

REVIEW OF THE SPACE PROGRAM

WEDNESDAY, FEBRUARY 24, 1960

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND ASTRONAUTICS,
Washington, D.C.

The committee met at 10 a.m., Hon. Overton Brooks, chairman, presiding.

The CHAIRMAN. The committee will come to order.

This morning, members of the committee, we have a very distinguished witness here to talk to us. We have been wanting to have Dr. Pickering for some time. Now, I want to say before I introduce Dr. Pickering that it is the purpose of the committee to pick up—we didn't quite finish our posture hearings. There are some witnesses still outstanding, unheard, and Dr. Sheldon knows about them. It is my purpose to pick them up as we go along at convenient times and hear the rest of them so that we will complete the posture hearings.

The ones that we have not heard from are largely nongovernmental witnesses and I think the committee would be especially interested in that. We have not heard, also, from some of the atomic witnesses. I think we ought to hear from them, also.

So, Dr. Sheldon, if you will gather together a list of those that we still have scheduled to be heard, we will try to work them in at convenient times.

Now, again, members of the committee, we have Dr. William H. Pickering, director of the Jet Propulsion Laboratory of the California Institute of Technology.

Dr. Pickering's biography is before the members.¹ He has appeared previously before this committee and we welcome him back. The laboratory which he heads has made important contributions to the defense of this Nation over many years. Under his leadership, it made key contributions also to the first American satellite and to the first and only American device in solar orbit.

The Jet Propulsion Laboratory has now passed from its former close relationship with the Army to become the largest contract facility under the general control of the National Aeronautics and Space

¹ Pickering, Prof. William Hayward, California Institute of Technology, Pasadena, Calif. Electrical engineering. Wellington, New Zealand, December 24, 1910; naturalized 1941; married 1932; two children; B.S., California Institute of Technology, 1932; M.S., 1933; Coffin fellow, 1933-35; Ph. D. (physics), 1936. Assistant and teaching fellow physics, California Institute of Technology, 1932-36; instructor, 1936-40; assistant professor, electrical engineering, 1940-45; associate professor, 1945-47; professor, 1947-; division chief, Jet Propulsion Laboratory, 1952-54; director, 1954-; lecturer, Southern California, 1938. Civilian with Research Development Board; Air Force; U.S. Army, 1944. Instructor, electrical engineering; senior member Institute of Radio Engineering, cosmic rays; telemetering from balloons and rockets; microwave propagation; development of cosmic ray radiosonde; missile guidance problems. (From: American Men of Science.)
Committee note: Dr. Pickering is director of Jet Propulsion Laboratories, California Institute of Technology, Pasadena, Calif.

Administration, insofar as ownership of facilities and assignment of funds for work is concerned.

Having Dr. Pickering here today represents the first opportunity of this committee to hear from a distinguished American as to how the new arrangement for the Jet Propulsion Laboratory under NASA is working out.

It also represents a rare opportunity for us to hear the independent and courageous views of a man of respected judgment on our national space program.

Dr. Pickering, you have a prepared statement?

Dr. PICKERING. Yes, Mr. Chairman.

The CHAIRMAN. Needless for me to tell you, the committee has profound respect for your statements and your judgment. When we have finished with your statement, we are probably going to ask you specifically about how the new arrangement for the Jet Propulsion Laboratory is working insofar as you see it.

We will be delighted if you will proceed with your statement.

STATEMENT OF DR. WILLIAM H. PICKERING, DIRECTOR, JET PROPULSION LABORATORY, CALIFORNIA INSTITUTE OF TECHNOLOGY

Dr. PICKERING. Thank you, Mr. Chairman.

Mr. Chairman, members of the committee, I appreciate this opportunity to discuss the national space program, its direction, and its impetus with the members of this committee.

To put what I have to say in perspective, I would like to go back to the pre-Sputnik days, when President Eisenhower announced that the United States would attempt to launch a small Earth satellite as part of the International Geophysical Year program.

The CHAIRMAN. Wait just a moment. Can everyone hear the doctor with the loudspeaker where it is? You might pull it a little closer to you, Doctor.

Dr. PICKERING. Yes, sir.

I think that most scientists associated with that program visualized it as being a low-pressure, slowly evolving effort, starting with relatively few shots of space payloads having capacities measured in a few pounds or tens of pounds. I think they saw this as a state of affairs which would exist for several years and would then gradually work up to larger space vehicles and, ultimately, to lunar and planetary exploration. Only a few enthusiasts were concerned with a rapid rate of advance of our space capability and a rapid development of large launching vehicles.

Most of us concerned with space in 1955 would have dismissed as incredible the statement that in the 1960's the United States would be spending almost \$1 billion on a space program. Let us remember that in 1955 the United States was everywhere the recognized world leader in technology, in know-how, in daring and imaginative engineering projects.

Now, in the short space of 5 years, we find the situation dramatically reversed. We do not debate the necessity for large expenditures in a space program, and the position of the United States as a techno-

logical leader in the world is seriously threatened, and perhaps overcome.

I was interested in reading several weeks ago the results of an international public opinion poll in which the people of 10 nations were asked which country would have the leading position in science in 10 years. People in 8 of the 10 nations polled believed that Russia will hold the leading position in science by 1970; only in Greece and the United States was there confidence that the United States will hold the top position in science at that time. (Gallup poll, as reported in the Los Angeles Times, Monday, Feb. 15, 1960.)

What has caused this dramatic reversal in world opinion? I think there is a complex of answers, but certainly one of the most important factors involved is the unexpected and dramatic advance of Russia in the technology of space.

Shortly after Sputnik, Dr. Killian's committee presented a space primer in which a calm assessment was made of the reasons for a space program. Among other things, the space primer listed four objectives for space exploration. In brief, these were scientific, commercial, military, and human objectives.

With the hindsight that comes 2 years after the event, it would seem to me that the space primer omitted the most important immediate objective; that is, to equal or exceed the achievements of Russia in space. In other words, we should frankly admit what the rest of the world knows—that we are indeed in a race with the U.S.S.R. in space. One can come to no other conclusion.

The organization of the National Aeronautics and Space Administration occurred only 10 months after Sputnik I, and indeed it can be argued that the size and magnitude of the U.S. civilian space effort since then has been greatly influenced by the Russian program. The Space Act declares in section 102, paragraph 5, that one of the objectives of the NASA is "the preservation of the role of the United States as a leader in aeronautical and space science and technology, and in the application thereof to the conduct of peaceful activities within and outside the atmosphere."

Between October 1957 and February 1960, the U.S.S.R. successfully launched three satellites and three lunar vehicles, each one different, better, and more dramatic. Russia, quite frankly, attaches great weight to the propaganda value it can extract from its space program, and at least one major objective of this program is a well-planned campaign that can convince the world that Russia, and not the United States, is the technological leader of the world.

I think it is most important to recognize that Russian leadership in space technology is extrapolated by people everywhere to mean Russian leadership in all technology. I was interested in reading some time ago (Los Angeles Examiner, Wednesday, Feb. 3, 1960) of a proposal to import small Russian cars to the United States for sale to the U.S. public. Five years ago, before Sputnik, the idea that a U.S. car-buying public would choose to buy a Russian automobile would have been regarded as absurd. But now, because of the Sputnik and Lunik shots, all Russian technology is suddenly invested with an aura of excellence.

While Russia has been skillfully exploiting these space successes in the past 2 years, what have we done in this country to compete? Actu-

ally, we have done a great deal, but much more remains to be done before we can say, in the words of the Space Act, that we are preserving the role of the United States as a leader in aeronautical and space science and technology.

The real problem results from our confusion and indecision as to what the exploration of space really means, and what is the motivation for the exploration of space. There have been statements, frequently conflicting, from Government sources, military sources, and experts in all fields, as to what the United States should do, and why. There has been confusion as to the relationship between the missile program and the space program—between the civilian space program and the military space programs. It seems to me that this is the heart of the problem. If we can really understand the motivation and the reasons for the space program, and agree upon this, then it is easy to establish the priorities and support necessary for the program.

