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No. 956

APOLLO 204 ACCIDENT

REPORT

S. Congress, 90th, 2d Session OF THE

COMMITTEE ON AERONAUTICAL AND SPACE SCIENCES UNITED STATES SENATE WITH ADDITIONAL VIEWS



JANUARY 30, 1968.—Ordered to be printed

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PREFACE

It is the committee's view that, when an event such as the tragic Apollo 204 accident occurs, it is necessary for the appropriate congressional committees to review the event thoroughly. The Congress has a duty to be fully informed and to provide an information flow to the people. Further, the committee has a responsibility to satisfy itself that a strong NASA management is exercising vigilance over the safety of the people working on the space programs.

No single person bears all of the responsibility for the Apollo 204 accident. It happened because many people made the mistake of failing to recognize a hazardous situation.

Three courageous men lost their lives in this tragic accident. They died in the service of their country. Because of their deaths, manned space flight will be safer for those who follow them. The names Grissom, White, and Chaffee are recorded in history and the most fitting memorial the country can leave these men is the success of the Apollo program—the goal for which they gave their lives.

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JANUARY 30, 1968.—Ordered to be printed

Mr. ANDERSON, from the Committee on Aeronautical and Space Sciences, submitted the following

R E P O R T

together with

ADDITIONAL VIEWS

APOLLO 204 ACCIDENT

INTRODUCTION

During one of the final prelaunch tests¹ for the first manned Apollo flight,² at about 6:31:04.7 p.m., e.s.t.—on January 27, 1967, a fire was reported by the astronauts in the Apollo Command Module 012 located on top of the uprated Saturn I 204 launch vehicle on the launch pad of Complex 34 at the John F. Kennedy Space Center, Fla. After detection, the fire lasted only about 25½ seconds—less than one-half minute—before consuming all of the oxygen in the command module; nevertheless, very high temperatures were reached inside the spacecraft. This fire, designated the Apollo 204 accident, resulted in the deaths of Astronauts Virgil I. Grissom, Edward H. White, and Roger B. Chaffee.

On January 27, 1967, the Administrator of NASA, James E. Webb, in accordance with NASA regulations, established the Apollo 204 Review Board to investigate the Apollo 204 accident.

On January 28, the chairman of the U.S. Senate Committee on Aeronautical and Space Sciences, Senator Clinton P. Anderson, with the agreement of the ranking minority member, Senator Margaret Chase Smith, announced that the committee would conduct a full review of the Apollo 204 accident, that the committee would examine the procedures and findings of the Apollo 204 Review Board, and would gather any additional information necessary to fulfill the committee's responsibility. The chairman later announced, again with the agreement of the ranking minority member, that the committee would review related aspects of NASA's stewardship of the Apollo program in order to accomplish the above objective; and further, he directed the committee staff to undertake such background study as was appropriate at that time and to keep informed of the progress of the NASA inquiry but to take no action which would in any way impede the formal inquiry of NASA. The chairman, on January 31, 1967, by letter, requested from the Administrator of NASA all reports of the board of inquiry and such other supporting data as was necessary for the committee to conduct its review.

The committee conducted its review of the Apollo 204 accident along two lines: (1) the study of background data necessary to understand all the aspects of the accident; and (2) a series of hearings³ at which NASA officials, the Apollo 204 Review Board and representatives from the prime contractor, North American Aviation, Inc.,⁴ appeared before the committee to give the committee their views. The committee has reviewed the—

¹ This was a space vehicle plugs-out integrated test, its purpose being to demonstrate all space vehicle systems and operational procedures in as near a flight configuration as practical on the ground and to verify their capability in a simulated launch.

² The launch was scheduled for mid-February 1967.

³ See "Apollo Accident Hearings" before the U.S. Senate Committee on Aeronautical and Space Sciences, pts. 1 through 8. See app. I for dates of committee hearings and list of witnesses.

⁴ The name of the company was changed on Sept. 22, 1967, to North American-Rockwell Corp.

1. Events leading to the accident;
2. Events surrounding the accident on January 27, 1967;
3. Cause and nature of the accident;
4. Report of the Apollo 204 Review Board;
5. Stewardship of the National Aeronautics and Space Administration in the Apollo Program;
6. Performance of North American Aviation, Inc., as the prime contractor for the Apollo command module; and
7. Changes in the Apollo program made by NASA as a result of the Apollo 204 accident and the effect of the accident on program costs and schedules.

The committee's findings and conclusions resulting from its review are set forth below.

FINDINGS AND CONCLUSIONS

APOLLO 204 BOARD⁵

On January 27, 1967, the Administrator of the National Aeronautics and Space Administration established the Apollo 204 Review Board, appointing as Chairman, Dr. Floyd L. Thompson, Director, Langley Research Center. Seven additional members were named to the Board, five from the National Aeronautics and Space Administration, one from the U.S. Air Force and one from the U.S. Bureau of Mines.

The Board was heavily weighted with NASA personnel because, in the judgment of the Administrator, the complexity of the Apollo program required Board members thoroughly familiar with the Apollo system and with the NASA management procedures to make an orderly and accurate investigation of the accident and determine its cause.

The "Report of Apollo 204 Review Board," along with several appendixes containing the Board's Panel reports, was submitted by the National Aeronautics and Space Administration to the committee on Sunday, April 9, 1967. During the latter part of May 1967, NASA submitted to the committee appendix G, part 1, of the report which is comprised of errata to the Board report and the appendixes previously submitted to the committee. On November 6, 1967, the committee received appendix G, part 2, containing a chronology of the Board's activities through May 24, 1967, the supplementary report of Panel 18, a report of test results, additional errata sheets and other material.

