UTILIZATION OF FEDERAL LABORATORIES

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HEARINGS

BEFORE THE

SUBCOMMITTEE ON SCIENCE, RESEARCH, AND DEVELOPMENT

OF THE

COMMITTEE ON SCIENCE AND ASTRONAUTICS U.S. HOUSE OF REPRESENTATIVES

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UTILIZATION OF FEDERAL LABORATORIES

TUESDAY, MARCH 26, 1968

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

The subcommittee met, pursuant to adjournment, at 10 a.m., in room 2325, Rayburn House Office Building, Hon. Emilio Q. Daddario (chairman of the subcommittee) presiding.

Mr. DADDARIO. This meeting will come to order.

This morning the subcommittee begins 6 days of hearings on the utilization of Federal laboratories.

The subcommittee's interest in Federal laboratories, and by this I mean both Government owned and operated, such as the National Bureau of Standards and those which are Government owned and contractor operated, such as Oak Ridge, stems from a number of reasons.

First of all, the Federal Government has a tremendous investment in laboratory facilities and trained manpower, and in a time of budget constraint such as we are experiencing now, we must assure that our available resources are utilized most effectively. Much research and development is needed to restore the quality of our environment; to cope with crime; to solve the transportation crisis, and to supply food, water, and shelter to a growing population. But we are coming to realize that our resources assignable to science and technology are not infinite, and that they do have limits. Yet, within these limits, we must accommodate the continuing demands for new research and development.

I am not inferring that every new agency or every new program find accommodation for all of its research and development within existing Federal laboratories, but I am saying we should look first to the expertise we already have developed. What the subcommittee is interested in is the policy guidelines that govern agency decisions in this area, and how existing competence can be applied to new areas of opportunity.

These issues are not new, but they do warrant the continuing attention of the Congress.

In a 1960 Joint Committee report about the future of the Atomic Energy Commission's laboratories, the AEC describes its laboratories as vital national assets that should not be considered the exclusive resources of the atomic energy field. This view was endorsed by the Commission's General Advisory Committee which added the thought that:

> The Commission's laboratories . . . should be doing what, at the time, best serves the National welfare and security.

Two years later, the Bureau of the Budget issued its report to the President on Government contracting for research and development. This report, known as the Bell report, focused upon improving the quality and the utilization of Federal laboratories. The President endorsed the recommendations in the report; however, there has not been an overall review since that time that shows what was done to carry out these recommendations of 1962.

In 1966 the Research and Technical Programs Subcommittee of the Committee on Government Operations published a case study on utilization of Federal laboratory resources which raised questions relevant to our present hearings.

Most recently, this committee received a report from the National Academy of Sciences in 1967 entitled "Applied Science and Technological Progress." One conclusion of this report was that the "applied research establishments of the Federal Government should be examined for redeployment in the light of changing national needs." The Panel recommended, and this recommendation was endorsed by the Academy's Committee on Science and Public Policy, that programs and organizational locations of Federal laboratories should be examined at intervals to determine whether the maturity of their original missions would justify some reassignment of effort to emerging problems of challenging national interest. "Thus redefinition" the report states, "is essential for exploiting new developments in science and technology in a timely and effective way, and for realizing the maximum benefits from prior investments in science."

I believe these actions indicate that we are moving into a new phase of the relationship between science, technology, and Government, and one in which more attention will have to be given to the allocation of scarce resources among important, competing demands. This will involve hard and difficult decisions, and we expect that the testimony we will hear over the next few days should highlight the present Federal policy for use of Government laboratories and a better understanding of some of the opportunities and problems involved in such action.

We are pleased to have as our opening witness Dr. Donald F. Hornig, Director of the Office of Science and Technology and science adviser to the President. Dr. Hornig always has been a great help to this subcommittee in the past, and we look forward to his testimony again today.

Following Dr. Hornig, we will hear from Dr. Alvin M. Weinberg, Director of the Oak Ridge National Laboratory. Dr. Weinberg has been on the forefront of applying AEC-developed technology to new fields, and he has been an articulate spokesman of ideas that can shape and effect Federal policy for use of Government laboratories.

We are pleased that we are starting these hearings, and believe that the subject is important. We feel that we have the foremost spokesmen available to us here today. We are particularly concerned about this problem because the use of national laboratories and the applied technology capability of our country has been discussed a number of times in our previous hearings and seminars. The opportunities available to make them more useful in accomplishing some of our national goals are enormous.

Dr. Hornig, I am happy, of course, to see you, and we are anxious to hear from you.

(Dr. Hornig's biography follows:)

DR. DONALD F. HORNIG

Dr. Donald F. Hornig was born in Milwaukee on March 17, 1920, the son of C. Arthur Hornig and the former Emma Knuth. In 1943 he married Lilli Schwenk and they have four children: Joanna, Ellen, Christopher and Leslie.

Dr. Hornig became Special Assistant to President Johnson for Science and Technology on January 24, 1964. He was simultaneously named by the President to be Chairman of the Federal Council for Science and Technology. On January 27, 1964, the Senate confirmed the President's nomination of Dr. Hornig as Director of the Office of Science and Technology in the Executive Office of the President. Dr. Hornig also serves as the Chairman of the President's Science Advisory Committee.

A graduate of Harvard University, where he received his B.S. degree in 1940 and his Ph.D. in chemistry three years later, he was awarded a Guggenheim grant and a Fulbright scholarship for research at St. John's College, Oxford University, England in 1954–55, and in 1955 was appointed the first Bourke Overseas lecturer by the Faraday Society of London.

After receiving his doctorate at Harvard, Dr. Hornig spent a year as a Research Associate at the Woods Hole Oceanographic Institution in Massachusetts. From 1944 to 1946 he was a Group Leader at the Los Alamos Laboratory in New Mexico and in the latter year he joined the faculty at Brown University as assistant professor. Three years later he became an associate professor and Director of the Metcalf Research Laboratory. He was promoted to the rank of Professor in 1951 and the following year became Associate Dean of the Graduate School. Subsequently he was Acting Dean. In 1957 he joined the faculty of Princeton University and was appointed Chairman of the Department of Chemistry in 1958. Dr. Hornig was the first incumbent of the Donner Chair of Science at Princeton, established in 1958 by the Donner Foundation, Inc.

Dr. Hornig has been an associate editor of the *Journal of Chemical Physics* and a member of the Editorial Advisory Boards of *Spectrochimica Acta* and *Molecular Physics*. He was President, from 1945 to 1947, of Radiation Instruments Company, and served as Chairman of Project Metcalf of the Office of Naval Research in 1951–52. Before coming to Washington in 1964, he was a member of the Advisory Committee, Office of Scientific Research, U.S. Air Force. In 1959 he was appointed to the Space Science Board of the National Academy of Sciences, on which he served until February 1964. In 1960 President Eisenhower appointed Dr. Hornig to his Science Advisory Comittee, and he was reappointed by President Kennedy in 1961. In late 1960 he served on the Kennedy Task Force on Space to help formulate policy in this field for the new administration.

In 1962–63 Dr. Hornig served as a member of the U.S. Delegation headed by Dr. Hugh Dryden which negotiated the agreement with the U.S.S.R. for cooperation in certain space activities.

Dr. Hornig was elected in 1954 to a three year term on the Executive Committee, Division of Physical and Inorganic Chemistry, American Chemical Society. He is also a Fellow of the American Physical Society (Member, Executive Committee, Division of Chemical Physics, and Chairman 1957–58); a Fellow of the American Academy of Arts and Sciences; a Fellow of the Faraday Society, London, and was elected as member of the Washington Academy of Sciences in 1967. He was elected to the U.S. National Academy of Sciences in 1957, and in 1964 he was named a member of the Board of Overseers of Harvard University. He was elected an Honorary Member of the Rumanian Academy of Sciences in February 1965. Dr. Hornig is a member of the American Philosophical Society (1967); in February 1967 was awarded the Engineering Centennial Award by PMC Colleges, Chester, Pennsylvania; and was the recipient of the 1967 Charles Lathrop Parsons Award of the American Chemical Society on November 30, 1967.

Dr. Hornig has published about seventy papers in the *Journal of Chemical Physics, Journal of the Optical Society of America, Journal of Physical Chemistry, Review of Scientific Instruments, Physics of Fluids, Molecular Physics, Spectrochimica Acta, Discussion of the Faraday Society,* etc. on molecular and crystal structure, infrared and Raman spectra, shock and detonation waves, relaxation phenomena and fast chemical reactions at high temperatures.

Dr. Hornig has been awarded honorary degrees by: Temple University (LLD 1964); Yeshiva University of New York (Doctor of Humane Letters 1965); University of Notre Dame (LLD 1965); Rensselaer Polytechnic Institute (Doctor of Science 1965); University of Maryland (Doctor of Science 1965); Ripon College (Doctor of Science 1966); Boston College (Doctor of Laws 1966); PMC Colleges (Doctor of Science 1967); University of Wisconsin (Doctor of Science 1967); and Worcester Polytechnic Institute (Doctor of Engineering 1967).

STATEMENT OF DR. DONALD F. HORNIG, DIRECTOR, OFFICE OF SCIENCE AND TECHNOLOGY, EXECUTIVE OFFICE OF THE PRESIDENT

Dr. HORNIG. Mr. Chairman, it is always a pleasure to appear before this subcommittee.

These hearings are addressed to the question of how to make the best use of existing Federal laboratories. It is a very important question, about which I have been much concerned, as has the Federal Council for Science and Technology and the President's Science Advisory Committee. There are well over 100 laboratories of substantial size in the Federal Establishment, and perhaps several times that number of installations where some research and development is performed. Around $3.5 billion is being spent annually in laboratories operated by the Federal Government and our cumulative investment in these facilities in the last decade exceeds $7 billion.

Nevertheless, it would be a mistake to consider the utilization of existing laboratories in isolation from larger problems. The function of laboratories is to solve present problems and to lay the foundation for the future. Their productivity must be measured by their effect on current and future programs, public and private, of the entire Nation, usually involving expenditures many times greater than those directly involved in laboratory operations. Because of this "multiplier effect" it is important that the utilization of the Federal laboratories be viewed in the context of their overall contribution to national progress rather than a narrow problem of the administration of the laboratories themselves.

The most critical questions are: (1) The choice of problems, their significance, and the feasibility of finding solutions through research and development; (2) the creation of capabilities in the laboratories which can, in fact, solve the most difficult problems; and (3) the translation of the results of the laboratories' work into action in either the public or the private sectors. The variations in how these questions are answered may far outweigh such other questions as whether one agency uses the capabilities of another agency or whether all facilities are used to the maximum extent.

These questions have received a great deal of consideration and thought from my office through the years. I must tell you frankly that I am not satisfied with our performance; I cannot give you a solution myself, but I know of no one else who thinks he has final answers, either. Of course, there are no final answers, but we can look for the best provisional answers in a constantly changing situation.

There has been a Committee on the Federal Laboratories in the Federal Council for Science and Technology since 1959, chaired by Dr. Allen Astin, Director of the National Bureau of Standards. It has studied the salary and nonsalary factors that bear on the ability

of laboratories to attract and retain superior scientific and engineering people, and thus maintain their competence and ability. Two reports were published in 1962 under the title, "The Competition for Quality." More recently, the views of laboratory personnel were comprehensively polled on how they weigh the relative importance of various factors in sustaining laboratory excellence. The results were published in 1966 under the title "The Environment for Quality." What emerged was that the single most important factor in laboratory morale was a sense of purpose on the part of each scientist and a sense that the results mattered to someone.

The broadest single study made to date of Federal R. & D. activities, the "Report to the President on Government Contracting for Research and Development" was prepared by a committee of Federal department and agency heads, chaired by David Bell, then Director of the Bureau of the Budget, and including the Special Assistant for Science and Technology. The Bell report was chiefly concerned with questions related to the Government's use of private institutions and enterprises to obtain scientific and technical work needed for public purposes. It exploded the conditions under which contractor operations are effective and the limitations which make Federal laboratory operations difficult. As regards Federal laboratories, it emphasized the importance of the relationship between the laboratory and the agency it serves, as follows:

> Director Federal operations, such as the governmental laboratory, enjoy a close and continuing relationship to the agency they serve which permits maximum responsiveness to the needs of that agency and a maximum sense of sharing the mission of the agency. Such operations accordingly have a natural advantage in conducting research, feasibility studies, developmental and analytical work, user tests and evaluations which directly support the management functions of the agency. Furthermore, an agency-operated research and development installation may provide a useful source of technical management personnel for its sponsor.

Mr. DADDARIO. At that point, Dr. Hornig, I would like to quote again from the Bell report and ask you a question. The Bell report recommended, and I quote:

> It would seem, based on the results of this review, that it would be possible and desirable to make more use of existing government facilities and avoid the completion of duplicate facilities. This is not as easy as it might seem. Nevertheless, in some cases, and to some extent, it is clearly possible to do this and a continuing scrutiny is necessary in order to make sure that the facilities which the government has are used to their fullest extent.

No, the first question is, Who do you see is providing the continuing security factor?

Dr. HORNIG. Well, in a very general sense, I suppose this is to some extent my responsibility. These questions of mating facilities to agencies involve matters of considerable detail, both in the management and functions of the agency and the capabilities of the laboratory, and so the hard questions really relate, I think, to the technical managers in the individual agencies and to the laboratory directors.

Mr. DADDARIO. I agree wholeheartedly with the idea that men do their best work and morale is highest when they relate their work to a specific mission of the agency. Yet, somewhere along the line, doesn't this begin to fall apart if the mission objectives of the agency have been pretty much completed?

Dr. HORNIG. Yes; but this can be done in a variety of ways. In many cases, the best may be simply to close down the laboratory and turn its physical properties over to another agency rather than to push a low morale, inefficient organization into another job which it might do just as poorly. What I am saying is that if one grades laboratories from zero to a hundred and puts our best laboratories at a scale of a hundred, there will be lots of laboratories which come down to 10 in their productivity. It isn't because everybody isn't busy, and it wouldn't necessarily be helped if you put somebody else's job in those laboratories. They would produce at the level 10 no matter what you did to them.

Mr. DADDARIO. There is no question but that the subcommittee feels that the closing down of laboratories is one of the possibilities, and we ought to be able to come to a judgment about how to do it sooner rather than later.

On the other hand, it is more important to understand what the good laboratories are, in fact, doing and to develop within them the competence and the confidence that they may continue to do highest quality work and not feel that every Federal laboratory was under pressure of being closed down. Somewhere along the line a rating system, perhaps, seems to be in order.

Dr. HORNIG. As I will indicate in my testimony, my own office, the Federal Council, and the Science Advisory Committee, have been trying to do precisely the things you said: to work with the system as a whole, to work with the individual agencies, and to look at specific laboratories and try to encourage better performance where we see it is necessary, and to close down where it is necessary, too.

Mr. DADDARIO. Why don't we go on? We can come back to this when you are finished.

Dr. HORNIG. All right.

The Federal organization for the conduct of in-house research has also been periodically examined by the President's Science Advisory Committee. In 1961, a PSAC panel, under the chairmanship of Dr. George Harrar of the Rockefeller Foundation, studied the scientific programs of the Department of Agriculture. In 1964, PSAC asked Dr. E. R. Piore, vice president for research of IBM Corp., and formerly Chief Scientist of the Navy, to head a panel on Government laboratories. The Panel was asked "to search for ways to increase the total effectiveness with which the resources of over 100 laboratories of widely differing size and purpose can contribute to the missions of the executive agencies." This is exactly the question you have asked me.

At the same time, the PSAC set up a panel scientific and technical manpower for Government service, under the chairmanship of Dr. Albert G. Hill of MIT. The Panels ended up working very closely together because they both concluded that the central problem was management rather than administrative and personnel procedures, particularly the validity of the laboratory missions and the way the laboratories report into the departmental structure.

Both of these Panels focused their attention on the Department of Defense because DOD has a far larger and more complex technical organization than any other agency of the Federal Government.

In the course of their studies, the Panels initiated a series of productive discussions with the Defense Department which are continuing.

Mr. DADDARIO. Dr. Hornig, was the PSAC report ever published?

Dr. HORNIG. No, the Committee has worked closely with me, and with the agencies concerned, but they produced no published reports.

Mr. DADDARIO. Its purpose was other than a published publication?

Dr. HORNIG. That is right. The purpose was to secure some action.

Mr. DADDARIO. The Panels have been working together?

Dr. HORNIG. That is right.

Mr. DADDARIO. And you feel it has produced action?

Dr. HORNIG. Yes. There is lots more needed, but on many of these things one can achieve much more by working with the people who have to remedy the problem than by publishing documents about them.

Mr. DADDARIO. Could we sometimes say when we bring together a commission of this kind that it will not necessarily produce a report so when it does not, there will not be suspicion about it?

Dr. HORNIG. The normal state of affairs for the President's Advisory Committee is that it does not publish reports. It is the case 95 percent of the time.

Mr. DADDARIO. Notwithstanding that, when somebody heads a panel to perform a study and the study is not published, then there are sometimes dire statements made in the press about something of a cloudy nature being hidden. I know that is not the case, but it might be a good idea to spell it out in the first instance.

Dr. HORNIG. I think this is an excellent suggestion.

During the past year the Department of Defense has been taking vigorous steps to realine and redefine the missions in the Army and Navy laboratories, and to some extent the Air Force laboratories. An analysis has been made to determine whether the administrative inhibitions found in those laboratories have their origin in congressional actions, in civil service rules, or have been self-generated within the individual departments and commands. Most commonly it is the latter. What emerges in all these studies is that the laboratory is, and must be, closely related to the organization of the service of which it is a part. Thus, there is no single general prescription even for the Department of Defense.

In 1964–65 a major study of the National Institutes of Health was conducted under the auspices of the Office of Science and Technology by a distinguished panel headed by Dr. Dean E. Wooldridge. Its report, entitled "Biomedical Science and Its Administration," was published in February 1965. The panel found that the national biomedical program had been extraordinarily productive, but that there was much room for improvement in its management. Many of the suggestions have been taken into account.

From the various studies which have been carried out, there emerge some guidelines for successful laboratory operation on which there seems to be a remarkable consensus among groups with diverse backgrounds.

The Bell report states:

> It is generally recognized that having significant and challenging work to do is the most important element in establishing a successful research and development organization.

I would add to this the need for the laboratory to have strong, capable leadership, able to relate the laboratory to the purposes of its sponsoring agency or agencies, and able to motivate the laboratory personnel.

In my view, the people in the laboratory should have the strong sense of purpose which is essential to success. A strong sense of purpose is not nearly so much a matter of having a carefully written statement of laboratory mission, useful as this may be, as it is of having genuinely significant things to do, strong leadership, and a continuing sense of accomplishment.

The Bell report also recommends:

> Delegating to research laboratory directors more authority to make program and personnel decisions, to control funds, and otherwise to command the resources which are necessary to carry out the mission of the installation.
>
> Providing the research laboratory director a discretionary allotment of funds, to be available for projects of his choosing, and for the results of which he is to be responsible;
>
> Eliminating, where possible, excess layers or echelons of supervisory management, and insuring that technical, administrative, and fiscal reviews be conducted concurrently and in coordinated fashion; and
>
> Making laboratory research assignments in the form of a few major items with a reasonable degree of continuity rather than a multiplicity of small narrowly specified tasks; this will put responsibility for detailed definition of the work to be done at the laboratory level where it belongs.

I strongly believe that all of these points are still valid. So is the report's emphasis on the need for salary scales which will attract and hold highly competent men and women in the Federal laboratories. Salary reforms in the recent past have done much to improve the comparability between Federal and private pay scales for technical and scientific personnel, but we repeatedly find situations where key personnel receiving less than $20,000 are able to move easily to positions in the private sector paying two or three times that figure. There also remains a serious problem of compression of the top management salary levels, so that the highest echelons receive comparatively little more than the middle levels and are most likely to leave the Government service.

Mr. DADDARIO. Would you go back to the first two recommendations and spell out for us a little more what you mean by saying that laboratory directors should have more authority to control funds and should have a discretionary allotment of funds. What amount of money or what percentage are you talking about and how does this compare with a private laboratory such as Du Pont?

Dr. HORNIG. It varies from laboratory to laboratory, but I would say that the laboratory director ought to have something like 10 percent of his funds which are internally allocable. I don't think that one can give a general prescription without looking at the detailed circumstance of any given laboratory. The more general purpose the laboratory is in some ways and the stronger its leadership the more discretionary funds I would like to trust to its director.

Mr. DADDARIO. You have to relate the laboratory to the agency as you have said is one of a criteria of strength. If the laboratory director has this discretionary authority to use funds as he sees fit, how do you protect him from the people back in the agency? They may think he is spinning his wheels in areas which are not related to mission purposes, and this is in a time when they are looking for every dollar possible to accomplish a mission objective?

Dr. HORNIG. He still has to submit an annual budget and review of what he does, and if he goes off on tracks which don't contribute to his agency, you don't fund him.

Mr. DADDARIO. Isn't that one of the problems that would arise? The reason I ask you that is to make a comparison with the private sector. If he does have to explain it and if he is not going to get support, he does not really have discretionary authority which you would like him to have.

Dr. HORNIG. I don't have any hard figures for the private sector.

Mr. DADDARIO. How it would work generally?

Dr. HORNIG. In general, when research directors confer with us from the private sector we learn that there are more discretionary funds in a private business than we allow our directors in a Federal laboratory.

The director is supposed to know what his job is; if he is in a company he knows what the business is. If it is discretionary, it is still not within his discretion to go off and do something that the company is not involved in.

When we give a laboratory director a discretionary authority, it is discretion essentially to explore what are the best technical opportunities to contribute to his job, not to go off on tangents. You catch up with him on the next year's budget if he goes off on tangents.

Mr. DADDARIO. Let me ask you this question to see if I can satisfy some of the questions in my mind. Being fundamentally of the opinion that the laboratory director should have this authority, do we in fact enhance the capabilities of the laboratory. Are we able to make better use of the knowledge developed and do it more quickly? We just had hearings on pollution and unless we are able to rapidly use the knowledge in this particular area, the problem will get out of hand. We must apply our knowledge quicker rather than later. One of the objectives we would hope to achieve by giving the laboratory director this discretionary authority would be to do this.

Dr. HORNIG. I think this is precisely right. In the first place, very little of what we are talking about is basic research.

Secondly, the job of the laboratory is not to accumulate a pile of knowledge or to turn over the grains of sand in the Sahara Desert and examine them one at a time. Its hardest problem is to decide what the problems really are and how they can be tackled, and for this one needs keen technical insight. It is not usually true that desk-bound people like myself can sit at the top of the pyramid and say what the real technical problems are that are soluble next year. This takes ideas from the people who are hard at work and this is the importance of the role of the laboratory and its director. In many cases one can define the general outline of problems from the agency level, but the question of whether you make progress depends on picking the right detailed problems, those which are ripe for solving at a given time. That requires keen technical insight. This is why I emphasize the role of the laboratory director. As all the study panels have emphasized, the most critical thing is the technical talent.

Mr. DADDARIO. The discretionary authority then would allow the director to pick the right problem because he has the best ability to do that, and then he would be able to pick the right people to accomplish the job.

Dr. HORNIG. Ninety percent of a program is laid out between the laboratory director and his management. But when there are good ideas arising from the technical staff, subject to internal review, that look promising, he should be in a position to move rapidly. This is

important both for the results it will give us and for what it does for the morale of his people when they can act on good ideas when they come up, rather than writing proposals for successive review which may result in permission 2 years later to go ahead with it.

Mr. DADDARIO. How far would you allow this discretionary authority to go if during the course of his work a laboratory director saw an opportunity to be helpful in an area of great interest to the country? For example, if Dr. Weinberg sees that some of his people in accomplishing one thing developed an ability to handle certain of our problems relating to crime, would you allow him to use part of his discretionary funds to prove this out to the point where it could be used?

Dr. HORNIG. Well, this, for instance, gets outside of the general mission of Dr. Weinberg's laboratory, so I would say that no, I would not include any real program in crime within his discretionary authority.

On the other hand, if his people came up with a really good and promising idea that was on a relatively small scale, and as a prelude to discussion with, for instance, the Attorney General, if he wanted to do some exploratory work to test the validity of the concepts they were going to provide, I would say, yes, this made good sense.

Mr. DADDARIO. This is one of the weaknesses I see in your argument about the agency relationship. On occasion, knowledge could develop to the point where it could be applied to other problems and people who are working on this, having a social conscience, being concerned about the problems of the country, should be allowed to pursue it. In fact, it may affect their work if they were not allowed to have this kind of flexibility. I recognize it is a difficult decision, and should not be allowed in every instance. Nor do I, at the moment, see any type of language that we as a committee could recommend as a guideline. Nonetheless, I think that there ought to be some provision whereby such work can be done even though it is not related to the particular agency.

Shouldn't we in some instances allow the director to do a certain amount of whatever he wants, regardless of the mission objective?

Dr. HORNIG. You ask a number of questions. Obviously, if the Oak Ridge National Laboratory has capabilities, for instance, in the crime or pollution area, we can and we do use its capabilities on behalf of other agencies. But this is a little different from a question of what should he do within his discretionary authority, because within his discretionary authority he is using AEC funds. I think Dr. Weinberg would have a pretty hard time explaining to the Joint Committee on Atomic Energy any extensive efforts in areas not related to atomic energy which he carried out with money appropriated for atomic energy. This is a management problem. Somebody else has got to pay for it.

Mr. DADDARIO. That is what we are trying to find an answer to.

Dr. HORNIG. We do it.

Mr. DADDARIO. But how will he know this capability has other applications in the first instance? He would have to compress his activity because it is not within the mission objective. Therefore, you would be stifling this growth before it has a chance to prove itself.

Dr. HORNIG. I don't see how to answer this question generally. You can ask him about it. There are two routes. One is general. If it is within his discretion, he can do it. It is important, of course, that we utilize the full capabilities of a laboratory, but I would simply say that within the discretionary funds the scale of what he undertakes in a different direction is actually limited. I don't think it inhibits him very much.

Dr. Weinberg, and I will mention this later in my testimony, does do work for the Office of Saline Water; he has worked in collaboration with the National Institutes of Health. I believe, for instance, that other agencies put about $50 million a year into all the AEC laboratories. The route you mention is surely one we want to go, but the problem that has to be answered in detail is when and what scale one should go off in new directions.

I remember in the early days of missiles when just about every military organization and laboratory in the business wanted to go off and invent its missiles and this had to be brought back under control.

Granted crime and pollution are very important problems, we don't want every agency in the country to go off on its own private pollution program, except where it has something special to contribute.

Mr. DADDARIO. This committee has wrestled with this laboratory problem, and I can recall some years back we were, some of us, against the development of a biomedical capability within NASA. Notwithstanding that, they did develop a capability which went along for years until the committee was able to put certain budgetary restraints on them. They are now getting together and working more with other agencies. The fact is that it is not always an easy thing to do. If the agency head recognizes that Congress does want the laboratory director to have such authority, it would be somewhat easier.

The reason I am asking these questions is to see if somehow we can lay the base with this testimony on which we can develop some guidelines which would protect the director. I would suspect he would need some protection, in fact.

Dr. HORNIG. I think I would say that a reasonable fraction of his budget ought to be at his discretion in order to cope with the points you mention.

I mention 10 percent, but I think that is a variable number. It depends on the nature of the organization, whether it is a highly focused organization or a general nature organization.

Mr. DADDARIO. The point you raise in comparing this with the private laboratories is that a private company which is successful allows their research people to have some discretion because it is a profitable thing to do.

Dr. HORNIG. But the laboratory director knows what business his company is in when he is exercising this discretion. I have conferred with a number of big private industries on this matter. I find they make statements, for instance, that yes, they have given him authority to pursue any promising opportunity that appears. I then try to find out what did he do. He never strayed very far from the general area in which the company might utilize his results, and the reason is very simple. The talent he had assembled in the laboratory was related to the business. His own interests were related to the company, and the promising ideas appear to be related.

In the case of one big company, I known that one of their scientists had a good idea that went off at completely right angles, and by mutual consent he went somewhere else.

Mr. DADDARIO. What you have said is extremely helpful. If we could establish the guidelines so that within that framework there would be that type of latitude, we would improve the situation from what it presently is.

Dr. HORNIG. Yes. In the best cases, that is the way it is, but it isn't widespread enough. I would agree with you.

Almost all reports agree that there is generally excessive administrative control and not enough freedom given to the directors of the laboratories, due not only to civil service or other rules, but to practices and procedures which have evolved through the years in the various departments.

For example, in the military departments there has been a difficult problem in the relationship between military and civilian personnel in the direction of laboratories, which has been accentuated by the policy of rotation of technically qualified officers.

Everyone has observed that the average capability of the Government laboratories compares favorably to the average capability of industrial laboratories and most university laboratories.

Mr. DADDARIO. Has there developed a retraining program so that those employees who are not up to snuff because they have not been trained and whom you cannot get rid of because of civil service regulations could, in fact, be retrained in order to keep them up to the quality level you would like?

Dr. HORNIG. There is retraining authority. It is exercised in some laboratories and some organizations, but what is actually done is highly variable among the laboratories and agencies of the Government.

Mr. DADDARIO. Should there be a procedure or control of this, or is this one of the things that ought to be left to the discretion of the laboratory director?

Dr. HORNIG. Well, as a general principle there always ought to be some training and retraining activities. I think just how this is done, and the extent to which it is done, depends again on the nature of the laboratory, the nature of its personnel and the nature of its task, and I think considerable discretion should be left to the director.

When there is lack of performance it can usually be associated with lack of mission, lack of urgency, and lack of a reward system for performance and recognition.

I should like to underscore the importance of discretionary funds for the laboratory management. We just discussed that. The laboratory director ought to be able to seize initiatives without waiting for the 24-month cycle of budget requests by the laboratory, budget approval by the agency, budget requests by the agency to the Bureau of the Budget, approval by the President, appropriations requests to the Congress, and congressional appropriations action. But even if funds are available, there is a question of whether all ideas from a laboratory should be subjected to successive detailed reviews by deskbound administrators.

A laboratory needs to be able to generate its own ideas about what it should be doing. A significant number of major technical develop-

ments coming out of our Federal laboratories, such as the Sidewinder missile which is still one of our best air-to-air weapons, were started or nurtured with funds that would not have been available if the laboratory director had taken the rules too literally.

I will leave the details of this problem for laboratory directors such as Dr. Weinberg and Dr. McLean who will follow me.

Let me now turn to the adaptation of Federal laboratories as they complete the tasks for which they were established, or the immediacy of tasks changes, or the nature of the problem is modified by subsequent events. How to assign new tasks to existing laboratories, when to establish new laboratories, and when and how to disband existing organizations and abandon existing facilities are closely related questions.

It is certainly true that the roles of some of the Federal laboratories have changed significantly or diminished with time, leaving a substantial combination of talent and capital investment without a clearly defined job. At the same time, the changing needs of the Nation from time to time require inauguration of new research programs, whether in the effects of pollutants and the setting of standards, the abatement of pollution, improved transportation systems, or crime control. The question, of course, is how to manage the total collection of Federal laboratories to take account of the changing mix of priorities.

One of the suggestions which has been made is to establish a Federal agency to operate laboratories and perform what is in effect contract research for the rest of the Federal establishment. This hypothetical agency has sometimes been termed a "GSA for Federal research." This is essentially what is done in the Soviet Union for everything but defense research, atomic energy research, and basic research.

The feasibility of such an approach depends, I think, on how the agency is conceived and what kinds of work are assigned to it. As a housekeeping and general management device, it might be successful in the same way as the industrial contractors who operate the AEC laboratories. However, I have serious misgivings about this approach. An effective R. & D. program involves a dynamic give and take between the laboratory and its parent agency. It must not only carry out assigned tasks, but spell out the tasks which need to be performed; it must be a source of ideas for its parent agency and help the agency to put the laboratory's output into practice. All of this requires a very close identification between a laboratory and its sponsoring agency.

Nonetheless, under certain conditions, we have seen that one Federal agency can perform research effectively for another. The Office of Saline Water in the Department of the Interior, for example, is one of the best examples we have of a technically oriented Federal agency which has performed an important part of its research and development work through "contract" with other Federal agencies. Since part of this work is being done at AEC's Oak Ridge National Laboratory, you may want to go into some detail about it with Dr. Weinberg. OSW work has also been performed by other Federal agencies such as the National Bureau of Standards and the Bureau of Reclamation.

In general, OSW experience suggests that work performed by other Federal agencies can be highly successful provided the performing laboratory shares fundamental objectives and research traditions with the sponsoring agency. The question really comes down to compati-

bility in how the two organizations do business. The problems of liaison, of making sure that the sponsoring organization has effective means of input into the performing organization and vice versa, are distinctly more complicated when a direct line of management control is absent, but when conditions are right, this difficulty can be overcome. It is not unlike the problem of contracting for research outside the Government which is, after all, the way we carry out most federally sponsored R. & D.

Each case must be considered on its merits, but I would hope that we could encourage more of the kind of use OSW has made of capabilities in other agencies, so that we can obtain a broader base of experience on which to make judgments in the future. It is probably no accident that the transfer of work has been most effective when carried out in the large "general-purpose laboratories" such as the Bureau of Standards or the AEC's national laboratories.

Such considerations lead me to the conclusion that it would be a mistake to establish general Federal policies at this time, either legislatively or otherwise, regarding performance of Federal research and development work in Federal laboratories outside the sponsoring agency. I am not aware of any current policies or procedures which hinder one agency from using another's capabilities. As a practical matter, there may be a need to remove or modify personnel ceilings for laboratories which are going to perform research for nonparent agencies. It is also possible that in some cases, one might need to seek further interpretation by the Comptroller General of the Economy Act of 1932. If there are any real obstacles, I would want to work to resolve them.

The temptation to keep all existing laboratories busy and to make maximum use of capital facilities already in existence is strong. However, the simple fact is that in many cases we would do better to start afresh on a new problem. The question of when to start new laboratories, and what to do about those that are obsolescent or too small to be effective, should also receive careful attention on a case-by-case basis. Obsolescent laboratories are inefficient, because the best people leave first. Facilities and equipment established for one purpose often are very difficult and costly to adapt to wholly new missions. It is not at all clear that one gains financially by trying to refurbish old laboratories, and meanwhile one may be losing the dedication and enthusiasm which often go with a wholly fresh start.

In restructuring the Federal laboratory system, it is important to recognize that laboratories need to be of a critical size to be really effective. There should not only be adequate strength in the principal areas of effort, but also enough scientific and technical disciplines represented among the laboratory personnel to yield useful interaction among them—as when the biologist needs the help of a physicist or an engineer to overcome a particular problem. A "critical mass" of people allows for internal redisposition of jobs and people and permits it to take on new assignments without undue strain or complete reorganization. A scattering of small laboratories, such as some in the Department of Agriculture, for example, dissipates this opportunity. One of the recommendations of the PSAC study of agricultural research which I mentioned earlier is that many of the USDA research field stations be either closed or transferred to the State experiment stations.

In short, if we are really seeking efficiency, I believe the place to start is by shoring up our determination to close old or ineffective facilities down and walk away from them. It isn't easy. Agencies themselves often find it hard to contemplate the shutdown of a facility which may still be doing some useful residual work and with which it may have developed close personal relations over the years. Laboratories, like any other installations, become a part of the economic life of the communities in which they are located. The communities do not like to see them closed, and it is not uncommon for Members of the distinguished body you gentlemen represent to take a lively interest in plans to close facilities located in their districts. Secretary McNamara has proved that obsolete facilities can be closed by tough-minded Federal managers. Moreover, this can be done with the understanding of a Congress which recognizes the need for efficiency and flexibility.

The Bureau of Mines closed down 11 of its 30 laboratories during its 2 years under the direction of Dr. Walter Hibbard, who is resigning next week to take over an important industrial post. The Bureau also opened one new laboratory in this period, for the very good reason that it is hard to study permafrost anywhere in the United States except Alaska, where the new facility is located.

The closed laboratories were judged by the Bureau to be too small or too weak to make an effective contribution to the Bureau's work. Their more important tasks have been transferred to other installations. In Dr. Hibbard's judgment, there are additional laboratories which ought to be closed, but in at least one case he has been prevented from taking action by congressional direction. It is clear that we have continuing need for mutual understanding and accommodation between firm and effective executive management, on the one hand, and the Congress and the political realities, on the other.

Mr. DADDARIO. I am pleased you have made reference to Dr. Walter Hibbard and the work he has done. Dr. Hibbard was a classmate of mine and one of the most distinguished members of our class. I consider it a great honor that you have complimented him this morning.

Dr. HORNIG. He has done a distinguished job at the Bureau of Mines.

I would like to note in conclusion that the Federal laboratories are not there just to do research for its own sake. They are there to produce the ideas on which the next generation of the parent agency's activity will be based. The laboratories need to operate as a system and not as loose collection of disconnected components. They need to have meaningful problems to work on, where the end results of what they do will be visible and on which they can be judged. We need more of the sort of thing the Navy is doing in reorganizing some of its laboratories around problem areas such as antisubmarine warfare.

While effective adaptation of the Federal laboratories to changing missions is an important consideration, it is not the only obstacle to the attainment of higher levels of effectiveness. Salary scales that are not competitive with either universities or industry, particularly in the upper brackets, are a central issue. Heavy layering of the power of decision above the level of laboratory directors is a particularly acute problem.

I not that most industrial laboratory directors report directly to the top management. Similarly, a wide array of administrative rules imposes a deadening effect upon the operation of laboratories in many agencies.

Mr. DADDARIO. Do you have any recommendations about salary scales, how to overcome what is obviously an inhibiting factor here?

Dr. HORNIG. The main recommendation is that in the first place we ought to keep comparability more current. One of the problems with comparability at present is it lags several years behind.

Secondly, as compared to industrial salary scales, not only for the technical people, but generally in the Federal Government, our distribution is cut off at the top. Therefore, I would say more attention to the salary scale for the key people who guide the ventures is a particularly acute problem.

These are the people who really determine whether this flexibility we want to give the laboratories and the laboratory directors can be wisely exercised. These are the people who guide the work.

Mr. DADDARIO. Recognizing that this is a problem, and considering the opposition that you get regarding the supergrade level, which is really not so super, would an institute such as that mentioned in the Bell report be the answer? The Bell report recommended an institute which would have its own merit system, its own salary scales, and this type of thing.

How do you justify your opposition to the creation of such an institute? It seems to me you were going counter to the recommendation of the Bell report. Although I have not come to any conclusion about the need to establish such an institute, it seems to me that it does offer the capability, at least, of establishing control over this salary problem.

Dr. HORNIG. If it is basically a housekeeping device, and if it gave one the handle to solve the salary problem, I think this might be a good argument for it. I would hope, however, that we could approach the salary problem more directly.

Mr. DADDARIO. Do you consider it a serious enough problem so that if you are not able to do it considering civil service rules and regulations, congressional opposition, that this would be something we ought to consider? Is the salary situation that serious?

Dr. HORNIG. No. We have taken enough steps to improve the salary situation that I think all of the groups that have looked at it agree that the salary situation is a serious problem, but not the most serious one. In the poll that Dr. Astin's committee took of Federal personnel in Federal laboratories, this was not considered to be the most central question as regards their staying, their leaving, or their happiness in the job.

The most central one to them was the question of whether they thought they were doing a useful job and their ability to get on with the things that they thought were important. The internal management of the laboratories is still a more critical problem than the problem of salaries.

Mr. DADDARIO. You think it would be a mistake for this committee to isolate it, but rather to take it into consideration with these other problems?

Dr. HORNIG. I think all of the advice that I have had is that it is one of a complex of problems.

Mr. MOSHER. You just went back to a sentence on page 11 in Dr. Hornig's testimony that interested me. It says,

> Such considerations lead me to the conclusion that it would be a mistake to establish general Federal policies at this time. . . .

Are you emphasizing that phrase "at this time"? Are you implying the time may come when, for some reason of greater experience or something like that, the Congress might then attempt to establish general Federal policies?

Dr. HORNIG. Yes. I was emphasizing two things. The word "general" because there is such a wide variety of institutions and tasks, and I was emphasizing somewhat "at this time" because I think as we get more experience with the transfer of tasks from one laboratory to another that we might want to reconsider that.

Mr. MOSHER. You aren't going to mention any specific time such as 2 years from now or 10 years from now?

Dr. HORNIG. I think it is extremely unlikely, considering our efforts over the last 4 years, that the time is anything like 2 years.

Clearly there is work to be done. My Office and its associated mechanisms—the President's Science Advisory Committee and the Federal Council for Science and Technology—have played an active role throughout their existence in trying to improve the administration of Federal laboratories.

I consider the most important job to encourage the departments to strengthen their own internal management structure for scientific and technical activities. This has resulted in the past in the establishment of positions such as the Director of Research and Enginering in the Defense Department, the Assistant Secretary for Science and Technology in the Commerce Department, and recently, for example, a Director of Laboratories in the Navy.

Fundamentally, I see the problems I have discussed as questions of effective management and effective managers. This emphatically includes the whole complex of questions relating to effective use of existing laboratories, including how to cope with obsolescent missions, use by one agency of the laboratories of another, and when to start new facilities to meet newly emphasized problems such as transportation, pollution, housing, and crime.

The problem for the Federal Government is that it has no models. The successful management of R. & D. is one of the most elusive problems of industrial management. But the range of problems and the size of the R. & D. establishment in several agencies is greater than in the largest industrial corporations.

