficulty experienced had been communicated to OMSF, and, in September and October 1965, MSFC presented its proposed incentive arrangements for the S-IVB and S-IC contracts to OMSF for approval.

These proposals were prepared in accordance with the OMSF guidelines in that schedule incentives were emphasized over cost and performance incentives. MSFC's records show however that the proposed schedule incentives were designed to ensure that reliable flight stages would be delivered in accordance with the MA-2 schedule and did not provide incentives for delivery of the stages ahead of the schedule dates. Instead, MSFC's proposed schedule incentives for the S-IC contract provided for (1) the payment to the contractor of a target fee if the stages were delivered no more than 5 days late, (2) payment of the maximum schedule incentive fee if the stages were delivered on schedule, and (3) the assessment of penalties against the contractor if the stages were delivered more than 5 days late.

The schedule incentives proposed by MSFC for the S-IVB contract provided for (1) the payment to the contractor of a target fee if the stages were delivered no more than 1 day late, (2) payment of the maximum schedule incentive fee if the stages were delivered on schedule, and (3) the assessment of penalties against the contractor if the S-IVB stages were delivered more than 1 day late. The MSFC proposals provided for schedule incentive fees of $9.3 million and $3.6 million to be incorporated into the S-IC and S-IVB stage contracts, respectively.

At the prenegotiation conferences the Associate Administrator, OMSF, directed MSFC to modify its proposed incentive arrangements for both the S-IC and S-IVB stages in order to motivate the contractors to deliver the stages earlier than scheduled.

In this regard the Associate Administrator, OMSF, directed that the S-IC stages should be delivered 6 weeks early, and this provision was incorporated by MSFC into its proposal. The documents we reviewed did not show whether the Associate Administrator, OMSF, had specified the number of days that the S-IVB stages should be delivered ahead of the MA-2 schedule. However, MSFC's revised incentive

proposal, which MSFC officials advised us had been prepared in accordance with the Associate Administrator's direction and had been approved by OMSF, included incentives for delivery of the S-IVB stages 4 weeks ahead of schedule.

The negotiations with the contractors for the conversion of the S-IC and S-IVB stage CPFF contracts to CPIF contracts were conducted during the period September 1965 to January 1966. In general terms the multiple incentive arrangements agreed to by NASA and the contractors established schedule, cost, and performance targets and provided for the upward or downward adjustment of the contract fee if the contractor exceeded or failed to meet these predetermined schedule, cost, or performance targets.

The schedule incentive provisions agreed to for the S-IC stages (S-IC-3 through S-IC-10) provided for a total increase of $20.8 million[1] in the contract fee for delivering the stages 6 weeks in advance of the MA-2 schedule delivery dates. No additional fee would be paid if the stages were delivered on schedule, and penalties would be assessed if the stages were delivered late. The amount of the schedule incentives, when added to the S-IC contract target fee of about $25 million, equaled the maximum fee of about $46 million provided for in the contract. Thus, as a result of the emphasis placed on the schedule incentives, the contractor could receive the maximum fee provided for in the contract without either underrunning the target costs or exceeding the performance goals. The contract amendment converting the S-IC contract to a CPIF contract was signed by MSFC and the contractor in December 1965 and approved by NASA Headquarters in March 1966.

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[1] A total of $3.9 million in schedule incentives for the S-IC and S-IVB stages was applicable to the early accomplishment of schedule milestones other than final delivery. However, in our opinion, the early accomplishment of these milestones was intended to aid in the accomplishment of the main objective of delivering the S-IC and S-IVB stages early. Hence, in our view, the entire $26.2 million in schedule incentives was directly related to delivery of the stages in advance of the MA-2 schedule dates.

The schedule incentive provisions agreed to for the Saturn V, S-IVB stages 501 through 506 provided for an increase of about $5.4 million[1] in the contract fee for the delivery of these stages generally 30 days ahead of the MA-2 schedule delivery dates. No additional fee would be paid if the stages were delivered on schedule and penalties would be assessed if the stages were delivered late. In order to have earned the maximum fee under the contract, however, the contractor would have had to underrun the target costs and exceed the performance targets as well. The negotiation of the contract amendment converting the S-IVB contract to a CPIF contract was completed in January 1966. The contract amendment was signed by the contractor and MSFC in April and May 1966, respectively, and was approved by NASA Headquarters in June 1966.

We believe that delivery of the S-IC and S-IVB stages in advance of the dates provided for by the MA-2 schedule could have been obtained without providing for the payment of substantial schedule incentives. As shown on page 11, the MA-2 schedule established delivery dates for Saturn V vehicles 505 through 510 that were 1 to 4 months later than NASA's September 1964 assessment of when these vehicles could be delivered. Nevertheless, after implementing the MA-2 schedule revision in April and May 1965, NASA decided in September and October 1965 that it was appropriate to pay substantial bonuses--$15.3 million of the $26.2 million in schedule incentives--to obtain early delivery of S-IC stages 5 through 10 and S-IVB stages 505 and 506, and in so doing, reverted to delivery dates that the September program assessment indicated could be met.

It appears to us that, had NASA merely reduced the extent of the MA-2 schedule stretch-out in February 1965, it could have obtained delivery of the stages on the dates desired without added cost to the Government. Moreover, although we believe that early delivery could have been achieved without provision for the payment of schedule incentives, we believe also that the decision to accelerate the delivery of the S-IC and S-IVB stages was inconsistent

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[1]See footnote 1 on page 14.

with the purpose of the MA-2 schedule revision, which we understand was to provide longer intervals between the stage deliveries for later vehicles and the initial Saturn V launches in order to allow sufficient time to make any necessary modifications to the vehicles.

Adoption of air transportation negated the need for S-IVB early delivery incentives

We found that the delivery dates provided for by the MA-2 schedule were based on shipment of the stages to KSC by water transportation. In the case of the S-IVB stages, the contract delivery dates were set 4 weeks in advance of the dates KSC would need the stages, in order to provide sufficient time for delivery by ocean transportation. On September 1, 1965, just prior to the start of negotiations with the S-IVB contractor for the conversion of the contract from CPFF to CPIF, the Associate Administrator, OMSF, recommended to the NASA Deputy Associate Administrator that NASA utilize an aircraft having large cargo capabilities--the Super Guppy, which was then expected to become available for final testing in October 1965--to transport the S-IVB stages to KSC.

On December 1, 1965, NASA contracted for the use of the Super Guppy aircraft contingent upon the aircraft's successfully completing certain tests to NASA's satisfaction. According to information furnished to us by NASA, test flights, covering 26,600 miles, were made of the Super Guppy aircraft between December 1, 1965, and March 25, 1966, including a number of test flights with a dummy S-IVB stage. On March 25, 1966, the primary mode of transportation for S-IVB stages was changed by NASA from water to air. We were advised by NASA that on April 6, 1966, about 2 months prior to approval by NASA Headquarters, in June 1966, of the contract amendment incorporating early delivery incentives into the S-IVB contract, it began airlifting S-IVB flight stages to KSC on the Super Guppy.

Since delivery by air only takes about 1 day, NASA, in effect, accelerated the delivery of S-IVB stages to KSC by about 4 weeks by changing the mode of transportation from water to air. Since the best S-IVB schedule position NASA hoped to achieve through its use of schedule incentives was a 4-week acceleration and since the change in the mode of transportation in March 1966 provided this additional time, there is some question, in our opinion, as to the need in June 1966 for amending the S-IVB contract to provide for early delivery incentives.

Behind-schedule status of S-II stage negated the need for early delivery of S-IC and S-IVB stages

From October 19 through November 4, 1965, during the period that negotiations for the conversion of the S-IC and S-IVB contracts were under way, a survey team headed by the MSFC S-II stage manager conducted a review of the S-II stage contractor's operations. The survey team concluded that the initial S-II stages would be delivered late and that, on a tight schedule, the first three S-II flight stages would be delivered to KSC 19, 17, and 6 weeks late, respectively. According to the survey team's report, no assessments were made for subsequent S-II stages.

From November 22 through December 6, 1965, a second management review team headed by the Apollo Program Director conducted a review of the S-II contractor's operations. The members of this review team were specifically chosen because of their experience with the contractor and their intimate knowledge of the S-II program, and their findings were considered by NASA to be the culmination of the judgments of Government personnel directly involved with the program.

The review team's report, which was furnished to the contractor on December 19, 1965, stated that the S-II stage manufacturing was at least 5 months behind schedule and that extraordinary effort would be required if the contractor were to maintain this schedule, let alone improve it.

The Apollo Program Office, during the period that these management reviews were being conducted, considered the status of the S-II stage to be critical, but, at the same time, characterized the S-IC and S-IVB stages as being in "good shape" and thus free of any major weaknesses.

In view of the review team's findings that the S-II stages would be late, it appeared to us that there was little benefit to be gained by paying schedule incentives to the S-IC and S-IVB contractors to achieve even earlier delivery than provided for by the MA-2 schedule. Accordingly, on March 13, 1968, we requested the Associate Administrator, OMSF, to advise us of the reasons for including early delivery incentives in the S-IC and S-IVB contracts.

By letter dated May 23, 1968, the Associate Administrator, OMSF, advised us that early delivery of the S-IC and S-IVB stages was desirable, in order to provide additional time for testing to ensure reliability and as a hedge against unforeseen development problems.

Although our discussions with MSFC officials disclosed that there were no specific additional tests to be performed, an Apollo Program Office official with whom we discussed this matter advised us that early delivery of the S-IC and S-IVB stages was desirable because certain operations associated with assembly and checkout of the Saturn V vehicle at KSC prior to launch could be expected to require more time than originally planned because of unforeseen problems. In commenting on our draft report, OMSF stated that the added time would be used for test time overruns, additional test requirements emanating from the ground and qualification test programs, mandatory design changes, and test reruns. (See p. 70.)

Although we do not question the possibility of unforeseen problems, it appears that time was provided in the MA-2 schedule for just such contingencies. The Apollo Program Director, in transmitting the MA-2 schedule to the field centers for comment in January 1965, stated that the preflight checkout flow time provided by the MA-2 schedule contained a reasonable allowance for contingencies. (Also see pp. 26 and 27 on this matter.) Moreover, as discussed earlier in this report, one of the objectives of stretching out the delivery schedule in February 1965 was to provide additional time in which to solve problems arising from either the ground test program or the initial Saturn V flights.

In addition, on the basis of the review team's assessment of the schedule status of the S-II stage in December 1965, it appears to us that additional time for testing the S-IC and S-IVB stages was available because the S-II stage, which was characterized by NASA as being technically the most sophisticated but the least mature of the Saturn V's major components in late 1965, was then substantially behind schedule. In this connection, the Apollo Program Director, prior to conducting the review of the S-II stage contractor's operations, stated that the development and testing of the S-II stage would determine when the first

Saturn V could be launched and when confidence in the Saturn V vehicle would be attained.

SUBSEQUENT DELETION OF SCHEDULE INCENTIVES

The S-IC stage contractor earned about $7.4 million in incentive fees by delivering the stages in advance of the MA-2 schedule delivery dates. (See app. I.) However, as a result of various problems in the Apollo Program which caused launch delays, each of the stages for which NASA paid early delivery incentives had to be placed in storage prior to being shipped to KSC. On June 20, 1967, the Associate Administrator, OMSF, directed MSFC to negotiate a revised incentive arrangement for those S-IC stages that had not yet been completed, and on September 1, 1967, MSFC directed the contractor to continue to store S-IC stages 4 through 6 and to place all subsequent stages in storage upon completion of manufacturing but prior to being test fired.

On November 13, 1967, MSFC and the S-IC stage contractor entered into an agreement wherein the contractor agreed to accept a delivery schedule change provided that an equitable contract price adjustment, including adjustment of the incentive-fee provisions, could be negotiated which would not leave the contractor in a less favorable position. The available information indicates that, at the time this agreement was made, the S-IC stage contractor was in a position to earn sufficient schedule incentives to ensure the receipt of the maximum contract fee.

The contract amendment negotiated by MSFC pursuant to the November 13, 1967, agreement deleted all early delivery incentives that were still unearned and increased the fee that the S-IC stage contractor could earn by underrunning costs. Also, the contract target cost and the target fee were increased $22 million and $1.5 million, respectively, as a result of the schedule change.

The incentive provisions of the S-IVB stage contract were revised as a result of an accident which destroyed the S-IVB-503 stage on January 20, 1967. The contract amendment negotiated by MSFC (1) deleted from the contract the schedule incentives applicable to the destroyed stage, (2) revised the delivery dates for S-IVB stages 504, 505, and 506

and redesignated them as 503N, 504N, and 505N, respectively, and (3) provided for a replacement S-IVB stage for Saturn V-506. The revised delivery dates required the storage of S-IVB -504N and -505N for about 5 to 6 months prior to delivery.

As shown in appendix I, the S-IVB stage contractor earned a total of about $4.1 million in schedule incentives.

CHAPTER 3

AGENCY AND CONTRACTOR COMMENTS AND OUR EVALUATION

By letter dated April 10, 1969, NASA's Associate Administrator for Organization and Management (O&M) furnished us with the agency's comments on our draft report. NASA did not agree with our findings and conclusions, and the full text of its comments, including those prepared by OMSF, are included in this report as appendix II.

The Associate Administrator for O&M stated that the incentive provisions of the Saturn V contracts recognized the performance status of those contracts at the time of contract conversion. He stated also that the incentive provisions reflected a total management judgment involving the adjustment of open changes, the status of the Apollo Program at that time, anticipated progress, past experience, available resources, and the objective of program completion by the end of the decade. He stated further that: "The conclusion is inescapable that the management decisions that were made, including the incentive structures for certain Saturn V contracts, did lower on-going costs and will contribute to total program accomplishment for the least cost."

As discussed earlier in this report, the incentive-fee arrangements for the S-IVB and S-IC contracts were developed in accordance with the decision made in late 1964 and early 1965 to place the major incentive emphasis on schedule rather than cost and performance. In our opinion, as discussed on pages 17 through 20, the emphasis on schedule incentives did not reflect the status of the program at the time of negotiations, because it ignored not only the imbalance that existed between the progress of the S-II stage contractor and the progress of the S-IC and S-IVB contractors but also the planned use of the Super Guppy aircraft for transporting the S-IVB stages to KSC. Further, the decision to use incentives to motivate the contractor toward early delivery of the S-IC and S-IVB stages was inconsistent with the stated technical rationale behind the MA-2 schedule

stretch-out, that is, the need to allow more time between stage deliveries and between launches to enable modification of the stages as a result of experience gained from the ground test program and early flights.

With respect to lower program costs, we do not question that the use of incentive-fee contracts, particularly the use of cost incentives, can result in lower program costs. However, as shown in appendix I, the S-IC and S-IVB contractors earned about $11.5 million in schedule incentives. We believe that, to the extent that it was not necessary to pay incentives to achieve early delivery, total program costs will be higher than necessary.

The Associate Administrator for O&M stated also that the $22 million to $33 million range, cited by us in this report as the estimated cost of the MA-2 schedule adjustment, reflected inadequate consideration of many factors dealt with in NASA's and OMSF's comments. The essence of OMSF's comments and our evaluation thereof are discussed in the following sections of this report. However, as discussed earlier, the $22 million to $33 million range cited in this report represents the prenegotiation estimates of NASA and the contractors, respectively, of the cost of implementing the MA-2 delivery schedule.

MA-2 SCHEDULE RATIONALE

OMSF stated that the data developed during the 1964 program assessment unequivocally showed that the program was 3 to 5 months behind schedule and, on the basis of past performance, action had to be taken to form a new realistic schedule base to keep the program from deteriorating further.

OMSF stated also that between September 1964 and February 1965 it made a thorough analysis of the material gathered during the program assessment, to which was added the expert judgment of the Apollo Program Director and his staff. OMSF stated further that this judgment, which had considered the scope of the problem ahead, the acceleration of the first manned launch from Saturn V -507 to -503, and the design, development, and manufacturing capability of

the contractors, had considerably influenced the final outcome of the MA-2 schedule.

During our discussions with Apollo Program officials subsequent to receiving OMSF's comments, they indicated to us that, although there was no documentation of these considerations and of how they had influenced the decision to adopt the MA-2 schedule, the interval between the deliveries and between the launches of the early Saturn V vehicles in the program were lengthened as a result of the judgment of the program office. They indicated also that the additional time gained was intended to provide time to make modifications to undelivered vehicles by incorporating changes resulting from either the ground test program or the initial Saturn V flights.