The committee found that the Board did conduct an exhaustive and thorough review of the accident and that the Board's review was objective. The objectivity of the review is pointedly supported by the critical findings the Board made of certain National Aeronautics and Space Administration management and technical operations.

In accomplishing its assigned task the Review Board established 21 working panels to review the many Apollo spacecraft subsystems, components, and materials, and conducted many actual tests and studies to verify its conclusions.

⁵ See app. II.

CONDITIONS LEADING TO THE ACCIDENT

On the basis of its review and the testimony obtained during hearings, the committee believes that the conditions which led to and were directly or indirectly related to the disaster follow:

Failure to Identify Test as Hazardous

The test in process at the time of the accident was being conducted with a 100-percent pure oxygen cabin atmosphere at 16.7 p.s.i. and had not been identified as hazardous by responsible officials. However, one of the principal determinations of the Apollo 204 Review Board was that "the test conditions were extremely hazardous." The successful Mercury and Gemini programs both of which were tested and flown using a pure oxygen atmosphere and the hundreds of hours of successful testing with 100 percent pure oxygen apparently led to a false sense of confidence and therefore complacency in this operation. The committee can find no other explanation for the failure of the hundreds of highly-trained people on the Apollo program, including the astronauts, to evaluate the conditions under which the test was being conducted as hazardous. Other serious oxygen fires had occurred.⁶ NASA itself had commissioned research⁷ on the cause and effects of fires in oxygen-rich atmospheres. It appears that everyone associated with the design and test of the spacecraft simply failed to understand fully the danger and the cooperative effect of an ignition source, the combustible materials, and the pure oxygen atmosphere in the sealed spacecraft cabin.⁸

Spacecraft Hatch

The Apollo spacecraft 012 was equipped with an inward opening hatch which required at least 90 seconds for either internal or external removal and crew egress. Further, the 16.7 p.s.i. test atmosphere and the increase of pressure created by the fire did not permit opening of the hatch without cabin depressurization and the cabin had no means for depressurizing it quickly.⁹ The National Aeronautics and Space Administration, in the establishment of its design specifications for the Apollo spacecraft, had considered the merits of this hatch with those of a quick-opening hatch such as had been used on the Mercury and Gemini spacecraft. However, in weighing the tradeoffs, the possibility of accidental release in space of a quick-opening hatch (like the ones used in the earlier spacecraft) was considered to impose a risk in excess of the benefits to be gained from such a hatch.

Ground Safety Procedures

Ground safety procedures, personnel training in safety procedures, and the availability of proper emergency equipment at the launch pad and in the vicinity of the spacecraft were completely inadequate. The absence of properly trained and equipped personnel prevented the test support crews from rendering immediate emergency assistance to the astronauts in the spacecraft. These inadequacies originated in the failure to identify this test as hazardous.

⁶"Apollo Accident Hearings," pt. 1, Feb. 7, 1967, p. 33.

⁷ For example, see NASA SP-48, "Space Cabin Atmospheres, Part II—Fire and Blast Hazards, 1964."

⁸ The Air Force 2 days later had a fire in a test chamber with a pure oxygen atmosphere at Brooks Air Force Base, Tex., which took the lives of two airmen.

⁹ A device existed for *very slow* depressurization but for reasons unknown this device was not activated.

Operational Test Procedures

Operational test procedures for the spacecraft were subjected to last-minute changes, which were agreed to verbally but not reduced to writing, so that all personnel would be informed and have an opportunity to study the changes and thereby become aware of their impact upon the test being conducted. The Apollo 204 Review Board found and witnesses testified, that this did not cause or contribute to the accident; but NASA testified that the policy for development of test procedures does require that an adequate time be provided prior to a test to complete procedures.

Communications

The Apollo 204 Review Board determined that the overall communications system was unsatisfactory and recommended that the ground communication system be improved to insure reliable communications between all test elements before any manned operations. NASA agrees that there were certain deficiencies in the communications system but witnesses testified that in no way were they able to determine that the communications problem was related to the ignition of the fire or contributed to the accident.

Control of Combustible Material

Control of material present inside the command module during the test was inadequate. Combustible standards established for nonmetallic materials were too low and the criteria for selection and approval of spacecraft material were inadequate. Furthermore, there were no criteria for the placement of material to minimize the propagation of a fire if ignited, and there was little control over the temporary usage of nonflight materials during ground test. Consequently, at the time of the fire there were nonflight materials inside the spacecraft.

Engineering, Workmanship, and Quality Control Deficiencies

The Apollo 204 Review Board identified deficiencies in the command module concerned with design, workmanship, and quality control which it believes created an unnecessarily hazardous condition.

Among the deficiencies noted by the Board were problems in design and installation of electrical wiring; chronic failures of components of the environmental control system; and the fact that no vibration tests were conducted of a complete flight configured spacecraft.

Deficiencies existed in engineering design of the spacecraft as evidenced by improper protection for electrical cabling.

Deficiencies existed in the management of engineering such as change orders, configuration control, and general status of the hardware at a particular point in time.

The level of workmanship in manufacturing, installation, and rework which is required and expected in a program of the technical sophistication of the Apollo spacecraft was absent.

Combined with poor workmanship was inadequate quality control to identify and so permit correction of such workmanship deficiencies. This was most clearly shown by the discovery of a wrench socket in the 012 Command Module during the postfire disassembly process.

The committee recognizes that a highly complex research and development project, such as the Apollo spacecraft, involves untried techniques and concepts, new materials and components, all focused

on accomplishing an objective never before achieved. However, these characteristics were well known from the start of the program; therefore, the committee concludes that the care and diligence exercised in both technical and managerial areas were below the level required for this undertaking.