Therefore, for the present I see the best room for progress in encouraging effective management within the Federal agencies. Beyond this, my Office and all its associated mechanisms will continue to advise and assist the President and work with the Bureau of the Budget and the executive agencies to continually seek improvements in the system as a whole.

Thank you.

Mr. ROUSH. Mr. Chairman.

Mr. DADDARIO. Mr. Roush.

Mr. ROUSH. Dr. Hornig, I have before me an article written by Dr. Harvey Brooks entitled "Needed—More Freedom in our National Labs." It occurred to me during the discussion you had with the chairman on this matter of discretion that the managers of the labs perhaps do need more freedom. On the other hand, I wonder if they are capable of identifying the real problems relating to the needs and wants of the people. I am afraid they are liable to decide to stress the sex life of a frog instead of the population explosion and its effect on the economy and the social life of the country.

Dr. HORNIG. I would answer it this way. There is a range of decision which ought to be allowed at each level of management, and we are trying to say, How do we make a whole dynamic system work?

Obviously, the general guidelines as to what topics need to be tackled in the public interest have to come from the political structure of the Government, but the translation of those into what is technically feasible, and where the technical opportunities lie is the job of the technical people.

When you ask how much responsibility is appropriate, this depends entirely on the qualification of the laboratory and the laboratory director. I could make two general observations. It turns out to be precisely the best and busiest laboratories that have also the best ideas as to what else they might be doing. In those laboratories which have run out of missions, the standard thing to do is turn to basic research, and one finds this building up in these laboratories. In some ways, laboratories which have the most capacity to absorb more are the ones that have the fewest ideas as to what they should most effectively do. I don't know how to make a general prescription, except to have a good management.

Mr. ROUSH. I think these hearings are going to be very fruitful and very good. It seems to me that you put your finger on it in your testimony when you said that one of the most critical questions was the choice of problems.

Now, the chairman in his preliminary statement identified several problems which confront the Nation and are going to confront the Nation. He pointed out such things as crime, transportation, housing, food, and water.

Now, one of the difficulties is that these are very general. We would like for a lab which may be dealing with atomic energy to be able to know that one of the problems is, for example, the storage of food, and that in the course of their work they should be alerted to the fact that perhaps through the use of radiation they can store foods for longer periods of time. Another lab which may be working on communications should know that one of the problems in crime detection is the need for rapid, prompt, accurate communications, or in the storage of knowledge, the use of the computer. I think that our problem is to tell these people on this level that this is what we are seeking, not that they are to solve at that laboratory all of the problems of crime.

Dr. HORNIG. I think that this is precisely right. If we can encourage ideas to come up from anywhere, so they will all know that they can contribute, then it becomes a management problem to do it at the best places.

Another topic we haven't touched upon is the problem of duplication. That is the other half of this problem.

Mr. ROUSH. Is there any program or is there any plan to get these problems to the various Government laboratories? Is there any way at this time that we are alerting them to these various problems or do we just put them on their own initiative?

Dr. HORNIG. It is very hard to talk in general. I think I can say, though, as we begin to put together a program in housing research and development there has been a quite careful look at the possibility of utilizing both the in-house establishment and contractual methods. In-house approaches are all in competition with contractual relations with outside performers. There are even more potential contractual performers than there are Government laboratories.

I think a more or less constant examination is necessary.

You will find when you talk to Dr. Weinberg that his laboratory provides a constant series of proposals. I think the area covered by these proposals extends well beyond the narrow bounds of nuclear energy. I think the first proposals for desalting plants came out of the Los Alamos Laboratory and subsequently were developed by Dr. Weinberg's group at Oak Ridge. They are starting in one area and moving into another area. They are now developing the idea of large industrial complexes as a way of getting at the food problem in some parts of the world.

It is an open question whether that should be developed at Oak Ridge or some parts should be developed at another place. The ideas are out for discussion and consideration now.

Mr. ROUSH. It is my own feeling that we do not have a program of directing these problems to the labs with the thought that they might pick up ideas which will be helpful, and I am particularly referring to the problem of crime. It seems to me that we just have not directed an endeavor in this direction and that if we did it would be most helpful.

Mr. DADDARIO. Mr. Roush brings up a point I would like to just touch on before turning over to Mr. Mosher.

Dr. Weinberg in his book, "Reflections on Big Science" states: "When a government laboratory finishes a project it cannot ask what are the most important national problems as seen from the widest possible viewpoint to which our talents can be put. Rather, the laboratory must ask, what is the most important problem coming within the purview of our sponsoring agency to which we should next turn."

Would you be fundamentally in disagreement with this quotation from Dr. Weinberg's book?

Dr. HORNIG. No, I wouldn't be in disagreement. It is stated from the advantage point of the director of a strong general purpose laboratory of a very high level of competence which can turn to various problems that it can perform. Whether this particular collection of people should turn to something else or be disbanded is a question that would have to be decided case by case.

Mr. DADDARIO. Then, your recommendation in that regard would seem to follow somewhat the committee's feeling at this point. Although we haven't had an opportunity to examine it in detail, it would appear necessary to classify laboratories and to give wider flexibility and latitude to the directors of some, and to take a harder line on some of the others.

Dr. HORNIG. I think there is no question that there is a great range in the quality and competence both of the laboratories and the directors. There is also a great range in the character of the laboratories, and all of these differences ought to be taken into account by proper technical management.

Mr. DADDARIO. One of the points that we are including within the scope of these hearings is whether highly competent and highly qualified laboratories have the capability to do as much as they are able.

Mr. Mosher?

Mr. MOSHER. No further questions.

Mr. DADDARIO. Dr. Hornig, we still have to hear from Dr. Weinberg. I have a whole series of other questions. I am going to ask you just one and we will send the rest of them to you, if we could.

Dr. HORNIG. That is fine.

Mr. DADDARIO. I know that imposes a burden on you, but we can work it out in a way most suitable to you.

On page 11 you say you know of no current policies or procedures which hinder one agency from using another's capabilities. Aren't you saying that because we have gotten where we are in this whole area as a result of purely happenstance, that somehow it has worked out pretty well, and, therefore, we ought not to change it?

Dr. HORNIG. Not in the least. I know of no formal administrative bars to carrying out the work of one agency in another. It means exactly what it says. It doesn't mean to imply anything further than that.

Mr. DADDARIO. It does not mean that if we were to improve the management set up as it presently exists we would not, in fact, make it easier?

Dr. HORNIG. When I say bar, I mean that there are no rules or regulations, except possibly the ones I mentioned which exist, such as personnel ceiling. The laboratory can't always expand to take a new task at the present time, and there is some question regarding the Economy Act of 1932 which has been interpreted by some—and this is a somewhat open question—to restrict the recipient laboratory from building new facilities to take on the work from someone else. There may be some marginal bars, but I means that the big bar lies in the technical management of the agencies. The big problem is to determine when it is appropriate to use facilities in other agencies—when this is the best procedure as opposed to contracting it out or building a new facility in which the collection of people is particularly adapted to the problem. The procedure of job shopping in the case of a big problem might be a very weak way of doing it. The principal bar and the principal problem is that of the technical management in the agencies.

Mr. DADDARIO. We always make a mistake in not setting aside the whole day of hearings to hear you, and we have in this particular instance, but I appreciate the fact that you have been here. You have already given us a great deal of help and we will call on you again.

Dr. HORNIG. You have a very distinguished list of witnesses who can speak really first hand to many of the problems we have addressed this morning.

Mr. DADDARIO. Thank you ever so much.

QUESTIONS SUBMITTED TO DR. DONALD F. HORNIG BY THE SUBCOMMITTEE ON SCIENCE, RESEARCH, AND DEVELOPMENT

Question 1. To what extent does section 8 of Executive Order 10521 represent the policy of the present Administration with respect to the efficient use of scientific research equipment and facilities held by Federal agencies?

Answer. Section 8 of Executive Order 10521 (March 26, 1954), as amended by Section 6 of E.O. 10807 (March 13, 1959), correctly states the general policy of the present Administration with respect to the efficient use of scientific research equipment and facilities held by Federal agencies. This section reads as follows:

"Sec. 8. To facilitate the efficient use of scientific research equipment and facilities held by Federal agencies: (a) the head of each such agency engaged in scientific research shall, to the extent practicable, encourage and facilitate the sharing with other Federal agencies of major equipment and facilities; and (b) a Federal agency shall procure new major equipment or facilities for scientific research purposes only after taking suitable steps to ascertain that the need cannot be met adequately from existing inventories or facilities of its own or of other agencies."

Question 2. What information about Federal laboratories—including both directly and contractor operated laboratories—is maintained by OST and the Federal Council?

Answer. Neither OST nor FCST maintains information on individual laboratories, just as they do not maintain complete information on research projects or on Federal research funds supplied to individual universities. OST and FCST endeavor (1) to ensure that systems for collecting and analyzing important data exist so that appropriate information will be available to OST and FCST on call, and (2) to promote good administration of laboratories, including efficient use of equipment and facilities.

The National Science Foundation maintains information on Federal research funds, and the Science Information Exchange (SIE) maintains information on research projects in progress. Some of the FCST Committees maintain information on research funds and projects of special interest to them. The Federal Council's Committee on Scientific and Technical Information has worked steadily on the improvement of Government-wide information systems for managers, as well as for bench workers. For example, a 1966 DOD–NASA agreement to use common research project formats for information reporting is being expanded to other agencies as a result of a 1967 FCST agreement, and a contract study is underway to improve agency project reporting activities.

As noted below, the Federal Council is considering the maintenance of an inventory of Federal laboratories and facilities.

The attention given by OST to the question of the efficiency of Federal laboratories has been directed at issues that are considered to be more central than the efficient use of research equipment and facilities, although this element of efficiency is encompassed within the broader questions. The role of Federal laboratories, the criteria for deciding whether work should be done in in-house labs or under contract, personnel policies, adaptation of laboratories to changes in missions, and means of up-grading management capability have been matters of primary concern.

Question 2(a). How does this compare with what you would consider to be the ideal information for fostering full and effective use of government laboratories and their capabilities?

Question 2(b). What guidance has OST or the Federal Council given to agency heads about information they should maintain?

Answer. FCST has instructed its Committee on Federal Laboratories to develop a plan for an inventory of all Federal laboratories, building upon the substantial experience that has accumulated in preparing agency-wide or special purpose inventories. It is not yet clear that the benefits from compiling and publishing an inventory of laboratories will equal the cost of doing it. Accordingly, we expect that any plan approved by the FCST will be on an experimental basis and that the plan will provide for an assessment of the value of the inventory.

Question 2(c). Without information about what work the various Federal laboratories are doing and whether or not they are being used to capacity, is it realistic to say that an agency should make use of existing resources?

Answer. The existing system rests on the assumption that scientists, engineers and research administrators in Federal laboratories are well acquainted with their scientific colleagues in and out of government, and that they have a realistic

idea of their resources and what work they are doing. This assumption is, of course, not entirely true. For this reason, the plan to establish an inventory of Federal laboratories will be put into effect.

Question 3. What consideration has been given to applying the standards and procedures devised for appraisal of contractor research and development performance to government-operated laboratories? To what extent would this be desirable?

Answer. Appraisal of in-house laboratory performance is a normal responsibility of agency management and does not differ in any important way from the appraisal of contractor research and development performance. Procedures in use in the Government for both in-house and contractor R&D appraisal commonly involve such techniques as visits to the laboratory by teams of agency management representatives; evaluation of results by agency management and—especially where more basic research is involved—by outside advisory groups; and continuing reviews of laboratory operations through reports, audits, conferences, day-to-day contacts, and so on. In some cases, development activities lend themselves to controlled scheduling procedures such as PERT, but such control methods are generally not applicable to research near the basic end of the spectrum. Evaluations are necessarily qualitative rather than quantitative to a considerable degree, and involve judgments based on such factors as experience and comparison with good practice elsewhere.

The prime objective is not the application of any specific set of administrative techniques, but the elevation of the quality and efficiency of administration of Federal laboratories totally, including such matters as maintenance of challenging and relevant laboratory missions, elevation of salary scales to attract first class managers, and securing sufficient freedom for laboratory managers.

Question 4. What was the experience of the Federal Council Committee for Long-Range Planning in its attempts to put together a long-range plan for the research and development planned by the various agencies? Are there alternative approaches to this goal of long range planning?

Answer. The answers to these questions have been well stated in a 1967 report, "The Office of Science and Technology" of the Science Policy Research Division of the Legislative Reference Service of the Library of Congress for the Military Operations Subcommittee of the Committee on Government Operations.

"Planning is one of the commonly accepted elements of modern administration. As such, planning has held the attention of the White House Science structure. Long-range planning for research and development has been described by the Federal Council as: * * * the process of identifying the major alternative strategic paths that programs might follow, weighing the technical knowledge and resource commitments required if each alternative path were followed, assessing the full consequences of following each path, assessing the major contingencies that might arise if each path were followed, and making sets of decisions in the light of all of these considerations.[1]

According to the Council, two considerations tend to extend the time scale for Federal long-range planning for research and development. First, the required resources take a long time to create. Second, once created, many of the important resources for science have a long life.

The Committee on Long-Range Planning.—In September 1961 the Federal Council concluded that more systematic, continuing planning was necessary for all the departments and agencies active in research and development. Accordingly it recommended appointment of a Committee on Long-Range Planning. The recommendation was approved and the Committee was established. Its functions are to:[2]

1. Identify and coordinate long-range goals of Federal agencies in science and technology.
2. Foster preparation of an inventory of research resources—manpower and facilities.
3. Project future demands for resources and funding.
4. Develop techniques for Government-wide planning to minimize gaps and redundancies, and to achieve maximum utilization of resources.

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[1] The Role of the Federal Council for Science and Technology: Report for 1963 and 1964. Office of Science & Technology. Washington, U.S. Government Printing Office, 1965, p. 19.

[2] Federal Council for Science and Technology: 1962 Annual Report. Office of Science and Technology. Washington, U.S. Government Printing Office, 1963, p. 12. Departments and agencies represented on the Committee on Long-Range Planning are: Agriculture; Commerce; Defense; Health, Education, and Welfare; Interior; and the Atomic Energy Commission; the Federal Aviation Agency; the National Aeronautics and Space Administration; the National Science Foundation. The Bureau of the Budget may observe its meetings.

5. Formulate recommendations for program emphasis and allocation of resources.

6. Function as a clearinghouse of information on planning techniques, to aid departments and agencies in formulating their individual plans and programs.

The first chairman of this Committee was Dr. Harvey Brooks, the only chairman of a Federal Council Committee who was not a Federal official. The Committee's actiivties were described in the Federal Council's reports for 1962 and for 1963–64. The draft FCST report for 1965 does not mention the Committee at all. According to the Office of the Federal Council's secretary, this Committee is presently inactive.

The Interdepartmental Study of Long-Range Planning.—One early undertaking of the Committee on Long-Range Planning was to begin a survey to develop a projection through 1970 of research and development plans and requirements of the Federal agencies. Working with the Science Resources Planning Office of the NSF, data was to be sought for funds, facilities, and technical manpower requirements.

The Federal Council described preparations for this report as follows:

With due consideration for practicability of data solicitation, definitions were formulated and categories selected for in-house versus out-of-house; basic versus applied research and develpment; of different fields and subfields of science and of objects of science (missions). Assumptions which underlie planning and constraints imposed by agency, departmental, executive, and legislative branches are also being studied.

A series of briefings have begun by representatives of individual agencies to share their experience in planning policies and practices.[3]

The study, however, was not published by the Federal Council, which gave the following reasons:

1. It was difficult to secure from all agencies usable assessments of basic goals, issues and alternatives because some were more immersed in looking ahead and had a more favorable attitude toward long-range planning than others.

2. The initial approach had centered upon one dimension of planning—resource use as measured by money and manpower, and had placed less stress upon matters of vital practical significance, such as identification of goals, and alterantive paths of program development.

3. Attention and resources directed to future consequences of current decisions, and their implications, were not fully adequate at all points of the Government. Here the report specifically said that the OST did not have the staff resources required to keep attention centered on the major goals of the study, and that the National Science Foundation was not adequately equipped to guide the study toward exploration of policy issues.

4. Finally, it had proven impossible in this first effort to add the data from the agencies together for the Federal Government as a whole in a meaningful way.[4]

Looking at this experience, the Federal Council observed that planning must proceed simultaneously in a number of largely autonomous spheres, which had important implications for planning process, for there could be no such thing as "the plan."

* * * there can under such a concept be no thing as "the plan," just as there is no simple, single national science policy. There are many plans, each representing a valid way of looking at science and technology. This characteristic of planning process is consistent with our pluralistic approach to the definition and resolution of important public matters. Pluralism allows wide participation and the stressing of various kinds of legitimate goals. This sort of process is a familiar one in political affairs, and it makes planning for science consistent with our fundamental traditions.[5]

The Councils conclusion was that such developments as the experience of the Committee on Long-Range Planning had led to concepts and methods of long-range planning for science which are more realistic and more complex than those of a few years ago. Future activities of the Federal Council related to long-range planning will reflect experience accumulated by all of these groups.

The OST and Long-Range Planning.—Statements by the OST have shown its interest in long-range planning for research and development. Its budget state-

[3] Federal Council for Science and Technology; 1962 Annual Report, op. cit., p. 13.
[4] The Role of the Federal Council for Science and Technology: Report for 1963 and 1964, op. cit., p. 20.
[5] Ibid., p. 22.

ments for fiscal years 1964 and 1965 highlighted the planning function. For fiscal year 1965, OST said it was "spearheading an effort to rationalize long-range planning of Federal research and development." OST said it was working closely with the Bureau of the Budget and the planning staff of the National Science Foundation, but did not mention the Federal Council's Committee on Long-Range Planning. OST's expectations indicated an optimistic outlook for long-range planning in 1964:

We expect to identify more clearly the aggregate requirements for Federal funds and for skilled manpower; to determine future commitments to support major research and development facilities; to visualize the implications of concentration or diffusion of effort between scientific fields and between institutions, where the impact of support from a number of separate agencies may be quite different from that determined on an agency-by-agency basis. Such long-range planning should also make it possible to identify unwitting duplication in the planning of new research facilities and to illuminate gaps in programs which inadvertently occur when one agency is of the belief that another has assumed program responsibility.[6]

But by 1966 Dr. Hornig apparently had changed his views. In testimony early in 1966 to the Research and Technical Programs Subcommittee of the House Government Operations Committee, he said:

I do not believe that any single mechanism within the Executive Office of the President, for example, or even within the office of the head of each department and agency, could be relied upon to blueprint the nature of research and development to satisfy our needs.[7]

In answer to a question, he elaborated further, saying:

I do not think a single planning mechanism—I have watched attempts—is capable of introducing enough ideas to make the system good. I do not believe the blueprinting process from the top is the best method.

What we try to do, therefore, is collect and put together ideas from outside the Government and from within the Government and develop programs. That I think is a proper central function.[8]

Question: 5. What past or present studies sponsored by the Federal Government are providing information about factors that determine the "critical size" for a given laboratory? Are any future studies planned?

Answer: There have been no formal studies of what consitutes a "critical size" for a Federal laboratory. The critical size would vary widely depending on the purpose and function of the individual laboratory concerned. The Defense Science Board, for example, has judged that 1,000 or more professional scientists and engineers would constitute a critical mass in a "weapon-center" laboratory; one can visualize other situations where a number smaller than 10 might be sufficient. This is properly a matter for judgment by the technical managers of each agency. Studies and discussion of what constitutes a "critical size" under varying circumstances might be helpful, but no specific studies are planned by OST at present.

Question: 6(a). What has been done to implement the Bell Report recommendation that "arrangements should be made to call on Government laboratory and development center personnel to a larger extent for technical advice and participation in broad program and management decisions—in contract to the predominant use of outside advisors."

Answer: I agree wholeheartedly that Government laboratory personnel should be called upon for advice and should participate in broad program and management decisions. At the same time, of course, there remains a strong need to provide continuously to the system the breadth, freshness of viewpoint and independence which is obtained only from outside advisers.

A number of agencies have taken steps since publication of the Bell report to increase participation in management decisions by their laboratory directors. I would refer you, for example, to the testimony by the Defense Department, which discussed the establishment in the Armed Services of new overall management positions responsible for the effective management of the laboratories, and of the improvements in communication with the laboratories this is helping to provide. Groups of laboratory directors meet regularly with these top technical managers to discuss requirements and capabilities, and to exchange views with

[6] "Independent Offices Appropriations for Fiscal Year 1965." Hearings before a subcommittee of the House Committee on Appropriations, 88th Cong., 2d sess., 1964, p. 903.
[7] "The Federal Research and Development Programs: The Decisionmaking Process," op. cit., p. 8.
[8] Ibid., p. 9.

users. Other agencies such as the Commerce Department have established Assistant Secretaries for research and development in recent years, who as a general rule meet frequently with directors of the laboratories for which they are responsible.

The Committee on Federal Laboratories of FCST has sponsored a series of important seminars in which the major participants have been laboratory managers. Major topics have included (1) how to create and sustain an environment for creativity in Federal laboratories and (2) administration of personnel ceilings. In the fall of 1968, Federal laboratory managers will meet with representatives of universities to discuss the educational role of Federal laboratories.

Question 6(b)–(c). How many laboratory directors are now members of PSAC and its established panels? How many are OST consultants?

Answer: One of the present members of PSAC is Dr. Lewis Branscomb, Director of the Joint Institute for Laboratory Astrophysics of the National Bureau of Standards. Several past members of PSAC have served, prior to their terms on PSAC, as Federal laboratory directors or as Federal technical program managers.

Federal laboratory directors occasionally serve as active OST or PSAC panel members, but much more frequently are called upon for advice or assistance on an ad hoc basis. For example, Drs. Astin and McLean who appeared at the recent hearings of the Subcommittee on Science, Research and Development, have served actively in the past on panels and as consultants, and my office continues to seek their advice on a variety of matters as the need arises. Dr. McLean is currently a members of a PSAC panel studying certain military technology. This of course is in addition to the extensive involvement of Federal laboratory directors and research managers in the work of the many committees of the Federal Council for Science and Technology, which itself is an adjunct of the OST structure.

Question 7. Do you agree with Dr. Astin's statement about the essential importance of a laboratory directors' council, and if so, what steps are being taken to form a laboratory directors' council at the OST level? Would it include directors of contractor operated laboratories?

Answer: Dr. Astin has assured me that his comment regarding the usefulness of councils of laboratory directors was intended to apply to the departmental level. OST does not now have a laboratory directors' council, and has no present plans to establish one. The Committee on Federal Laboratories of the Federal Council for Science and Technology, under Dr. Astin's chairmanship, is making a very effective contribution in my opinion to bringing together the best judgments of the Federal agencies on how to improve laboratory management and utilization. Membership of this Committee is as follows:

COMMITTEE ON FEDERAL LABORATORIES

Chairman

Dr. Allen V. Astin, Director, Administration Building, National Bureau of Standards.

Members

Edward M. Glass, Assistant Director (Laboratory Management), O.D.R.&E., the Pentagon.

Dr. George W. Irving, Jr., Administrator, Agricultural Research Service.

Dr. Robert W. Berliner, Director of Laboratories and Clinics, National Institutes of Health, Bethesda, Maryland.

Executive Secretary

George E. Auman, Assistant to the Director, Administration Building, National Bureau of Standards.

Alternates (A) and/or Staff Assistants (S)

Evan Anderson, Staff Assistant, Office of Assistant Director (Laboratory Management), O.D.D.R.&E., the Pentagon.

Dr. Robert J. Anderson, Associate Administrator, Agricultural Research Service.

Dr. Steven C. King, Assistant Director, Animal Husbandry Research Division, Agricultural Research Center, Beltsville, Maryland.

Dr. Seymour J. Kreshover, Director, Institute of Dental Research, National Institutes of Health, Bethesda, Maryland.

James H. Noone, Personnel Management Specialist, National Institutes of Health, Bethesda, Maryland.

John M. Sangster, Chief of Personnel, National Institutes of Health, Bethesda, Maryland.

Dr. Allen O. Gamble, Chief, Manpower Planning and Studies Section, Resources and Analysis Branch, National Institutes of Health, Bethesda, Maryland.

Members

Boyd C. Myers, II, Deputy Associate Administrator for Advanced Research & Technology (Operation), NASA Headquarters.

Dr. William T. Pecora, Director, U.S. Geological Survey.

Dr. S. Dillon Ripley II, Secretary, Smithsonian Institution.

Harold H. Leich, Chief, Policy Development Division, Civil Service Commission.

J. Lee Westrate, Management Analyst, Office of Management & Organization.

Alternates (A) and/or Staff Assistants (S)

Grove Webster, Director, Personnel Division, Office of Administration, NASA Headquarters.

Dr. William Thurston, Assistant to the Science Adviser, Office of the Secretary Interior Department.

Leonard Pouliot, Director of Personnel, Smithsonian Institution.

Dr. Philip G. Ritterbush, Assistant to the Secretary, Smithsonian Institution.

Observers

Dr. Sidney G. Reed, Jr., Head, Office of Planning and Policy Studies, National Science Foundation.

Question 8(a). Would you please describe what OST has done to make sure that the facilities which the Government has are used to their fullest extent, and what direction it has provided to bring the needs of technical managers and laboratory directors together?

Answer: Through studies such as the one on Federal laboratories conducted under PSAC sponsorship by a panel chaired by Dr. E. R. Piore, my office has examined the question of improving the effectiveness of Government laboratories and has discussed its findings with the agencies. Members of my staff, who are in close touch with the agencies, are continuously concerned with effective use of these facilities, and the Federal Council provides a continuing forum for discussion. The Budget Bureau is of course much involved in these questions as well.

The question of bringing together the needs of laboratory directors and technical managers remains fundamentally a responsibility of the agencies and departments. OST can encourage the establishment of mechanisms for doing this, as indicated in the answer to question 6(a).

Question 8(b). Is it a fair statement to say that the Federal Council's Laboratory Committee looks more to the internal management and operation of laboratories than to questions of duplication of work by different laboratories?

Answer: This statement is essentially correct. We do not believe the problem of duplication of work is a serious one. When it does come up, however, we take steps in cooperation with the Bureau of the Budget to eliminate it.

Question 8(c). Would a laboratroy management office at the OST level, with functions comparable to those of the Office of the Assistant Director for Laboratory Management of DOD, be a constructive addition?

Answer: In view of the primary function of my office to advise and assist the President, it would seem inappropriate to establish an activity in this setting which would have a management function analogous to the DOD Assistant Director for Laboratory Management. Establishment of a separate office for this purpose at the Presidential level seem to me to be out of proportion to the size and nature of the problem. I am continuing to examine the question of whether the existing OST–BOB and Federal Council machinery can be strengthened to accomplish the essential functions you have in mind.

Question 9(a). Of the over 100 laboratories of substantial size in the Federal establishment which you mentioned, in how many do you estimate the laboratory director has discretionary funds? What do you estimate is the average amount of these funds as a percentage of the laboratory's budget?

Answer: The diversity and nature of agency practices makes this a difficult question to answer with any certainty, but I would estimate on the basis of discussion with the major R&D agencies that directors of perhaps 75–80 percent

of the larger laboratories have either earmarked "discretionary funds" or have internal reprogramming authority which in effect gives them significant latitude to take initiatives.

Reprogramming authority is theoretically quite extensive in some cases. The "real" flexibility available to these laboratory directors probably averages in the range of 5–10 percent of their total budgets for in-house work.

The Defense Department, for example, operates somewhat more than half of the Federal laboratories. It provides earmarked discretionary funds to its laboratory directors ranging from 0% to perhaps 8% of in-house budgets, depending on negotiations between the directors and the Assistant Secretaries for Research and Development in the three Services. The laboratories performing research of a more basic character generally have smaller earmarked discretionary funds—the Naval Research Laboratory has none, for example—but provide relatively wide latitude to the director in program determination.

Question 9(b)–(c). Do any directors of contractor operated laboratories now have discretionary funds? Is the same reasoning regarding discretionary funds for the directors of Government operated laboratories applicable also to contractor operated laboratories?

Answer. I believe that the same general reasoning applies to both. Flexibility is provided in principle to the directors of many contractor operated laboratories (1) through provision for independent R&D as an allowable cost under the contract, (2) through the fee paid to the contractor—part of which can in some cases be used for independent research and development—or (3) through the management practices of the agency, which permit some internal shifting of funds at the director's discretion.

Question 10. What is your reaction to the DOD proposal to eliminate manpower controls on cross-agency work to achieve flexibility similar to that available to the AEC contract laboratories? If you agree, what action do you propose to take? If you do not agree, what is the basis for your position?

Answer. In general, I believe that laboratory directors can be most effective when they have reasonably wide latitude in internal allocation of financial resources made available to them. When controls or manpower or other resources are superimposed on dollar limitations, the effect tends to circumscribe the director's flexibility in ways which in some cases may be undesirable. Under the present system, manpower controls are applied by the Budget Bureau to entire agencies or departments, which must then reallocate these controls internally. Although this system theoretically provides internal flexibility within which an agency might be expected to meet newly arising needs for cross-agency work, the agencies have indicated that this flexibility is difficult to preserve in practice. I endorse the DOD proposal as an ideal solution, but recognize that we can not consider it seriously under the new restrictions on Federal employment. If future circumstances permit relaxation of the overall limitations, we will work with the BOB to see whether the DOD proposal can be adopted.

Mr. DADDARIO. Dr. Weinberg, do you have others with you whom you would like to sit at the table?

Dr. WEINBERG. No, just myself.

Mr. DADDARIO. You have come alone?

Dr. WEINBERG. Yes, sir.

Mr. DADDARIO. We are happy to have you.

Dr. WEINBERG. It is a pleasure to be with you here to talk to you on a question that has concerned me for many years.

STATEMENT OF DR. ALVIN M. WEINBERG, DIRECTOR, OAK RIDGE NATIONAL LABORATORY

Dr. WEINBERG. In spite of much talk about the necessity of redeploying Federal laboratories, I shall begin my testimony with an admonition against premature redeployment. There are many urgent problems of the Federal Government to which large Federal establishments have devoted themselves for a long time. But simply because the problems are difficult, and progress is slow, does not mean that the

instrumentalities devoted to these problems ought to be scrapped and the problems forgotten. I want to warn most earnestly against redeploying a laboratory before the problem around which the laboratory was originally mobilized has been resolved. You notice I don't use the word "solve", but "resolve".

I dwell on this point because in so many of the discussions of redeployment the atomic energy laboratories are given as examples of establishments that have worked themselves "out of a job." In point of fact, nuclear energy development is entering a completely new and unprecedentedly hopeful era: The development of the really economical breeder reactor. Until this goal has been reached, nuclear energy has not achieved its goal, nor has the nuclear research community come close to working itself out of a job. The cheap breeder reactor represents a permanent solution to the world's energy problem. Insofar as a cheap, ubiquitous, and inexhaustible source of energy can serve to extend mankind's natural resources indefinitely, it is clear that the achievement of this goal is one of the most important long-term jobs of our society. Any talk of dismantling or massively redeploying the Government laboratories responsibile for getting on with this job is, in my opinion, irresponsible and mischievous.

Mr. DADDARIO. I hope that is not a charge.

Dr. WEINBERG. No, I didn't have any Members of Congress in mind when I wrote that. It is rather some speeches I have heard recently by people other than Congressmen.

Having made this disclaimer, I shall describe the way in which the Oak Ridge National Laboratory has partially redeployed into several new areas, and I shall try to draw some general conclusions from our experiences in redeployment. I am submitting for the record a short history of ORNL, but in this statement I shall refer only to those aspects of our history that are relevant to the matter of redeployment.

In 1955 I wrote an article, "Future Aims of Large Scale Research," in which I pointed out that the job of creating a new energy source from fission, though very difficult, was finite. Eventually the laboratories concerned with fission reactor development would no longer be so centrally occupied with this job, although, as I have already said, this time has not yet really come. In line with this sort of speculation we organized a series of "advanced technology seminars" at the Oak Ridge National Laboratory in 1961. At these seminars we examined a number of large-scale technological problems, generally those having important social implications. The subjects treated at these seminars included desalting the sea, atmospheric pollution, carcinogenesis, civil defense, liquefaction of coal, and space technology. As matters turned out, we have in the ensuing 7 or so years become involved in a major way with desalting, civil defense, and carcinogenesis. I shall described how we became involved in each of these activities, and what our experience has been.

Desalting the Sea.—Our involvement with desalting the sea had two separate origins. On the one hand, several of our solution chemists who had worked on the original development of plutonium chemistry during the Manhattan project were intrigued by the physical chemistry of desalting, a topic we discussed in our advanced technology seminars. At that time I was a member of the President's Science

Advisory Committee, and I was in close contact with the President's Science Adviser, George B. Kistiakowsky, and Roger Revelle, Science Adviser to the Secretary of the Interior. Encouraged by both Drs. Kistiakowsky and Revelle, we held conversations with the Atomic Energy Commission and the Department of the Interior about Oak Ridge working in this field. The two congressional committees involved—the Joint Committee on Atomic Energy and the House Committee on Interior and Insular Affairs—became interested in the possibility of Oak Ridge participating in this work. A rather formal agreement was executed between the two Government departments, and the agreement was officially sanctioned by the corresponding committees, setting ORNL up as a desalting laboratory for the Department of the Interior, but still operated as a contractor establishment of the AEC. The program, headed by Dr. K. A. Kraus, has involved about 20 chemists and engineers, and has been largely concerned with the physical chemistry of reverse osmosis. The budget for the work runs around $600,000 per year. In the 6 years since the work started, some very striking findings have been made, the most important being the discovery of "dynamic" membranes that have much higher capacities than any previous reverse osmosis membranes.

The second thread in the ORNL desalting story began in 1961 when Dr. R. P. Hammond of Los Alamos pointed out in a lecture at ORNL that heat from nuclear reactors could be used to desalt the sea economically if the whole process, including evaporation, were performed on a large enough scale. Though greeted at first with skepticism, we at ORNL finally were persuaded that Hammond was basically correct. These exciting findings were conveyed to Dr. Jerome B. Wiesner, the President's Science Adviser, to the AEC, and to the Office of Saline Water. A committee under Roger Revelle was formed to investigate the validity of these claims; the committee in the main substantiated these claims and as a consequence the AEC and the Department of the Interior expanded their programs in nuclear desalting. By this time Hammond had moved to Oak Ridge and, since ORNL was the Laboratory most interested in desalting, it was natural that the responsibility for research and development in nuclear desalting should devolve on the Oak Ridge National Laboratory.

At present we have about 90 scientists and technicians working on all phases of desalting, both its nuclear and nonnuclear aspects. The total budget for these activities is around $3.6 million per year, of which $2.2 million comes from the Department of the Interior, $1.4 million from the AEC. This makes ORNL one of the larger, if not the largest, desalting laboratories in the world. However, this represents only about 4 percent of the entire operating budget of the Laboratory.

Civil Defense.—In 1962 the distinguished Nobel laureate, Eugene P. Wigner, became deeply concerned about the state of civil defense in the United States. Largely under his urging, the National Academy of Sciences sponsored a summer study, Project Harbor, which tried to assess our knowledge of civil defense. One of the recommendations of Project Harbor was that one or several laboratories be set up to study civil defense in a coherent, integrated way.

Participating in Project Harbor were several Oak Ridgers. Moreover, Eugene Wigner, who was the guiding spirit of the effort, was a

former Research Director of ORNL. It was therefore natural that ORNL be put forward as a possible site for one of the civil defense laboratories proposed by Project Harbor. This idea met with the approval of both the AEC, which has some statutory responsibility in civil defense, and the Department of Defense, and a civil defense project was established at ORNL in 1964. The project has been rather small—about 20 engineers, natural scientists, and social scientists—and its total budget is around $730,000 of which DOD (OCD and ARPA) contributes $580,000, AEC $150,000. Though the group is small, it is one of the few groups that looks at the problem of civil defense from a global, coherent viewpoint. It therefore probably has had more influence on our country's civil defense policies than its small size would suggest.

Co-carcinogenesis and other Involvements with NIH.—ORNL has always been extremely strong in the biological sciences: the largest single division at the laboratory (450 scientists and technicians) is the biology division. The laboratory has always been concerned with the genetic and somatic effects of radiation. Since radiation is only one of the many physical insults to the biosphere, it seemed natural to many of us at ORNL (and this came out of one of our advanced technology seminars) to see whether we could contribute to resolving biological problems caused by environmental contaminants other than radiation. Our interest came to a head at about the same time the Government began to take a serious interest in the "Rachel Carson" problem, as I like to call it, which is the growing deterioration of our biological environment as a result of the spread of chemical agents of one sort or another.

These concerns led to conversations with the National Institutes of Health, particularly with the National Cancer Institute, and a joint ORNL–NCI program aimed at elucidating the synergistic action of radiation and chemicals in inducing cancer was set up. At present this co-carcinogenesis program runs at about $2 million per year.

Another important involvement with NIH came about through our development of the zonal centrifuge, an outgrowth of the centrifuges developed for uranium isotope separation. In this case, Dr. Norman Anderson saw the usefulness of these devices for separating biological moieties of various sorts. This was a matter of obvious interest to NIH as well as to AEC, and a joint program to develop zonal centrifuges for biomedical use was undertaken. The program has been a success: this past year ORNL zonal centrifuges have been used to purify flu vaccine for human use, and it is likely that, before too long, many vaccines will be routinely processed by means of ORNL–NIH developed zonal centrifuges.

We find ourselves being further drawn into work of interest to, and supported by, NIH: bioengineering, automation of clinical chemistry, and large-scale separation of transfer RNA's. In most of these cases the unique characteristic of ORNL—a mission-oriented, interdisciplinary institution in which strong biology and strong engineering coexist—seems to be a strong attractant for NIH. At present ORNL spends $4,500,000 per year for biomedical research sponsored by NIH.

Other Involvements.—ORNL also does work for NASA and various defense agencies. The total of all non-AEC work comes to

about $12 million per year, which represents about 13 percent of ORNL's total operating budget.

As things are now going, we may find ourselves drawn ever further into matters that grow naturally from what we already do. For example, civil defense, with its requirement for dual-purpose tunnel shelters, inevitably impinges on the whole question of the basic structure of the city. Thus to do civil defense properly, we become involved in the city itself; and HUD is interested in involving our civil defense staff in some of its research.

Or from our interest in desalting, we are drawn to the fascinating question first of desalted water for agriculture, and then to the possibility of agro-industrial complexes in desert areas as an instrument of international development. Here we become involved, very naturally, and almost inevitably, in dry-land agriculture and irrigation; hence, our involvement with the Department of Agriculture and the Bureau of Reclamation, foreign aid agencies, and possibly those agencies concerned with natural resources, since cheap power can be used to extend our resources.

Or again, from our interest in radiation ecology, co-carcinogenesis, and analytical chemistry, we find ourselves drawn toward the general question of pollution, and particularly the matter of eutrophication of fresh waters. In this we are being encouraged by the Joint Committee, and also by the recent amendment to the Atomic Energy Act of 1954 that directs AEC laboratories to participate, under proper circumstances, in research aimed at promoting public safety and health.

General Observations.—What general lessons do I draw from our experience at Oak Ridge in partial redeployment? Perhaps the most important is that successful redeployment is possible, but only if the redeployment flows naturally from the interest and capability of the laboratory itself. We discussed desalting for more than 2 years before we took the plunge; during that time many of our people acquired familiarity with the issues. I like to use the phrase, "Successful redeployment must be done adiabatically"—that is, gradually, so that the redeployment activities are natural extensions of the old ones.

The big mission-oriented Government laboratories are to my mind uniquely useful and powerful instrumentalities for helping to solve difficult sociotechnological problems. Perhaps the most important advantage that these mission-oriented, interdisciplinary laboratories afford is their ability to impose a reintegration on the fragmented research that is inherent in the splinter organization of the Federal Government.

Mr. DADDARIO. You would then somewhat support the Bell Committee's recommendation of such an institute?

Dr. WEINBERG. I think I would support that in the long run, but I agree with Dr. Hornig's view that gradually giving Government agency laboratories much more of the flavor of Government laboratories is the proper direction to move at the present time.

Whether we should eventually seek some Federal policies that officially deals with redeployment that now seems to happen rather naturally, I can't say at present. At any rate, I agree with Dr. Hornig that the time is not yet ripe to make a general Federal policy on the matter as was envisaged in the Bell report.

Mr. DADDARIO. You already have given some examples of how your laboratory gradually developed other activities to the point where now some 13 percent of the funds you expend come from other agencies.

Dr. WEINBERG. Right.

Mr. DADDARIO. Notwithstanding that, you then said you agreed with Dr. Hornig that we ought not to be rushing into this. This subcommittee is particularly concerned about taking advantage of what we have learned, and I would think that we ought to make this gradual development a little more accelerated. I guess our argument here would be a matter of speed.

Dr. WEINBERG. Yes.

I guess I am not prepared at this stage to say that we should have a GSA for the general laboratories. It is to this extent that I disagree with the Bell report.

On the other hand, I agree with you fully, Mr. Daddario, that giving the agencies a Government-wide flavor is a good thing, and I think it can be done in the way that we have been doing it at Oak Ridge.

Mr. DADDARIO. At this stage I do not believe I would be in favor of a GSA-type program, either. But that is not to say that I believe that because various agencies of Government or even various committees of the Congress have jurisdiction over certain areas that it ought to be that way and we ought not to recognize these as to what they are and then break them down. It would follow more logically from one type of laboratory to another if these inhibiting barriers can be removed.