The rationale of the Apollo Program Office for the decision to implement the MA-2 schedule seems reasonable to us and appears to be supported by the incentive arrangements initially proposed by MSFC, which were directed to ensuring that delivery of the stages be made on time rather than early. The fact that the incentive arrangements proposed by the officials responsible for development, production, and testing of the stages did not provide for early delivery seems to indicate that delivery ahead of schedule was not mandatory and, perhaps, not particularly desirable.

OMSF advised us that, concurrent with adopting the MA-2 schedule, it made the decision to incorporate incentives into the Apollo prime contracts as a positive way of motivating the contractors to hold or to better this schedule.

We believe that the use of substantial schedule incentives to motivate the contractors to maintain the MA-2 schedule is questionable since NASA's assessment indicated that, for the most part, the stages could have been delivered well in advance of the MA-2 schedule delivery dates. In addition, OMSF's position that the decision to incorporate incentive provisions into the contracts also contemplated an acceleration of launch vehicle deliveries does not, in our view, appear supportable. First, as indicated by the incentive arrangements proposed by MSFC, the decision to incorporate incentive provisions into the contracts was

not interpreted by MSFC to include early delivery. Second, accelerating the delivery schedule would allow less time to make modifications to stages not yet delivered and would thus be in conflict with one of the major objectives of the MA-2 schedule stretch-out.

When we discussed this apparent conflict with Apollo Program Office officials, they indicated that the schedule incentives in the S-IC and S-IVB contracts were primarily intended to ensure that the stages would be delivered in accordance with the MA-2 schedule; however, they indicated also that early delivery was desirable if it could be achieved.

It seems to us that the incentive provisions of the S-IC and S-IVB stage contracts that provided for the payment of about $26.2 million in early delivery incentives would certainly tend to ensure early delivery since delivery on schedule would result in no additional fee to the contractors. Thus, we were unable to resolve the apparent conflict in the objectives of the schedule stretch-out and the use of early delivery incentives.

OMSF stated that, until a major accident had occurred in January 1967, it had been capitalizing on the earlier hardware deliveries that were the result of the schedule incentives by planning to launch the vehicles up to 2 months earlier than provided for in the MA-2 schedule. NASA referred us to extracts from Apollo Program Directives issued in September and November 1966 as evidence of the plan to launch early.

We do not dispute the fact that, by the latter part of 1966, NASA planned to take advantage of the then anticipated earlier hardware deliveries by launching early. Neither do we dispute the fact that launching early would have been desirable. Launching earlier than provided for in the MA-2 schedule, however, was not indicated as an objective of the decision to obtain early delivery of the stages. (See pp. 18 and 19.) In any event we do not believe that OMSF's comment about early launches is germane to the issue. NASA, in our opinion, could have obtained the S-IC and S-IVB stages on the dates desired without added cost to the Government had it either retained the MA-1 delivery schedule

intact or reduced the extent of the MA-2 schedule stretchout in February 1965. Such courses of action in our opinion not only could have resulted in the stages' being delivered on the dates desired but also presumably could have permitted early launches if desired.

OMSF indicated that the incentive arrangements in the S-IC and S-IVB stage contracts had resulted in lower program costs. (See pp. 80 and 81.) However, OMSF did not provide us with any documentation showing that the lower program costs were attributable to the schedule or other incentive provisions of the contracts. Further, in July 1966, after the S-IC and S-IVB contracts had been converted from CPFF to CPIF, NASA apparently decided that schedule incentives were not as effective as cost incentives in reducing program costs. In July 1966 the Associate Administrator, OMSF, directed MSFC to emphasize cost incentives in the procurement of the second group of S-IC and S-IVB stages in an effort to reduce the cost of the Apollo Program. Moreover, the schedule incentives approved by the Associate Administrator, OMSF, for the second group of S-IC and S-IVB stages provided only for the assessment of a penalty against the contractor if the stages were delivered late. It appears that the Associate Administrator, OMSF, would have continued to emphasize schedule incentives in the follow-on procurements had the lower program costs mentioned by OMSF been primarily attributed to schedule incentives.

KSC PRELAUNCH CHECKOUT

OMSF stated (see p. 65) that the conclusion in our report that the MA-2 schedule had a built-in hedge against unforeseen problems was not compatible with the facts. OMSF stated also that during 1964 KSC had proposed a checkout plan providing for a gradual reduction in preflight checkout time from 5-1/2 months for the 501 vehicle to 3 months for the 505 and subsequent vehicles. OMSF stated further that, although this plan had been used in developing the MA-2 schedule, it had been viewed as being somewhat optimistic and that an additional 1 to 1-1/2 months was added to the KSC proposed checkout plan for vehicles 503 to 507 to provide for unforeseen problems. In addition, OMSF stated that the additional preflight checkout time for the

501 and 502 vehicles had been added by extending the launch intervals between vehicles 501, 502, and 503.

In our opinion the above explanation shows that time to solve unforeseen problems was built into the MA-2 schedule and thus confirms our conclusion.

ADDITIONAL TIME FOR TESTING

OMSF stated that the added time gained from the schedule incentives had been utilized for correcting a number of unforeseen problems. (See pp. 72 and 73.) We do not question the need for having undertaken the work cited by OMSF, nor do we question the desirability of having additional time available for added testing if required. However, it is our view, as stated in other sections of this report, that the added time at KSC could have been obtained without paying schedule incentives for early delivery.

Further, as noted on page 20, each of the S-IC stages for which NASA paid early delivery incentive fees was placed in storage prior to being shipped to KSC. For example, stages S-IC-3 and S-IC-4, for which the contractor earned about $6.4 million in schedule incentives, were placed in storage and not shipped to KSC until about 9 and 13 months, respectively, after having been accepted by MSFC. Also as noted earlier (see p. 21), under the revised incentive arrangement negotiated by MSFC, the S-IVB-504N and 505N stages were to be stored for 5 to 6 months prior to delivery even though the contractor earned about $2 million in schedule incentives for these stages.

DELIVERY SCHEDULE IMBALANCE

With respect to our opinion (see p. 19) that, at the time of the negotiations for the conversion of the S-IC and S-IVB contracts, the behind-schedule status of the S-II stage had provided NASA with additional time to test both the S-IC and S-IVB stages, OMSF stated (see p. 74) that, from late 1965 through the spring of 1966, the behind-schedule condition of the S-II stage was steadily improving. OMSF stated also that by mid-February 1966, MSFC was of the opinion that the actions that had been taken by the contractor and by MSFC since December 1965 had reduced the behind-schedule condition of the S-II-1 stage from 22 weeks to 2 weeks. The essence of OMSF's position seems to be that, although there may have been some imbalance in the anticipated delivery of the three stages in late 1965 and early 1966, this imbalance was soon dissipated; therefore, the need for early delivery of the S-IC and S-IVB stages was not really affected by the S-II status.

The projected improvement in schedule condition referred to by OMSF was the S-II stage contractor's assessment, which was based on a planned reduction of 20 weeks in the time primarily allotted for the testing and checkout of the S-II stage. Further, the contractor's plan was described by MSFC as being "highly optimistic." (See p. 76.) It should be noted that the first four S-II stages were delivered from 6 to 8 months late.

More important, we find it difficult to understand NASA's subscribing to a plan that would substantially reduce the time available for testing the S-II stage, which at the time was considered to be the least mature of the three stages and a critical problem, and would, at the same time, increase at considerable cost to the Government the time available to test the S-IC and S-IVB stages, which were then reported to be in good shape and free of any major weaknesses.

However, we believe that the question of whether the S-II stage project was behind or on schedule during 1966 tends to cloud the underlying issue, that is, adherence by NASA management in late 1965 to an earlier decision to

emphasize schedule incentives for the S-IC and S-IVB stages even though the information at the time of the contract conversion negotiations showed that a great disparity existed in the progress of the three Saturn V stage projects and that the disparity did not appear to be a situation that could be easily remedied.

S-IVB TRANSPORTATION

OMSF stated that it was unreasonable to conclude that in March 1966 a decision could have been made to restructure the S-IVB stage delivery requirements to take advantage of the time to be gained by using the Super Guppy aircraft to transport the S-IVB stages to KSC. OMSF cited two problems experienced by the aircraft prior to its certification and stated that, because of these problems and the absence of operational experience, OMSF would have been very shortsighted and derelict to make a major adjustment in the S-IVB schedule to compensate for the potential time to be gained. OMSF stated also that NASA elected not to adjust the S-IVB delivery schedule until confidence in the aircraft could be established and thereby to retain the capability to revert to water transportation without impacting the S-IVB deliveries to KSC.

As discussed on page 17 , prior to the start of negotiations with the S-IVB stage contractor for the conversion of the contract, the Associate Administrator, OMSF, recommended that the Super Guppy be used to transport the S-IVB stages to KSC. While the negotiations were in process, NASA contracted for the exclusive use of the Super Guppy aircraft. Prior to approval of NASA Headquarters of the amendment converting the contract to CPIF, NASA began airlifting the S-IVB stages to KSC.

We believe that NASA should have recognized that early delivery incentives might not have been needed to accelerate the S-IVB stage deliveries to KSC. In our opinion the pending availability of the Super Guppy should have caused NASA to defer negotiating the schedule incentive provisions with the S-IVB stage contractor. Had the use of the Super Guppy to obtain the added time at KSC subsequently appeared infeasible, the S-IVB stage contract could have been

further amended to provide the contractor with the desired motivation to accelerate deliveries. Even without early delivery incentives in the contract, the delivery of the S-IVB stages would not have been materially affected in the event that the Super Guppy aircraft could not have been used, since NASA still could have reverted to water transportation and could have delivered the stages in time to meet the established KSC need dates.

Also, it should be noted that the first precertification problem mentioned by OMSF occurred about 2 months prior to the time NASA contracted for the exclusive use of the aircraft, and the second precertification problem was overcome by early March 1966. Inasmuch as NASA began using the Super Guppy aircraft to airlift the S-IVB stages to KSC in early April 1966--about 2 months prior to approving the amendment incorporating the early delivery incentives into the S-IVB contract--it obviously had satisfied itself as to the aircraft's reliability.

CONTRACTORS' COMMENTS

Our draft report was submitted to each of the three stage contractors for their review and comment.

The North American Rockwell Corporation, contractor for the S-II stage, made certain suggestions, which we adopted in the preparation of our final report. The Boeing Company, contractor for the S-IC stage, stated that it did not believe it was appropriate to comment on the matters discussed in the report but did state that it believed that "*** schedule incentives do or will serve to reduce the overall cost of a program." We have not included North American's or Boeing's comments as appendixes to this report.

The McDonnell Douglas Astronautics Company (MDAC), contractor for the S-IVB stage, advised us, in essence, that the decision to use incentive provisions in its contract with NASA, particularly the schedule incentives, was the key to the program's achievements culminating in the successful lunar landing mission.

MDAC stated that a number of ultimate program and contractual objectives had been established by NASA at the time of contract conversion, and that the achievement of these objectives by MDAC was due in large part to the incentive provisions of its contract, which effectively motivated MDAC in a number of management and technical areas. (The full text of MDAC's comments are included in this report as app. III.)

However, there are means, other than schedule incentives for early delivery, that can be used to motivate contractors to achieve predetermined objectives and that are, we believe, more in the Government's interest. In our opinion, this is evidenced by (1) NASA's decision in July 1966 to include only schedule penalty provisions in the contract amendments for the procurement of the second group of S-IC and S-IVB stages, and (2) the guidelines in the joint Department of Defense (DOD)/NASA incentive contracting guide issued in October 1969 (see p. 33) which provide that, usually, rewards for delivery ahead of schedule should not be paid.

CHAPTER 4

CONCLUSIONS

In our view, had delivery of the S-IC and S-IVB stages in advance of the MA-2 schedule delivery dates been desirable, it could have been obtained by not incorporating the full extent of the MA-2 schedule stretch-out into the stage contracts. We believe that such a course of action could have resulted in the stages' being delivered on the dates desired and in avoidance of the need for NASA to subsequently agree to pay schedule incentives of about $26.2 million.

Although we discussed this course of action a number of times with NASA officials, we were not advised, in our opinion, of any substantive reasons that would have precluded NASA from limiting the MA-2 schedule stretch-out when incorporating the revised delivery dates into the S-IC and S-IVB stage contracts. In this regard, the MA-2 schedule was not initially incorporated into all the launch vehicle contracts. The delivery schedule for the IU remained on the MA-1 schedule until October 1966--about 20 months after the centers had been advised to incorporate the MA-2 schedule into the hardware contracts. The IU project manager stated in a memorandum dated September 23, 1966, that the MA-2 schedule had not been incorporated into the IU contract because he

> "*** elected to keep the pressure on *** [the contractor] during the initial phase of operations to insure meeting the later MA-2 dates."

When the IU project manager determined that the IU contractor was capable of meeting the required schedule dates, the MA-2 schedule was incorporated into the contract.

We believe further that, even after incorporating the MA-2 schedule into the stage contracts, NASA could have avoided paying schedule incentives to obtain extra time to conduct unplanned tests on the S-IC and S-IVB stages. At the time that negotiations were held with the S-IC and S-IVB

contractors to convert the contracts from CPFF to CPIF, NASA program officials were aware that the S-II stage was behind schedule. Unless a major acceleration of the S-II schedule could have been achieved, the S-IC and S-IVB stages, if delivered to KSC on the dates specified, would have been on hand at KSC before the S-II stages arrived and additional time would have been provided for contingencies and unplanned testing in connection with the S-IC and S-IVB stages. We believe therefore that the need to have obtained delivery of the S-IC and S-IVB stages in advance of the required dates is not apparent.

Also, it should be noted that there was no plan to undertake additional tests; the need for such tests would have been due, presumably, to unforeseen problems arising during prelaunch checkout. In this respect, as can be seen by the chart on page 11, if the MA-2 schedule had been met, the first Saturn V vehicle (501) would have been launched and the second Saturn V vehicle (502) would have gone through almost all the KSC prelaunch checkout process by the time the S-IC stage for Saturn V-503--the first S-IC stage on which an early delivery incentive fee was involved--arrived at KSC. Thus, it appears that some of the unanticipated checkout problems for which NASA was attempting to buy time to solve would have already come to light and been solved in the checkout and launch of Saturn V vehicles 501 and 502.

In October 1969 DOD and NASA issued a joint incentive contracting guide to describe improved incentive contracting techniques reflecting the experience gained by the two agencies in the negotiation and administration of more than 5,000 incentive contracts.

The new guide states that generally, penalty-only incentives appear to be the most appropriate for schedule, since schedule is the most difficult program element to control and is usually the least important element to major program success. The guide states also that, even though there is no incentive on schedule, the desire to avoid a record of lateness and the probability that a schedule delay will result in added cost and therefore a lower fee through the application of cost incentives, provides some

inducement for the contractor to fulfill his responsibilities on time.

The new guide notes that, usually, early delivery is of no value to the Government and can, in fact, result in additional costs. The guide states that rewards for advancing delivery schedules are, therefore, generally not advisable.

We believe that the new guidelines, if properly implemented, should preclude a recurrence of the situation described in this report.

CHAPTER 5

SCOPE OF REVIEW

Our review was performed at MSFC, Huntsville, Alabama, and at NASA Headquarters, Washington, D.C. We examined NASA records relating to the incentive provisions contained in selected contracts, NASA's policies and procedures with respect to incentive contracting, and records of Apollo/Saturn V Program assessments. Also, we held discussions with NASA Headquarters and MSFC officials responsible for managing the Apollo Program.

APPENDIXES

TOTAL SCHEDULE INCENTIVES EARNED BY THE CONTRACTORS FOR EARLY ACCOMPLISHMENT OF SCHEDULE MILESTONES ON S-IC AND S-IVB STAGES

Stage number	Incentives earned
S-IC stages (note a):	
S-IC-3	$ 2,124,227
S-IC-4	4,287,309
S-IC-5	321,570
S-IC-6	321,570
S-IC-7	321,570
Total	7,376,246
S-IVB stages:	
S-IVB-501	8,000
S-IVB-502	860,000
S-IVB-504 (redesignated S-IVB-503N)	1,250,000
S-IVB-505 (redesignated S-IVB-504N)	1,145,000
S-IVB-506 (redesignated S-IVB-505N)	875,000
Total	4,138,000
Total	$11,514,246

[a]By contract amendment dated August 22, 1969, the unearned schedule incentives applicable to S-IC stages 5 through 10 were deleted from the contract. The amounts shown for incentives earned on S-IC stages 5 through 7 were earned for early completion of interim schedule milestones prior to November 13, 1967, the date MSFC and the S-IC contractor agreed to negotiate a revised incentive arrangement.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D C 20546

IN REPLY REFER TO D

APR 10 1969

Mr. Morton E. Henig
Assistant Director
Civil Division
U. S. General Accounting Office
Washington, D. C. 20548

Dear Mr. Henig:

This is in reply to your letter of December 18, 1968, requesting our comments on your draft report concerning incentive provisions of selected Saturn V contracts. Detailed comments in amplification of some of the matters discussed herein and on other points contained in your draft report are enclosed as Exhibit A. Comments on the preliminary draft report were contained in a letter to you from Dr. George Mueller, dated May 23, 1968.

