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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

OFFICE OF THE ADMINISTRATOR

September 13, 1968

MEMORANDUM FOR: A/Administrator
AA/Associate Administrator
ADA/Associate Deputy Administrator
D/Associate Administrator for Organization and Management
M/Associate Administrator for Manned Space Flight
R/Associate Administrator for Advanced Research and Technology
S/Associate Administrator for Space Science and Applications
T/Associate Administrator for Tracking and Data Acquisition

FROM: AD/Deputy Administrator

SUBJECT: Development of the FY 1970 Agency Budget Plan

This memorandum outlines the process and procedures for completing the development of NASA's FY 1970 budget plan to meet the Bureau of the Budget's submission requirements.

In a letter to the Administrator dated August 20, 1968, and in subsequent discussions with me, the Director of BOB provided the FY 1970 budget guidance and planning figures to be used in developing NASA's budget estimates. In summary, this planning guidance requires submission by September 30, of a $3.6 billion FY 1970 Program Plan together with proposed high-priority program additions to that plan.

The work of the Planning Steering Group structure outlined in the September 9 meeting developed a broad range of program alternatives and strategies for our consideration in budget formulation and the preparation of Program Memoranda. We should make maximum utilization of this framework of alternative program considerations together with the runout implications of the FY 1969 Interim Operating Budget. Three alternative programs will be prepared as outlined below.

Plan A - $3.6 Billion

Plan A corresponds to the BOB-directed planning figure of $3.6 billion. As you know, the FY 196[illegible] Interim Operating Budget now governing our operations (pending final appropriations and Administration decisions) is estimated to commit the Agency to a runout FY 1970 program level of $3.65 billion, excluding the third increment civil service pay raise and essential Construction of Facilities projects. Such a program is generally compatible with the BOB's $3.6 billion planning figure. Accordingly, Plan A should largely be based on FY 1970 requirements generated by the FY 1969 Interim Operating Budget runout. Program Associate Administrators should conduct a thorough review and updating of these requirements, making adjustments as appropriate. One essential adjustment must be a further reduction in FY 1970 from the institutional support base level for the end of FY 1969 as contained in the FY 1969 Interim Operating Budget. This adjustment should provide for reductions in Civil Service employment, a proportional reduction in support service contractor effort, and further reduction in JPL employment to levels consistenc with a NASA FY 1970 Administrative Operations budget of $603 million (based on pre-July, 1968, Civil Service salary scales). Construction of Facilities projects should include only those essential to the conduct of R&D programs.

Plan B $4.1 Billion

Plan B corresponds to Plan A plus selected high-priority new starts and program additions leading to a NASA FY 1970 budget of approximately $4.1 billion. In view of the need for great government-wide restraint in budget planning for FY 1970, careful consideration must be given to the selection of recommended additions and new starts for Plan B, and thorough justifications prepared. The full impact on NASA resources must be set forth in terms of runout implications, in-house operations, personnel requirements, and tracking and data acquisition and other support. It is recognized that the work increment of Plan B over Plan A may require certain increases over the institutional support levels proposed for Plan A. In considering possible additions or new starts for Plan B, however, it is highly desirable that total institutional support requirements do not exceed those now planned for the end of FY 1969 as contained in the FY 1969 Interim Operating Budget.

Plan C - Most Effective Use of Available NASA Capabilities

Plan C corresponds to Plan B plus those selected new starts and worthwhile program additions that take maximum advantage of the nation's past investment in building NASA's capabilities. Under Plan C, NASA

would operate its existing plant at the most efficient levels in FY 1970 to move the United States as far ahead in aerospace leadership as possible. This plan, therefore, includes programs selected from the PSG alternatives which our current facilities could support were it not for limitations on overall budget levels. Plan C should thus indicate the cost to the nation of a NASA space and aeronautics program that most efficiently achieves United States aerospace preeminence through effective utilization of NASA's full capabilities, both in-house and external. The Associate Administrator is requesting the PSG to conduct a parallel study to define an optimum Plan C Program.

As in the case of the Interim Operating Budget decision process, three management meetings are scheduled for the afternoon of September 24, the day of September 25, and the morning of September 26, to review alternative budget plans, discuss the major questions and issues they raised for NASA, and arrive at the necessary decisions to complete the development of NASA's FY 1970 budget submissions. Center Directors and high-level consultants will be invited to participate. To make these meetings most effective, I am scheduling preliminary meetings with the Program Associate Administrators in advance.

In view of the limited time available, it is necessary to concentrate on this essential effort with appropriate coordination between Program Offices in areas of mutual concern. As key issues and major questions are identified through current reviews of the activities of the past several months and in the preliminary meetings with the Program Associate Administrators, they will be transmitted immediately for your consideration and response. Specific guidelines and instructions to govern these phases of the budgeting process will be issued on September 16, by the Assistant Administrator for Administration.

T. O. Paine
Deputy Administrator

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10/3/68

Statement of

Dr. Thomas O. Paine
Deputy Administrator

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

before the

Committee on Aeronautical and Space Sciences
United States Senate

Mr. Chairman and Members of the Committee:

I appreciate this opportunity, in my first appearance before this Committee since my confirmation, to present to you the NASA interim operating plan for FY 1969. My statement will be addressed primarily to the policy considerations that have guided us in establishing the plan and to the principal decisions embodied in it. My associates and I are prepared to go into greater detail in response to your questions -- both on matters covered in my statement and on any other matters which may be of interest to you.

The interim operating plan, which we placed into effect on August 8, 1968, was, and with the minor modifications we have made since that time, now is our response as the officials responsible for administering the National Aeronautics and Space Administration to three different and not wholly compatible requirements that we faced as we entered Fiscal Year 1969.

First, it became clear in June and July of 1968 that Congressional action on our FY 1969 authorization and appropriation bills would result in the appropriation to NASA of a total of about $4 billion. As you know, the amounts for NASA now approved by the Congress and before the President in H.R. 17023 total $3.995 billion, a reduction of $375 million in the President's budget request.

Second, Congress, by a separate action in the Revenue and Expenditure Control Act of 1968, has required the President to make further reductions in the total budget to reduce total federal expenditures for FY 1969 by $6 billion below the budget estimates. At the time we prepared the interim operating plan it was clear that this provision would require a limitation on NASA's FY 1969 budget below the amounts approved by Congress in its actions on NASA's authorization and appropriation bills. It was also clear, however, that a final decision on the limitations to be placed on NASA for FY 1969 would not be forthcoming until, at the earliest, Congress had completed its action on our appropriation bill and we received the apportionment of funds by the Bureau of the Budget, and that a final decision by the President might not be possible until after Congressional action on all FY 1969 appropriation bills was completed.

The President has not yet signed the appropriation bill and we have not yet received our apportionment from the Bureau of the Budget. However, we did receive an indication from the Bureau of the Budget early in August that based on the assumptions then being used by the Director of the Budget, NASA's share of the $6 billion expenditure reduction might amount to $350 million. Translated into terms of new obligational authority, this meant that our use of FY 1969 appropriations would have to be limited to $3.85 billion. In establishing our interim operating plan, we have assumed that a limitation of $3.85 billion will in fact be the final decision of the President, although the Director of the Budget even now is not able, at this time, to give us definite assurance that this will be the case.

The third crucial consideration we have faced is the necessity and our responsibility to carry forward the NASA program during a period of uncertainty that could last four months or more into the fiscal year. We not only had to provide a basis for moving ahead with those decisions and actions which had to be made during these months, but also had to recognize the necessity of making necessary reductions as early as possible in the fiscal year to avoid the much deeper reductions that might be required if we waited for final decisions later in the year.

It was for these reasons that in advance of decisions by the Bureau of the Budget or the President, we felt it was essential, in the light of all the information available to us, to construct an interim operating plan within a self-imposed $3.85 billion limitation and to decide to operate on the basis of this plan pending final decisions.

Our actions also have had to be constrained by our current instructions within the Executive Branch to hold expenditures to a minimum in 1970 as well as in 1969, and to be prepared for the eventuality of budgetary limitations in FY 1970 even more restrictive than those in FY 1969. I am personally convinced that the nation's space program requires an increase in funding in FY 1970 and I am hopeful that as we proceed with the preparation of the FY 1970 budget we will succeed in establishing the need for a significant increase. Until this decision is made, however, we have no alternative but to proceed with an interim operating plan which is designed to take into account the possibility of either an increase or a decrease in FY 1970, i.e. a plan which, where possible, holds open options we can exercise in FY 1970 if the budget is higher but which does not overcommit us if the FY 1970 budget is lower.

Let me now turn to the operating plan itself and its more significant features.

The table attached to my statement compares the amounts in the FY 1969 operating plan with the corresponding amounts in the

budget request, the amounts authorized in P.L. 90-373 and those appropriated in H.R. 17023.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
FY 1969 INTERIM OPERATING BUDGET
NOA

	Budget Request	Authorization	Appropriation	Interim Operating Budget
Apollo	2,038.8	2,025.0		2,025.0
Apollo Applications	439.6	253.2		150.0
Advanced Missions	5.0	2.5		2.5
Physics and Astronomy	141.9	136.9		132.1
Lunar and Planetary	107.3	92.3		75.8
Launch Vehicle Procurement	128.3	115.7		100.2
Bioscience	48.5	33.0		32.7
Space Applications	112.2	98.7		98.7
Elect. System	39.4	35.5		34.9
Space Vehicle System	35.3	31.8		31.7
Human Factors System	21.7	19.7		19.7
Basic Research	22.0	21.0		21.0
Sp Pwr & Elec Prop System	44.8	42.3		42.2
Nuclear Rockets	60.0	55.0		32.0
Chemical Propulsion	36.7	30.2		28.9
Aeronautics	76.9	74.9		74.9
Tracking & Data Acq.	304.8	289.8		280.0
Sustaning University Prog.	10.0	9.0		9.0
Technology Utilization	4.0	3.8		3.8
Total R&D	3,677.2	3,370.3	3,370.3	3,195.1
C of F	45.0	39.6	21.8	35.7
Administrative Operations 1/	648.2	603.2	603.2	623.3
Total NASA	4,370.4	4,013.1	3,995.3	3,854.1

1/ Excludes Pay Raise est at $23.7 M

Manned Space Flight Program

Apollo The operating plan includes $2.025 billion for the Apollo program, the amount authorized. This is approximately $14 million below the budget request.

Much progress has been made in the Apollo program this year, despite the many problems, large and small, that we have encountered, and despite greatly reduced flexibility to cope with problems as a result of reduction in Research and Development and Administrative Operations funding. Next week we plan to resume manned space flight with an earth orbital mission of up to ten days duration in the Block II Command and Service Modules, launched by a Saturn IB.