I think that we should first understand the difference between the missile program and the space program of the country. It is true that the space program utilizes the large military missiles as booster vehicles, but beyond this there is very little relationship. Military missiles are being developed for a specific purpose as part of the military weapons systems, and as such, they must indeed have the very highest priority. I do not wish to comment about the so-called missile gap, but I have no hesitation in saying that I find it not only proper but necessary for the military to be developing accurate and reliable long-range ballistic missile weapon systems.

Our space program, and here I include both our military and our civilian space programs, is not in any way analogous to the ballistic missile weapon program. In a word, we can say that the missile program is developing a weapon to be used in war or to prevent war; and our space program is a cold-war weapon. It seems to me that if this key point could be accepted by the scientists on the one hand and the military on the other, then we as a Nation could establish a space program which would quickly reestablish our technological position in the world. At the same time, the scientists should be able to conduct the scientific exploration of space, and the military would be in a position to exploit possible military applications of space.

My concern with our present space program is that, as it is currently evolving, there is an increasing tendency for military applications to dominate the space picture. This, I believe to be unfortunate as far as our international position is concerned, and also as far as internal support of the total space program is concerned. Clearly, the military and civilian programs must compete for relatively scarce manpower and facilities as well as dollars, and because of the very high costs of this program, unnecessary duplication and competition should obviously be avoided. Therefore, it is essential that the program be kept in proper balance, consistent with our real national space objectives.

Last month, the President submitted to Congress some proposals for changes in the Space Act of 1958. I believe that these proposed changes would indeed clarify the fact that there should be a well established civilian space program as well as a military program, but I am concerned that there is no place in the act which provides that the program be kept in proper balance. True, there is provision for

the Administrator and the Secretary of Defense to advise and consult with each other concerning their respective programs, but since the Department of Defense is permitted to conduct such research programs as are deemed necessary to support the weapons activities, it appears to me that on many occasions, both the NASA and the DOD will be conducting almost identical research activities.

Furthermore, there is nothing to prevent military space systems of only peripheral value from demanding such a large share of research support in both the DOD and perhaps the NASA that these efforts dominate the space program to the detriment of our real objectives.

It appears to me that the answer to this problem is to require a greater coordination and cooperation between the NASA and the DOD in this area of space; in other words, to require a truly unified national space program. Conceptually, I believe the problem could be solved in one of three ways: Giving essential control of the program to the NASA, to the DOD, or to some third office superior to either in this area. This last concept I dismiss as being unnecessary and probably unworkable. Of the other two, I believe that the NASA should indeed be strengthened to the point where it effectively controls a complete unified national space program.

I believe this was the intent of Congress when the original act was written in 1958, and in view of what I consider to be the primary motivation for a space program, namely, its cold war importance, it seems to me essential that the program be effectively unified by the civilian space agency. If a decision were made to put the entire unified program under the NASA, this agency would then indeed be required to produce the bold and imaginative program which is so badly needed. It appears to me that the program submitted to your committee in these last few weeks represents bold and imaginative thinking based on solid engineering analysis. The NASA has come a long way in the past year. The time has now arrived when it should be clearly responsible for our entire national space effort.

Unless we pursue these goals with energy and solve some of the troublesome problems, we may unhappily be in the position of having to say, as Cassius said to Brutus:

The fault, dear Brutus, is not in our stars, but in ourselves, that we are underlings.

Thank you, gentlemen.

The CHAIRMAN. Thank you, Dr. Pickering, for a very excellent statement.

We are certainly happy to have you here and your words there are most timely. You are head of the Jet Propulsion Laboratory which is doing a whale of a good job out there on the Pacific coast.

In behalf of my colleague, Mr. Fulton, I want you to be assured of our strong support for the missile and space programs.

I want to ask you a question or two regarding your statement.

How do you find the situation working now under the new arrangement for the Jet Propulsion Laboratory?

Dr. PICKERING. Well, sir, during this past year, the Laboratory was transferred from an Army contract to a NASA contract, with a provision that the Army programs in progress at the Laboratory would be phased out in reasonable fashion.

This is being done and is being done very successfully. The Laboratory will be essentially out of its Army programs by about the middle of this calendar year.

The CHAIRMAN. Does the NASA seem to have the proper perspective of the type, character, and capability of the Jet Propulsion Laboratory for work?

Dr. PICKERING. Well, sir, I think that during this past year we have evolved a relationship with NASA headquarters which I find is becoming very satisfactory. I think that we have clearly established the role of the Jet Propulsion Laboratory within the entire NASA effort. In a word, this is that the Laboratory will be responsible for the lunar and planetary programs of the NASA.

In other words, our interest is in the field of space craft and scientific experiments to be conducted on vehicles which will go to the Moon and beyond.

The CHAIRMAN. Then your leadership in the Jet Propulsion Laboratory seems to be fairly satisfied, is that correct, with the arrangements now developing in the organization, the larger organization of the NASA?

Dr. PICKERING. Yes.

It would be, of course, not correct to say we have not had our troubles during this past year. With a new organization, with a change of contract management, et cetera, there have been inevitable difficulties; but I feel these are becoming resolved and, as I say, I feel that our role within the NASA is becoming clearly defined and I look forward to a very satisfactory relationship with the NASA.

The CHAIRMAN. Well, would you say then that under this new arrangement Jet Propulsion Laboratory will be able to do just as good, if not a greater job than they have done in the past for the space effort?

Dr. PICKERING. I hope, sir, that particularly with the ABMA team, Von Braun's team, coming into the NASA, that we will indeed be able to do at least as well and I hope better than we have done in the past.

The CHAIRMAN. Fine.

Dr. PICKERING. I think that the——

The CHAIRMAN. Now, you suggest a closer relationship between the DOD, the Defense Department, and its various departments under the Defense Department and NASA. Now, what is your opinion regarding the military liaison committee which the law creates to maintain proper relationships between the two departments?

Dr. PICKERING. Well, sir, I think if there is not a very close liaison between the two departments, between the Department of Defense and the NASA, that the two groups will develop space programs which will sap the energies of the country from the point of view of manpower and resources and they will inevitably be conducting parallel programs instead of a unified program.

The CHAIRMAN. And waste a lot of money and a lot of manpower; is that correct?

Dr. PICKERING. Yes, sir; that is my opinion.

The CHAIRMAN. You would have, though, according to the way I read your statement, you would have the balance established by NASA.

Dr. PICKERING. Yes, sir.

The CHAIRMAN. As a peacetime agency rather than the Defense Department?

Dr. PICKERING. Yes, sir. Because I feel that at the present time it is more important that the primary effort in space be civilian oriented rather than military oriented. In other words, my feeling is that the military applications of space are not clearly defined at this time, that this may very well develop; in fact, past experience would say almost surely that it will develop, but I would regard this as being a natural development out of a program which is oriented in the direction of a civilian space program.

The CHAIRMAN. You would not take, however, from the Defense Department the applied development in the field, for instance, of weapons and missiles—

Dr. PICKERING. No, sir.

The CHAIRMAN (continuing). That the Defense Department needs in the normal defense of this country?

Dr. PICKERING. No, sir; I would certainly insist that the Defense Department do the best job it possibly can in the field of missiles and that it be alert to the opportunities presented by developments in space, to use these as the occasion arose.

The CHAIRMAN. But you would permit NASA to take the leadership in pure science, basic science and take over more or less that field, the research and development program.

Dr. PICKERING. Yes, sir; and also in developing an overall program to have a comparable dramatic impact to the Russian program.

The CHAIRMAN. I ask these questions because the next hearings we will have in this committee will be on the Presidential proposals for changes and what you say will be very influential with the committee.

