NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON 25, D.C.

OFFICE OF THE ADMINISTRATOR

December 3, 1965

Honorable George P. Miller
Chairman
Committee on Science and Astronautics
House of Representatives
Washington, D. C.

Dear Mr. Chairman:

We have recently requested and received apportionment of $2 million of FY 1966 funds held in reserve by the Bureau of the Budget for application to the phasing out of the M-1 engine project along the lines that we described to the Congress in our testimony during the last session. It is my desire to acquaint you with our reasons for this decision and to outline our proposals for further work in the advanced liquid propulsion area.

The M-1 engine project was initiated in 1962 to develop a large hydrogen-oxygen upper stage engine that could be used in post-Saturn launch vehicles. No specific requirements for such launch vehicles have been adopted. In the absence of such requirements a thorough review has been made of the basic technological contributions that could be expected from continued effort on the M-1 project as compared with research on other liquid propulsion concepts.

The concepts incorporated in the M-1 engine are now several years old and still more advanced concepts, promising performance advantages over the M-1 engine approach, have recently become apparent. These newer concepts can be explored in smaller scale and, hence, at lower funding rates than would be necessary for efficient continuation of the M-1 work. We have, therefore, concluded that the M-1 engine development should be terminated after uncooled thrust-chamber tests, now underway, are completed. This phase-out will be consistent with the plan presented to the Committees during the last session of the Congress.

Because of problems and delays in the fabrication of injectors, the M-1 thrust-chamber testing schedule is presently several months behind that contemplated at the time we concluded that the project could be phased-out within FY 1965 fund availabilities. In order to insure that significant technological results will be in hand prior to termination of the project, we have recommended, and the Bureau

of the Budget has concurred, that $2.0 million of the FY 1966 funds being held in reserve be provided for completion of this test program. We will now notify the contractor, the Aerojet-General Corporation, that upon the expenditure of the available funds the M-1 project will be terminated.

We have further proposed that early work be initiated to explore and develop certain of the newer, advanced concepts that appear to hold great promise for high-energy, liquid engines. The two concepts being considered are (1) the toroidal combustion chamber with regeneratively cooled nozzle, and (2) the two-stage high-pressure combustion chamber using advanced cooling and a conventional bell nozzle. These engine types offer advantages over current engines of conventional design in that when used in conjunction with the plug nozzle exit configuration they will provide improved altitude compensation; more compact structural arrangement, and lower overall engine system weights.

Both engines would use oxygen-hydrogen propellants. It is proposed that the concepts be explored at the 200,000 to 300,000 pound thrust scale in order to utilize presently available equipment and test facilities.

In addition to research and development of components, it is proposed that investigation be accelerated in the areas of cooling, materials and fabrication methods, propellant injection and combustion characteristics at high pressures, and nozzle flows in order to supplement the advanced engine work.

NASA has recommended that this advanced, high performance engine technology effort be initiated with $3.5 million of the FY 1966 funds presently being held in reserve. If approved and supported by additional funds in the FY 1967 budget for continuation of the effort, we will initiate this activity through contracts that will be open for competition within the industry.

I would emphasize that the plans outlined above, except for the $2.0 million testing extension of the M-1 contract prior to termination, will require additional funding in FY 1967 and subsequent years to accomplish their objectives. Their execution along the proposed lines is contingent upon inclusion of sufficient funds in the FY 1967 budget to warrant their initiation.

As for the SNAP-8 and 260" solid rocket motor effort, both of which are in the same category as the M-1, we are still reviewing the possible avenues of activity open to us and have not yet come to a final determination.

Trusting that this will meet the needs of your Committee and with much respect, believe me,

Sincerely yours,

James E. Webb
Administrator

AEROJET GENERAL

AEROJET-GENERAL CORPORATION

9100 EAST FLAIR DRIVE EL MONTE, CALIFORNIA

partial term in Aug. Had order in Feb. have never gone beyond partial term. On verge of term (Mar '67) now Mar w/ 7 PIC Mar 13 '6

1 E. ZISCH
SIDENT

24 November 1965

Mr. James E. Webb
Administrator
National Aeronautics and Space Administration
Washington, D. C. 20546

Dear Jim:

I am writing in response to your request for my considered views on what course of action should be followed in FY 67 on the 260-inch solid motor program, the SNAP-8 space power plant and the M-1 liquid oxygen-liquid hydrogen engine.