Following this flight, we had hoped to attempt an all-up, manned Saturn V, Command and Service Module and Lunar Module mission in December. This Saturn V flight was conditioned, as we have reported to the Committee, upon the successful completion of our program of modification and retest of the Saturn V in order to arrive at demonstrated solutions to the problems encountered on the Apollo 6 (AS-502) mission. The Saturn V will be ready for manned space flight in December. However, delays in test and check-out, at the Kennedy Space Center, of the first manned Lunar Module made it obvious last month that a manned Lunar Module mission could not be undertaken

before February or March of next year. Therefore, we have decided to fly the next Saturn V, No. 503, with the Apollo Command and Service Module only, and not to carry the Lunar Module on that flight. This decision enables us to move forward in employing the Apollo-Saturn V space system while we work out the problems that are currently delaying the checkout of LM 3, the Lunar Module that we had intended to fly on 503.

In the revised schedule, the flight this month, if successful, will be followed by a "CSM-only" Saturn V launch in December or January; that is, by a Saturn V launch of the Block II Command and Service Modules into earth orbit without a Lunar Module spacecraft. A Lunar Module test vehicle will replace the spacecraft, and "all-up" testing will be resumed on Saturn V number 504, which we hope to launch by March of 1969 with LM 3 and the third Block II CSM.

The Saturn V mission in December or January is planned as a low earth orbit mission to prove out the modifications to the Saturn V launch vehicle shown necessary in Apollo 6 and to cover any difficulties in the CSM that Apollo 7 might encounter. Depending on the success of the Saturn IB Apollo 7

mission this month, it may be necessary to repeat one or more experiments of that flight on the first manned Saturn V flight. On the other hand, should Apollo 7 prove highly successful, we may be able to plan on a more ambitious Saturn V mission in December or January, with deeper penetration into space and with consequently more rapid accumulation of knowledge and experience on the capabilities of the Saturn V CSM system for long range mission operations. With this in mind, we are holding the option open, in our contingency planning, for higher earth orbits, a circumlunar mission or a lunar orbital mission. The final mission decision will be made in November, after a thorough review of Apollo 7 and the status of Apollo 8 at that time.

We testified before you earlier this year that manned lunar landing and return in 1969 remained a possibility if we could accomplish the first eight Saturn V missions by the end of 1969. This is still the case under our present operating plan. During this period, the Apollo operational workload in NASA Centers will reach a peak. This is so not only in the three manned space flight centers and at Goddard, which support manned flight directly, but also at our other centers, almost all of which support each manned mission in one or more ways.

Apollo Applications The President's authorization request for this program totalled $439.6 million. The amount in the Authorization Act is $253.2 million. At this level we simply cannot carry out the program which we presented to you earlier this year.

The strong desirability of maintaining the Apollo, Aeronautics, and Space Applications programs at the full level authorized by the Congress; the need to rebalance accounts in order to match the in-house scientific, technical and managerial resources under Administrative Operations with requirements of our on-going programs; the need to retain some momentum in the unmanned planetary program; and the importance of preserving the options to move ahead in areas such as nuclear propulsion in the future -- all of these factors have forced us to reduce still further the Apollo Applications program.

Accordingly, we have included in the operating plan $150 million for this program. This amount is required to work toward the important but sharply limited and deferred Apollo Applications program we now propose.

Under the plan, production of the Saturn IB launch vehicle will terminate upon completion of the fourteenth launch vehicle, Saturn 214. This will leave nine Saturn IB's if we are able to

proceed with the Apollo schedule I discussed earlier. The twelfth Saturn IB has been completed, and the last two are well along in fabrication and assembly.

Production of the Saturn V will be discontinued at the end of the first 15 vehicles, which are being procured as part of the Apollo program. Of these 15 Saturn V's, 6 have been manufactured and 4 more will be completed this fiscal year.

In the revised Apollo Applications program we will work toward launching, in the early 1970's, a single Saturn I workshop and a single Apollo Telescope Mount (ATM) of the types we have discussed in the past. A back-up unit for each will be prepared. There will be one revisit to the workshop before the ATM is joined to it. Later, we hope to proceed with the Saturn V workshop, but work toward that goal under this operating plan will be limited to studies.

Advanced Missions In this third element of the manned space flight program, we plan to utilize $2.5 million, one-half of the budget request, for continued studies related to manned earth-orbital and lunar missions.

Space Science and Applications

Physics and Astronomy $141.9 million was requested for the Physics and Astronomy program, and $136.9 million was authorized.

The operating plan provides $132.1 million for this program. At this level, the program includes the geophysical, solar and astronomical observatories, all on-going Explorers, and the Pioneer F and G missions. The Small Astronomy Satellite (SAS-B), and a prototype Sunblazer (using the Phases-Array Antenna to be funded from the Construction of Facilities appropriation) are also included. The Sounding Rocket program is continued at a level equivalent to that of FY 1968. At the reduced level for Physics and Astronomy, the level of effort in Supporting Research and Technology and Data Analysis will be approximately 10% lower than in FY 1968.

Lunar and Planetary Exploration $92.3 million was authorized for the Lunar and Planetary Exploration program, a reduction of $15 million from the budget request. NASA's interim operating plan for FY 1969 includes $75.8 million for this program of which $6.8 million is for lunar and $69.0 million for planetary. The $69.0 million for planetary programs is required to support the Mariner-Mars 1969 mission, the reacquisition of telemetry from the Mariner V, and the Mariner-Mars 1971 mission.

Our plan also supports in FY 1969, at a reduced funding level, the capability to conduct a mission to Mars during the 1973 opportunity. This 1973 mission as now planned will include a

survivable lander with instrumentation consistent with the minimum scientific objectives recommended by the Space Science Board of the National Academy of Sciences in July of this year. However, the over-all scope of the mission will be reduced and the schedule compressed from that which could have been done under the original budget request.

As a related matter, I should note that the operating plan provides for proceeding with the construction of two 210 foot antennas which will provide support for the Mars 1973 mission and other projects, including Pioneer missions, during the 1970's.

Bioscience The operating plan includes $32.7 million for this program, a reduction of about $15 million from the budget request. The 30-day Biosatellites are retained in the program as planned; however, the reduction requires that we slip the 21-day missions by approximately 6 to 12 months to minimize expenditures in FY 1969.

Space Applications The interim operating plan supports the Space Applications program at the full amount authorized, $98.7 million. This amount is about $14 million less than the budget request.

The program is somewhat recast from that which we presented in connection with the budget request, however, due to a decision to launch a replacement for the Nimbus B experimental weather satellite. You will recall that Nimbus B was destroyed on May 18 because of a malfunction in the Thorad launch vehicle. The launch

of the replacement spacecraft, Nimbus B2, will be in the Spring of 1969, according to present plans. Our decision to repeat the Nimbus B mission, using a number of back-up experiments which are available, will avoid a delay of more than twenty-one months in obtaining the advanced meteorological data which the Nimbus experiments are designed to get.

The Space Applications program includes, in addition to the Nimbus program through Nimbus F, the Application Technology Satellites through ATS-G, although funding for the downstream missions, ATS F and G and the Advanced Applications Flight Experiments is reduced. The Earth Resources Survey portion of Space Application will be funded at the level of $11.2 million. At this level we will continue to place emphasis on the Earth Resources Survey Aircraft Program, with extension to higher altitude observations and instrument development using the RB-57 aircraft made available by the Air Weather Service. Our studies of the Earth Resources Technology Satellite (ERTS) are continuing to work toward defining the optimum spacecraft approach to the space testing and evaluation of instruments and sensors using automated satellites.

Also included are the TIROS M and planned TOS improvements, the International Applications project, the Meteorological Soundings program and data analysis for the Geodetic Satellites now aloft.

Launch Vehicle Procurement $115.7 million was authorized in FY 1969 for the procurement of launch vehicles in support of unmanned space mission requirements, a reduction of $12.6 million from the budget request. The current FY 1969 operating plan of $100.2 million reflects further reductions commensurate with flight mission requirements supported by the reduced operating plan.

Advanced Research and Technology

Aeronautics Work in aeronautics will proceed at the level authorized. The original budget request for Aeronautical Vehicles was $76.9 million, and the amount authorized, $74.9 million. The authorized level will support the projects essentially as outlined in the original budget justification, with minor revisions. In addition, we will accelerate our efforts to advance the definition and implementation of NASA's supporting function so that NASA can make the most effective contribution to those agencies, such as DOD, which have specific developmental responsibilities.

Nuclear Rockets In testimony before the Senate Appropriations Committee on June 24, Mr. Webb indicated that it was doubtful that sufficient funds could be programmed to begin development of the NERVA flight weight engine at the $4.008 billion level. Our analyses of our total FY 1969 budget problem and all the constraints we face at this time for late FY 1969 and FY 1970 have confirmed the earlier judgment that funds sufficient for this development cannot be programmed at the $3.85 billion level. Therefore, we have decided to limit the FY 1969 effort in nuclear rockets and to defer the development of the flight weight NERVA engine at this time. Originally, the tentative operating plan before you provided $25 million

for nuclear rockets and, thus, $32.5 million would have been available for this program during FY 1969, since we would also apply $7.5 million which was withheld in FY 1968. In addition to continuation of a limited advanced technology effort and experimental engine testing, we planned, in providing funds at this level, to hold together a sufficient cadre of design, development and test personnel to permit us to proceed with development of the flight-weight engine, if possible, in FY 1970. We will seek support to do so.

After the interim plan was first formulated, Mr. Beggs, Mr. Klein of the Joint AEC/NASA Office, and I visited the various NERVA sites in an attempt to make certain, first-hand, if this could in fact be accomplished at the $32.5 million level. We have determined that the development could proceed in FY 1970 with greater continuity and momentum if additional funds totaling $7 million were made available. Thus, $39.5 million in total would be available under the plan. The additional funds which we are providing would allow more complete experimental engine testing and permit us to retain more of the highly skilled contractor personnel now engaged in the nuclear rocket program, thus assuring the possibility of a more economical start toward a flight-weight engine in FY 1970. These contractor personnel will proceed with the design of the NERVA engine and, to the extent possible,

component design and development, furthering the progress, albeit limited, toward an operational nuclear rocket capability.

We appreciate fully the long range benefits of nuclear propulsion and of the prospects for its use in the future national space program. Faced with the great difficulty of achieving a balanced program in FY 1969, and of holding expenditures to a minimum in FY 1969 and FY 1970, we have taken the actions we believe necessary to achieve some NERVA program continuity and work toward an eventual nuclear rocket capability.