As informally outlined to you in our meeting of March 21, 1969, the incentive provisions of the Saturn V contracts which are the subject of your draft report recognize the performance status of those contracts at the time of contract conversion. They reflect a total management judgment regarding many considerations, including the adjustment of open changes, later referred to herein in some detail; the status of the Apollo program at the time; anticipated technical progress; past spacecraft experience; available resources, both actual and anticipated, and the objective of program completion by the end of the decade. It should be emphasized also that the schedules involved in these particular incentive arrangements were compatible with other Apollo contracts and that, as a totality, all contracts were instrumental in achieving a measure of mission and schedule flexibility. The conclusion is inescapable that the management decisions that were made, including the incentive structures for certain Saturn V contracts, did lower on-going costs and will contribute to total program accomplishment for the least cost.

The GAO asserts in the draft report that the cost of the Apollo program "stretchout" could have been reduced if NASA had not incorporated the full extent of the MA-2 schedule into the Saturn V contracts and that NASA could have thereby avoided the payment of schedule incentives. The GAO view appears to be based on the belief that the stage contract schedules should have been adjusted to the desired earlier delivery dates, as distinguished from the MA-2 schedule dates, and that this would have resulted in timely

deliveries without the need for incentive payments. The GAO position is understood as placing reliance upon certain interim conclusions reached by NASA. We believe this reliance to be misplaced because there is failure to recognize all the considerations which finally resulted in the MA-2 schedule. For example, a significant program change not considered in interim thinking concerning the Apollo schedule adjustment was accelerating the first manned flight from Saturn 507 to Saturn 503. The target delivery dates finally included in the MA-2 schedule reflected a management assessment by NASA based upon all pertinent factors which was agreed to by the contracting parties as realistic and equitable in the circumstances.

It may be somewhat misleading to characterize the adjustments in the Apollo program that were made as a "stretchout," for that term implies to some a lengthening due only to budget considerations, whereas contract changes were present and had impact in the matter. As stated earlier, NASA management was cognizant of budget factors, but they by no means dictated the program changes which were effected.

The views expressed above may be better understood through certain background which follows. The MA-2 program schedule was the result of the most comprehensive review of the Apollo program ever conducted. When this review indicated that all of the major elements of the program, including the Saturn V launch vehicle, were behind schedule, it was NASA's judgement, based on prior experience with programs such as Gemini, that positive action was required to place the program on firm, realistic base and to implement methods to hold the program to that base. The base which was established was the MA-2 schedule. Incentive contracting was one of the methods used to maintain the MA-2 schedule.

Experience within NASA with research and development programs had indicated that there is a tendency to design in excess of requirements. While this is a cautious procedure, it results in increased program costs and a lengthened performance period. The Apollo Program Director, therefore, desired a form of contractual arrangement for the Saturn V contracts which contained the optimum balance of performance, cost and schedule motivations. Relevant to the Saturn V contract conversions involving the S-IVB and S-IC stages is the fact that there were a large number of change orders outstanding with an estimated value of $280 to $360 million and $75 to $100 million, respectively. The conversions were negotiated on a total basis, and the process did not include detailed negotiation of each change with specific identification of cost and schedule impact due to each change. The matter of

changes gave the stage contractors the right of schedule or other relief.

In conclusion, we feel that the $22 to $33 million range suggested in the GAO report as the estimated cost of the MA-2 schedule adjustment reflects inadequate consideration of many matters dealt with herein and in Exhibit A. Moreover, it embodies a questionable view of one aspect of a management action without regard to the results achieved by the action. NASA strongly believes, as previously stated, that early delivery incentives did reduce on-going costs, permitted mission adjustments, and will keep total program costs to the minimum obtainable.

Sincerely,

Bernard Moritz for
Harold B. Finger
Associate Administrator for
Organization and Management

Enclosure
Exhibit A -- Detailed Comments

NASA COMMENTS ON GAO DRAFT REPORT ON
INCENTIVE PROVISIONS OF SELECTED SATURN V
STAGE CONTRACTS

The attached comments represent our position regarding the following issues raised by GAO:

(1) MA-2 Schedule Rationale

(2) KSC Prelaunch Checkout Activity Time

(3) Additional Time for Testing, Requirement, and Utilization, Thereof

(4) MA-2 Schedule/Incentive Contract Coordination Between Program and Procurement Officials

(5) S-II Lateness vs. S-IC and S-IVB On-schedule Conditions

(6) Adoption of Air Transportation Negated Need for S-IVB Early Delivery Incentives

(7) Incentive Costs

(8) S-IVB-503 and 504 Schedule Adjustment in December 1966

In conclusion, the incorporation of the MA-2 schedule in the contracts was a realistic reflection of the actual program status at that point in time and what could be expected in the future based on programmatic, technical, budgetary, and contractual considerations. Once this base was formed, we incentivized the contracts in order to provide the motivation necessary to assure contractor performance commensurate with program goals. These goals are being achieved with the least cost to the Government.

for George E. Mueller
Associate Administrator
for Manned Space Flight

MA-2 SCHEDULE RATIONALE

During the summer of CY 1964, it became evident that a comprehensive review of the entire Apollo Program was required to determine the status of the program and the necessary corrective actions needed to bring the program back in balance which was due to intricate technical problems, numbers of outstanding change orders, slippages in ground test programs, late GSE, all of which impacted heavily on a realistic schedule.

This review and assessment was the most comprehensive made of the program up to and since that time. Prior to this review and assessment, and the resulting MA-2 schedule, the Apollo Program had experienced continued significant slippages. Over a period of two years, 1962-1964, program schedules slipped 12 months Subsequent to the implementation of the MA-2 schedule, the program schedules remained constant for two years until the AS-204 accident in January 1967 which required a revamping of the entire schedule picture. Attachment 1, shows this history of schedule slippages and the two year period of stability. NASA attributes this two year stability in schedules to (1) establishing a new program (MA-2 Schedule base) that had a reasonable chance of being met; (2) conversion of the CPFF contract to a CPIF contract which motivated the contractors to hold to that schedule and, if possible, to better it, and (3) other concerted technical and management actions by the Government with the contractors. History shows that NASA was successful in accomplishing its objective of a stable schedule situation. Other benefits that resulted from this condition were lower costs and additional time for solution of unknown problems and/or accelerated launches. Attachment 2 is an extract from the official Apollo Program Directive (APD #4, Revisions E and F) on Program Planning that was issued the fall of 1966. These two extracts show that, until the accident in January, 1967, NASA was capitalizing on the earlier hardware delivery schedule position that was resulting from the schedule incentives by planning to launch up to two months early.

The MA-2 schedule provided a sound basis from which to begin negotiations with the contractors on conversion to incentives. To preclude a repetition of the previously experienced schedule slippages, schedule incentives were proposed that would motivate the contractor to deliver on schedule and even earlier. The use of schedule incentives with the associated fee potential brought the contractor's corporate management into the program more deeply than they had been previously under the CPFF arrangement. This had a salutory effect in reducing nonessential design changes and improving efficiency, thereby increasing the probability of meeting the target schedule as well as reducing program costs.

The program assessment was begun in August 1964 with the announcement to the MSF Centers that an indepth review and assessment of the entire program would be [illegible] Apollo and NASA management from [illegible] and MSF Centers and NASA [illegible] Areas [illegible] a copy of this announcement and [illegible] the breadth [illegible] that [illegible] and assessment was to cover

Attachment 4 is a listing of key documents produced during this review. The initial ones are those produced internally in the Apollo Program Office just prior to the review; the second group lists the contractors' presentations to the review team; the third group the MSF Centers' assessments; and the last group the synopsis of all the material previously gathered that was presented to the NASA Associate Administrator. Pertinent extracts of this material are shown in Attachment 5. The first chart in Attachment 5 is a schedule summary of the status of the program as a result of the review and assessment. It shows the S-IC being 2 months late and the S-II and S-IVB three months late. Further, it depicts for each of these stages the serial impact of these late deliveries projected through the completion of the program.

Attachment 6, extracted from the presentation made to the NASA Associate Administrator on the findings of the assessment, describes in summary form the status of Saturn V program:

a) S-IC Stage - Ground test program is 4 to 6 months late and S-IC-1 fabrication is 2 to 3 months late.

b) S-II Stage - Ground test program is 2 to 5 months late and S-II-1 fabrication is 3 months late.

c) S-IVB Stage - Ground test program is $3\frac{1}{2}$ months late and S-IVB-201 fabrication 3 months late.

(extracted from Saturn IB Summary Attachment 7)

Attachments 5 and 6, and the supporting documentation from which they were extracted unequivocally show that the program was three to five months late, and based on past performance, action had to be taken to form a new realistic schedule base or the program would further deteriorate

Attachment 8, shows the actual schedule trend of not only the AS-501 launch vehicle delivery to KSC but also the major ground test milestone for the S-IC and S-IVB programs; that of initial ground test static firings for each of these programs. It can be seen from these trends that the ground test program was experiencing continuing delays during 1963 and 1964. The last trend shows the slippages that occurred in the completion of the S-II stage common bulkhead, the most important manufactured assembly of the S-II stage.

Attachment 5, as stated earlier, shows the status of the Apollo Program as determined by the program assessment. This status schedule, shown on line 6 of attachment 5A, was presented to NASA Associate Administrator to indicate to him that the program was in trouble and further analysis of the results of the review was required before a firm recommendation for a program adjustment could be made. (Attachment 5A, is a comparison of the MA-1 Schedule, the immediate impact of the program assessment (Sept.'64 Schedule) and the MA-2 Schedule). From late September 1964 to February 1965, when the MA-2 schedule was officially adopted, a thorough analysis of the material gathered in the program assessment was made. To this analysis was added the expert judgment of the Apollo Program Director and his staff. This judgment took into consideration

1. The analysis of the output of the program assessment

2. The scope of the problem ahead:

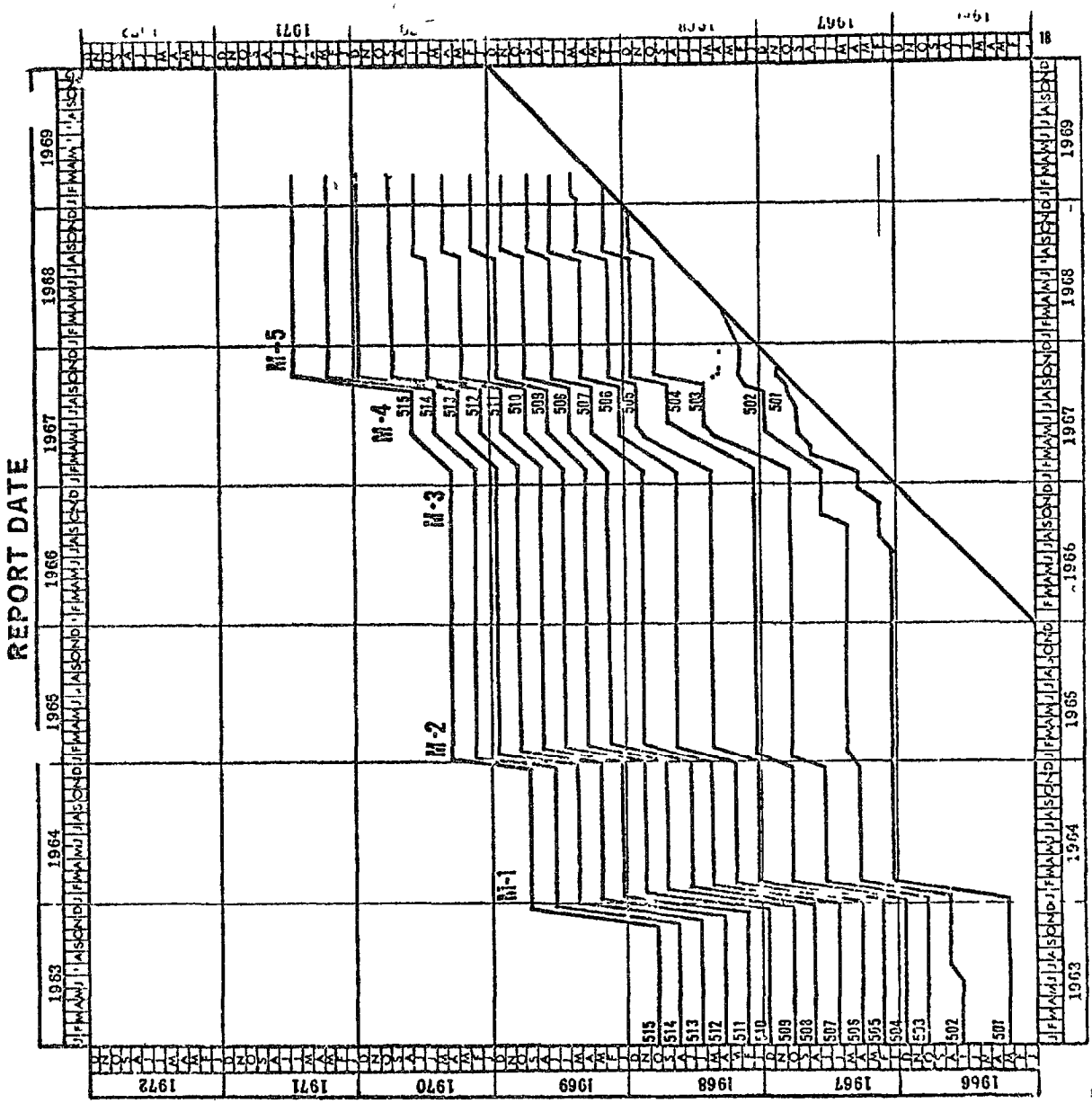
   technical problems

   ground test program

3. The acceleration of the first manned launch from AS-507 to AS-503

4. The design, development, and manufacturing capability of the contractors.

These factors integrated, by the Program Director and his staff with their previous experience with large scale research and development programs, resulted in the MA-2 Delivery and Launch Schedule. As can be seen in Attachment 5A, by comparing the Sept, '64 Schedule and the MA-2 Schedule, this judgement considerably influenced the final outcome of the program adjustment which was the MA-2 Schedule. It was also recognized at this point that unless some method was found to motivate the contractors to adhere to this new realistic Schedule it would not be met, based on the trend of the program at that time under the CPIF contract arrangement. Concurrent with the adoption of the MA-2 Schedule, the decision was made to incentivize the Apollo prime contracts as a positive way of motivating the contractor to hold or better this schedule. It was recognized that incentivization alone would not assure meeting the schedule, but this together with a concerted management effort on the part of the government would enhance the probability of achieving it.



SCHEDULE HISTORY

SATURN V LAUNCHES

SOURCE (S):

BEST DOCUMENT AVAILABLE

5 AS-209/210

These launches are either Apollo or SAA Missions As Apollo these launches are planned as a repeat of the AS-207/208 mission

6 AS-211/212

These launches are either Apollo or SAA Missions As Apollo these launches are planned as a repeat of the AS-207/208 mission

B Saturn V

1. Dynamic Test Program - SA-500F/Pad B Checkout

The S-II-F will be scheduled to arrive at MSFC by 10 November 1966 after completion of Pad A Checkout

MSFC will conduct a minimum Saturn V Dynamic Test Program and return the S-II-F to KSC 19 May 1967.

KSC will complete activation of Pad B in sufficient time to accommodate an AS-504 launch from either Pad A or Pad B.

2. AS-501

The AS-501 launch is scheduled for mid-February 1967 The S-II-1 is targeted for delivery to KSC by 15 November 1966. The launch schedule will be re-evaluated following the S-II-1 delivery to KSC.

3. AS-502

The S-II-2 stage is now targeted for delivery to KSC by 13 January 1967. Delivery of CSM 020 to KSC has been rescheduled from 30 November 1966 to 6 January 1967.