First, let me thank you for inviting Mr. Kimball, Bill Gore and me to discuss these programs two weeks ago. I appreciated your very candid comments on the status of planning for these programs.

Over the past several months we have given considerable thought to the future of the National Space Program and how we at Aerojet might best contribute to it. We have done our best to perceive the overall purposes and aims of the nation's space effort and to examine the most effective ways of achieving them. We have tried to do this in today's framework of reality, detaching ourselves from the circumstances and objectives of several years ago when the three programs in question were initiated. We certainly have no intention of flogging any dead horses up blind alleys. Our company's future will be best assured when our objectives are aligned with those of the national defense and space programs.

In the light of present planning for the National Space Program -- in which Apollo and the Apollo applications program will play such a conspicuous role for some time to come -- we have indeed come to certain definite conclusions as to what course of action should be followed on each of the three advanced technology programs in question.

Guidance Copy to ____
Action Copy to ____
Info Copy to ____

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With respect to the 260-inch solid motor program, it is our conviction that a program of this kind should by all means be continued. We believe that large solid motors have great intrinsic merit as first stage booster propulsion systems. We do not believe that the liquid type systems presently in use enjoy the commanding lead that they are often assumed to have. In fact, the relatively short development programs and the predictability of cost and schedule that are demonstrated characteristics of the large solid motor are the most convincing arguments in their favor. Our experience has indicated that the development time and cost of a solid for first stage application is from 1/4 to 1/2 that of a liquid system. We believe that a large solid rocket first stage can become a valuable asset among NASA resources for the further exploitation of its Apollo based hardware. Even with relatively modest expenditures in the next year or two it will be possible to integrate large solid motors into the post-Apollo phases of Saturn IB applications, and also (at some later date) into the Saturn V family of vehicles. Our people are working actively with Douglas and others on attractive configurations and we will be seeking opportunities in the near future to present these possibilities.

It is our conclusion also that the SNAP-8 program should be continued at an appropriate level of effort to ensure at the earliest possible date the mating of the reactor and power conversion units. The SNAP-8 is the only power plant under development in any size close to its power range of 35 to 50 KW.

With respect to the M-1, we concur in your analysis that a liquid hydrogen-liquid oxygen engine in the 1.5 million pound thrust class does not fit in the future requirements picture at this time. We see no way in which the M-1 can find practical application in the present family of space boosters. The application for such a large size upper stage engine then must be in some completely new generation of launch vehicles (perhaps that class once identified as NOVA). Such an application is now so remote as not to warrant continuation of the M-1 on any basis other than development of advanced components and, therefore, we understand the decision not to continue the M-1 as a line item in the FY 67 budget. In the next several years technological advancements undoubtedly will be made in fields applicable to this type of engine and we ourselves would wish to be free to pursue such avenues without the constraint of schedule requirements and design rigidity associated with complete engine development.

In accordance with these conclusions our recommendations are that funding for these programs in FY 66 and FY 67 be as follows:

> 260-inch solid -- release the presently appropriated funds for FY 66 and continue effort on development of 2/3 or full length motors as appropriate, complete with thrust vector control systems at a level of $14 to $22 million. This will protect the option to integrate solid motors into the Saturn family of vehicles in the early phases of the Apollo spplications program.
>
> For the SNAP-8, continue the basic development of components and system testing at a level of $8 to $10 million in FY 67, leading ultimately to complete system test in the 1970 time period.
>
> Permit the M-1 engine program to come to an orderly conclusion as now planned with the transition to more advanced components being made in a way to most effectively utilize existing NASA facilities and contractor development capability. We will be proposing specific programs of an advanced character directly to the Lewis Flight Propulsion Laboratory.