The future scope of the space program beyond Apollo is an important issue facing the nation. FY 1969 continues the decline that has led us to such drastic measures as stopping Saturn IB production, discontinuing Saturn V production, and delaying NERVA engine development. The FY 1969 program for NERVA permits some work to proceed and retains the option to resume our past momentum in this program. I am confident that the country will adopt a vigorous space program leading in the next decade to more advanced exploration and exploitation of this new medium. This kind of program will require new propulsion capabilities that are examplified in the nuclear rocket. We intend, therefore, to urge that the nation proceed with nuclear rocket flight development if the national goals

and corresponding budget levels permit. If conditions are such that we cannot proceed, we will have lost a large national investment and an opportunity for the exploitation of a significant advancement in technology.

Space Technology At a time when we are reducing our planned space missions and deferring development of operational space hardward, it is important that, to the extent we can, we continue our efforts in developing and advancing the technology which will be necessary when work toward specific future missions can be resumed.

Of the $180.5 million total authorized for Basic Research, Space Vehicle Systems, Electronics System, Human Factor Systems, Space Power and Electric Propulsion Systems and Chemical Propulsion, we are providing a total of $178.4 million in the operating plan. This is a reduction of $21.5 million from the budget request.

Work in the important technologies of long-endurance life support equipment and man and man-machine relationships will proceed as planned. In many other areas, however, the pace of research and technical developments will be reduced, especially in efforts that support advanced space missions. Investigations of high-energy space-propulsion systems will be limited in scope, as well as the effort devoted to MHD power generation

and electric propulsion system investigations. Although research on the critical technical problems of new launch vehicles will continue, the $3.1 million included in the budget request for large solid rockets is not included in the operating plan. Flight experiments on optical telescope technology, on laser communications, and on a meteoroid probe to the asteriod belt is deferred and SNAP-8 system testing, while continued, is reduced.

Tracking and Data Acquisition

The budget request for Tracking and Data Acquisition of $304.8 million was reduced to $289.8 million in the Authorization Act. The reduction in total available resources has required a further reduction of $9.8 million to a new total of $280 million in the operating plan.

These reductions will limit the amount of tracking and data acquisition support which can be provided for spacecraft aloft and for future missions; however, the plan provides full support for the Apollo schedule I outlined previously.

Construction of Facilities

The budget request for Construction of Facilities totalled $45 million. $39.6 million was authorized and $21.8 million was appropriated. The amount included in the operating plan is $35.7 million, the increase over the appropriation amount being transferred from the Research and Development appropriation. We will initiate an appropriate action to provide for this transfer between accounts.

Under the plan, we will proceed with the construction of the two 210-foot Deep Space Antennas. These antennas, which will be substantially identical with the 210-foot dish at Goldstone, are essential to provide continuous surveillance, command, and

data acquisition for future deep space missions, including the 1973 Mars mission. A number of near earth missions in the past have succeeded only because we were able to maintain continuous communications with the spacecraft in spite of anomalies. The risks involved in attempting future deep space missions with a single 210-foot antenna providing only intermittent surveillance and communications are too great, and the benefits in terms of increased data return are too significant for us to have deleted these antennas from the plan.

We will also proceed, as I have stated, with the construction of the Phased Array Antenna needed to support the Sunblazer project. The amount required for this antenna is $2.9 million.

Under the plan, we will not proceed with the alterations and rehabilitation of Launch Complexes LC-34 and LC-37 at the Kennedy Space Center; additions to the Flight Crew Training Facility at the Manned Spacecraft Center are deleted; and modifications to the Environmental Test Laboratory at the Manned Spacecraft Center are reduced in scope. Facility Planning and Design is reduced from the $3 million requested to $1 million.

Administrative Operations

Let me now turn to "Administrative Operations." The interim operating plan anticipates the transfer, in accordance with law, of $20.1 million from "Research and Development" into "Administrative Operations" bringing the total in that account to $623.3 million as compared to the $603.2 million in the Authorization and Appropriation Acts, and the $648.2 million requested in the budget. (I should add parenthetically that all of these figures exclude the amount that will be required for Federal Employees Salary Act increases, now estimated at about $23.7 million, which is to be handled separately.)

In presenting the FY 1969 budget to the several committees of the Congress, NASA was very conscious of the critical relationship between the funds required in this category and our ability to carry on in FY 1969 the programs approved in prior years as well as those to be undertaken in FY 1969, and NASA witnesses made every effort to justify the requirements in as much detail as possible. We were highly gratified that this Committee and the Committees of the House of Representatives which took detailed testimony and examined this matter in depth showed by their conclusions and recommendations that they understood the problems that we face in this area. This Committee recommended $635.6 million. The House Committee on

Science and Astronautics recommended $646.7 million. Both of these amounts are substantially above the figure of $623.3 million in our interim operating plan. As you know, the reduction of the authorization for "Administrative Operations" to $603.2 million came in floor amendments, first in the House as one of several amendments directed at reducing the total amounts for NASA recommended by the Committee, and subsequently in the Senate in an amendment to conform the bill to the House figure.

The legislative history relating to "Administrative Operations" this year indicates that there are two aspects on which the Congress as a whole may not have been entirely clear.

First is the point which we made very strongly in our testimony and which I am sure is understood by the Committees in both the Senate and the House, namely, that this appropriation does not cover only "Administrative" expenses in the usual sense. It pays the salaries of all NASA personnel -- engineers, scientists, technicians, managers, and administrators -- responsible for carrying out the total NASA program, plus maintenance and operation costs of the NASA capital plant. It is not an overhead account -- it covers the direct costs of operating NASA laboratories, research centers, development centers, and launch centers. I hope we can change the name of

of this account to something more descriptive next year, so that members of Congress who do not have the opportunity to hear the testimony will not mistakenly assume that it is an overhead-type administrative account and will understand that it is just as essential to our program as the Research and Development appropriation.

The second point is one which we feel in retrospect that perhaps we did not make clearly enough in our appearances before this Committee and the other Committees concerned. I refer to the fact that most of the workload each fiscal year under the "Administrative Operations" account is not directly related to the size of the NASA R&D budget, or of the total NASA budget, in the same year. Over a period of years, of course, the requirements in "Administrative Operations" can be expected to follow the same general trend as the total "Research and Development" budget. But in any given year the work to be done under "Administrative Operations" is very largely of two sorts that are not related to the size of the research and development budget in the same year:

First, the largest portion of our work under "Administrative Operations" is in the testing, modification, checkout, launch, and operation of launch vehicles and spacecraft developed and procured with Research and Development funds provided in previous years. This is the nature of almost all of the work at centers like Kennedy, Houston, Marshall, and Goddard. For example, our funding requirements in "Research and Development" for Apollo hardware are declining in FY 1969, but the hardware itself is moving through our test centers to Cape Kennedy for

test, checkout, and launch in greater volume than ever before. The fact that in our $3.85 billion program we have a lower amount for "Research and Development" than in FY 1968 and do not have as much as we asked for in FY 1969 for new work, does not reduce significantly the basic load on these centers in FY 1969.

Secondly, a significant portion of the Administrative Operations workload is research and development work done by NASA people in the NASA centers--work which makes only minor demands on "Research and Development" funds, for technical equipment and the like. This is typical of much of the workload at the Langley, Lewis, and Ames Centers, for example. In the time of the NACA, these laboratories operated entirely on a "Salaries and Expenses" appropriation, with no "Research and Development" appropriation at all. While they now also have responsibility for substantial amounts of "Research and Development" funds for work performed by contractors, the NACA pattern of laboratory work done by civil service people is still their basic mode of operation, and much of our most important work in advanced research and technology, both on aeronautics and space, is done in this way. The requirements for this work have not been reduced by the reductions in "Research and Development" funds.

I have stressed this point, with examples drawn from our major centers, because it is the fundamental reason why we have found in our detailed reviews that we cannot acceptably make reductions in "Administrative Operations" of the magnitude

indicated by the Congress. The level of "Administrative Operations" required depends on the work that needs to be done, and cannot be determined by percentage relationships to "Research and Development" in the total NASA Budget.

Let me summarize briefly the actions we have taken in Administrative Operations and the results of the reviews we have made.

As it became apparent that the final NASA FY 1969 appropriations, including Administrative Operations, would be significantly reduced from the budget request and that additional Government-wide reductions would undoubtedly be imposed in response to the then pending Revenue and Expenditure Controls legislation, actions were started within NASA to begin the necessary adjustments to its planning and operations. A series of intensive reviews involving all principal Headquarters and Center officials was initiated. In early May, while these reviews were proceeding, authority throughout the agency to employ new personnel was sharply curtailed so as to develop the maximum flexibility to respond to the expected lower funding levels in FY 1969. This action restricted the replacement of positions vacated through separation to only one of every four separations, with the exception of the Manned Spacecraft Center, Kennedy Space Center, and Goddard Space Flight Center, which had to be exempted because of the heavy Apollo requirements.

We examined carefully the actions that would be necessary to reduce the "Administrative Operations" account to the $603.2 million authorized by the Congress. It was found that, after all costs other than personnel compensation were reduced as much as possible, the $603.2 million level would still require us to eliminate 2,570 manyears of Civil Service effort. Had we taken this course of action immediately and if a reduction-in-force could have been implemented in time to remove employees from the rolls by September 1, we would have had to eliminate about 4,900 positions. This number of positions would have had to be reduced in order to generate dollar savings corresponding to the 2,570 manyears because employees to be separated would be on the rolls for two months of the fiscal year and they would also be entitled to lump sum leave payments and severance pay. If the action were to be completed in October, we would have had to abolish 5,600 positions and, if in November, 6,300 positions.

As we found in our difficult experience with a major RIF at the Marshall Center last year, the number of employees actually affected in a RIF procedure is far greater -- normally by a factor of two or three -- than the number of positions actually abolished. Therefore, we could see that, depending on when the action could be completed, as many as 50% or more of the NASA work force would have felt the impact of the actions necessary to stay within an Administrative Operations budget of $603.2 million for FY 1969.

Mr. Webb and I concluded that an impact even approaching this magnitude would have had such severe disruptive effects on NASA activities that the successful execution of the programs approved by the Congress at the $4 billion total level, or of the programs we could conduct within the $3.85 billion limitation, would have been virtually impossible. We further concluded that we should approach the problem of determining our "Administrative Operations" requirements for the interim operating plan by a careful review of the requirements for effectively carrying out the program at the $3.85 billion level, making all the reductions we could, and to anticipate in the plan a transfer of funds from "Research and development" to "Administrative Operations" to the extent required.