Mr. McCormack?

Mr. McCORMACK. I am glad to see you again, Doctor.

Dr. PICKERING. Thank you, sir.

Mr. McCORMACK. We have a lot of fine, young Americans and I hope they are sapping in the atmosphere [in reference to part of the audience at the hearing]. We have one of the outstanding leaders in the field of science testifying, Dr. Pickering. Doctor, in the world of today we have got to be very practical.

Dr. PICKERING. Yes, sir.

Mr. McCORMACK. We have to realize the question of self-preservation; is that right?

Dr. PICKERING. Yes, sir.

Mr. McCORMACK. Not only of ourselves personally, but the way of life we believe in.

Dr. PICKERING. Yes, sir.

Mr. McCORMACK. And our way of life is being challenged, sharply so.

While I recognize the importance of nonmilitary research and development—I was Chairman of the select committee out of which NASA came—we have to be practical in the world of today and realize not only the potential but actual danger that confronts our way of life, the way of life we believe in, democratic institutions of Government.

Dr. PICKERING. Yes, sir.

Mr. McCORMACK. The job we have to do, would you agree, is to try to create a harmonious relationship between the civilian agency and the military to make the maximum contributions to our national interest and our national preservation?

Dr. PICKERING. Yes, sir.

Mr. McCORMACK. As a matter of fact, most of the developments in the field of research in the past conducted by the military have had tremendous peaceful results; is that right?

Dr. PICKERING. Yes, sir.

Mr. McCORMACK. You don't advocate the elimination of research and development by the military in the world of today; do you?

Dr. PICKERING. No, sir; I do not. I think the military is doing a fine job in supporting a great deal of fundamental research in many areas.

Mr. McCORMACK. You wouldn't—would you take the position that in the field of military research and development, and civilian, that the military should be subordinated in the world of today, to the civilian?

Dr. PICKERING. Well, sir, if you are referring particularly to the area of space research then what I believe is that having established the NASA as an independent agency to conduct a space program, that this agency should, indeed, establish the national programs, part of which may very well be done by the military, but it should be done in a coordinated fashion with NASA taking the lead.

Mr. McCORMACK. You mean the NASA taking the lead in the—

Dr. PICKERING. In the research.

Mr. McCORMACK. In the basic research.

Dr. PICKERING. In this particular area of space.

I single this out because I feel that the—

Mr. McCORMACK. I am just exploring your views, you understand.

Dr. PICKERING. Yes, sir.

Mr. McCORMACK. My views are not to be judged by any questions I ask.

Dr. PICKERING. No.

I single out the area of space research because of the very high costs of this. The payoff in the space program is obviously the material which you deliver in space and the data which you get back from space and this is a very expensive business. It is a business which, of course, requires the support of the military, because quite obviously a space-research program must be conducted using rockets and the whole art of rocketry which has been developed by the military at this time. I think in the future the space-research program may very well develop its own rocketry with its own special requirements.

But because of the cost of this program I feel that the Nation cannot afford a completely independent and uncoordinated program between the civilian and military programs.

Mr. McCORMACK. Now, you are talking about another thing. I agree with that; there should be a coordination, but I was trying to go beyond that to see what your thinking was on the question of priority—at this point in the world's history. I am not talking about a peaceful world. You can't deal with the Soviets on a moral plane;

they have no moral origin, that is the institution as such. I am not talking about the people of Russia or many of them. I am talking about the regime in control.

Dr. PICKERING. Yes, sir.

Mr. McCORMACK. And if they have no moral origin you can't deal with them on the idealistic level.

Dr. PICKERING. No, sir.

Mr. McCORMACK. And therefore it is on the level of the law of self-preservation—

Dr. PICKERING. Yes, sir.

Mr. McCORMACK. That we are forced to consider these questions.

Dr. PICKERING. Yes, sir.

Mr. McCORMACK. Idealism is one of them and I am for it. I have ideals, but I try to be practical in the world of today.

Dr. PICKERING. Well, sir, I think I am also trying to take a practical approach, which says namely that the military must devote its efforts and its support to the military-weapons systems and I would regard the intercontinental and long-range ballistic missiles as a very important weapons system which the military must indeed be supporting and be supporting with very high priority. I regard the space program as, indeed, another part of this struggle between two conflicting ideologies, and that to much of the world the achievements of the United States in the space program are a very important factor in their attitude toward the United States. Therefore, I feel it is essential that the United States have significant and dramatic achievements in space.

The question it seems to me hinges around How does the United States organize to accomplish this? It seems to me that having established the NASA, having set up a definite channel of scientific and general civilian achievement in space, that the United States should pursue this route with the military putting its research efforts in the field of missiles, as such, the NASA putting its efforts in the field of space.

Mr. McCORMACK. How about reconnaissance satellites, that could be used for both military and peaceful purposes, what would you say on that?

Dr. PICKERING. Yes, sir; this reconnaissance satellite may indeed be a useful military weapon.

Mr. McCORMACK. There are various types of reconnaissance satellites.

Dr. PICKERING. Yes, sir. I think the only question I would raise is whether or not one should at this time embark on a full-fledged reconnaissance satellite program or should one say to the NASA: "Move ahead as fast as you can in developing the technology appropriate to reconnaissance satellites."

For example, NASA is proposing to conduct some experiments with a meteorological satellite which will explore cloud cover and so forth. This surely is a—

Mr. McCORMACK. What about—I don't want to interrupt you. Go ahead, Doctor.

Dr. PICKERING. This surely is the first step in looking at the Earth from a satellite, in transmitting back to the ground signals from the satellite which give you a picture of what the satellite sees.

As a result of this, then, it seems to me one moves ahead into the next step as to whether or not this is a military weapons system, rather than to say at this time, when nobody except the Russians have produced a picture which has been taken from a satellite, should we at this time conclude that we can indeed see our way clear to develop a reconnaissance satellite system.

The CHAIRMAN. The gentleman's time has expired there.

Mr. FULTON? Mr. Fulton has lost his voice. [Laughter.]

The CHAIRMAN. Mr. Anfuso—that gives the committee a little break here. [Laughter.]

Mr. ANFUSO. May I say that in the absence of Mr. Fulton's voice that he has certainly made a very valuable contribution to this committee in his questioning. He has always been very enlightening.

Dr. PICKERING, you talked about a cold war. Isn't that really the thing that we are going to be mostly concerned with in the next few years, a cold war?

Dr. PICKERING. Yes, sir; I certainly hope it is not a hot war.

Mr. ANFUSO. And in a cold war you are fighting to capture men's minds all over the world; isn't that correct?

Dr. PICKERING. Yes, sir.

Mr. ANFUSO. And the nation which convinces the rest of the world that what they are doing is for peaceful purposes will gain more friends; isn't that correct?

Dr. PICKERING. Yes, sir.

Mr. ANFUSO. Now, do you see a hope in the peaceful discoveries in outer space which someday can create an abundance and a sufficiency in this world to make all nations recognize the futility of war?

Dr. PICKERING. Well, sir, it is difficult to predict exactly what will be the outcome of our ventures into space, but we can certainly say that at this time we have reached the stage in the development of mankind when mankind for the first time is able to look beyond our planet. We have explored our planet, we have mapped it, we have walked all over it and so forth and now we are beginning for the first time to go off the planet, and the ability to do this, it seems to me, is something which has fired the imagination of people all over the world and therefore achievements in this area are going to be looked upon by people all over the world as a very important index of the capability of a nation.

Mr. ANFUSO. Right. Now, Dr. Pickering, do we have the capacity now, both moneywise and in talent to not only catch up with the Russians in this space effort but also to surpass them? Your answer is "Yes"?

Dr. PICKERING. The answer is "Yes." I must qualify it—

Mr. ANFUSO. Let me go on to another question. If your answer is "Yes" I will take it. And would you say we have had that capacity for the past several years?