The foregoing recommendations on these three programs make sense, I believe, in the context of existing plans for the space program as I understand them. I would not be completely candid, however, if I left you with the impression that I believe these plans are entirely adequate. In particular, I would hope that a more purposeful definition of what is to come beyond Apollo could be made which would serve to better focus effort of the kind we are considering here. I fear that in becoming preoccupied with the many attractive applications of Apollo hardware the space program will lose the forward momentum of advancing technology. I see a very serious problem in maintaining adequate support for advanced technology work. This has been clearly evidenced in the case of the three programs we have been discussing. I will not take your time here to elaborate further on these concerns. I have discussed them at some length in my response to the request of The Honorable Olin E. Teague, Chairman of the Subcommittee on NASA Oversight, for my views about the future of the National Space

Program. I enclose a copy for your information and would be pleased to discuss these broader issues at any time should you wish to do so.

Sincerely,

W. E. Zisch

WEZ:dl

Enclosure

cc: Dan A. Kimball
W. L. Gore

P. S. Bill Gore has reviewed the contents of this letter with Dr. M. C. Adams.

NOV 3 0 1965

"Mr. Webb has seen this"

MEMORANDUM

To: Associate Administrator for Advanced Research and Technology

From: Associate Administrator

Subject: Advanced liquid engine technology plans

Reference: Letter to Mr. Schultze, BoB from Mr. Webb dtd 11/20/65

The referenced letter indicates our plans for terminating the M-1 engine development contract and our intention to initiate advanced technology efforts on new high energy liquid engine concepts if the FY 1967 budget provides the necessary continuing support. Officials of the Aerojet General Corporation have already been advised that the advanced propulsion technology effort would be open for competition.

Although the work to be undertaken in the next few years will be basic technological development and confirmation of concepts on "scale" sized engine components, it is implicit in the overall picture that at some future date we may wish to initiate development of a full-scale engine based on the most promising concepts. Both Mr. Webb and I believe that competition must begin at this time and must be continued in some effective fashion if we are to have meaningful competition at the time we might undertake the full-scale engine development.

As the referenced letter further indicates, we intend to notify the Aerojet General Corporation of our termination decision and to disclose our overall plans to our Congressional committees. Although we do not plan to incorporate great detail regarding specific procurement plans in our information to the committees, inquiries in some depth may be anticipated. Accordingly, I would like to have from you within the next several days a detailed understanding of the work package to be initiated with the $3.5 million of FY 1966 monies. This information should include the contracts to be awarded and the methods and criteria to be used to obtain competitive selection of these contractors. I would also like to have your concepts on the total organizational effort to accomplish effective integration of the several component developments into effective systems, and your concepts on how we can maintain effective technical competition between the various technical concepts to ensure maximum technological progress.

cc: A/Webb
ADA/Shapley

AA/Seamans
Original Signed by
Robert C. Seamans, Jr.
Robert C. Seamans, Jr.
Associate Administrator

P/DEM/prj 11/23/65

AAD AA

"Mr. Webb has seen this"

FRANK C. DILUZIO, STAFF DIRECTOR

United States Senate

COMMITTEE ON AERONAUTICAL AND SPACE SCIENCES

December 6, 1965

4030 Federal Building
Albuquerque, New Mexico

7023

Honorable James E. Webb
Administrator
National Aeronautics and
Space Administration
Washington, D. C.

Dear Jim:

I have read through your letter of December 3 concerning the M-1 engine and various other activities and will reply briefly to you on that subject.

It is my understanding that the Space Committee of the Senate, the Conferees and the Appropriations Committee had quite definite ideas about the M-1 engine. They thought it was being stopped in Fiscal Year 1965 and probably early in Fiscal 1966. Now we have a proposal to use $2 million more on the M-1 engine and the question the Committee will ask will be, "Why is an additional sum needed?"

When we got into the discussion of the termination of the 260-inch Motor, the M-1 engine and the SNAP program, some of us tried to say that the way to get out is to get out. These companies are resourceful and they say, "stop gradually." Then they get the new program worked up that goes on for some more years and we couldn't ever stop.