A number of alternative planning levels were assessed. It was our conclusion in the end that it was not possible to reduce the Administrative Operations account below $623.3 million, and, accordingly, the Administrative Operations plan has been established at that figure. This plan requires a 1,661 reduction in planned civil service employment and a slightly larger reduction in man-years of support service contract effort. We hope that this reduction can be accomplished primarily through attrition with possibly a few selective RIF's, and believe that it represents the maximum reduction and disruption to the work force feasible without unacceptable consequences for our ability to conduct our programs.

With the reductions in personnel now planned, NASA will have reduced its actual employment by approximately 3000 since July, 1967. A continuing effort has been made to keep Administrative Operations costs to the minimum consistent with the effective and economic

execution of the agency's approved programs. A measure of the effectiveness of these measures is the fact that if NASA were able to pay salaries on the average of the same rates in existence in 1966, and the 1969 Administrative Operations budget would be approximately $70 million less than the current plan.

Mr. Chairman, taking account of the total situation we face I believe that we have had no alternative but to plan our Administrative Operations on the basis I have described. I also believe that it was not the intent of Congress that we fail to use the flexibility and transfer authority available to us, when the consequences of our failure to do so would have been to frsutrate the conduct of the important research and development programs which Congress clearly approved.

Mr. Chairman, this concludes my prepared statement.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

OFFICE OF THE ADMINISTRATOR

October 14, 1968

Honorable Charles J. Zwick
Director
Bureau of the Budget
Washington, D. C. 20503

Dear Charlie:

The purpose of this letter is to place before you the FY 1970 budgetary requirements of the National Aeronautics and Space Administration as we now see them and to summarize our analysis of the impact of the guidelines we have received from the Bureau of the Budget. The details of the estimates, revised drafts of our program memoranda with associated summary and decision statements and other supporting materials are being made available to your staff in accordance with arrangements that have been worked out jointly.

It is clear to me that the severe downward trend of the past several years in NASA's budgets must be reversed in FY 1970. A continuation of Executive and Congressional budget reductions and the even more restrictive recent expenditure limitations would cripple the nation's space effort immediately after Apollo, virtually bringing to a halt the great program that was built at such great cost. I cannot believe that President Johnson or the new President would permit his 1970 Budget to place the nation in such an untenable position. In my opinion, four principal considerations will be overriding in leading to a final decision to support a substantial increase in the NASA 1970 Budget:

First, it is impossible to justify a rational national policy in which the United States, having invested so much in the first ten years to develop and demonstrate a capability to conduct significant operations in space, turns its back in the second decade on what it can accomplish. New goals can be set now which are just as challenging and significant as those originally set, and programs can now be implemented that have even greater future promise than those of the first decade.

Second, in the world of the 1970's the space program may well be the best and perhaps the only effective vehicle we will have to project on both sides of the Iron Curtain the peaceful image and the reality of United States power and leadership, in a manner which does not threaten other nations but evokes continuing respect and admiration. This opportunity, which depends on our having a strong continuing space program openly conducted, is one which in my view the United States can ill afford to pass up.

Third, a realistic assessment of the current position of the United States in military and civil aviation shows an alarming threat to America's leadership in these fields and increasing problems with our air traffic systems and operations.

Fourth, the FY 1970 Budget recommendations of the President will be publicly debated during a period when our manned Apollo flights are vigorously underway, and the renewed thrust of the USSR program is coming into full public view. In this situation, the President's position should be one of vision and leadership in space and aeronautics.

We have therefore developed our FY 1970 Budget estimates within the framework of the major program goals toward which in our view the President should lead the nation. I believe that NASA's major program goals for the next ten years should be those outlined below -- five major goals in space and two in aeronautics:

1. Understand and put to use what space means to people on earth:

   a. Increase our scientific understanding of the vital earth-sun relationship, and study the earth itself from space.

   b. Develop and experiment with new and improved practical applications of satellites.

   c. Foster the prompt introduction into the economy of space-developed applications and advanced technology.

   d. Keep alert to potential military applications of space and support the Department of Defense as required.

2. Follow up the first Apollo landing with a sound program of manned lunar exploration.

3. Proceed with the orderly development and experimental operation of manned orbital space stations.

4. Move steadily out in the exploration of deeper space -- to the planets with unmanned probes, and to the stars from orbital observatories outside the atmosphere.

5. Maintain the momentum of U. S. technological advance in aerospace disciplines.

6. Develop the full potential of U. S. military aeronautics.

7. Develop the full potential of U. S. civil aeronautics.

Programs directed at these NASA goals will make essential and significant contributions to broader national goals in the fields of national influence and security, the increase of scientific knowledge, the improvement of communications and transportation, the development of advanced technology on a wide front, and many others.

We have attempted to configure our program in such a way that incremental steps to meet each goal can be proposed, reviewed, and decided each year in the annual budget process. However, our ability to do this is limited by the fact that multi-year commitments -- implied if not actual -- are required for major space programs that take from three to eight years from inception to fulfillment. The flexibility in our total budget is further limited by the fact that funding for each activity cannot be permitted to fall below the threshold for meaningful progress -- with the optimum rate for efficiency and economy generally being well above the threshold -- and by the fact that major discontinuities in the institutional base must be avoided in order to preserve capabilities to complete ongoing programs and hold open options for future work. Thus, while we have selected program goals toward which we can move with greater or less efficiency at higher or lower annual budget levels depending on the resources available, our downward flexibility is severely limited, i.e., we cannot go below the total amount required to sustain meaningful progress toward all of the goals without abandoning one or more of them.

The FY 1970 budget estimates required to proceed toward the above goals at an optimum rate -- starting from our operating budget in FY 1969 -- total about $4.7 billion, rising to between $5.5 and $6.0 billion in succeeding years depending on the options selected and the rate of progress desired. These estimates are the "A" budget which we recommend as the proper course to move this nation toward a position of world leadership in space and aeronautics. They are summarized in the attached estimates. We consider this also to be a well-balanced program -- balanced among acquisition of scientific knowledge,

technological advance, development of manned space flight, and space applications of direct benefit to man; balanced among the efforts to complete previously established mission goals, to initiate new flight missions based on what we already know how to do, and to advance U. S. capability for new accomplishments in space; balanced also in the sense that it makes effective use of the capabilities established by the nation's past investments (both public and private) with minimal additional investment or resources required for substantially greater accomplishments.

In accordance with your budget guidelines and our previous discussion, we have also developed budget estimates which would carry forward the program embodied in our FY 1969 operating budget with limited provision for new starts. Included in the latter category are only those new starts and program augmentations required for meaningful progress in FY 1970 toward each of the seven major program goals outlined above. Our estimates on this basis total $4.2 billion for FY 1970, as summarized in the "B" budget in our estimates.

In compliance with the budget instructions, we have prepared detailed supporting materials for the "B" budget. The estimated augmentations to the "B" estimates required to produce the "A" budget are not provided herewith in the same detail, but we will be pleased to provide upon request further details of this more progressive leadership program.

You have also asked us to consider the implications of a total FY 1970 program limited to $3.6 billion of obligational authority in FY 1970. Our current estimates of the amounts required in FY 1970 to carry forward, without any new starts whatsoever, the FY 1969 operating budget total $3.8 billion. This is strictly a "going-out-of-business" projection, certainly not a viable program. A NASA FY 1970 budget at this or a lower level would not be reasonable for reasons outlined in the opening paragraphs of this letter. A reduction to $3.6 billion in FY 1970 would require the termination of approved programs included in the already greatly reduced FY 1969 operating budget. I do not see how the nation's space program could absorb such a further reduction and survive in any meaningful sense. Such goals as further manned explorations of the moon and space station development would have to be abandoned. Taking a substantial portion of the reduction in the Apollo program would jeopardize our prospects of success in the last hours; taking the reduction elsewhere would wipe out many important projects and further cut back advanced technology and our institutional base. I cannot see any realistic basis on which such a budget could be presented to the public or defended before the Congress.

One of the outstanding points brought out in our analyses of NASA FY 1970 budget alternatives is the great elasticity of achievement as the budget rises above the level of $4.0 billion, i.e., the large amount of additional productive work that can be completed for relatively modest additional funding increments. Conversely, after the many cuts that have been made, the inelasticity of the budget below that level causes even small further reductions to have large and undesirable repercussions. We clearly recognize the necessity of taking what steps we can, without endangering or disrupting Apollo and other important programs, to gradually reduce our institutional base, both at NASA centers and in contractor plants, to provide a greater measure of flexibility for the future. For this reason, we have purposely constrained the civil service personnel projected in the "B" estimate to the levels we expect to reach at the end of FY 1969 or lower, except for the Electronics Research Center. We are hopeful that the various studies we have underway of future requirements and costs of large launch vehicles will point the way to substantial future savings in our industrial contractor base in the post-Apollo period.

In the so-called "Administrative Operations" area we have encountered annual problems in Congress because this appropriation account covers much more than "administrative operations." This misleading title fails to convey the fact that this account covers our large in-house technical activity, and is not directly related to the total level of NASA research and development activity. We are exploring possible changes in our appropriation structure to permit a clearer statement of our operating requirements. We expect to be in a position to make a firm proposal to you for handling this matter in the FY 1970 budget within a few weeks.

During the next few weeks we will continue to discuss with the Department of Defense the approximately 12 areas in which we have agreed with them to explore the possibilities of joint planning and of near-term or long-term economy. While we believe that our operating plan for FY 1969 and our FY 1970 budget estimates take account of the savings that are likely to be possible in those years, we will modify our plans and estimates if our discussions with Defense show that this should be done.

I should also state that our FY 1970 proposals in the Earth Resources area of Space Applications are not yet complete and final. When we have finished our reviews and considered further the many pertinent interagency aspects of this work, we will amend our submission in accordance with our final recommendations.

We are proceeding to review all of our programs and estimates in detail with members of your staff. In addition, it seems to me that it would be desirable for you and me to discuss the major policy aspects and implications of our estimates. If you agree, I propose some time in the last week of October or the first week in November.

Sincerely yours,

Tom Paine

T. O. Paine
Acting Administrator

Attachment

November 18, 1968

Honorable Charles J. Zwick
Director
Bureau of the Budget
Washington, D. C. 20503

Dear Mr. Zwick:

The purpose of this letter is to summarize our current position on the NASA FY 1970 Budget in accordance with the understandings we reached in our meeting of November 6, 1968. At our meeting we agreed that the underlying policy issue was whether

1. President Johnson should, as I strongly believe, place before the country in his 1970 Budget a strong aeronautics and space program which reverses the decline of the last year and proposes modest progress toward each of the seven national goals set forth in my letter of October 14, 1968, or

2. The NASA FY 1970 Budget should, as your assessment of the total budgetary situation leads you to believe may be necessary, be further reduced below 1969, while still providing the minimum levels of funding required to preserve for the next Administration the options, in the next two years, to decide whether and in what areas to move ahead in aeronautics and space.