Dr. WEINBERG. I agree

Take civil defense, for example. The Federal Government supports some 200 separate contracts, but where can one go for a "coherent doctrine" with respect to civil defense? The interdisciplinary "projectism" that characterizes research in the national laboratories can impose a much-desired coherence on the research of the Federal Government. The crossing of agency lines implies a reintegration at the working level that can counteract the inevitable fragmentation caused by the structure of our Government. Problems transcend agencies. Only when problems are dealt with as a whole, as is possible in the big laboratories, do they get solved as a whole. Desalting requires the technology of evaporators and the technology of energy sources; in a laboratory these two can be reintegrated, even though in the Government they are fragmented, the one being the concern of the OSW, the other of the AEC.

I am convinced that the key to the responsible redeployment of the big laboratories is the role and attitude of the top management. I believe that the redeployment will be successful and in the national interest if the laboratory director himself views very broadly his responsibilities in a way that transcends the confines of his own supporting agency, and if he is aware of and sensitive to the national interest. It is on this account that I have strongly recommended that directors of big interdisciplinary Government or captive laboratories be brought into the highest levels of Government science policy. I would recommend that PSAC, for instance, always have at least one laboratory director on it. I must say that I have always valued my own term on PSAC not so much for what I contributed, but rather for the breadth of understanding that my tenure gave me, a breadth that has proved invaluable in the current redeployment of ORNL.

How can the crossing of agency lines be made smoother? Our experience at ORNL suggests that though the initial stages are sometimes rough, smooth relations can be worked out. As to the question of when a laboratory ought to become involved in something outside its own agency, I think this is judged best from within the laboratory, particularly by the laboratory director, in cooperation with the laboratory's main supporting agency.

The redeployment can run into difficulty if there is no fiscal "flywheel" to smooth out fluctuations in funding. Our Laboratory is an arm of the AEC; we, therefore, have enough flexibility in shifting funds between AEC programs to shield our scientists from drastic fiscal fluctuations. Without such flexibility on how to use social scientists effectively, I think that we begin to see a pattern of mutual interaction at our institution that might eventually serve as a pattern for how National Socio-Technical Institutes of the future should operate.

Thank you, Mr. Daddario.

Mr. DADDARIO. Thank you, Dr. Weinberg.

When you talk about this fiscal flywheel as means of exploring new ideas, do you mean to put it all together? Wouldn't you run into a problem there of giving the other agencies who have assigned work to you an understanding that they need not be as efficient as they ought to be in paying and as a result you would not have sufficient funds?

Dr. WEINBERG. We would hope that the other agencies, if they are satisfied with what the Laboratory is doing, would deal with us in much the same way as our parent agency does.

The fiscal flywheel I have in mind here is partly to eliminate this redtape problem which has beset us and partly to take account of the fact that the fiscal year for some agencies seems to go a little differently than the fiscal year for other agencies; and perhaps most important is the matter of having the option of using this money to get completely new things started.

Mr. DADDARIO. That really is the point to which I am referring.

Dr. WEINBERG. Yes.

Mr. DADDARIO. If you could separate out this redtape situation from the good-idea area, how much or what percentage are you thinking about?

Dr. WEINBERG. This depends really on the size of the laboratory. A laboratory as large as the Oak Ridge National Laboratory would be in very good shape in this respect if the laboratory director had an overhead account of, say, 4 percent.

Now, the money presumably would be used when a real hot idea comes up. The director would not, of course, use very much of his "kitty" without informing his sponsoring agency, but I would think that there would be enough give and take in the situation so that the sponsoring agency, if it has confidence in the director, would give him some leeway in using these funds. As Dr. Hornig said, some of the best ideas are the bootlegged ideas.

The way Harvey Brooks puts it is very good. It should always be possible to bootleg work in one of these laboratories, but it shouldn't be too easy to bootleg; and having a 4-percent overhead which is part of the laboratory's property strikes me as being about the right sort of thing.

Mr. DADDARIO. How much would that all amount to, what you are bootlegging and the 4 percent you will get?

Dr. WEINBERG. We have a director's account in our Laboratory which is rather a private matter.

Mr. DADDARIO. Just tell me privately.

Dr. WEINBERG. About one and a half percent, but it really isn't all that much that is within the control of the laboratory director. The AEC feels this is a very real problem and would like to do something about giving the Director additional leeway. The Commission feels that it is constrained because of the way the money is appropriated. Congress puts labels on its money and is very uncomfortable if money that is appropriated for something is used elsewhere.

I can understand the concern from the point of view of the Joint Committee, but I really think the laboratories should say, well, there is a certain cost of doing business at our laboratory and that cost is the director's kitty.

Mr. DADDARIO. What would it do to the quality of your laboratory if you were able to have such a fund?

Dr. WEINBERG. After the very kind things that Dr. Hornig said about me and Oak Ridge National Laboratory, I couldn't say anything but that it would remains as good as it is.

Mr. DADDARIO. Anything can be improved.

Dr. WEINBERG. But I would say that I think this more than any other single thing would give to the Laboratory a kind of flexibility and flare that really would make a very great difference.

Mr. DADDARIO. I recognize that there are problems here and that there must be some judgment as to how it ought to be done and with whom. It does appear, however, that for a relatively small percentage of the total funds expended that the quality of effort could be raised considerably.

Dr. WEINBERG. I agree completely, and if the Subcommittee on Science, Research, and Development can somehow put this across, I would say that it would be doing the Federal research picture a very great service.

Mr. DADDARIO. Dr. Weinberg, you talked about this irresponsible and mischievous redeployment with which I would agree and——

Dr. WEINBERG. I speak of massive redeployment there.

Mr. DADDARIO. Yes. I would not feel that there is support for the idea that the AEC laboratories are working themselves out of a job.

You talk about the tremendous hope that you have for the new breeder reactors and the effect it would have on our resources generally.

Then you look to the future and visualize the place of your laboratory. I would agree that this would be a proper and logical development, yet it will not come about unless we pay some attention to it now. What guidance can you give us as to whether you expect this to occur and in what way you conceive it coming about?

Dr. WEINBERG. Let me say that at the Oak Ridge National Laboratory we already have started co-opting social scientists. We have about five social scientists who work full time. These are mainly connected with the work on civil defense, but this summer we had chemists, agronomists, and sociologists, working with us on developing this new agro-industrial complex for desert areas. You ask how I visualize our acquiring a "social" floor; I think it will follow rather naturally from our involvement in problems that obviously have stronger social components.

If civil defense ever becomes a serious question in the United States, or if our involvement in civil defense really does develop into concern with urban development, then it is inevitable that we shall have to bring in additional social scientists. In general, the proper word is "gradualism." We seek salients where we can make important contributions. We move in those salients when they coincide with obvious national necessities; where these salients do have social components, we draw in the social scientists as we need them.

I don't visualize the Laboratory simply saying, "We will, whole hog, establish a department of social science," without having some rather definite job for the social scientists.

Mr. DADDARIO. But as this gradual redeployment activity takes place, you find other areas of activity coming before you. Unless competent people can be assigned to these projects, they will flounder and cannot be taken advantage of. Do you see this as a need for you to have such a flexibility?

Dr. WEINBERG. I think it is. I guess we have moved in this direction perhaps more strongly than most of the AEC laboratories; about 13 percent of the Laboratory is redeployed in areas some of which have strong social implications. The question of how much further and how much faster we should move is something that is under active discussion at our Laboratory, and I guess I am not prepared to say how much further and how much faster we should move.

Mr. DADDARIO. You could not have arrived at the point where you are now in this redeployment unless you had been able to make arrangements to transfer personnel or if you had personnel ceilings.

Dr. WEINBERG. We operate our Laboratory by contract, so we don't have a personnel ceiling; this actually is one of the advantages, in this redeployment business, of dealing with contractor laboratories because they have dollar ceilings rather than personnel ceilings, as the civil service laboratories do.

However, we generally have obtained personnel for new projects by taking them away from things that in our judgment and the judgment of the Atomic Energy Commission were less important, and putting them to work on those things which we thought to be most fruitful and with which the Commission seemed to agree.

The 90 people on desalting were taken from predominantly AEC jobs, but the AEC contributes about half of desalting support. Of the 20 who are working on civil defense, about half had been working on other jobs. The chap who is in charge of Civil Defense at ORNL, Dr. J. C. Bresee is a very able chemical engineer who became interested in civil defense.

Mr. DADDARIO. Isn't this one of the important objectives we ought to have, people who have been working in one field who have a flare or have developed a capability of applying knowledge?

Dr. WEINBERG. Very much so.

I must say I don't know if this is entirely relevant to the question here, but this assumption that out of social science as we now know it will come the solutions or resolution of problems—this is on the whole a vast and unprovable assumption. It may be what we need is a completely new breed of social engineers or possibly hard engineers who learn something about social science. I think that what the social scientists supply to the solution of problems which have a technolog-

ical component is not so much their expertise and method as it is their perspective. They know what the problem is. They have read widely on the historical and social factors involved. Designing a social system isn't like designing a desalting plant, but a desalting plant can be an economic base around which a changed approach to an unsatisfactory social system can be organized. It is much more tricky and difficult to help correct a social ill. But to me it seems reasonable to have emerge what might be called sociotechnical institutes which would result from the redeployment of the present mission-oriented laboratories. Well, we don't have a book that says this actually can be done, but we should try as best we can.

Mr. DADDARIO. What you are doing is developing an environment in which the engineers can work together and get to understand each other. They will be talking to each other about the same problems and have their ideas rub off on one another, and this is certainly a lot better than it has been.

Dr. WEINBERG. I agree, and therefore I consider this idea of National Sociotechnical Institutes as sort of the paradigm for the Federal Research Institute of the coming generation.

I take this thought quite seriously. Support for it comes from both sides. On the one hand you see the hardware people like we are reaching out toward social science people.

On the other hand, you also see the think tanks, which are predominantly social, reaching toward hardware solutions. We have had a variety of conversations with think tankers about the possibility of having them supply some of the social science expertise that we might need.

Mr. DADDARIO. We ought to get them out of the tank.

Dr. WEINBERG. Yes.

Mr. DADDARIO. That is a boxing expression; not a very nice one.

But at any rate, Dr. Weinberg, we have reached the point where this first day's session must close.

I certainly appreciate your coming here and I do think you have given us some advice that will be helpful in the formulation of certain of our objectives and guidelines, and the criteria through which these objectives can be obtained. The committee appreciates your presence.

(The following is a brief history of the Oak Ridge National Laboratory:)

A BRIEF HISTORY OF THE OAK RIDGE NATIONAL LABORATORY

In the war years of 1940, 1941, and 1942 there emerged in the United States several physical research groups whose aim was centered on the exploration of techniques for releasing power from the atomic nucleus. The groups soon combined into three main centers—one at the University of California in Berkeley, one at Columbia University in New York, and one deliberately misnamed the "Metallurgical Laboratory" at the University of Chicago. These efforts were coordinated under the sponsorship of the Office of Scientific Research and Development in Washington, but in a year they grew so big that they needed a new administration, and thus was born the now famous "Manhattan District" of the United States Army. Almost simultaneously, the three projects, plus a fourth, demanded large-scale engineering realization of their laboratory efforts. The Army engineers in the Manhattan District decided upon "site X" in eastern Tennessee, 25 miles west of Knoxville, protectively located, rather sparsely settled, in an attractive countryside, well watered, and supplied with abundant electric power from the Tennessee Valley Authority. A 58,880-acre tract of land was

marked off, the bulldozers moved in, and a city which reached a maximum of 75,000 inhabitants sprang up in a matter of months. The community was named Oak Ridge, for it lay along a crest known as Black Oak Ridge, and the whole establishment was called "Clinton Engineer Works," after the nearby town of Clinton.

The scientists from Columbia joined forces with the Union Carbide Corporation and set up an enormous plant for separating isotopes of uranium by means of their new gaseous diffusion process. The men from California joined with the Tennessee Eastman Company and erected a fantastic set of magnetic separators as an independent attack on the same job. The fourth plant was designed and constructed for the separation job also, but its process, based on thermal diffusion, was deemed less promising and the project was discontinued. The physicists and chemists from Chicago had a different kind of problem on their hands. They joined forces with the Du Pont Company, and it is their story that we wish to follow in particular.

Late in 1942 the Metallurgical Laboratory had succeeded in the controlled release of nuclear energy. Conditions had been found under which neutrons could propagate a chain reaction in uranium, burning the rare isotope U–235. This, however, was only the first step toward the wartime need. The chain reaction supplies extra neutrons which on being absorbed by the other uranium isotope, U–238, produces a new element, plutonium. Plutonium in kilogram quantities was the objective of the moment. However, it was unsafe to operate a high-powered nuclear chain reactor in the midst of Chicago, with little shielding and under the knowledge that the reaction had in it the power to go out of control and cause a disaster. Therefore the Metallurgical Laboratory established at its branch, "Clinton Laboratories" in Oak Ridge, a much larger chain reactor, air-cooled and originally designed to dissipate 500 kilowatts of heat from nuclear fission, but it was quickly raised to several times that level. This "X–10" reactor was the first nuclear reactor to be run at power; it gave mankind its first experience in the behavior of reactors when they are operated under other than cold conditions. And most importantly, it provided the plutonium needed to operate the pilot plant and show that the separations process to be used for full scale production at Hanford was workable.

Although the original purpose of Clinton Laboratories, later named the Oak Ridge National Laboratory, was met by mid-1945, these early years left an imprint which remains even today. There is an acceptance of the responsibility for pursuing goals in the national interest, and teams composed of many disciplines are willing to work together in achieving important objectives. There still exists the chemical and chemical engineering flavor of the Laboratory's first assignment, and it shows up in ORNL-developed processes used for fissionable material production throughout the Commission and for the recovery of uranium and thorium from ores. Even the ORNL power reactors, based upon the fluid fuel concept, follow this chemical tradition.

After the war there was a period of readjustment. Many of the scientists left for university posts, but a sufficient number remained to form the nucleus of what is now the Oak Ridge National Laboratory. The University of Chicago relinquished the responsibility of operation, to be followed by the Monsanto Chemical Company, and then by the Union Carbide Corporation, whose contract with the Atomic Energy Commission has been in force at the Laboratory since 1948. Thus the business and personnel policies of the Laboratory are those of the Union Carbide Corporation, but the research policies are determined by the Laboratory management in direct collaboration with the Atomic Energy Commission or other government agencies such as may be involved.

The Oak Ridge National Laboratory today provides a striking contrast to the original laboratory which cost $13 million and had a wartime peak staff of 1515 people. The now diverse program which encompasses almost every area of interest to the AEC—and other federal agencies as well—is carried out by a staff of more than 5400 people in facilities valued at $365 million. The annual operating cost of ORNL is about $100 million. About 87% of this represents programs of the AEC itself; the balance, work for other government agencies. Of the AEC portion, approximately 44% is devoted to reactor development and technology; 39% to physical research; 15% to the life sciences; 2% to radioisotopes development; and smaller amounts to nuclear education and training.

At ORNL, two approaches to organization are traditional. First, we have divisions which may be grouped somewhat homogeneously by discipline. Five divisions are primarily chemically oriented; six are mainly concerned with physics; and five are concerned one each with biology, health physics, mathe-

matics, metallurgy and ceramics, and engineering. A second kind of organization, projects, crosses divisional lines; these projects are organized to attack large problems that require a massive effort on the part of a multidisciplinary team. The project-division structure of ORNL fits well with the role of basic research at the Laboratory, with about 25% of the research classified as "basic." However, because this basic research is performed in the environment of a laboratory dedicated to large national purposes, it usually acquires a general relevance that often is missing in basic research conducted in institutions whose sole purpose is basic research.

The Oak Ridge National Laboratory's contractor, Union Carbide Corporation, operates three other installations for the Atomic Energy Commission, two of which are in Oak Ridge, and the third in Paducah, Kentucky. ORNL derives many advantages from the single contractor operation. By the use of common functions such as purchasing, accounting, and legal staff, many economies are realized. Both personnel and work may be moved with relative ease between installations. Many ORNL successes, such as the liquid centrifuge and the High Flux Isotopes Reactor, are due in considerable measure to support received from the other installations in Oak Ridge.

MAJOR PROJECTS AT ORNL

Thermal breeding

We have long believed that our most important objective is attainment of an inexhaustible, cheap source of energy. The ORNL approach to abundant energy by means of the thermal breeder may be traced back to 1944 when studies of an aqueous homogeneous reactor were carried out. Two small experimental homogeneous reactors were operated during the period 1952–1960. The more significant step, however, was taken in 1949 when the Laboratory became involved in development of the nuclear powered aircraft. In the course of this investigation, a vast amount of knowledge of molten fluoride fuel systems was accumulated, and the work culminated with the operation of the Aircraft Reactor Experiment in 1954. Since that time, study of molten fluoride systems as fuels and molten salt breeder reactors has continued, and the great promise of the concept has now been proved in the Molten Salt Reactor Experiment.

Although the Laboratory's major power reactor effort is devoted to the molten salt concept, a program aimed at thorium utilization in general is also carried out.

Transuranium element development

The Laboratory has been interested in the transuranium elements since its inception, with development of processes for purifying plutonium providing a vein of continuity. The program reached a milestone in 1965 when the High Flux Isotopes Reactor, the world's highest flux research reactor, became critical. The HFIR ultimately will produce 1 gram of californium-252 per year, as well as other interesting elements of both higher and lower atomic number, for use in the national heavy element research program. Other parts of the transuranium element complex are the Transuranium Processing Facility, where targets containing heavy elements to be irradiated in the HFIR are made. Following irradiation in the HFIR, the targets are returned to the Transuranium Processing Facility for separation of the transuranium elements. Because study of the heavy elements requires special facilities, a Transuranium Research Laboratory was constructed. Up to one-half of the staff may be composed of visiting scientists from other parts of the United States and the world.

Water and food

The economics of nuclear power are such that very large reactors are relatively less expensive than small ones. This introduces the possibility of vast agro-industrial complexes. Such a complex might employ a 10,000 MWe reactor to produce inexpensive water and electricity. The electricity would be used to make agricultural chemicals and other products, and the excess reactor heat would be used for evaporating sea water. The water and agricultural chemicals from one such complex would then be used by methods of intensive agriculture to provide food for millions of people. We are currently making economic studies of big reactors, and research is being carried out on improved evaporators. A recent summer study was devoted to the agro-industrial complex itself.

Nuclear safety and other reactor development

Our largest activity in reactor development is the nuclear safety program. From a modest beginning in 1955, when a few observations were made on fission product release from overheated reactor fuel, the scope of the program has increased to encompass almost all of the safety problems which confront the nuclear power industry, including seismic effects on reactors, structural problems of pressure vessels, reactor safety standards, and an information center serving the industry. In addition, the Laboratory conducts a variety of smaller studies in support of most phases of the U.S. reactor development program.

Isotopes development center

It is natural that we should always have been interested in fission products, for they presented so many problems in the early work on plutonium purification—problems that were only resolved by gaining an understanding of the fission products themselves. In addition, the Laboratory found itself with an available reactor and a collection of the best electromagnetic separators in the world. As a result of these circumstances, modest production of radioisotopes and separated stable isotopes was undertaken, and, on August 2, 1946, the first commercial shipment of radioisotopes—to the Barnard Free Skin and Cancer Hospital—was made. For many years the Laboratory remained the world's largest producer of radio- and stable isotopes; the impact on science, technology, and medicine of the Laboratory's efforts in isotope production has been enormous. At one time, processes for producing commercial quantities of about 100 radioisotopes and more than 250 stable isotopes of 52 elements were operating. By the end of 1962, more than 1½ million curies of radioisotopes and 5 kilograms of enriched stable isotopes had been shipped. For many years now, ORNL has been steadily withdrawing from radioisotope production to make way for private industry. In spite of this, each year the number of curies shipped from the Laboratory has increased, reflecting a transition from making many small shipments to making a few very large ones. Today we are concerned mainly with those difficult problems of isotope technology such as big power sources with which private industry is not prepared to cope. The Isotope Development Center, in addition to producing isotopic power sources, seeks new ways of using radioisotopes and radiation and provides an information service for radioisotope users.

Controlled thermonuclear program

Research on ways of obtaining power from the fusion process has been under way since 1953. The ORNL approach is based on continuous high energy injection into a containing magnetic field. Two large devices, DCX–1 and DCX–2, have been built to study the processes involved. More recently, increased emphasis has been placed upon the theoretical aspects of plasma instabilities and finding ways of dealing with them.

Life sciences

Biology.—Some of the earliest investigations carried out at ORNL had to do with the effect of radiation on animals and man and finding ways of ameliorating these effects. Over a period of many years, an extensive mouse colony was established to permit study of these effects, and experimental techniques were developed. By 1946 the program was sufficiently extensive to warrant establishing a Biology Division at the Laboratory. In the last few years, biological science at ORNL, as elsewhere, has undergone growth at a rate akin to that of physics during the early decades of the century. The Biology Division is now the largest division of the Laboratory. Many of the programs being carried out for other federal agencies are based in large measure upon experience acquired in the study of radiation effects: problems of aging, the effects of germ-free environment on animal welfare, and chemical mutagenesis. Equipment is being developed, and techniques for applying ultracentrifugation to the separation of viruses and to the preparation of vaccines are being pursued. The entire biology program at ORNL is underlain by a very large program of basic research in many areas of modern biology.

Ecology.—During the war years radioactive waste from the Laboratory was discharged to the environment, and it is natural that adjoining areas should be exploited as a unique laboratory for studying the effect of radiation on the environment. The program has expanded greatly and now constitutes a comprehensive effort aimed at understanding most aspects of radiation ecology.

Physical sciences

Physics.—Physics research at ORNL lies predominately in the low- and medium-energy ranges. A large fraction of the program concerns reactions of neutrons, especially those pertaining to reactor development or the utilization of neutrons as tools for research. Important problems under investigation are elucidating the physics of fission, nuclear structure determinations, measurements of cross sections of importance to both thermal and fast reactors (and the origin of the universe), and studies of shielding both reactor and space radiation. In much of this work the Laboratory's superb reactors and medium-energy accelerators are used.

Chemistry.—Studies of chemical properties and of reactions in aqueous and nonaqueous media are carried out, to a large measure, in support of the AEC's reactor programs. The first weighable quantities of technetium were separated at ORNI, and the element promethium was discovered at the Laboratory. More recently, emphasis has been placed on the chemistry of the transpultonium elements; and, in early 1968, two new isotopes of neptunium were discovered at ORNL.

Metallurgy and Solid State Physics.—The importance of materials problems in reactor technology were fully appreciated in 1946 when the Metallurgy Division was established. Early work on fuel element development resulted in an aluminum plate-type fuel technology upon which much of the current generation of research reactors is based. More recently, attention has been focused on the materials problems of new reactor types and on high-temperature materials suitable for high-performance reactors and space applications.

Research in solid state physics deals not only with the effect of radiation on simple systems such as single crystals but also on actual material of contruction, with the hope of undertanding the processes involved and ultimately controlling them.

Education

Since its inception, the Laboratory has been active in education and training, beginning with training the staff for such AEC installations as Hanford, Savannah River, and the National Reactor Test Site. Between 1950 and 1965 more than 1000 individuals, many from industry, were provided formal training in the Oak Ridge School of Reactor Technology. Almost from the beginning, ORNL staff members have taught at the neighboring University of Tennessee, but a major step forward was taken in 1963 with the awarding of a Ford Foundation grant to UT. This makes it possible for 30 senior ORNL staff members to spend one day per week teaching at the University as regular members of the faculty. In late 1965 a major new undertaking, the Oak Ridge-University of Tennessee Graduate School of Biomedical Sciences, was initiated. The school is jointly administered by the Oak Ridge National Laboratory and UT; the first class of students entered in the fall of 1967.

For many years the Massachusetts Institute of Technology maintained a practice school in Oak Ridge. This school was re-established in September, 1966; and, in late 1967, the University of Tennessee established a similar practice school. Other educational activities at the Laboratory include the Research Participation Program, under which college faculty members work at the Laboratory, a Traveling Lecture Program, and a program which permits promising technical students to work at the Laboratory during the summer months. Currently, more than 140 people are engaged in graduate thesis activities at ORNL.

March 25, 1968.

QUESTIONS SUBMITTED TO DR. ALVIN M. WEINBERG BY THE SUBCOMMITTEE ON SCIENCE, RESEARCH, AND DEVELOPMENT

1. In your prepared statement you say that the key to responsible redeployment is the role and attitude of top management, and that a laboratory director must view very broadly his responsibilities in a way that transcends the confines of his supporting agency.

(*a*) *Are there any policy statements that you are aware of at the OST or Bureau of the Budget level that would specifically foster or hinder this policy?*

(*b*) *Do you believe that you could have redeployed your laboratory as you described without the specific authorization of the AEC and the Joint Committee?*

(*c*) *The other side of the redeployment question is duplication of activities. How do you encourage the former without encouraging the latter? What guidelines would you recommend?*

1. (*a*) I know of no statements sponsored either by OST or BOB that partic-

ularly relate to this question. I believe the attitude of top management toward redeployment would be improved if laboratory directors had more opportunity to participate in the work of OST and PSAC. Although I know of no policy to hinder this, I believe there is no special policy to foster such participation.

(*b*) In every case of redeployment, our laboratory received the full sanction and concurrence of AEC. All money spent at ORNL goes through AEC—either by direct appropriation or through interagency transfer.

(*c*) Duplication is not really much of a problem since ultimately what any government or contractor laboratory spends is paid for by a government agency, and the government agency presumably has cognizance of what is going on in fields it pays for.

2. While the present Laboratories Committee of the Federal Council for Science and Technology is concerned with Government laboratories as such, with the exception of Dr. Astin its members are not working laboratory directors. What advantages and disadvantages do you see for establishing a small council of Federal laboratory directors that would represent the views of both directly and contractor operated Federal laboratories at the Executive Office level?

2. I don't think much of a council composed exclusively of Federal laboratory directors. They would spend most of their time talking about unessential administrative questions. Rather, Federal laboratory directors should be brought into the existing scientific policy-making framework of the government as panel members, advisors, and members of the regular committees such as the Defense Science Board, General Advisory Committee to AEC, PSAC, etc.

3. A sharp line frequently is drawn between those Government laboratories that are directly operated and those that are contractor operated. In terms of your experience, what are the principal characteristics of each mode of operation and the differences between them that are significant to utilization of Government laboratories?

3. The main practical difference is that a government laboratory usually operates both on a personnel and budget ceiling, a contractor laboratory only on a budget ceiling. This gives the contractor laboratory a good deal more flexibility than the government laboratory. On the other hand, since the contractor laboratory is not really part of government, its influence on government practice is apt to be less direct. However, this depends profoundly upon the personalities of the laboratory management and their counterparts in government.

4. What authority do you have to deal directly with other agencies that may wish to engage ORNL's research and development services?

4. Strictly speaking, all our contacts must go through AEC; in this sense we have no authority to deal directly with other agencies. However, AEC has interpreted our prerogatives in this respect liberally, and, once contacts through official channels have been set up, day-to-day relations with other agencies are handled about like day-to-day relations with separate branches of AEC.

5, As a general policy, do you believe that discretionary funds should be made available to all laboratories or only those which have demonstrated quality work (a reward for competence)?

(*a*) *Do you believe that discretionary funds should be used only in furtherance of an agency's mission or could some of the funds be used as seed money to explore how technology developed by a laboratory could be applied to other national problems, perhaps outside the jurisdiction of the sponsoring agency?*

5. I think some discretionary funds should be available to every laboratory. The size of the fund should be negotiable, and naturally would be cut back if the management used these funds irresponsibly.

The laboratory management should be allowed to use the funds for very broad exploration, even if this leads outside the agency's narrow mission. Again what is required is a sense of proportion and responsibility on the part of management, and this comes from participation in policy formulation.

6. The DOD witness proposed the elimination of manpower controls on cross-agency work in order to achieve flexibility similar to that available to the AEC contract laboratories. What is your opinion of this proposal?

6. As I said in number 3, I agree that there should be a budget ceiling, not a personnel ceiling on a laboratory. This implies that people can be fired; I assume that even within Civil Service this is possible when there is a reduction in force.

Mr. DADDARIO. This committee will adjourn until tomorrow morning at this same place at 10 o'clock.

(Whereupon, at 12:15 p.m., the subcommittee adjourned to reconvene at 10 a.m., Wednesday, March 27, 1968.)

UTILIZATION OF FEDERAL LABORATORIES

WEDNESDAY, MARCH 27, 1968

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

The subcommittee met, pursuant to adjournment, at 10:20 a.m., in room 2325, Rayburn House Office Building, Hon. Emilio Q. Daddario (chairman of the subcommittee) presiding.

Mr. DADDARIO. The meeting will come to order.

This is the second day of our hearings on the utilization of Federal laboratories, and the subcommittee will hear from two distinguished Federal laboratory directors and from an able and thoughtful administrator of Federal research and development.

The achievements of the National Bureau of Standards and its laboratories are well known and need not be recounted here, but there is one particular attainment whose history is virtually a case study of Federal laboratory utilization. During the urgent days of World War II, the National Bureau of Standards developed the proximity fuse, and subsequently the scientists and engineers of this project spun off to become the present Harry Diamond Fuse Laboratory of the Department of Defense.

This indicates, I believe, that laboratories can be responsive to urgent national needs, and indicates also that a capability existing in one agency can be successfully redirected to other agency missions.

We are pleased, therefore, to have as our first witness Dr. Allan V. Astin, Director of the National Bureau of Standards. Dr. Astin is also the Chairman of the Federal Council's Laboratory Committee. The human resources of our Federal laboratories are a precious asset and, like other assets, their value to society depends upon how well or how poorly they are used.

Following Dr. Astin, we will hear from Dr. William B. McLean, technical director of the Navy Undersea Welfare Center. Dr. McLean is responsible for the development of the Sidewinder air-to-air missile system, and has received the President's Award for Distinguished Federal Civilian Service.

Our final witness this morning will be Mr. Harold B. Finger, Associate Administrator for Organization and Management, NASA. Mr. Finger has had extensive experience as a research and development administrator and has been a frequent witness before our committee.

As the space program has matured during the last 10 years, it has produced a wealth of new knowledge, technology, and methods of management which have found application far removed from their original space-oriented purpose, and we are particularly interested in

NASA's experience in accelerating the transfer of space science and technology to other national goals or problems.

Dr. Astin, we would appreciate it if we could insert your first statement in the record, perhaps with a few general comments, and have you go right into your statement concerning the Laboratory Committee.

Dr. ASTIN. Thank you, Mr. Chairman. I would be most happy to do that.

(Dr. Astin's biography follows:)

DR. ALLAN V. ASTIN

Dr. Astin was born in Salt Lake City, Utah, in 1904. He received his bachelor's degree in physics from the University of Utah in 1925 and his PhD from New York University in 1928. From 1928 to 1930 he was a National Research Council Fellow at Johns Hopkins University.

Dr. Astin joined the staff of the National Bureau of Standards in 1932. His principal fields of work included precision electrical measurements, the development of early radio telemetering techniques, and during World War II the development of proximity fuzes. He was named Chief of the Bureau's Ordnance Development Division in 1948. The President appointed him as the fifth Director of the National Bureau of Standards May 31, 1952.

Honors and awards include the following: Gold Medal Exceptional Service Award, Department of Commerce; honorary Doctor of Science Degrees from Lehigh University, George Washington University, New York University; the National Civil Service League Award; the Rockefeller Public Service Award; the Scott Gold Medal of the American Ordnance Association; the Award to Executives of the American Society for Testing and Materials; and the Distinguished Alumni Award of the University of Utah. Dr. Astin is a Fellow of the American Physical Society, the Institute of Electrical and Electronic Engineers; an honorary life member of the Instrument Society of America, the Standards Engineers Society, Inc., and the American Dental Association. He is a member of the American Philosophical Society, American Academy of Arts and Sciences, and the National Academy of Sciences. He serves as the U.S. member on the International Committee of Weights and Measures and as Chairman of the Committee on Federal Laboratories of the Federal Council for Science and Technology.

STATEMENT OF DR. ALLAN V. ASTIN, DIRECTOR OF THE NATIONAL BUREAU OF STANDARDS

Dr. ASTIN. I would also like to offer to the committee two descriptive documents concerning the Bureau which I think some of you have seen. We would be happy to furnish additional copies if you wish.

First, the recently published history of the national Bureau of Standards called "Measures for Progress," and the other is our 1967 annual report.

The history contains a foreword by Dr. Vannevar Bush, in which he says, "If men are to accomplish together anything useful whatever, they must above all be able to understood one another. That is the basic reason for a National Bureau of Standards."

Our basic concern is, as Dr. Bush indicated, to provide the framework for communication, understanding, and exchange in the Nation's scientific and engineering community.

We have a second function, however, of providing a center for scientific and technical services to the Government and to the private sector.

The first responsibility consists really of two aspects. We must provide the national framework for uniform, consistent, accurate, compatible, physical measurement in this country. That includes provid-

ing services so that everybody can be assured of means of coupling to the measurement system, and coordinating our measuring system with that of other nations.

The second part of this particular function is to provide data on the properties of materials which are of great importance to science and not available elsewhere.

These two activities involve us very much in the science of measurement with close coupling with everybody in the country who uses physical measurement. In this connection, we acquire various skills which have led to the Bureau being looked upon as a scientific service center to the rest of Government. This is the function which is changing, and which I would like to talk about briefly to summarize some of the things that are in my statement.

In the early days of the Bureau we were very much involved in industrial research and development. We were involved in such things as development activities on automotive and aircraft engines, and in the development of optical glass. As the Nation's technical competence rose we rapidly got out of these activities and concentrated on the measurement problems to insure compatibility of the many activities in the various technical fields.

At the same time the Bureau began early in its history to serve the Federal Government as a service center. I think one of the first tasks was the testing of material used in the old House Office Building.

We have also been used by other Government agencies as a central resource for research. The Navy Department used the National Bureau of Standards as its research center for 10 years before the Naval Research Laboratory was established.

The old National Advisory Committee for Aeronautics used the National Bureau of Standards for its laboratory resource for several years before it established laboratories of its own.

You referred to our part in the formation of the Harry Diamond Laboratories. The Navy Ordnance Laboratory at Corona, Calif., was spun off from the National Bureau of Standards at the same time.

More recently, our former Central Radio Propagation Laboratory became a key research component of the newly formed Environmental Science Services Administration.

These represent instances where other organizations use the Bureau for a particular job. The work develops to a certain stage, or they acquire facilities of their own, and then the activity is taken out of the Bureau.

We have similar things now in process. We are working with the General Services Administration and helping them set up in our facilities a laboratory to develop product acceptance test procedures and do qualified product testing for GSA.

At the same time we have a laboratory dealing with several aspects of motor vehicle safety research for the Department of Transportation. We expect that these two activities, as they mature, will probably ultimately be transferred to the sponsor agency.

We are also working with the Department of Housing and Urban Development toward use of our building research activities as a resource to help them in the solution of some of their problems. So, you see, in this way we provide a central service to Government, and it is a changing service.

We sometimes play a similar role in relation to the industrial sector. Our staff will frequently get involved in and interested in some aspect of development which they find they cannot carry as far as they would like to and still remain part of the National Bureau of Standards. This is because we do not encourage or authorize the development of commercial or proprietary products. However, we can't and would not want to stop people from getting ideas.

Frequently when this happens, the individuals leave the National Bureau of Standards, either to go with a commercial company, or very often to set up their own companies. Examples of this have been Harris Laboratories, Rabinow Engineering, The Weinschel Engineering Laboratories.

In addition, we have helped organizations like the American Gas Association and the National Institute of Dry Cleaning in setting up laboratory activities of their own.

Mr. DADDARIO. Dr. Astin, you bring up the way in which the Bureau has been helpful in developing the first steps which have led to the creation of other agencies in Government and new industry. It would seem to me that the ones that have been established in industry developed in response to needs within our society.

What is your thinking about the way in which the Government agencies have developed laboratories after the groundwork has been broken. Is it your view that this is a healthy situation and that it should always work this way? Does your experience give you any indication as to how this pattern might, in fact, be improved? We are concerned about how we can, in fact, develop better laboratories, and I have some question really as to whether they should always be under and completely subservient to the agency which has a particular mission.

Dr. ASTIN. I am not sure that I could define any general rules for this. It is my view that any agency, particularly some of the new ones who think they need a laboratory, should explore the opportunities to have their work done in existing facilities before the decision is made to establish a new laboratory.

It is specifically for this reason that I mentioned the experiences with the Department of Transportation in the vehicle safety area and with GSA in the product testing area. I think, ultimately, these will become laboratories within the parent agencies, but what they did was to look first for some existing activity on which they could build before they start something on their own.

Mr. DADDARIO. Would your work as Chairman of the Federal Council's Laboratory Committee include some judgment on whether or not such laboratories are to, in fact, be established? We know that some laboratories are established only because the parent agency has the authority to do it under its organic legislation. We had some problems in this area, as you will recall, with the biomedical developments within the space program. We had some concern about whether this work should have been done in existing laboratories. We have kept after it over the course of time, and yet it did grow in a very strange way.

Dr. ASTIN. The interdepartmental committee has not looked at the problem of criteria for establishing laboratories. We have been very much concerned, however, with the elements which make for the effec-

tive operation of laboratories and it is one of our conclusions that one of the most important things for any laboratory is a broad, dynamic, and challenging mission. This would mean, I think, that one would not set up a laboratory unless there is a broad, challenging, continuing responsibility. I would think that one would avoid setting up a laboratory for an ad hoc task because then you get stuck when the job is done with a resource that you really don't know what to do with.

I would like to make one more comment about the activities of the National Bureau of Standards before going on to the Federal Council activities. This concerns our coupling with the educational community as well as the industrial community. We like to look upon the resources of the National Bureau of Standards as national resources which are available to anyone with a legitimate need for sharing or using them. At our new laboratories at Gaithersburg, for example, we have a number of very unique facilities. We have some very fine ionizing radiation producing facilities. We have probably the best spectroscopy facilities in the world. These are facilities which we share. We have mechanisms in operation for sharing with the scientific and technological community throughout the area, including most of the universities in this area and other Federal agencies like the Naval Research Laboratory and the National Institutes of Health. So we look on these as facilities that have unique and significant aspects, but they are national facilities, national resources, and are there to be shared.

Similarly, we make all of our facilities available to the industrial community for their people to come in and work with our people on problems of interest to them and of national significance.

At the present time we have approximately 65 people who are on the staffs of different industrial organizations working in our laboratories on problems of mutual interest. This sharing thing, I think, is most important, and it is one of the things I wanted to emphasize before closing my comments on the Bureau.

Mr. DADDARIO. Dr. Astin, you touched on your work with the Department of Housing and Urban Development. I wonder if you could go into that in a little detail because that is a subject of interest to us.

Dr. ASTIN. Yes. We are interested in working with HUD in developing better techniques for evaluating building structures and their components. We feel that much of the present technology for evaluation of building systems is archaic and does not really take adequate account of the performance aspect. In general, most building codes to which buildings must conform are based on detailed specifications as to the materials that go into a structure and the form and arrangement of materials. They have no relationship, or very remote relationship, I should say, to the functions the building is to perform.

Consider, for example, the wall of a building. A wall provides structural support. It also provides shielding from heat and light and sound. Ideally, one should specify the properties of a wall in terms of its ability to attenuate sounds, to withhold the transmission of heat or cold and in terms of the forces it is required to withstand.

Most building codes specify materials. If it is going to be a brick wall they specify the sizes of the bricks, the composition of the mortar and things of this sort, or if it is a wood wall they specify size and spacing of the structural members.

This completely freezes innovation. If we are going to bring to bear the best of modern technology in coping with the Nation's housing problems, particularly the problems of low-cost housing, we have to have building codes and building regulations which permit to the maximum possible extent the development of new ideas. This can only be done if we know how to specify the performance requirements of a building and have related test methods to determine whether or not a proposed structure will conform to these requirements. It is this problem that we are working with. We are outlining now some specific activities, some short term, some long term, where we can begin to get performance-type building codes rather than design-type building codes. This is a specific problem area.

Mr. DADDARIO. The objective would also be to do this at a lesser price than presently?

Dr. ASTIN. Definitely, yes. Through innovative use of modern technology I am sure that much more can be done in getting better housing for less money.

Mr. DADDARIO. Do you have any estimate, Dr. Astin, of how much lower? I think this is important because the way you are going to get building codes down is by public opinion being drawn to this particular fact.

Dr. ASTIN. Well, I have no good way of making an estimate as to how much the possible lowering of cost would be. I am sure that there could be some significant reductions if we could get away from many of the restrictions of present designed base building codes.

Mr. DADDARIO. Do you contemplate it to be in the order of 10 percent, 20 percent, or do you have no judgment at all on it?

Dr. ASTIN. I would rather not make an estimate on it at this time, sir. I think it would be large enough to devote considerable amount of effort to try and bring this about. In other words, I think the gain is well worth whatever it costs to develop performance based building codes.

Mr. DADDARIO. You are talking about better houses at a lower price tag?

Dr. ASTIN. That is right, yes, sir.

I would now like to speak to you in my capacity as Chairman of the Federal Council for Science and Technology's Committee on Federal Laboratories.

The Committee on Federal Laboratories is the current designation for a continuing Federal Council Committee which, under a series of different names, has concentrated from the time of its formation in 1959 on achieving the most effective operation of Federal laboratories from a management point of view, as contrasted to other Federal Council committees which deal primarily with programs and policies. Perhaps the best way to explain the functions, operation and concerns of the Committee on Federal Laboratories is to trace its development and activities starting with a predecessor group to the Federal Council, the Interdepartmental Committtee on Scientific Research and Development.

