

**STATEMENT**

by

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before the

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In January 1963 the Lunar Module Program performance requirements, key milestones and cost plans were agreed upon by NASA and the Grumman Aircraft Engineering Corporation (GAEC) and formed the basis for a negotiated cost-plus-fixed-fee (CPFF) contract. GAEC's performance from this point up through the start of calendar year 1965 was typical of that experienced by NASA with other companies in the early phases of a new research and development program. Initially, progress was slow. This was mainly because GAEC proceeded slowly and deliberately with the process of building up its technical and manufacturing capability.

Early in 1965 it was NASA's belief that GAEC's performance was lagging and that basic improvements were required in the timeliness of technical solutions, program staffing, cost control, subcontract management and schedule position. At this time the first steps were taken towards an incentive contract arrangement with GAEC. After a detailed review of the Grumman proposal, and a series of joint MSC/GAEC subcontractor

reviews, it was concluded by NASA that the LM Program was not sufficiently stable nor the numerous development problems sufficiently well understood to negotiate an incentive type contract. Accordingly, negotiations were held in abeyance, and a first quarter Fiscal Year 66 cost control plan was agreed to by NASA and GAEC management. The intent was to negotiate an incentive conversion of the existing CPFF contract, if Grumman could demonstrate its ability to control the LM Program to this plan and make progress on the critical technical problems.

Grumman did demonstrate this capability, negotiation of the incentive contract proceeded and joint NASA/Grumman agreement was reached in December 1965.

Early in 1966, it appeared to NASA that the Grumman LM Program costs were beginning to escalate and that Grumman's control of its subcontractors was deficient, and that in-house cost control was also beginning to weaken. It was in this context that Dr. Gilruth, the Manned Spacecraft Center Director, and Mr. Evans, the new GAEC President, discussed the problems of the LM Program. As the newly appointed President of GAEC, Mr. Evans requested assistance in identifying the causes of the cost control and subcontractor management problems and agreed with Dr. Gilruth that a NASA Management Review Team should be formed to assist GAEC in determining the underlying reasons for the problems.

A NASA Management Review Team, consisting of members from MSC and NASA Headquarters, was formed and met with GAEC personnel at Bethpage, Long Island, New York, June 20 through July 1, 1966. The review was not structured to be a total GAEC LM Program Management Review, but rather, focused on:

Why cost forecasting and the ability to control to a forecast seemed weak?

and, why the management of major subcontractors seemed ineffective?

During the period of the review Grumman management and LM Program personnel were most responsive and provided all information, including introspective self appraisals, essential to a successful analysis. Accordingly, the review team was able to identify, by detail example, problems existent at GAEC and to direct attention to some of the causes of these problems. The findings of the review team were organized into five basic categories. These were:

Program Cost Control

Ground Support Equipment (GSE)

Subcontract Management

Schedule, Planning, Analysis and Control

and, Program Management

An oral preliminary report on the review team's findings and recommendations were presented to the GAEC President on June 28, 1966. The

Management Review Team's findings were transmitted to Grumman and provided detailed identification of problems with recommended solutions. Since the GAEC President regarded and worked with the Team as though it were his personal management analysis staff, immediate steps were taken to implement the recommendations. On August 9, 1966, <sup>at 11:00. From the meeting,</sup> the Team leaders returned to Grumman to review Grumman's responses to the NASA Management Review Team's findings and recommendations. The implementing actions Grumman was taking were fully responsive to the review team's recommendations. 8

In summary, the review team findings and Grumman's actions were as follows:

1. Program Costs were not sufficiently controlled. It was recommended that Grumman implement a more effective cost control system through the application of a work management plan with provisions for budget reserves to assure stability of the program. Grumman responded by developing, with NASA assistance, a "Work Package" management plan to establish a program baseline, responsibility assignment, cost awareness, and specific budgets for all levels of the LM Program. Grumman's fiscal year 67 plan set in August 1966 called for the expenditure of \$372M cost without fee. Grumman's expenditures for the 1967 fiscal year will be approximately \$395M cost without fee. In order to arrive at a number that corresponds to Grumman's plan you must subtract out several added items, such as \$10M for advanced material buys that allowed Grumman to

buy more economically and \$7M in change activity which results in a comparable cost of approximately \$378M. Thus Grumman has controlled cost to within about 2 percent of a target established immediately after the review, although this level of cost exceeds the incentive target by approximately 20%.

2. Integrated Ground Support Equipment schedules were not available, were not supported by detailed work plans, and the actual status of GSE was not clearly understood. The review team recommended the establishment of more detailed certified drawing release schedules, the implementation of a production task force, and daily management review of GSE status. Grumman responded by identifying and scheduling at a substantially more detailed level the drawing lists for all undelivered GSE, assigned a senior individual full time to expedite GSE manufacturing, and established a command post to track and status each item of GSE. By December GSE was no longer a program constraint.

3. Subcontract Management was found to be deficient in that there was not an individual who was responsible and accountable for overall subcontractor management, including cost, schedule and technical performance. Authority and responsibility was diffuse and splintered. The NASA team recommended that Grumman appoint a senior individual who would be responsible and accountable for all aspects of subcontractor management

both internally and externally. Grumman responded by appointing a Manager of LM Subcontracts with the necessary authority to establish and maintain control of LM subcontractors' costs, schedule and technical performance. Since then deliveries have become more predictable and the qualification program has been substantially completed.