Dr. PICKERING. Yes, sir.

Mr. ANFUSO. Now, a gentleman testified here yesterday, representing a very large association, and he said that we should spend \$4 billion more in this space effort. Supposing, Dr. Pickering, you were chosen to tell the Nation how that money should be spent and supposing you were given \$1 billion, \$2 billion, \$3 billion, or \$4 billion,

do you think you can find ways of properly spending that money in this effort to not only catch up with the Russians, but to surpass them?

Dr. PICKERING. No, sir; I would disagree. I do not feel that \$4 billion spent, say, this year—

Mr. ANFUSO. I didn't say this year. I say \$4 billion. You see, the Russians don't have a goal for 1 year, they speak about plans, 5-year plans, 10-year plans.

Let us suppose that we had a plan—we only planned for today and we have never planned for tomorrow. Let's suppose now—let's look into tomorrow and say we had \$4 billion, do we have the ingenuity right now, capable men such as yourself, where you could say: Well, we can start this project or that project, which 3, 4 years from now will pay off? Do we have that ingenuity?

Dr. PICKERING. Yes, sir; we do have that ingenuity.

My concern, of course, must be geared to what is the total technical effort which can sensibly be applied in these areas and I don't know what the figure is. It is obviously a growing figure. If we have a program which is a growing program, then we can build to the effort as time goes on.

Mr. ANFUSO. Do we have a growing program?

Dr. PICKERING. I believe that the program as submitted by the NASA, this 10-year program I feel is a growing program.

Mr. ANFUSO. Could we improve on it, could we have a better growing program?

Dr. PICKERING. Given more money, more effort, yes, it could grow faster.

Mr. ANFUSO. That is what I want to know.

The CHAIRMAN. Mr. Van Pelt?

Mr. VAN PELT. Dr. Pickering, I certainly am glad I attended this session this morning because I appreciate your statement. You have clarified a number of things that have concerned me and concerned me with regard to propaganda that we, ourselves, are putting out for the general public here in the United States.

On page 3 of your statement you mention that Russia quite frankly attaches a great deal of weight to the propaganda value it can extract from its space program.

Now, I am wondering just what we can do, either as individuals or as a committee, a part of the U.S. Congress, to help, because we have had many witnesses before this year and last year that have pointed out many dramatic accomplishments that we have made.

Dr. PICKERING. Well, sir, it is true that we have made some dramatic accomplishments. Unfortunately they have not been firsts and unfortunately they have not been as dramatic in the eyes of the man in the street as the Russian accomplishments. Now, I do not feel that we can reverse this situation overnight. The Russians have a demonstrated capability of putting very large payloads into orbit. They have apparently the ability to put these into orbit when they want to, approximately when they want to, and—one doesn't know what their next step will be, but one can be assured that it will be some additional dramatic step. They seem to be more concerned with making each step a dramatic advance over the previous one, rather than consolidating their scientific work.

I think in order for us to be doing comparable things, we must, first of all, have the comparable vehicle capability and ability to fire successfully essentially when we want to.

This is a matter of time because of the engineering experience which is inevitably associated with this and therefore, it seems to me that what we can do now is to convince the public that we have an evolving program here and that with a little patience we will be able to conduct experiments and do things comparable to what the Russians are doing. But I do not think that we should mislead the public into believing that overnight we are suddenly going to do something really dramatic or something really startling, as measured by the Russian standards.

Mr. VAN PELT. Well, Doctor, on this you may or may not want to comment, but I have been one of those that is not too sympathetic to the foreign aid program that we have had, particularly the amount of money that we have been spending. Apparently we haven't bought any friends with the dollars. Would I be right in suggesting that perhaps we ought to amend this appropriation bill that is coming out and designate a part of that money for propaganda on this program to see if we could increase our friends with it, rather than just trying to buy it with dollars?

Dr. PICKERING. Sir, I am afraid I find that a difficult question to comment on.

It seems to me there are many facets of the foreign aid problem with which I am not familiar, but I will say, again, that if we can conduct a space program which begins to match and exceed the Russian program, that we will buy a tremendous number of friends with it.

Mr. VAN PELT. Thank you very much.

The CHAIRMAN. Mr. Sisk?

Mr. SISK. Dr. Pickering, at the top of page 3 you make this statement, after commenting on hindsight and the Space Primer, that in other words, we should frankly admit with the rest of the world that we are indeed in a race with the U.S.S.R. in space. One can come to no other conclusion. Some of us have hated to admit this, but I am, of course, in agreement with what you say.

Dr. PICKERING. Yes, sir.

Mr. SISK. Now, in view of that fact I am concerned with what should be a definite or a primary objective in space and I would like to have your comment on it, not necessarily just this year's primary objective, but, let's say, within the next 5 to 8 years. It seems to me that we should have a prime objective in order to put the maximum effort into it. I have been somewhat concerned as to whether or not NASA actually has that as yet in mind. Now, they have outlined to us a very nice program, various shots that are going to be made, what they propose to do step by step, and yet is that aim—let's ask this: Is that aim to develop and make possible a manned exploration to the Moon or is it something else? What in your opinion should be our prime objective, whether we take it for 4 years or 8 years or whatever it may be?

Dr. PICKERING. The first thing as you have indicated is that there should be an objective, a long-term objective, not something we are going to do this year because the Russians did that, but a long-term

evolving objective. I think in the mind of most of us in this program the eventual objective is manned exploration of the planets.

Now, when that will come, one will undoubtedly find various opinions, but when we say that we are looking at space as an opportunity to step out off the Earth into other parts of the universe, the steps will undoubtedly be first to do this with instruments and eventually to do this with man. We could see it then first in satellites, then in lunar exploration, then planetary exploration, in that order, with instruments first, instruments being put into satellite orbits, they are beginning to go to the Moon, soon instruments will be beginning to go to the planets. Project Mercury will put a man in orbit around the Earth, next step is man on the Moon and next step is man on the planets.

The long-term objective of the goal as far as I am concerned is this long-term objective that says we want to send a man at least to Mars or Venus and safely returning.

Mr. SISK. I agree in the long range, but let's talk about the next 10 years, let's talk about this decade in which we live. Wouldn't it be helpful if, for example, once and for all we said that our objective, if it is humanly possible, is to put a manned expedition on the Moon in this decade? Maybe you think that is impossible, but visualizing and basing my statement on what you state here is a race with the Russians, what more dramatic and what more important or what even more—in other words, what could produce more in the way of possible value than this? Would you consider that a legitimate, primary objective?

Dr. PICKERING. I certainly would; to have a man explore the Moon and return safely to the Earth.

Mr. SISK. All right.

Dr. PICKERING. Now, in order to do this sort of thing one must establish a program which first of all gives you the vehicle capability to do this and it is quite clear that this requires a very large launching vehicle, or else the capability of refueling in orbit or something of that sort, either of two alternatives. In either case this is a tremendous advance in technology as we now know it. Therefore, it seems to me that one should indeed say: Yes, we must proceed with the development of a vehicle capability which is considerably larger than we now have and we must exploit this vehicle capability as we are developing it, exploit it with instruments, but we must keep in mind to put the man in the vehicle as quickly as possible.

Mr. SISK. Now, that is exactly in line with some of the things with which I have been quite concerned. I am happy to hear you say it.

Now, if you were handling a program to achieve this objective, and, of course, you do have a very definite part in it, then to what extent would you put priority on, let's say, the F-1 engine? I realize there are two possible ways that you people anticipate doing this, one is by an initial launch, which because of the power of the thrust and the size of the vehicle, you could go directly there or you could do it through the rendezvous technique where you have various groups meet in space and then launch out from there.

Dr. PICKERING. Yes.