THE INTERDEPARTMENTAL COMMITTEE ON SCIENTIFIC RESEARCH AND DEVELOPMENT

The Interdepartmental Committee on Scientific Research and Development (ICSRD) was established by Executive Order 9912 in 1947. One of the duties of the Interdepartmental Committee as enumerated in the Executive order was to:

> Study or propose studies and recommend changes in administrative policies and procedures, including personnel policies, designed to increase the efficiency of the Federal research and development program.

While ICSRD was also concerned with Federal policies and practices concerning research grants and contracts, encouraging collaboration among Federal agencies engaged in scientific research and development, obtaining advice from persons outside the Federal Government, and similar matters, its most productive activities generally proved to be in the area of administration of scientific programs.

ESTABLISHMENT OF THE FCST AND THE PANEL ON ENVIRONMENT AND INCENTIVES FOR RESEARCH

In 1959 Executive Order 10807 established the Federal Council for Science and Technology and revoked Executive Order 9912. The new order, in addition to establishing the Federal Council, specifically included provision for a Standing Committee of scientist-administrators to undertake studies for and make reports to the Council, and to provide a continuing source of recommendations. Thus, in effect, Executive Order 10807 provided for the abolition of ICSRD and its reconstitution as a Standing Committee of the Federal Council.

Two of the functions of the Federal Council are to recommend policies and other measures to provide more effective planning and administration of Federal scientific and technological programs and to achieve more effective utilization of the scientific and technological resources and facilities of Federal agencies, including the elimination of unnecessary duplication. To help carry out these objectives the Council organized the Standing Committee of scientist-administrators, as specified in the order, and the Standing Committee in turn appointed a Panel on Environment and Incentives for Research. This was the predecessor of the present Committee on Federal Laboratories.

From its beginning the Panel on Environment and Incentives for Research concerned itself with (*a*) problems affecting the assigned responsibilities of Federal laboratories, (*b*) the condition of Federal laboratory management, and (*c*) organizational and personnel practices.

ACTIVITIES DURING 1961 AND 1962

During 1961 and 1962, an obvious and increasing deterioration in the ability of Federal laboratories to recruit and retain sufficient numbers of the outstanding scientists and engineers vital to effective accomplishment of their missions was perceived by the Panel to be the primary matter of importance requiring immediate attention.

Accordingly, the Panel, with the help of a working staff contributed by its members, initiated studies and recommendations as to both the salary and nonsalary factors which were affecting the Government's ability to obtain its share of highly competent people from the

competitive market. The Panel's subsequent analysis and recommendations were adopted by the Council and submitted to the President in a two-part report entitled "The Competition for Quality". The portion bearing on salary reform was used in developing the administration's legislative proposals and was submitted to the Congress with relevant statistics on July 12, 1962. The analysis of nonsalary factors which could be effected by administrative action was transmitted by the President to department and agency heads on May 13, 1962, with a publicly released directive for implementation.

During 1962 the Panel also submitted recommendations to the Federal Council on improved utilization of the Government Employees Incentives Awards Act of 1954.

Mr. DADDARIO. At the top of page 3 you speak of the Panel looking at problems affecting the assigned responsibilities of Federal laboratories. Are you talking there about duplication or are you talking about internal management of those organizations?

Dr. ASTIN. We are talking about the organizational and procedural problems which interfere with getting the job done.

Mr. DADDARIO. How do you bring the individuals together and how do you allow the people who are involved in the Federal laboratories to participate? Yesterday we had some testimony on the need to do this more often than we do, not only because you can get different points of view, but also because laboratory directors would find out more what was going on and they could improve their own management activities.

Dr. ASTIN. Well, it is my feeling that every laboratory manager or director should have some responsibility for formulating at least a portion of his program. In general the laboratory supports the mission of the agency, and to be effective, it has to be responsive. But if the program is to be dynamic and effective, then formulation of some portion of this program has to be under the control of the laboratory manager.

At the same time it is desirable, I think, for him to have mechanisms for seeking advice from experts in the technologies involved. In general advisory committees to laboratory managers have proved very helpful.

Now, this essentially means first of all, that the laboratory director should have some significant input into the program he is concerned with.

Second, he must have the necessary resources, freedoms, and flexibilities to manage the program that is assigned to him.

We have been concerned with both aspects of this problem; that is, with the manager's need for some role in defining his program content, and second, with the authorities which he needs to have in order to effectively manage the program assigned to him.

Mr. DADDARIO. What kind of discretionary authority are you talking about and what amount of funds percentagewise would you allow him, in order to develop this capability that you are talking about?

Dr. ASTIN. I would think that the amount of funds or resources at his disposal would vary some with the nature of the mission. I would guess, in general, it could run from a low of 5 percent up to perhaps 20 or 25 percent of his total resources. This would depend on the

nature of his mission or program, but of that order, well under a half, but better than 5 percent.

Mr. DADDARIO. You fluctuate from a low to a high?

Dr. ASTIN. Yes.

Mr. DADDARIO. Do you include in that, that there should be some judgment made as to the amount in respect to the laboratory?

Dr. ASTIN. Yes. A laboratory with a very routine responsibility would probably need less. A laboratory with extremely difficult technological problems to solve would need more. It would depend to some extent on the nature of the assignment to the lab.

Mr. DADDARIO. The nature of the assignment and the quality of the laboratory?

Dr. ASTIN. Yes.

Mr. DADDARIO. Are you going to rate them through this committee? How are you going to do that?

Dr. ASTIN. No. Our interagency committee will not get involved in rating laboratories.

On the other hand——

Mr. DADDARIO. You indicate that they should be?

Dr. ASTIN. I think that it is essential in any organization that is concerned with a number of laboratories. I think they have to have some mechanism of rating. Within the National Bureau of Standards, for example, I consider that NBS is a composition of many laboratories. I think one of my responsibilities is to have techniques for rating the different laboratories within the organization, and where the leadership or management is ineffective, doing something about strengthening it as well as encouraging those that are strong.

Mr. DADDARIO. I think it is extremely important to come to some determination about how much flexibility and discretionary authority you would allow a director. I would quite agree it should vary whatever the figures might be, and one of the most important criteria would be the quality of the laboratory itself. I have the feeling. although we have not come to that conclusion as yet, that a small percentage of funds would, in fact, raise the quality of good laboratories even further. If a director had this authority, it would not only enhance his capability, but it would have some bearing on the entire quality of the performance of the people under him. You would, I imagine, support that?

Dr. ASTIN. Yes.

Mr. DADDARIO. Dr. Hornig yesterday touched on part of the responsibility that he has and came to some determination about eliminating laboratories when they reach a certain point. Considering that he was considering a judgment of that kind, would his office be the place where this rating process should take place?

Dr. ASTIN. I am not sure whether that would be a proper place or whether it ought to be done on a department basis. Most certainly, though, I would think Dr. Hornig's office is concerned with the overall quality of Federal laboratories. That is one of the reasons his office has encouraged our interagency committee because we are very much involved with the problems which affect the quality of Federal laboratories. In fact, most of our reports deal with one or another aspect of the quality of Federal laboratories.

Mr. DADDARIO. However, it might be done; then, we ought to be giving it considerable thought to how this could be brought about?

Dr. ASTIN. Yes, I would agree.

Mr. DADDARIO. The idea that a laboratory director's council be formed has been proposed from time to time. Do you see this as a helpful step in allowing the directors to participate better in overall management policy?

Dr. ASTIN. I think it is essential. I don't think you will either develop or retain good laboratory directors unless they have the opportunity to have such participation.

Mr. DADDARIO. That is a very good answer, Dr. Astin. I do think that there is a requirement to allow these men to so function. They are men of such competence that their advice would be helpful.

I guess we can move along.

Dr. ASTIN. All right.

NAME AND REPORTING CHANGE

In line with its primary preoccupation with the quality of the Federal R. & D. staff, in May of 1962 the name of the "Panel on Environment and Incentives for Research" was changed to the "Panel on Scientific Personnel." In 1963 the committee began reporting directly to the Federal Council rather than through the standing committee and the title was changed to the "Committee on Scientific Personnel."

ACTIVITIES DURING 1963

During 1963 the Council concentrated on putting into effect the recommendations in the committee's 1962 report, "The Competition for Quality." The recommendations stressing the threat to the quality of science in Federal laboratories arising from noncompetitive salaries for the higher level positions were a factor in enactment of Federal salary legislation. The recommmendations of the committee relating to the environment and incentives for work in Federal laboratories were considered within the executive branch.

Based upon the committee's report, the Council agreed that these steps should be taken by agencies:

(*a*) To sustain a challenging scientific environment capable of keeping and attracting good people, the missions of laboratories should be broad enough to present a set of scientifically challenging tasks, and redefined wherever necessary to give them continuing vitality;

(*b*) Research directors should have more authority;

(*c*) Layers of management over laboratories should be reduced;

(*d*) Full advantage should be taken of the flexibility existing in civil service regulations, and these regulations should be less often used as a rationalization for ineffective personnel management.

Also, during 1963 members of the Committee on Scientific Personnel, together with several invited scientists, met with the Civil Service Commissioners and senior officials of the Commission to discuss staffing and personnel management problems associated with the administration of Federal research and development activities and to explore possible remedies. A summary report of this conference was distributed by CSC Chairman John Macy to senior scientists and

engineers in the Federal Government. The primary point of the report was to reemphasize that the existing Federal personnel system is, in general, quite adaptable to the special needs of research and development establishments if full use is made by management of this adaptability.

Mr. DADDARIO. Dr. Astin, yesterday I asked about the recommendation made by the Bell committee on the formation of a GSA type research institution which would have its own merit system, its own salary levels, and this type of thing. I did not understand Dr. Hornig to be particularly in support of that. What are your feelings?

Dr. ASTIN. Well, we have considered this problem within the committee. As a matter of fact, one of the reports that I am coming to a little later in my statement began initially to try and see if there was a need to create a special scientific corps in the Federal Government. We came to the conclusion that this is not necessary, although there are special considerations in terms of environment and management that professional personnel need. If management is aware of the special requirements for professional growth and development, then these can probably be achieved quite satisfactorily without setting up a special scientific corps.

I think, though, one of the best arguments I can think of for the development of a corps, or something associated with it, is the absolute necessity of providing in any scientific and engineering organization for the continuing education of the staff.

We have, I think, at NBS a fairly good program for this, but it could be better and one of the reasons it isn't better—one of the reasons it isn't better throughout Government—is that it takes money and it takes an investment of resources to train people.

Now, the military services do this and the way they can do it is because they are a corps. I think estimates have ben made that people in the military officer corps spend as much as 10 to 15 percent of their time in total career life in training. No scientific agency begins to approach this, but I don't think the requirements are any less critical in a scientific organization for continuing education if they are to keep abreast of new developments and to maintain a high level of quality.

Again I say that if one recognizes the special requirements for professional development and has an opportunity for it, you don't need a corps, but maybe it would be easier to get them if we had a corps.

Mr. DADDARIO. You could have this constant education which would be helpful to a person's career as it is in the military. There is the problem, though, that if a man were to decide to take a year's leave of absence to go off somewhere on his own, when he came back he could find himself in a position where his career might be affected?

Dr. ASTIN. That is correct.

Mr. DADDARIO. But in the military, unless you go to these various schools, your military career is affected by not going. It is just the opposite.

Dr. ASTIN. Yes.

Mr. DADDARIO. What areas, particularly, need constant education?

Dr. ASTIN. I don't know of any field in the physical, medical, biological, or engineering sciences that do not require continuing education. In scientific fields there are always new discoveries in technology, there are always new and better ways of doing things, new tools to do

things with. Unless there is a mechanism to keep up to date on these, the scientist's effectiveness is lowered.

I remember a number of years ago a meeting involving the late Lloyd Berkner. He made the assertion that Ph. D.'s ought to be outlawed when they are 7 years old because they are no longer effective, and if a man is to keep his Ph. D. effective he should reearn it every 7 years.

Mr. DADDARIO. Then you would say that the quality of our national laboratories, as good as some of them are and as poor as others might be, that all would improve in quality if we did, in fact, have a policy for such education?

Dr. ASTIN. I have no doubt about it, sir. It is most desirable.

Mr. DADDARIO. This would be something that you would advise us to set our goals to?

Dr. ASTIN. Yes, sir.

Mr. LUKENS. May I ask a question?

Mr. DADDARIO. Yes.

Mr. LUKENS. I am interested in this program. I certainly endorse it fully, and I agree with your assessment that continuous training is vital.

I would like to ask this. In the military a person is retrained for specific assignment and reassigned every 3 years. Do you think that the personnel assignment concept within the scientific discipline is a major advantage or would there by any advantage to changing the physical surroundings, or is there a basic advantage to have a man serve for 20 years in one position?

Dr. ASTIN. It varies. There are many cases, and we have a number of them at the National Bureau of Standards, where very intensive and long specializations are essential.

However, I am of the opinion that any individual, any senior individual in one of the Federal laboratories, would be a better man if his outlook were broadened; that is, if he had a better appreciation of where his work fits in, not only to his own agency's mission, but where his agency's mission fits into national goals. For this reason I have been a strong proponent of training fellowships which tend to broaden an individual's outlook.

Now, we have in the Department of Commerce a science technical fellowship program. It was established while Dr. Hollomon was Assistant Secretary for Science and Technology. Its primary purpose is to give promising individuals within the four technical agencies of the Department a broadened outlook on the Government's involvement in science. They are selected on a merit basis, and spend an academic year in such training. It generally consists of a series of courses consuming perhaps 2 months and then actual work assignment in another agency. All of these individuals return to either their prior job or a better job at the end of the training assignment. This training is now in its fourth or fifth year in the Commerce Department.

I would think that a program of this sort governmentwide would help very much to improve the overall quality and certainly the perspective and breadth of view of the scientific and professional people.

Mr. LUKENS. This is assumed with a minimum jeopardy?

Dr. ASTIN. Yes. The man is assured of either his present job at the end of the training assignment, or a different, and usually better, job.

Mr. LUKENS. Mr. Chairman, may I ask permission to ask a couple of more questions?

Mr. DADDARIO. Yes.

Mr. LUKENS. What is your assessment of the fellowship program right now. It seems to have paid off very handsomely.

Dr. ASTIN. Our postdoctoral associate program, which is now about 12 or 13 years old, is in my judgment one of the most effective devices we have for maintaining the quality of our scientific staff. It is a program that brings into the Bureau 16 to 20 new Ph. D.'s each year. These individuals are selected for us by the National Research Council. They come in and work on any one of a list of projects we propose, and with any one of a list of supervisors they select from the list we have given. So, they have essentially all of the freedoms of a postdoctoral research fellowship in any university.

The appointment is for 1 year subject to 1 year renewal. This program does for us two things. It provides a continual flow through the organization of extremely bright people because they represent some of the best new Ph. D.'s in the country.

For example, this year for the 16 appointments we could make there were over 100 applicants, and the National Research Council certified to us around 50 of these as being well qualified. This means that we can select only a third of the very best of these.

Thus we have this flow through the Bureau continually of this bright talent.

It has another advantage, although this is secondary. We retain a few of these people, approximately a third, as permanent employees of the NBS. Those that came through the program first now represent some of our very best young scientists in the organization.

Mr. LUKENS. At the University of Colorado you also have a visiting fellowship program. Are there any plans to increase that?

Dr. ASTIN. Yes. All of these programs are limited now by lack of funds. Both of these programs essentially represent an investment in the long-term capability of the organization. When we are in a time of extremely tight budget, we have to defer some of these long-term investments, and we are in that state right now.

Mr. LUKENS. Thank you.

Mr. Chairman, I would like to thank you for your courtesy.

I would like also to go on record to say that you, Dr. Astin, are doing a very fine job, and the National Bureau of Standards has a fine reputation throughout the world. I think whatever help we can give to NBS in the furtherance of these basic programs and standards would certainly have my vote and my support.

Dr. ASTIN. Thank you very much, sir.

Mr. DADDARIO. You would like to hear that more often, wouldn't you, Doctor?

Dr. ASTIN. Yes, sir. I would like to hear it tomorrow. [Laughter]

I am scheduled to appear before the Appropriations Committee.

Mr. DADDARIO. Will you keep this in mind?

Mr. LUKENS. That is not my committee. [Laughter]

Dr. ASTIN. "Change in Function of the Standing Committee." About this time a reevaluation of the functions of the standing committee of scientist-administrators was undertaken and resulted in a proposal, accepted by the Council, that the standing committee have

as its primary function the improvement of communication between policy level officials in the various agencies and the entire body of career scientists, engineers, and administrators of technical programs. The major device for communicating would be symposia held once or twice a year as the need arose, with wide participation and with publication of transactions so as to reach roughly 2,000 senior Federal scientists and research administrators.

The first symposium, planned in close cooperation with the Committee on Scientific Personnel and sponsored jointly by the Civil Service Commission, was held in October 1963, and dealt with "Current Problems in the Management of Scientific Personnel." A second symposium in April 1964, was concerned with "Technical Information and the Federal Laboratory."

A third symposium in December 1964, was organized for the purpose of discussing "The Environment of the Federal Laboratory." This symposium, like the first in the series, was jointly sponsored by the Federal Council and the Civil Service Commission. The program included a review of many completed and ongoing studies of inflexibilities and management problems in the Federal service and provided for small group discussions of specific problem areas.

Copies of the proceedings of the three symposia and of the other panel reports have been published and are available if the committee would like to have them.

Mr. DADDARIO. Is there any way we can come to a judgment about what effect they have had?

Dr. ASTIN. We have not appraised their value. I think they have been of some use. I have been a little disappointed in the use that has been made of them, but I occasionally get reports from someone that they found something of value in one or the other of them.

Mr. DADDARIO. We will not go into your reasons for having been disappointed at this time, but we should explore it for the record along with other questions we may have.

Dr. ASTIN. We would be pleased to explore these things with you; yes.

CONSOLIDATION OF STANDING COMMITTEE AND COMMITTEE ON SCIENTIFIC PERSONNEL

As the activities and committees of the Federal Council continued to expand, the standing committee became concerned primarily with the effective operation of laboratories operated by the Federal agencies. This had much in common with the interest and activities of the Committee on Scientific Personnel and in May of 1965 operations of the two committees were merged into the standing committee.

STUDY OF ENVIRONMENTAL FACTORS IMPORTANT TO FEDERAL SCIENTISTS AND ENGINEERS

A major project of the Committee on Scientific Personnel, and subsequently the standing committee, during 1964 and 1965 was the systematic identification and assessment of environmental factors important to Federal scientists and engineers. Questionnaires were administered to suitably chosen samples totaling some 1,025 Federal scientists and engineers employed in 17 representative Federal laboratories through-

out the United States. A summary of the data and its analysis was presented to the Federal Council during March 1966. The analysis indicated the importance of various environmental features to Federal scientists and engineers and evaluated the extent to which these persons were satisfied with provision of these features in the Federal service. The results were published in a report entitled "The Environment for Quality" and in the July–September 1966 issue of the Civil Service Journal.

The Committee's analysis clearly identifies three sets of factors of high importance to Federal scientists and engineers. These are: (1) professional values, such as the opportunity to work on creative and challenging projects and to make full use of skills and abilities; (2) features concerning appropriate and equitable pay and ability to advance; and (3) matters related to adequate on-the-job support. On the other hand, such things as job titles, the retention of rights to patents, consulting fees and honoraria, rigidity of security controls, and freedom to consult, lecture, and teach are considered relatively unimportant by the vast majority of persons.

STUDY AND RECOMMENDATIONS CONCERNING MARGINAL EMPLOYEES

The Standing Committee took account of frequent indications of concern and dissatisfaction about the difficulty of removing marginal employees and the consequent adverse effects upon the efficiency of laboratories. The Standing Committee studied problems related to marginal employees in some depth and concluded that these could best be minimized by the continuous and systematic application of sound personnel practices at all stages of employment and at all levels of management within the agencies.

Changes in civil service rules and new legislation were proposed in a number of cases. These were identified in a report, "Management and the Marginal Employee," and related to 22 specific recommendations directed at laboratory managers and directors, agency officials, the Office of Science and Technology, the Civil Service Commission, and the Bureau of the Budget. The report was distributed by the Chairman of the Federal Council to the heads of major Federal agencies.

Legislative needs implicit in the situation include the authority to require a longer probationary period for research scientists and engineers and the ability in some cases to reimburse prospective appointees for a preemployment interview at the Federal laboratory. Avoidance of marginal employees begins with the initial selection and screening process.

USE OF FEDERAL LABORATORIES FOR EDUCATIONAL ACTIVITIES

During 1966 and 1967 in response to a request from the Federal Council for Science and Technology, the standing committee undertook a study relating to the use of Federal research and development (R. & D.) facilities for advanced education and training: (1) To determine how well Federal laboratories are doing in continuing educational efforts, (2) to make recommendations for improvements, and (3) to explore the potential of Federal agencies in contributing more broadly to the educational activities of the Nation.

The principal requirements for the study were knowledge of present types of relationships between Federal laboratories and universities, identification of successful experiences, and definition of the major impediments to more productive interplay. To obtain the necessary information several members of a committee task force visited and interviewed laboratory managers and their staffs at some 75 Federal research and development installations and one Federal contract research center located throughout the United States.

Information gathered by the task force was analyzed, summarized, and submitted together with recommendations for improvement action to the Federal Council in September 1967. The Federal Council has approved the report in principle and it is presently in the process of revision and publication for possible general use.

Concurrently with the study of educational relationships the Committee on Federal Laboratories was asked to help evaluate a closely related policy statement proposed by the National Science Board to facilitate increased use of Government facilities by the general scientific community. A report and recommendation was presented to the Federal Council and accepted for appropriate action. Data, discussion, and recommendations pertinent to this proposal have been incorporated in the aforementioned report on university-laboratory relationships.

CURRENT AND FUTURE COMMITTEE ACTIVITIES

In July 1967, in order to provide a more meaningful name in line with its present functions, the name of the standing committee was changed to the Committee on Federal Laboratories.

Currently the Committee is engaged in followup activities to its study and recommendations on "Education and the Federal Laboratories." Tentative plans are being made for a symposium of Federal laboratory and department officials to discuss the findings and facilitate implementation of the recommendations throughout the Federal service. Planning for this is an early item of business.

One specific recommendation of the committee is that a further study of some aspects of university-laboratory relationships be undertaken jointly by a group made up of both universities and Federal representatives. If feasible this might begin by planning for the above symposium to include university as well as Federal laboratory participation.

Another subject which the committee is tentatively exploring for possible future study is the procurement, management and utilization of Federal R. & D. equipment and facilities. As yet no definitive answers have been arrived at as to the feasibility and advisability of such a study.

In addition to the foregoing, numerous factors such as restrictions on travel, which tend to hinder training programs and communication with the wider scientific community; the compression of salaries at the top of the grade structure; manpower ceilings; and similar matters which reduce the ability of Federal laboratory managers to manage in a flexible and effective manner, are, and will continue to be, matters of concern to the Committee on Federal Laboratories.

SOME CONCLUDING REMARKS

As Chairman of the Committee on Federal Laboratories, I feel that the subcommittee's interest in increasing the flexibility and usefulness of existing Federal laboratories to avoid needless proliferation of organizations is a sound one. The extent of contracting for outside research and development, the creation of new Federal Contract Research Centers, and the disruption of staffing efforts resulting from periodic expansions and contractions of Federal research programs, have all been matters of concern to committee members, to Federal R. & D. officials, and to the Congress itself from time to time.

In this context the experience of the Committee on Federal Laboratories does have something to offer. Probably one of the primary reasons for the creation of new laboratories is the need for a rapid buildup or restructuring of R. & D. capabilities for specific programs. To the extent that Federal salaries do not permit the rapid recruitment of frequently scarce and highly competent personnel, to the extent that Federal examining procedures and the establishment of registers slow down the hiring process, to the extent that Federal leave and other benefits are not designed to accommodate the staffing fluctuations, and to the extent that it is difficult to terminate, retrain, or transfer employees with no longer needed skills, the inevitable tendency is for officials responsible for new programs to let new contracts or start new facilities.

There are a number of legislative and administrative steps that could be taken to alleviate the above deterrents to Federal laboratory flexibility. One is the ability to make short-term appointments to all levels of positions without conferring permanent civil service tenure and without going through the routine examination process. To attract the type of people needed, one should also eliminate such side deterrents as the inability of new appointees to take any leave during the first 90 days of their appointment.

There are times when new programs need to have the ability to hire scientists of other nations. A legislative proposal for a visiting scientist and scholar program that would correct some of these deficiencies is currently in the process of preparation.

Further restrictions hindering the ability of the directors of existing Federal laboratories to adjust to new and changing programs are administrative and budgetary controls on travel, which hinder training and informational exchange; unduly restrictive controls on manpower; extra-laboratory controls of various types on the number of employees at various grades and on average grade and salary levels; and narrow management interpretations of agency and laboratory missions.

The number of hierarchical levels in an organization generally has an increasingly restrictive effect upon laboratory flexibility as their number increases.

As a concluding statement I would recommend that, to the maximum extent practicable, laboratory directors be given an overall allocation of resources with which to achieve a mutually understood set of program goals. Within this general framework, administrative and management decisions as to the proper mix of staff, supporting services, facilities, travel, et cetera, should be left to the judgment of

the laboratory director, who should be held subject to postaudit and fully accountable for the end results.

Thank you very much, Mr. Chairman.

(The prepared statement follows:)

PREPARED STATEMENT OF ALLAN V. ASTIN, DIRECTOR OF THE NATIONAL BUREAU OF STANDARDS

Mr. Chairman, members of the Subcommittee, I am pleased to have this opportunity to participate in these discussions on the utilization of Federal laboratories.

The National Bureau of Standards, which observed its 67th birthday this month, is among the oldest and largest of the Federal laboratories. Since its inception, the Bureau has been concerned primarily with providing the central basis within the United States for a complete and consistent system of physical measurement. This responsibility for measurement standards and techniques, and for reliable data on the properties of matter and materials constitutes a unique continuing mission that will exist so long as we have scientific and technological activities in this country.

Furthermore, it is a most demanding mission. This was well expressed by the Ad Hoc Committee of the National Academy of Sciences that evaluated the Bureau's functions and responsibilities in 1953. Their report stated:

"It is not sufficient to have fairly good standards of measurements, fairly good methods of testing materials, mechanisms, or structures, or reasonably good determinations of important physical constants. The standards, the measurements, the test procedures must be the very best, the most accurate, the most reliable that can possibly be achieved at any given time, limited only by the state of the art at the time. It is thus more than a play on words to say that the 'standards' by which the Bureau is judged must be the very highest and best."

By its very nature, the measurement standards mission grows with each passing year. As our Nation's science and technology advances at an ever accelerating rate, our measurement capabilities must keep pace. As our Nation becomes increasingly dependent upon science and technology for industrial growth, and for solutions to a variety of pressing national problems ranging from environmental pollution to safety on our highways, the measurement standards mission of the Bureau becomes increasingly important to our national welfare and national goals.

While this basic measurement mission has provided the prime focus of NBS activities through the years, the Bureau also has served since its inception as a central resource of scientific and technical competence within Government. Other agencies have made extensive use of the Bureau's competence and facilities, particularly in the exploratory stages of new technical endeavors. This has been a constantly changing role that has involved the Bureau, at least temporarily, in a great variety of technical activities, some of which have continued and have grown to become major national programs involving new Federal laboratories.

A brief résumé of the Bureau's historical development may help to illustrate ways in which its program has changed to meet changing requirements of the Government and of the Nation.

ESTABLISHMENT OF NBS

The National Bureau of Standards was established in 1901, after over 20 years of effort toward this goal by the Nation's scientists and engineers.

Standards laboratories in other countries had been meeting the needs of industry for measurement instruments of maximum reliability, accuracy, and range. Outstanding among these were the Physikalisch-Technische Reichsanstalt established in 1887 in Germany and the National Physical Laboratory authorized in 1899 in Great Britain. At the same time the United States was emerging from a primarily agricultural nation to a primarily industrial one with a rapidly expanding export market.

In 1900, the National Academy of Sciences, supported by unanimous endorsements from professional societies and the country's leading physicists, chemists, and engineers strongly urged the Congress that the establishment of a National Bureau of Standards was indispensable to the Nation's scientific, technical, and economic progress.

Congress responded in 1901 by passing the Organic Act which established the Bureau as the central point within the Federal Government for the construction, custody and comparison of measurement standards, and the determination of physical constants and the properties of materials, when such data were of great importance to scientific or manufacturing interests and were not to be obtained of sufficient accuracy elsewhere.

The first and most urgent task of the National Bureau of Standards in 1901 was to establish its own working standards so that it could begin to provide calibration services to science and industry. The prototype meter bar and kilogram had been in the custody of the Treasury Department's Office of Standard Weights and Measures. The office and the two standards were transferred to the new Bureau and work was begun on developing multiples and submultiples of these two primary standards.

A few electrical standards were obtained from the national standards laboratory of Germany, and the Bureau immediately embarked upon what was to become a long and difficult program—ranging over a time span of almost 50 years—before suitable standards for the basic electrical units were assured.

Other agencies of Government were quick to recognize the exceptional scientific and technical competence of the staff being assembled at the Bureau in those early years, and were eager to draw upon their talents. For example, when the Bureau was established, there were no other government scientific laboratories in the fields of physics and engineering. Soon, the Bureau began to test and evaluate materials other agencies were using. This gradually led to the development of methods of testing and standard purchase specifications, an activity in which we continue to have some involvement to this day.

Private industry was equally interested in standardization. In 1904, at the request of the American Chemical Society, work was begun on standards of purity for chemical reagents. A year later, the American Foundrymen's Association turned over to the Bureau a project on the standardization of four types of cast iron. These were reanalyzed by chemists at the Bureau, and in industrial and commercial laboratories. They were then issued as National Bureau of Standards standard samples. This program has grown, until today, there are more than 600 standard reference materials issued by the Bureau, including metals, ores, chemicals, spectroscopic standards, isotopic standards, and radioactivity standards. The demand by science and industry for new standard reference materials is so great it seems unlikely the list will be completed in the near future.

DECADES OF EVOLUTION AND ADAPTATION

During the first two decades of its existence, the Bureau was, in many respects, carrying on an industrial research program. Typical investigations involved: lubricating oils, automotive engineering, studies of refrigerants, electrolysis, corrosion, determination of critical points of steels, properties of ceramics, lime, metals, protective coatings, rubber, textiles, paper, and optical glass. In many of these areas, industry rapidly recognized the value of the Bureau's pioneering research and organized its own research programs. As this occurred, the Bureau would gradually withdraw from the field, except insofar as the remaining problems involved compatibility of physical measurement.

The second two decades might loosely be described as a period when the Bureau became involved in standards of practice and performance, codes and specifications. This trend had been accelerated by the industrial problems connected with the First World War. Typical of these activities were programs on screw thread standardization, development of the National Electrical Safety Code, and Commercial Standards and Simplified Practice Recommendations.

The two world wars offer a striking comparison of the general level of science and technology, and the way NBS programs were utilized to meet urgent national needs. In the first war the Bureau aided in the development of a method for manufacturing precision gauge blocks, production of high quality optical glass, and sound-ranging devices to locate artillery. The problems were essentially of an industrial nature, and the facilities and competence of the Bureau were utilized accordingly.

World War II made different demands upon science and industry, and the Bureau's role was thus of a different nature. The Bureau contributed to the development of methods for the purification of reactor materials in the Manhattan project, the radio proximity fuze, the BAT guided missile, and the prediction of radio weather for long-range military communication. Here, the Bureau's

long-standing work in chemistry, radio, electricity and electronics had been needed.

The heavy commitment of NBS resources to the assistance of other Federal agencies during World War II, and the almost explosive development of Government concern with scientific and technological programs in the years immediately following, created severe problems for the Bureau. In its efforts to be responsive to the many demands for technical assistance from the military, the Atomic Energy Commission, and numerous other agencies intent upon exploiting and refining the scientific and technological breakthroughs achieved during the war, the Bureau at times devoted as much as 77% of its manpower to the programs of other agencies, and depended on funds transferred from those agencies for up to 85% of its financial support.

In 1953, following a study of the Bureau's programs and activities by a committee of the National Academy of Sciences, substantial changes were initiated in the content of the Bureau's scientific activities and in the emphasis which would be placed on its varied functions. Military development programs were transferred to agencies of the Department of Defense. Plans were begun to decrease the amount of work done by the Bureau for other Government agencies. These moves would enable the Bureau to concentrate its efforts on the vital measurement and calibration services needed by the Nation, and on the determination of the physical constants and the properties of materials. It would continue its long-standing, close cooperation with industrial and scientific standardizing organizations. This reorientation of the Bureau toward its original, basic functions was given special emphasis and appropriateness by the greatly increased demands made upon the Bureau's measurement services as a result of the advent of the space age in 1957.

The new and exacting requirements of the space age, the widening use of automation, the ever faster application and transfer of technological breakthroughs to the civilian economy—these factors and others all offer evidence that the measurement needs of the Nation will be greater in the years ahead than ever before. It is within this context that the Bureau during the last decade has modernized its facilities, and has continued to strengthen its measurement capabilities and the research which is essential to its measurement competence.

CHANGES IN LEGISLATION

The evolutionary changes in NBS activities that I have outlined were not accompanied by significant changes in the Bureau's basic legislation until 1950. This was possible largely as a result of the liberal interpretation of the comparatively general language in the original Organic Act and a substantial amount of authorizing language inserted in appropriation bills over the years. In 1950, the Organic Act of 1901 was amended to include more specifically four additional functions which the Bureau had been performing for many years. These were:

(1) The development of methods for testing materials, mechanisms, and structures, and the testing of materials, supplies, and equipment, including items purchased for use of Government departments and independent establishments.

(2) Cooperation with other Government agencies and with private organizations in the establishment of standard practices, incorporated in codes and specifications.

(3) Advisory service to Government agencies on scientific and technical problems.

(4) Invention and development of devices to serve special needs of the Government.

In 1950, the Bureau also was given authority to establish a working capital fund that has proved to be an excellent mechanism for handling reimbursements for the extensive services we render to other agencies and the public.

NEW IDEAS AND ORGANIZATIONS

The National Bureau of Standards has served over the years as a breeding ground for both new ideas and new organizations. This, quite possibly, has been one of the most important contributions of the Bureau to the operations of the Government and of the private sector. It has taken various forms. In some cases actual organizational units were transferred from NBS to another agency. In others, research initiated at NBS was picked up and carried on elsewhere—in another Federal laboratory, in private industry, in standards-making organizations, and in standards laboratories. This has not occurred by accident. It has

been the continuing policy of the Bureau to do those things in the physical sciences which are related to our basic missions when a national need exists and the work is not being done adequately by anyone else. When another agency or industry develops the capability to carry on and become self-reliant in the field, we step aside and turn our attention to the unending appearance of new areas that require our attention.

For example, the Naval Research Laboratory, established in 1923, absorbed research on radio communications with submarines that was initiated in laboratories at the Bureau during World War I. Similarly, the Naval Ordnance Laboratory absorbed work NBS had done on range finding and the stabilization of naval guns.

For a time after the establishment of the National Advisory Committee for Aeronautics in 1915, the Bureau served as its main research facility. The early aerodynamic research performed at NBS was ultimately greatly expanded in the NACA's own laboratories, which in turn became a part of the National Aeronautics and Space Administration.

In 1953, in response to the recommendations of the National Academy of Sciences Committee I mentioned earlier, ordnance work generated at the Bureau during World War II and the Korean conflict was transferred from NBS. Three NBS divisions became the Harry Diamond Laboratories under Army Ordnance. Naval Ordnance took over NBS work on missile development that had been conducted at Corona, California.

Other examples could be cited concerning research initiated at NBS that has provided a basis for activities now conducted by the Federal Aviation Administration, the Federal Communications Commission, and others. Most recently, our Central Radio Propagation Laboratory became a key research component of the newly formed Environmental Science Services Administration.

NBS also has provided a breeding ground for private endeavors. Many of our staff members get ideas that need industrial, exploitation and leave the Bureau for this reason. Two of our neighbors in Maryland, Rabinow Electronics, and Weinschel Engineering, were formed by former NBS employees. The American Instrument Company was also founded by a former employee, and techniques for geophysical prospecting became the basis for private enterprises headed by former NBS employees working in that field.

Certain of the technical activities in which the Bureau pioneered provided the basis for extensive industries. For example, there was no optical glass made in the United States prior to World War I. When the war cut off supplies from Europe, NBS established a research program in the making of optical glass. The technology developed in that research program, especially the development of new types of pots for melting the glass, was the foundation of our domestic optical glass industry.

In 1921, NBS scientists tested their first crude radio guidance system for aircraft. By 1929 they had refined it to the point where the pilot could keep on course and know his approximate position at all times without being able to see outside his plane. By 1930 they had accomplished the first blind landing of an airplane entirely by radio guidance. The continuation of this technology under private development has helped to shape large segments of the transportation and instrument industries.

There are other examples. The printed electronic circuit which is used so widely today was developed under NBS sponsorship during the wartime ordnance development. NBS built the first internally programmed electronic computer in this country. The technology from that project was absorbed immediately into what has become a multimillion dollar private industry. Numerous other cases could be cited.

SHARING RESOURCES

As you can see, the Bureau has a long tradition of sharing its laboratories—both staff and equipment—with others. This is provided for in our Organic Act as amended.

NBS is really a complex of many laboratories. The range of research in them and the sophistication of the labs themselves have grown greatly over the years. So much so that our former quarters in the District of Columbia became hopelessly cramped and outmoded. Provision was made for moving the Bureau to its present quarters at Gaithersburg, Maryland. The present facilities are as modern as today's state of the art permits. These facilities, and the professionals who staff them, are available, to varying degrees and in diverse ways, to the Federal

and State governments, the academic community, private and public standards making bodies and standards laboratories, professional societies, and industry.

GOVERNMENT AGENCIES

We do a considerable amount of work for other Federal agencies, ranging from fairly fundamental research to testing and calibration. A substantial part of the NBS annual budget—currently 40% of the total—is made up of funds transferred to us from other agencies for services rendered. This percentage has varied over the years, and even now differs among the various organizational units within the Bureau. For example, about 70% of the funds available to the Institute for Applied Technology is transferred from other agencies. While we wish to, and will continue to, provide services to other Federal agencies, we do have to be careful that the ratio of other agency funds to appropriated funds is such that the basic missions of the Bureau are not distorted by over-dependence on outside support.

NBS laboratories also serve State and local needs, primarily in the weights and measures field. Here, our specialized expertise is passed on to the States mainly through the mechanism of the NBS-sponsored National Conference on Weights and Measures, an annual meeting of State weights and measures officials, in which NBS scientists and engineers actively participate. We are also in constant contact with State officials on calibration problems, measurement techniques, training of local personnel, and other areas related to weights and measures used in commerce.

THE ACADEMIC COMMUNITY

NBS interactions with the academic community are varied and growing. They include use of our laboratory facilities in a number of ways.

NBS has an Associate Director for Academic Liaison, with the following objectives: (1) to improve and stimulate the intellectual quality of NBS programs and staff, (2) to make the fullest possible use of NBS special resources, both laboratory facilities and staff, (3) to strengthen national competence in those areas of science and engineering which are related to NBS missions, (4) to provide a means for NBS staff to further their education through collaborative research, (5) to train personnel in fields important to NBS but in which a shortage of competent people exists, (6) to serve as a resource to industry through educational training programs aimed at meeting national as well as regional industrial needs.

An outstanding example of Government-university cooperation is the Joint Institute for Laboratory Astrophysics (JILA), a cooperative effort of NBS and the University of Colorado. JILA itself is located at the University of Colorado in Boulder, Colorado. Its purpose is to further laboratory and theoretical research and graduate level training in astrophysics. The faculty comes from both the University and NBS. The laboratory facilities of both institutions are likewise shared. In addition, JILA's visiting fellowship program brings to Boulder about 10 distinguished scientists in the broad field of laboratory astrophysics. These scientists come from all over the world.

We maintain a graduate school at NBS. Courses may be given for credit at universities or strictly on an in-hours career development basis. Enrollment is not limited to NBS or other Federal employees.

The postdoctoral associate program is another important cooperative effort involving the academic community. A list of candidates is chosen and ranked by a National Academy of Sciences-National Research Council panel. An NBS Postdoctoral Committee meets at lest annually and makes its selections from this list. The program was started at NBS in 1955. Since then, it has been successfully extended to many other laboratories in the Federal Government.

PRIVATE STANDARDS ORGANIZATIONS

NBS works very closely with private standards making bodies, of which there are some 500 in the United States. We participate in the work of many of the organizations, such as the United States of America Standards Institute, and of course help any of them with problems associated with measurement standards and techniques.

In 1961, NBS sponsored the establishment of the National Conference of Standards Laboratories, and has acted as its secretariat ever since. The NCSL is a continuing, non-profit, laboratory-oriented organization to promote coopera-

tive efforts toward solving common standards and measurement problems. Its members include standards laboratories of individual companies, universities, independent laboratories, and those in other government agencies.

NBS extends its laboratory resources to professional societies and standards groups in several ways. Our experts visit groups all over the country and pass on the latest developments of NBS research in different fields. We also sponsor (or are host to) many conferences, seminars, workshops, meetings, and such, at which Bureau scientists and engineers report on the latest results of NBS research, and participants are given an opportunity to visit NBS labs, and thus note how our special facilities may be used at some future time to solve a measurement or standard problem.