PRINCIPAL ASPECTS OF THE ACCIDENT

The Review Board did not conclusively identify a single ignition source of the fire; however, it identified the most probable initiator as an electrical arc occurring near the floor in the lower forward section of the left-hand equipment bay where environmental control system instrumentation power wiring led into the area between the environmental control unit and the oxygen panel.

The spacecraft design objective was to eliminate all sources of ignition. Consequently, this influenced other design criteria such as the decision not to use a quick-opening hatch nor to include a fire extinguishing system in the cabin.¹⁰

Upon ignition a three-phase fire occurred. During the second phase combustible materials caused the fire to spread rapidly through the spacecraft. The resulting increase in pressure ruptured the cabin at about 14.7 seconds after the call of fire. Temperatures at some places in the cabin during the second phase reached more than 1,000° F.

The three crewmembers became unconscious from inhaling toxic gases shortly after initiation of the fire and death occurred soon thereafter. Autopsy reports proved conclusively that the astronauts died of asphyxiation and not from burns from the fire.

The hatch was not removed until 4 minutes and 55 seconds¹¹ after the crew's report of fire and it was the opinion of the best medical advice available to the Board that the crew was beyond revival at that time.

The first firemen did not arrive on the scene of the fire until about 8 minutes, 55 seconds after the fire was reported; the first medical doctor did not arrive on the scene until at least 11 minutes, 55 seconds after the fire was reported.

NASA RESPONSE TO FINDINGS, DETERMINATIONS, AND RECOMMENDATIONS OF APOLLO 204 REVIEW BOARD

In addition to the extensive system, subsystem, and component studies on the Apollo spacecraft made by the Apollo 204 Review Board, NASA undertook a detailed analysis of the entire Apollo program and its management. This included a comprehensive review of each deficiency noted by the Board and its supporting panels to

¹⁰ A fire extinguishing system could introduce hazards because of the toxic fumes generated by some systems and the impact of such fumes on the crew if they are not in their space suits when the system was activated. A quick outward opening hatch presents risks such as being inadvertently activated especially on long duration space voyages. Therefore, these items had not been omitted through neglect, but because of decisions based on an attempt to balance one potential set of risks against another.

¹¹ Testimony before the committee was 4 minutes, 36 seconds (pt. III, p. 246, of the hearings). However, data in the report of the Apollo 204 Review Board and the report of Panel 3 shows about 4 minutes, 55 seconds.

identify and initiate corrective action in those areas noted. In addition to identifying and taking actions to improve crew safety, this review, because of its extraordinary depth and analysis, should result in substantial improvements to many other aspects of the Apollo program.

Many changes have been made in the Apollo program because of the accident and are discussed in parts 6, 7, and 8 of the hearings. The astronauts have had and will continue to have a direct hand in all planning and changes for the Apollo command module and no manned flights have been or will be attempted in the Apollo program until the astronauts, in the light of their newly acquired technical information, are completely satisfied with all aspects of the Apollo system.

Substantial changes in the management of the Apollo program have been made both in the agency and in the prime contractor's effort.

Some of the more important procedure and hardware changes that have been initiated by NASA follow.

Procedures

1. All tests taking place in 100 percent pure oxygen environments are now defined as hazardous.
2. Responsibility for test procedures at the Kennedy Space Center and the Manned Spacecraft Center has been redefined.
3. An Office of Flight Safety has been established independent of the flight program office at both headquarters and field centers to review all aspects of design, manufacturing, test, and flight from a safety standpoint.
4. Emergency-type training is now required for test support personnel and the launch pad is required to be equipped with appropriate fire fighting and rescue equipment.

Spacecraft and Facility Modifications

1. All manned flights will be in the Block II spacecraft, the design of which already incorporates many of the changes recommended by the Apollo 204 Review Board.
2. A significant change has been instituted in the approach to the selection and placement of materials inside the command module. This change, which severely restricts and controls the amount and location of combustible material in the command module, is more significant than any other improvement resulting from the accident.
3. A new quick-opening hatch to be installed on all Block II spacecraft is being developed.
4. Provision has been made in the spacecraft for a fire extinguishing capability using jellied water.
5. An emergency oxygen supply system has been provided for the flight crew in the event they are separated from their suits.
6. The launch facilities have been modified to accommodate the quick-opening hatch and expedite flight crew exit through the service structure in the event of fire.

One Hundred Percent Pure Oxygen Environment

NASA has defined all tests taking place in 100 percent pure oxygen environment as hazardous. While NASA has reconfirmed by detailed review that the inflight cabin atmosphere, outside the Earth's atmosphere, should continue to be 100 percent oxygen at 5 p.s.i.a., it has modified the command module systems to be capable of using air, as well as pure oxygen, as a pressurant on the launch pad. Should full

scale flammability tests indicate a need to change to an air atmosphere for ground operations, NASA will implement this capability. However, the dual gas cabin atmosphere, while reducing the fire hazard, creates other risks such as the risk of the astronauts getting the "bends" if their cabin pressure is reduced quickly.

NASA Status Report

NASA submitted to the committee on January 8, 1968, a report on the status of actions taken on the Apollo 204 Review Board Report as of December 28, 1967. This document is printed as part 8 of the committee's hearings on the Apollo accident. This status report shows that NASA has made substantial progress in adopting and implementing the findings, determinations, and recommendations of the Apollo 204 Review Board and its task panels.