I would be happier if we closed down the M-1 project on the basis approved by the Congress and at that time approved by the President. I think we are going to waste a lot of money and then wake up with a whole new idea that we better keep it alive.

Furthermore, I think we have gone really far enough in the steps which you mentioned of great promise for high energy, liquid engines. Are you sure that you will need new high energy, liquid engines? Will you be able to use solid propellants? Will you be able to use nuclear propulsion? Just what are these advance concepts designed to do that is not being done or projected?

I know that it is easy to be skeptical, but I feel the day will come when the budget will be drastically trimmed because of our war effort and we will then decide that some of these things will have to be stopped. In the meantime, we would have spent quite a bit of money on them, and it is this which I would like to avoid.

Sincerely yours,

Clinton P. Anderson

CPA:mjq

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

OFFICE OF THE ADMINISTRATOR

Honorable Clinton P. Anderson
Chairman
Committee on Aeronautical and Space Sciences
United States Senate
Washington, D. C.

Dear Mr. Chairman:

In your letter of December 6, 1965, concerning the M-1 engine and the advanced propulsion technology effort of NASA you raised several important questions which I believe we should treat in some detail to assure a complete mutual understanding as to our program thinking and actions.

First, we are proceeding in the termination of the M-1 engine effort exactly as outlined during hearings before your Committee last Spring. The key point in this termination is to assure that the country receives the maximum return in terms of technology and information for the total investment that has been applied to this project. This investment is accumulated in hardware components and test facilities, and therefore we feel that the maximum benefit will be derived from careful and complete testing of the four principal components of the systems that have been developed: the gas generator, oxygen pump, fuel pump, and the thrust chamber. These tests will provide important information that will establish the scale issues and correlation factors that will be applicable to the development of large liquid engines necessary for the next generation of launch vehicles beyond the capabilities of the existing Saturn.

Much of this work has already been completed. For example, the gas generator has undergone some fifty tests during which we have learned to control combustion oscillation in such a system at high flow rates. We have had twenty-three tests of the full scale oxygen pump, the results of which we can now compare with the tests run on the 1/3 scale model. We have found that there is direct correlation between the scale model and the full sized hardware performance; this ability to use and understand the performance of scale models has broad applicability to future designs and systems. At the present time we are running similar tests on the fuel pumps. Since liquid hydrogen has quite different characteristics from liquid oxygen, these tests are necessary to develop similar correlations between model and full scale liquid hydrogen pump systems.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

OFFICE OF THE ASSOCIATE ADMINISTRATOR

12/17/65

~~Shap -~~ JEW

I have not shown this draft to Dr. Seamans or Mac Adams' people--Julian Scheer glanced at it and felt it to be quite satisfactory. Do you wish to review first or should we proceed to get OART, AC, and Dr. Seamans' concurrence first?

DWjr

DW
Very good. Check facts, particularly the stability of the details on what we are proposing for the future liquid work, Clear with all concerned & we'll try it on Mr W. Jew

D R A F T
DWjr/blp
12/16/65

Clinton P. Anderson
Chairman
Committee on Aero & Space Sciences
U.S. Senate

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The fourth component, which we plan to test but whose schedule was delayed by carburization of the injector plates during fabrication, is the M-1 combustion chamber. This chamber, the largest yet built, represents the application of sophisticated design criteria. Only by careful testing can we determine whether or not the combustion oscillation and instability problems which have plagued all large engine designs in the past and which have been resolved only by "cut and ~~try~~" methods can be avoided by the application of such design criteria. If the combustion chamber works successfully, it would mean that we have improved design ~~sound mechanical~~ rules that can be applied to the control of a highly complex ~~still poorly understood~~ phenomenon.