The early May 1967 scheduled launch of AS-502 is unchanged.

4. AS-503

Projected hardware delivery and required checkout time at KSC will allow an early October 1967 launch, as scheduled.

5. AS-504 through AS-515

Projected hardware delivery and planned checkout time at KSC provides a capability for launch one to two months earlier than the official launch schedule in Attachment A.

Source: Apollo Program Directive 4F dated 30 Nov. 1966

The RTCC will utilize the 360 computer programs to support this mission and all subsequent Saturn V missions.

2. AS-502

The Apollo Launch Schedule is 15 June 1967.

To support this launch date hardware delivery to KSC will be

S-IVB-502, S-IU-502	20 January 1967
S-IC-2, S-IU-502	27 January 1967
S-II-2	24 March 1967
CM 020/SM 014	15 March 1967
LTA-2	14 January 1967

MSFC will return the S-II Spacer to KSC by 30 January 1967. KSC will utilize the S-II Spacer for AS-502 pre-launch checkout as required until S-II-2 is available.

3. AS-503

The Apollo Launch Schedule is 21 September 1967.

To support this launch date, hardware delivery to KSC will be

S-IC-3, S-IVB-503, S-IU-503	30 April 1967
S-II-3	31 May 1967
CSM 102	31 May 1967 (SM will not be static fired)
LM-3	1 June 1967

4. AS-504

For this launch, the program will plan a contingency Apollo launch date in the event that the alternate Apollo mission (lunar simulation) is flown instead of the designated primary lunar mission.

Alternate mission planning (Reference B) for this launch calls for a lunar simulation like AS-503. In the event that AS-504 is designated a lunar simulation, the Apollo Launch Schedule will be 6 December 1967. Current flight hardware delivery schedules support this launch date. If the primary AS-504 mission is flown, the launch date will remain February 1968.

Source Apollo Program Directive 4E dated 22 Sept. 66

5. AS-505 through AS-515

Current scheduled hardware deliveries, including early delivery incentives, for these vehicles support launches earlier than the Official NASA Launch Schedule. Apollo Launch Schedules for primary or alternate Apollo missions are established as follows.

AS-505	Mar 68	AS-511	Jun 69
AS-503	Jun 68	AS-512	Aug 69
AS-507	Sep 68	AS-513	Oct 69
AS-508	Dec 68	AS-514	Dec 69
AS-509	Feb 69	AS-515	Feb 70
AS-510	Apr 69		

The stage controlled milestone deliveries for AS-505 through AS-515 have all been advanced one month to accommodate this launch schedule This change is reflected in Attachment D.

6. Dynamic Test Program LC-39 - Pad B Checkout

MSFC will conduct the Saturn V Dynamic Test Program and return the S-IC-F to KSC on dock 15 June 1967 for Pad B checkout.

KSC will conduct Pad B checkout so that Pad B is operational by 15 November 1967.

C. Ground Support Equipment and Site Activation

1. Uprated Saturn I

a. LC-37B LM Capability

LC-37B will be modified for LM capability to allow 1 January 1967 start of 206 launch vehicle checkout

b. LC-34 Block II CSM Capability

Immediately following AS-204 launch, LC-34 will be modified to a Block II CSM configuration in preparation for the AS-205/208 dual mission.

To support this modification, Block II CSM ground support equipment deliveries to KSC must be complete by 1 February 1967.

Source: Apollo Program Directive 4E dated 22 Sept. 66.

PRIORITY
PRIORITY

NASA HEADQUARTERS

UNCLASSIFIED

FYI

DR. JOSEPH SHEA (PO)
MANNED SPACECRAFT CENTER
HOUSTON, TEXAS

DR. ARTHUR RUDOLPH (I-V-DIR)
MARSHALL SPACE FLIGHT CENTER
HUNTSVILLE, ALABAMA

COLONEL LEO JONES (I-I/IB-DIR)
MARSHALL SPACE FLIGHT CENTER
HUNTSVILLE, ALABAMA

MR. HOWARD BELL (I-L-DIR)
MARSHALL SPACE FLIGHT CENTER
HUNTSVILLE, ALABAMA

LT COLONEL R. A. PETRONE (LO-P)
J. F. KENNEDY SPACE CENTER
COCOA BEACH, FLORIDA

INFO: MANNED SPACECRAFT CENTER
HOUSTON, TEXAS
ATTN: DR. ROBERT GILRUTH (D)
MR. GEORGE LOW (D)

MARSHALL SPACE FLIGHT CENTER
HUNTSVILLE, ALABAMA
ATTN: DR. WERNHER VON BRAUN (DIR)
MR. E. ROLS (DEP-T)
MR. R. B. YOUNG (I-DIR)

J. F. KENNEDY SPACE CENTER
COCOA BEACH, FLORIDA
ATTN: DR. ROBERT BERGS (LO-A)

1. THE ASSOCIATE ADMINISTRATOR HAS DIRECTED THAT A SPECIAL

ASSESSMENT OF THE APOLLO PROGRAM BE COMPLETED AT THE EARLIEST

POSSIBLE DATE. THE BACKGROUND WHICH ESTABLISHED THE REQUIREMENT

FOR A IN ASSESSMENT AND DECISIONS THAT COULD RESULT THEREFROM. IT IS DESIRED THAT THIS EFFORT BE GIVEN PRIORITY ATTENTION BY KEY PROGRAM PERSONNEL.

2. THE SCHEDULE FOR COMPLETION OF MY REPORT TO DR. SEAMANS IS AS FOLLOWS:

REPORT COMPLETED - SEPTEMBER 7

REVIEW WITH PROGRAM MANAGERS - SEPTEMBER 8

PRESENTATION TO MANAGEMENT COUNCIL - SEPTEMBER 10

PRESENTATION TO ASSOCIATE ADMINISTRATOR - SEPTEMBER 11

3. MY FINAL EVALUATION AND RECOMMENDATIONS WILL DEPEND HEAVILY ON YOUR ASSESSMENTS. YOU ARE THEREFORE REQUESTED TO CONDUCT AN ASSESSMENT IN DEPTH OF YOUR PROGRAM, THE RESULTS OF WHICH I WILL REVIEW AT YOUR CENTER ON THE FOLLOWING DATES:

KSC - AUGUST 31

MSFC - SEPTEMBER 1 AND 2

MSC - SEPTEMBER 3

YOUR ASSESSMENT SHOULD INCLUDE BUT NOT BE LIMITED TO THE FOLLOWING:

A. REVIEW OF YOUR MASTER DEVELOPMENT PLAN, DEPICTING THE TIME PHASING RELATIONSHIP OF MAJOR PROGRAM ELEMENTS HIGHLIGHTING CRITICAL DEVELOPMENT, TESTING, ASSEMBLY AND CHECKOUT ACTIVITIES LEADING TO THE FIRST MANNED LUNAR MISSION. IT IS ESPECIALLY IMPORTANT THAT

YOUR ASSESSMENT CONTAIN A FORECAST OF THE MILESTONE DATES FOR KEY [illegible], TAKING INTO [illegible] AND FLIGHT TESTS. THIS SHOULD INCLUDE NOT ONLY AN APPRAISAL OF THE CONTRACTORS' ACTIVITIES, BUT ALSO THE NASA'S CAPE CHECKOUT AND FLIGHT OPERATIONS ACTIVITIES AND THE FLIGHT TEST DENSITY RESULTING FROM THE PROPOSED GEMINI, SATURN IB AND SATURN V FLIGHT SCHEDULES.

B. IDENTIFICATION OF PRESENT AND POTENTIAL TECHNICAL PROBLEM AREAS TOGETHER WITH YOUR ASSESSMENT OF THEIR IMPACT ON KEY DELIVERY, GROUND TEST AND FLIGHT DATES.

C. REVIEW OF CENTERS' APOLLO PROGRAM MANNING REQUIREMENTS SHOWING ACTUALS FROM JANUARY 1964 TO DATE AND PROJECTED REQUIREMENTS THROUGH COMPLETION OF THE PROGRAM. RELATE PROJECTED REQUIREMENTS TO YOUR CURRENT CEILING.

D. REVIEW OF YOUR MAJOR CONTRACTORS' MANPOWER AND FUNDS REQUIREMENTS.

E. IDENTIFICATION OF DECISIONS, ACTIONS, AND/OR DIRECTIONS REQUIRED TO COMPLETE THE CURRENTLY AUTHORIZED PROGRAM.

4. IT IS FURTHER REQUESTED THAT ARRANGEMENTS BE MADE FOR ME TO MEET WITH THE FOLLOWING CONTRACTORS AT THEIR PLANTS ON THE DATES INDICATED:

CONTRACTOR	PROGRAM	DATE
NORTH AMERICAN ROCKWELL	F-1 , J-2 ENGINES, RCS, LEM DESCENT	AUGUST 19
NORTH AMERICAN SEID	S-II STAGE	AUGUST 20
NORTH AMERICAN SEID	CSM	AUGUST 21
DOUGLAS	S-IVB STAGES	AUGUST 25
MC&DAC	S-IC STAGE	AUGUST 26
CHRYSLER	S-IB/I STAGE	AUGUST 27
GRUMMAN	LEM	AUGUST 28

APPROPRIATE CENTER PROGRAM OFFICE PERSONNEL SHOULD PARTICIPATE IN THESE BRIEFINGS TOGETHER WITH THE FOLLOWING MEMBERS OF THE APOLLO PROGRAM OFFICE: J. COLOPY, C. KING, M. SAVAGE, G. WHITE, B. JOHNSON, J. MOSLY, T. THOMPSON, J. UNDERWOOD. VISITS TO THE CONTRACTORS ARE TO BE OF ONE-DAY DURATION, WITH THE EXCEPTION OF A HALF-DAY AT CHRYSLER.

THE CONTRACTORS SHOULD ALLOT APPROXIMATELY HALF OF THE TIME FOR PRESENTATIONS TO THE TOTAL GROUP. THE REMAINDER OF THE TIME IS TO BE DEVOTED TO DISCUSSION AND ASSESSMENT OF SPECIFIC PROBLEM AREAS. ACCORDINGLY, THE CONTRACTORS SHOULD NOT PLAN FACILITY TOURS.

5. THE CONTRACTORS' PRESENTATIONS SHOULD SUPPORT OUR ASSESSMENT OF

THE PROGRAM AND SPECIFICALLY INCLUDE THE FOLLOWING:

A. REVIEW OF THEIR MASTER PROGRAM PLAN, DEPICTING THE TIME PHASING RELATIONSHIPS OF MAJOR PROGRAM ELEMENTS, THE INTERRELATIONSHIPS AND INTERDEPENDENCIES OF THESE PROGRAM ELEMENTS TO DEVELOPMENT, QUALIFICATION, MANUFACTURING, ASSEMBLY AND CHECKOUT ACTIVITIES, IN SUPPORT OF THE APOLLO PROGRAM MAJOR MILESTONES.

B. REVIEW OF CRITICAL PROGRAM MILESTONES FOR SUCH AREAS AS: DESIGN, DEVELOPMENT, MANUFACTURING, GROUND TESTING, QUALIFICATION TESTING, GROUND SUPPORT EQUIPMENT INTEGRATION, CHECKOUT AND MAJOR END ITEM DELIVERIES. IDENTIFY KEY CONSTRAINTS AND CRITICAL EVENTS THAT ARE PART OF THE CRITICAL PATH TO MEETING KEY PROGRAM FLIGHT DATES.

C. IDENTIFICATION OF ALL SIGNIFICANT BEHIND SCHEDULE AREAS AND A DISCUSSION OF ACTIONS BEING TAKEN.

D. IDENTIFICATION OF PRESENT AND POTENTIAL TECHNICAL PROBLEM AREAS TOGETHER WITH AN ASSESSMENT OF THEIR IMPACT ON KEY DELIVERY, GROUND TEST AND FLIGHT DATES.

E. IDENTIFICATION OF THE TYPES AND QUANTITIES OF SPACE VEHICLE EQUIPMENT AND GROUND SUPPORT EQUIPMENT BEING PROVIDED. CATEGORIZE THESE REQUIREMENTS BY CALENDAR YEARS AS TO:

(1) END ITEMS CURRENTLY UNDER CONTRACT:

(A) UNITS COMPLETED TO DATE.

(B) UNITS CURRENTLY IN PROCESS AND UNITS PARTIALLY COMPLETED (INDICATE EQUIVALENT UNITS).

(C) UNITS REMAINING TO BE COMPLETED.

(2) END ITEMS REQUIRING CONTRACTUAL ACTION:

(A) UNITS BY MAJOR TYPE.

(3) POTENTIAL FOLLOW-ON REQUIREMENTS.

F. REVIEW OF THEIR MANNING REQUIREMENTS, SHOWING ACTUALS FROM JANUARY 1963 TO DATE AND PROJECTED REQUIREMENTS THROUGH PROGRAM COMPLETION FOR THE FOLLOWING:

(1) TOTAL EQUIVALENT MANPOWER - DIRECT AND INDIRECT - ALL LOCATIONS.

(2) ENGINEERING DIRECT MANPOWER - ALL LOCATIONS.

(3) MANUFACTURING DIRECT MANPOWER - ALL LOCATIONS.

(4) TOTAL DIRECT MANPOWER BY LOCATION, SUBCATEGORIZED BY ENGINEERING AND MANUFACTURING.

G. REVIEW OF THEIR EXPENDITURES AND FUNDING REQUIREMENTS BY FISCAL YEAR, COVERING FISCAL YEAR 1963 AND PRIOR YEAR ACTUALS, AND FISCAL YEAR 1964 ACTUALS AS WELL AS THEIR PROJECTED FUND REQUIREMENTS THROUGH FISCAL YEAR 1970 BY THE FOLLOWING:

(1) DEFINITIVE CONTRACT BASE

(2) AUTHORIZED AND NEGOTIATED CHANGES

(3) AUTHORIZED AND TIMELY PRICED CHANGES

(4) AUTHORIZED BUT NOT PRICED CHANGES

(5) ANTICIPATED UNDER/OVER RUNS

(6) FORECASTED CHANGE ALLOWANCES

(7) ESTIMATED FOLLOW-ON COSTS THROUGH PROGRAM COMPLETION.

H. DISCUSSION OF THE PRINCIPAL REPORTS AND METHODS USED BY THE PROGRAM MANAGER TO EVALUATE PROGRAM STATUS AND PROGRESS ON BOTH ROUTINE AND EXCEPTIONAL BASIS.

I. DISCUSSION OF THOSE PROGRAM PERFORMANCE INDICES THAT ARE REGULARLY REPORTED BY THE PROGRAM MANAGER TO HIS HIGHER MANAGEMENT AS AN INDICATION OF THE PROGRAM STATUS AND EFFICIENCY OF OPERATIONS.

J. IDENTIFICATION OF DECISIONS, ACTIONS, AND/OR DIRECTION REQUIRED OF NASA TO COMPLETE THEIR CURRENTLY AUTHORIZED PROGRAM.

K. A SUMMARIZATION OF THEIR PROGRAM STATUS, TECHNICAL AND RESOURCE PROBLEMS, TOGETHER WITH AN ASSESSMENT OF THEIR POTENTIAL IMPACT ON THE ACCOMPLISHMENT OF PROGRAM KEY MILESTONES.

6. IN ADDITION TO THE ABOVE, THERE WILL BE SEVERAL STUDIES ON SELECTED TOPICS WHICH I WILL DISCUSS WITH YOU PERSONALLY.

SIGNED: SAMUEL C. PHILLIPS
MAJOR GENERAL, USAF
DEPUTY DIRECTOR, APOLLO PROGRAM

7. A LAST MINUTE PROBLEM HAS DEVELOPED WHICH WILL NECESSITATE MAKING MINOR CHANGES TO THE ABOVE SCHEDULES TO ACCOMMODATE DR. STAPP'S PLANNED VISIT. I WILL WORK THESE OUT AND TRANSMIT NECESSARY REVISIONS AS SOON AS POSSIBLE.