Mr. SISK. But to what extent do you believe it would be necessary to give a DX priority to the F-1 engine or some similar booster? Let

me explain the context of my question. I am somewhat critical that we have not given the priority to the F-1 engine—

The CHAIRMAN. The gentleman's time has expired, but I think the witness ought to go ahead, if he can, and answer the question.

Dr. PICKERING. Sir, I think I would answer it this way, yes, if I had the resources, primarily financial resources, in this case, I would certainly pursue the F-1 engine as rapidly as I could. I would not, however, discount the clustered engine technology which is being developed with the Saturn, because even the F-1 engine will probably have to be clustered for some of the future missions, therefore, I would pursue both of them really. I would pursue the Saturn effort as fast as I could and also I would get the F-1 engine coming right along, too.

The CHAIRMAN. Mr. Bass, Mr. King has to leave here to make an important appointment at 11. If you have no objection I will recognize him for questioning.

Mr. BASS. No objection.

Mr. KING. Dr. Pickering, I would like to ask a question that may carry us into the realm of the psychological and philosophical but it is a realm that your testimony inevitably leads us. I have always been an enthusiastic advocate for the American system and I am sure I shall be until the day I die. But your testimony raises some interesting questions in my mind. The American system, as I have conceived it, has always featured and specialized in cultivating men of imagination, men who could think tall, see tall, walk tall, be tall, and so on.

Dr. PICKERING. Yes, sir.

Mr. KING. Yet, your testimony is that at the birth of the missile age and the space age the Russian scientists were obviously the ones that were walking tall and thinking tall, taller than we were, rather considerably.

Dr. PICKERING. That is right.

Mr. KING. You suggested in your testimony that our scientists were thinking in terms of very modest space exertions.

Dr. PICKERING. Yes, sir.

Mr. KING. Starting out with just a few pounds and building up to the larger poundage over a period of 10, 20, perhaps 30 years, but the Russian scientists in a comparable situation were compressing into 2, 4, 6 years what we were going to accomplish in 10, 20 or 30 years.

Dr. PICKERING. Yes, sir.

Mr. KING. So, then, in the light of what they have done we immediately reorganize our thinking and we start walking a little taller than we did before. But my question is what was wrong with our system that all of us I know are a thousand percent behind, we know freemen are the ones who should be engaging in the greatest flights of imagination. But I am puzzled as to why the Russian scientists were able to outdo us in the very area in which we have always considered ourselves supreme.

Dr. PICKERING. I would answer that as follows: I would say that we had dreamers who were dreaming just as big as the Russians, but the ones who were more concerned with the, shall I say, with the realities of getting programs going were not dreaming nearly as big and the reason was simply this, that we were basing our extrapola-

tions on the state of the art in large rockets in this country. Let's recognize that at that time we knew very little about the state of the art of large rockets including the work underway in Russia. We had our own rocket developments here and based on just where we were in those developments, this was the sort of thing we had been talking about. Furthermore, let me make one other comment, sir, and that is that for a number of years, in fact, ever since the war, scientists in this country had been conducting an upper atmosphere research program using rockets and it had practically always been a program which was woefully underfunded. There was plenty of imagination, plenty of desire on the part of the scientists to conduct additional research programs with sounding rocket, vertical rockets. If that program had received more support in the late forties it would very naturally have led into the satellite program. But just based on where we stood in the early fifties, our experience with the sounding rocket program, the general state of the art with large rockets, this was as far as we dared extrapolate.

Mr. KING. Dr. Pickering, are you saying then that although we had the imagination, we had the initiative, we had the dreamers who could dream big dreams, that nevertheless the ponderous, waiting bureaucracy and all of the other delays, redtape, and other things that we associate with democratic procedures were sort of squeezing the life out of some of these dreams and hence we were 10 years late.

Dr. PICKERING. No, sir, I would say, rather, that we recognized the fraction of the gross national product that we are talking about when we start talking about a big space program. As scientists we had been accustomed to getting along on a very much smaller fraction of the gross national product and also obviously the only way in which these sorts of funds can be made available is through governmental action and it was not at all clear that governmental action of the magnitude required for this effort would be forthcoming on the word of a few dreamers as to what they could do in space.

Mr. KING. Thank you.

The CHAIRMAN. The gentleman's time has expired.

May I say here that we are delighted to have the classes of Miss Florence V. Curran's class at St. Timothy's School, Stevenson, Md., and also from the class of Mr. Lawrence B. Mayer of Kensington Junior High School, Kensington, Md. I wish we had seats for everybody, but we are glad to have you here.

Now, Mr. Bass?

Mr. BASS. Dr. Pickering, you told us earlier, I believe, that you considered the NASA 10-year program, which was recently presented to the committee as a very good one, is that correct?

Dr. PICKERING. Yes, sir. I said that this does represent an imaginative program with sound engineering thinking behind it.

Mr. BASS. I believe it is fair to say that this program at least to start off with calls for an annual spending rate of about a billion dollars.

Dr. PICKERING. Yes, sir.

Mr. BASS. Now, you also intimated, I believe, earlier that this program could be accelerated if we spent more.

Dr. PICKERING. Yes, sir, this is true. I do not feel competent to give the rate of increase of that program as to whether it should be—

when it should be 2 billion or 4 billion or whatnot, but I certainly must say that if the program was established at a more rapid rate or more ambitious level with a corresponding increase in funding this could be accomplished over a period of a few years. I do not believe that you could go into a \$4 billion program this year and spend the money intelligently. I think it has to build up.

Mr. BASS. Would you recommend to this committee that more money be programed than is now being recommended to us?

Dr. PICKERING. Well, sir, it is always easy to say. I would like more money. But I think the answer is "Yes," that we could establish a more ambitious program and that really the important thing would be to establish a definite growing program over a period of years which could have some assurance of being supported at a growing level.

Mr. BASS. In what terms are you talking about, Doctor, relative to expenditures, increased expenditures?

Dr. PICKERING. Well, sir, I don't know just what figures the NASA 10-year program gets up to, but I imagine it is somewhere in the order of a billion and a half, or thereabouts, on an annual rate. It increases from about a billion to a billion and a half. It seems to me if one was to really put a full-fledged effort into, say, the F-1 engine and the application thereof or a larger effort into the Saturn program, that expenditures of perhaps twice this amount could easily be required.

Mr. BASS. Beginning next year?

Dr. PICKERING. Certainly beginning next year. Whether it would come up to twice that amount next year or not, I don't know, but I would say an increase certainly within a year or two to perhaps twice what the NASA program calls for would indeed be intelligently used in a program of considerably greater impact than the program as submitted.

Mr. BASS. Dr. Pickering, the statement has been made earlier in these hearings that because we are behind Russia in this space field—I am talking about the civilian, nonmilitary space field—we are losing friends throughout the world.

Dr. PICKERING. Yes, sir.

Mr. BASS. I just can't—do you think that is true?

Dr. PICKERING. Well, sir, from the point of view of anything approaching a personal reaction to this, my only contact was that last fall I was in Italy and talked with the U.S. Information Agency in Naples and got their general reaction to this whole program. What they said was certainly consistent with this view, that of—of course, I must say this was right after the Lunik II shot and it was very much in people's minds, but the people at the U.S. Information Agency over there expressed great concern to me as to the sort of—as to the difficulties they had in countering the kind of propaganda which was coming out of Russia centered around the space activities and space achievements and gearing it to civilian and scientific achievements, of course.

Mr. BASS. Well, there is a difference, as I see it, between being impressed by what the Russians are doing and actually going over and espousing the Russian ideology and way of life.

Dr. PICKERING. I must agree with you, but on the other hand, I must also feel that if one is impressed with the Russian abilities in

this area, then one will find that when a need for technological support of some sort comes up in a relatively undeveloped country, the reaction is: Let's go to Russia, they will know how to do this better than the United States will.

The CHAIRMAN. The gentleman's time has expired.

Mr. Quigley?