INDUSTRY

Finally, our laboratory facilities are shared with industry itself. The most effective mechanism is our Research Associate Program. Under this plan, industrial groups sponsor research at the Bureau which is of special interest to them and yet has public significance. Experiments are carried out by Research Associates who are paid by their sponsors but who work in Bureau laboratories with the Bureau staff. The knowledge and skills thus derived by Research Associates are expected to advance the Nation's economy and to increase utilization of NBS research results. The Research Associates contribute their industrial experience and their knowledge of urgent industrial needs.

The work of Research Associates is not directed to proprietary solutions. Instead, it is aimed at removing obstacles to the use of measurement; such obstacles may arise from a lack of sound data or instrumentation, or from a lack of criteria or of appropriate techniques.

At present there are 63 Research Associates at NBS representing 23 companies, trade groups, and government organizations.

In summary, the laboratories of the NBS are utilized in many different ways and by many groups. These include actual use of NBS equipment by others, work done for others, extension of our laboratory capability through contact between our experts and others, calibration and testing for various customers, and by the distribution of our laboratory products, such as the standard reference materials and reference data.

THE PROBLEM OF ADDED RESPONSIBILITIES

Since 1950, when the basic missions of the Bureau were fully spelled out, a number of responsibilities have been assigned to us—some by amendment of the Organic Act, some by specific legislation, and some by delegation from the Secretary of Commerce. Among these new assignments are:

(1) The dissemination of technical, scientific and engineering information through the Federal Clearinghouse for Scientific and Technical Information.

(2) The establishment of uniform Federal automatic data processing standards.

(3) Operation of a National Standard Reference Data System.

(4) Research on and development of flammability standards for fabrics and household furnishings.

(5) Operation of a National Fire Research and Safety Program.

The problem is not that we don't have the capability of performing these functions, but that we have not been provided with the resources necessary to carry out the programs at optimum levels. The result is that we have had to do extensive reprogramming which has seriously hurt our longer established programs. Our ability to pick and choose priorities now is practically nonexistent. And we face this situation at a time when there is an urgent need to keep abreast of rapid technological advances requiring basic standards and data services. As a Nation, we can ill afford any unnecessary delays in these technological advances which are vital to our domestic economy, to the expansion of our export trade, and to the solution of such far ranging national problems as urbanization, environmental pollution, transportation, and many others.

Mr. DADDARIO. Just one question, Dr. Astin, because we do have two more witnesses.

On your first statement, the one that I asked you to summarize, you say on the last page "our ability to pick and choose priorities now is practically nonexistent."

Do you have a whole series of things that you would like to do?

Dr. ASTIN. Yes, sir.

Mr. DADDARIO. This position would seem to make it difficult to accomplish any of those.

Dr. ASTIN. Well, the point I was trying to make there is that we have been given a number of new responsibilities at the National Bureau of Standards, some by exective direction, some by legislation, and we are finding it difficult to get resources for these new responsibilities.

For example, the standard reference data responsibility given to us nearly five years ago now by the Federal Council for Science and Technology is being funded primarily through curtailment we have made in other activities in order to put some resources on it. We have been unsuccessful in convincing the Congress of the importance of funding this program at the level that would make it most effective for the Nation's scientific and technological effort. This country spends approximately $17 billion a year for scientific research and development. Standard reference data, if adequate, would greatly facilitate this total activity. If it only improved it as much as a percent or two, which I think would be a very modest achievement to expect from a data system, the savings would be phenomenal, but we are now operating the standard reference data program at one-tenth the level we consider necessary to be effective.

Similarly, the Congress two and a half years ago gave us the responsibility to develop standard for automatic data processing systems, and to assist other Government agencies in the optimum or more effective utilization of automatic data processing systems. During the hearings preceding the enactment of that legislation it was shown that if that program were adequately implemented it would save the Government around $150 million every year in its expenditures for automatic data processing systems.

The Government's expenditures totaled about $3 billion a year, and it was conservatively estimated during the hearings that savings of a hundred and fifty million would be achieved. This is some 20 times what we think it would take in appropriations to NBS to operate the program—clearly a good investment, but we are nowhere near the operating level it takes. Because we consider these important programs, we have converted our resources to them to the maximum extent possible, but we can't do any further reprograming of this sort without killing something equally as important.

Mr. DADDARIO. The inhibiting factors placed by the Congress is not anything we are trying to avoid. We have made it clear from time to time that these programs do reflect quality. From the standpoint of standard reference data program, we hope that we can impress upon the Senate the need to pass the bill already passed by the House.

The reason I asked you this question about the problems you have insofar as priorities are concerned is because it does appear clear that there are management problems and some of these management problems are related things that Congress has or has not done. We do not intend to infer that all the problems are in the executive branch.

I am pleased, Dr. Astin, you brought up these two points because without any question the effectiveness of your activities could be enhanced by support in these areas. They are good examples.

Dr. Astin, we are pleased to have you here. As always we overestimate our ability to hear the number of witnesses we had planned because what you have to say is of such importance to us.

Dr. ASTIN. It is always a pleasure to appear before you, Mr. Chairman. Thank you.

QUESTIONS SUBMITTED TO DR. ALLAN V. ASTIN BY THE SUBCOMMITTEE ON SCIENCE, RESEARCH AND DEVELOPMENT

Question 1. Are contractor operated laboratories represented on the Laboratory Committee? If not, why? Is the work done by the Laboratory Committee inapplicable to contractor operated laboratories?

Answer: Contractor operated laboratories are not represented on the Committee on Federal Laboratories. The Committee on Federal Laboratories is concerned with the management and staffing of the Government's in-house laboratories and with the rules, policies and procedures that affect their operation. Contract operated laboratories are not bound by the same laws and regulations as in-house laboratories, and their employees are not under the civil service system. However, if and when some of the management principles or problems dealt with by the Committee on Federal Laboratories would appear to be of interest and concern to contract laboratories, the Committee would not hesitate to seek the participation of contract laboratories in pertinent studies. This has been done in at least one instance.

Question 2. You state that the "inevitable tendency is for officials responsible for new programs to let new contracts or start new facilities" because of certain problems you mention in connection with the Civil Service laws and regulations. Can you illustrate specifically what the problems are and what you believe should be done to correct them?

Answer: When an agency is made responsible for a program requiring a significantly new or different R&D capability, or when a new agency with an R&D need is created, the key consideration usually is how can this need be met within the pressing time requirements that generally prevail. In this context, unless one can readily expand and/or restructure existing Federal R&D staffs and facilities, agencies are prone to establish a new laboratory for several reasons.

The need for greater flexibility in providing for something new, frequently leads to the formation of a federally financed or related laboratory outside of the civil service system. This is due to the fact that appointments can be made easier and faster; prospective appointees can be paid for their travel for preemployment interviews; more competitive salaries can be paid—particularly at the critical higher levels; procurement of supplies, equipment and facilities can be accomplished quickly with less red tape; etc.

Establishment of new laboratories within the Federal structure occurs in part because of the time consuming and difficult problems involved in reorienting or reshaping existing staffs. These may include difficulties in terminating marginal people or those with no longer needed skills, in transferring civil service personnel to other units, in retiring non-productive employees, and in getting sufficient manpower ceiling or travel and training allocations to retrain significant portions of the present staff.

A second reason for the formation of new in-house laboratories is the human tendency of many people to want to have the work for which they are responsible performed under their immediate control rather than through some other organization. Other persons may have an empire building tendency.

A third reason for the formation of new laboratories is the simple fact that the person involved may not be aware of the existence elsewhere of a suitable existing Federal competence that could do the work.

Specific management actions that would facilitate redirection of effort would be the maximum delegation of authority for consummating personnel, training, and procurement actions to the laboratory director level. Legislative and regulatory actions that would help would be to increase the ability of laboratory managers to hire the necessary professional talent. Some current examples of such legislative action would be passage of the bill to permit the reimbursement of selected professional applicants for preemployment interview travel, and the attainment of truly competitive salaries for top scientific positions. Federal laboratories need the capability to hire outstanding experts for limited

periods of time as embodied, for example, in a legislative proposal for a Visiting Scientist and Scholar Program which has recently been submitted to Congress by the Civil Service Commission. Additional authority to permit the temporary hiring of research scientists and engineers for periods up to five years without going through competitive civil service examinations and registers and without granting them permanent civil service status would facilitate the hiring of eminent scientists and ensure much greater flexibility in more readily restructuring laboratories' staffing capabilities. The present law precluding the taking of annual leave during the first 90 days of employment hinders, in some instances, the recruitment of top quality and senior personnel. The ability to retire people after 30 years of Federal service at the option of management would also help.

Question 3. You mentioned that you were a "little disappointed" in the effect of the three symposia which were sponsored in conjunction with the Civil Service Commission. What did the symposia attempt to accomplish and why were you a "little disappointed" in the results?

Answer: In general the symposia sponsored by the Federal Council for Science and Technology were designed to exchange ideas about effective ways of solving administrative matters and Government problems—particularly those pertaining to personnel. A number of valuable ideas were exchanged.

In the Committee's experience, management and staffing problems in Federal laboratories are due much more frequently to the policies, practices and decisions of managers at various levels within the departments and agencies than to the Government-wide laws and regulations. The symposia attempted to deal with this problem through fostering communication (1) laterally among laboratory management officials regarding the system and what is possible and (2) vertically with agency officials at various bureau and department levels in order to arrive at better understanding of the operating level's problems and needs. While the symposia have been generally successful in respect to item 1, we were in the main unsuccessful in obtaining the attendance of a broad spectrum from the higher administrative levels.

In retrospect, another weakness in the planning was that the Committee did not include a mechanism for followup to determine how much was achieved. From random comments received from some participants it did appear that some symposium generated information was useful. Accordingly, plans for the next symposium will include provisions for a systematic followup to evaluate results.

Question 4. If the Committee decides not to study the procurement, management and utilization of Federal R&D equipment and facilities, is there any other organization at the OST level that could perform the study? What considerations would be before the Committee in deciding whether or not to make the study?

Answer: The Committee on Federal Laboratories is currently making an abbreviated survey of Federal equipment policies and practices. Whether or not the Committee decides to make a detailed study and analysis will depend on its ability to devise a meaningful objective study pertaining to the utilization of equipment, being able to obtain the necessary types of information, and being able to foresee some rationale for analysis that would seem to promise useful and generally relevant conclusions and recommendations.

At present we know of no other organization at the OST level that might readily perform such a study, although, of course, the Office of Science and Technology could, if it so decided and funds were available, hire a person and/or staff specifically for the purpose of monitoring the management and utilization of Federal facilities and equipment.

Question 5. What information about Federal laboratories—both directly and contractor operated—should be collected and maintained by the Executive Branch? Who should do it? How desirable and feasible would it be to set up a clearinghouse for information about selected Federal laboratories?

Answer: In order to carry out the intent behind this question one needs to resolve a basic matter of understanding, namely, definition of what constitutes a laboratory. To illustrate, we frequently have difficulty in responding to queries about the "laboratories" of the National Bureau of Standards. Does the Bureau have three laboratories—the Institute for Basic Standards, the Institute for Materials Research, and the Institute for Applied Technology? Or does it have three laboratories—one in Washington, D.C., one in Gaithersburg, Md., and one in Boulder, Colorado? Looking at the definition from a more specific point of view, is each of the technical divisions, each with its own distinctive types of activity, a laboratory? In other agencies with numerous small field stations, one needs to make a decision as to minimum size. Is a five, ten

or twenty man unit a laboratory? This suggests that at least two parameters in any definition would be the questions of geographical concentration and of the number of professional personnel.

Once a laboratory is identified, I would say the following data would be helpful in making an initial screening of existing Federal facilities for possible new program assignments:

Name of Federal laboratory;

Location;

Number of professional staff, broken down by major disciplines, that is, engineers, physical scientists, biological scientists, behavioral scientists, and medical scientists;

A statement of the laboratory's major mission(s); and

A brief statement concerning each of the laboratory's major facilities or fields of competences.

I believe it would be *feasible* to establish a center clearinghouse for this type of information, probably in OST. However, in 1955 the Interdepartmental Committee on Scientific Research and Development, the predecessor to the present Committee on Federal Laboratories, in response to Executive Order 10521, did prepare a Government-wide inventory of major Federal laboratories and equipment. A supplement was issued in 1957. Insofar as the Interdepartmental Committee was able to determine, little or no use was ever made of the information, which, incidently, was given a security classification of "restricted" because of the amount of specific, detailed information in the total compilation.

Two types of clearinghouse might be considered. One type would be to establish an office which would promulgate certain guidelines as to the level and type of information to be sought and a standard format for its presentation. Then to periodically request, update and disseminate the information. This would be a formidable undertaking requiring a fulltime staff of several persons, use of automatic data processing and printing equipment, space, and significant funding. A second, less ambitious approach would be one of gathering existing equipment, facility and program inventories which are already being produced in varying degrees by many agencies and simply function as a central reference and information facility. Even this latter approach would require a minimum staff capable of establishing a useful integrative indexing system and of motivating agencies to fill in blank spaces where inventories do not now exist. This too would require space and a not insignificant amount of financing if it was to really fill a useful role.

This leads to the question of *desirability* of establishing a clearinghouse of such information. Its desirability would have to await the test of use. I think this would depend heavily on the extent to which agencies were brought to think in job shop terms by direction, policy, and urgings from Congress and top Executive Branch officials.

Question 6. Several agencies have set up procedures to appraise the performance of contractors that do research and development for them, or that manage agency laboratories. To your knowledge, what consideration has been given to applying the standards and procedures of these appraisal processes to Government operated laboratories? To what extent would this be desirable?

Answer: The Committee on Federal Laboratories has not studied this subject. The Department of Defense uses criteria to measure contract performance, but I am not familiar with the standards and procedures referred to. We plan to investigate these. In view of the foregoing, I am not prepared to say to what extent specific existing appraisal techniques should be used in any particular laboratory other than our own. From a management viewpoint, of course, some type of evaluation is a practical necessity.

Question 7. What criteria do you use to rate the laboratories within the NBS?

Answer: To answer this question meaningful for NBS I would like to paraphrase the question as follows: What means or criteria do you use to assess program capabilities within the NBS? The answer is that an annual or sometimes more frequent series of reviews of all of the significant programs of the Bureau are made by operating personnel to top NBS officials. Generally programs are closely related to one or several organizational units. The program of each division is also subject to review at least annually by Advisory Committees of the National Academy of Sciences. Finally, an outside evaluation of the Bureau as a whole is made by a Statutory Visiting Committee which reports annually to the Secretary of Commerce on the efficiency of NBS operations.

At the program reviews those responsible for the program discuss their past accomplishments, present work and future program plans. Information is given

and questions raised concerning the adequacy and competence of the staff and future requirements; similar matters are covered in respect to facilities, equipment, funds and other resources. Program requirements and priorities are discussed in respect to their relationship to national needs. On the basis of all of the above, the present health and future outlook of Bureau programs are assessed by NBS officials, priorities are set, and appropriate allocations and commitments are made. Occasionally decisions are made that some programs of substantially diminished importance have outlived their usefulness. When such decisions are made, the staff members involved are reassigned when possible or reduced in force when reassignment is impractical.

Question 8. The DOD witness proposed the elimination of manpower controls on cross-agency work in order to achieve flexibility similar to that available to the AEC contract laboratories. What is your opinion on this proposal?

Answer: As indicated in my statement before your Committee, I feel strongly that laboratory directors should be given an overall allocation of resources with which to achieve a mutually understood set of program goals and, within this general framework, should be free to use the resources as he best sees fit. In this context I would endorse the elimination of manpower controls on cross-agency work in terms of numbers. However, laboratory directors should be subject to certain policy guidelines to ensure a reasonable balance. For example, one such guideline might be that the laboratory not undertake such work when acceptance of it would require the building or acquisition of additional space.

If political considerations or policies require some type of manpower controls then a more acceptable and practical limitation would be one placed on the total amount that could be paid for salaries, rather than one in terms of staffing patterns. Manpower controls contribute to the inflexibility of in-house procedures and, in our judgment, sometimes lead to contracts for personal services as a means of circumvention.

Question 9. What criteria should govern: (a) how much independent money a laboratory director should have? (b) the appraisal of what the director has accomplished with funds previously authorized to him?

Answer: In respect to the criteria for part (a), I would agree with Dr. Hornig that suitable factors to apply would be the degree of narrowness or leeway in the mission and work of the agency and the quality of the laboratory and its management. The more general the nature of the work and the higher the quality, the more independent money should be provided. This might reasonably range from 3 to 15 percent.

In respect to question (b), the appraisal of what a director has accomplished with funds previously authorized to him could probably best be accomplished by periodic program reviews at which laboratory officials present and discuss their program accomplishments, plans, and problems with a competent technical review board of higher authority. These periodic reviews should evaluate the results obtained from use of the independent funds in terms of their relevance and contribution to:

1. The laboratory's mission;
2. The parent agency's mission; and
3. Building and strengthening the basic capability of the laboratory staff.

A pattern of results of trivial value or little relevance to the above objectives would indicate inefficient use of funds.

Question 10. Does your laboratory have ceilings for its personnel? If so, how are these ceilings set and who does it? What flexibility do you have for assignments within a ceiling? How feasible is it for you to obtain a change in personnel ceiling to accommodate work for another agency?

Answer: The NBS does have manpower ceilings controlling the number of personnel. Bureau requests are reviewed by Departmental and Bureau of the Budget officials with the numbers adjusted accordingly. The manpower ceiling allocated to the Bureau is specified in terms of two numbers: (1) total employment and (2) number of permanent full-time positions. Within these overall totals NBS is free to shift personnel assignments among any of its subordinate organizations. If forecast in time, a change in personnel ceiling to accommodate work for another agency would be reflected in our yearly manpower request to the Department. If this was not known until after allocation of the annual ceiling, it would require a request that the ceiling be changed. The result would depend on the decision of Department officials. In a recent case the Bureau's manpower ceiling was increased to accommodate a new program for another agency to implement recently enacted legislation.

Question 11. The concept of utilization implies that sooner or later decisions will have to be made to allocate and schedule existing laboratory capability among competing agency needs. Is there as present any place in the Executive Branch short of the President where priorities can be assigned to Federal missions for the guidance of agency heads and laboratory directors in the event of competing requirements for the same facility? What is the function of the Laboratory Committee in the setting of such priorities and scheduling?

Answer: I think that assistance and coordination in the assessment of mission priorities and the allocation and scheduling of work at existing laboratory capabilities is presently an important function of the FCST and the Office of Science and Technology. For the most part this is a voluntary effort depending on consensus and the acceptance of guidelines by agency officials. The Committee on Federal Laboratories has no role or responsibility in the setting of such priorities and scheduling. Its concern is primarily with the procedures and resources by means of which the policy decisions are implemented.

Mr. DADDARIO. Our next witness is Dr. William McLean, technical director, Navy Undersea Warfare Center.

(Dr. McLean's biography follows:)

DR. WILLIAM B. MCLEAN

Dr. McLean obtained BS (1935), MS (1937), and Ph.D. (1939) degrees in physics from the California Institute of Technology and served as a part-time physics instructor. He received a Post Doctoral Fellowship for academic years 1939–40 and 1940–41 at the University of Iowa and entered Federal Civil Service in 1941 as a nuclear physicist with the National Bureau of Standards. In 1945, Dr. McLean transferred to the Naval Ordnance Test Station, China Lake, California where he advanced to the position of Head, Aviation Ordnance Department. In 1954, he was appointed to his present position of Technical Director.

Special awards include the maximum Federal Government Award of $25,000 for the development of the SIDEWINDER air-to-air missile (1956), the Naval Ordnance Test Station's L. T. E. THOMPSON Award (1956), a Resolution of Commendation by the California State Legislature (1957), the President's Award for Distinguished Federal Civilian Service (1958), and the American Ordnance Association's Blandy Gold Medal (1960).

He is a member of Tau Beta Pi, Sigma Xi, American Physical Society, American Association for Advancement of Science, Research Society of America, American Ordnance Association, Institute of Radio Engineer, American Society for Public Administration, and American Institute of Aeronautics and Astronautics.

STATEMENT OF DR. WILLIAM B. McLEAN, TECHNICAL DIRECTOR, NAVY UNDERSEA WARFARE CENTER

Dr. MCLEAN. Mr. Chairman and gentlemen, I appreciate this opportunity to talk with you about the research and development effort in Federal laboratories.

As recognized by this group in its present inquiry, the management of research has become a national problem of some magnitude. The researcher is no longer concerned only with purely technical problems but also with the application of his technology to social, economic, and political problems on a national and an international scale. I am of the opinion that research is never a job that can be completed, but will continually expand as more positive results become available. It is, therefore, obvious that no single organization can ever attempt to cover all possible areas of research, even in a very superficial manner. I believe it should be our objective in research to make sure that our work is as near the frontiers of knowledge as is possible; that we are working in those areas where we have strong interests and the proper tools to carry out the research; and that we are continually searching for a better understanding of nature and are always on the lookout

to find discrepancies in our known knowledge which will lead us to interesting new possibilities.

Mr. DADDARIO. Dr. McLean, I am pleased to see that you have included in your preliminary remarks the concern that the researcher has with the social, economic, and political problems. I believe this to be a very important aspect.

Dr. MCLEAN. Yes.

Mr. DADDARIO. This gives us a great opportunity to use these talented men in the solving our social, economic, and political problems, and a great effort must be made to enhance this capability.

Dr. MCLEAN. Yes, sir. I think the interdisciplinary work is very important to include in laboratory programs.

Mr. DADDARIO. You were here yesterday when Dr. Weinberg talked about this?

Dr. MCLEAN. Yes.

Mr. DADDARIO. In some of their work at Oak Ridge they find as they begin to accomplish some of these objectives for other agencies they are going further and further into problems of society. This would also be the case from what you have said.

Dr. MCLEAN. I believe so, yes.

We know that federally financed research and development can be accomplished through several different means: the in-house laboratory, the Government-owned facility operated by a contractor, universities provided grants or contracts, contracts with nonprofit organizations, and contracts with private corporations. All of these types of management structure appear to work well. To me, the crux of the problem is not the type of organization but the process of setting management objectives for the organization so as to keep them broad enough and just impossible enough that people can generate their own methods of working toward these common objectives and be judged by the impersonal process of competition. Management of the development of our weapons systems is a complex and complicated task requiring not only the skills to solve the purely technical problems, but also the highest order of management coordination. Let me illustrate from my past experience as Technical Director of the Naval Ordnance Test Station, a laboratory of approximately 5,000 people engaged principally in the development of air launched weapons—now the Naval Weapons Center.

The ASROC weapons system involved an extensive research and development effort whereby NOTS as lead laboratory for the Bureau of Naval Weapons undertook project responsibility for development of the entire weapons system, including propulsion, fire control, launcher, and development of the torpedo and mechanical test and incorporation of the nuclear depth charge. This required interfaces with a wide range of governmental and industrial activities, including several Navy bureaus, the Atomic Energy Commission, and numerous prime and subcontractors for production of the system and its component parts. The laboratory's involvement with this program started with the definition of a fleet need. It carried through concept development, feasibility demonstration, prototype development, contractor direction on production, and finally fleet introduction and troubleshooting.

NOTS was able to accomplish this program because of its broad mission, extensive experience in a variety of program areas, and diverse technical skills. It is my belief that a broad charter and work experience utilizing skills from many disciplines are essential keystones to undertaking large systems developments which must be supported by the effort of many agencies.

In addition, some one must have the desire, determination, and skill to establish and maintain control of all the variables involved.

The concept of a single responsible designer for systems as complicated as those of our modern weapons has not been employed frequently in our current military designs. To achieve a simple, integrated design, we should employ the concept of appointing a single master designer for each system, who would execute his responsibilities in a manner similar to that of the master architect of a building. If we are to have a truly integrated design, a single man must understand what he is trying to create, must be responsible for the choices among the infinitude of alternatives available, and must weave the various elements of the design into the integrated system. Like an architect, he must understand the tools of his trade. An outstanding example of such an architect is Adm. Levering Smith in the Polaris program.

In the planning of military equipment, with which I am most familiar, we have for centuries operated under the general objective of developing devices to destroy more effectively the enemy or his tools for making war. During recent years our national R. & D. effort has achieved for us the capability of near total destruction. I believe now that our national goals have shifted a portion of our R. & D. attention to "limited warfare," which in effect is the extension of police methods and weapons against international crime.

The control of crime on a national level and waging conflicts such as the one in Vietnam would seem to have many aspects in common. It is highly probable as your questions suggest, that we will see the use in international settings of the techniques and equipment developed for control of national crime and vice versa.

The Naval Undersea Warfare Center is a relatively new organization, established on July 1, 1967. The functions and programs, however that were brought together to make up this new organization were already well established within the Navy laboratory structure, and will provide the takeoff point for new program developments.

This new organization was part of a general Navy plan to restructure in-house laboratory effort into centers of excellence for improved utilization of laboratory resources. The plan encompassed the development of a number of self-contained organizations, to include enlarged systems integration capabilities, with each center working toward the identification and solution of specific and related military problems.

The Naval Undersea Warfare Center was created from elements of the former Naval Ordnance Test Station and Navy Electronics Laboratory. It is a primary research, development, test, and evaluation activity of the Naval Material Command, and it is responsible to the Chief of Naval Material for the administration of assigned funds, conduct of operations, and the accomplishment of the mission. The mission of the Center is to support the fleet by originating and anal-

yzing new ideas in undersea warfare and ocean technology, by translating these into effective operating systems and by assisting in the introduction of resultant undersea warfare systems and technologies into production and service use.

The work of this Center covers a wide range of research and development in such fields as underwater optics, underwater acoustics, military oceanography, sonor technology, oceanometrics, fluid dynamics, lasars; and advanced computer techniques, and systems developments in submarine launched weapons, deep submersibles, homing torpedoes, deep sea salvage systems, deep-operating research vehicles, fire control systems, underwater sensors, and search and recovery systems.

I have provided your committee with brochures and reports of our work. Some of the material describes the work of the new Center organization; some from the former Navy Electronics Laboratory and the Naval Ordnance Test Station describe our ocean research and sensor development, ASW weapon developments and ocean engineering programs prior to the reorganization of last July which transferred these programs to the new Center.

NUWC is currently operating on the original sites of the two primary laboratories from which the Center was formed. The Center has major laboratories both in Pasadena and on the Point Loma waterfront at San Diego, Calif. with additional research facilities at Mission Beach, Calif.; Kaneohe Bay, Oahu, Hawaii; Cape Prince of Wales, Alaska; and Lake Pend Oreille, Idaho. The Center operates test ranges at Morris Dam, Long Beach, and San Clemente Island in California.

The Center is currently operating with a civilian ceiling of 1,400, including 567 scientists and engineers. We have 350 assigned military personnel. The budget for this fiscal year is $51.1 million. Resources in technical facilities and equipment assigned or used by NUWC, are valued at approximately $100 million.

The functions of this laboratory are moving in the direction of designing equipments and techniques needed for the inspection, exploration, and control of the undersea environment. A broad mission in this area is required for the support of the Navy's undersea warfare effort. The programs on the detection and tracking of submarines are primarily classified and designed for control of the seas. They involve sonar systems, advanced data processing, weapons, and fire control, as well as investigations of the structure of the oceans of the world on a regional basis. The report of the Panel on Oceanography of the President's Science Advisory Committee (issued by the White House in June 1966) provides us with excellent guidelines for exploration and use of the sea during the next 10 years. National goals as expressed in this report are: Prediction and control of the sea's phenomena for safety and economy of seagoing activities, the full development of marine resources for man's use, and more strategic use of the undersea environment to enhance national security.

The Naval Undersea Warfare Center work at this time includes effort in all of these areas. The Center is currently a strong element in implementing the recommendations of the President's Science Advisory Committee. For example, NUWC was designated by the Chief of Naval Material as the lead laboratory for the deep ocean technology program. The interlaboratory task team working on this program is

coordinating its effort with the national agencies and committees working in the fields of oceanography and engineering.

Other efforts now underway are in such areas as marine biology, oceanography, underwater photography, and the man-in-the-sea program. These provide NUWC with skills and capabilities for the pursuit of research and development tasks for other agencies outside the Department of Defense.

The most difficult problem for the laboratory director is to understand and evaluate the multiple conflicting inputs which he receives, and from them choose a course of action for the employment of his limited resources to do research and exploratory work on which to base future programs. His guesses may be inaccurate but he must take them. My guess at the present is that the Navy will continue to execute its historical mission of exploration and control of new resources and of providing the tools for furtherance of the U.S. international aims. The changes during the next 10 years will reflect the facts that the new resources are on the sea floor and that the exertion of political pressure by the United States is limited by the existence of mutual atomic deterrence.

We, therefore, should be putting research and exploratory effort into:

1. New equipment to explore and operate on the sea floor.
2. Understand how to define and recognize limited and definite objectives.
3. Creating a variety of the precise tools, equipment and procedures needed to achieve objectives of limited scope.

It would appear that a limited war operating with clearly defined objectives involving persuasion rather than destruction will require procedures similar to those needed for the control of crime under the objectives created by national law.

You discussed yesterday the question of a national policy for laboratories. This question is related to the whole problem of organizational life cycle. A laboratory of the type I have been associated with takes at least 5 years to become productive and after perhaps 20 years has come to know its field so well that it is sure that nothing new is likely to arise. Creativity requires bringing together previously unassociated ideas; that is, change requires knowledge applied to new problems. The continuing resource and essential product of Government laboratories is the accumulated experience of its people. The organizational problem is to continue to generate changes which will allow this experience to be applied in new areas. Organizational changes are needed at a rate matched to the effective life cycle. For R. & D. labs, changes at rates less than 5 years will stop productivity and at more than 20 years will promote atrophy.

Mr. DADDARIO. Do you fit into that the need to retrain people?

Dr. MCLEAN. To send the people away for training.

Another method is to reorganize so that you need people in new positions. Any mechanism that keeps things from becoming too stable I think will keep the laboratories alive.

Mr. DADDARIO. Since you depend to a degree upon guesswork, it would help in making your guesses more accurate.

Dr. MCLEAN. Broader experience will help make the guesses more accurate.

A Federal policy which would insure that the changes in laboratory management and mission are slower than 5 years and more rapid than 20 might be considered desirable for maximum return on the investment made in creating experienced laboratory people. The present procedure of establishing new organizations as new needs arise is probably good if it can be coupled with a mechanism for transferring people and facilities from organizations whose effectiveness and missions are disappearing. The procedures for disestablishing laboratories should be improved. In the real world many organizational loyalties make the dissolution process extremely difficult.

In the process of selecting between laboratories, as in any growth process, competition is very important. Therefore, if the Government were to establish clearly defined, narrow, and exclusive missions for its laboratory organizations it would eliminate competition and would soon be faced with the complete coverage of all areas of technical endeavor by organizations convinced that nothing can be changed and all new projects are worthless.

Within the effective life cycle of a laboratory I believe the laboratory can develop its competence to the highest degree if it is exposed to a variety of problems. The legal limitations on accepting work from other agencies have presented no problems. The general belief that there is a definite relationship between manpower and performance does present problems. My own experience would indicate that people can perform at rates at least in order of magnitude (factor of 10) different depending on interest or lack of it in the work being undertaken. Interesting programs are easy to add to an already full workload.

As Parkinson states in one of his organizational laws, "Work expands to fill the time available for its accomplishment." I believe in the converse and that only by overloading development groups can we be sure of maximum return. We should by all means encourage **interagency use of laboratory facilities.**

The policies on interagency use are generally permissive rather than directive. The procedures for placing work in other laboratories or accepting work from other agencies are well established and can be utilized on a mutual agreement basis. There is much merit in doing work for multiple agencies. There is no substitute for being known by one's peers and outside effort accomplishes this objective. Interlaboratory contacts also provide data for the comparison of civil service standards.

There are limiting factors that control the amount of outside workload that can be accepted. These limiting factors are the physical plant, the mix of scientific talent available, existing program commitments, and restrictions on the use of resources (overtime limitations, for example).

Laboratories lack a fast reaction time when new facilities are required. As you know, to construct new facilities requires a minimum of 5 to 6 years from the time that the requirement is first known. There needs to be more flexibility in construction for research and development activities. Because of the complicated array of factors affecting laboratory workload, it is difficult to assess the the laboratory capability remotely. This assessment should be a prime function of the laboratory director assisted by his staff.

In addition to evaluating laboratory workload, the laboratory director has complete control of the line items in the budget allocated to independent research and independent exploratory development. I believe that one of his most important functions is to apply these resources in such a way as to investigate new ideas of the laboratory personnel. The ability to act quickly on new suggestions is very important in maintaining the morale of scientific people.

In selecting from ideas, which are always more numerous than the funds available, the director must have clearly in mind the needs of his parent organization and the state of technology. He should give highest priority to suggestions that will provide developments which the organization will need in the next 5 years and to experiments which attack critical questions on the forefronts of technology.

Mr. DADDARIO. You are talking about areas which he feels fall within the province of his agency's jurisdiction or mission. How far would you allow him to vary that in the achievement of national goals?

Dr. MCLEAN. I think that this is a very complicated question to answer because there are two forces working. One is that he has to have things which will show a need by the organization in the immediate future, and at the same time he needs to know that things are likely to have the biggest payoff, so he needs to look to things that are quite far out and haven't really ever previously been associated with his organizational needs, but in the future might very well have advantages to the organization.

Mr. DADDARIO. Would your recommendation be that he be given, if guidelines were to be established, the widest possible latitude or would you narrow it down?

Dr. MCLEAN. I believe he needs the widest possible latitude in the choice of problems and at the same time the greatest amount of information on what the organization needs and how it is likely to be going in the next period. In other words, he needs both information and latitude in selection.

Mr. DADDARIO. A laboratory council would be helpful in this regard.

Dr. MCLEAN. Yes.

Mr. DADDARIO. Would you agree with Dr. Astin that laboratory directors ought to meet and tell each other what they are doing, and that if they are given wide latitude they could come to a judgment about their problems?

Dr. MCLEAN. Yes. The Navy has had such a council working for the last 8 years between the laboratory directors and this has been very helpful.

Mr. DADDARIO. You suggest it be expanded?

Dr. MCLEAN. I suggest it is needed very much. The only problem is size, that you will have to limit the size of the groups because all the laboratory directors of the Federal Government in one organization or one meeting would be unmanageable.

Mr. DADDARIO. Please continue.

Dr. MCLEAN. The independent programs are reviewed after the fact and future allocation of new funds made on the basis of judgments on the success of each laboratory's past programs.

The most unbiased judgment of a director's use of independent funds is the degree to which the laboratory secures development projects from the parent organization based on information and demonstrations made possible by independent work.

Of the various methods of supplying independent research funds, I would favor the one which assigns a certain percentage of the total budget of the laboratory for this purpose. The rewards for careful use of the funds to guide developments toward things which are needed by the sponsoring agencies will, in this case, be automatic. Cross agency use of the laboratories will be improved and will provide that each user pay part of the support needed to develop laboratory competence.

Mr. DADDARIO. What is the percentage amount in your own instance?

Dr. MCLEAN. In our own experience we have had about 5 percent in this category, and I believe that this is a workable number.

Of course, you always have more things to do than 5 percent will allow you to accomplish, but——

Mr. DADDARIO. If you were to have 5 percent and the widest discretionary authority in the use of it, you feel this would be a good beginning?

Dr. MCLEAN. Yes. I have had 5 percent over the last 20 years and this has been very useful in directing the laboratory's program. It is the money which keeps the laboratory creative, I believe.

Mr. DADDARIO. We do not have time to get into that now, but it is something we would like to develop for the record, Doctor.

Dr. MCLEAN. All right.

Civilian personnel ceilings are set for the laboratory by the Director of Navy Laboratories who receives a total allocation of billets for Navy laboratory operations from the Office of Civilian Manpower Management.

The Navy ceiling, of course, is derived from overall DOD and Executive establishment limitations. Hirings are based upon funds available to support a certain employment level, within the established ceiling. Increases to the ceiling depend upon a number of factors including need, total employment level within the Department of the Navy, and ceiling points available within the system for reallocation. Typically, the laboratory ceiling is not adjusted for performing particular projects, whether these are Navy sponsored or for another agency. Rather, the laboratory is expected to adjust its total resources, which should in the long run, represent the optimum size and skills mix to perform a broad spectrum of work to meet priority needs.

I might repeat that there is value in a workload consistently higher than the laboratory can handle, since the pressure of taking on additional interesting work tends to force out low interest and low payoff programs and promotes the early transfer of work to industry. However, with an accounting system where an efficient operation can be judged and rewarded, the need for manpower ceilings as a control could be removed and greater flexibility obtained by allocating funds.

Mr. DADDARIO. If you really took off the personnel ceilings, would it have that effect or would it just give you the opportunity to continue low payoff programs? Would it make matters worse rather than better? I don't know that I would particularly agree with you. I recognize this is a problem, but you already raise the problem by saying you can only force out low priority work by having something new and more interesting.

Dr. McLean. The reason if you don't have the manpower ceilings you need a very good accounting system which relates money to manpower.

Mr. Daddario. What you mean is you establish your own ceiling.

Dr. McLean. And it is controlled by funds and you have to use the funds to force out the low interest, low payoff problems.

Mr. Daddario. What do you do by forcing them out anyway?

Dr. McLean. Generally that is a problem of—actually, they get forced out just by the fact that nobody works on them if they have other work to do.

Mr. Daddario. You say that you have to force them out and I agree with you. You are not just raising it for the first time. One of the objectives ought to be to come to some determination about how to prevent this from coming about in the first instance.

On the other hand, we have had some recommendations covering retraining and giving the directors more authority.

Dr. McLean. The most effective method, I believed, for forcing out programs of low payoff is to give the men something more interesting and something more valuable to do.

Mr. Daddario. The low payoff comes not because the director has been negligent, but rather some of the guesswork is bad. You get things going——

Dr. McLean. And he has been working on the job for a long time and he has reached the area of marginal return for effort in that particular area. He has discovered all the things that are really important, but if he doesn't have any new job to go to, the pressures to keep going on the old job are very strong.

Mr. Daddario. So we have to follow your suggestion to develop better capabilities in the first instance to keep it narrowed down.

The other is to come to the earliest assessment possible about what ought to be eliminated.

Dr. McLean. It isn't so important to assess what ought to be eliminated. The problem is to give them new work that is better, that they will recognize as being better.

Mr. Daddario. Then you know what is better and what should be eliminated. I recognize it is not an easy decision.

Dr. McLean. No, it is not easy, but I think the more we can push people into new fields the easier it is to get them to transfer from work that they have been with for a long time, but should be dropped.

Mr. Daddario. Please continue, Doctor.

Dr. McLean. When doing work for agencies other than the parent activity the balance between work for the parents and others is important. In the laboratories where I have worked, the ratio was about 90 percent for the Navy and 10 percent for other activities. I think this is a reasonable split to provide outside contacts and exchange of information. In military laboratories it might be desirable to have as much as 5 percent of the effort supported by nonmilitary agencies. We have performed work supported by other agencies or of direct benefit to them, such as warhead and missile tests for the AEC and Army, provision of ocean range facilities for NASA and major industrial firms such as Lockheed, North American, General Atomics, and Westinghouse. Other effort includes undersea geologic maps used by the Geological Survey, assistance to the Air Force and AEC in recovering

lost objects, calibration work on instruments, assistance to Arctic Research Institute on the structure of sea ice, and the use of sonar to count fish in the Columbia River for the Department of Interior. One commercial aspect of our work is the appearance on the market of handheld sonar for skindivers and sonar equipment for fishermen. NUWC test facilities are available to all Government agencies and contractors.

I believe the only nonsubjective measure of effectiveness in R. & D. must result from comparisons on a competitive basis. This means that we need more than one laboratory in each field of endeavor which is important to Government operations; or more realistically, we need two or three groups of laboratories, each having a broad scope of activities extending all the way from research through development, testing, and evaluation, and limited production of the type needed to provide guidelines for large-scale industrial production. Competition between these laboratories, or groups of laboratories, should be encouraged and the record of their accomplishments evaluated. Our abilities to satisfy society's needs are judged by competition and rewarded by success or failure. This process provides high incentives and high motivation. People work best when they feel they have set their own objectives and have control of the process. The general management can be very loose and competition can provide opportunities both to try and to judge organizational procedures. Such management will be successful only for laboratories with a broad mission since parts of the total process cannot be productive by themselves, for example, pure research without application is never profitable; the final product is the most reliable measure of productivity.

In my opinion, the most practical method of supporting interagency research and development is through a direct agreement between the laboratory and the outside agency. Joint undertakings and interagency transfer of funds, while quite feasible in principle, tend to become enmeshed in workings of the system to the point where a great deal of program effort is absorbed by administrative and communication problems unless a central focal point exists. When a program needs integrated planning the existence of a planner or a master architect seems essential. This man should have the following characteristics:

1. Technical competence.
2. Dedication and enthusiasm for the job.
3. Planned availability for the duration of the job.
4. Knowledge of, and control of, the needed resources including supporting laboratory efforts.

If such a man is not available the programs will proceed better in smaller units without overall coordination. A study of our successful and unsuccessful projects as related to the continuity of management might serve to enlighten this point.

In conclusion, gentlemen, I feel that in the management of Federal laboratories the following operational principles should be retained:

(*a*) Self-determination of the direction of a laboratory's programs by the skillful use of independent funds and friendly interlaboratory competition.

(*b*) Reward for achievements and discipline for ineffectiveness through competition.