The extension by $2 million of the M-1 engine termination effort has been required by the delay encountered by a subcontractor during the brazing of the injector posts into the structural plate of the

injector, ~~tests~~. This delay of nearly two months requires that additional funds be made available if test objectives are to be met. The prime contractor for the M-1 effort, Aerojet-General Corporation, fully supports NASA in our efforts to complete this work quickly and efficiently; furthermore, the contractor fully ~~appreciates~~ understands that there will be no additional funding for M-1 work ~~effort~~ beyond ~~that already~~ the $2 million which has been made available.

The second major question noted in your letter deals with the advisability of continuing an effort in advanced, high performance, high thrust, liquid engine technology and in the relationship of this work to other propulsion effort in the solid and nuclear areas. At the outset, I must state that we consider these three areas of advanced propulsion to be complementary rather than competitive. Our solid rocket effort is aimed toward developing the technology that would permit using very large solids as economical first stage boosters in a possible post-Saturn launch vehicle system. The advanced liquid effort is directly applicable to the upper stages of such a vehicle that would reach orbital velocity, ~~still have to operate, at least partially, within the atmosphere.~~ A nuclear stage, ~~when~~, would provide the economic space propulsion necessary for certain classes of very advanced future missions. I believe it would be shortsighted to assume that the nation will never require an advanced launch vehicle of greater capability than the Saturn V. In order to be able to undertake eventually the development of such a system in the most efficient and economical fashion, we feel that all of the technology which must underly such a development should be pursued at a meaningful level of effort, prior to the time that the

final system requirement is established.

Speaking specifically to the advanced liquid engine technology effort which we are planning to initiate in 1966 and to continue in 1967, we foresee here a "breadboard" engine system available for tests in 1968 or 1969. This "breadboard" will test oxygen and fuel pumps operating at pressures in the ranges of 5500 lbs per square inch (current pumps are operating in the range of 2200 psi), new combustion chamber designs, and new high expansion nozzles. The value of a "breadboard" test program will be to develop feedback and identify problems as yet unknown in systems operating at these very high pressures and very high heat fluxes. The work done on the "breadboard" will then define the options we will have in the large liquid engine area: either to continue the technological program looking toward a second breadboard to test the concepts established during the first, or to proceed directly to the development of an engine system which by that time can be foreseen as needed on a given time scale.

This philosophy of developing the technology, building the components, testing breadboard or prototype systems, then feeding back into the development loop the information gained during the test phase, and then proceeding with assurance to full scale system development, is a key factor to the understanding of the conduct of the NASA program. It is this approach that in the past has permitted us to take great strides forward in relatively short periods of time. For example, in 1958 the specific impulse of chemical rocket systems was limited

to around 300 seconds; today we have reached nearly 450 seconds. Even here we do not believe that we have approached the limits of efficiency that will be available in liquid propulsion systems.

The last point, certainly one of grave importance to the current and future posture of this nation in its assumption of leadership in science and technology, is that basic technological effort or technology projects are subject to curtailment in the phase of limited budgetary resources. In the partnership that we have both worked hard to establish between the Committee and the agency, I believe that there are two difficult but complementary roles which have to be carried out. On our part, we must assure, through careful planning and assesment of alternate managerial approaches, that the agency's program remains balanced, flexible, and always directed toward those short and long term goals which are of fundamental value to the nation's strength. Even with limited resources, some meaningful effort must be kept alive on a very broad front of technological advance if we are not to surrender, as a nation, the position of preeminence we have sought. On the part of the Congress, a careful analysis of the agency's plans in terms of national goals with a commensurate allocation of resources completes the equation which, if properly phrased, will avoid the pitfalls of arbitrary initiation and termination of effort and will assure constant and meaningful gains in all the critical areas of aeronautics and space science and technology.

I believe that the program we will present to your Committee for review in the Spring can be fruitfully discussed along these lines.

With much respect, believe me

Fy 66

DEC 2 8 1965

Honorable Clinton P. Anderson
Chairman
Committee on Aeronautical and Space Sciences
United States Senate
Washington, D.C.

Dear Mr. Chairman:

In your letter of December 6, 1965, concerning the M-1 engine and the advanced propulsion technology effort of NASA, you raised several important questions which I believe we should report on in some detail.