Mr. QUIGLEY. Dr. Pickering, to me the great merit of the NASA 10-year program as it has been outlined to this committee is that it is apparently a well-thought-out program and I think we have heard more than one witness testify before this committee saying that what this country needs to do is establish a definite program and stick with it and not go off in fits and jerks and jumps every time the Russians do something.

Dr. PICKERING. Yes, sir.

Mr. QUIGLEY. I think this is the value and the merit of the program as outlined. What bothers me about it is I think it has certain built-in defects which will invite just the type of fits and jerks that have harmed us in the past. For example, we have a program and if I recall the NASA program it plans putting a man on the Moon, say, somewhere around 1970. I find it difficult to conceive that this country and that this Congress and that any administration that might be in control of the White House will be able to stick to NASA's present program if, for example, the Russians put a man on the Moon in 1966.

I have trouble conceiving this Congress and any administration of this country sticking to NASA's program if Russia puts a man in orbit before the end of this year. In other words, I think the program is realistic in planning in the sense that it lays it out and knows what our capabilities are; it tries to develop and to grow gradually, but my own impression—and I would appreciate your comment—is that it has erred on, shall we say, the side of modesty or it is balanced in the wrong direction.

In other words, I am inclined to feel that instead of a billion and a half, real quick like, if we are going to do anything in the way of catching up—and I agree just not spending money is the answer—I think maybe \$3 billion a year, \$4 billion a year, \$5 billion a year over a period would be the answer. Would you care to comment on that?

Dr. PICKERING. Yes, sir. I must agree with you that if the Russians put a man in orbit next week the NASA program—

Mr. QUIGLEY. We go through the same thing we did after hitting the Moon and after Sputnik.

Dr. PICKERING. Yes, sir. Perhaps the only answer to that would be to put down a program which is, indeed, an ambitious program, one which we can have confidence in, will do well enough to beat the Russians some time soon and then try and support it and not get excited by Russian achievements.

As I said to Congressman Bass, I think that the program could indeed be doubled, shall we say, more or less doubled in expenditure within a few years and accomplish things faster than has been suggested, although as you commented, sir, the answer is not just money alone; you have to build up technical capability and technical know-how, engineering know-how, and this takes time.

I have no answer, really, to your question except to say that I will agree with you it would be unfortunate if we do jump when the Russians do something again next week or next month and that if we had the courage to embark on a program of considerably larger magnitude we could achieve these things sooner.

Mr. QUIGLEY. Well, aren't we bound to jump if we are supporting a program which at the very outstart, I am afraid, is designed not to catch up with the Russians? I mean is this the best we can do? That is what I keep asking myself. If it isn't, why shouldn't we at least try to do more.

The CHAIRMAN. The gentleman's time has expired. Go ahead and answer it, though.

Dr. PICKERING. Thank you, sir.

Well, I frankly don't really know how to answer. Because I can only agree that it is unfortunate if we go by fits and starts in various directions that we have to try and establish some level which we think we can indeed work out both physically and manpower-wise, then we should go to it and expect that within 5 years, 10 years, whatever it may be, that it takes us to beat the Russians that we will have to take that time.

Now, I personally feel that if we really emphasized in our planning, if we emphasized the importance of this race with the Russians, that we could come out with a somewhat different program from the one that has been presented, that we could have a program which would advance us more rapidly.

But in order to advance more rapidly—if I may for a moment digress—in order to advance more rapidly, what we really need is the large vehicle capability.

Granted the ability to fire a very large rocket, reliably, we can do all sorts of things. And, therefore, it is important that we develop this capability as quickly as possible, not that the large vehicle capability is the only thing you need, because, just because you can throw a big lump of concrete out into space, this is interesting but not significant.

To make it significant we have to have spacecraft which can utilize that capability, can support a man in space, can navigate in space, can return to the Earth safely and these are very tough engineering problems which have to be worked on at the same time that the large vehicle capability is being worked on.

Now, the NASA program, as I see it, is aimed at doing these things at a rate which expressed in fiscal terms is somewhere in the order of a billion and a half a year.

The CHAIRMAN. Mr. Hechler. I didn't mean to cut you off.

Dr. PICKERING. No, sir; that is all.

Mr. HECHLER. I want to help clarify some of the answers you have been giving to Mr. Quigley.

Dr. PICKERING. Yes, sir.

Mr. HECHLER. All of us agree we shouldn't respond to Russia by fits, starts, by or with jerks. Nevertheless, isn't it true that our program in this country has moved forward at greater speed because of what Russia has done? I mean hasn't Russia really given us a great break by spurring us to greater action?

Dr. PICKERING. Sir, as I said in the beginning of my paper, 5 years ago none of us visualized the program moving ahead this rapidly.

Mr. HECHLER. Therefore, the thing we have to face in this country is complacency.

Dr. PICKERING. Yes, sir.

Mr. HECHLER. We face a psychological problem.

Dr. PICKERING. Yes, sir.

Mr. HECHLER. And really we should not simply sit back and say we are mature enough to have a program that will not be affected in any way by what Russia does.

Dr. PICKERING. Yes, sir.

Mr. HECHLER. It seems to me—and I would like to get your comment on this—that the stimulus which Russia provides by her activity is, in effect, fortunate for this country, because it helps awaken the people.

Dr. PICKERING. Yes.

Mr. HECHLER. Something which perhaps the leadership of this Nation hasn't done enough of.

Dr. PICKERING. Yes, sir; I certainly agree that the Russian actions have helped to awaken us. What concerns me, however, is the fact that a program of this type involves long leadtimes. One must stay awake for a period of many years.

Mr. HECHLER. All right. Let's follow this out on the issue of long leadtimes. We have been talking in terms of the decade of the 1960's. Now, this group of young people that were here this morning, I think, represents perhaps a cross section of what will constitute the future security of this country. When we talk about long leadtimes isn't it just as important that we enlist the intelligence, the interest, and the application of the younger people today who can help us move forward in technology in the 1970's?

Shouldn't we be thinking of the 1970's and shouldn't we be thinking of how we can strengthen our general education system in order to produce the kind of people that will keep us ahead?

Isn't that just as important as the hardware we produce today and the man we may put in space tomorrow, that we strengthen our educational system in order to continue to move forward?

Dr. PICKERING. Yes, sir; I think it is even more important, because when we look ahead into the next decade we cannot predict what is going to be the important scientific development or engineering development. We cannot now lay out a program and say this is our next 20 years.

Mr. HECHLER. All right. What could we in Congress and the country do in order to strengthen our general educational system in order to achieve that objective? Isn't it just as important to pass a Federal-aid-to-education bill as it is to talk about the things we are talking about this morning?

Dr. PICKERING. Well, sir, I would rather say that it is indeed important that the educational system of the country provides the incentive to young men and women to work hard to develop their talents in the fields of mathematics and science, the fields which will pay off in the technology of the decade after this one.

As to how this should be accomplished, I don't feel that I am in a position to answer that one.

The CHAIRMAN. The gentleman's time has expired. Mr. Daddario?

Mr. DADDARIO. You have recommended, Dr. Pickering, that one of the ways to achieve these ends which you feel are so important is to strengthen NASA so that it is in charge of a national space program.

Dr. PICKERING. Yes, sir.

Mr. DADDARIO. Now, having drawn another conclusion within your statement, what would you classify presently in the space program that the Department of Defense is doing in the peripheral area?

Dr. PICKERING. Well, sir, I would feel that the work, at least the proposed programs of reconnaissance, say, the Midas and Samos programs, which I guess are the large programs in the Department of Defense, I would feel that these programs should be proceeding at a modest rate until we know more about them.

Now, I frankly don't know what the Department of Defense plans are in detail for the development of these two systems. But either one of those systems, if carried out to its logical conclusion, could sap a tremendous amount of the space effort of the country.