I propose also that the management of Federal laboratories:

(*a*) Extend and augment the concept of laboratory centers of excellence with broad missions such as the Naval Weapons Center, Naval Undersea Warfare Center, Naval Ship Research and Development Center, and Naval Command Control Communications Laboratory Center.

(*b*) Extend and augment councils of laboratory directors to promote better interlaboratory communications and understanding of laboratory capabilities.

(*c*) Use the methods of the Navy's Vietnam laboratory assistance program to bring technical problems directly to people with the requisite technical competence for resolution of the problems.

(*d*) Ask laboratories to review their contractual actions for cross-service to other laboratories; that is, reward interlaboratory cooperation.

(*e*) Propose legislation that will decrease the leadtime required to procure facilities to support research, test, and evaluation effort.

(*f*) Continue to make laboratories available to other agencies so long as this effort does not exceed 10 percent of the total effort of the laboratory.

(*g*) Give the laboratory directory the authority to decide on proper balance between programs.

(*h*) Consider colocation of facilities by Federal agencies in order to broaden the experience of each.

Mr. DADDARIO. How do we get this evaluation process to the point where it can be effective so that Congress, which must make the final determination and allocation of funds, can effectively deal with it?

Dr. MCLEAN. I think it has to be done on the basis of having more than one group in each field. They don't have to cover the same field, but for instance, we have had for many years the work which was pretty well allocated to just one organization so if anybody wanted a particular fuse of a particular kind it was only that organization which could provide it.

I think it would have been much better if we had had more than one organization in that particular field. At the present time we have only one organization for producing guided missiles, or I mean space vehicles. I hate to suggest it, but perhaps two NASA's would have been useful and perhaps the Air Force performs a useful function in providing competition to the NASA organization.

Mr. DADDARIO. Well, when you say we only have one, we do in fact have two.

Dr. MCLEAN. That is probably a good idea.

Mr. DADDARIO. Are you saying we should have three?

Dr. MCLEAN. No, but I think we need to maintain that idea of competition throughout the whole research and development structure. It is very bad to get an organization charged with the entire responsibility for a particular area that is important to the Government.

That brings up the problem——

Mr. DADDARIO. You wouldn't say in every instance?

Dr. MCLEAN. No, but I think the users, the people who need the product, ought to have more than one alternative when it comes to getting a particular kind of job done and therefore there should be a number of laboratories with broad missions rather than the same number of laboratories with very specific missions.

Mr. DADDARIO. I do not find any argument with that. But you do have to come to some judgment as to what they are all doing in the final analysis even though you create this competitive situation.

Dr. MCLEAN. Yes. I guess it might be nice to make that a user choice. Congress, for instance, in allocating funds to particular organizations can decide which ones it thinks have been doing the best job and does decide that.

Mr. DADDARIO. I think we tried to do it. My question goes to the mechanism. I do not believe that we have a particularly workable system at the moment although we try to come to these judgments. However, to come to these judgments in the most effective way requires that we improve the decisionmaking process.

My interest in asking these questions is who do you see as making these decisions? Do you think that the director or the agency head should come to a judgment through some mechanism which he would establish?

Dr. MCLEAN. Well, in the experience that I have had at the Naval Ordnance Test Station where we were developing systems that could be used by the Army, the Navy, or the Air Force, one of the mechanisms of judging progress was how many systems were purchased by the Army or the Air Force, whereas the development work was supported primarily by the Navy.

Mr. DADDARIO. We are not going to develop this mechanism here and now, but your general attitude about this is helpful.

What do you mean by reward for laboratory cooperation?

Dr. MCLEAN. From the standpoint of the interlaboratory cooperation rather than disapproving.

Mr. DADDARIO. Rewarding by looking with pleasure rather than dissatisfaction.

Dr. MCLEAN. For instance, one way to punish interlaboratory cooperation is to have a management that doesn't understand what either of them is doing, threaten to take funds away from one and give it to the other laboratory without any idea as to whether either program is being effective.

I was caught between competition as a deciding mechanism and the fact that that also punishes for cooperation between laboratories. The same problem that industrial organizations have. If they are in competition they have difficulty in cooperating.

Mr. DADDARIO. By cooperation do you means people working side by side in the same building, joint use of personnel, or even the transfer of personnel from one agency to another if the facilities are available?

Dr. MCLEAN. I mean more of the side-by-side cooperation so that they understand each other's programs.

Mr. DADDARIO. So that they would be available to each other?

Dr. MCLEAN. Yes.

Mr. DADDARIO. And business would be made easier.

Dr. MCLEAN. Yes, they know the kind of programs the other laboratories are working on, and can utilize their facilities if they are particularly adaptable.

Mr. DADDARIO. That being possible in every instance, it would certainly increase the use of technology in this regard, which today is considerable.

Dr. MCLEAN. Yes.

Mr. DADDARIO. Dr. McLean, you have been extremely helpful, and I hope that we might send some further questions to you for the record.

Dr. MCLEAN. All right.

Mr. DADDARIO. I appreciate your being here.

QUESTIONS SUBMITTED TO DR. WILLIAM B. MCLEAN BY THE SUBCOMMITTEE ON SCIENCE, RESEARCH AND DEVELOPMENT

1. In your statement you say, "the procedures for disestablishing laboratories should be improved." What specific recommendations would you make in this regard?

This problem was introduced only in recognition of the need for more consideration and study of alternatives for accomplishing the disestablishment of laboratories. My mention of the need was intended to indicate the lack of ideas as to workable techniques for the closing of laboratories. Some of the factors which make the disestablishment of laboratories difficult, or in some cases prevent it, are the following:

a. The organizational unity and loyalty necessary to the operation of an organization prevents its rapid dissolution. The more effective and productive an organization has been in the past, the more it generates internal resistance to disestablishment.

b. The political environment in which laboratories exist also contributes to the difficulties encountered in the dissolution of laboratory organizations.

2. In your testimony you speak of competition as a measure of quality, yet the other side of the coin is duplication. How do you draw the dividing line, and what criteria are there to guide you?

In research we set a general goal of understanding the operation of nature. Such an objective allows freedom for each research man to define his own areas of interest. Competition provides a general management function as long as all the individuals can understand what the others are doing and can judge their own rate of progress relative to that of others. We have a breakdown when the rate of progress exceeds our ability to absorb, and we have duplication through ignorance. This is obviously a waste and the demands for centralized planning come to the front. We have a choice between broadening our ability to consume by discovering better methods for transmitting and absorbing information, or we can choose to limit production by instituting centralized planning as a substitute for individual goals.

I like to think of research as being those operations which occur at the borders of the known area of knowledge and which are concerned with the penetration into the surrounding infinitude of the unknown. As the realm of the known increases, it is obvious that the total number of areas of research which can be undertaken will also increase.

We hear a great deal about planning research in such a way as to avoid gaps in coverage, about trying to make sure that all research will be profitable, and about the necessity to avoid duplication. It is my belief that it will always be impossible to cover all possible areas of research. The best we can do in the management of research is to find people who have a genuine interest in carrying out research activities and try to stimulate discussions across organizational lines in order to promote the generation of new ideas. I hope we can forget about clearly defined missions and the avoidance of duplication. No well-informed and sensible research man is going to deliberately do the same kinds of work which are being carried out in another organization. The more the planning of research can be delegated to the man close to the work, the more likely it is that it will approach the boundaries of the known realm of knowledge.

3. In your testimony you state that the 5 percent discretionary funds which you have had "keeps the laboratory creative." Would you please provide some examples of how this authority has helped?

The following items or techniques were fostered or developed by the use of discretionary funds available to me:

(*a*) The Johnson Shark Screen (a major advancement in the Navy's search for adequate protection of its personnel from sharks).

(*b*) Syntactic Foam (this buoyant material is now used in most deep submersible vehicles).

(*c*) The use of ultra sonics for wire and metal forming.

(*d*) Color sonar (presentation of sonic information in color). This may prove useful in the recognition of specific rock formations below the sea floor.

(e) Sea-See. A research vessel designed for observation of biological activity in the first 50 feet of the ocean's depth. The device utilizes plastic hemispheres which provide the observer with all-around visibility and will be useful for observation of fish schools, porpoise behavior, sea lions, and the operation of travel nets.

4. Several agencies have set up procedures to appraise the performance of contractors that do research and development for them, or that manage agency laboratories. To your knowledge, what consideration has been given to applying the standards and procedures of these appraisal processes to Government-operated laboratories? To what extent would this be desirable?

For any organization or individual to feel successful there must be some mechanism for measuring the degree in which they have fulfilled their goals. In an organization which is profit-oriented, such an evaluation is straightforward, rigorous, and simple. If the figures are in the black, all associated with the organization are happy. If they are in the red, or tending toward the red, then something must be done to rectify the situation. Government organizations, military organizations, educational institutions, and research and development activities, whenever they are adequately removed from the profit-making pressures, have a more difficult time in establishing a proper evaluation of the effectiveness of their processes and results. For all such organizations I believe the evaluation must be on the basis of competition similar to that involved in making a profit. The fact, however, that results cannot easily be expressed in terms of a single variable, such as money, tends to make the evaluation process much more difficult. Governments are judged by history, and military organizations by wars. These are very harsh and final judgments and do not provide a very adequate, self-rectifying mechanism.

In essence, the appraisal of contractor and laboratory performance is limited by the capabilities of the individuals available to perform the appraisal. Of necessity, an appraiser must be a person who has been very successful in the field being evaluated. Yet, every appraiser has his own set of biases and believes that his own approach is the only correct approach. The competitive system is the only appraisal system that leaves open the possibility of innovation.

In spite of these difficulties in evaluation, the Navy is setting up technically competent review committees to review laboratory performance. The effect of these committees on laboratory performance has yet to be evaluated.

5. The DOD witness proposed the elimination of manpower controls on cross-agency work to promote flexibility similar to that available to the AEC contract laboratories. What is your opinion of this proposal?

I believe that some form of manpower controls or ceilings are essential in the absence of competition or techniques for measuring the output of a laboratory. Independent of the size of an organization assigned any particular job, pressure will always arise to demonstrate the requirements for more people.

The difficulty of maintaining effective communication with increasing size of an organization is the reason, I believe, that organizations tend to become less efficient as they become larger. Dr. R. B. Kershner of the Applied Physics Laboratory, Johns Hopkins University, has written a very interesting paper [1] on the optimum size of organization for any given job. He plots the time to accomplish a given objective against the number of people assigned to the task and shows that the curve has a minimum value. With too few people assigned, the job moves too slowly to maintain the interests of the people and their sense of accomplishment. As a result, a long time is required to finish the job. If the number of people is increased beyond the optimum, competition for the jobs available becomes keen. Communications begin to fall off. The understanding of what is to be accomplished becomes more remote. The need for specific, definite specifications becomes greater. And, finally, the ability of each engineer to participate in setting the goals toward which he is working, and his contribution to the total design, becomes less with a resulting loss of interest. Tension within such an overstaffed organization grows, mistakes become more common, and the ability to try new things which might lead to significant short cuts becomes entirely too risky. The need for more coordination and more planning as the program lags becomes more apparent. The system is self-accelerating in that, as more coordinators are added, the engineers and scientists have less opportunity to provide feedback into the setting of specifications; thus, progress toward the final

[1] R. B. Kershner, "The Size of Research and Engineering Teams," in *The Proceedings of the Eleventh National Conference on Administration of Research,* Penn State University Press, September 1957, pp. 77–83.

goal is further delayed. If we want to avoid these difficulties and have a participative type of operation, we should, as managers, try to do every job with an organization which is at the optimum, and this usually means the smallest size for its effective completion. If we increase beyond the optimum size, however, the forces become such as to automatically justify further increases in size.

I have proposed that as a management tool every important job should be undertaken by two organizations having a factor of ten difference in size.

6. What criteria should govern:

A. How much independent money a laboratory director should have?

B. The appraisal of what the Director has accomplished with funds previously authorized to him?

a. Of the various methods of supplying independent research funds, I favor the one which assigns a certain percentage, say 5%, of the total budget of the laboratory for this purpose. This should not be an automatic level for all laboratories but should vary according to the original and significant work that is accomplished by a laboratory.

b. The independent programs are reviewed after the fact, and future allocation of new funds is made on the basis of judgments on the success of each laboratory's past programs. In my opinion, therefore, the most valid appraisal of a director's use of independent research funds is the degree to which the laboratory secures development projects from the parent, or other sponsoring organization, based on information and demonstrations made possible by independent research.

7. Does your laboratory have ceilings for its personnel? If so, how are these ceilings set and who does it? What flexibility do you have for assignments within a ceiling? How feasible is it for you to obtain a change in personnel ceiling to accommodate work for another agency?

Civilian personnel ceilings are set for the laboratory by the Director of Navy Laboratories who receives a total allocation of billets for Navy laboratory operations from the office of Civilian Manpower Management. The Navy ceiling, of course, is derived from overall DOD and Executive Establishment limitations. Hirings are made based upon funds available to support a certain employment level within the established ceiling. Increases to the ceiling depend upon a number of factors including need, total employment level within the Department of the Navy, and ceiling points available within the system for reallocation. Typically, the laboratory ceiling is not adjusted for performance particular projects, whether these are Navy sponsored or for another agency. Rather, the laboratory is expected to adjust its total resources, which should in the long run, represent the optimum size and skills mix to perform a broad spectrum of work to meet priority needs. I might repeat that there is value in a workload consistently higher than the laboratory can handle, since the pressure of taking on additional interesting work tends to force out low interest and low pay-off programs and promotes the early transfer of work to industry. However, with an accounting system where an efficient operation can be judged and rewarded, the need for manpower ceilings as a control could be removed and greater flexibility obtained.

I feel that the need for ceilings will decrease in proportion as our ability to correlate manpower and costs and performance improves. If the accounting and evaluation can be such as to make this possible, then one ceiling on money should provide the local managers with more flexibility.

Mr. DADDARIO. I apologize that we will not be able to hear you today Mr. Finger, but I hope you will be able to come back tomorrow and be our first witness.

Mr. Finger has done fine work for NASA and the AEC, and we are pleased to have him as a witness. We are sorry that we have to hold you over to tomorrow.

Our other witnesses tomorrow will be Dr. William H. Pickering, Director of the Jet Propulsion Laboratory, and Phillip S. Hughes, Deputy Director of the Bureau of the Budget.

This committee will be adjourned until 10 a.m. tomorrow at this same place.

(Whereupon, at 12:25 p.m., the subcommittee adjourned to reconvene at 10 a.m., Thursday, March 28, 1968.)

UTILIZATION OF FEDERAL LABORATORIES

THURSDAY, MARCH 28, 1968

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

The subcommittee met, pursuant to adjournment, at 10 a.m., in room 2325, Rayburn House Office Building, Hon. Emilio Q. Daddario (chairman of the subcommittee) presiding.

Mr. DADDARIO. The meeting will come to order.

Today we continue our hearing on the utilization of Federal laboratories.

Our first witness today is Harold B. Finger, Associate Administrator, Office of Organization and Management, NASA. We had hoped to hear from Mr. Finger yesterday, but time prevented us from doing so. We appreciate your coming back again this morning.

Our second witness is Dr. William H. Pickering, director of the Jet Propulsion Laboratory. The outstanding performance of the Surveyor spacecraft, and the other missions to the moon and the planets, have made the Jet Propulsion Laboratory a well-known name throughout America. The technologies of telemetering, remote control, communication, data processing, and analysis that have been developed for these missions appear to have application to many other Federal programs and in many nonspace fields. The subcommittee notes, for example, that two important areas mentioned by the President's Crime Commission which would have the most significant impact on law-enforcement work were the need for better communications and the need to apply systems analysis to police operations.

Our final witness this morning is Phillip S. Hughes, Deputy Director of the Bureau of the Budget. It was the Bureau of the Budget that produced the Bell report which has been referred to a number of times in these hearings.

In preparing the President's annual budget request to Congress, the Bureau has the opportunity to effect the proper utilization of Federal laboratories to a great extent. By budget allocation between agencies, the Bureau in effect must decide whether to use existing facilities to accomplish Federal research and development programs, to establish new facilities, or to expand existing ones. What we are interested in today is how these decisions are made.

Mr. Finger, we are pleased again to have you here and to find out what you have to say about this problem.

(Mr. Finger's biography follows:)

HAROLD B. FINGER

Mr. Finger was appointed to this position on March 15, 1967. He reports directly to the Administrator and is responsible for the evaluation and strengthening of agency-wide management policies and practices involved in the conduct of NASA programs and activities. He provides executive leadership for the offices under the direction of the Assistant Administrators for Administration, Industry Affairs, Technology Utilization, University Affairs, and Special Contracts Review and Negotiation. In addition, elements responsible for audit, inspection, Headquarters administration, and organization and management planning report to him.

Previously, Mr. Finger had been Manager of the Space Nuclear Propulsion Office since August 1960. This office is responsible for nuclear rocket development for both NASA and the Atomic Energy Commission and isotopically-heated rocket thruster work for the AEC. Beginning in November 1961, he also served as Director of Nuclear Systems for NASA's Office of Advanced Research and Technology. In this capacity, he managed research, development and flight testing of nuclear electric power systems and electrical propulsion and the flight testing of nuclear rocket systems. During this period he was also named Director of AEC's Space Nuclear Systems Division in June 1965. Here he headed a new Space Electric Power Office, administering space reactor and isotope electrical power systems work.

Finger had been on the NASA Headquarters staff since it was established in October 1958. He was Chief of the Nuclear Engine Program. On March 5, 1961, he was appointed Assistant Director for Nuclear Applications.

Finger joined the National Advisory Committee for Aeronautics, the predecessor to NASA, in 1944 as an aeronautical research scientist at the Lewis Flight Propulsion Laboratory, Cleveland. In 1952, he was named Head of the Axial Flow Compressor Section and in 1854, Associate Chief of the Compressor Research Branch. Three years later, after nuclear training at Lewis, he was made Head of the Nuclear Radiation Shielding Group and of a Nuclear Rocket Design Analysis Group.

Finger was born in New York City, February 18, 1924. He earned a B.S. degree in Mechanical Engineering from City College of New York in 1944. He was awarded an M.S. degree in Aeronautical Engineering at Case Institute of Technology in 1950.

Finger has specialized in research on turbo-machinery, gas turbine engines, nuclear rockets, and shielding. Author of numerous technical papers, he was co-winner of the 1957 Society of Automotive Engineers Manley Award for the best paper on aeronautics. He is a member of the American Institute of Aeronautics and Astronautics.

Mr. and Mrs. Finger (the former Arlene Karsch) and their three daughters live in Bethesda, Maryland.

Mr. FINGER. Thank you, Mr. Chairman.

Members of the committee, I find that anything any one of us can say in this area is only a small part of this total problem because there are so many factors to be discussed in determining how best to use the laboratories and get them to adjust to new needs and get them prepared for new needs that may come along as essential national requirements. Therefore, although I have prepared a lengthy statement on this subject, it does not cover all of the points that need discussion. With your permission, Mr. Chairman, I propose that I summarize my statement using it only as an outline.

Mr. DADDARIO. Fine.

STATEMENT OF HAROLD B. FINGER, ASSOCIATE ADMINISTRATOR FOR ORGANIZATION AND MANAGEMENT, NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Mr. FINGER. Mr. Chairman and members of the subcommittee, the National Aeronautics and Space Administration is a research

and development agency applying its scientific, engineering, and management capabilities primarily to the accomplishment of aeronautical and space programs for which it is responsible.

NASA's laboratories are its in-house technical strength and are an essential element of its management system. That strength has been carefully and deliberately built up to provide a national resource that is now applying its talents to advancing the technology of aeronautical and space systems so as to provide scientific understanding of the earth and its atmosphere, of the solar system, and of man and other forms of life and also to apply that technology in other ways that will also benefit mankind. These other ways include the direct applications of space technology to communications, weather prediction, and navigational aids.

I want to emphasize, however, that the funds for this program, about 90 percent of our budget, are spent in industry with the in-house laboratory competence providing a technical interface with the contractors to anticipate problems, help guide the contractors to the proper solutions of problems that come up during the development programs. The laboratories are then a very key part of our system for getting the work done, but we do rely very heavily on the available capabilities of industry. Also trying, during the course of the program, to strengthen the capabilities of industry to carry out advanced technological programs and to apply that advanced technology in other areas.

Although NASA could not predict or guarantee the magnitude or exact direction of future mission activities, it did establish its laboratories so that expansion or retrenchment could be achieved while maintaining this basic capability.

Thus, when the most active periods of mission-oriented work begin to decline, the laboratory does not have to deteriorate and decline as well. It has the flexibility to take on new roles and missions, to shift its primary emphasis (from development to research, for example) or to retrench its total capability to a lower level where effectiveness can still be maintained. In the broad range of science and technology, there should be no end to a laboratory's mission or purpose. The best laboratories of all kinds repeatedly demonstrate the ability to go through a continuous renewal of challenging objectives in order to stay alive and vital. And this process of renewal is only successful where the new objectives are those which are best oriented toward new needs.

NASA now has 11 research and space flight centers; counting the various unique installations that are associated with these centers, we have 19 installations, plus 27 tracking stations. We own a total of 143,000 acres of land and utilize through leasing and other arrangements an additional 194,000 acres. We now have 32,442 civil service employees and, in addition, contractor and university employees operating or supporting these installations. These employees cover the span of disciplines from mechanics and technicians to Ph. D.'s in all of the science and engineering disciplines. Our total capital investment at these in-house installations is over $3.5 billion.

In addition, there is another half a billion dollars that is located with various other institutions, industrial contractor and university institutions, where we have ownership of the capitalized equipment and facilities.

The development and growth of NASA's laboratory competence has been accomplished in several ways that are indicative of the changing mission goals that have been and must be assigned to research and development organizations.

When NASA was established, the research capabilities of the National Advisory Committee for Aeronautics—the Langley, Lewis, Ames, Wallops, and Flight Research Centers—were brought in to serve as the nucleus for this country's aeronautical and space research and development.

The research laboratories of the NACA still serve as a major NASA element leading the forward thrust of our aeronautical and space technology. Each of these research centers directs limited flight mission development projects as a means of using its capabilities to assist NASA in handling its large growth in flight activity and also to keep so involved in real flight problems that research activities are realistically directed toward advancing the country's capability in aeronautics and space.

Among the flight development activities that have been placed in these research centers are, for example, the responsibility for directing the development of the Centaur rocket at the Lewis Research Center, the Pioneer Solar probes at the Ames Research Center, the biosatellite projects aimed at determining the effects of the space environment on life forms at the Ames Research Center, the Lunar Orbiter project directed by the Langley Research Center. Because their emphasis is on a broad program of research and technology development, their activities are characterized by relatively stable workloads that are not subject to the rapid buildup and phasedown characteristic of individual flight mission projects.

In addition to the research capabilities required to carry out the assignments made by the National Aeronautics and Space Act to the National Aeronautics and Space Administration, the Congress assigned to NASA a development and space flight operations responsibility that required a scientific and engineering development capability beyond that available in NACA.

As a result of authorities specified in the National Aeronautics and Space Act of 1958, the Vanguard team of the Naval Research Laboratory was transferred to NASA and formed the nucleus for NASA's Goddard Space Flight Center in Greenbelt, Md.

Incidentally, they were supplemented by a group out of the Signal Corps activities in Fort Monmouth that later became the leading people in the weather, meteorological, and atmospheric science areas.

The Development Operations Division of the Army Ballistic Missile Agency was transferred to NASA to form the basis for the Marshall Space Flight Center in Huntsville, Ala. The Jet Propulsion Laboratory operated for the Army by the California Institute of Technology was transferred to NASA, and you will hear more about that from Dr. Pickering.

A cadre of personnel of the Langley Research Center was assigned to the space task group to initiate this country's first manned space flight activities in Project Mercury. In 1961 when the national commitment was established to develop a space flight capability sufficient to land men on the moon in this decade, the space task group became the core of the Manned Spacecraft Center in Houston that is now responsi-

ble for developing the Apollo command and service modules and the lunar module that will land men on the surface of the moon and for the flight operations of these systems. What is now the Kennedy Space Center in Florida was established as an outgrowth of the launch operations directorate of the Marshall Space Flight Center.

We generally refer to these newer centers as our "development" centers because of the nature of their mission responsibilities. Although their emphasis is on the development and conduct of space missions, we still maintain the research and advanced technological development base at these centers as a means of anticipating the best means for carrying out and planning our future programs and, in the process, to maintain their technical competence. These centers have been responsible for our major space flight missions including our manned Mercury and Gemini missions in which almost 2,000 hours of manned space flight were achieved and the capabilities of man to operate in space were demonstrated. These flights also demonstrated the capability to control, rendezvous, and dock vehicles in space and evaluated many other requirements for manned space operations. The NASA development centers have also directed the development of such projects as the TIROS, Nimbus, Syncom, Relay, Ranger, Mariner, Surveyor, and many other major scientific space experiments and satellites that apply this technology for communications and meteorology.

All of these organizational units were, therefore, based on the scientific, engineering, and management discipline competence that was already in existence as a national resource. These skills are now applied to different mission goals and have resulted in substantial progress toward the achievement of those goals.

In order to carry out the programs that have been established, the NASA civil service employment has grown from 8,420 employees in 1958 to a peak of 33,726 in 1967 and is now down to 32,422. Combined with the contractor and university people who are working with us in our installations, this manpower and the equipment and facilities that are available to them give NASA the competence to carry out the missions assigned to it and also provide the competence that can be applied to other activities by NASA within its overall area of responsibility.

If we consider the history of all of these centers from their NACA and Department of Defense background to the current time, we find a continual change in work assignment, in mission goal, and even in discipline mix. Facilities have also undergone continual change. For example, the altitude wind tunnel was built at the Lewis Research Center in 1942. Its 20-foot diameter test section was used to test aircraft reciprocating engine-nacelle-propeller combinations at speeds of 500 miles an hour and at conditions equivalent to 50,000-foot altitudes.

During World War II tests in this facility resulted in important contributions to the improvement of the B–29. That facility is now known as the space power chambers. It has been divided into separate environmental space chambers that simulate conditions up to altitudes of 400,000 feet and temperatures approaching space conditions. It is, therefore, now a space environmental test facility. From aircraft tests at 500 miles an hour and altitudes of 50,000 feet we have now gone to tests of the Centaur rocket and to models of large solid rock nozzles and also to tests of space power systems.

The Lewis 10- by 10-foot supersonic wind tunnel was completed in 1955 as part of the nationwide unitary wind tunnel plan. It was used to test turbojet and ramjet engine systems, but was then modified after NASA was established to do work on rocket systems that included the investigation of the vehicle base heating problem which results when multiple engines are clustered together, such as is the case in our Saturn rockets. During recent years that facility has been modified again to provide the capability to simulate conditions that would be experienced in a supersonic aircraft so that engine and engine inlet configuration matching problems can be investigated for the supersonic transport.

The engine propeller research building was built in 1942 and was the first operational facility at the Lewis Research Center. It was used for a reciprocating engine testing, for turbojet engine testing, and is now used for electric propulsion research.

At the Langley Research Center, which is our oldest installation, having been established in 1918, many facilities have been converted to meet new needs.

The fan drive system of the full-scale wind tunnel at Langley was modified so that accurate control was possible through the tunnel speed range required for vertical and short takeoff landing research and low-speed flying quality studies of high-speed aircraft designs.

Changing research needs prompted the phasing out of the gust tunnel and the conversion of the available space to an urgently needed noise research laboratory. The aircraft loads calibration laboratory is a large laboratory building which has undergone several conversions to meet changing research needs; it now houses such simulation equipment as LOLA (Lunar Orbit Letdown and Approach simulator), zero gravity simulation water tank, a tactical effectiveness simulator, and visual simulator for a foot control maneuvering unit.

The Jet Propulsion Laboratory moved from the development of jet assisted takeoff (JATO) equipment for aircraft to other projects involving rocket and jet propulsion technology. Emphasis was changed to the development of reliable liquid and solid fuel propellants, guidance systems, tracking devices, and telemetry.

In conjunction with the Army Ballistic Missile Agency, JPL had a major responsibility for this country's first satellite, Explorer spacecraft. From this background JPL has developed to its present role of responsibility for such major NASA projects as Surveyor, Ranger, and Mariner. JPL's special capabilities are also being applied to solve specific problems of the Department of Defense.

Certain capabilities of the Signal Corps laboratory at Fort Monmouth, that were brought into the Goddard Space Flight Center in 1959, had carried out one of the four upper atmosphere sounding rocket programs in the United States through the 1950's. They designed and developed Vanguard II, a cloud cover experiment, and the first meteorological satellite, which was launched in 1959.

This group, in NASA, formed the nucleus of the organization that managed TIROS, Nimbus, and the atmosphere Explorers, a total of 14 successful satellites.

This group of men became one of the strongest groups of meteorological and atmospheric scientists in the world, in particular pioneering the use of infrared technique to measure the earth's atmosphere and surface and in studying the structure of the atmosphere.

At the Marshall Space Flight Center, the test stand that had originally been built for testing the Jupiter and Redstone rockets, the Redstone placed our first satellite into orbit, was used later for the static testing of the first stage of the Saturn I rocket having a thrust of one and a half million pounds.

What was done, existing capabilities were brought into NASA built on a nucleus of the basic engineering and scientific skills that were available. These people could move into areas of work. They are just as qualified to move into other new areas.

I might mention here also that skills of people have also been adjusted.

For example, a year ago we set up at the Manned Spacecraft Center, which is responsible for the development of Apollo Command and Service Modules and the Lunar Module, a space science directorate which looks forward to the long-term application of the Apollo hardware, and to the scientific analysis and research that is to be done with the experiments carried in that Apollo hardware. My prepared statement discusses this further.

Some facilities have also been closed down and are no longer used except for the space that they make available for shops, small laboratories, and offices. New facilities have been built to take on the new activities that are required by our programs. The engine and stage test facilities at Marshall Space Flight Center and the Mississippi Test Facility, the space propulsion facility being completed at the Lewis Plum Brook Station in Sandusky, Ohio, the Space Environmental Simulation Laboratory at the Manned Spacecraft Center in Houston, the space simulation facilities at the Goddard Space Flight Center that permit development of complex unmanned spacecraft, are all new installations required by our programs, but made available through the scientific and engineering capabilities of our people working in close association with the capabilities of industry, university, and other Government agencies.

Recognizing that in the Saturn-Apollo system, we will have developed a strong capability for investigating and exploring space, we are now looking ahead to the increasing emphasis that will be required in applying this capability to meeting important scientific needs and to the continued advancement of technology. While the Manned Spacecraft Center is still busy with the research and development required to assure that the Apollo spacecraft systems will operate successfully in orbital and lunar mission flights, we are emphasizing the scientific disciplines required to draw full benefit from these flights. During 1967 we established at the Manned Spacecraft Center a space science directorate which we believe must grow to emphasize the scientific content of our activities.

Also, at the Manned Spacecraft Center we are nearing completion of a Lunar Receiving Laboratory that will have all of the equipment necessary to analyze the samples that are returned from the moon by our astronauts and to do other scientific research related to the moon.

We are also, as was just announced by the President on March 1, 1968, establishing a Lunar Science Institute near the Manned Spacecraft Center to provide an opportunity for university scientists to come into close association with the work carried out by the Manned

Spacecraft Center so that that work and the data obtained can be made available to these scientists throughout the country that are interested in and concerned with these matters. Therefore, while the development activities are proceeding, we are also phasing over into a stronger science emphasis.

At the Marshall Space Flight Center, the Saturn vehicle development work, for which Marshall has been responsible, is now nearing completion. The 14 successive successful flights of the Saturn IB and the first successful flight of the Saturn V conducted last November, indicate the competence of the NASA organization at the Marshall Space Flight Center and of the industrial contractors with whom Marshall has worked in the development of this vehicle. Although continued testing will be required at the Mississippi Test Facility in order to test out those vehicles that are produced to be flown in later missions, the advanced design, research and development work is decreasing on these vehicles. We have, therefore, assigned to the Marshall Space Flight Center responsibility for development of the ATM, the Astronomy Telescope Mount, that will be used in conjunction with manned flights to be conducted in the 1970's using much of the Saturn-Apollo capability. This astronomy work is quite different from the kind of vehicle development work with which Marshall has been associated in the past but, here again, it is the basic competence of the people assigned that permits them to move from one activity to another and still make significant contributions. Obviously, some change in the discipline skill mix at Marshall will be required as they phase over into these other activities, but this change is still built on the foundation of the basic scientific, engineering and management competence of that organization.

The Ames Research Center, at which hypersonic aerodynamic research led to the definition of the shapes required to permit ICBM weapons to reenter the atmosphere and also led to the basic theory and design information for the reentry conditions of space vehicles has moved into the field of biosciences as an essential ingredient of NASA's program. They are defining experiments, developing instruments, and working on evaluation of biologic chemistry as part of their activities aimed at the study of exobiology, extraterrestrial life. Again, on the base of an overall scientific and engineering competence, it is possible to modify work assignments and to expand readily into new areas of science and technology.

The main point I want to emphasize by these numerous examples is that the skill and training and competence of our people permits them to make significant contributions in the changing needs of aeronautics and space work and can do the same in work on other national programs and needs. Physics is physics no matter what organization it sits in; chemistry, mathematics, biology, these are basic sciences that do not vary depending on the organization in which these disciplines are practiced even though the specific application and emphasis may be different.

The engineering talents required to advance our technology of batteries, fuel cells, nuclear power sources, aircraft engines, rocket propulsion, materials development and fabrication, electronics systems analysis and design, test and development methods are also directly applicable to the propulsion, power, structural analysis, guidance and

control, design, and development associated with other environments than air and space travel, with travel under the seas, on their surface, and on the ground.

We have found repeatedly that a significant proportion of the technological advances we have generated in meeting our own program needs, turn out to have a current or potential application to the activities of some other Federal agency. We have tried to capitalize on this R. & D. fact of life by making real efforts to make this technology known to other Federal agencies and to industry and the academic community as well. We are are working to disseminate all of our technology to all segments of the economy. However, we feel that it is easier for the people who understand the technology to infer its possible use for other purposes, than it is for managers in other programs to search the entire range of technology to find things that may be of use.

In many cases NASA, therefore, has taken the initiative in approaching other agencies where we have felt that some facet of our emerging technology might be of value to them. In other cases, agencies have approached us about making use of some NASA capability. From these kinds of contacts, we have over the years developed a number of different types of working relationships which can be tailored to meet many kinds of national needs. I would like briefly to illustrate some of these relationships for this subcommittee.

Perhaps our most important relationships with another agency are the long standing associations we have maintained with the Department of Defense in which NASA and its predecessor, the NACA, conducted research on military aircrafts of all kinds. We have conducted research ranging from preliminary design to operational trouble shooting on virtually every significant military aircraft developed in this country since the 1920's.

In addition to work on and with military aircraft, NASA has exercised an important role in civil aviation. In some cases military departments have come to us with specific problems of design, structures, materials, or operating problems. In other instances our research has produced a technological advance which we recognize can be applied to a military plane, DOD has furnished NASA with aircraft for test and evaluation programs and we do the research. NASA benefits in this relationship because we learn about the latest aircraft development and extrapolate that knowledge into more advanced research. NACA and NASA research results have been applied in almost every aircraft that is flying.

In these areas NASA has worked with DOD on the F–111, the C5A, various vertical and short takeoff landing aircraft, et cetera. The development of high-performance gyros for space flight has been applied in navigation platforms for aircraft such as the C141 and the C5A. Some of the most important gas turbine engine research results and design concepts and solutions for operating problems on gas turbine engines grew out of the test and analysis work done at the Lewis Research Center in the late 1940's through the 1950's. As an example, the real understanding of compressor and turbine operation in such engines over the range of speeds and altitudes and over the range of engine acceleration and with disturbance of inlet air conditions came from that testing. Interestingly enough, in research on SST problems

at Lewis, it has been necessary to go back to that work and to extend it to new regimes of flight. Fortunately the capability still exists in the people who did that original work and are still available to carry it out now.

In our manned space flight programs, NASA has made extensive use of DOD research facilities such as those at the Arnold Engineering Development Center at Tullahoma, Tenn., and the Department of the Navy Man Rated Centrifuge at Johnstown, Pa.

The NASA approach to making full utilization of existing national capabilities is further illustrated by the relationships which have evolved with the U.S. Geological Survey. The need for expertise in the geology disciplines was recognized early in the space program and assumed critical importance with the approval of the Apollo program early in 1961. The NASA choice in fulfilling this requirement was to call upon the geological competence already developed by the USGS. The utilization of USGS expertise in direct support of the space program has been evidenced in several forms.

For example, the USGS has detailed outstanding scientists to work directly with NASA during the formative stages of the Apollo program development. The USGS has also detailed specialists to assist in the planning and formulation of an earth resources program. In other instances, USGS scientists have been principal investigators on NASA missions such as Ranger, Surveyor, and Lunar Orbiter. Finally, the USGS is contributing to the planning for detailed exploration of the moon through creation of a Center of Astrogeology located at Flagstaff, Ariz., which works in close association with the NASA Manned Spacecraft Center at Houston, Tex.

Obviously, as part of NASA's role in aeronautics and space, we are also in a position to serve the needs of the Department of Transportation through the technology produced. For example, we are currently funding research in cooperation with the Department of Defense and the Department of Transportation involving the feasibility of a form of grooved aircraft runway which could improve aircraft tire traction under adverse weather conditions. Work in the aircraft landing loads facility at Langley Research Center several years ago, aimed at investigating the performance of aircraft tires on wet or slippery surfaces, produced technical data that proved of value to the study of automobile tires in wet road conditions as well. This led to experiments with grooved runways at our Wallops Station and resulted in an awareness of the hydroplaning problem of automobile tires on wet roads. These experiments combined with data from other countries and other research efforts have led to grooving the sections of this country's highways and have clearly demonstrated the reduction in accidents that result. This work was brought to the attention of the Department of the Army and the Bureau of Public Roads and through these agencies to the tire and automobile industries as well.

Another example of work done in support of the missions of other agencies is the effort getting underway with the National Institutes of Health in computerized image processing. During the conduct of the Ranger, Surveyor, and Mariner projects and based on advanced lunar and planetary video image or picture data. As a result, contrast and detail were brought out far more clearly than was the case through the normal video system. It was found that essentially the

same technique could be used to enhance medical X-rays and NIH is now arranging to sponsor work at JPL aimed at the medical application of this space related technique.

Obviously, support of the supersonic transport work is directly a part of NASA's overall responsibility for aeronautics and space. Over 200 NASA scientists and engineers work with the Federal Aviation Agency in the evaluation of the proposals that were submitted to that Agency for the development of the supersonic transport. In addition, it was the basic calculations conducted by NASA that indicated that aircraft configurations could be defined to provide a financially sound transportation system. Technological development and technological advancements are still required to make such a system fully effective and NASA as well as the FAA contractors are working to provide this technology and NASA is also working to advance technology beyond that required for the SST.

Supersonic transport models have been tested in NASA wind tunnels, engine research is underway on all of the components that would be involved in supersonic aircraft engines, noise and sonic boom studies are underway, materials work related to the high and low temperatures that will be experienced in supersonic aircraft is underway. All of this obviously fits within NASA's overall responsibility. Support is, therefore, readily provided to the FAA in these areas.

It should be emphasized that NASA is, in general, not a user agency. We are a research and development agency. The research and development work that has led to the early communications and weather satellites has resulted in operational systems under Comsat, the DOD, and the Department of Commerce. These organizations fund for the operational systems while NASA funds for the initial development work to prove out the principles involved sufficiently well that economic and other factors can be judged by the user to determine the desirability of an operational system.

In a similar way we are now conducting early phases of work to determine the technological capabilities of earth resources satellites. If the technology can be developed to provide effective surveys of agriculture output, crops, water, and other resources, timber, et cetera, through use of space systems, then agencies such as the Department of Interior and the Department of Agriculture could determine the suitability of such techniques for operational systems and they would fund for the operational systems and use their output.

In general, NASA's policy is to apply its capabilities, manpower, facilities, equipment, to the support of work requested by other agencies that are within its overall area of responsibility without requiring reimbursement by the other agency. Only those out-of-pocket costs associated with the specific equipment that must be procured or the special add-on costs beyond those that are directly a part of NASA's operating capability are provided by the other agency. This is similar to the case I described earlier where the Department of Defense provided NASA with aircraft or engine components while NASA applied its capabilities to the conduct of the work without reimbursement.

Obviously, our budget and program plans must anticipate such work. With recent reductions in our budget, particularly in our administrative operations budget, we are now hard pressed to carry out those programs for which we have a primary responsibility. We, therefore,

have less ability to respond to requests for assistance from other agencies than we had previously. It is the administrative operations appropriation that provides the funds necessary to support the technical and management competence in our laboratories and headquarters operations. In addition, these administrative operations funds provide for the operation of our unique facilities and equipment that we have established in our Government laboratories.

In those cases where industrial groups are interested in using certain of our facilities and capabilities, we would make such opportunities available if the work fits properly within our overall program and capabilities and if the resulting information is to be made generally available. Under these conditions, we would fund for the normal operating costs involved, but would require that the industry provide the special equipment and special out-of-pocket costs over and above those that are required to maintain our operating capability. In certain cases where industry has requested special tests in our facilities for their information and use, they have appropriately reimbursed the Government for normal costs incurred.

As we see it, our laboratories are a national resource available to assist other agencies as well as we can, while still carrying out the responsibilities with which we are charged. We believe that it is our responsibility to retain that capability as an effective, advancing, competent, highly motivated resource. We believe we must fund for it. We do not believe that it is appropriate to charge other agencies for operating costs incurred as we apply that resource to support these other agencies. We do not believe that a stable operating capability could be retained in our laboratories if we required reimbursement for every task performed for another agency and became a job shop operation. We believe the country's scientific and technological strength would suffer in this case.