SIGNED: SAMUEL C. PHILLIPS
MAJOR GENERAL, USAF
DEPUTY DIRECTOR, APOLLO PROGRAM

11 Aug 64 5:15 p.m.

J. Kobat/MAP M. Savage/MAT WO 36244

Original signed by
General Phillips

UNCLASSIFIED

APOLLO PROGRAM ASSESSMENT
AUG-SEP 1964

Apollo Program Office Internal Assessments

Saturn IB Program	Aug 64
S-IC Stage Project	Aug 64
S-II Stage Project	Aug 64
S-IVB Stage Project	21 Aug 64
Checkout/GSE	29 Aug 64
CSM Project	Aug 64
LM Project	19 Aug 64
Manned Space Flight Network	Aug 64

Contractor Presentations

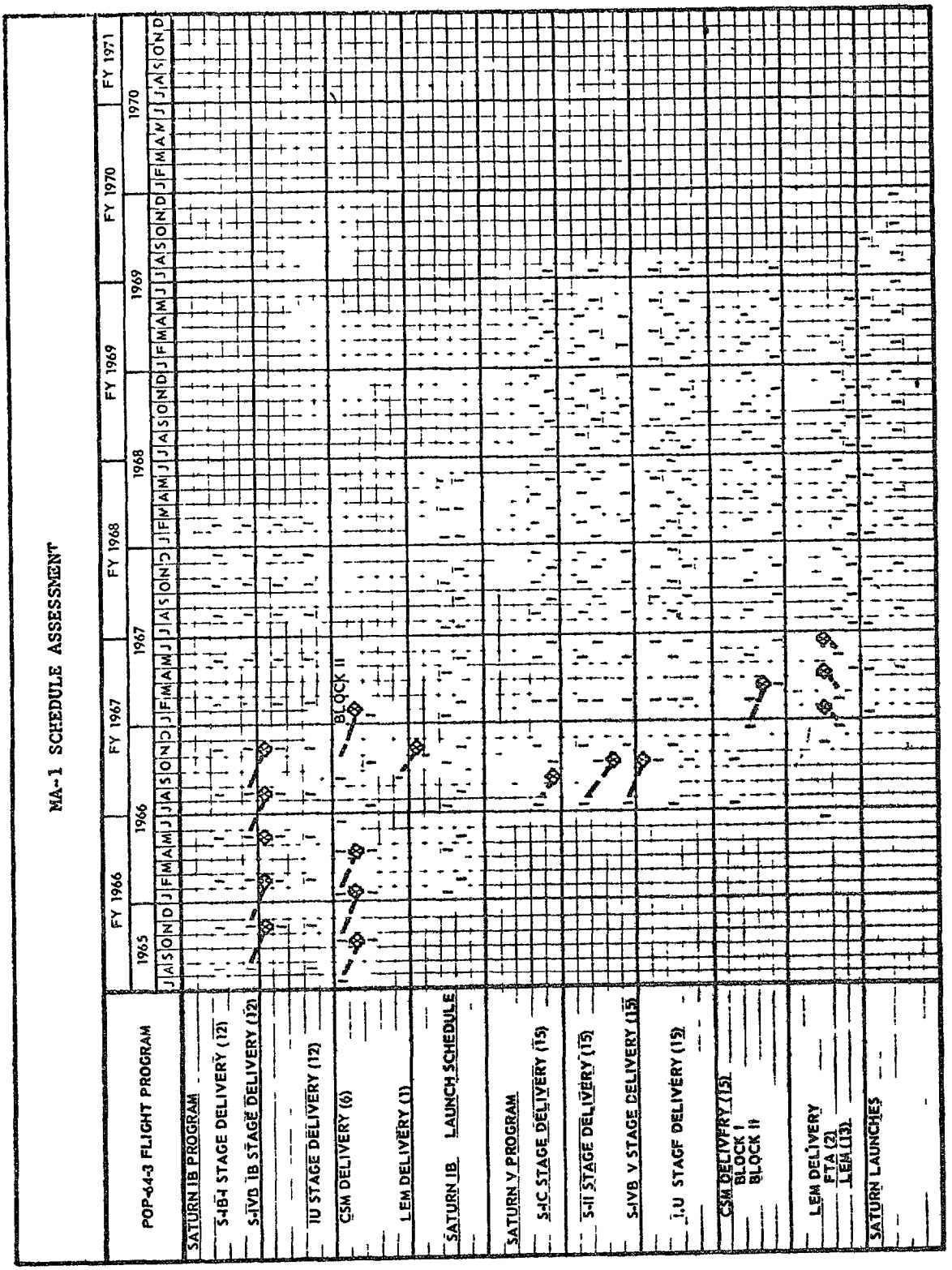
Saturn S-IB Stage	Chrysler	26 Aug 64
S-IC Program Review & Assessment	Boeing Co.	25 Aug 64
S-II Review	North American	20 Aug 64
S-IVB Program Review	Douglas Aircraft	22 Aug 64
Engine Review (F-1, J-2, RCS, LM Descent)	North American	19 Aug 64
CSM Review	North American	21 Aug 64
LM Program Review	Grumman Aircraft	27 Aug 64

MSF Center Assessments

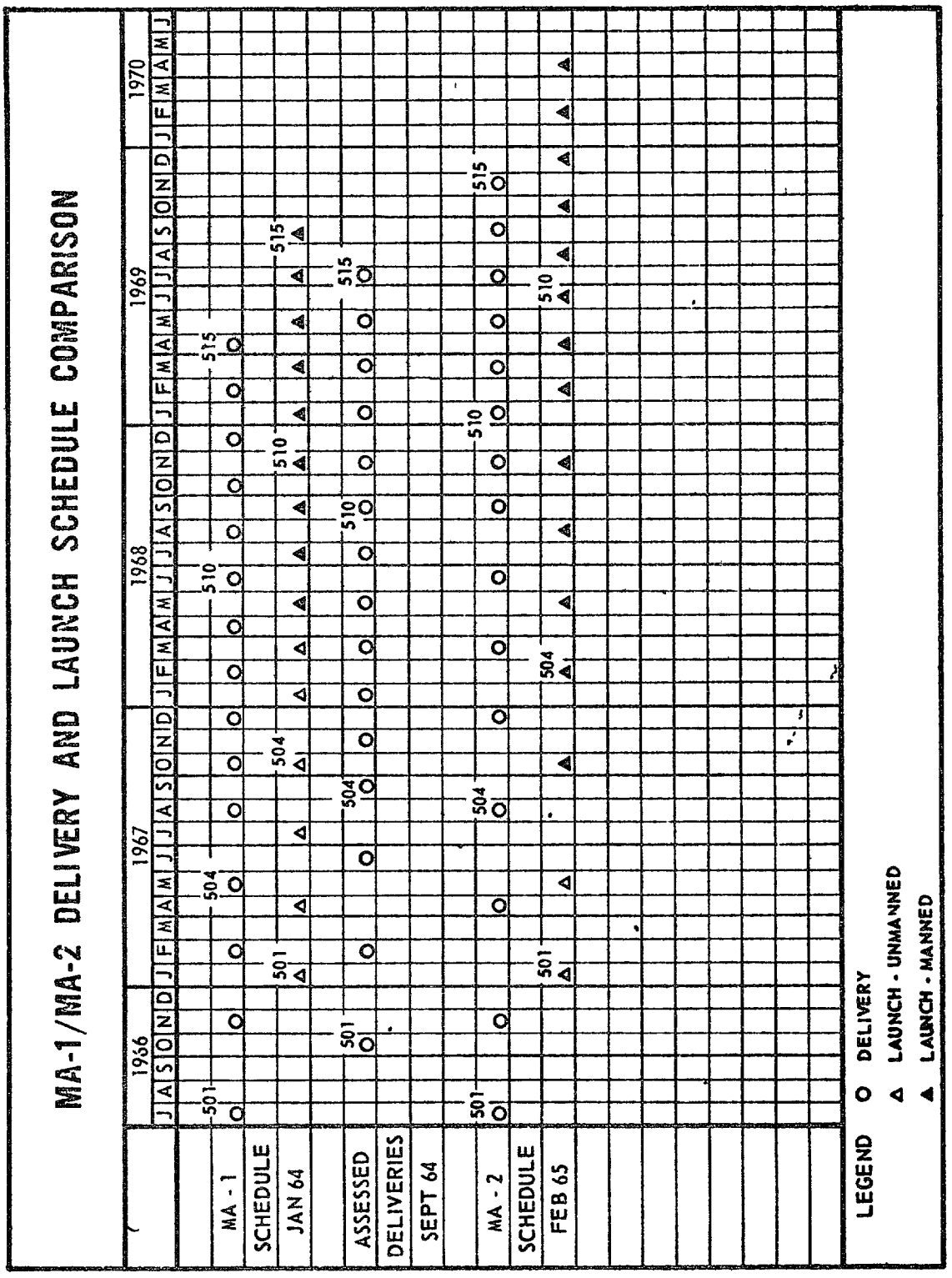
Launch & Flight Operations	Kennedy Space Center	31 Aug 64
Apollo Program Assessment (launch vehs.)	Marshall Space Center	1 Sep 64
Apollo Spacecraft Program	Manned Spacecraft Center	3 Sep 64

NASA Headquarters Reviews

Apollo Program Assessment to MSF Management Council	14 Sep 64
Apollo Program Assessment to NASA Associate Administrator	9 Oct 64



SOURCE - 9 Oct 1964 Presentation to NASA Associate Administrator



CONCLUSIONS

SATURN V PROGRAM

501 LAUNCH

CURRENTLY PACED BY

S-II STAGE

GROUND TEST PROGRAM 3 TO 5 MONTHS LATE

S-II-I FABRICATION 3 MONTHS LATE

S-IC STAGE

GROUND TEST PROGRAM 4 TO 6 MONTHS LATE

S-IC-I FABRICATION 2 TO 3 MONTHS LATE

UNCERTAINTIES

GROUND TEST PROGRAM RESULTS

ESE DEVELOPMENT FABRICATION, INSTALLATION AND CHECKOUT, PROGRAMMING

S-IVB RESTART

SOURCE - 9 Oct 1964 Presentation to NASA Associate Administrator

CONCLUSIONS

SATURN IB PROGRAM

201 LAUNCH

CURRENTLY PACED BY

S-IVB STAGE

GROUND TEST PROGRAM	3½ MONTHS BEHIND
S-IVB-I FABRICATION	3 MONTHS BEHIND

CSM 009

GROUND TEST PROGRAM	5 MONTHS BEHIND
009 FABRICATION	3 MONTHS BEHIND

UNCERTAINTIES

GROUND TEST PROGRAM RESULTS

S-IVB-1 INSTALLATION AND CHECKOUT FLOW TIME

CSM SUBSYSTEM AVAILABILITY AND INTEGRATION

ESE DEVELOPMENT, FABRICATION, INSTALLATION AND CHECKOUT PROGRAMMING

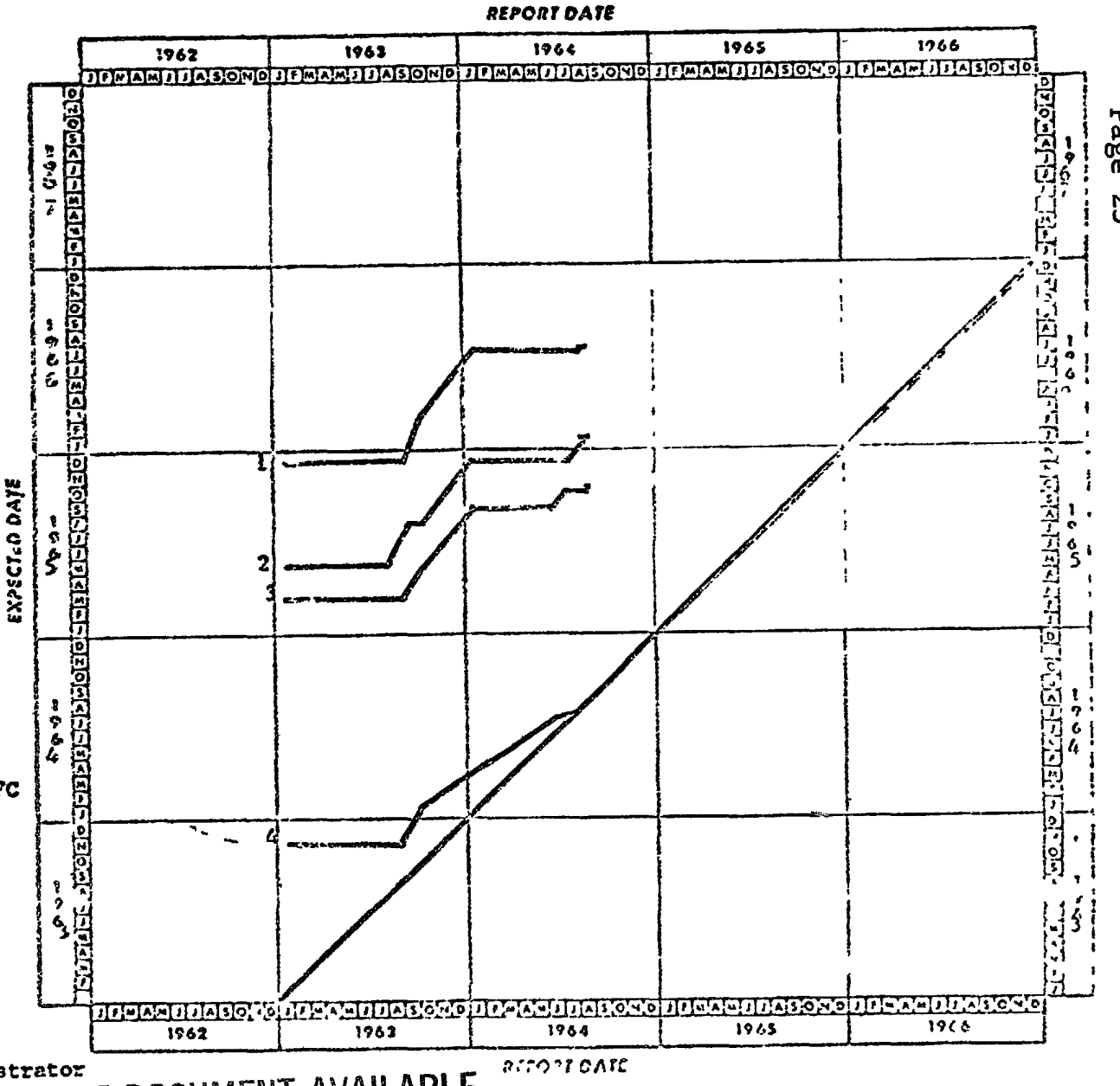
IMCC-NETWORK CHECKOUT (MISSION SIMULATION)

SOURCE - 9 Oct Presentation to NASA Associate Administrator

MANNED SPACE FLIGHT
SCHEDULE TREND
FOR

501 LAUNCH VEHICLE

MSF ASSESSMENT



1. Stage Deliveries S-IC, S-II, S-IVB, IU
2. Complete S-IC A/S Test - MSFC
3. S-II A/S First Firing
4. Complete First Common Bulkhead (S-II-S)

SOURCE - 9 Oct 1964 Presentation to NASA Associate Administrator

KSC PRELAUNCH CHECKOUT ACTIVITY TIMES

The GAO draft report states "KSC officials, moreover, have advised us that a 3 month preflight checkout cycle was practical. This would be a further indication that the MA-2 schedule, which generally provided for the delivery of the stages to KSC about 4 to 5 months prior to the scheduled launch, had a built in hedge against unforeseen assembly and checkout problems." (page 15 and 16).

This statement is not compatible with the facts. NASA does not disagree that a 3 month preflight checkout cycle was a practical goal to work toward based on the assumptions discussed below. However, experience to date does not support that such a position is readily attainable.