NASA-SPACECRAFT CONTRACTOR RELATIONS

During the course of the committee's hearings it was called to the attention of the committee that NASA had experienced schedule, cost and performance problems with North American Aviation, Inc., prime contractor for the Apollo command and service modules and the Saturn S-II stage.

A task force review,¹² headed by Apollo Program Director Samuel C. Phillips, made a detailed examination of the contractor's management of assigned programs and made many recommendations for remedial action on all aspects of the contractor's operations in order to return the program to an acceptable level of performance. Its results were submitted to North American management on December 19, 1965.

Such a review is considered to be a proper management action on the part of NASA and the committee was impressed by its professionalism and thoroughness. However, it was not made clear why the responsible NASA centers permitted the situation to deteriorate as far as it apparently had before initiating appropriate remedial action.

In response to committee questioning, NASA witnesses testified that (a) the contractor has been responsive to the recommendations and that NASA has confidence that the contractor will be able to perform to the level of managerial and technical performance required and expected in the Apollo program; (b) that the results of such review were supplied to the Apollo 204 Review Board for its consideration;¹³ and (c) that the findings of the task force had no effect on the accident, did not lead to the accident, and were not related to the accident.¹⁴

The Administrator of NASA testified on May 9, 1967, that NASA has realigned certain responsibilities in the Apollo hardware program to streamline the Apollo effort in the interests of better performance and greater efficiency on the part of the spacecraft contractor. One principal action in this regard is to assure that the contractor's efforts to meet schedule and performance targets for the Apollo program will not be diluted during this period by follow-on Apollo Applications work. Also, NASA has ordered the freezing of the command module design throughout the Block II production.

¹² For a summary of this review see "Apollo Accident Hearings," pt. 4, Apr. 13 and 17, 1967, p. 319.

¹³ Ibid., pp. 319 and 332.

¹⁴ Ibid., p. 319.

EFFECTS OF THE APOLLO 204 ACCIDENT ON SCHEDULE AND COST OF THE
APOLLO PROGRAM

The Apollo 204 accident and its investigation resulted in substantial changes in the program with resultant impacts on costs and schedules. The principal schedule changes and the cost impact of the accident on the program follow.

*Apollo Schedule*¹⁵

The initial Apollo manned flight with the modified Block II spacecraft is scheduled for launch by an uprated Saturn I vehicle during the third or fourth quarter of calendar year 1968, some 17 or 18 months after the scheduled launch of Apollo 204 in February 1967.¹⁶ The first unmanned qualification flight of the Saturn V launch vehicle carrying a Block I spacecraft was rescheduled from early 1967 to late 1967 when a highly successful system performance was realized. This flight is to be followed by a second unmanned Saturn V flight in March 1968 followed by a third Saturn V unmanned flight in 1968. If the Saturn V launch vehicle is manrated as a result of these flights and the first manned Block II spacecraft mission meets its objectives, subsequent Apollo flights involving command module and lunar module operations in earth orbit in preparation for the lunar landing would be transferred to the Saturn V vehicle rather than utilizing dual uprated Saturn I launches for these practice missions as previously contemplated. However, dual uprated Saturn I missions could be flown as backup missions in the event of Saturn V vehicle qualification delays. A Saturn V vehicle success schedule now projects six manned launches in 1968 and 1969 with the possibility of accomplishing a lunar landing before 1970.

The impact of the Apollo 204 accident has been to reduce the probability of such a landing, not eliminate it. If required for the lunar landing objective, the last six of the original complement of 15 Saturn V vehicles would be launched after 1969.

Apollo Program Cost

Time is a major factor influencing the cost of the Apollo program. In 1966 NASA advised the committee that the total estimated cost of the Apollo program was \$22.718 billion assuming that all 12 uprated Saturn I and 15 Saturn V launch vehicles were required for the lunar landing. The comparable estimate provided by NASA during the May 9, 1967 hearing is \$23.190 billion, an increase of \$472 million. The increase is largely due to the effect of stretching out the Apollo/Saturn V launch schedule. However, early achievement of the lunar landing objective would permit the allocation of unused Apollo hard-

¹⁵ NASA announced a new Apollo/Saturn launch schedule which is printed in app. III to this report.

¹⁶ On May 9, 1967, Dr. George Mueller, Associate Administrator for Manned Space Flight, testified that the first manned space flight of the Apollo program would be delayed about a year so that it would take place in about March 1968. Later, before the House Appropriations Committee, Maj. Gen. Samuel C. Phillips, Director of the Apollo program, testified that the first manned launch had slipped until at least May 1968. Still later, it became clear that the first manned flight will not take place until the summer of 1968. The reason for the slippage of the first manned Apollo flight is that the required redesign and development of the Block II spacecraft has turned out to be a much larger job than first estimated. However, NASA expects these efforts to provide an improved spacecraft and booster system. On November 8, 1967, Mr. James E. Webb testified before this committee that:

"* * * in the redesign of the Apollo capsule, we have incorporated many changes which relate to developed new knowledge following the fire or new knowledge that was available at the time of the fire but which we could not incorporate without major change in the whole schedule. For instance, the elimination of combustible material in the capsule to the fullest extent possible has produced a very much more advanced capsule which I think will be extremely useful over a long period of time if we choose to use it."

The committee believes that every reasonable effort should be made to make the Apollo and all other space flights as safe as possible and finds no fault with NASA's decision to slip the schedule.

ware and an appropriate share of operational expenses to the Apollo applications program with an offsetting reduction in the cost of the Apollo program.