We also agreed to attempt to reach a BOB-NASA staff agreement on the facts and issues involved so that mutually accepted estimates for each alternative with a minimum number of issues could be presented to the President.

With respect to the budget level I recommended (designated the "A" Budget), my position is still as stated in my letter of October 14, 1968, and in our discussion of November 6, 1968. I am preparing a brief statement for the President summarizing the objectives, content, and justification of the "A" Budget and will provide you a copy when we meet Thursday morning, or before if possible. I assume that we will discuss at that meeting how we will submit our respective recommendations to the President.

With respect to the budget alternative intended to preserve capability and options at minimum cost in FY 1970, we have carefully reexamined the "B" estimates submitted with my letter of October 14, 1968, in the light of the BOB premises stated in the BOB staff paper of November 8, 1968, with particular consideration to the tentative allowances set forth in that paper. Based on the stated premises and my understanding of their underlying intent, we have developed new estimates reduced from our "B" Budget which we designate now our "C" Budget totalling $4,074.2 million, as set forth in detail in the attachment to this letter. I believe that these are the estimates that should be presented to the President as the alternative that maintains NASA capability at a minimum level and preserves options for future decision.

The supporting papers provided with this letter compare our "C" estimates with the BOB tentative allowance, and deal with the main points of difference between NASA and BOB analyses and conclusions. In this letter I will summarize the basic reasons for these differences and the consequences that significant reductions below our "C" estimate would have for the nation.

Manned Space Flight Programs

The premises applicable to the "C" Budget for manned space flight are:

a. Minimize FY 1970 funding,

b. Complete the manned lunar landing,

c. Maintain options for go-ahead or termination decisions in the next two years,

d. Postpone major new starts, and

e. 1970 funding limitations should not force termination of manned space flight activity.

Since our planning is based on the expectation that the first manned lunar landing mission (MLL) will be accomplished during FY 1970, the problem of constructing a "C" Budget on the above premises in the manned space flight areas involves determining (a) a minimal program plan for continuing NASA manned space flight activities after the first lunar landing, and (b) the minimum funding necessary in FY 1970 to support that plan.

The sequence of flights on which our "B" estimates were based is a minimal plan developed on premises equivalent to those listed above. A gap in Saturn V production after 515, termination of Saturn IB production after 214, and a gap in Saturn V flights during the period of

AAP Saturn IB flights have been accepted. The program is not geared to meeting desired launch schedule objectives; rather the launch schedule is the minimum launch rate required to avoid termination of NASA manned flight activity. The minimum effective rate is three manned launches per year. With the launch rate of approximately two manned launches per year in our "B" program, we can avoid termination of our manned flight activity, but at the price of an uneconomical and higher risk operation, because of substantial periods of forced inactivity on the part of the large specially trained work forces required for checkout, launch, and mission operations and control. Below this rate the work force would be wastefully unoccupied for many months each year and we would face unacceptable problems with respect to reliability and crew safety. For these reasons, the Saturn V launch rate of one per year suggested by the BOB staff as a basis for eliminating $100 million for vehicles 514 and 515 from the FY 1970 Budget is unacceptable. Also for these reasons, it is essential that we have the funds in the Apollo Applications and Lunar Exploration categories required in FY 1970 to support this minimal overall sequence of manned flight activity.

The Apollo Applications Program (AAP) is not a new start; it has been an approved program by both the President and Congress for three years. As you know, to assist the Administration in minimizing expenditures we have repeatedly delayed contracts, applied lower funding than approved by Congress, stretched out schedules, and cut back program scope and content. We are at the point in FY 1970, however, where gross wastage and dubious values will result if FY 1970 funding does not support a sound phasing of the limited program set forth in our approved FY 1969 operating plan and now well underway. For AAP the assumptions of our "B" estimates correspond to the "C" Budget premises; hence the full amount of the $345.1 million we requested should be included in the "C" Budget.

For Lunar Exploration, in addition to the need for retaining in the "C" Budget the $100 million required for 514 and 515 as discussed above, our reviews indicate that we need a minimum of $70 million (rather than $50 million) in FY 1970 for timely preparations and initiation of equipment development to support a meaningful program of manned lunar exploration based on resumption of a Saturn V launch rate of two per year after completion of the AAP program. For Space Station studies, we need $24 million (in lieu of $9 million) for system and experiment definition and mission and operations studies necessary to provide sound options for decisions in the next two years.

Programs other than Manned Space Flight

Our review indicates that there are seven main areas in which FY 1970 funding above the BOB tentative allowances is required on the premises applicable to the "C" Budget, which are

a. Minimize 1970 funding, and

b. Provide for a significant but restrained continuing program.

1. Titan-Mars 1973 - Since the preparation of our "B" estimates, the Langley and Jet Propulsion Laboratories, working with the associated contractors, have completed further definition studies of the Titan-Mars 1973 orbiter/lander mission approved in our FY 1969 Budget and Operating Plan. These studies show that with a small increment of added cost we can proceed with combined orbiter and soft lander missions having very significantly increased scientific value. For 1970, $10 million above our previous estimate is needed. We will also require the $15.5 for Titan III-Centaur integration that was included in our "B" estimate.

2. OAO-D - Continuity in the field of space astronomy--a principal area where important new discoveries are expected--requires that we not entirely eliminate FY 1970 funding for the next orbiting astronomical observatory. By slipping schedules, continuity can be maintained with $9 million instead of the $15 million in our "B" estimates.

3. Earth Resources Experiments - We have now completed our internal reviews and are formally requesting inclusion of the experimental earth resources satellite programs (ERTS A & B and LOM A & B) in our 1970 Budget. As set forth in the separate paper, which has been made available to your staff, we are at a point in this experimental program where research satellites for further experimentation must be initiated to continue significant progress. Further details of the planned experiments and of the arrangements for participation of other cooperating agencies (Interior, Agriculture, Commerce, and Navy) are being worked out and will be completed in the 3-year period before the first ERTS satellite can be launched. A more precise understanding of the potential benefits of possible future operational systems depends on experimental data from space operations as well as on continued experimentation with aircraft and completion and further refinement of economic benefit studies such as those we now have underway in collaboration with the Bureau of the Budget and other agencies. The amount required in FY 1970 is the same as previously included tentatively in our "B" estimates, i.e., $19.1 million.

4. Other Space Applications - Significant and timely continuing progress in the important area of large space antennas and direct broadcast experiments requires the full amount of our "B" estimate for the ATS F & G programs, i.e., $10.3 million. Continuation to completion of the National Geodetic Satellite Program requires restoration of $1.3 million for GEOS C.

5. NERVA - The $9 million included in the BOB tentative allowances will not continue significant activity in nuclear propulsion. With the completion of the experiments in our FY 1969 operating plan, we have stretched to the limit our ability to hold open but not implement the option to proceed with the development of a flight-weight nuclear engine. The only feasible way of preserving the option now is to proceed with the development of the flight-weight engine in FY 1970, subject to cancellation if the new Administration decides to eliminate this program. We strongly support the development of the NERVA engine as an essential feature of the nation's long term future space capabilities. The decision to proceed should not be predicated on a specific mission requirement. As our studies proceed, however, attractive, significant applications--especially in the unmanned exploration of the more distant planets--are becoming increasingly apparent. We believe that the "C" Budget premises require the inclusion of $27.5 million for nuclear propulsion, which is the minimum required to preserve the possibility of significant progress in this field.

6. Aeronautics - The position of world leadership in aeronautics, which the United States has enjoyed for over two decades, is now threatened. To regain this position, our "B" estimates are required in full in the "C" Budget to support significant continued progress, with particular emphasis on these important areas of national concern:

a. Noise reduction - The coordinated national program should be supported. The noise research facility proposed for our Langley Laboratory is required for a better scientific understanding of noise problems--aircraft and others.

b. V/STOL aircraft research - Both civil and military needs depend on aggressive research and experimentation.

c. Supersonic aircraft - Current design problems in both the civilian SST and in high performance military aircraft clearly indicate the need for more emphasis on research prior to prototype construction.

d. Aeronautical technology - The status of U.S. military and civil aviation in relation to the USSR and others urgently requires an expansion of our advanced research in aeronautics.

c. Aircraft Operating Problems - The critical nature of the air traffic control problem requires study and research aimed at new concepts in order to lay a sound groundwork for future decisions on systems development.

7. University Programs - We believe that we have a responsibility, from the national point of view, to include in our 1970 Budget, even at the "C" level, what funds we reasonably can in our university programs to help preserve the strength of U.S. universities as institutions on which our scientific future depend. For this reason, we propose restoration of $9 million for Sustaining University Programs and $15 million for step funding to further stabilize NASA university research activities without augmenting the level of expenditures.

Conclusion

The items described above, plus a few small miscellaneous other necessary adjustments, result in a "C" Budget totalling $4,074.2 million. The above discussion, and the supporting materials made available to your staff, clearly show that a 1970 Budget at this level is required to maintain capabilities and options for the new Administration to decide what the future course of the nation in aeronautics and space should be. I hope that you will be able to agree that the "C" Budget is the appropriate alternative for the President to consider in the event he is not able to support the alternative that I recommend of a forward-looking program at or approaching the "A" Budget level.

Sincerely yours,

Original signed
T.O. Paine

T. O. Paine
Acting Administrator

Attachment

cc: All Program & Staff Offices
& Center Directors

Shapley/Paine:aom

Industrial Applications Gen

November 5, 1963

MEMORANDUM for D/Mr. Finger

Subject: Potential Contributions of Aerospace Technology to the Solution of National Problems

The potential applications of aerospace technologies, methodologies, and institutions to the solution of critical urban problems, such as environmental pollution, crime, poor education, inadequate housing, etc., are referred to frequently in a superficial way. We should be working to define this potential more precisely with interested government agencies, aerospace companies, and universities.

We should take a thoughtful and rigorous approach to this, being particularly careful to avoid oversimplified and exaggerated views of our capabilities to solve problems that we do not yet fully understand. The initial emphasis should clearly be on understanding selected areas; then the approaches to solutions.

I wish you would consider how we might initiate a useful study effort on this complex subject.

Original signed
T.O. Paine

T. O. Paine
Acting Administrator

OE/Farley;rt
AD/Paine;hlm
CC: AA/NEWELL
ADA/SHARLEY

808553

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

IN REPLY REFER TO:

December 11, 1968

Memorandum for: D/Harold B. Finger

Subject: Dr. Paine's memorandum dated November 5, 1968, "Potential Contributions of Aerospace Technology to the Solution of National Problems"

I agree very much with you and Dr. Paine that the potential applications of aerospace capabilities to the solution of national problems is often cited in a superficial way. We should be working to define this potential more precisely. It will certainly require a thoughtful and rigorous approach, and I will indicate some potential starting points at the end of this memorandum.