In the late summer of CY 1964, KSC presented a prelaunch checkout plan for Saturn V space vehicles (the summary sheet is shown in Attachment 1) that showed a gradual reduction in preflight checkout time from 5½ months for AS-501 to 3 months for AS-505 and subsequent vehicles. This plan was based upon a number of assumptions, e.g.,

1. Hardware would arrive at KSC with all manufacturing checkout and modification work completed.

2. No significant problems would be encountered during checkout.

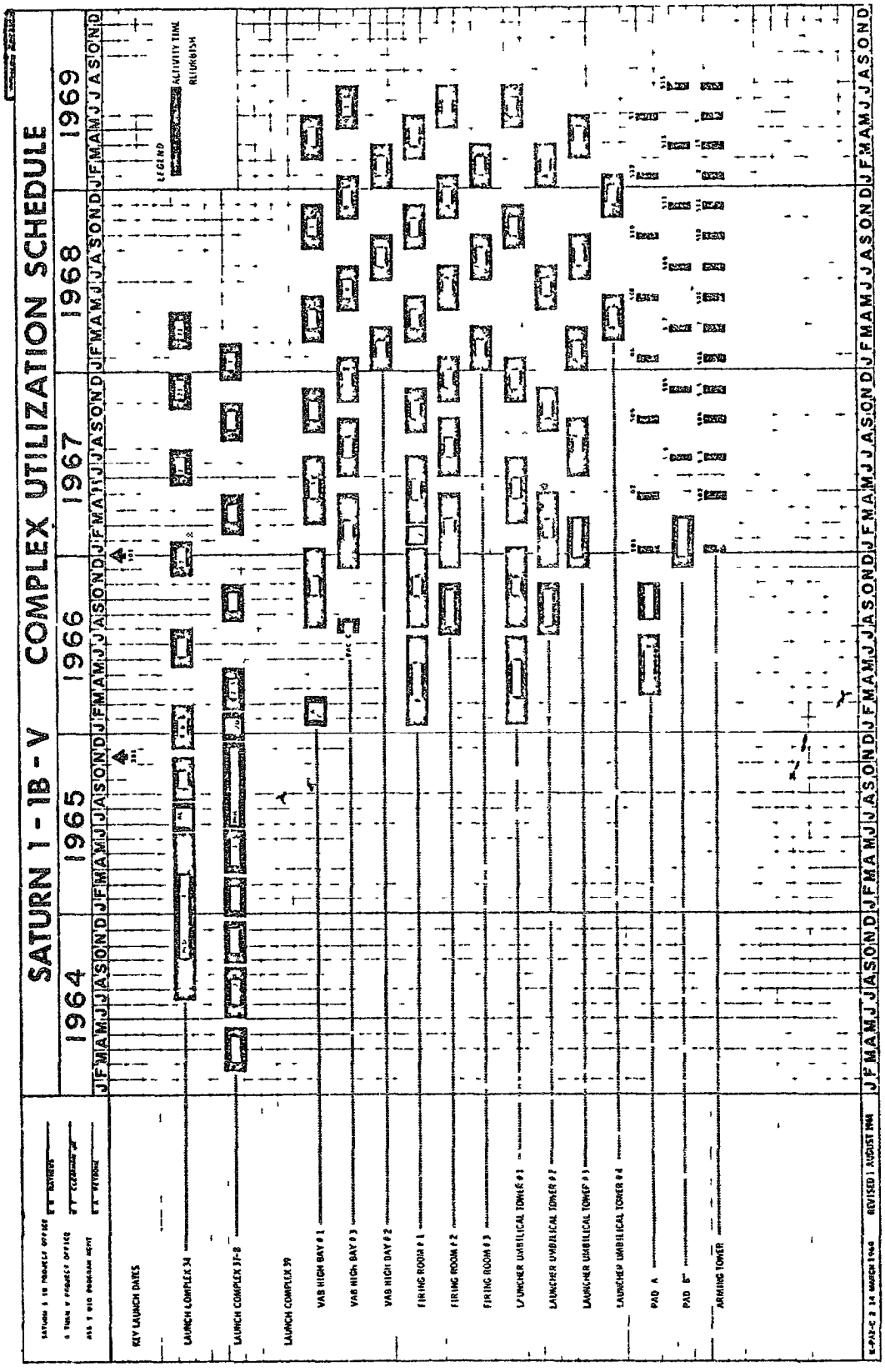
3. No additional testing requirements would be imposed.

4. An approximate 10% reduction in flow time would be achieved with each succeeding vehicle due to learning.

This plan was used in the development of the MA-2 hardware delivery and launch schedule. This plan was viewed as being somewhat optimistic by the Program Director in its assumptions and was therefore modified to a certain extent in the development of the official MA-2 schedule. This modification consisted of adding an additional month to month and a half to the KSC proposed flow times for unforeseen problems for vehicles AS-503 through 507. For AS-501 and AS-502, the additional time was added by extending the launch intervals between AS-501, AS-502, and AS-503.

Although the official MA-2 schedule allowed for 4½ months of flow time for AS-508 and on, Attachment 2, lines 11 and 12, shows (this is an extract from the February 16, 1965 letter that implemented the MA-2 schedule) that a lesser flow time, 3½ months, was actually planned for these vehicles. This was only a goal to strive for under the rigorous conditions discussed in the third paragraph above.

Attachment 3 shows the actual preflight checkout time required by vehicles AS-501 through AS-504 which ranged from 14 months for AS-501 (Apollo 4) to 5 months for AS-504 (Apollo 9) and NASA's current prelaunch checkout planning regarding vehicles AS-505 and AS-506. It can be concluded from, Attachment 2 that our assumptions and planned flow times were not realized and even today NASA has not been able to achieve a preflight checkout cycle of less than 5 months. NASA will continue to attempt to reduce this prelaunch checkout cycle, but much work must be done in this area before it can be achieved.



SOURCE - KSC 13 Aug 1964 Program Assessment Presentation

MAP 3-5466

5 YEAR

APOLLO PROGRAM DIRECTOR SAMUEL C PHILLIPS

PLANS, PROGRAMS & RESOURCES DIRECTOR ROCCO A PETRONE

SATURN V LAUNCH SCHEDULES (1 LEVEL)

PROJECT APOLLO

CENTER KSC

MASTER SCH D NO Ma- 933-2

LAST SCHEDULE CHANGE (Date) FEB 2, 1965 (Date) (No) (In tools)

(Date) (Initials)

	MILESTONES	CY 1966	CY 1967	CY 1968	CY 1969	CY 1970
		J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D	J F M A M J J A S O N D
1	LAUNCH VEHICLE STAGE DELIVERIES (15)	1 1	1 1 1	1 1 1 1 1	1 1 1 1 1 1	
2						
3	CSM DELIVERIES					
4	BLOCK I (2)	1 1				
5	BLOCK II (13)		1 1 1 1	1 1 1 1 1	1 1 1 1 1	
6						
7	LEM DELIVERIES					
8	FTA (2)	1	1			
9	LEM (13)		1 1 1 1	1 1 1 1 1	1 1 1 1 1	
10						
11	SPACE VEHICLE AVAILABILITY FOR					
12	LAUNCH		5 5 5	5 5 5 5 5	5 5 5 5 5 5	5 5 6/YEAR
13	PROGRAM REQUIREMENTS (15)		0 0 0 1 2 3	0 0 0 0 0 4 5 6 7	0 0 1 1 1 1 8 9 0 1 2 3	1 1 CAPABILITY 4 5
14	PROGRAM MANAGERS COMMITMENT					
15						
16	LAUNCH SCHEDULE		5 5	5 5	5 5 5 5	5
17	PAD A (8)		0 0 1 2	0 0 4 5 6	0 1 0 1 2 8 0 1	1 4 5
18	PAD B (7)		5 0 3	0 5 0 7	5 1 1 5 1 3 9 1	1 5
19	POSSIBLE APOLLO EXTENSION					
20	MISSIONS					

NOTES

NASA FORM 796 REV SEP 63

SOURCE - Apollo Program Office letter dated 16 Feb 1965 Implementing the MA-2 schedule.

SATURN V SPACE VEHICLE
PRELAUNCH CHECKOUT ACTIVITY TIME

Launch Vehicle Stages	Delivery to KSC	Prelaunch Checkout Activity Time		Launch Date
		Actual	MA-2 Schedule Plan	
AS-501 (Apollo 4)				
S-IC-1	12 Sep 66	14 mo.		
S-II-1	21 Jan 67	9 mo.		
S-IVB-501	14 Aug 66	15 mo.	5½ mo.	9 Nov 67
S-IU-501	25 Aug 66	14½ mo.		
AS-502 (Apollo 6)				
S-IC-2	13 Mar 67	12 mo.		
S-II-2	24 May 67	9 mo.		
S-IVB-502	21 Feb 67	12½ mo.	5½ mo.	4 Mar 68
S-IU-502	20 Mar 67	11½ mo.		
AS-503 (Apollo 8)				
S-IC-3	27 Dec 67	12 mo.		
S-II-3	24 Dec 67	12 mo.		
S-IVB-503	30 Dec 67	12 mo.	5½ mo.	21 Dec 68
S-IU-503	4 Jan 68	11½ mo.		
AS-504 (Apollo 9)				
S-IC-4	30 Sep 68	5 mo.		
S-II-4	15 May 68	9½ mo.		
S-IVB-504	12 Sep 68	5½ mo.	5½ mo.	3 Mar 69
S-IU-504	30 Sep 68	5 mo.		
AS-505 (Apollo 10)				
S-IC-5	27 Nov 68			
S-II-5	10 Dec 68			
S-IVB-505	3 Dec 68	5 mo.	4½ mo.	17 May 69
S-IU-505	15 Dec 68			(planned)
AS-506 (Apollo 11)				
S-IC-6	20 Feb 69			
S-II-6	6 Feb 69			
S-IVB-506	20 Jan 69	5 mo.	4½ mo.	15 July 69
S-IU-506	27 Feb 69			(planned)

ADDITIONAL TIME FOR TESTING
REQUIREMENT AND UTILIZATION THEREOF

In numerous passages through the draft report, particularly page 15, GAO contends that NASA had no firm plan or did not utilize the "additional time for testing" that NASA has given as one of the reasons for early delivery of the launch vehicle stages.

First, the above statement is not factually correct. In an R&D program, this time would be used to (1) compensate for test time overruns; (2) allow for additional test requirements emanating from ground and qualification test programs and mandatory design changes; and (3) allow time to rerun tests that were compromised due to unforeseen problems. From the very nature of a complex R&D program with telescoped production, firm plans cannot be made for the use of this additional time since what may occur is not known. What is obvious is that a period of time must be allotted for contingencies that occur in our R&D program without precedent anywhere.

Attachment 1, demonstrates the actual time taken to conduct the prelaunch checkout of Saturn V vehicles at KSC. It is clear that these KSC flow times were even greater than anticipated (See Appendix - KSC Prelaunch Checkout) and that NASA, in fact, under-estimated the "additional testing time" required. As further clarification on the use of this additional time, Attachment 2 gives several specific examples in the S-IC and S-IVB areas of the unplanned activities conducted and the schedule impact that resulted from them. Even today, on vehicles as late as 507 508, and 509, unforeseen problems have caused delays of over 30 days in completing factory and MTF work.

SATURN V SPACE VEHICLE
PRELAUNCH CHECKOUT ACTIVITY TIME

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		Actual	MA-2 Schedule Plan	
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S-IU-502	20 Mar 67	11½ mo.		
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S-IC-6	20 Feb 69			
S-II-6	6 Feb 69			
S-IVB-506	20 Jan 69	5 mo.	4½ mo.	15 July 69
S-IU-506	27 Feb 69			(planned)

S-IC-1 STAGE

S-IC-1

1. Replaced five critical S-IC distributors just prior to rollout for foam expansion (UCR's 300079, -082, -084 and -088)

2. Replaced all 14 fairing turnbuckles (ECP 320) and UCR 300160), a two day task, for stress corrosion suseptability.

3. Slipped CDDT and subsequent testing 4 days for changeout of all S-I C actuators because of an anti-backlash spring which was stress corrosion susceptable.

4. Encountered substantial problems installing ordnance (flexible linear shaped charges)

5. Incorporated over 6,600 manhours of modification installation, plus inspection and retest.

S-IC-2

1. Leaking servoactuator (UCR 300486) required special drain installation (ECP 0411) Leakage was within system specifications but was saturating the thermal insulation.

2. In excess of 6600 manhours were expended on modifications.

3. Substantial problems were again encountered during ordnance installation. Problem was traced to an undersized tool fixture which caused the difficulties on S-IC-1 and S-IC-2.

S-IC-3

1. Thermal insulation was added to the forward skirt at KSC, a 626 manhour task. (ECP 207)

2. Additional weather protection (ECP 299) was added, requiring 475 installation manhours

3. Instrumentation alterations in the engine area (ECP 333) required 387 installation manhours.

4. Servoactuators were again changed at KSC (ECP 347; 134 installation manhours).

S-IVB STAGE

S-IVB-501

1. Replace LH2 Tank Repressurization control module because of qualification problems. MDAC ECP 2305

2. Replace LOX Tank Pressurization Control Module because of qualification problem. 13 hours of effort caused retest MDAC 2304

3. Modify LH2 Duck Assembly because of qualification problems 18 hours of effort caused retest. MDAC ECP 2308

4. Flutter kit installation - approximately 3000 hours of effort

This stage was delivered to KSC with 400 hours of open work An additional 6,230 hours were worked while it was here.

S-IVB-502

1. Install larger size bolts at the S-II-S-IVB interface, 270 hours of effort. MDAC 2218

2. Enter LH2 tank to replace damaged ground strap, install end caps on 21 wires left bare after ECP 2047 was worked at MDAC STC, inspected PU probe for proper configuration and work on ECP on the PU probe. Approximately 1000 hours of effort.

3. Reinforcement of Main Auxiliary Tunnel Clips, 1000 hours of effort. MDAC ECP 2597

This stage was delivered to KSC with 2,260 hours of open work An additional 8,100 hours of work was done after receipt of the stage.

S-IVB-503

1. Additional measurements added because of the anomalies of the AS-62 flight, 7,600 hours of effort. MDAC ECP 2281

2. Engine modifications required for Dual Restart Mission, 1,300 hours of effort. MDAC ECP 2760

3. LOX Tank Non-Propulsive vent system installation, 3,300 hours of effort MDAC ECP 2057

This stage came to KSC with 3,390 hours of open work An additional 12,000 hours were worked while it was here.

S-II LATENESS VERSUS
S-IC & S-IVB ON SCHEDULE CONDITION

The draft report places considerable emphasis on the relative schedule positions of the S-II stage versus the S-IC and S-IVB stages in late CY 1965 and CY 1966. The GAO opinion is that because the S-II was assessed as behind schedule, NASA should not have placed early delivery incentives on the S-IC and S-IVB stages. NASA does not dispute that the estimates/assessment of the early S-II stages (S-II-1 through S-II-4) were negative, but during the period addressed by the report, i.e., late CY 1965 and through the spring of CY 1966, the assessments of the S-II-1 through S-II-4 behind schedule condition were steadily improving as, attachment 1, assessment chart shows. This improvement peaked in June 1966 when S-II-3 and S-II-4 were assessed on schedule and S-II-1 and S-II-2 were assessed 8 weeks and 2 weeks behind schedule, respectively. The subsequent schedule deterioration resulted from additional static firing testing requirements due to the loss of the S-II all systems test stage and insulation problems.

In early January 1966, the Apollo Program Office assessed S-II-1 as 12 weeks behind schedule. However, by mid February, MSFC in the MSF Program Review on 15 February 1966 (attachment 2) indicated that in their opinion actions that had been taken by NAA and MSFC since December 1965 had reduced the behind schedule condition of S-II-1 from 22 weeks to 2 weeks.

From attachments 1 and 2 it was concluded by the Program Director that the S-II schedule would recover to be in phase with the S-IC and S-IVB schedules. Further, all during this time NASA was having discussions with NAA to establish a base within the MA-2 schedule framework that would lead to the conversion of the S-II contract to an incentive contract.

Finally, to show that the S-IVB and S-IC were experiencing schedule problems during this same time period, attachment 3 is a chart extracted from the MSFC MSF Review presentation of 15 April 1966 indicating that the S-IC-1 needed an additional month to complete all pre-delivery activities that were required. Attachment 4 is an extract from the 9 February 1966 APO Review indicating that S-IVB-501 was 8 weeks behind schedule and a potential delivery problem. It was, therefore, NASA's considered judgement that the assessments of the initial deliveries of the three Saturn V stages were, in fact, in phase with one another. Because these deliveries were assessed "in synch" there was no reason to believe that the behind-schedule assessment of the S-IC and S-IVB could not be improved like the S-II situation had improved. Therefore, there was no necessity to make a schedule adjustment for these stages.

SATURN V
S-IC-1 STAGE

- KSC's required on-dock date for S-IC-1 to support 1 September 66 start of SA-501 stacking is 30 August 66.

- S-IC-1 on-dock KSC date is now planned for 30 August 66.

- Additional month of S-IC-1 dwell time at MSFC will allow:

  - Additional time to incorporate mandatory changes (approx 45) prior to start of "Post Captive Firing Checkout." (Reduces manufacturing interruptions during checkout activities)

  - Reduced amount of S-IC-1 "travel" work to KSC (approximately 350 man hours to 100 man hours as of 15 April 66.)