There was no immediate impact of the accident on the NASA fiscal year 1967 financial plan or the fiscal year 1968 budget request¹⁷ because of offsetting factors such as the suspension of flight schedules and changes in spacecraft production planning, which permitted adjustments within the total NASA budget framework for these years. The overall impact of the Apollo 204 accident, therefore, will appear in future years as is evidenced by the increase in the total runout cost estimate for the Apollo program.

SUMMARY

The thorough investigation by the Apollo 204 Review Board of the Apollo accident determined that the test conditions at the time of the accident were "extremely hazardous." However, the test was not recognized as being hazardous by either NASA or the contractor prior to the accident. Consequently, adequate safety precautions were neither established nor observed for this test. The amount and location of combustibles in the command module were not closely restricted and controlled, and there was no way for the crew to egress rapidly from the command module during this type of emergency nor had procedures been established for ground support personnel outside the spacecraft to assist the crew. Proper emergency equipment was not located in the "white room" surrounding the Apollo command module nor were emergency fire and medical rescue teams in attendance.

There appears to be no adequate explanation for the failure to recognize the test being conducted at the time of the accident as hazardous. The only explanation offered by the committee is that NASA officials believed they had eliminated all sources of ignition and since to have a fire requires an ignition source, combustible material, and oxygen, NASA believed that necessary and sufficient action had been taken to prevent a fire.

Of course, all ignition sources had not been eliminated.

The Apollo 204 Review Board reported that it took approximately 5 minutes to open all hatches and remove the two outer hatches after the fire was reported; that the first firemen arrived about 8 to 9 minutes after the fire was reported and that the first medical doctors did not arrive until about 12 minutes or more after the fire was reported. Thus there was not expert medical opinion available on opening the hatch to determine the condition of the three astronauts although medical opinion based on autopsy reports concluded that chances for resuscitation decreased rapidly once consciousness was lost and that resuscitation was impossible by the time the hatch was opened.

It is clear from the Board's report and the testimony before the committee that this kind of accident was completely unexpected; that both NASA and the contractor were completely unprepared for it despite the amount of documentation of fire hazards in pure oxygen environments. The committee can only conclude that NASA's

¹⁷ NASA's appropriation for fiscal year 1968 was \$511,100,000 less than the budget request, of which \$50,500,000 was applied against the Apollo program.

long history of successes in testing and launching space vehicles with pure oxygen environments at 16.7 p.s.i. and lower pressures led to overconfidence and complacency.

The Apollo 204 accident was a tragic event in the nation's space program. Because of it there has been a thorough analysis and review of all aspects of the Apollo program. Consequently many changes have been made in the Apollo system design, operations, management, and procedures and NASA expects this will result in an improved spacecraft and booster system. The committee's review of the accident found nothing which would make the committee question this expectation. It is the committee's hope that the remainder of the program will be carried out with greater understanding and dedication than if there had been no accident. The total impact of the Apollo 204 accident on the Apollo program is not yet known. In continuing its close surveillance over the Apollo program, your committee will be especially mindful of the impact of the accident on program schedules and cost, and on the effectiveness of the changes in management and operations made by NASA during the past several months.

RECOMMENDATIONS

The committee recommends that NASA continue to move the Apollo program forward to achieve its goal.

NASA has testified that it is still possible to achieve a manned landing on the moon and a safe return to earth before the end of 1969 provided that this can be accomplished within the first nine Saturn V flights. The Apollo 204 accident, however, may well cause the date for an American landing on the moon to be accomplished early in the next decade outside the schedule set in 1961. That would be regrettable. When set in 1961, it was a goal set for achievement and it was technically feasible. While this goal has attracted a great deal of attention in terms of national prestige, as a pacesetter for the program and as a rallying point for the people on the program, its true significance is seldom mentioned. The target date was and still is essential to efficient management of the program. It is essential to the planning process and to maintaining a vigorous and competent organization. Any program and particularly the largest and most complex research and development program ever undertaken by man—the Apollo program—must have scheduled goals. The schedule is an essential and significant management tool—without it the program would require more and more time and more and more money.

Safety must be considered of paramount importance in the manned space flight program even at the expense of target dates. The earnest declaration that "safety is our prime consideration" must be transfused into watchfulness so that people do not again stumble into the pitfall of complacency. NASA's creation of a Flight Safety Office with broadened capabilities and better lines of communication is a step in that direction. The Congress, in the National Aeronautics and Space Administration's fiscal year 1968 authorization act,¹⁸ directed

¹⁸ Public Law 90-67.

the Administrator to appoint an Aerospace Safety Advisory Panel to review NASA's operational plans and advise the Administrator with respect to the hazards of proposed or existing facilities, proposed operations, and on the adequacy of proposed or existing safety standards. The committee urges NASA to continue its postaccident efforts to achieve a high degree of safety in all of its operations and we recommend that NASA utilize the above-mentioned organizations to achieve the primacy in safety desired.

Finally, the committee urges that the National Aeronautics and Space Administration keep the appropriate congressional committees informed on significant problems arising in its programs.

During the hearings it was found that late in 1965 NASA found serious problems with the contractor's management of the contracts for the Apollo command and service module spacecraft and S-II stage—the second stage of the Saturn V vehicle. Notwithstanding that in NASA's judgment the contractor later made significant progress in overcoming the problems, the committee believes it should have been informed of the situation. The committee does not object to the position of the Administrator of NASA, that all details of Government/contractor relationships should not be put in the public domain. However, that position in no way can be used as an argument for not bringing this or other serious situations to the attention of the committee.