The first step in a large complex problem of this nature is to examine the work which has already been accomplished. I have pulled together some materials, while not all inconclusive, they give the impression that a great deal of effort has already been expended. And some impressive results are already in hand but aren't being fully exploited. I will cite some of these efforts in the following paragraphs.

Aerospace Industries Association (AIA) Report

The transfer of technology from its point of origination to the many possible end uses is the primary purpose of the Office of Technology Utilization. In a very specific sense we are engaged in many experimental projects to transfer technology to the individual user, to industry, and to other government agencies. By technology we mean both hardware and management technology. But, we recognize, that our specific efforts are designed to enhance and accelerate a process which is taking place all around us. Studies have shown that one of the best ways to transfer technology is to do so through

regular market mechanisms. This occurs when people shift jobs as is happening currently or when industrial organizations shift markets. This latter process has occurred much more so than most people realize. Attachment 1 is a booklet produced by the AIA, "Aerospace Technology: Creating Social Progress". It is a factual report on many projects aerospace companies have undertaken in non-aerospace areas, but which build upon their experience gained in their efforts for NASA. Aerospace managerial and hardware technologies are being applied in such diverse areas as urban affairs, information systems, transportation systems, medical applications, power generation, material applications, and management of the environment. This booklet is well worth a few moments for examination and may be the best base that we could build upon in this endeavor.

Many studies in this area have indicated that managerial technologies--the systems approach and all that is embraced therein--are needed much more for the solution of these national problems than is hardware technology per se. Unfortunately it appears that the transfer of managerial technologies often demands intimate involvement which may not be permitted under the NASA mandate or may be resented by others with some exceptions as noted below. The managers who operate in many of these other fields are not trained in aerospace management techniques and disciplines. And until they are, it is unlikely that these techniques will receive widespread use except on a contract basis.

Notwithstanding these formidable barriers to the transfer of management technologies, we are attempting to do so in a number of ways. The University of California at Berkley has been receiving grant funds (jointly funded by Code Y and Code U) for the past several years and their efforts have been directed at applying aerospace management

techniques to urban problems. They have worked principally with the Fire Department and the Police Department in the City of Oakland.

Additionally, the Technology Utilization Division has just published a Tech Survey entitled "Applications of Systems Analysis Models" (Attachment 2). Tech Surveys are state-of-the-art summaries of selected fields which have been advanced by NASA efforts. This survey is written for managers in the non-aerospace community and is a very good document. We intend to give it a very wide distribution.

NASA Sponsored Studies

As you know, the Office of Policy, until very recently, managed a program of social, economic, political, legal, historical, and administrative aspects of the space program. In this entire array of studies, there have been a number which deal with applying NASA technology to national problems. Attachment 3 is an annotated bibliography of the types of studies in these areas which were supported by NASA either directly or indirectly. But judging from the titles, some seem particularly appropriate such as:

No. 90 - Weidenbaum, Federal Resources and Urban Needs;

No. 99 - Weidenbaum, Strategies for Diversification of Defense/Space Companies; (diversification into areas of national problems)

No. 146 - Hoos, The Application of Systems Analysis to Social Problems: The California Experience;

No. 147 - Hoos, Systems Analysis in State Governments;

No. 151 - Megee, Urban Systems Analysis and the Planning of New Cities; and

No. 156 - Conference on Space, Society, and Urban Life (Proceedings of a 1963 conference on applying space technology to problems of urban growth).

This annotated bibliography also contains many other articles which are relevant to more specific questions like the aerospace impact on regional or local economic development. Incidentally, some of these local economic impact studies can be used to good advantage to support the position that Dr. Paine has taken in some of his speeches, i.e., that the space effort has created jobs and wealth and has helped urgrade the standard of living in certain lagging areas, notably the South.

Programmatic Benefits--Present and Future

NASA is, of course, presently involved in many activities which will significantly contribute toward the solution of various national problems. The cognizant program offices have documented some of the results to date, but I do not know if these have ever been pulled together in a systematic fashion, and this may well be a worthwhile undertaking.

About two years ago the Office of Manned Space Flight selected a contractor (Planning Research Corporation) through a competitive procurement to conduct studies on the measurement of potential benefits to be derived from various AAP projects. The contractor

was to develop a good cost/benefits analysis model and to analyze three or four specific cases. The final report on this contract has been in for some time now. Again, it might be worthwhile to build upon this effort.

The recent United Nations Conference on the Exploration and Peaceful Uses of Outer Space (held in Vienna, August 1968) was divided into nine thematic sessions all of which impacted on various portions of the total "national problems" arena. The sessions were:

I. Communications;

II. Meteorology;

III. Navigation;

IV. Other Space Techniques of Practical Benefit;

V. Biology and Medicine;

VI. Non-Space Applications of Space Technology;

VII. Education and Training;

VIII. International cooperation and Opportunities for Participation in Space Research and Applications;

IX. Economic, Legal and Social Problems of the Exploration and Use of Outer Space Relevant to International Cooperation and Practical Benefits.

Of these sessions, I, II, and III deal with on-going programmatic efforts which have a substantial history of contribution toward the solution of national problems in specific areas.

Thematic Session IV, Other Techniques of Practical Benefit contained a number of important papers in the earth resources area and indicated the substantial impact which may one day be generated through these programmatic efforts. Many of these were presented by other agency representatives and the subjects included agriculture and forestry; water resources development; artography and geography; geology; oceanography; and geodesy.

Sessions V, VI, VII, and VIII (Biology and Medicine; Non-Space Applications; Education and Training; and International Cooperation (in economic, legal and social problem areas)) are a mixture of programmatic and second order impacts, but, nevertheless, again demonstrate an impressive potential as well as already accrued benefits.

In addition to all of these present and potential efforts, we have, of course, even more direct and daily efforts directed toward solutions of specific national problems. For example, there is our work in aeronautics with the FAA, more broadly with the Department of Transportation, and other agencies in such problem areas as airport congestion, urban transportation, etc.

Within the Office of Technology Utilization, we are currently managing nine inter-agency activities. Most of these consist of working with cognizant Federal agencies to assist in the definition of their problems and then to search the NASA system to see if our science and technology bank contains knowledge relevant to these problems. The agencies involved in these efforts are the Bureau of Reclamation; the Social and Rehibilitation Service, the Bureau of Public Roads, the Department of Housing and Urban Development, the Federal Water Pollution Control Administration and the Law Enforcement Assistance Administration.

While these are rather modest efforts by any standards, they do represent an attempt to honor our objectives of applying NASA technology to the solution of other national problems; they do offer considerable promise and, more importantly, they provide us with a learning process in this important area.

Additionally, the main thrust of the Technology Utilization Program, that of transferring technology through regular market mechanisms, is already resulting in a rapidly growing volume of "confirmed transfers" and many of these are in the public sector--in medicine, education, etc. These are being carefully documented on a regular basis by Denver Research Institute.

Problem Definition

It seems that the most important first step in all of this work is to produce specific definitions of problems. This, of course, is easier in those areas where NASA has some programmatic responsibility such as in aeronautics. We have made progress in earth resources and other areas mentioned above. However, for the most part, we have a very long way to go as some of the principle agencies involved, such as HUD, have not clearly defined their problems. We do not have either the experience, expertise or the mandate to perform this task for them even though, as surprising as it may seem, we have been asked to do so in some cases.

Once the problems have been defined, there still remains the matter of setting priorities so as to make a reasonable allocation of resources. Until these steps are taken, we should not make promises or overstatementsin these areas.

Conclusions

There is, in fact, the danger of overselling or overstating the potential contributions of NASA technology to the solution of national problems especially if the statements are superficial and not substantiated by facts. The great bulk of the impact will, of course, occur in the future but what is not fully realized or appreciated by NASA officials is that so much has already occurred and a great deal of this has already been studied and documented.

Thus it seems that a very useful effort, which might be broken down into sub-tasks would be one which pulled together existing documentation and produced materials which would be useful in communication of these results to the external world and which would assist us in assessing priorities for further efforts. Some specific tasks are:

1. The AIA effort--As mentioned above, I feel that the AIA efforts to date have been very useful and could be enhanced by a more in-depth treatment of the work already accomplished.

2. A comprehensive, annotated inventory on all on-going efforts--I have briefly outlined above some of the many on-going and future NASA involvements. An inventory of NASA inter-agency activities already exists in Code W, but a useful exercise might be one which would how the substantive composite of what these efforts are producing. I have discussed this matter with General Smart, and he is interested in discussing an in-house effort to do this.

3. Future Specific Efforts--In addition to Nos. 1 and 2 of this section above which essentially involves pulling together aerospace industrial efforts to date and NASA/inter-agency efforts to date, a contractor study of other potential efforts might, in concert with cognizent agencies, identify other potential areas, define problems for which NASA technology would be relevant, and, perhaps, provide some insight as to priorities.

Richard L. Lesher /s/
Assistant Administrator
for Technology Utilization

Attachments
as stated

SUMMARY LOG OF APOLLO 8

(All Times Eastern Standard)
(All Distances in Nautical Miles)
Saturday, December 21, 1968

7:51 a.m. Liftoff from Cape Kennedy

7:53 a.m. Saturn V first stage completes burn. G forces in spacecraft reach a maximum of 4 1/2. Second stage ignition. Altitude 40 miles.

8:00 a.m. Second stage completes burn. G forces reach maximum of 2. Third stage ignition. Altitude 100 miles.

8:03 a.m. Third stage completes first burn. G forces reach maximum of 2/3. In orbit, perigee 99 miles, apogee 103.

10:17 a.m.

Capcom (Michael Collins): Apollo 8, Houston.
Spacecraft (Frank Borman): Go ahead, Houston.
Capcom: All right, you are go for TLI (Trans-Lunar Injection) over.
Spacecraft: Roger, we understand, we are go for TLI.

10:42 a.m. Trans-Lunar Injection, second burn of third stage.

10:47 a.m. Third stage completes burn. G forces reach maximum of 1 3/4. Velocity 35,527 feet per second.

11:12 a.m. Separation of third stage and instrument unit from Apollo 8 spacecraft.

12:12 p.m. Spacecraft oriented for burn of service module reaction control system, to increase separation from third stage.

Spacecraft: OK, as soon as we find the earth, we'll do it.

12:36 p.m. Altitude 17,200 miles. Burn adds 8 feet per second to velocity.