4. Integrated Schedule Planning, Analysis and Control was found to be practically non-existent across GAEC departments supporting the LM Program. It was recommended that Grumman provide adequate and current schedule direction, establish a consistent and documented detailed planning procedure, and provide a timely program status and analysis. Grumman responded by tying all schedules to the requirements of their master schedule. Levels for program integration was established, and a statusing and analysis system was created. In spite of this Grumman's performance in meeting the detailed schedules established has not been up to NASA's expectations. 8

5. Strong Program Management was found to be absent. It was recommended that LM Program management aggressively force required actions across the entire program to assure that all decisions are, in fact, reaching the operating organizations. Grumman responded by creating and filling the positions of Subcontract Manager and Program Control Manager.

Additionally, they placed their Senior Vice President in charge of all space activities within GAEC to ensure that corporate decisions would fully recognize the high priority of the LM Program. Other organizational improvements were made and Grumman with NASA assistance implemented the work package plan through the establishment of manageable units of work, thus facilitating the decision making process.

Although GAEC took timely corrective actions to resolve the management deficiencies revealed by the NASA review conducted June 20-July 1, 1966, there have been a continuing series of actions taken by GAEC and NASA subsequent to this review.

At NASA's suggestion GAEC corporate officers have pursued the GAEC subcontractor problems by the establishment of a series of quarterly Subcontractor President's Meetings. At these meetings the status of the subcontracts is discussed with the presidents of the corporations. These reviews, which consider total subcontractor performance, serve as an excellent tool for increasing the top management attention at the subcontractors. Subcontractors performance during this period has improved as a result of this additional management attention.

During the period of August to November 1966 a NASA team assisted Grumman in the development and installation of the "work package" management system at Grumman. In the latter part of this period a joint

team of GAEC and NASA personnel traveled to the major subcontractors to install the system at that level also.

Schedule achievement problems on the early vehicles became apparent in November and December 1966 and as a result, NASA moved the Assistant Apollo Spacecraft Program Manager for LM into the Grumman plant on a full time basis. This action was taken during the first quarter of calendar 1967 in order to assure that every possible NASA assistance would be brought to bear on LM program problems and in order to insure that decisions required of NASA could be made on the spot.

During this period a stronger management team was assigned by GAEC to the LM Final Assembly and Checkout Operation and a detailed work scheduling and control command post was established for each LM vehicle. This is much the same approach used by GAEC in breaking the GSE bottleneck earlier.

In order to revalidate Grumman's quality effort, a detailed LM shake-down inspection of the LM-1 vehicle was conducted by NASA in April and an across the board quality program audit was made by Admiral Middleton in May. The shakedown inspection resulted in identifying 2,000 discrepancies. Analysis showed, however, that only 10 of these could have affected mission success and none would have affected flight safety. The results of the Middleton review uncovered only minor deficiencies which were accepted by GAEC with an attitude of determination to resolve the problems and implement corrective action.

In addition to management problems there have also been numerous technical problems in the LM program. In fact, there have been serious developmental problems with almost every major subsystem in the LM vehicle. There have been problems with the durability and repeatability of the LM descent engine performance, as well as chamber pressure spiking of the reaction control engines. Fabrication and chamber under cutting problems have also developed on the ascent engine. There has been a problem of adequate gyro availability to support the needs of the LM Abort Guidance Subsystem. There was a question of lock on accuracy of the landing radar.

The rendezvous radar has experienced false lock on difficulties together with electronic module manufacturing problems. The environmental control system has also presented a serious problem in its design and manufacture. Associated with each of these individual subsystem technical problems there has been a critical weight problem on the LM vehicle. This problem was aggravated by the requirement to wrap the LM vehicle in a thermal shield in order to resolve certain of the mission environmental problems. Each of these technical problems have been dealt with by aggressive NASA and GAEC management action. With the exception of the ascent engine problem and the LM weight situation it can be said with some degree of confidence that acceptable solutions to these technical problems have been established.

Problems do continue to exist in the program. The first flight article will, we believe, be delivered by July 1, approximately seven months late. The ascent engine continues to have worrisome problems. The most significant of the problems are an uneven ablation of the thrust chamber, low and high frequency instability and an injector fabrication problem. The solution to these problems is being aggressively pursued by the application of both NASA and GAEC technical talent together with special assistance secured from other engine manufacturers and government agencies. However, the immediate effect of these problems has served to delay the completion of the ascent engine qualification program. The weight margin of 1% remaining in the LM vehicle is uncomfortably low. The necessary fire prevention related changes in the spacecraft will add a further complication to cost control, weight and schedule problems.

The contractor performance is improving, many difficult technical problems have been overcome. With the exception of the engine problems, we do not believe any major hardware problems remain unresolved. 00

However, this is a very complex device which has not yet passed all its ground tests nor its manned flight test. It is also one of the most critical elements of the Apollo Program in that it must operate manned in earth orbit and in the critical lunar landing portion of the mission. Any problem in this element of the program I regard as an extremely critical situation.

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