ADDITIONAL VIEWS OF MR. BROOKE AND MR. PERCY

While concurring in the report, we believe a number of points deserve additional emphasis. The committee's inquiry into the Apollo 204 tragedy raised several important issues which go beyond the specific aspects of last year's disaster treated in the committee report. In our judgment, questions regarding the candor and responsiveness of NASA in its relations with the committee, the quality of management of the Apollo program by NASA and its contractors, and the flexibility of the program goal of reaching the moon in this decade all call for additional discussion.

During the course of the committee's hearings, a NASA task force review of the prime contractor's management of the Apollo Command and Service Module and the Saturn S-II stage came to the attention of the press, the public, and finally the committee. This was the task force headed by the Apollo program director, Maj. Gen. Samuel Phillips. The written material submitted by General Phillips to the contractor late in 1965 became known as the Phillips report. It was an adverse, hard-hitting, point-by-point critique of the contractor's management of the program. The history of this report provides a ready focal point for amplification of those issues of particular concern to us.

Several members of the committee became concerned with the responsiveness of some of NASA's officials when members sought to obtain information concerning the report. Such concern prompted the committee, in the report accompanying the annual NASA authorization bill, to insist that NASA keep the committee currently informed on all NASA problems in order for the committee properly to meet its responsibilities. This admonition is now repeated in the report on the Apollo fire. But NASA's curious reticence to supply these facts and materials relevant to a thorough evaluation of Apollo program management brought the credibility of NASA and its top management into sharp question.

The committee report correctly notes NASA's testimony that the deficiencies uncovered in the Phillips report were not related to the disaster. Two facts remain, however: it is not possible to pinpoint the precise ignition source of the fire; and the Apollo Spacecraft 012 was on the production line at Downey during the period of the Phillips team inspection.¹ We do not mean to conclude here that there was a causal connection. But these circumstances, together with the similarity between certain of the Phillips report conclusions and those of the Apollo Review Board, made the Phillips report of more than incidental interest to the work of the committee.

This initial lack of candor as to the existence and then the status of the Phillips report threatened one of the essential assets of the space program—the confidence of the American public and their elected

¹ Apollo Accident Hearings, Committee on Aeronautical and Space Sciences, U.S. Senate, pp. 444-445

representatives. It will be difficult for this report, these supplemental views, or any official pronouncement to restore the public and congressional trust forfeited by the agency's response to members of this committee who sought to clarify the matter. While NASA will do well to invoke all remedial means to improve this unfortunate situation, in the long run both NASA's public credibility and effective congressional review of the agency's stewardship require a fuller and more open agency-congressional relationship.

The committee and the undersigned respect the necessity for NASA and its contractors to maintain mutual confidence. We understand NASA's reluctance to publicize internal exchanges with contractor teams. It is not our intention to have the committee intrude, unnecessarily in NASA's daily management responsibilities or to substitute congressional judgment on the innumerable matters requiring decision by the program managers. It is a practical impossibility for the committee to review all communications between NASA and its contractors. Clearly NASA must exercise discretion in determining what information it will call to the attention of Congress.

Nevertheless, the committee's investigation demonstrated that NASA must make a more concerted effort to alert Congress to major problem areas as the space program evolves. The serious contractor deficiencies noted by the Phillips task force should certainly have been reported to the committee at the time of the 1967 budget hearings, if not before.

We are disturbed at the possibility that, had there been no disaster, important shortcomings in management, scheduling, design, production, and quality control might never have come to light. It would be unfortunate if the impetus for improvement to the program that may have come from discussion of the Phillips report with the committee was delayed.

We are also concerned that NASA did not make clear to the contractor that inferior performance would lead the Agency to seek other sources for the hardware involved and would prejudice the contractor's standing in competition for future work. The contractor, for all its good intentions and reputed improvement in later months, may have felt NASA had no alternative source once the original contract was let. This, as well as the stupendous complexity of the Apollo program, may have contributed to the contractor's inadequate performance, observed on many occasions up to and including late 1965. We agree that the sharp critique contained in the Phillips report may have been belated. NASA should act early and energetically to correct contractor weaknesses; it should maintain equally vigilant surveillance over its own management functions.

We are pleased to have NASA's assurances that the original problems with the contractor were largely corrected during 1966. But it is evident that the agency must prevent a repetition of the unsatisfactory experience during the early phases of the Apollo contract work.

We believe it is possible to develop more specific criteria to guide NASA in meeting its commitment to keep the Congress informed. The general standard now set up is too broad to be very useful; it may impose undue burdens on NASA and swamp the committee with more paperwork than it can digest.

In the interest of promoting a better dialog with NASA and as a contribution to developing more concrete guidelines, we would urge NASA to report promptly (a) any case involving a major contract (e.g., more than \$20 million) in which a 15-percent cost overrun is projected; (b) any such case in which contractor management fails to meet major scheduled deadlines more than five times within a year, or experiences a single failure which disrupts the timely completion of a major project; (c) any such case in which management deficiencies, quality control problems, or other production difficulties require an exceptional contractor review (comparable to the Phillips exercise of late 1965) to supplement NASA's regular contract monitoring and program management activities.

We repeat that these standards are only suggestive. But they could well serve as starting points for a discussion of improved guidelines which might be agreed upon between NASA and the committee. That discussion, in and of itself, could do much to relieve the existing difficulties.

We should like to add a final observation concerning the implementation of Apollo program goals discussed in the committee report. We recognize the value to management of scheduled goals, such as the objective of landing a man on the moon in this decade, but we feel obliged to stress that under no circumstances must the Apollo target date of 1969 be considered immutable. The goal of a lunar landing in this decade should be pursued with vigor, but we must be prepared to adjust the schedule in light of a prudent appreciation of the obstacles encountered since that goal was established. In our opinion a delay of the landing into the next decade, brought about in the interests of greater safety or as a result of efforts to avoid excessive costs that might develop in holding to the present schedule, would in no way be a political or technical disaster.