  - Additional time to complete "Post Captive Firing Checkout - reducing risks (human errors) inherent in overtime operation.

I-V-P 84 Sheed Apr 15 '66

SOURCE - MSFC Saturn V presentation to MCM 15 Apr 1966

SATURN V

S-IVB-501

POTENTIAL PROBLEM

-S-IVB-501 BASELINE SCHEDULE (S-IVB SUMMARY PHASING PLAN) PLANNED FOR DELIVERY OF S-IVB-501 TO SACTO APPROXIMATELY 22 JANUARY 1966.

-PRESENT S-IVB-501 SCHEDULE (BASED ON INCENTIVE CONTRACT) CALLS FOR DELIVERY OF S-IVB-501 TO SACTO ON 19 MARCH 1966 WITH NO DELAY IN DELIVERY TO KSC PER MA-2 SCHEDULE (31 JULY 1966).

- ABOVE SHOWS 8 WEEKS SLIP IN DELIVERY OF S-IVB-501 TO SACTO.

-HOWEVER, DAC'S PAST PERFORMANCE INDICATES THAT THEY CAN ABSORB THIS DELAY WITHOUT IMPACT DELIVERY OF SA-501 TO KSC.

-CAUSE OF DELAY - VENDOR DELIVERIES OF HARDWARE.

SOURCE - 9 Feb 1966 Apollo Program Office Review

Apollo Program Office

S-II Stage Contract Requirements and Assessments

Stage	Contract Delivery Requested	Jan. 1966 Assessment	May 1966 Assessment	June 1966 Assessment	Jan. 1967 Assessment	Actual KSC Delivery Date
S-II-1	7-31-66	12 Wks. late	8 Wks. Late	8 Wks. late	24 Wks. late	21 Jan. 1967
S-II-2	11-30-66	12 Wks. late	4 Wks. late	2 Wks. late	20 Wks. late	24 May 1967
S-II-3	4-30-67	12 Wks. late	On Schedule	On Schedule	12 Wks. late	24 Dec. 1967
S-II-4	8-31-67	6 Wks. late	On Schedule	On Schedule	6 Wks. late	15 May 1968

Source: Apollo Program Office contractor notebooks

	MANNED SPACE FLIGHT SCHEDULE SATURN V S-II STAGE	Status as of Feb. 15, 1966

- At December 1965 MCM Program Review reported S-II-1 schedule slippage - 22 weeks (5 months).

- Present S&ID Recovery Schedule (S&ID Plan 66A) indicates S-II-1 schedule slippage - 2 weeks (On Dock KSC - 15 August 1966)

- 20 week recovery in S-II-1 schedule (Effect of Yarchin, Driscoll, Trott Team) based on:

  9 weeks recovery at Seal Beach
  - Hydro & Clean - 5 wks to 3 wks = 2 wks
  - Systems Installation/Insulation Closeout - 12 wks to 9 wks=3 wks
  - Post Manufacturing Checkout - 12 wks to 8 wks - 4 wks

  11 weeks recovery at MTF - Dwell Time at MTF reduced from 20 wks to 9 wks
  - Reduced Pre-Acceptance Test Checkout & Tanking Test - 10 wks to 3 wks = 7 wks
  - Reduced Acceptance Test Firing time - 2 wks to 1 wk = 1 wk
  - Reduced Post Acceptance Test Checkout - 6 wks to 4 wks = 2 wks

- New S&ID Schedule 66A incorporating 20 week reduction is highly optimistic.

- New S&ID Schedule 66A results in S-II-T Captive Firing Program of only approximately 3 weeks.

SOURCE - MSFC Saturn V presentation to MCM 15 Feb 1966

ADOPTION OF AIR TRANSPORTATION NOTED NEED
FOR S-IVB EARLY DELIVERY INCENTIVES

Although the Super Guppy aircraft did not experience any major problems after its certification (March 1966), it is unreasonable to conclude that at that time a decision could be made to restructure the stage delivery requirements to take advantage of the time gained by using the Guppy aircraft. For NASA to jeopardize the Apollo launch program at that time by not providing sufficient time in the S-IVB delivery schedule to compensate for a potential loss of this aircraft would have been unwise.

The Super Guppy was a one-of-a-kind aircraft. It originally was to have been certified by the end of CY 1965. However, due to two major problems in late CY 1965 and early CY 1966 it was not finally certified until 30 March 1966 due to: (1) the aircraft nose caved in during a test flight due to inadequate structural strength, (2) a propeller stress problem. Since prior operational experience with the aircraft was not available and with the problems that the aircraft had just experienced, it would have been very shortsighted and derelict on the part of NASA to, at that same time, make a major adjustment in the S-IVB schedule to compensate for the potential time gained. There was no assurance at that time (and the only way this assurance could be realized was through operational use and experience) that NASA could totally depend on this one-of-a-kind, out-sized aircraft for S-IVB transportation. Until confidence could be built up in this aircraft through usage, NASA elected not to adjust the delivery schedule and thereby retain the capability to revert to S-IVB water transportation without impacting the S-IVB delivery schedule to KSC.

INCENTIVE COSTS

The draft report contends that (1) NASA incurred costs in the S-IC and S-IVB stage contracts of between $22M and $33M as a result of the schedule stretchout reflected in the MA-2 schedule, (2) $26.2M of bonus fee payments related to S-IC and S-IVB stages were provided for unnecessarily; and (3) that had NASA limited the extent of schedule stretchout, the need for NASA to agree to pay bonus fees to obtain the desired earlier deliveries would have been eliminated.

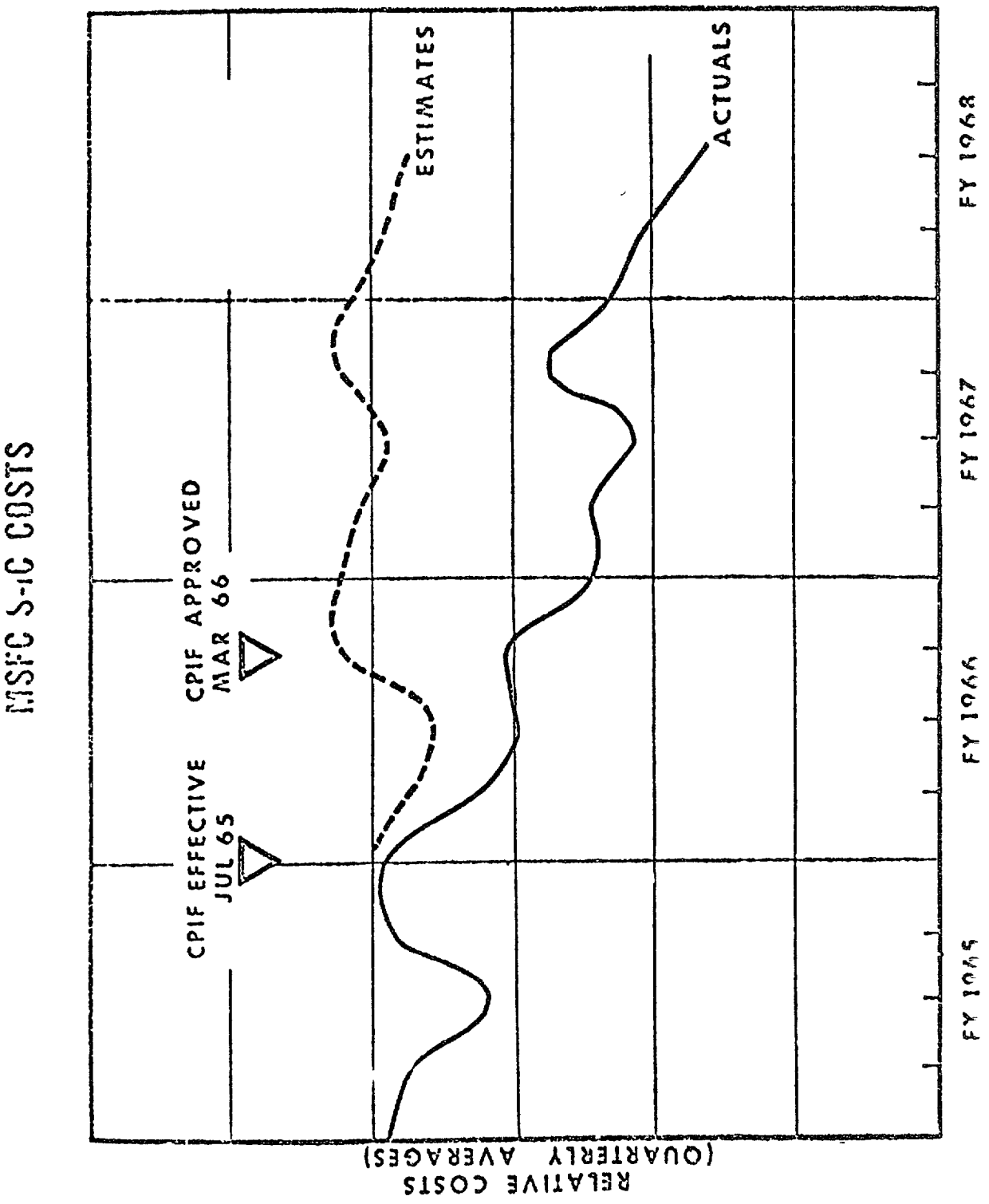
One significant point needs to be made regarding these costs and incentive fees. The draft report implies that they were already incurred, upon conversion of the contract. This is incorrect. The incentive fees had to be earned and the costs were to be incurred over the life of the program.

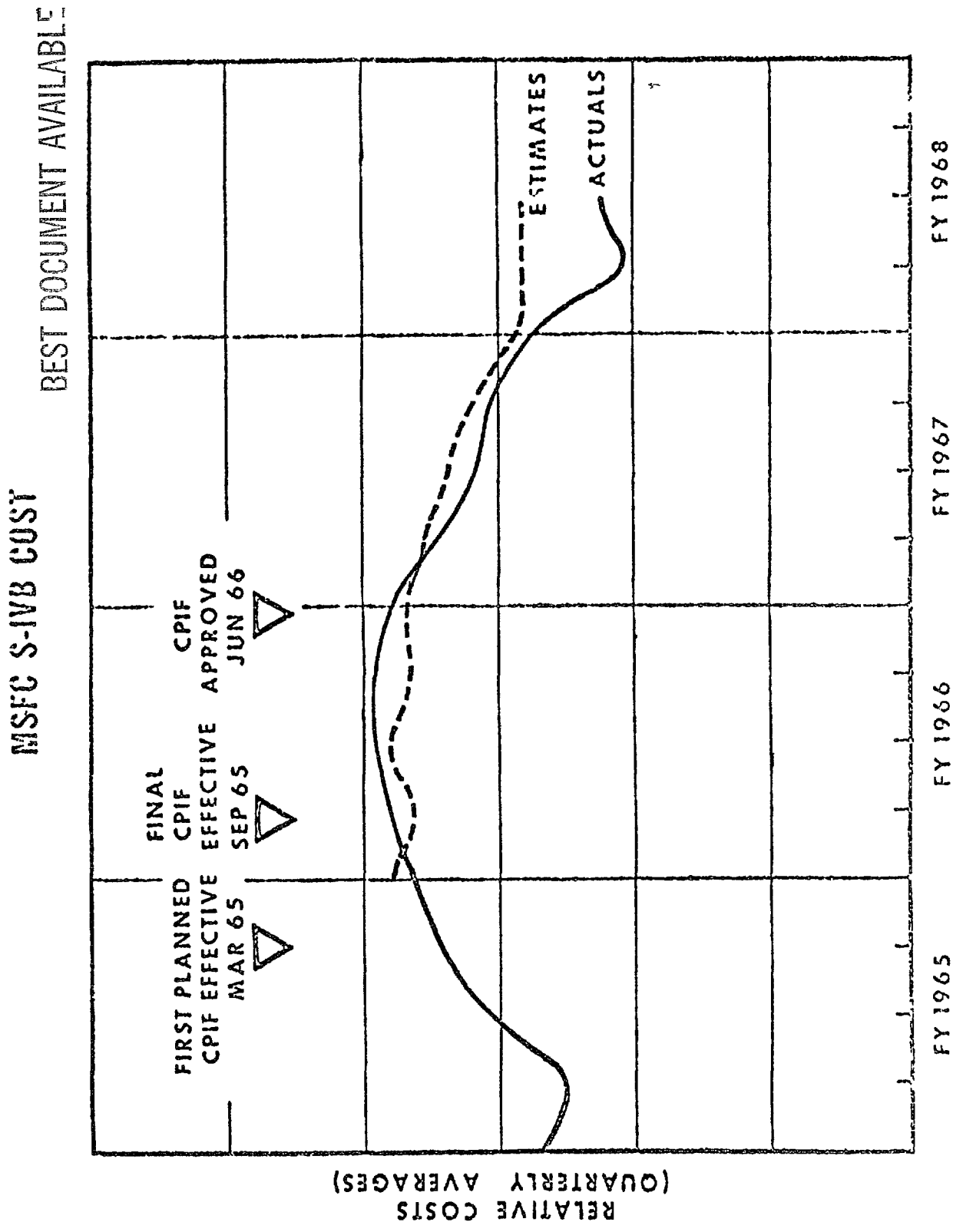
With regard to costs incurred in the S-IC contract, reference is made to trends reflected in the chart shown in attachment #1 (this chart was attached as an enclosure to the OMSF letter to GAO, dated May 23, 1968). This chart depicts a very significant decrease in actual costs incurred under the incentive provisions throughout the 18 month period, July 1965 through calendar year 1966. Specifically, actual costs for Fiscal Year 1966 (through June 1966) were $40.9M less than the NASA's February 1965 estimate (at which time the contract was still CPFF). Actual costs for FY 1967 (through June 1967) were $51.8M less than NASA's February 1965 estimates. These figures have been extracted from NASA's official program operating plans and accounting records for the periods concerned. Also pertinent is the fact that the cost estimate projections made by the S-IC contractor for that period were higher than those made by NASA. Thus, the actual experience on this contract does not support the implication that NASA would have been wiser to avoid incentivizing this contract with emphasis on early delivery.

With regard to the S-IVB stage, (attachment #2 is the S-IVB Stage Relative Cost Trend), there are several complications impacting the cost trend. Although NASA's official records identify stage costs separately for stages to be used in the Saturn IB flight program from those in Saturn V, available contractor cost information is not structured to provide detail S-IVB cost identification to each of the two Saturn programs. Thus the S-IVB actual costs for FY 1966 reflected a concentration of effort to solve the pre-launch problems associated with the imminent initial flight (201) in the Saturn IB Program. The actual Saturn V S-IVB stage costs in the McDonnell-Douglas contract for Fiscal Year 1966 (through June 1966) reflected higher costs for FY 1966 than those projected by NASA in November 1965. Thus, actual costs for FY 1966 exceeded estimates by $8.1M, however, in FY 1967 (the first full year under incentive provisions) actuals materialized below estimates by $17.1M. This decrease would have been even more substantial except for the destruction of the flight stage S-IVB-503 during ground test[illegible] in May 1967. This loss required a [illegible] facility [illegible] ground [illegible] and the procurement of a replacement flight stage.

From the above discussion there appears no support for the contention that the incentive provisions of the two contracts contributed to an unnecessary increase in actual costs to the government.

The decision to adjust the launch/delivery schedule was a practical necessity notwithstanding the subsequent and discrete decision to incentivize the two stage contracts. The decision to incentivize the contracts was made to enhance cost effectiveness as well as to expedite delivery of the early stages. It was clearly established at the time the incentive provisions were firmed, that the earlier the hardware delivery could be attained, the sooner the contractor's manpower levels would be reduced. It was the success of this policy that enabled the two contractors to show substantial reductions in their cost profiles during the eighteen month period following the dates of incentive effectivity. For these reasons the $26.2M in the form of contract schedule incentives for the S-IC and S-IVB stages was substantially more than offset by the economies achieved.


MSFC S-IC COSTS
ESTIMATES
ACTUALS
CPIF APPROVED
MAR 66
CPIF EFFECTIVE
JUL 65
FY 1965
FY 1966
FY 1967
FY 1968
RELATIVE COSTS
(QUARTERLY AVERAGES)


MSFC S-IVB COST
BEST DOCUMENT AVAILABLE
FIRST PLANNED CPIF EFFECTIVE MAR 65
FINAL CPIF EFFECTIVE SEP 65
CPIF APPROVED JUN 66
ESTIMATES
ACTUALS
FY 1965
FY 1966
FY 1967
FY 1968
RELATIVE COSTS
(QUARTERLY AVERAGES)

GAO Note The last 10 pages of OMSF's comments refer to matters discussed in our draft report which were deleted from the final report.