First, we are proceeding in the termination of the M-1 engine effort exactly as outlined during hearings before your committee last spring. The key point in this termination is to assure that the country obtains, in usable form, the maximum of know-how and technology for the investment that has been applied to this project. This investment has been partly in hardware components and test facilities. Therefore the maximum benefit will be derived from careful and complete testing of the four principal components of the systems that have been developed: the gas generator, oxygen pump, fuel pump, and the thrust chamber. These tests will provide important information that will establish the scale issues and correlation factors that will be applicable to the development of any large liquid engines which may be needed for a generation of launch vehicles beyond the capabilities of the existing Saturn.

Much of this work has already been completed. For example, the gas generator has undergone some fifty tests during which we have learned to control combustion oscillation in such a system at high flow rates. We have had twenty-three tests of the full scale oxygen pump, the results of which we can now compare with the tests run on the 1/3 scale model. We have found that there is direct correlation between the scale model and the full sized hardware performance, this ability to use and understand the performance of scale models has broad applicability to future designs and systems. At the present time we are running similar tests on the fuel pumps. Since liquid hydrogen has quite different characteristics from liquid oxygen, these tests are necessary to develop similar correlations between model and full scale liquid hydrogen pump systems.

The fourth component, which we plan to test but whose schedule was delayed by carburization of the injector plates during fabrication, is the M-1 combustion chamber. This chamber, the largest yet built, represents the application of sophisticated design criteria. Only by careful testing can we determine whether or not the combustion oscillation and instability problems which have plagued all large engine designs and which have been resolved only by "cut and try" methods in the past, can be avoided by the application of such design criteria. If the combustion chamber works successfully, it would mean that we have improved design rules that can be applied to the control of a highly complex phenomenon.

The extension by $2 million of the M-1 engine termination effort has been made necessary by the delay encountered by a subcontractor during the brazing of the injector posts into the structural plate of the injector. This delay of nearly two months requires that additional funds be made available if test objectives are to be met.

The prime contractor for the M-1 effort, Aerojet-General Corporation, fully supports NASA in our efforts to complete this work quickly and efficiently. We have made it very clear and the contractor fully understands that there will be no additional funding for M-1 work beyond the $2 million that has now been made available.

The second major question noted in your letter deals with the advisability of continuing an effort in advanced, high performance, high thrust, liquid engine technology and in the relationship of this work to other propulsion effort in the solid and nuclear areas. At the outset, I must state that we consider these three areas of advanced propulsion to be complementary rather than competitive. Our solid rocket effort is aimed toward developing the technology that would permit using very large solids as economical first stage boosters in a possible post-Saturn launch vehicle system. The advanced liquid effort is directly applicable to the upper stages of such a vehicle that would reach orbital velocity. A nuclear stage would provide the escape propulsion necessary for certain classes of very advanced future missions.

I believe it would be shortsighted to assume that the nation will never require an advanced launch vehicle of greater capability than the Saturn V. Moreover these engine technologies would be valuable in the uprating of existing launch vehicles and in the development of possible recoverable upper stages. In order to be able to undertake eventually the development of such systems efficiently and economically, we feel that all of the technologies which must underly such developments should be pursued at a meaningful level of effort, prior to the time that the final system requirement is established.

Speaking specifically to the advanced liquid engine technology effort which we are planning to initiate in 1966 and to continue in 1967, we foresee here a "breadboard" engine system available for tests in 1969 or 1970. This "breadboard" will test oxygen and fuel pumps operating at pressures in the ranges of 5500 lbs. per square inch (current pumps are operating in the range of 2200 psi), new combustion chamber designs, and new high expansion nozzles. The value of a "breadboard" test program will be to identify, and through feedback into the research cycle, solve problems as yet unknown in systems operating at these very high pressures and very high heat fluxes. The work done on the "breadboard" will then define the options we will have in the large liquid engine area; either to continue the technological program looking toward a more complete breadboard to establish the design characteristics derived from the first, or to proceed directly to the development of an engine system which by that time may be foreseen as needed on a given time scale.