Mr. DADDARIO. When you say they should be conducted in a modest manner, do you really mean by that that it should be not done at all and if done, should be under the NASA program?

Dr. PICKERING. I should rather regard these programs as evolving out of the NASA program.

In other words, I would say that taking the specific reconnaissance satellite, that the experience of NASA in developing meteorological satellites and the general technology of observing from a satellite—NASA is going to observe both the heavens and the Earth from a satellite—and that the problems associated with this, the problems of developing this technology are rather difficult engineering problems. I would feel that we would be better off if we were putting all the effort we could into those programs as part of NASA, and then allowing the military reconnaissance programs to evolve out of them, as we see the technology evolving in the NASA program.

Mr. DADDARIO. In answer to one of Mr. McCormack's questions, you said following along somewhat the same line that the Department of Defense should then be alert to the developments in space.

Do you believe that if it is done that way that it will not slow down the military program in space insofar as development of a necessary weapons system might be considered?

Dr. PICKERING. No, sir; I think it would not slow it down because of the following reasons: That in any of these really advanced weapons ideas, there is a tremendous lot of frontier technology which has to be developed. I think that in many cases we try to jump too fast in these things and we are much better off to really put effort into building this frontier technology in a logical fashion and then branching off from it, when the time comes, rather than to say "NASA, you go ahead with your experiments, fund them as best you can, pick up vehicles as best you can, do what you can on it. Department of Defense, you go ahead and evolve a complete system, plan a complete system which is very extensive in scope and hope that all the breakthroughs will come along at the right time."

Now, there are occasions when one has to do this. I think, for example, that the decisions which were made with regard to the ICBM programs in the middle 1950's said that this had to be a crash program,

we had to go into it, we had to conduct necessary parallel approaches in order to get started on this program, with the expectation that the necessary breakthroughs would be achieved.

What I am suggesting, of course, is that the military space systems are not in this category. I obviously should have said, you will obviously find that the military people will disagree with me on this point.

The CHAIRMAN. The gentleman's time has expired.
Mr. Moeller?

Mr. MOELLER. Dr. Pickering, first of all I would like to state publicly my appreciation for the wonderful manner in which you hosted some of us at the Jet Propulsion Laboratory last November. We were very happy to see your institution. Incidentally, I am surprised that you are not asking for more money for that particular place, because of all the places we saw, it seemed as though you were cramped more for space than anyone else.

I would like to see you get more space.

Dr. PICKERING. Thank you sir; I would, too.

The CHAIRMAN. Inner or outer space?

Mr. MOELLER. Outer space, yes.

I would like to digress from this general discussion of the space program to another aspect that I think possibly you could give us some guidance in. Unquestionably we have suffered tremendously, psychologically and in prestige in the world because of what the Soviets have done in space exploration.

Now, you said you were in Italy last fall and I assume that you have had contact with other people that might give you some cue, some hint as to what the Russians might be doing next.

They are certainly not going to stop with space. Now, are they going to come out with some new cure-all for heart trouble? Are they going to have the cure for cancer? They are going to be first in some other things one of these days. Are we conscious of this?

Do you think we are putting forth as much effort as we ought to in other branches of science, not particularly the one we are talking about this morning, to be a match or stay even with them?

Dr. PICKERING. This is a very interesting problem. I think that space has sort of an overruling priority because of the spirit of the times, but I certainly think that we must not overlook the fact that the next dramatic advance is going to be in some other area.

Mr. MOELLER. That is right. Are we prepared for it?

Dr. PICKERING. Are we prepared? I hope so.

Mr. MOELLER. Well, I say it is only conjecture, we know they are going to do something and I hope our people in science are doing something about it now.

The CHAIRMAN. Mr. Roush?

Mr. ROUSH. Dr. Pickering, I was very glad to hear you state this morning that we should frankly admit what the rest of the world knows that we are indeed in a race with the U.S.S.R., in space.

I couldn't agree with you more. As I understand, the one great area in which we are behind lies in this fact that we have not yet developed a super-booster engine, is that correct, sir?

Dr. PICKERING. That is probably the most important area that we are behind.

Mr. ROUSH. Are there other areas where we are behind?

Dr. PICKERING. Probably not. That is, let me say that we know definitely about their capabilities with super-boosters. We know definitely that they are pretty good in the guidance area. Discounting anything they say about their ICBM's, they did hit the Moon, and from the various bits and pieces of tracking data which one can get, they hit the Moon pretty close to the center.

Likewise, we know they have communications systems that are pretty good, they have instruments that are pretty good.

So I don't think there is any other area in which there is any significant difference, in which they are significantly ahead of us.

Mr. ROUSH. Well this series of dramatic firsts which Russia has managed to achieve has not been attributed directly to their superiority with their large engine, has it, Doctor.

Dr. PICKERING. Well, sir, they have to this extent, that the weight capability which they have put into space has been a function of the large engine.

Mr. ROUSH. Well, it didn't take a large engine to put a satellite in orbit first, did it, Doctor?

Dr. PICKERING. No, sir.

Mr. ROUSH. It didn't take a larger engine than we have to hit the Moon first, did it, Doctor?

Dr. PICKERING. No, sir.

Mr. ROUSH. It didn't take a larger engine than we have to orbit the Moon first?

Dr. PICKERING. I am sorry, sir, let me back off on that one. To hit the Moon, I would say yes, sir, that did require a larger—well, shall I say a larger vehicle than we have actually flown successfully in space.

Mr. ROUSH. We have gone right by the Moon and missed it with what we have, though, haven't we?

Dr. PICKERING. Yes, but that is without an accurate enough guidance system to hit the Moon.

Mr. ROUSH. Then to hit the Moon you need a larger booster?

Dr. PICKERING. Yes, because you put more weight in it to carry the guidance system.

Mr. ROUSH. And you require a larger engine to orbit the Moon?

Dr. PICKERING. No.

Mr. ROUSH. We plan to do that and even go one step further.

Dr. PICKERING. Yes, sir.

Mr. ROUSH. It didn't require a larger booster to put a dog in orbit, did it?

Dr. PICKERING. No, sir.

Mr. ROUSH. But it is the future that we are concerned with, this matter of being able to put a man into space, this matter of being able to go to the Moon, this matter of a soft landing on the Moon and then go to Mars. Can you tell me why it is that we have been so slow in coming to the place that we suddenly realize the importance of this large booster engine, that only recently we gave a priority to the Saturn and we still refuse reluctantly to give a priority to this large thrust single-engine?

Dr. PICKERING. No, sir. It seems to me that this is a logical and reasonable development if one goes back to the immediate post-Sputnik era when it became obvious that we were going to have to embark on

a much more ambitious space program than we were talking about at that time. Clearly the step to take first is to exploit the capability of military vehicles which we now have, namely the IRBM and ICBM, and indeed NASA is proposing to do this. In the NASA program you see the Agena vehicle and the Centaur vehicle being talked about, these being based on Atlas and having capabilities which are thousands of pounds in orbit and a thousand pounds or so on the Moon.

So this capability is a capability which we do intend to use and exploit and to use it as quickly as we can move into it.

Then we go on to the larger ones, so that we are not saying that we will wait until we get the very large boosters and then try to do something dramatic with them. We are building up experience, technology, useful scientific information by using vehicles based on our ICBM, namely on the Atlas.

Mr. ROUSH. I can agree—

The CHAIRMAN. The gentleman's time has expired. Mr. Morris?

Mr. MORRIS. No questions.

The CHAIRMAN. Do you want to ask the question you were going to ask then, where I cut you off?

Mr. MORRIS. I yield my time.

The CHAIRMAN. You can't do it under the rules.

Mr. ROUSH. Thank you.

The CHAIRMAN. May I ask you a question, Doctor: Do you think all of the space projects ought to have DX priority?