In summary, there are several points I would like to reiterate:

1. NASA is a research and development agency depending primarily on its laboratories for the technical competence to permit it to effectively carry out the aeronautical and space programs with which it is charged.

2. NASA's laboratories are a national resource that has applied its skills to ever-changing problems and to ever-changing goals and has, therefore, retained and attracted competent, highly trained, highly motivated scientists, engineers, and management people. This competence can be applied in other program areas.

3. NASA is continuing to adjust its laboratory discipline and skill distribution and its research emphasis in recognition of the changing character of its programs.

4. Within its overall areas of responsibility and competence and within the limits of its resources available for carrying out its own programs, NASA is supporting other program needs and is prepared to provide more of that support if its resources, its current workload, and its program requirements permit.

5. NASA does not believe that laboratories established and developed over long periods and with great difficulty and at great expense should be converted to job shop operations, but should rather be retained and supported and adjusted to permit these laboratories to take on new missions and new assignments as the need for such work develops.

In addition, there are several broader conclusions that we have reached from our experience.

First.—Our experience in the creation of new laboratories has made it clear that this is an extremely difficult and complex process, and one that cannot be entered into lightly. The basic requirements for success appear to be a strong and clear purpose for the laboratory, significant future beyond the immediate set of problems which inspired the need, and challenging missions and objectives which serve to attract and hold the competent people who constitute the real capability of any institution. Even under these circumstances, constant management reinforcement of resources of the laboratory will be needed to assure the formation of the "critical mass" which makes a laboratory self-sustaining and productive.

Second.—Agency and laboratory management cannot assume that the existence of effectiveness assures its maintenance. The creation of new and useful contributions to technology by a laboratory can be lost very quickly if the laboratory is incapable of continuously renewing its objectives in a way which meets real national needs. Laboratories must be free enough and flexible enough to take advantage of research "targets of opportunity" as they present themselves. New missions are important in that they serve as the challenge around which a laboratory can organize its efforts.

Third.—It has become increasingly apparent that new technology almost inevitably has significant application outside of the environment in which it was created, and the creator of technology has a real responsibility to make the results of his work known to others who might benefit from it. In NASA, we feel that this cannot be a passive responsibility, and we have actively sought to initiate contacts with many agencies. Not all agencies are able to have laboratory capability of their own, nor is it necessary that they should have. One of the key factors in the ultimate effective utilization of the Federal laboratory capability is that agencies acquire at least enough technical competence to recognize their own needs for research and development support and to establish contact with the existing laboratory capabilities which can be used to solve these kinds of problems.

Fourth.—NASA has found that a laboratory capability and a real need for laboratory support can almost always be brought together. This has proved to be true in ways ranging from informal consultation to interchange of people all the way up to the joint conduct of major R. & D. programs. The solution to many of the problems which this subcommittee has identified in its past hearings, such as more and better information about Government-wide research capability, better budgeting and accounting practices, better interagency coordination, could speed up and improve the process, but the agencies involved must take the initiative in their own behalf.

That completes what I had prepared, Mr. Chairman.

Mr. DADDARIO. Thank you, Mr. Finger.

Mr. Mosher.

Mr. MOSHER. Not at this point.

Mr. DADDARIO. Mr. Brown?

Mr. BROWN. While you have been talking, I have been running through my mind a method of conceptualizing the role of the laboratories. I would just ask your comment on this because I have not really

explored it much in my own mind. It seems to me that abstracting from what the laboratories are doing and almost removing it from any relationship to the space program or to any other specific program, what we have is a competence in various ways, you might say. We have a competence in the field of sensing and communicating information, a competence in the field of the transporting matter, and a competence in the way of providing life support systems for organisms. We are talking here about the fundamental concern of human beings for sensing and for obtaining information in the widest possible variety of ways.

For example, the orbiting astronomical laboratory is merely a sensing device and the development you are doing on laser communication is just another way of communicating information. The development of space capsules are means of transporting humans and providing life support systems for them. These are essentially the problems that face mankind, and if the laboratories are looked upon in this way, I would think it could be the most versatile of instruments for fulfilling the wide variety of tasks.

Is there within your management operation some far out thinkers who conceptualize and think in this way and have a feedback going on all the time in terms of missions, of process, so that this can can organized and managed in a reasonable way?

We are really talking about how many dollars are we going to allocate here. The thing that bothers me about the whole space program is that it was conceptualized really as a sort of challenge, an adventure, and not in terms of the fundamental needs of human beings—except insofar as challenge and adventure is one of those fundamental needs. My thinking has been going in this general direction for some time now, and I wonder if you have any comments along that line?

Mr. FINGER. Yes, sir. One of the main points, I think, we have tried to emphasize in the space program is that what develops out of it is the advancement in the broad areas of science and technology that then can be applied outside of the specific programs with which we are involved. At various times we made the point that it was really the development of a total capability that was significant in the lunar mission; not that particular mission as such, although a great deal will be learned. But more is learned, during the process of getting to the moon in new technology and in the sciences.

In the unmanned space program there is a similar kind of scientific and technological development that results.

We have also tried to emphasize that this scientific and technological information would have broad applicability. The application of space technology in communications and meteorological satellites are part of the already proven benefits.

The work going on in NASA is aimed primarily at the specific responsibilities we have. Although at the same time we have recognized these broader implications by trying to make this scientific and technological information known to the broadest range of people possible. Therefore, we haven't let this happen in a haphazard way.

We have tried to force this dissemination and transfer of information. I don't mean only through the technological utilization program as such, but through the agency's scientific and technical information

data banks that provide for storage and broad dissemination of the information obtained. Through the project activities in universities and industries we believe that the process of having that work done in those institutions they then can apply the technology to other activities that they have in all areas.

NASA's prime responsibility is for space and aeronautics. Our major efforts have been in planning that program in a way that gets the scientific information that we need for those programs, but also tries to advance technology as much as possible to have the greatest benefit across the wide spectrum of disciplines involved in NASA's programs.

I have tried to indicate, and I think you really did it better than I did, that these basic capabilities that we built up are capabilities that can be moved to any scientific and technological undertaking. The fact that it is now applied to aeronautics and space doesn't mean it must always be there.

We have tried to define where this technology is transferable to other activities. That sometimes is difficult to do because we are still in the middle of accumulating much data and we will be for sometime, but we do see some of these applications.

Mr. BROWN. This long-range planning is the thing that interests me because I see some signs. They may not be important, but there are signs of allocating resources and planning the direction in which we are going. This may be a reaction to, say, the large-scale application of resources to space per se or to some projects like the supersonic transport which is coming in for a lot of criticism.

Insofar as NASA or the laboratories are identified exclusively as adjunct to major products with which the body politic becomes disenchanted, the laboratories will suffer and NASA will suffer. Hence, there needs to be fundamental research and development in its broadest possible light and this is one thing I think perhaps we have failed to do. Again and again people ask us to justify the space program. It is hard to explain to them that this is a part of the fundamental development of the human mind and its progress into new areas. They say what are we getting out of it today on earth. The laboratories have tremendous potential in this area conceptualized in a fashion that effects the broad range of human needs rather than something that people may not quite see the value of today. For example, this moon laboratory. I am big on the moon laboratory, but I would rather conceptualize it in a way that would make it more understandable to more people.

Mr. FINGER. I should mention a planning activity that is getting underway in NASA that is trying to define those programs that would offer the greatest benefits generally that might be conducted or that would logically be conducted in the future. We are bringing our centers, the laboratories, and Center Directors and center personnel into that planning process in a way that the Center Directors sit on the senior group and the laboratory personnel take direct participation in the work.

In some of those discussions, for example, we went through this same kind of a problem. How do you indicate very clearly what the scientific and technological output of these programs are?

As an example, I think one important feature of the orbital experiments that have been run with man and that might be run by follow-on orbital laboratories is not so much to find out what man can do, but to learn more about man himself.

Mr. BROWN. The development of satellites may do more for the remote sensing and communication fields than anything that has ever happened. We already have ComSat, a spinoff from our space activities. We have the potential to revolutionize our knowledge about weather, resources, and communicating information through broadcast satellites which ultimately may provide direct access to every home with unlimited information. This aspect of the space program is something most people do not understand unless you point it out to them in very specific terms. Ultimately it may be as important, or more important, than anything else we are doing. Yet abstractly what we are doing is sensing and communicating. That is why I am talking in terms of abstracts and the capacity of the laboratories to work in the broadest possible conceptual framework.

Mr. DADDARIO. Mr. Rumsfeld.

Mr. RUMSFELD. On page 12, you made the statement that "we feel it is easier for the people who understand the technology to infer its possible use for other purposes, than it is for the managers in other programs to search the entire range of technology to find things that may be of use."

What do you mean by "easier"? Easier for whom?

Mr. FINGER. What I really mean is that—incidentally, there are some differences of opinion on this point.

Mr. RUMSFELD. Indeed there are.

Mr. FINGER. We are really trying to work it both ways. What I am saying here is that if a problem is defined, it is easier for those people who have worked on the technology to determine what elements of their technology could be used to solve that problem.

Mr. RUMSFELD. The problems aren't defined in most cases.

Mr. FINGER. We are trying to work it both ways. This is why we set up these biomedical application teams to work with university medical schools, with hospitals, to have those institutions, the practicing institutions, define the problems that they face in carrying out their work. This is what we are also doing with the law enforcement people. We then go through our technology using these team approaches to try to search the technology for direct applicability to defining solutions of those problems.

At the same time through our Dissemination Centers and other technological utilization approaches, we are also trying to assure the broadest possible dissemination of the technology we have or that we develop so that anyone can look through that technology. We are trying to present it in a way that they can see it and know that it exists. We are trying to approach it both ways.

Mr. RUMSFELD. Is it a fair analogy to state that, based on the assumption that people in this country like to read books and since it would not be feasible to send every person in the country a list of every book in every library, you want to develop a situation where NASA can serve as the librarian, searching its index file to see what information might be available on any given problem, for anyone who might make an inquiry?

Mr. FINGER. That is correct. But we are also trying the other approach too. We just think you have to work very hard at this business of making the greatest use of scientific and technological developments and information.

Mr. RUMSFELD. So it is going to take an education process to get people to pose the problems?

Mr. FINGER. That is correct. It took Mr. Rumsfeld some education even to get the people with whom we work in industry, universities, and in our own laboratories, even within Government, to define the technology they were developing. A man who has to solve a particular problem of fasteners goes ahead and solves it for his application and doesn't realize he has developed a piece of technology in the process. We are getting better reporting from the pepole who work in our program. But you also have to define the problems that may be solvable by technology or scientific information that is developed.

Mr. RUMSFELD. It would seem that the Bureau of the Budget could play a rather significant role if it would require an indication, regardless of what Government agency is making the request for funds to undertake certain activities, that the agency has gone to an indexing system and talked to the people. Do they do that now?

Mr. FINGER. There are several approaches for doing this. Our approach is to a large extent experimental. We are trying to find ways of doing this. The Commerce Department has activities set up for this through the State Technological Services groups. We have got these Disseminating Centers that work with them, but many of these are Department of Commerce activities and activities of other agencies.

Mr. RUMSFELD. Maybe it would be helpful to the record to give examples where NASA has taken the initiative.

Mr. FINGER. Fine.

(The information requested is as follows:)

Listed below are some examples of where NASA has taken the initiative to transfer technology to other Government agencies:

1. Recent work of the Ames Research Center in the field of ablation materials for protection of satellites during reentry has produced a family of polymer composites that demonstrate fire suppressant and insulation properties that appear to be useful in a variety of military applications. This material appeared of sufficient importance to warrant bringing it to the special attention of the Director of Defense Research and Engineering by letter.

2. The results of research on the causes and prevention of aircraft tire hydroplaning were made available to the Bureau of Public Roads for use in bringing about a reduction in the number of accidents due to automobile tire hydroplaning.

3. The techniques of enhancing lunar photographs by means of computer analyses was found by JPL to be of value in the enhancement of X-ray photographs. This was brought to the attention of the National Institutes of Health which now plans to continue this JPL effort with NIH fund support.

On occasion a whole body of technology has been transferred to other Government agencies to enable them to better utilize systems developed by NASA. Examples of such transfer include:

1. To the Environmental Science Services Administration, technology pertinent to their use of meteorological satellites.

2. To the Air Force, technology pertaining to the Gemini reentry vehicle, in connection with the use of that vehicle, as the basic crew transfer means in the Air Force MOL Program.

3. To COMSAT, technology pertaining to communication satellites.

Within the regular framework of the Technology Utilization program new knowledge from the NASA R&D programs is being selected and organized by

means of computerized techniques to match some of the needs and special problems of the following agencies: Department of Transportation; Office of Atmospheric Water Resources, Bureau of Reclamation; Social and Rehabilitation Service, HEW; National Institute of Child Health and Human Development; and the Office of Law Enforcement Assistance. Specific examples are:

1. The Office of Atmospheric Water Resources of the Bureau of Reclamation is using NASA provided aerospace technology on a continuing basis in four of its university based weather modification studies.

2. The Social and Rehabilitation Service, HEW, is currently utilizing aerospace generated technological information in the field of vocational rehabilitation to help develop better prosthetic devices and to improve training aids and techniques.

3. Following the Ohio River bridge tragedy in late 1967, NASA met with representatives of the Atomic Energy Commission and the Department of Transportation to explore the possibility of applying technology derived from the aerospace and nuclear energy programs to problems of inspecting bridges for safety. From the NASA information bank have come several areas of technology which are potentially applicable to bridge inspection problems.

In addition a great deal of technology has been transferred by various continuing arrangements. Such arrangements usually have been established on the basis of mutual recognition by NASA and the other Government agencies of a need for positive efforts to facilitate the flow and exchange of information. Frequently this is accomplished by means of interagency committees or working groups. Another example is the dissemination of thousands of NASA scientific and technical publications to other agencies, their contractors, and grantees.

Mr. RUMSFELD. On page 17 you get to this question of funding, and I am sure we will have an opportunity to discuss this in greater detail. However it would seem to me that you can't anticipate it. You can simply guess and try to keep a reasonable level of competence.

Mr. FINGER. Well, some of this work is of such a magnitude that you really can't fit it within the budget without a preliminary plan.

Also, it is of such a magnitude that it requires that kind of planning on the part of the other agency as well so that there is an advance notice on it.

The kinds of things that come up within a year, within budget periods, are usually smaller initial efforts aimed at some research activity or the procurement of a piece of equipment that is needed to carry out a research activity that has been going at a fairly low level and some flexibility has to be provided for that.

Our Administrative Operations or in-house operating fund has come down along with the program reductions and, therefore, there is less flexibility to do this.

Mr. RUMSFELD. Just for the sake of discussion here, let's say that that is a good idea and argue it this way: That this country has a Federal Government; a Federal Government has certain revenues, and it makes determinations as to how revenues are going to be expended. Priorities are established to do that. It seems to me that it would be much easier for both the Congress and the executive branch to make intelligent judgments with respect to priorities if, in fact, the user agency of Government were required to and did plug into its set of priorities, first to the Budget Bureau and then to Congress, the specific requests that are being made.

I think that there is some merit to that argument. I think further that not only is there some merit, but it would seem there is some merit to the point that Mr. Brown raised that we just have to be a little realistic about what things are going to be funded. There are going to be things of a higher priority. To the extent that things can't be credited with a higher priority, these things which cannot be com-

municated in such a way that they plausibly fit into that higher priority, will find, I would think, that the funds or funding through the Bureau of the Budget, through Congress, and ultimately through the taxpayers of this country, will be at a minimum.

Mr. FINGER. That is the way it is done. The Bureau of the Budget does get the various proposals of the various agencies and these include the user requests where the user justifies his need for his system.

Mr. RUMSFELD. Yes; but the thrust of your statement from page 17 is against that. It seems to me that you say you don't want to be a job shop. And yet how else can priorities be established unless one option is weighed against another option and a decision made that one option has a higher priority and one has a lower priority?

Mr. FINGER. I was making that point in support of the position that we have taken that when we do work in support of another agency using our existing capabilities, we should be prepared to fund it.

Mr. RUMSFELD. Are you saying that because that is the position you have taken?

Mr. FINGER. When you build a national resource in a laboratory with the capability that exists in it, you can't have that capability fluctuate by demands from other agencies if you are to retain that capability as an effective resource.

Mr. RUMSFELD. To the extent that a capability is being used to fulfill an effort that has a high priority and is being funded through a different department, wouldn't it be proper to identify the funding and allocate a normal portion of the cost to it? You are arguing against it.

Mr. FINGER. No; if the capability that is in existence is applied to that other required effort, but we need to retain that capability, we should add to the operating costs the add-on costs——

Mr. RUMSFELD. Why do you draw the line there? I am not saying if it weren't used, it should still go on. Then, it would be allocated to NASA.

Mr. FINGER. There are real problems with how those kinds of funds would be transferred back into the responsible agency to support the existing capability.

Mr. RUMSFELD. Wouldn't it be proper to assume that if there is no use for that capability over a period of years in one agency, it should be transferred to a different agency?

Mr. FINGER. I am saying if you have that capability, you ought to evaluate its worth and rather than allowing fluctuations in support levels, there is someone responsible for retaining that capability in existence and applying it against the programs and responsibilities that are undertaken by the Government. We are suggesting that it is an essential requirement to keep that capability in existence and someone—some agency—should be charged with that responsibility.

Obviously, if there is no need for it, that is going show in the program activities that are presented to the Bureau of the Budget, to the Congress, and in the priorities established. In that process, it will be determined if there is no need for the capability and——

Mr. RUMSFELD. It won't show. What will show is that there is a level of capability through which things are being done. What won't show is that the technology that is being developed as a result of those

activities during a given year simply wasn't needed or wasn't scheduled for or wasn't desired. That won't show as clearly.

Mr. FINGER. I am going into too much detail in my consideration of it, but it seems to me it would be very difficult to present the integrated picture of what that organization is doing in support of the laboratory people associated with it. Some people would be charged to one agency and others to another and I do not believe you would get a budget that would show the total context of what that organization is supposed to do, and what its total workload is.

Mr. RUMSFELD. I won't pursue this because I suppose it is more properly a subject for people who deal in that area.

Mr. FINGER. It is an active subject of discussion.

Mr. RUMSFELD. I will say this as a member of the Government Operations Committee. We just yesterday had a discussion about the many Government reports that are put out. Should the public pay for them or should the people who want them, pay for them? It seems to me having to pay for something is a very good way to impose a discipline. If people want them, they will purchase them. If the demand is that great, people will be willing to pay 25 cents for this little publication that is being reprinted. I am just afraid that NASA might be wandering out of its area of expertise in recommending these very fixed conclusions as to how the funding should take place.

Mr. FINGER. Without meaning to get into that subject that you discussed in a broad sense, we found that when we do put a charge on some of these technology utilization reports, the demand actually goes up.

Mr. RUMSFELD. You bet your life.

I don't have any other questions.

Mr. DADDARIO. Mr. Finger, just one further point on this, however. Mr. Rumsfeld mentioned a point which I think to be particularly important.

You had a lot of agencies looking to NASA to do work when it had the money and they did not. You now have a period of severe budget limitations and you can no longer do that. I would come to the conclusion then that the work was not important in the first place, and that it was just being done by chance and there was no particular plan to it. What we would like to know is how, in fact, do you manage these things so that you are doing things you ought to do and not doing it just because money is available?

Mr. FINGER. The point I really was trying to make is that if work is requested, NASA has taken it on within its broad areas of responsibility; in such areas as the aerodynamic research or in communications activity, weather research, where we are charged with a research and development responsibility in a broad sense.

That is still our primary responsibility. If someone else came into NASA to ask to use a part of the capability that was in existence for work that was not at all within NASA's areas of responsibility, then I think that would have to be weighed in terms of priorities with the ongoing activities that NASA had. NASA would have to weigh them. They would certainly also be reviewed in the Bureau of the Budget in the process of their budget review activity. They would be reviewed in Congress as the Congress acted on total resource allocations to these installations.

Mr. DADDARIO. But you weigh these priorities with having something to do with the money manpower and facilities to do it. Is that criteria enough to make such judgments because obviously when the funds are not there, the ability to do this work is restricted. You can accept less than you had the year before. Therefore, things are not being done that you could have done, and it becomes a question as to whether this is important or not. If it is important, it ought not to be judged in this way.

Mr. FINGER. The way our authorizations work, we get authorization by program area. These are adjusted in the process of budget review through the executive branch and through the Congress so that we get an authorization against a program line item. That tells us, in effect, what the maximum amount is that can be spent in that line item. Any increase requires that we first notify the Authorization Committees. If a program area were not cut at all, that would clearly indicate the intent of the Congress to keep that area going along. Our general attitude would be to try to conform with that intent.

Mr. RUMSFELD. Then NASA would reprogram it into another area?

Mr. FINGER. I was trying to avoid that.

No; I think the important thing is that if other areas were cut, we would not have the flexibility to reprogram into those, and we could not reprogram in those cases without coming back to the Congress and notifying Congress of that intent. The issue comes up before the Congress to judge so the program is reviewed.

Mr. DADDARIO. Thank you, Mr. Finger, we appreciate the benefit of your statement and some of the questions we have been able to ask.We will have other questions for the record.

QUESTIONS SUBMITTED TO HAROLD B. FINGER BY THE SUBCOMMITTEE ON SCIENCE, RESEARCH, AND DEVELOPMENT

Question No. 1. Do all of the directors of NASA's inhouse laboratories have discretionary funds?

(a) What is the average amount as a percentage of the laboratory's budget?

(b) If all of the directors do not have such funds, what criteria are there to determine who gets it and who does not?

(c) What criteria are used to evaluate the work performed with such funds?

(d) Dr. Pickering stated that he did not have discretionary funds. If you agree that such funds improve a laboratory's capabilities, should not contractor operated laboratories also have such funds?

(e) Was the work on computerized image processing for medical x-rays funded initially by NASA?

Response. NASA has not made use of the approach to discretional funding as described by Dr. Pickering and others during the hearings of the Daddario Committee, i.e., entirely discretionary without any stated purpose for the funds at all. We have always recognized, however, the importance of allowing our laboratory directors to have flexibility and discretion in the selection of specific tasks to be researched, and in the adjustment of tasks selected, and have developed a research program management system which permits this flexibility. This system provides for definition of the overall technical scope of the research program at three different progessively refined levels, i.e., program, subprogram, and task area. A NASA Center Director is authorized to initiate a research work unit at any time if he has available resources and the unit falls generally within the technical definition of the task area involved. In addition, at any time during the fiscal year, a NASA Center Director is authorized to reprogram funds from one task area to another within the same subprogram if more promising technology areas are identified. This overall management system assures sound overall balance in the agency's research program and provides sufficient discretion to

Center Directors to initiate work and change emphasis within a broad subprogram at any time during the year.

In answer to part e. of this question, the development of techniques for enhancing distorted photographic images through the use of computers was undertaken by NASA to provide technology necessary for such spacecraft as Surveyor, Lunar Orbiter, and some Mariners. Once these techniques were proved successful, their possible applicability to biomedical problems was pointed out by NASA's Office of Technology Utilization. The NASA Office of Advanced Research and Technology (OART) supported preliminary investigations of these applications and, when it became apparent that these computer techniques did indeed have biomedical applications, NASA queried the National Institutes of Health (NIH) as to their interest in supporting further research along these lines. NIH has indicated a strong interest in pursuing this line of applied research at the Jet Propulsion Laboratory and has approved a grant to Cal Tech for this purpose.

Question No. 2. In your testimony you cited a number of instances where NASA is doing work for other agencies; however, you do not discuss what work other agencies are doing for NASA. Please describe the extent of this latter effort and the amount of money normally involved annually.

(a) How is NASA kept aware of the work being performed in laboratories of other agencies?

(b) What criteria are there to determine if NASA should perform work in-house, contract to industry or universities, or have the work performed by another government agency?

Response. Virtually every agency in the Federal Government provides some support to NASA in some form. The following is a list of the agencies which were reimbursed for some form of support in 1968:

Agency for International Development
Atomic Energy Commission
Civil Service Commission
Department of Agriculture
Department of Commerce
Department of Defense
Department of Health, Education, and Welfare
Department of the Interior
Department of Labor
Department of State
Department of Transportation (FAA)
Government Printing Office
General Services Administration
Library of Congress
National Academy of Sciences
National Science Foundation
Post Office Department
Smithsonian Institution
Veterans' Administration

The total reimbursement to these agencies in 1967 was $312.7 million, and in 1968 this total is expected to decline to $281 million. Approximately 81% of this sum is to the Department of Defense.

The support provided covers a broad range of activities from research to custodial and related services. In the Space Applications Program, for example, support is received from DOD, Department of Commerce, Department of Interior, AEC, and the Department of Agriculture, for work in supporting research and technology, NIMBUS, geodetic satellites and meteorological soundings. Much of the DOD support to NASA over several years has been operational support for the manned space flight program. In the Apollo program for instance, DOD provides, through its various services, spacecraft technical support and contract administration; launch vehicle technical support, propellants, and contract administration; technical and administrative support at the Eastern Test Range; engine development testing; range operations, aircraft services; and manned space flight recovery operations. The Corps of Engineers has been instrumental in carrying out the bulk of NASA's major facility construction needs since the earliest days of the agency.

NASA also obtains support from DOD and other agencies on smaller research and development activities on a non-reimbursable basis. These activities are usually arranged informally between NASA laboratory directors and their counterparts in other research establishments, on the basis that the requested assistance is consistent with the existing research program of the helping organization.

NASA keeps informed of the research work being performed in other agencies through a variety of interagency groups designed to provide forums for the discussion of and the exchange of data on research efforts. These include efforts of the Aeronautics and Astronautics Coordinating Board and its subsidiary panels, the Office of Science and Technology, the National Science Foundation, the Federal Council on Science and Technology and specific interagency groups working on such problems as oceanography and weather. In addition it uses the ability of the individual scientist and engineer to keep himself currently informed about advances or work under way in his discipline through personal contact, professional meetings, scientific and technical information systems, scientific journals, and other professional contacts and activities. In addition, NASA maintains a highly effective scientific and technical information program to provide current technical information to its own staff, and also to make the results of NASA's own technical programs rapidly available to scientists and engineers in industry and the universities.

The question of what criteria are used by NASA to determine whether NASA should perform work inhouse, by contract, by universities, or by another government agency really depends on a set of complex management factors which must be appraised on a case-by-case basis. There is no set of criteria which are followed in every instance. There are, however, several general policies which NASA follows as a basis for decision-making:

1. NASA's statutory charter, the National Aeronautics and Space Act of 1958, requires us to make "the most effective utilization of the scientific resources of the United States." In implementing this policy, NASA has placed reliance on universities as the principal source of scientific capability in the space program.

2. NASA has conformed to applicable policies of the Executive Branch, important among which is the Bureau of the Budget's Circular A–76, which provides guidelines "in furtherance of the Government's general policy of relying on the private enterprise system to supply its needs." NASA does rely on industry for the performance of the great bulk of its development, fabrication, and operational support of hardware systems.

3. NASA will maintain strong inhouse Civil Service technical competence in order to define our technical goals and objectives and control our technical programs. We will also maintain strong management and administrative competence in order to protect the government's interests, and properly control the expenditure of government funds.

Beyond these basic policies, each decision as to whether to perform work inhouse, by contract, by universities, or by another government agency must be based on a thorough evaluation of all management considerations such as the following:

1. Where the best capability is.
2. Whether that capability is really available.
3. The relative cost of each alternative.
4. Urgency, or the need to have a result by a certain time.
5. Whether capability is complete or must be built up.
6. Need to preserve inhouse capability.
7. Workload balancing.
8. Government laws, regulations, and policies.
9. Need to apply NASA management and technical capability to the major mission requirements.

Question No. 3.—In performing work for industry, you say that NASA charges for "normal" costs of the work. How does this compare with the full-cost recovery policy of the Atomic Energy Commission? What effect would a full-cost recovery policy have, in your opinion, upon private use of NASA facilities?

Response.—When the accounting practices underlying the NASA and AEC policies for charging industry for use of agency facilities are examined, we find that they are essentially the same. NASA develops a schedule of user charges for each of its facilities where industry use is desired. This user charge includes the normal cost of doing each specific activity. Both NASA and AEC follow the policy of requiring users to bear any special costs—such as the cost of special equipment peculiar to the user's work—which are necessary.

Question No. 4.—In your testimony you stated that in the broad range of science and technology, there should be no "end" to a laboratory's mission or purpose; that the best laboratories of all kinds repeatedly demonstrated the ability to go through continuous renewal of objectives in order to stay alive and

vital. How do you define the "best" laboratories, how do you determine this quality? To what extent would you preserve the less than best laboratories?

Response.—The problem of evaluating the capability and performance of research organizations is a difficult one and perhaps one which can be answered only subjectively, since it is difficult to quantify or "score" such a complex and sophisticated organization as a research laboratory or development center. We believe that the NASA experience confirms what appears to be a widely held view among research administrators, that the basic determinant of strength or weakness is a very fundamental issue of the value and importance of the purposes of the organization, the validity of its objectives to recognize national or social needs and the capability to satisfy these purposes, objectives and needs. It would seem very hard for a research organization to succeed if its basic purposes and motivations seemed unimportant; on the other hand, the research organization which has an important and significant role to fulfill has a very good start in the critical process of building and holding a research competence.

We believe that the buildup of NASA in the years immediately following its formation has many illustrative examples as cases in point. Many of these were cited during the testimony before the Subcommittee on Science, Research and Development of the House Committee on Science and Astronautics. But it can be reiterated that the strong sense of national purpose and the challenge of the new opportunities for space research and development played an incalculable role in attracting a high quality of personnel within our new laboratories and in providing the motivation to reorient capable people into new technical areas. The continuing challenge of the program, plus the spirit of purpose and sense of accomplishment, has resulted in the retention of these talented and highly motivated people to an extraordinary degree. Our research and development centers, as institutions, have thus achieved a high order of effectiveness through the feeling of all of their people that important things were being accomplished and valid national purposes were being served.

As for the preservation of laboratories which are "less-than-best," just as a business executive, faced with declining sales, looks first for ways to improve efficiency and produce products which will be better received, so also the first reaction of the research administrator is usually to re-examine the research objectives and productivity of a laboratory which is faltering, or which is nearing the completion of its initial goals. In each case, the central fact is that the creation of a business or a laboratory is very difficult, time-consuming and expensive, and a manager must think long and hard before he makes any decision to terminate what has been created or to create an entirely new installation. In the case of a research and development organization, there are almost always many research areas, not receiving adequate attention, toward which a lab can be directed. Under the circumstances, the abolishment of a laboratory would probably be undertaken only when, in the judgment of management (and probably an external appraisal as well), the following conditions exist:

1. The initial purpose of the lab has been served, and there is no reasonable extension or continuation of it.
2. There is little likelihood that a reasonably pertinent new role for the laboratory can be found.
3. The abolishment of the laboratory would not leave any important gap in the national capability for performing necessary research or development work.

Finally, if the re-development of a declining lab were attempted and failed, it should probably not be continued. In many cases, consolidation of the most effective parts of a lab which is being abolished with some other research institution is an effective compromise which may save the best of the remaining personnel.

Question No. 5.—You testified that NASA laboratories do not have to deteriorate and decline, that they have the flexibility to take on new roles and missions, to shift primary emphasis, to retrench. Please illustrate this concept with reference to NASA policies and procedures that affect a NASA laboratory director's discretionary authority to use funds for new research, to reassign personnel, to change the total personnel strength of his laboratory.

Response.—The testimony given before the Subcommittee on Science, Research and Development of the House Committee on Science and Astronautics gave many examples where NASA organizations have demonstrated the flexibility to take on new roles and missions, shift primary emphasis, or retrench. The answer to question #1, above, discusses the discretion which can be exercised by laboratory directors in the selection and funding of research activity. Several other

points of long standing NASA/NACA policy can also be cited to illustrate the substantial freedom and independence of the NASA field installations:

1. It should be emphasized that NASA is a research and development agency. Because this is true, the NASA Headquarters has just as strong an interest as its field installations in the development of the strongest possible R&D capability and the preservation of the flexibility to take advantage of new research opportunities and serve the most significant national goals which are within its capabilities. Thus, the goals of the Headquarters and the laboratories are in consonance.
2. Center directors have flexibility and significant authority to control the assignment of their people.
3. Center directors have the responsibility as well as authority to ask for more people if they need them.
4. Center directors have authority and responsibility to initiate requests for new or additional facilities and research equipment necessary to carry out their work.

The realities of the budget process frequently mean that a laboratory director does not always get what he asks for, and there may be fiscal or policy reasons which cause agency management or the Executive Branch to turn down resource requests. But the basic policies of center director discretion and control over his own work force and research facilities are well understood and have played an important part in maintaining flexibility. NASA has a unique capability to manage large scale R&D programs of many kinds and to sustain a research program over a broad range of technology. This capability is in our laboratory structure and innovative ideas and concepts for research usually generate in these labs and are initiated by them.

Question No. 6. Several agencies have set up procedures to appraise the performance of contractors that do research and development for them, or that manage agency laboratories. What procedures does NASA use, and what consideration has been given to applying the standards and procedures of these appraisal processes to NASA operated laboratories? To what extent would this be desirable?

Response. NASA recognizes that the appraisal of the effectiveness of its research and development activities is an important part of management, and this applies whether these activities are inhouse or contracted. We have developed systems for R&D contractor performance evaluation tied to the basic requirements of contract management and administration, and also tied to our incentive fee patterns. Indeed, the NASA inhouse technical competence provides the capability to make such evaluations. In addition, many of our R&D contractors are those who design, fabricate and operate hardware for NASA rather than those who do research, and their performance can be judged rather precisely in terms of cost, performance, ability to meet schedules, and the success of the mission. These same criteria are also used to judge inhouse NASA performance in those laboratories which are flight mission oriented and are charged with the management of flight hardware.

In the special case of the Cal Tech/JPL contract which is for research and development, NASA regularly evaluates technical and administrative performance using an evaluation board composed of representatives designated by the Administrator.

Evaluations are performed semiannually and are based upon criteria established by the Board. In addition, there are two other regularly scheduled meetings each year in order to discusss trends, questions or performance factors which could become agenda items at subsequent formal evaluation meetings.

Since NASA Centers undergo continuous technical, functional and management review the extrapolation of the Cal Tech/JPL appraisal is not contemplated. For NASA's inhouse Centers, the most effective appraisal system has been demonstrated to be reliance on continued close and regular technical and professional Headquarters/Center communications and association, plus regular reviews and appraisals by functional staff offices.

Question No. 7. The DOD witness proposed the elimination of manpower controls on cross-agency work in order to achieve flexibility similar to that available to the AEC contract laboratories. What is your opinion of this proposal?

Response. While the idea of relief from manpower limitations for cross-agency work has some attraction, we feel that the necessary flexibility for undertaking work between agencies should be possible within present budget approval techniques. Where relatively small manpower commitments would be required of a performing agency in doing work in its general area of responsibility for another agency, it should be possible to absorb these requirements

within the total existing capability. The existence of such cross-agency work would, of course, help buttress the manpower budget of the performing agency. In instances where a major manpower commitment would have to be undertaken by the performing agency, the magnitude of the intended research program would probably be such that the requesting and performing agencies should, in any event, present their intentions to the BOB and include provision for necessary money, manpower, and equipment requirements in the budget of the performing agency where it would be jointly defended. We believe that it would be sufficient to rely on BOB willingness to accept these forms of cross-agency arrangements and work with agencies to assure that appropriate resources can be made available.

Questions No. 8 and 10. No. 8: The concept of utilization implies that sooner or later decisions will have to be made to allocate and schedule existing laboratory capability among competing agency needs. Is there at present any place in the Executive Branch short of the President where priorities can be assigned to Federal missions for the guidance of agency heads and laboratory directors in the event of competing requirements for the same facility?

No. 10: Based on your experience, what advantages and disadvantages would you see in an office of Government laboratory management located at the level of or within the Office of Science and Technology? Such an office would be analogous to the present office of the Assistant Director (Laboratory Management), in the Department of Defense's Office of Defense Research and Engineering.

Response. There is not, at this time, any office in the Executive Branch where priorities are assigned to Federal research missions, and in fact, it would be difficult to establish research priorities separate from the process of establishing national goals, objectives and priorities themselves. This process is accomplished now by the President working through the Bureau of the Budget and the entire framework of relationships between the Congress, the Administration, and the agencies directly. The question of whether there should be an office of Government Laboratory Management can probably be answered only if the functions of such an office could be defined to show how it should fit into this existing framework, and how it would relate to the large number of agencies having line management responsibility over Federal laboratories. NASA would support specific means of assuring more effective inter-agency coordination and cooperation in R&D activities and cross-servicing between agencies.

Question No. 9. A sharp line is drawn between those Government laboratories that are directly operated and those that are contractor operated. In terms of your experience, what are the principal characteristics of each mode of operation and the differences between them that are significant to utilization of Government laboratories?

Response. NASA's only major experience using a contractor to operate a research and development laboratory is the Cal Tech/JPL experience. Our experience clearly demonstrates that the contractor approach can be made to work in the NASA context, and, in the last analysis, our management of the Jet Propulsion Laboratory has been quite comparable to our management of inhouse labs.

Question No. 11. What authority do your laboratory directors have to deal directly with other agencies that may wish to engage their research and development services?

Response. NASA laboratory directors are authorized and encouraged to deal directly with any other government agency which may desire to engage their research and development services. They may not, however, expend NASA research and development funds, nor accept reimbursement from other agencies to pay for these services. All NASA research and development funds are authorized for specific NASA projects only in accordance with Project Approval Documents approved by the Administrator. Authority to accept reimbursements for work performed by NASA for other agencies is also controlled by NASA Headquarters. When the effort proposed by another agency is of sufficient magnitude or of the nature to require more than a simple exchange of funds between agencies, an interagency agreement or memorandum of understanding requiring the approval of top NASA management is required.

Question No. 12. In what ways are the directors of your large, multi-program laboratories kept informed of the scientific and technological content of new or changed government functions, such as those of the Department of Transportation or the Department of Housing and Urban Development? What incentives

are there for your laboratory directors to give thought to such matters in addition to their primary responsibilities to your programs?

Response. NASA laboratory directors and other senior NASA officials are able to obtain information about the scientific content and research requirements of other Federal agencies through such normal devices as national professional meetings, trade journals, scientific and technical information systems, and direct contact between agencies, particularly in Washington. NASA has recently expanded the role of its Office of DOD Affairs into DOD and Interagency Affairs specifically to expand and improve our contacts with other agencies, and the quality of our knowledge about their research activities and needs. We believe, however, that much could be done to improve this kind of information exchange, and NASA is working toward, and will support specific measures to facilitate such improvements.

Question No. 13. The Committee understands there have been discussions between NASA and the International Association of Chiefs of Police about application of NASA technology to specific police needs. Please provide details about these discussions, particularly concerning the outcome. How is the NASA-supplied information expected to be used? By whom?

Response. In late 1967, at the request of the International Association of Chiefs of Police (IACP), members of NASA's Office of Technology Utilization briefed IACP representatives on the NASA effort to encourage additional uses of knowledge gained in the space programs and in particular to aid in movement of this knowledge across disciplinary boundaries.

The briefing included a description of the work of NASA-sponsored Biomedical Application Teams in seeking answers in aerospace technology to the problems currently impeding medical progress. These teams, serving as a link between aerospace laboratories and medical research groups, help the medical researchers define their problems in functional terms, then seek suggested answers from experts among NASA scientists and engineers and those of its contractors. The teams also make searches of the NASA stockpile of scientific and technical literature by using computers to match terms describing the medical problems against terms describing documents in the NASA collection of some 350,000 technical reports.

IACP followed up the briefing by asking NASA to make pilot searches on two problems specified by IACP:

a. Development of extended range personal radio communications, so that police officers, whether in car or on foot, could be contacted individually or as a group, could have three-way voice capability (i.e., station to officer, officer to station, and officer to officer), and could direct original messages to discrete addresses.

b. Development of lightweight thermal clothing to eliminate the need for heavy cumbersome clothing.

The results of these searches were provided to IACP in February, 1968, and the Office of Technology Utilization is currently awaiting IACP comments on both the literature searches and the reports.

Question No. 14. To what extent has NASA reviewed the Science and Technology task force report of the President's Crime Commission to see what NASA capabilities might contribute to the specific prospective applications of science and technology set out in that report?

a. Two areas identified by the Commission as having the greatest immediate impact on police operations are communications and systems analysis—areas presumably in which NASA has great competence. This being the case, how is, or how could, NASA make its capabilities available?

Response. The Office of Technology Utilization does not attempt to develop or select unilaterally the specific technology needed to solve the problems of potential users of aerospace technology. It cannot do this alone. This would presume a knowledge of the problems in depth, detail, and specificity not possessed by NASA. Rather, the Office of Technology Utilization strives to establish a working interface which will facilitate the acquisition of the technology by the user. The user is helped to describe his problem in language used in aerospace technical literature. Choice and definition of the problems for which solutions are desired can best be determined by the potential user just as he can best judge the relevance of suggested solutions resulting from searches of the aerospace literature and personal interface with aerospace scientists and engineers.

NASA can best make its capabilities available by working with and through the agencies or institutions having primary or direct responsibility for crime prevention or control.