This philosophy of developing the technology, building the components, testing breadboard or prototype systems, then feeding back into the development loop the information gained during the test phase, and then proceeding with assurance to full scale system development, is a key factor to the understanding of the conduct of the NASA program. It is this approach that in the past has permitted us to take great strides forward in relatively short periods of time. For example, in 1958 the specific impulse of chemical rocket systems was limited to around 300 seconds; today we have reached nearly 450 seconds. Even here we do not believe that we have approached the limits of efficiency that will be available in liquid propulsion systems.

The last point, certainly one of grave importance to the current and future posture of this nation in its assumption of leadership in science and technology, is that basic technological effort or technology projects are subject to curtailment in periods when budgetary resources are specially limited. In the partnership that we have both worked hard to establish between the Committee and the agency, I believe that there are two difficult but complementary roles which have to be carried out. On our part, we must assure, through careful planning and assessment of alternate managerial approaches, that the agency's program remains balanced, flexible, and always directed toward those short and long term goals which are of fundamental value to the nation's strength. Even with limited resources, some meaningful effort must be kept alive on a very broad front of technological advance if we are not to surrender, as a nation, the position of preeminence we have sought. On the part of the Congress, a careful analysis of the agency's plans in terms of national goals with a commensurate allocation of resources completes the equation which, if properly phrased, will avoid the pitfalls of arbitrary initiation and termination of effort and will assure constant and meaningful gains in all the critical areas of aeronautics and space science and technology.

I believe that the program we will present to your Committee for review at the coming session of Congress can be fruitfully discussed along these lines.

With much respect, believe me

Sincerely,

Original Signed By
James E. Webb
James E. Webb
Administrator

DWjr/blp

cc: AAD/Mr. Hilburn
R/Dr. Adams
P/Mr. Wyatt
K/Mr. Rieke
AC/Mr. Callaghan
AF/Mr. Scheer
AXC/Mr. McJennett

:RENCES:

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DATE ▶					12/21	

Honorable Clinton P. Anderson
Chairman
Committee on Aeronautical and Space Sciences
United States Senate
Washington, D. C.

Honorable George P. Miller
Chairman
Committee on Science and Astronautics
House of Representatives
Washington, D. C.

Dear Mr. Chairmen:

The President's budget request for the FY 1966 NASA program did not include funds for the continuation of the M-1 engine, 260" solid rocket, or SNAP-8 projects. The NASA Authorization Bill (P.L. 89-53) included $19.7 million that was added by the Congress for continuation of these projects; however, the Independent Offices Appropriation Act (P.L. 89-128) provided R&D funding that was only $13.7 million in excess of the funds required for the authorized portion of the President's program request. This $13.7 million has been held in reserve by the Bureau of the Budget pending resolution of suitable project extensions.

We have recently requested and received apportionment of $2 million of these funds for application to the phasing out of the M-1 engine project along the lines that we described to the Congress in our testimony during the last session. It is my desire to acquaint you with our reasons for this decision and to outline our proposals for further work in all three project areas.

M-1 Engine - The M-1 engine project was initiated in 1962 to develop a large hydrogen-oxygen upper stage engine that could be used in post-Saturn launch vehicles. No specific requirements for such launch vehicles have been adopted. In the absence of such requirements a thorough review has been made of the basic technological contributions that could be expected from continued effort on the M-1 project as compared with research on other liquid propulsion concepts.

ENCES: 17 Concurrences

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The concepts incorporated in the M-1 engine are now several years old and still more advanced concepts, promising performance advantages over the M-1 engine approach, have recently become apparent. These newer concepts can be explored in smaller scale and, hence, at lower funding rates than would be necessary for efficient continuation of the M-1 work. We have, therefore, concluded that the M-1 engine development should be terminated after uncooled thrust-chamber tests, now underway, are completed. This phase-out will be consistent with the plan presented to the Committees during the last session of the Congress.