12:51 p.m. Altitude 19,000 miles

Spacecraft (James Lovell): It's really hard to describe what this earth looks like. I'm looking out my center window, which is the round window, and the window is bigger than the earth is right now. I can clearly see the terminator. I can see

most of South America all the way up to Central America, Yucatan, and the Peninsula of Florida. There is a big swirling motion just off the east coast, and then going on over toward the east I can still see West Africa, which has a few clouds right now. We can see all the way down to Cape Horn in South America.
Capcom (Collins): Good grief, that must be quite a view.
Spacecraft: Yes, tell the people in Tierra del Fuego to put on their rain coats. Looks like a storm is out there.

6:51 p.m. Altitude 52,770 miles. Midcourse correction burn of service propulsion system engine, duration 2.4 seconds, increases velocity by 24 to 25 feet per second.

8:51 p.m. Borman requests and receives permission to take a Seconal sleeping pill.

Sunday, December 22, 1968

6:50 a.m. Analysis of tracking data shows the second mid-course correction burn would require a velocity change of only 0.7 feet per second. Decision not to bother with so small a correction.

8:55 a.m. Altitude 140,000 miles.

Capcom (Collins): How are you doing up there? Did you get a good night's sleep?
Spacecraft (Lovell): Oh, you know. The first night in space all the time --
Capcom: The old man woke you up earlier than he needed to.
Spacecraft: Well, we just couldn't sleep any longer.

8:56 a.m.

Spacecraft (Borman): This is a mighty nice view we have down there today. A little bit more than a half earth. Looks like Africa and the Red Sea are visible--we're not quite sure as there is quite a bit of cloud cover. But even through the hazy windows it is mighty nice.

11:00 a.m. Apollo 8 crew reports illness.

11:50 a.m.

Capcom (Collins): We are on a private loop now and we would like to get some amplifying details on your medical problems. Could you go back to the beginning and give us a brief recap, please?
Spacecraft (Borman): Mike, this is Frank. I'm feeling a lot better now. I think I had a case of the 24-hour flu, intestinal flu.
Capcom: Roger, understand. When did you first notice it?. . .

Spacecraft: Roger. About, I guess about 20 hours, 19 hours yesterday . . . .
Flight Surgeon (Dr. Charles Berry): Frank, this is Chuck. The story we got from the tape and from Jim a while ago went like this. At some 10 to 11 hours ago, you had a loose BM, you vomited twice, you had a headache, you've had some chills, and they thought you had a fever. Is that firm?
Spacecraft: Everything is true, but I don't have a fever now. I slept for a couple of hours and the nausea is gone, and controlling the loose BM. I think everything is in good shape right now.
Flight Surgeon: Did you have a sore throat?
Spacecraft: The roof of my mouth was sore, Roger.
Flight Surgeon: As we understand it at the moment, Frank, neither Bill nor Jim have anything at the present time except some nausea. Is that right?
Spacecraft: No, none of us are nauseated now. We are all fine now.
Flight Surgeon: Okay, and you have taken the Lomotil?
Spacecraft: No, we haven't. Pardon me, yes, they have.
Flight Surgeon: They have and you have not?
Spacecraft: Roger. I just woke up, Chuck. They took them while I was asleep.
Flight Surgeon: Okay, I think you ought to take one, Frank, and the Marezine will help if that nausea returns.... The Marezine can be used if you do get nauseated, any one of the three of you.
Spacecraft: Okay, thank you.

3:00 p.m. Altitude 120,600 miles. First television transmission shows good views of inside of Apollo 8 spacecraft, but image of earth is too bright.

4:36 p.m. Anders requests and receives permission to take sleeping pill.

8:14 p.m. Flight surgeon directs Borman to take a second Lomotil tablet.

8:55 p.m. Altitude 136,500 miles. Analysis of tracking data shows that Apollo 8 is headed for a pericynthion (nearest passage of the moon) between 60 and 70 miles. Third midcourse correction would be less than one foot per second.

10:00 p.m. Discussion of guidance and navigation calculations regarding contingency plans.

Capcom (Kenneth Mattingly): Jim, we have just been looking at your mark with respect to accuracy and they figure they are within a couple of thousandths of a degree of the theoretical optimum. The integrator seems to bear that out.
Spacecraft (Lovell): Well, I hope that they are enough to get us home if we have to use them.

Capcom: Well, I am getting a lot of confidence in your ability to run that mystery show now.
Spacecraft (William Anders): Hey, Ken, we have to spend four more days up here with him--will you take it easy. He is already talking about going back to MIT as a professor.

Monday, December 23, 1968

2:53 a.m. Altitude 150,500 miles. Temperature inside spacecraft drops to 60°F. Crew requests advice on how to increase temperature.

2:58 a.m. Ground suggests two options. Crew decides to turn up heat exchanger and turn on one fan.

3:40 a.m. Lovell reports he can see stars in daylight at this altitude (152,200 miles). Temperature back up to 70°.

5:40 a.m. Spacecraft (Lovell) reports that each crewman has had two sleep periods and Borman is in his third. In most recent periods, Anders 6 hours, Lovell 4 hours, Borman 5 hours.

Capcom (Gerald Carr): Roger, Jim. How are the three of you feeling?
Spacecraft: Wonderful. We're all feeling pretty good now, no problems.

12:50 p.m. Altitude 171,300 miles.

Capcom (Collins): If you have a few minutes, we would like to hear the detailed crew status report from you.
Spacecraft (Lovell): Like what?
Capcom: Well, like we would like to know, in the last 24 hours has anybody had any symptoms similar to Frank's. We would also like to how--you know we told you the other day to take more Marezine as you like. We would like to know if anybody had taken any drugs and then we would like to talk over there about sleep, rest and water and such.
Spacecraft: Okay, nobody has taken any other drugs. Nobody took any Marezine. Nobody is sick. Bill took one of those pills, a sleep Seconal pill, last night. Everybody had breakfast this morning and ate most of their meal--meal A, day 3. What else do you want?
Capcom: We would like to tell you to drink plenty of water. We think your water intake may be down, when we copied your dosimeter readings. The only other thing is we were wondering how you feel, in general. We show you to have about 15 hours sleep in total, Frank or Bill about 10 and Jim about the same and we were wondering just how you are feeling in general.

Spacecraft: We all feel fine. We are going to fix it now so that we all have one more rest period before the LOI (lunar orbit insertion).
Capcom: Roger, thank you.
Spacecraft (Lovell): Happiness is bacon squares for breakfast.
Capcom: If you don't eat them all, bring them back and we'll finish them off here.

2:58 p.m. Altitude 175,100 miles. Second television transmission. Camera and filter adjustments succeed in transmitting excellent image of the earth.

Spacecraft (Borman): What you are seeing is the Western Hemisphere. Looking, the top is the North Pole. In the center, just lower to the center is South America. All the way down to Cape Horn. I can see Baja California and the southwestern part of the United States. There is a big cloud bank going northeast, covers a lot of the Gulf of Mexico up to the eastern part of the United States. It appears now that the east coast is cloudy...
Spacecraft (Lovell): Frank, what I keep imagining is if I am some lonely traveler from another planet what I would think about the earth at this altitude. Whether I think it would be inhabited or not.
Capcom (Collins): Don't see anybody waving, is that what you are saying.
Spacecraft: I was just curious if I would land on the blue or the brown part of earth.

3:29 p.m. Altitude 176,275 miles above the earth; 33,821 miles above the moon. Apollo leaves the region in which the gravitation of the earth is dominant; enters the zone in which the moon's gravity is dominant.

8:51 p.m. Lunar altitude 21,100 miles. Service module reaction control system (four jets, each 100 lbs. thrust) fired 11 seconds to reduce velocity by 2 feet per second, to approach closer to desired distance of 60 miles to moon at nearest point of flight path.

10:15 p.m. Time of lunar orbit insertion calculated as 4:59 a.m. December 24, while Apollo 8 is behind the moon and out of communication with the earth.

10:55 p.m. Anders requests and is granted permission to take a small Seconal sleeping pill.

Tuesday, December 24, 1968

2:03 a.m. Mission control provides guidance and navigation data to Apollo 8 for the service propulsion system burn for lunar orbit insertion. A sample of the conversation:

Capcom (Carr): Minus 2 niner 837 plus zero 23 niner zero plus zero zero niner niner 4 zero zero zero 2 zero zero zero 5 zero 16 niner 3 plus zero zero 6 zero zero 2 niner niner 4 niner 4 zero 2 2 niner 7 8 2. Copy.
Spacecraft (Lovell): Copy.
Capcom: Roger 8. Zero 1 zero 6 8 niner 2 6 zero. Perpieye zeta. Down zero 4 8 left zero 5. The remainder is not applicable. Sirius Rigel set of stars for GDC alliance. 12 niner 1 5 5 zero 1 zero negative ullage. We'll pass the horizon data later....

3:55 a.m. Altitude 3,100 miles.

Capcom (Carr): Apollo 8, this is Houston at 68:04. You are go for LOI.
Spacecraft (Borman): Okay. Apollo 8 is go.

4:48 a.m. Altitude 400 miles.

Capcom (Carr): Apollo 8 Houston, one minute to LOS (loss of signal). All systems go. Roger, safe journey, guys.
Spacecraft (Anders): Thanks a lot, troops, we'll see you on the other side.
Capcom: Apollo 8, 10 seconds to go. You're go all the way.
Spacecraft: Roger.

4:49 a.m. Loss of signal as Apollo 8 passes behind the moon.

5:00 a.m. Borman presses "proceed" key on guidance and navigation display keyboard. Five seconds later, the service propulsion system begins its burn for lunar orbit insertion.

5:04 a.m. Burn completed after 4 minutes and 2 seconds, reducing speed by 2,994 feet per second, placing Apollo 8 in orbit with apolune (high point of orbit) of 168.5 miles and perilune (low point) of 60.5 miles.

7:36 a.m. During second revolution of the moon.

Spacecraft (Anders): There's a very new bright impact crater. Should be in the field of view right now.
Capcom (Carr): Roger, Bill.
Spacecraft: ...The color of the moon looks like a very whitish gray, like dirty beach sand with lots of footprints on it. Some of these craters look like pickaxes striking concrete, creating a lot of fine dust.

8:09 a.m. Mission Control gives Apollo 8 go-ahead for second lunar orbit insertion burn, again behind the moon, to make its orbit circular by reducing apolune from 168 to about 60 miles.

8:55 a.m. Loss of signal as Apollo 8 passes behind the moon at the conclusion of second revolution.

9:26 a.m. Service propulsion system burned for 11 seconds to reduce speed by 135 feet per second. Orbit now nearly circular: perilune 61 miles, apolune 61.5 miles.

9:42 a.m. Signal re-acquired as Apollo 8 emerges from behind the moon.

10:35 a.m. During third revolution.