MCDONNELL DOUGLAS ASTRONAUTICS COMPANY

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WALTER F BURKE
PRESIDENT

August 29, 1969

Mr. Morton E. Henig
Assistant Director
United States General Accounting Office
Washington, D.C 20548

Subject DRAFT REPORT TO CONGRESS - REVIEW OF INCENTIVE PROVISIONS OF SELECTED SATURN V STAGE CONTRACTS

Reference Letter dated August 1, 1969, from Mr Henig to Mr. Burke

Dear Mr. Henig,

This is in response to your letter of August 1, which transmitted for our comment portions of the proposed GAO report to the Congress on the incentive provisions of selected Saturn V Stage Contracts. As you noted, the activities of our Company are not at issue in the report. Since, however, the report discusses in part the NASA-MDC Stage Contract, I believe it appropriate for us to provide you our comments.

Following receipt of your letter, I asked those within McDonnell Douglas Astronautics Company - Western Division who are most knowledgeable with the background and evolution of the S-IVB Contract to examine the matters discussed in the draft GAO report that relate to the S-IVB Stage Contract. The attached comments were assembled by the Saturn Contracts organization and reflect the consensus of individuals within the Saturn Program and Division management who are personally acquainted with the history of the S-IVB Stage Contract including its conversion to cost plus incentive fee and the Company's experience under the multiple incentive arrangements.

I endorse the content of the attachment and hope that the General Accounting Office will consider it carefully in the preparation of any final report on the subject. I ask you to keep in mind the fact that goals set in 1962 by John F Kennedy to place a man on the moon and return him safely within the decade were indeed ambitious. In 1964 when NASA initiated the conversion of the Apollo Program prime contracts to incentive arrangements, the Apollo Program was beset by serious schedule and technical problems These problems were of sufficient magnitude to cast grave doubts on the nation's ability to achieve the Kennedy goals I am convinced that NASA's decision to place incentives upon the Apollo contractors has been the key to the Program's achievements, culminating in the success of the Apollo 11. When these achievements are viewed in

MCDONNELL DOUGLAS CORPORATION

the light of the funding limitations placed on the Program in recent years, the motivational effect of these incentives assumes an even brighter luster

Thank you for giving us the opportunity to review the report at this stage of its development

Sincerely yours,

Walter F Burke
President
McDonnell Douglas Astronautics Company

MDAC COMMENTS ON DRAFT GAO REPORT TO
THE CONGRESS OF THE UNITED STATES ENTITLED
"REVIEW OF INCENTIVE PROVISIONS
OF SELECTED SATURN V STAGE CONTRACTS"

The material provided for our review discusses, almost exclusively, S-IVB stage schedule incentives. The thrust of the material is that, in the 1964 planning of the S-IVB contract, NASA's principal goal was early (by 4 weeks) delivery of stages; that said early delivery was obtained chiefly through the use of schedule bonus incentives; and that, to quote from page 11a of the draft, "NASA ... could have obtained delivery of the stages on the dates desired without added cost to the Government ... without the payment of schedule incentives ..."

We believe that the GAO point of view results from an oversimplification of one element involved in the conversion of the S-IVB contract to a Cost-Plus-Incentive-Fee form. This conversion - in toto - has been pre-eminently successful, both from a NASA and Contractor point of view. Any evaluation of the conversion, to be useful and equitable, should include a comprehensive review of program status in the pre-conversion period together with consideration of all the elements involved in the conversion.

The S-IVB program was undertaken in September 1961. Recognizing the high content of beyond-the-state-of-the-art research and development effort, a Cost-Plus-Fixed-Fee contract was negotiated. Subsequent to definitization, the program was subject to an extremely high incidence of changes engineering changes to stage and support hardware, changes in facilities' availability, changes in testing approaches and philosophy, changes in performance requirements, changes in planned mission profiles, changes in quantities of hardware required, etc. During the period 1961-1965, this atmosphere of rapid change was, in our judgment, inevitable in view of the scope and complexity of the Apollo program and the national priority afforded to it. However, the cumulative effect of these changes was schedule and cost uncertainties, and the extensive amounts of replanning and out-of-position stage manufacturing posed potential threats to the concept of "built-in-reliability" at the factory.

To minimize Apollo program vulnerability to adverse effects of the above changes, in late 1964 and early 1965 NASA/MSFC and the Contractor embarked on a planned series of related actions whose ultimate goals included.

1) Providing maximum assurance of stage reliability,

2) Implementing expanded programs of reliability and quality both at Contractor locations and those of his suppliers,

3) Developing and enforcing rigorous new disciplines for the control of future changes,

4) Minimizing total program cost,

5) Completing, to the maximum extent practicable, the manufacturing and checkout of the stage at the factory in the originally planned manufacturing/testing sequences,

6) Minimizing the requirements for additional modification effort to be performed at the test site, Kennedy Space Center,

7) Updating the contract itself and all primary contract documentation to incorporate then current baseline information, and

8) Increasing the emphasis on timely completion of critical S-IVB stage milestones, viz., completion of manufacturing and checkout at the factory, completion of all pre-acceptance test requirements, and completion of pre-requisites for shipment of the stage to the Kennedy Space Center (KSC).

The above eight items, while representative of NASA's goals at the time in question are not a complete description of NASA/Contractor goals, such a description is well beyond the scope of these remarks.

All of the NASA/Contractor goals were related either directly or indirectly. Many of the specific actions taken were aimed at improving the likelihood of attaining several of the goals. The GAO has selected one of the above goals -- or more precisely, a part of one - (early readiness for delivery to KSC) - for analysis. On the basis of the material we reviewed, we conclude that GAO analysis of this sub-goal has been accomplished outside the context of other concurrent activities. Typical of these other concurrent activities were. imposition of a Configuration Management system designed to introduce new disciplines into the control of S-IVB program changes, incorporation into the contract of new Program Plans such as the Quality Program Plan and the Reliability Program Plan, and definitization into the contract of a large number of previously undefinitized changes with the corresponding adjustments in contract dollar values and provisions.

In conjunction with the above activities, NASA/MSFC and the Contractor developed for incorporation into the contract a set of balanced incentive features. These incentives, structured to operate together as a whole, were designed to relate earned fee to the level of success attained by Contractor in meeting stated

contract goals. For purposes of contract draftmanship and administration, the incentives were subdivided and identified as·

a) a cost incentive;

b) several schedule incentives, and

c) several flight performance incentives.

Each of these incentive features was aimed at stimulating achievement of several (sometimes almost all) of the NASA/MSFC goals Those incentives identified as schedule incentives included, in part, the following significant features

1. Measurement of the timeliness of completion of stage manufacturing and checkout,

2. Measurement of the completeness of stage checkout at the factory together with the extent to which non-flight hardware had been used,

3. Identification and measurement of the work (associated with late changes) to be incorporated into the stage subsequent to factory checkout,

4. Measurement of the timeliness of completion of pre-acceptance firing requirements,

5. Measurement of the timeliness of stage completion and readiness for shipment to Kennedy Space Center, and

6. Measurement of the amount and types of stage modifications to be accomplished at the KSC.

Schedule incentive administration required (in part) that all of the above measurements be made. Further, schedule incentive success required demonstrated compliance with the new disciplines imposed by Configuration Management, the new Quality Program Plan, etc. Thus, the S-IVB schedule incentives were structured to be one of the basic program management tools to stimulate and assure the development, implementation, refinement and ultimate success of the new elements being incorporated into the program.

Much of the above could probably have been accomplished with a larger number of "compartmentalized" incentives, e.g , separate incentives (which would probably have been labelled "performance incentives") could have been structured

to reward/penalize Contractor's progress on Configuration Management, on compliance with the revised Quality Program Plan requirements, on the amount and nature of stage modifications carried over from Contractor's California locations for accomplishment at KSC, etc. However, such compartmentalized incentives would have been uneconomical to administer - and probably less effective in producing the desired ends.

We believe that NASA elected to emphasize a small number of "big picture" type schedule incentives because of a belief in their efficacy. A Configuration Management incentive would have been understood by, and therefore capable of providing direct motivation to, a relatively small group of Configuration Management experts within the company. A cost incentive is understood by, and therefore capable of providing direct motivation to, a relatively small group of management people within a company. A flight performance incentive is understood by, and therefore capable of providing direct motivation to, a relatively small group of technical people within a company. However, incentives which emphasize completeness and timeliness of the hardware - plus compliance of that hardware with requirements - are understood by virtually everyone within a company. They are capable of motivating Engineering people to complete engineering documentation correctly and release it promptly; as well as motivating Purchasing, Manufacturing, Inspection, Testing, and Administrative people to optimize the quality, completeness, and timeliness of their individual contributions.

In addition to emphasizing total performance, the incentives labelled "schedule incentives" were structured in the firm belief that their operation, if successful, would lead to program economies. In many areas, the surest way of meeting or beating a dollar budget is to accomplish required effort on or ahead of schedule.

In our judgment, the incentives labelled "schedule incentives" were dramatically successful in achieving all of their intended goals, including early delivery. These incentives, together with related actions, stimulated the inventiveness and dedication which ultimately contributed to completion of the Apollo 11 mission with President Kennedy's original timetable as endorsed by the Congress.

We believe that the incentives, again in conjunction with related actions, have led to very substantial Government cost savings on the S-IVB program. At S-IVB program completion, we believe that total ultimate cost to the Government will be substantially less than it would otherwise have been in the absence of such incentives. (This belief is based on the cost of the program, as estimated by us, shortly before the conversion.)

We recognize that much of the above is judgmental. No one has ever solved the classical problem of validating the precise benefits achieved through the use of contract incentives. We believe that partial substantiation of our judgments can be obtained by comparing certain data from S-IVB stages 501 and 505 (N). (These are the first and last stages, respectively, on which schedule incentive bonuses were available.)

We have selected what we consider meaningful indicators of performance applicable to each of these stages. The indicators and the applicable results for each stage are summarized in the attached table.

In reviewing this table, please bear in mind that Stage 501 had been substantially completed at the time the incentives were implemented, and that Stage 505 (N) was in a position to enjoy the benefits of some three years of operation in an incentive atmosphere.

We believe that we have selected representative, meaningful indicators, and that these indicators, taken together, argue persuasively that the incentives incorporated into the S-IVB contract produced the intended results.

There are additional points which buttress our thesis that the GAO report oversimplifies, out of proper context, one element in a complex program. We draw attention to the following points, the omission of which in the draft report denies the reader a balanced, complete picture.

1) All schedule incentives on Stages 507 and subsequent were structured by NASA on a zero-bonus/penalty-only basis.

2) Following the loss of Stage 503, remaining schedule bonuses (on Stage 506 (N) and certain S-IB stages) were converted by NASA from a bonus/penalty to a zero-bonus/penalty-only basis.

3) Failure to include the fact that schedule incentive bonus opportunities existed (ultimately) only on Stages 501 through 505 (N) can readily cause a reader to reach an improper conclusion. For example, consider the following material quoted from page 11a of the proposed report

> "...the MA-2 schedule resulted in delivery dates for Saturn V vehicles -505 through -510 that were 1 to 4 months later than NASA's September 1964 assessment of when these vehicles could be delivered. Nevertheless,

only a short time after implementing this schedule revision, NASA decided it was appropriate to pay substantial bonuses to obtain early delivery of the S-IC and S-IVB stages for those vehicles ..."

The quoted material is intended to apply to Stages -505 through -510. In the case of the S-IVB, only one of these stages carried any schedule incentive bonus opportunities whatsoever.

4) Further to the point made in 3) above, GAO suggests that NASA could have achieved its desired schedule goals had they elected to "... in essence, revert back to the delivery dates that the September program assessment indicated could be met." However, the GAO chart printed as page 7a of the draft report contradicts rather than supports this GAO statement insofar as the early, critical stages (e.g., -501 through -504) are concerned This chart shows that the MA-2 schedule, used as the basis for the schedule incentives, required a substantial acceleration from the delivery dates that the September program assessment indicated could be met: for example, an acceleration of three (3) months is shown as required for Stage 502.

5) The added schedule time made available by adoption of air transportation for the S-IVB stages (see page 11b of draft report) did not become available with good confidence to program planners until mid-1966. The S-IVB schedule incentives for -501 through -506 were structured in 1964 and 1965, they were negotiated in late 1965 with "handshake" agreement in January 1966. Air transportation depended upon the development of a single airplane called "Super Guppy". This airplane, which in 1964-1965 had not been structurally proven, was intended for use by a number of Apollo Contractors. It would have not been prudent to negotiate and contract on the speculative premise that the R&D Super Guppy program was going to be a proven success, or be available for utilization by a particular Contractor, by a given date. (The benefits of air transportation were considered in structuring the schedule for Stages 507-515, negotiated in late 1966.) It should be noted that even at the present time, a capability to transport stages via the water mode has been retained, for backup purposes, on the program.

6) In planning delivery schedules, it is not possible to know, prospectively, which component will subsequently pace a complex program. Thus, when Contractor buys (as a prime Contractor), he normally emphasizes schedule compliance or betterment with all critical suppliers, to assure availability of all components required to meet his contract obligations. In the case of the S-IVB, this entailed, not only the integrated procurement, testing, and/or

manufacture of all stage components, but also the procurement, testing and/or manufacture of all ancillary items required for launch (e.g., special ordnance items installed at the test site, aft interstages delivered separately from the stage, etc.).

The Contractor believes that in 1964-1965 NASA was implementing a testing philosophy which called for integrated testing of the complete launch vehicle as a single entity, at KSC. This philosophy, the success of which has surely saved very substantial amounts of monies, required that great emphasis be placed on removing all schedule uncertainties from the total Apollo program. We believe that schedule incentives - including schedule incentive bonuses - played a meaningful role in this success.

In view of all of the above, we have very serious reservations about the usefulness of the proposed report in its present form. Conclusions drawn by reader would, in our judgment, be unreliable.

Because of our overall reaction to those portions of the report we reviewed and because of our previously stated recommendations, we have for the most part refrained from commenting on a detailed basis on the text itself.

Attachment. Comparison Chart,
Stages 501 vs. 505 (N)

COMPARISON OF S-IVB STAGES 501 AND 505 (N)
REPRESENTATIVE INDICATORS

INDICATOR	501	505N	IMPROVEMENT
Total time spent by stage in post-manufacturing checkout position (VCL)	65 days	38 days	27 days
Percentage of stage sub-systems successfully validated in above time span	57%	100%	75%
Out-of-position manufacturing work performed during checkout operations	6300 hrs.	3100 hrs.	3200 hrs
Open installation work transferred from factory to acceptance test site (Sacramento)	2005 hrs.	67 hrs.	1938 hrs.
Total time on test stand at Sacramento	88 days	70 days	18 days
Installation hours transferred to launch site (KSC) other than late Government changes	786 hrs.	27 hrs.	759 hrs.
Time of completion of stage readiness for shipment to launch site	27 days Late	44 days Early	71 days
Overtime expended (as a percent of straight time) during the 4 weeks immediately prior to launch, all locations	8.7%	4.9%	44%

PRINCIPAL OFFICIALS OF THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION RESPONSIBLE FOR THE ADMINISTRATION OF THE ACTIVITIES DISCUSSED IN THIS REPORT

	Tenure of office	
	From	To
HEADQUARTERS		
ADMINISTRATOR:		
Thomas O. Paine	Apr. 1969	Present
Thomas O. Paine (acting)	Oct. 1968	Apr. 1969
James E. Webb	Feb. 1961	Oct. 1968
DEPUTY ADMINISTRATOR:		
George M. Low	Dec. 1969	Present
Thomas O. Paine	Mar. 1968	Oct. 1968
Robert C. Seamans, Jr.	Dec. 1965	Jan. 1968
Hugh L. Dryden	Oct. 1958	Dec. 1965
ASSOCIATE ADMINISTRATOR:		
Homer E. Newell	Oct. 1967	Present
Robert C. Seamans, Jr.	Sept. 1960	Sept. 1967
ASSOCIATE ADMINISTRATOR FOR MANNED SPACE FLIGHT:		
George E. Mueller	Sept. 1963	Dec. 1969
MARSHALL SPACE FLIGHT CENTER		
DIRECTOR:		
Wernher von Braun	July 1960	Present

U S. GAO, Wash., D.C