Because of problems and delays in the fabrication of injectors, the M-1 thrust-chamber testing schedule is presently several months behind that contemplated at the time we concluded that the project could be phased-out within FY 1965 fund availabilities. In order to insure that significant technological results will be in hand prior to termination of the project, we have recommended, and the Bureau of the Budget has concurred, that $2.0 million of the FY 1966 funds being held in reserve be provided for completion of this test program. We will now notify the contractor, the Aerojet-General Corporation, that upon the expenditure of the available funds the M-1 project will be terminated.

We have further proposed that early work be initiated to explore and develop certain of the newer, advanced concepts that appear to hold great promise for high-energy, liquid engines. The two concepts being considered are (1) the toroidal combustion chamber with regeneratively cooled nozzle, and (2) the two-stage high-pressure combustion chamber using advanced cooling and a conventional bell nozzle. These engine types offer advantages over current engines of conventional design in that when used in conjunction with the plug nozzle exit configuration they will provide improved altitude compensation; more compact structural arrangement, and lower overall engine system weights.

Both engines would use oxygen-hydrogen propellants. It is proposed that the concepts be explored at the 200,000 to 300,000 pound thrust scale in order to utilize presently available equipment and test facilities.

In addition to research and development of components, it is proposed that investigation be accelerated in the areas of cooling, materials and fabrication methods, propellant injection and combustion characteristics at high pressures, and nozzle flows in order to supplement the advanced engine work.

NASA has recommended that this advanced, high performance engine technology effort be initiated with $3.5 million of the FY 1966 funds presently being held in reserve. If approved and supported by additional funds in the FY 1967 budget for continuation of the effort, we will initiate this activity through contracts that will be open for competition within the industry.

260" solid rocket - The current half-length motor development contract with the Aerojet-General Corporation will be completed about February, 1966 with the firing of their second motor. Our contracts with a second contractor, the Thiokol Chemical Corporation, have already been terminated following hydrotest failure of their 260" motor case.

NASA has proposed that the FY 1965 funds available from the Thiokol contract termination (approximately $4.0 million) be augmented with $4.2 million of the FY 1966 reserve funds to extend the Aerojet contract to provide for the fabrication and testing of an extended length 260" diameter motor which will deliver 6 to 7 million pounds of thrust and burn for about two minutes. This motor would be available for test firing about mid-1967. To minimize program costs consideration will be given to the fabrication of the motor case by cutting and rejoining sections of the two current cases. As part of the proposed program subscale motors will be fabricated and fired to prove supporting technology concepts for inclusion in possible later 260" motor firings. Of particular importance is the establishment of an efficient and reliable thrust vector control system for the large motor. Tests of concepts on 120" or 156" diameter motors will be necessary to obtain proper scale-up factors.

SNAP-8 - NASA has recommended that $4.0 million of the funds now held in the BoB reserve be released for continued development of the SNAP-8 power system. Specifically, two phases of activity have been recommended. In Phase I the ground development activity would be extended to cover

demonstration of long-lived (10,000 hour) components and power conversion system operation. Over 30,000 hours of non-nuclear component and power conversion system testing would be conducted in Phase I. Automatic power conversion system start-up, as required in space operation, will be demonstrated and the performance and operating characteristics of the power conversion system would be determined. These tests would be conducted in a manner to assure compatibility with the SNAP-8 reactor being developed by the Atomic Energy Commission.

A second phase of development activity has also been proposed. In Phase II a power conversion system would be mated with a reactor and tested for 10,000 hours in an AEC facility that has already been built for this purpose. Phase II will provide experimental determination and evaluation of any combined reactor and power conversion system interactions. It will also provide overall performance capabilities and operating characteristics of the full system.

I would emphasize that all of the plans outlined above, except for the $2.0 million testing extension of the M-1 contract prior to termination, will require additional funding in FY 1967 and subsequent years to accomplish their objectives. Their execution along the proposed lines is contingent upon inclusion of sufficient funds in the FY 1967 budget to warrant their initiation.

Trusting that this will meet the needs of your committee and with much respect, believe me,

Sincerely yours,

James E. Webb
Administrator

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