Dr. PICKERING. Well, I would like to see the space projects move as fast as the funds and resources available them permit and if this requires a DX priority, then the answer is "Yes."

The CHAIRMAN. Do you know of any of them that should not have a DX priority?

Dr. PICKERING. No, sir, my answer being based on this that all of our experience in space is important because it is all leading into this integrated 10-year program which NASA has presented. And it is important, indeed, that we have such an integrated program.

The CHAIRMAN. Any further questions?

Mr. McCORMACK. Yes, I would like to ask the Doctor a question or two.

Doctor, you said on page 6 of your statement:

It appears to me that the answer to this problem is to require a greater coordination and cooperation between NASA and DOD in this area of space. In other words, to require a truly unified national space program.

Now, I can understand that, that means coordination.

Dr. PICKERING. Yes, sir.

Mr. McCORMACK. Understanding minds.

Dr. PICKERING. Yes, sir.

Mr. McCORMACK. In the world of today, wouldn't you put the military exigencies as the primary consideration?

Dr. PICKERING. In this area of space, I would not.

Mr. McCORMACK. Can't space be used for military purposes?

Dr. PICKERING. I don't know.

Mr. McCORMACK. Well, suppose it is obvious that they can get up a satellite before we did, say within 300 miles of the Earth's surface capable of projecting a military instrument, say, up to 40,000

pounds on a designated target, a number of those satellites, is that beyond the realm of possibility?

Dr. PICKERING. No, sir, it is not beyond the realm of possibility. It just appears to me it is not a militarily useful way of doing this.

Mr. McCORMACK. All right. But that would be rather a sharp jolt to us, wouldn't it?

Dr. PICKERING. Yes, sir. But might I suggest, sir, if they had that same weapon on the launching stand in Russia, it should be an equally significant jolt to us.

Mr. McCORMACK. You say further that, "The time has now arrived when it should be clearly"—meaning NASA, should be "clearly responsible for our national space effort." You probably can reconcile the two statements I have read, but would you do it for my benefit?

I find it a little difficult to reconcile cooperation and coordination with clear responsibility.

Dr. PICKERING. Yes, sir. In the previous page, after mentioning coordination and cooperation, I follow that by saying that as I see it, this requires giving essential control of the program—where I am not defining essential control, but I mean that one of the two agencies must be able to direct a complete program.

Mr. McCORMACK. I see. You didn't mean by your latter statement that military research and developments—that the basic research should come under NASA?

Dr. PICKERING. What I mean, sir, is that NASA should direct the program; that a large part of the program may very well be conducted by the military, but that it should be conducted consistent with the plan established by NASA.

Mr. McCORMACK. That would put the military subject to the domination of NASA; wouldn't it?

Dr. PICKERING. In the area of space research, sir, not in the area of space weapons.

Mr. McCORMACK. Well, I am not referring to space—well you are referring to the intercontinental ballistic missiles and the intermediate missile now, in particular, I assume?

Dr. PICKERING. No, sir. The missiles I would regard exclusively as the problem of the military and they must indeed solve that problem.

Mr. McCORMACK. But there could be space weapons in the future which can be projected from a satellite?

Dr. PICKERING. Frankly, sir, I find difficulty in believing this.

Mr. McCORMACK. I am just a layman and—don't judge my mind by any questions I ask—I am just trying to explore your theory and thinking.

Dr. PICKERING. Yes, sir. Quite clearly I can find plenty of people who will disagree with me on this point, but I personally happen to believe that most of the so-called space weapons systems, if they are going to be weapons systems at all, will be a long way in the future.

Mr. McCORMACK. Well, we have to be planning for them now, though.

Dr. PICKERING. Sir, I would plan for them by conducting under the NASA—conducting a very active space program which is evolving the technology, discovering how to use them, just as the aircraft was developed first of all as a reconnaissance device and then eventually

as a bombing device; after you had a little experience with it, you saw how to use it. So I would say the same thing is true here, that we need to develop some experience in space, get some instruments, get some men, get some experience in sending things out to space, recovering things from space, and then decide where we will go.

Mr. McCORMACK. In other words, NASA will do the basic research and farm it out to the military so far as the technology is concerned?

Dr. PICKERING. Sir—

Mr. McCORMACK. On military weapons?

Dr. PICKERING. I would say in doing the basic research, I certainly conceive of NASA as conducting the space experiments. Sometimes, when one says "basic research," one thinks of a man in a laboratory sitting around a lot of glass tubing.

But in this case I would regard the research for space as meaning sending vehicles, instruments, men out into space. And developing all the necessary engineering technology to do that.

But there is a difference between sending a man out into space or sending instruments out into space as a scientific experiment or as a human venture and developing a weapons system.

The weapons system has to build on the technology which can be developed through the scientific exploration of space.

Mr. McCORMACK. Well, would you give NASA control of all basic research in the field of outer space?

Dr. PICKERING. Yes, sir.

Mr. McCORMACK. Both?

Dr. PICKERING. Both military and civilian.

Mr. McCORMACK. Thank you.

The CHAIRMAN. Any further questions? Mr. Hechler.

Mr. HECHLER. Following out what Mr. McCormack was asking, which I think is extremely important, isn't it necessary to insure that there is at least a military applications unit within this clearly responsible system of NASA which you would like to point toward?

Dr. PICKERING. Yes.

Mr. HECHLER. I acknowledge that you may possibly be correct in your appraisal of future military uses of space, but can we afford to take that chance? Isn't it vitally important that the military be given the opportunity to utilize what may develop?

Dr. PICKERING. Yes, sir.

Mr. HECHLER. Shouldn't the military be represented in the space agency, because the type of coordination and cooperation that you have outlined here, I think is not the answer to the question?

Dr. PICKERING. Well, sir, I must agree with you that the military must be alert to the possibilities and must feel that they have the right to exploit these possibilities, but it seems to me that this still can be accomplished with a civilian agency establishing the fundamental program, the fundamental research program. Without trying to push the analogy too far, I see some analogy to the Atomic Energy Commission, which indeed supplies the military with what they need and invites the military to put requirements on them—to give them special things, and so forth.

It seems to me that there is a somewhat analogous situation. I obviously cannot push the analogy very far, though, because of the greatly different circumstances in which the atomic energy program was established, vis-a-vis this program.

Mr. HECHLER. Isn't there some danger, Dr. Pickering, that if you put the complete control of basic research in outer space under NASA, without sufficient protection of the military, that you may choke off some very essential projects that if not carried forward, might endanger our national security, projects which the military feel are essential and which they cannot convince NASA are necessary?

Dr. PICKERING. I suppose it is possible. I think it is improbable, particularly considering the pressures which the military could bring to bear on a situation of this sort—I mean, as a practical matter.

The CHAIRMAN. As I understand your position, it is to give to NASA the pure, basic research and then all space research, but to retain in the military the applied science, is that it, especially in field applications of vehicles and weapons that the military might use?

Does that substantially size it up?

Dr. PICKERING. I would say that the military certainly has the requirement to develop weapons systems based on technology, research, and general information developed by NASA.

Let me, for example, suggest that in the field of, say—well, land-line telephones—the military obviously has an application for telephone systems of various sorts. They have special requirements on telephone systems. They draw on a great deal of civilian technology here and they just use it.

I would regard this as a somewhat similar situation. Now, again, I cannot push the analogy too far because of the greatly different civilian applications in the one case as in the other.

The CHAIRMAN. Well are there any further questions?

(No response.)

The CHAIRMAN. If not, then, Doctor, I think this has been a real opportunity to have been able to talk to you here today and to have you from the west coast and we appreciate very much your coming.

Now, if there is no further business, the subcommittees will meet and I hope clean up their work this afternoon and the full committee will meet Thursday morning at 10 o'clock.

(Whereupon, at 11:38 a.m., the committee adjourned to reconvene at 10 a.m., Thursday, February 25, 1960, on another subject.)