The mission is to develop a sound and safe operational capability at the earliest possible time. NASA should not misread this mandate as an imperative to meet the original schedule. The goal is more incentive than directive. Fulfillment of a schedule which the latest and most fully informed technical judgment deems appropriate should be the objective of program management. We believe that the Congress and the country are prepared to support a reasoned decision by NASA to alter any schedule, including that established at the outset of the Apollo program.

EDWARD W. BROOKE.
CHARLES H. PERCY.

ADDITIONAL VIEWS OF MR. MONDALE

I am in general agreement with the committee report as it now stands. However, one issue which arose during the committee's investigation into the Apollo 204 tragedy—the so-called Phillips report—requires further elaboration and emphasis.

The committee report rightly admonishes the National Aeronautics and Space Administration and its Administrator, the Honorable James E. Webb, for failing to appraise the committee of the serious contractor deficiencies which prompted the Phillips report at the time these problems were being investigated.

The Phillips report represented the most far-reaching and fundamental official criticism ever made of a major NASA program. The biggest and most ambitious NASA program of all—man's flight to the moon—was in deep and perilous trouble, and Congress was unaware of that fact.

Thus NASA's failure to inform the Congress of this grave situation was on unquestionably serious dereliction. But that this failure should be followed and compounded by deliberate efforts to mislead committee members and evade legitimate congressional inquiries during an investigation of this Nation's worst space tragedy, raises basic issues regarding the role of the committee vis-a-vis NASA and the ability of the committee and Congress to fulfill their responsibilities to the Nation. Specifically, the Phillips report incident raises the question of whether the committee and the Congress are to be limited to only that information which NASA sees fit to provide or whether the Congress will be supplied with complete and candid information regarding basic problems and difficulties being experienced in various NASA programs.

NASA has an unfortunate habit of swamping Congress with engineering details and starving it for policy and management information.

And it is in this second area—policy and management—not the first, where the responsibility of Congress lies.

Obviously, it is neither necessary nor desirable that the committee be inundated with every detail of NASA's relations with its contractors. But the Congress should be able to count on frank answers to pertinent, responsible, and legitimate inquiries.

Nonetheless, in response to such questions about the Phillips report, both NASA officials and representatives of the NASA contractor attempted to mislead the committee and evaded giving frank answers. When I first asked about the Phillips report on February 27, 1967, NASA officials responded with puzzlement and such statements as: "I know of no unusual General Phillips report." "I don't know of a specific report such as that." And "I cannot identify the (report) Senator Mondale was talking about." Representatives of the NASA contractor, North American Aviation, responded in a similar vein in testimony before the House Subcommittee on NASA Oversight on

April 11. When asked about the Phillips report, NAA President Atwood replied:

The Phillips report to whom? I have heard it mentioned, but General Phillips has not given us a copy of any report.

A month later, on May 4, the same North American officials were talking knowledgeably before the Senate committee about the review and report of the "General Phillips task force." Mr. Atwood described the review as "a very comprehensive and very complete * * * review and performance assessment," and said that he personally "put a tremendous amount of emphasis on it" and that NAA formed an action group consisting of "top corporate executives" to carry out the recommendations.

Similarly, the same NASA officials who knew of "no unusual General Phillips report" in February were calling it "a high-level review" and "an extraordinary effort" in testimony before the Senate committee on May 9.

These eventual admissions of the importance of the Phillips report did not come until after the existence of the document was an established fact. Unfortunately—and despite repeated requests to NASA—the Phillips report was first made available to the committee and Congress through sources other than official NASA channels, and throughout the hearings Congress was dependent upon an unofficial surreptitious source for the most significant single document involved in the Apollo 204 investigation.

Even when the facts of the Phillips review became known, NASA and NAA officials attempted to mislead members of the committee by engaging in a "semantic waltz" as to whether there was in fact a "report" or merely some informal "notes" made by the general and his associates. (The Phillips report is entitled "NASA Review Team Report" and it called a report no less than 10 times in the text.)

NASA's performance—the evasiveness, the lack of candor, the patronizing attitude exhibited toward Congress, the refusal to respond fully and forthrightly to legitimate congressional inquiries, and the solicitous concern for corporate sensitivities at a time of national tragedy—can only produce a loss of congressional and public confidence in NASA programs. And neither NASA nor the Nation can afford such a loss.

The very least this situation warrants is a thorough review and reassessment by NASA of its policies and practices regarding congressional inquiries and its responsibilities to keep the appropriate committees of Congress fully apprised of all basic aspects—good and bad—of NASA programs.

Unfortunately, there has been no indication to my knowledge that NASA intends to review or change the policies and practices brought to light by the Phillips report incident. Instead, there have been indications from the highest level of NASA management that such policies and practices will continue.

WALTER F. MONDALE.

APPENDICES

APPENDIX I

LIST OF WITNESSES—APOLLO ACCIDENT HEARINGS

Committee on Aeronautical and Space Sciences

February 7, 1967

Dr. Charles A. Berry, Chief of Center Medical Programs, Manned Spacecraft Center, National Aeronautics and Space Administration.

Mr. Richard S. Johnston, Chief of Crew Systems Division, Manned Spacecraft Center, National Aeronautics and Space Administration.

Dr. George E. Mueller, Associate Administrator, Office of Manned Space Flight, National Aeronautics and Space Administration.

Dr. Robert C. Seamans, Jr., Deputy Administrator, National Aeronautics and Space Administration.