Spacecraft (Borman): Is Ron Rose around?...
Capcom (Collins): Ron Rose is sitting in the viewing room. He can hear what you say.
Spacecraft: I wonder if he is ready for experiment P1?
Capcom: He says thumbs up on PI....
Spacecraft: Roger. Ron and I got together and I was going to record a little--say a little prayer for our church service tonight. And I wonder--I guess that's what we are ready on.
Capcom: Stand by one, Frank.
Spacecraft: All right....
Capcom: Apollo 8, Houston. Go ahead, Frank, with your message.
Spacecraft: Okay. This is to Ron Rose and the people at St. Christopher's (Episcopal Church in Seabrook, Texas)--actually to people everywhere.

> Give us, O God, the vision which can see Thy love in the world in spite of human failure. Give us the faith, the trust, the goodness in spite of our ignorance and weakness. Give us the knowledge that we may continue to pray with understanding hearts, and show us what each one of us can do to set forth coming of the day of universal peace. Amen.

Capcom: Amen.
Spacecraft: I was supposed to lay read tonight, and I couldn't quite make it.
Capcom: Roger, I think they understand.

4:03 p.m. During sixth revolution. Discussion of potential Apollo landing sites.

Spacecraft (Lovell): Mike, there are an awful lot of objects down on the landing site. It's just as formidable Jack Schmitt (Dr. Harrison H. Schmitt, scientist astronaut) marked. All of the objects are tracking perfectly on the target, and if you like it we can get it out beautifully. I have a beautiful view of it. The first I've seen just barely beneath the vertical now, and the second one coming up--just a grand view.

Capcom (Collins): Roger, Go ahead, Jim, Jack's listening.
Spacecraft: Jack, the information--the triangles that we see now are from the first IV, second IV and the C1 are just right, I think, for landing conditions. The shadows aren't too deep for you to get confused, the land has texture to it and enough shadows there should make everything stand out.

4:10 p.m.

Spacecraft (Lovell): We have a little piece of useful information if you're interested in deliberating over it.
Capcom (Collins): Go ahead.
Spacecraft: Roger. Our first control point (for navigation) is very near the terminator, and as the objects we're tracking, I had an occasion to watch the sun come up, and at about two minutes before sunrise you get the limb begins to brighten up into sort of a fine white haze, a faint glow completely over the space just behind the limb.
Capcom: ...How far out does it extend?
Spacecraft: It goes up quite a ways. It takes a fan shape, unlike the sunrise on earth where the atmosphere affects it. This is just sort of a complete haze all over the local area. It's concentrated at the exact time the sun comes up at ignition and then goes away from the sun spots.

6:32 p.m. During seventh revolution, following a report by Bowman that the Apollo 8 crew is getting tired.

Capcom (Collins): This rev coming up we would like to clarify whether you intend to scrub control point 1, 2 and 3 only and do the pseudo landing site or whether you also intend to scrub the pseudo landing site mark, over.
Spacecraft (Borman): We're scrubbing everything. I'll stay up and try to keep the spacecraft vertical and take some automatic pictures but I want Jim and Bill to get some rest.
Capcom: Roger, I understand.

8:20 p.m. During eighth revolution. Conversation about the weather.

Capcom (Mattingly): They told us that there is a beautiful moon out there.
Spacecraft (Borman): Now we were saying that there is a beautiful earth out there.
Capcom: It depends on your point of view.

8:23 p.m. Communications demonstration shows that a radio signal from the earth to Apollo 8 and back to earth takes about 3 seconds to make the round trip of more than 400,000 miles.

9:40 p.m. Television transmission during ninth revolution.

Spacecraft (Borman): I think that each one of us...carries his own impression of what he's seen today. I know my own impression is that it's a vast, lonely forbidding type existence--a great expanse of nothing, that looks rather like clouds and clouds of pumice stone, and it certainly would not appear to be a very inviting place to live or work.
(Lovell): ...The vast loneliness up here of the moon is awe inspiring and it makes you realize just what you have back there on earth. The earth from here is a grand oasis in the vastness of space.

9:43 p.m.

Spacecraft (Anders): ...The mountains coming up now are heavily impacted with numerous craters whose central peaks you can see and many of the larger ones. Actually, I think the best way to describe this area is a vastness of black and white, absolutely no color. The sky up here is also rather forbidding, foreboding extents of blackness with no stars visible when we're flying over the moon in daylight. You can see by the numerous craters that this planet has been bombarded through the eons with numerous small asteroids and meteoroids, pock-marking the surface every square inch. And one of the amazing features of the surface is the roundness that most of the craters--seems that most of them have a round mound type of appearance instead of shap, jagged rocks. All, only the newest of features have any sharp definitions to them, and eventually they get eroded down by the constant bombardment of small meteoroids.

9:56 p.m.

Spacecraft (Anders): ...I hope all of you back down on earth can see what we mean when we say that it is a very foreboding horizon, a very dark and unappetizing looking place.... Now you can see the long shadows of the lunar sunrise. We are now approaching the lunar sunrise and for all the people back on earth the crew of Apollo 8 has a message that we would like to send to you.

9:58 p.m.

Spacecraft (Anders): In the beginning, God created the Heaven and the earth. And the earth was without form and void and darkness was upon the face of the deep. And the spirit of God moved upon the face of the waters

and God said, Let there be light. And there was light. And God saw the light and that it was good and God divided the light from the darkness.
(Lovell): And God called the light day, and the darkness he called night. And the evening and the morning were the first day. And God said, let there be a firmament in the midst of the waters. And let it divide the waters from the waters. And God made the firmament. And divided the waters which were above the firmament. And it was so. And God called the firmament Heaven. And evening and morning were the second day.
(Borman): And God said let the waters under the Heavens be gathered together in one place. And the dry land appear. And it was so. And God called the dry land earth. And the gathering together of the waters called He seas. And God saw that it was good. And from the crew of Apollo 8, we pause with good night, good luck, a Merry Christmas and God bless all of you - all of you on the good earth.

10:17 p.m. Time of trans-earth injection calculated as 1:10 a.m. December 25, while spacecraft is behind the moon completing its 10th revolution.

11:55 p.m. Mission Control gives Apollo 8 a go-ahead for trans-earth injection.

Wednesday, December 25, 1968

12:42 a.m. Loss of signal as Apollo 8 passes behind the moon.

1:10 a.m. Service propulsion system begins burn to propel Apollo 8 back to earth.

1:13 a.m. Burn completed after 3 minutes and 23 seconds, increasing velocity by 3,523 feet per second.

1:20 a.m. Apollo 8 signal re-acquired as it emerges from behind the moon.

1:21 a.m.

Capcom (Mattingly): Apollo 8, Houston.
Spacecraft (Lovell): Apollo 8, over.
Capcom: Hello, Apollo 8, Loud and clear.
Spacecraft: Roger, Please be informed there is a Santa Claus.

1:35 a.m.

Capcom (D. K. Slayton): Good morning, Apollo 8, Deke here. I just would like to wish you all a very Merry Christmas on behalf of everyone in the Control Center and I'm sure everyone around the world. None of us ever expected a better

Christmas than this one. Hope you get a good night's sleep from here on and enjoy your Christmas dinner tomorrow and look forward to seeing you in Hawaii on the 28th.
Spacecraft: Okay, leader, see you there.

11:57 a.m.

Spacecraft (Anders): How was Christmas at your house today?
Capcom (Collins): Early and busy as usual. I told Michael you guys are up there and he said who's driving?
Spacecraft: That's a good question. I think Isaac Newton is doing most of the driving right now.

12:38 p.m. Altitude 175,528 miles above the earth. Apollo 8 leaves the lunar sphere of influence and returns to the region in which the gravity of the earth is dominant.

3:51 p.m. Mid-course correction burn of service module reaction control system, 14 seconds in duration and perpendicular to flight path, changes velocity by 5 feet per second.

4:15-24 p.m. Television transmission shows interior of spacecraft, controls, and food preparation.

Thursday, December 26, 1968

6:07 a.m. Analysis of tracking data shows there will be no need for midcourse correction No. 6. Decision will be made later regarding the final correction shortly before re-entry.

8:45 a.m.

Capcom (Carr): Could we have a crew status report?
Spacecraft (Borman): You may. We had a good night's sleep. Everyone slept at least 7 hours yesterday, and we have just finished breakfast, drunk a lot of water, and I think we are in very good shape. Just used the exerciser.

9:05 a.m.

Spacecraft: And we're happy to report the earth is getting larger.

12:40 p.m. Altitude 108,300 miles. Apollo 8 has passed that point in the return flight in which there are possibilities of landing in the Atlantic or Indian Oceans, permitting the release of recovery forces in those oceans.

3:51-56 p.m. Altitude 97,500 miles. Television transmission shows views of earth.

> Spacecraft (Anders): I think I must have the feeling that the travelers in the old sailing ships used to have. Going on a very long voyage away from home and now we're headed back and I have that feeling of being proud of the trip, but still happy to be going back home and back to our home port.

Friday, December 27, 1968

4:30 a.m. Altitude 43,000 miles. Calculations show that Apollo 8 flight path is within 0.06° of desired angle of entry. Thus there will be no further course correction. Entry interface (arrival at 400,000 ft. altitude, where earth's atmosphere begins to be felt) will be at 10:37 a.m.

5:44 a.m. Altitude 37,000 miles. Pre-landing stowage of flight equipment completed.

10:22 a.m. Altitude 9,000 miles. Service module separates from command module and its engine is fired to carry it 100 miles to the south of the landing point.

10:37 a.m. Apollo 8 reaches 400,000 feet altitude, traveling at 36,221 feet per second.

10:38 a.m. Communications blackout begins as meteoric heat of entry ionizes atmosphere surrounding spacecraft. G forces climb to almost 7.

10:43 a.m. Communications restored.

> Spacecraft: We are in real good shape, Houston.
> Capcom: Real fine.

10:45 a.m. Main parachutes deploy.

10:49 a.m. Voice contact reported with recovery forces.

10:51 a.m. Splashdown at 165° West Longitude, 8°8' North Latitude, about 5,000 yards from carrier USS Yorktown. Spacecraft overturns in water but is quickly righted. Apollo 8 crew reports all is well. According to plan, deployment of pararescue personnel is delayed until local sunrise, due in about three-quarters of an hour. Helicopters and aircraft hover in area.

11:31 a.m. First swimmer in the water.

11:35 a.m. Sea anchor attached to Apollo 8.

11:52 a.m. Large life raft dropped near spacecraft.

12:04 p.m. Apollo 8 hatch opened.

12:14 p.m. All three astronauts aboard helicopter. Yorktown less than 3,500 yards away.

12:20 p.m. Touchdown on the deck of the Yorktown.