February 27, 1967

Dr. Charles A. Berry, Chief of Center Medical Programs, Manned Spacecraft Center, National Aeronautics and Space Administration.

Dr. George E. Mueller, Associate Administrator, Office of Manned Space Flight, National Aeronautics and Space Administration.

Dr. Robert C. Seamans, Jr., Deputy Administrator, National Aeronautics and Space Administration.

Hon. James E. Webb, Administrator, National Aeronautics and Space Administration.

April 11, 1967

Dr. Floyd L. Thompson, Chairman of the Apollo 204 Review Board, accompanied by members of the Review Board who are as follows:

Col. Frank Borman.

Dr. Maxime A. Faget.

E. Barton Geer.

Dr. Robert W. Van Dolah.

Col. Charles F. Strang.

George C. White, Jr.

John J. Williams.

April 13, 1967

- Dr. George E. Mueller, Associate Administrator, Office of Manned Space Flight, National Aeronautics and Space Administration.
Gen. Samuel C. Phillips, Apollo Program Director, Office of Manned Space Flight, National Aeronautics and Space Administration.
Dr. Robert C. Seamans, Jr., Deputy Administrator, National Aeronautics and Space Administration.
Dr. Charles A. Berry, Chief of Center Medical Programs, Manned Spacecraft Center, National Aeronautics and Space Administration.

April 17, 1967

- Hon. James E. Webb, Administrator, National Aeronautics and Space Administration.
Dr. George E. Mueller, Associate Administrator, Office of Manned Space Flight, National Aeronautics and Space Administration.

May 4, 1967

- Mr. J. L. Atwood, president of North American Aviation, Inc.
Mr. Dale D. Myers, vice president of the Space Division, North American Aviation, Inc.

May 9, 1967

- Hon. James E. Webb, Administrator, National Aeronautics and Space Administration.
Dr. George E. Mueller, Associate Administrator for Manned Space Flight, National Aeronautics and Space Administration.
Gen. Samuel C. Phillips, Office of Manned Space Flight, National Aeronautics and Space Administration.
Dr. Robert C. Seamans, Jr., Deputy Administrator, National Aeronautics and Space Administration.

APPENDIX II

MEMBERS OF APOLLO 204 REVIEW BOARD¹

- Dr. Floyd L. Thompson, Director, Langley Research Center, NASA,
Chairman.
- Col. Frank Borman, Astronaut, Manned Spacecraft Center, NASA.
- Dr. Maxime A. Faget, Director, Engineering and Development,
Manned Spacecraft Center, NASA.
- E. Barton Geer, Associate Chief, Flight Vehicles and Systems Division,
Langley Research Center, NASA.
- Dr. Robert W. Van Dolah, Research Director, Explosive Research
Center, Bureau of Mines, Department of the Interior.
- Col. Charles F. Strang, Chief of Missiles and Space Safety Division,
Air Force Inspector General, Norton Air Force Base, Calif.
- George C. White, Jr., Director, Reliability and Quality, Apollo Pro-
gram Office, Headquarters NASA.
- John J. Williams, Director, Spacecraft Operations, Kennedy Space
Center, NASA.

¹ NASA, to date, has continued to keep the Board in force.

APPENDIX III

APOLLO/SATURN SCHEDULE¹

The National Aeronautics and Space Administration today announced an Apollo mission schedule of six flights in 1968 and five in 1969.

NASA Associate Administrator for Manned Space Flight, Dr. George Mueller, said the new schedule and alternative plans provide a schedule under which a limited number of Apollo command and service modules and lunar landing modules configured for lunar landing may be launched on test flights toward the Moon by the end of the decade.

In the revised Apollo schedule, command, service, and lunar modules will be tested and qualified on concurrent unmanned flights of the Up-rated Saturn and Saturn 5 launch vehicles. (Apollo/Up-rated Saturn flights are identified with a 200 series number, i.e., Apollo/Saturn 204. Saturn 5 flights are identified with a 500 series number, i.e., Apollo/Saturn 502.)

The schedule for 1968 includes—

Apollo/Saturn 204, the first unmanned test of the lunar module in earth orbit.²

Apollo/Saturn 502, second unmanned flight test of the Saturn 5 launch vehicle and Apollo command and service module.

Apollo/Saturn 503, third unmanned test of the Saturn 5 and command and service module.

Apollo/Saturn 206, second unmanned flight test of the lunar module in earth orbit.

Apollo/Saturn 205, first Apollo manned flight a 10-day mission qualifying the command and service modules for further manned operations.

Apollo/Saturn 504 first manned Apollo flight on the Saturn 5 launch vehicle. This mission will provide the first manned operation in space with both the command and service and lunar module, including crew transfer from the C. & S.M. to the L.M. and rendezvous and docking.

These flights will be flown in the above order and as rapidly as all necessary preparations can be completed. As they proceed, all opportunities to accelerate progress toward manned flights and a rapid accumulation of manned experience with the Apollo/Saturn system will be sought.

The 1969 Apollo flight schedule calls for five manned Apollo/Saturn flights, (AS 505 through AS 509) on the Saturn 5 space vehicle. Four of these flights, Apollo/Saturn 505 through 508, are programed as lunar mission development flights or lunar mission simulations.

It is possible that the lunar landing could be made on the Apollo/Saturn 509 but it is also possible that it may be delayed until one of the remaining six Saturn 5 flights.

¹ NASA release No. 67-282 dated Nov. 3, 1967.

² Accomplished Jan. 22, 1968.

LR 902 ,SAS5 1968
United States. Congress.
Senate, Committee on Science
Apollo 204 accident