Question No. 15. What other work is NASA's Office of Technology Utilization funding which is related to national problems such as crime?

a. How does NASA assure that it is not duplicating work sponsored by the Department of Justice or a similar agency?

b. What is the rationale behind such grants or contracts—what does NASA expect to achieve?

c. Do you believe that NASA could make such grants or contracts if it were not specifically authorized through its technology utilization program to accelerate the spin-off of the space program?

Response. Section 102 (c) (4) of the Space Act directs that NASA "shall conduct long range studies of the potential benefits to be gained from, the opportunities for, and the problems involved in the utilization of aeronautical and space activities for peaceful and scientific purposes." We are anxious to increase and extend efforts to transfer, where applicable, space developed technology to the solution of social problems, but only working with or through other agencies. For example, arrangements have been made for the Midwest Research Institute, one of the NASA-sponsored regional dissemination centers, to provide data to the Office of Atmospheric Water Resources of the Bureau of Reclamation which might assist in the solution of problems in the area of weather modification. We are also cooperating in various ways with, among others, the Atomic Energy Commission, the Department of Defense, the Department of Health, Education, and Welfare, and the Department of Agriculture. Working in this manner, there should be no duplication with other agencies.

There are no NASA grants or contracts which relate specifically to crime as such. The work done for IACP was done under existing contracts designed to bring about broad dissemination of new technology. NASA also supported a grant to the American Association for the Advancement of Science for studies on how a large program like the space program affects the economy. One of the published works resulting from this grant was a book called "Social Indicators" which did contain a discussion of the Uniform Crime Reports compiled by the FBI, citing them as an example of the need for improved and comprehensive information reporting systems.

NASA recognizes that useful products of research and technology historically have gained application outside of the place of origin. This would be expected to happen in time even if NASA had no technology utilization program. We feel that this process should be aided and expedited, and that aerospace technology can be brought to bear on many pressing social problems, for the benefit of all mankind. We believe that this historical tendency for specific inventions and developments to adapt themselves to society's needs has been recognized at several points in the Space Act as well as in annual Authorization Acts. Specific authorization for technology utilization does make possible grants or contracts designed to broaden and accelerate the dissemination of our technology.

Mr. DADDARIO. We will now hear from Dr. Pickering and get the point of view of a laboratory director.

Dr. Pickering.

Dr. PICKERING. Mr. Chairman, I should like to read to you a statement.

(Dr. Pickering's biography follows:)

DR. WILLIAM H. PICKERING

William H. Pickering has been director of the Jet Propulsion Laboratory of the California Institute of Technology since 1954. As such, he has been responsible for the programs which resulted in Explorer I, the first U.S. artificial satellite, Pioneer IV, the first succesful U.S. cislunar space probe, the Mariner flights to Venus in 1962 and 1967 and to Mars in 1964–65, the Ranger lunar photographic missions in 1964–65 and the Surveyor lunar landings of 1966–67.

Dr. Pickering was born in Wellington, New Zealand, but immigrated to California as a young man to attend the California Institute of Technology. There he obtained both bachelors and masters degrees in electrical engineering and a Ph. D. in physics, became a member of the faculty, and worked under Nobel Laureate Robert A. Millikan in a world-wide program of high-altitude cosmic-ray research. During World War II, he conducted applied research in electronics at Cal Tech, MIT, and other laboratories. In July 1944, he organized the electronics effort at JPL to support guided-missile research and development. He

became project manager for Corporal, the first operational missile developed by JPL.

As JPL's director, Dr. Pickering was involved in U.S. Army proposals for Earth-satellite launchings, and in 1957–58 for the development and operation of the early Explorer satellites and Pioneer space probes. Following these projects, he lead JPL into the new National Aeronautics and Space Administration as a major contractor responsible for unmanned lunar and planetary flight projects and the supporting technology.

He has been professor of electrical engineering at Cal Tech since 1946; he was the first president of the American Institute of Aeronautics and Astronautics in 1963, and president of the International Astronautical Federation in 1965–66. He is a member of the National Academy of Sciences, the National Academy of Engineering, and the Royal Society of New Zealand, among others.

He is an advisor to the University of California, the University of Washington, and the University of Connecticut. He has been a member of the Army Scientific Advisory Panel and was a charter member of the Air Force Scientific Advisory Board. He has published a number of articles and technical papers in the field in which he is active, and has received NASA's Distinguished Service Medal, the Army's Distinguished Civilian Service Award, the British Interplanetary Society's Special Award, the Columbus Gold Medal of Italy, the James Wyld Memorial of the American Rocket Society, the Robert H. Goddard Memorial Trophy of the National Space Club, the Galabert Award of France and Italy's Order of Merit, among others.

He is married to the former Muriel Bowler; they have two children, William Balfour and Anne Elizabeth (Mrs. Wayne Mezitt).

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

Your interest in the optimum utilization of Federal laboratories is particularly gratifying and reassuring to those of us who have been involved in Government-sponsored research and development activities. I am honored and pleased to be invited to testify before your committee today.

My remarks, Mr. Chairman, are made with reference to my experience as director of a mission-oriented laboratory sponsored by the Government but operated under contract to a university, and one which has worked for a number of agencies and experienced significant changes in primary objectives during the past 30 years.

The Jet Propulsion Laboratory was the first Government-sponsored rocket research group in the United States, originating on the campus at California Institute of Technology in 1939 as an outgrowth of the activities of the Guggenheim Aeronautical Laboratory. Headed by Dr. Theodore von Karman, JPL performed research and development on rocket propulsion devices for aircraft until 1940, when the Army Air Corps assumed sponsorship.

I might comment in passing that at that time the interest in the work was such that it grew beyond the scope of the university and the Aerojet Corp. was formed as a byproduct of our activities.

By 1941 the first successful jet-assisted aircraft takeoff units were developed, followed by pioneering liquid and solid propellant rocket systems and the basic concepts underlying modern telemetry systems. In 1944 JPL began a long association with the Army Ordnance Corps, during which it developed the first of the modern guided missile weapons systems, and, in the late 1950's, the first inertially guided, solid propellant missile system.

The national crisis following the first sputnik brought a significant shift in the Laboratory's interests, emphasis, and motivations. In 1958 JPL assisted the Army in developing and launching Explorer I. In December of that year, by Executive order of the President, sponsorship of JPL was assumed by the newly formed National Aeronautics and Space Administration.

During the past decade, the primary mission of the Laboratory has been to support NASA research and development associated with unmanned lunar and planetary missions.

Thus, in 30 years JPL has evolved into a seasoned, mission-oriented laboratory, based on experience in the technologies of guided missiles weaponry and deep space exploration.

It may be relevant here to recall the essential capability which a mission-oriented laboratory such as JPL affords. This capability is the common attack, by a number of diverse and often conflicting technical disciplines, upon a common problem or mission. The motivation for this process, and for the engineers and scientists who carry it out, is the mission itself. While the laboratory must be competent in the various disciplines, its special skill is the ability, through a matrix of talents or "systems engineering," to produce an integrated device or system, based on these disciplines, which will accomplish its mission. The development of such a team is a slow process and, once accomplished, it is a most important factor in the continuing success of a mission-oriented technical laboratory.

To turn now to the issue before the committee today, namely, how best to use our existing Federal laboratories, let me begin with the question of redirecting a laboratory when its assigned mission may have been completed or is of lower priority.

JPL has experienced one significant redirection in its history. This occurred in 1958, when sponsorship was transferred from the U.S. Army to NASA, and our mission changed accordingly from weapons systems development to deep space research. This redirection was orderly and valuable, I believe, to NASA and the Nation. There were a number of factors that made the transition successful.

With the creation of NASA, an explicit decision was made, at the necessary levels within the Government, that the services JPL could perform for NASA would be of more value to the Nation than its work for the Army. There also existed within JPL an enthusiasm for and adequate understanding of the new mission, its technical demands, and the functions the Laboratory could carry out in meeting these demands. This understanding derived largely from work in the space field JPL had performed under Army sponsorship, as, for example, the effort in the Explorer project.

The actual transition to NASA required about 18 months. The new mission required expansion in personnel, enlargement of facilities, and significant alteration of the technical discipline mix of the professional staff. An interdisciplinary development and maturing of systems engineering capability was accompanied by the addition of space sciences as a divisional function.

Mr. DADDARIO. Dr. Pickering, if you had civil service employees working for you, taking into consideration rules, regulations, and what not, could you have performed this transfer at all or would it have been made more difficult?

Dr. PICKERING. Mr. Chairman, as you know, about a year later the Marshall Center was transferred into NASA and this was an example of a civil service laboratory being transferred from the Army to NASA, and I believe the transition was made in a reasonable fashion.

The mission in the case of Marshall remained somewhat closer to their original mission than in our case where we had to reorient from weapons to deep space research.

Mr. DADDARIO. You would not see it as restrictive?

Dr. PICKERING. No.

The factors present in the transfer of JPL to NASA sponsorship are those necessary to any successful redirection of a mission-oriented laboratory. There must be a sponsoring agency having the requisite charter and funding. There must be a decision mechanism which can assess the national priorities of new versus old missions, and which has authority to make the decisions for redirection. There must be an appropriate match between the new mission and the existing capabilities of the laboratory. And there must be an understanding within the laboratory of the new mission.

The last factor, the understanding of the new mission, is needed not only for assessment of the match between capability and mission, but also for the formulation of plans and programs, and the motivation of the staff toward involvement in the new mission. Some elements of the laboratory must become immersed in and identified with a mission in order to have an appreciation in depth of its implications.

Mr. DADDARIO. Here you seem to be touching on a laboratory which is changing the direction of its activities, getting involved with new missions, but having had over a period of time an ability to develop experience in this, and it can redirect its activities.

Dr. PICKERING. Yes. I am thinking of the mission-oriented laboratory as distinct from the research laboratory. A research laboratory which is accustomed to performing research in a wide spectrum of activities can gradually evolve that basic research program to other ends.

But in the case of the mission-oriented laboratory, you have a team capable of carrying out a mission in which a large segment of the laboratory is integrated into that team. The question is how does that team get reoriented toward a new mission? For that there must be a real understanding of the mission and a real motivation of the people. This will come about after some elements of the laboratory have had experience and an ability to perform work in the new mission.

Mr. DADDARIO. During the course of our seminars, Dr. Teller and Dr. Weinberg and others have constantly referred to the fact that we do not have the greatest applied research capability in this country. We do extremely well in the basic research area, but we do not do as well as they think we can in the applied area.

What you are saying here is that you do have this kind of a capability and that you can, in fact, accomplish varying types of national goals and objectives.

Dr. PICKERING. Yes, sir. I believe we do have the applied capability in this country. I am a little bit surprised that Dr. Weinberg or Dr. Teller would criticize this because it seems to me in this country over the past couple of decades we have demonstrated some remarkable achievements in the area of applied science.

Mr. DADDARIO. They were not criticizing. They were saying we are not using our capabilities in this regard as efficiently as we could. Many of the problems of this day and age come upon us more rapidly now than ever before, and we must quickly develop the capability to meet them.

Pollution is an area where knowledge must be applied more rapidly before the situation becomes more dangerous than it presently is. This is what the discussion was about and I do not want to infer that it was a matter of criticism, but rather it concerned better use of our resources.

Dr. PICKERING. I think this is a matter of priorities. What have these resources been used for, these applied science laboratories? Have they been used for missions which have been regarded as the most urgent priority by the Congress?

Now, if the assessment of priorities places other problems first then I believe the mission-oriented teams can be reoriented toward new priorities even though the new priorities involve shills outside the purely physical sciences.

Mr. DADDARIO. Would you add to that, taking the situation as you see it, that we ought to be developing this competence in a broader way?

Dr. PICKERING. Yes, sir. I have some more to say about this later on in my testimony.

Mr. DADDARIO. All right.

Dr. PICKERING. Having touched on the complete redirection of a laboratory to a new mission, let me turn to a partial redirection, including such questions as the use by one Government agency of capabilities of a laboratory funded by another agency, and the utilization of a mission-oriented laboratory in seeking solutions to social problems.

The Jet Propulsion Laboratory has a long history in moderate-sized funding from agencies other than the principal sponsor. For example, for many years, the wind tunnels at JPL were partially funded by the three branches of the military services. At present, the Laboratory is carrying out tasks for the Department of Defense, and we hope also to perform work for the National Institutes of Health. Our experience here strongly suggests that where all of the involved agencies concur, implementation is feasible.

Whether the redirection be complete and permanent, or partial and temporary, preliminary technical work of "seed" effort in the new mission is required. Accordingly, seed work on a modest scale in areas outside of the primary laboratory mission is a justifiable investment. In JPL's experience, Explorer was such a seed project, enabling the Laboratory to make an orderly transition to the new NASA mission.

A new mission may be stimulated by a high-level policy decision from above, or a new technical idea from below; in either case, discretionary funds for such activities are required. In fact, some discretionary funds within the primary mission are generally needed to realize the fullest potential of a mission-oriented laboratory. The application of such resources should be within broad policy limits established by mutual agreement with the sponsoring agency, but should otherwise reflect the independent thought and judgment of the laboratory management and staff. At present, JPL has no such discretionary funds and all tasks are specified by contract.

Mr. DADDARIO. What percentage of those funds are you talking about?

Dr. PICKERING. In the 5- to 10-percent area of discretionary funds.

Mr. DADDARIO. What would this do in your opinion to the quality of your Laboratory?

Dr. PICKERING. It would improve the quality because Laboratory morale is related to the enthusiasm and support which people have for the work they are doing. It must be work they believe in.

In general, of course, the people at the Laboratory would not be there unless they believed in the total mission of the Laboratory. With reference to the research areas represented by seed effort, when people at the Laboratory who have good ideas which they would like to work on, in areas which are not directly supported under the contract, but which nevertheless in the judgment of the Laboratory Director would be appropriate areas to work in, an opportunity to do so would obviously help the morale of all the professional people at the Laboratory.

Mr. DADDARIO. It would help the morale and increase the quality of your Laboratory. It would allow you to do some of the seed work that could lead to directions you are not even aware of now. If you were to take 5 or 10 percent of your funds for discretionary work, wouldn't you with the remaining 90 percent, because of the increased quality of the work and the morale in the Laboratory, actually do better work with less funding?

Dr. PICKERING. I believe it would, but obviously this is just a matter of speculation. It would be difficult to prove.

Mr. DADDARIO. I understand it would be difficult to prove, but we have had laboratory directors here before and from whom would we get a better judgment than from you people who are involved in it? You seem to be unanimous in this regard.

Dr. PICKERING. I think it is an important factor.

Mr. RUMSFELD. How much is 5 percent?

Dr. PICKERING. $5 million. Excuse me, let me make it clear. I am talking about 5 percent of the total administrative operations type of funding for the Laboratory, and may I just interject that our Laboratory being operated under contract is not AO funded, it is funded through the R. & D. funds, but a fraction of about 70 percent of our funds goes out to contract.

Mr. RUMSFELD. What is the dollar figure you are talking about?

Dr. PICKERING. $5 million.

Mr. RUMSFELD. Your work is on specific contract?

Dr. PICKERING. Yes. At present we have a contract on which our work is provided by tasks.

Mr. RUMSFELD. It is all with the Federal Government?

Dr. PICKERING. All with NASA.

Mr. RUMSFELD. I know of institutes that do 98 percent of their business with the Federal Government, 95 at the minimum; between 2 and 5 percent with private sector; and use the profits in their private contracts as discretionary funds.

Dr. PICKERING. Well——

Mr. RUMSFELD. I am not suggesting it is necessarily applicable here, but this is a procedure that I know is being used.

Dr. PICKERING. In our case the physical plant, the facilities, are owned by the Federal Government. We operate the laboratories for the Federal Government.

Mr. RUMSFELD. Right. I just raise this as an example of a way that some people are getting discretionary funds. If discretionary funds can be allocated, there is no reason why an arrangement like this couldn't be. I am saying it is another way that it is being done, not the best way nor the way it should be done.

Your answer is not an answer because we have Government-owned property, as the gentleman sitting behind you can tell you, in private commercial operations all across this country, so the very fact that that is the rule now does not necessarily mean that it must be the rule forever.

Mr. DADDARIO. All right.

Dr. PICKERING. The question has been raised as to how a mission-oriented laboratory can be responsive to such national problems as transportation, housing, or crime. We tend to presume that problems which have been caused or aggravated by technology can be solved by technology. In fact, the solutions involve political, social, and economic considerations, and new technical devices may be a minor contribution to the total solution.

A concerted attack on the problems can best to made by a team of specialists including skills ranging from the physical to the behavorial sciences to economics and law. Such teams must operate under the disciplines developed by the systems analysts in the mission-oriented laboratories, and can be readily built around the existing groups. Some elements of these skills already exist in laboratories concerned with total mission responsibilities, because mission operations require human operators; thus human skills, motivations, and limitations must be incorporated into mission design. Therefore, it is quite feasible to convert existing Laboratory capabilities in response to these national problems. In fact, many engineers and scientists are deeply concerned with such social problems, and I am sure that in most laboratories, it would be easy to find high motivated individuals willing to explore these areas.

Recently, at JPL, we held informal discussions with senior members of the Los Angeles Police Department concerning the technical problems they face. It is clear that the Laboratory has the skills to develop some of the needed solutions.

The interdisciplinary attack, in which the system analysis is accomplished by social and political scientists as well as engineers and physical scientists, is an attractive and promising concept, although largely untried. Cal Tech has been moving in this direction, seeking to close the gap between the physical and social sciences by expanding and reorienting its curriculums.

Finally, we have the question of whether to create new laboratories for new missions, or whether to assign new missions to existing laboratories. I believe that the assignment of a new mission to an existing laboratory can be profitable. An established laboratory processing staff, management, and facilities can, if competent and suitably matched to the new task, move more rapidly into the new mission.

On the other hand, such a reassignment should be made only when there is assurance that the quality and character of the laboratory justify the new mission. Since the Federal Government does have a

large structure of multidisciplinary laboratories, we should seek to use them in the best national interests.

The present laboratories can be reoriented, if necessary, to match new needs. Broadening the interdisciplinary base and changing the professional mix of talents is an entirely reasonable and practical procedure in view of the ever-growing demands on the national resources. But to do so effectively, a proper effort must be made to assess the capabilities of the existing laboratories and to evaluate the new problems to determine what contributions they might make. Such an assessment can be made only if adequate seed money or discretionary resources are made available before a laboratory's primary mission has been completed. Some such procedure is necessary if we are to achieve optimum utilization of the existing Federal laboratory system.

Thank you, Mr. Chairman.

Mr. DADDARIO. Dr. Pickering, you point out, as has been done by others, that technology cannot be relied on to overcome all of the problems that have been caused or aggravated by technology, and that you bring in the political, economic, and social considerations.

You then speak about the utilization of present laboratories, and the fact that there are some extremely competent national laboratories.

You then get to the point where they must be evaluated. We have touched on this with others, and how to evaluate them is a pretty difficult problem.

What do you think about it? How do we go about this rating process?

Dr. PICKERING. Mr. Chairman, again I think that discretionary or seed effort in new areas may be the key. In other words, if you invite a laboratory to develop its capabilities in certain other areas to a limited extent, I think it will be quickly evident as to whether or not that laboratory will come up with useful new ideas.

For example, if you asked JPL to build submarines I couldn't tell you that we could build good submarines.

On the other hand, if you told me that you wanted JPL to build submarines and asked for a study effort over the next 6 months to determine what we could do, after a 6-month study an assessment of the JPL capability could be made against the total national competence for building submarines. This could then lead to a useful evaluation as to whether, in fact, JPL could help.

Mr. DADDARIO. That is sensible, but it still doesn't eliminate the need to have some kind of an evaluation process at this stage of the game. I do not think that every laboratory would deserve this discretionary authority. If we were to establish a policy that a certain number who we knew had the ability and the competence and would use this discretionary authority to raise their quality even higher, could have the funds, then the rating requirements would still be necessary.

Dr. PICKERING. Yes. I think that there is a certain element in the internal development of the laboratory itself to be considered. If I may reflect on our own experience in the transfer from Army to NASA, a year or two before the transition it was becoming evident to us at the laboratory that the mission we were performing for the Army was becoming a less valuable match to our capabilities.

In other words, we had accomplished certain things for the Army. But in looking to the future it was not at all obvious where we were

going next. At that point the people at the Laboratory on their own initiative began looking for areas which were a better match to our talents. In fact, the support which JPL gave to the Army, as the Army began to develop interest in the Explorer effort, evolved naturally and was partly initiated by the laboratory itself because of the realization that some sort of a change in mission was necessary.

I think that holds true in other laboratories. In other words, if a laboratory is a dynamic laboratory and if it sees its mission coming to an end or changing priorities, the laboratory itself will initiate some moves to explore new areas.

Mr. DADDARIO. Oak Ridge is now spending about 13 percent of its overall funds in areas beyond its original mission, especially in the areas of desalting and civil defense. As they work into both of these areas they find themselves capable of increasing their development in many of our social and economic problems, and they find that these become important involvements from the standpoint of finance.

Obviously, this would be the case in many areas, and we do need to bring some direction to it. I would think that the use of existing laboratories should be at the heart of it. Yet we would have to come to a determination about which laboratories have this quality.

Dr. PICKERING. Mr. Chairman, you do pose a difficult problem. I understand from Dr. Weinberg that the AEC agreed some 5 or 6 years ago that Oak Ridge should explore some new areas. I think that should be the position of a sponsoring agency. The sponsoring agency, would have to recognize the changing mission and the potential of the laboratory in new areas.

To do this on a total Federal basis, I feel, would be very difficult. It would imply a total Federal catalog of laboratory capabilities which I am sure does not now exist. I am not sure it could ever exist because it would involve too much comparison of apples and oranges.

Mr. DADDARIO. Would you have much difficulty in privately coming to an assessment about these things?

Dr. PICKERING. We laboratory directors have opinions about our quality and the quality of some of our competitors.

Mr. DADDARIO. You don't have to go any further than that.

Mr. Rumsfeld.

Mr. RUMSFELD. Just to clarify something. As I recall, the chairman indicated that he felt discretionary funds should not be available to all such laboratories, but some should be selected out.

Mr. DADDARIO. That is correct.

Mr. RUMSFELD. Is it correct that you agree with that?

Dr. PICKERING. I note in my testimony that the reassignment in new missions is only when there is an assurance that the character and quality of a laboratory justify the new mission.

Let me point out that in order to go into a new mission the first step is to provide discretionary funds and encouragement to explore.

Mr. RUMSFELD. Are you endorsing discretionary funds only for that purpose?

Dr. PICKERING. No, sir.

Mr. RUMSFELD. Let's refer to it apart from transition.

Dr. PICKERING. Then I will endorse discretionary funds in general I believe in a mission-oriented laboratory that the primary mission——

Mr. RUMSFELD. Do you agree or disagree with Mr. Daddario?

Dr. PICKERING. I disagree with him.

Mr. RUMSFELD. I was under the impression you agreed with him earlier, and I didn't see how you could agree.

Mr. DADDARIO. Let me add one provision here. If there happens to be, and I would expect that there is a laboratory hidden away here or there which ought to be put out of existence, would you give them 5 or 10 percent discretionary authority at this stage of the game? I am considering all laboratories.

Mr. RUMSFELD. As I recall, I have the floor. I would say that neither Dr. Pickering, nor I is suggesting that. If it should be out of business it should be out of business, but if it is in business the odds are it should be in business. What is good for the goose is good for the gander. You are talking about morale and the need for general competence. If discretionary funds have any merit then they have merit for those institutions which are in business if they should be in business.

Isn't this right?

Dr. PICKERING. I would suggest the following. If discretionary funds are provided for a laboratory, the sponsoring agency will not stand up and allow the laboratory to do whatever it wants to.

Mr. RUMSFELD. Then we shouldn't call them discretionary funds.

Dr. PICKERING. They are discretionary to the extent that the laboratory makes the initial decision, but after the laboratory has used these funds, it will be asked what it did with them and some sort of report will be expected.

I suggest that the way in which a laboratory uses its discretionary funds will be a good indication of whether or not the laboratory should continue in existence. I think if you gave discretionary funds to a laboratory which was in effect a dying laboratory, it would be pretty clear after a year or so that that, in fact, was the case.

Mr. RUMSFELD. This is one of the difficult problems the Bureau of the Budget has in evaluating such things.

Dr. PICKERING. If the laboratory is dying because of the quality of the staff, even with discretionary funds it will not produce anything very useful.

On the other hand, if it is dying because it has been under some sort of control and has been directed into areas which the staff hasn't been able to follow, by providing discretionary funds the laboratory may quickly revive.

Mr. DADDARIO. We are examining the situation as it pertains to all national laboratories. During the course of these discussions Dr. Hornig spoke of the difficulty in really phasing out a laboratory which for a number or multitude of reasons could be made necessary.

I don't know that we could or should in an overall way say you should eliminate a laboratory because of such and such a reason or we should take this discretionary authority and apply it to all. We ought to separate them.

On the other hand, if this discretionary authority is as important as it would appear to be, then we ought to take a look at the laboratories, and to prove that it can work, pick those of the highest quality. I do not think it would be the toughest job in the world. If you reach the point where you could prove this out, you could expand or restrict this particular authority. All we are doing is exploring this and theorizing in a sense, because nobody at this stage of the game on this

committee could come to such a recommendation with the facts now in. Would you find it difficult to accept the proposition, at least in the cases of those laboratories which are of the highest quality and considering we could come to a way to make some evaluation, that those directors ought to have such authority?

Dr. PICKERING. I believe they should.

Mr. DADDARIO. Dr. Pickering, I wish to thank you for your testimony, and we appreciate your coming here to appear before us. We are especially fortunate because your laboratory has had the flexibility to meet new challenges over the course of time and is a case study for us. It shows that flexibility is not an impossibility. You, as well as other laboratory directors, point again to the constant need of the society to bring together the physical and social problems and to use the men who are scientifically and technically trained to accomplish these objectives. Your testimony is extremely heartening to us.

Dr. PICKERING. Thank you, Mr. Chairman.

QUESTIONS SUBMITTED TO DR. WILLIAM H. PICKERING BY THE SUBCOMMITTEE ON SCIENCE, RESEARCH, & DEVELOPMENT

1. One of the factors you mention necessary to any successful redirection of a mission-oriented laboratory is "a decision mechanism which can assess the national priorities of new versus old missions, and which has authority to make the decisions for redirection."

(a) Who do you see in the Executive Branch as having this authority other than the President?

To the best of my knowledge, only the President possesses the authority to transfer a laboratory from one agency to another. Of course, mutual agreement by agency heads can effect such a transfer, as apparently occurred in 1953 when the National Bureau of Standards transferred laboratories to the Army and Navy; however, such agreements do not appear to be common. Also, of course, the assignments of individual laboratories are frequently changed, although within the overall mission of the agency.

(b) Do you have any suggestions as to how the present structure of government could be improved to provide this mechanism?

The Office of Science and Technology, together with the President as decision-maker, would seem to provide the framework for this mechanism. Apparently, OST has not been active in reviewing laboratory missions, and perhaps they could be encouraged to become more active in this area.

Another alternative is a Federal Department of Science and Technology. In my opinion, such a Department may, at some future time, become desirable.

2. Since JPL does not have discretionary funds, how does it explore new ideas or areas in which it may have a competence?

Discretionary funds are needed for the exploration of new areas, as well as for realization of the fullest potential within the primary mission of the laboratory. The absence of discretionary funds at JPL makes the exploration of new ideas and areas difficult and fragmentary. However, some exploration occurs within our primary mission, in which NASA establishes various research and study tasks pertaining to new programs and devices. Also, we are requested by NASA to be alert for and to document instances in which space-developed technology may be utilized in other fields.

(a) As the space program matures, please describe what efforts JPL has undertaken or plans to undertake to make use of its existing competence.

As you know, our primary mission is the unmanned exploration of the planets, and this venture has just begun. The maturation to which you refer is not imminent, either scientifically or technologically. The exploration of the planets would only be abandoned for lack of Congressional support and funding.

However, in view of existing national needs, our planning office is studying the feasibility of our performing work in new areas. In certain selected fields in which our competence has been demonstrated, we plan to make proposals on a modest scale through NASA for undertaking new work.

3. Please describe the results of JPL's discussions with the Los Angeles Police Department.

These discussions have yielded a greater mutual understanding of the considerable potential inherent in modern technology for solving some of the urgent problems in law enforcement. Our people have identified existing needs which our advanced technology can satisfy; for example, in areas of command and control, data processing, gas chromatography, and mass spectroscopy. However, funds presently available to the LAPD for work in these areas are exceedingly limited.

4. While the present Laboratories Committee of the Federal Council for Science and Technology is concerned with Government laboratories as such, with the exception of Dr. Astin its members are not working laboratory directors. What advantages and disadvantages do you see for establishing a small council of Federal laboratory directors that would represent the views of both directly and contractor operated Federal laboratories at the Executive Office level?

I am personally in favor of the establishment of a council of Federal laboratory directors. Such a council would have the advantage of rapid identification of the major common problems facing these laboratories, as well as the prompt evaluation of the practicality and consequences of proposed actions.

The principal problem with this council, as with almost every advisory committee, is in organizing the group with the requisite authority and reporting level such that it can be effective. Also, since these laboratories are rather diverse in character, it may be difficult to assemble a group which is large enough to represent a suitable cross section of laboratories, and yet not so large as to be unwieldy.

5. A sharp line frequently is drawn between those Government laboratories that are directly operated and those are are contractor operated. In terms of your experience, what are the principal characteristics of each mode of operation and the differences between them that are significant to utilization of Government laboratories.

In my view, the intrinsic difference between laboratories operated by the Government and those operated for the Government under contract, centers around motivation, flexibility in staffing, and the effects of Government regulations on the technical development process.

Many of the university operated Government laboratories were started during World War II, in order to accomplish missions requiring the application of technology that did not exist within the Government. The close association of these laboratories with the academic community has contributed to their ability to attract and maintain outstanding staffs.

Contract operation of these laboratories has allowed a degree of freedom and quick reaction that has not been possible within Government laboratories functioning wholly under Federal regulation. It has been my observation that mission-oriented, contract-operated laboratories have generally been better able to accommodate to changes in mission assignment, especially with regard to staffing and redeployment.

The constraints placed by the Government on the operation of Civil Service laboratories have undoubtedly affected their ability to compete for highly skilled technical manpower. The lack of these constraints, and the close association with universities, have placed the non-profit laboratories in a better competitive position. This has been covered rather well by the Bell Report.

6. What authority do you have to deal directly with other agencies that may wish to engage JPL's research and development services?

While we do carry out discussions of an information-exchange type with other agencies, we are not able to negotiate with them for tasks. The facilities at JPL are owned by the Federal government and administered under a contract between NASA and Caltech; thus, NASA must approve any use of these facilities for other agencies.

I appreciate the opportunity to further amplify my remarks to your Committee and I hope you will not hesitate to call on me at any time for further information.

Mr. DADDARIO. We are running a little late, but I would appreciate it if we might be able to hear as much of Mr. Hughes' testimony as we possibly can, and I regret keeping you here until this hour. I hope we might be able to hear you and not have to bring you back.

Mr. HUGHES. I would be very pleased to have my statement in the record and simply refer to two or three points in rather cryptic fash-

ion that reflect a position and then be available for your questioning. I think it might be more useful from the committee's standpoint.

(Mr. Hughes' biography follows:)

PHILLIP S. HUGHES

Phillip S. Hughes took office as Deputy Director of the Bureau of the Budget on March 10, 1966. Prior to his present appointment he was Assistant Director for Legislative Reference of the Bureau of the Budget for 8 years, from June 1958. In that capacity, he reviewed legislative proposals sponsored by the Administration and advised the Budget Director and the President on legislative matters. Earlier he served as Deputy Chief of the Office of Legislative Reference for 2½ years.

Mr. Hughes has been a career civil servant with the Bureau since 1949. At the time he joined the Bureau's staff he was a Budget Examiner for veterans programs. In 1953, he became an Assistant Division Chief.

Mr. Hughes was born in Chicago in 1917. In 1930 his family moved to the State of Washington, and in 1938 he received a B.A. degree from the University of Washington. He entered Federal service as an Analyst with the War Manpower Commission in the early days of World War II.

Subsequent to military service in the Navy, he joined the staff of the Veterans Administration. Three years later in 1949, he joined the staff of the Bureau of the Budget.

Mr. Hughes was honored with an Exceptional Service Award by the Bureau in 1965, and the Career Service Award by the National Civil Service League in 1962.

He is married to the former Jean Evans and they have 3 daughters and one son. They reside in Chevy Chase, Md.

STATEMENT OF PHILLIP S. HUGHES, DEPUTY DIRECTOR, BUREAU OF THE BUDGET

As I indicated we are here to discuss some of the key issues that you have identified related to the effective utilization of laboratories. I think quite obviously we share the committee's concern that the Government's research and development facilities are managed efficiently and effectively just as we have the same concern with the use of all Government resources. We recognize and agree that this requires at least some degree of flexibility in terms of the using of existing capabilities to meet the research needs of other agencies.

Feasibility is a problem here and I think this is something that we should talk about.

I refer in my statement to the Bell report, which I am sure you are thoroughly familiar with. Unless there is some point that you wish to pursue there, or perhaps we could come back to it, I would suggest that we move on perhaps to about page 4 of the statement.

We are in essential agreement with the general concepts of the Bell report, and I don't think it is necessary to reiterate them.

Mr. DADDARIO. No.

Mr. HUGHES. You have posed a number of questions which bear on two major aspects of Federal laboratory management: First, keeping the laboratory responsive to new needs and opportunities which strongly relates to the quality of the laboratory, and the second, the utilization of existing laboratory resources to meet such pressing national problems as transportation, pollution, housing, and crime.

With respect to the upgrading of laboratories these problems obviously are the prime responsibilities of the agencies.

We do, however, feel that basically the management of the agency must consider the future of its laboratories in terms of their capacity

to serve the research needs of the agency itself; that is, of the funding agency.

One suggestion advanced for keeping a laboratory responsive to new opportunities is to provide the laboratory director with some discretionary funds to undertake new projects of his own choosing. This Bell report recommendation has been implemented to some degree by the agencies. We fully agree that some discretionary funds are needed if a laboratory is to respond promptly to new opportunities within the area of its research competence.

The question is now of maximizing the use of labs to avoid needless duplication. There is no doubt that lab services should be available across agency lines but basically again we believe that the laboratories must support the mission of the agency which provides the major funds. Thus the sponsoring agency has first call on the services of its laboratories and sets the priorities of their efforts. The availability of any particular laboratory to serve the needs of any other Government agency depends largely upon the workload imposed by its own.

Whether or not the work of Federal laboratories should deliberately be redirected to meet the needs of other agencies is a difficult question. There should be no hard and fast rules on this because there is no simple answer. Conceptually and technically speaking, we know of no formal barriers preventing one Government agency drawing on the capabilities existing in a laboratory funded by another agency. However, a number of considerations or factors are relevant; current and anticipated workload in support of the parent agency's mission; the compatibility of existing laboratory skills for work on other agency problems; the amount of retraining of staff which is necessary; whether or not new leadership can be obtained expeditiously from the private sector or other Government laboratories; and the requirement for additional equipment and facility modification.

And, of course, Federal statutes, regulations, and procedures must be sufficiently flexible to make redirection of an existing laboratory a truly practical alternative to the establishment of a new Federal laboratory.

The Economy Act of 1932 provided the authority for agencies to place orders with other agencies for materials, supplies, equipment, work or services they can provide if funds are available and if this is in the interest of the Government. However, a major limitation on the use of this authority for any large-scale redirection of a laboratory's efforts is the Comptroller General's ruling that the performing agency should be in a position to supply what is necessary without adding new plant and equipment. The full implications of this interpretation must be examined case by case to determine the extent to which laboratories are prevented from doing work for other agencies.

Mr. RUMSFELD. On page 4, at the very top, you make the statement that laboratory's services should be available to other than the parent agency to the extent practical.

Mr. HUGHES. Yes.

Mr. RUMSFELD. I take it there that by "other" you mean other governmental agencies?

Mr. HUGHES. Yes.

Mr. RUMSFELD. Purely within the Federal Government?

Mr. HUGHES. Yes. The answer is "Yes" with regard to the statement. I had not thought particularly in terms of the utilization of the Government's research and laboratory facilities by extragovernmental organizations. I don't regard that as either unfeasible or undesirable, however.

Mr. DADDARIO. Such as the National Bureau of Standards does?

Mr. HUGHES. That is right.

Mr. RUMSFELD. And the Government Printing Office?

Mr. HUGHES. This is a little different area.

Mr. RUMSFELD. I certainly applaud the Bureau's encouraging the use of personnel and resources and facilities but it seems to me that I have a little trouble with your statement in the middle of page 4 where you say:

> With respect to upgrading the quality of Federal laboratories, the Bureau of the Budget feels that such matters are the prime responsibility of the agencies having jurisdiction over them.

I don't know what you mean by "quality" so I don't know that I disagree, but to some extent that might sound a little contradictory to some of the things that have been said here this morning if we agree they should be used within government at least within government as broadly as possible, then it would seem to me an office like the Office of Science and Technology would be in a very significant position here to depend on what quality means to see that these Federal laboratories have the competence or quality or are in fact used by the broadest number of governmental activities and agencies and if simply the agency that has jurisdiction over it determines the quality or competence or capability, then in fact that would be considerably narrower, one would think.

Mr. HUGHES. Yes, that is correct. Clearly, we have our share of responsibility in terms of financing, of the recommendations and actions we take which affect the allocation of funds and personnel, of choices which are made among programs for the allocation of resources, and so on. We are inevitably involved in that.

The management of the facility, however, must be, and the expertise, the technical expertise, must come primarily from the agency itself. I say this with due respect to Mr. Westrate and other people in the Bureau who give close attention to Federal laboratories and other research and development facilities, our job is a management job basically.

Mr. RUMSFELD. This is not true of the Office of Science and Technology.

Mr. HUGHES. It is less true, but I think you ought to ask Dr. Hornig. The Bureau's statement makes it clear we would and do work as closely as we can with the Office of Science and Technology, but I think Dr. Hornig would agree that Dr. Pickering, for instance, has the firmest understanding about the capacities and the qualities of his laboratory rather than Dr. Hornig or the Bureau of the Budget.

Truly, the financial choices that we make affect laboratory operations, but within those general constraints and within that general management framework the laboratory director, agency head, and his advisers must operate. Our techniques here——

Mr. RUMSFELD. Not must; are. If there is a broader government good to be served and it is determined by this committee and recommended

to the administration or acted into law that a final filter had to be applied to this to see that government generally had a certain level of competence, this then would filter down like everything else does.

Mr. HUGHES. I think that is right. But at least in the present state of art, and I characterize it as an art rather than a science, the best techniques which we have evolved for allocating funds in areas where choices are very difficult, where the management problems are very difficult, are techniques which involve the forcing of choices upon the people who manage the programs. Dr. Pickering referred to this and so did Mr. Finger. We are interested in Harry Finger's selection of R. & D. efforts within his particular sphere of responsibility. Certainly through our own expertise and whatever help we could obtain from Dr. Hornig and his staff, we would try to compare NASA's projects and NASA's laboratories with AEC and National Science Foundation activities.

Mr. RUMSFELD. Let's terminate the answer and go on to something else. I don't think we are on the same wavelength.

If you make a decision that water fountains were necessary in Government installations, then you would allow water fountains through the Bureau. You would let people have water fountains.

Have you ever approached this question of discretionary authority for these laboratories on this basis in the light that Dr. Pickering has suggested; that is, that it is a possible and necessary cost of doing business to see that a laboratory has funds for general competence, morale, or all of these reasons he lists, all of which would not be applicable if you did not apply them to all laboratories?

Mr. HUGHES. We have not taken the initiative with respect to discretionary funds as far as I know.

Mr. WESTRATE. The Bell report which was proposed essentially under the leadership of the Bureau of the Budget dealt with this problem. In that respect, the Bureau did take the initiative. As far as we are concerned that is still a very valid conclusion.

Mr. DADDARIO. Mr. Hughes, we are at the point where we most likely will have to have you come back.

The Bell report states that "it would seem, based on the results of this review, that it would be possible and desirable to make more use of existing governmental facilities and avoid the collection of duplicate facilities. This is not as easy a problem as it might seem. It is ordinarily necessary for a laboratory, if it is to provide strong and and competent facilities, to have a major mission and major source of funding."

It goes on to say this will limit the extent it is possible to make facilities available to other agencies but that "it is clearly possible to do this and a continuing scrutiny is necessary."

What we would like to know, and we can't possibly go into it at the moment, does the BOB feel the same way as it did when this report was published in 1962? What has been done about it? Who performs this continuing scrutiny?

How does it fit into these questions we have been asking about facility ratings and this type of thing?

We may be able to handle this by submitting a series of questions, but if we are not, we would like to try to work out an arrangement to have you come back.

Mr. HUGHES. As you wish, Mr. Chairman.

PREPARED STATEMENT OF PHILLIP S. HUGHES, DEPUTY DIRECTOR, BUREAU OF THE BUDGET

Mr. Chairman and Members of the Subcommittee:

We are here at your request to discuss some of the key issues you have identified which are related to effective utilization of Federal laboratories.

The Bureau of the Budget shares your concern that the Government's research and development facilities be managed efficiently and effectively just as we want the most effective use of all Government sources. Efficient and effective utilization includes use of a laboratory's capabilities to meet the research needs of an agency other than its own when this is feasible.

Federal laboratories are one element of the Federal Government's broad involvement in research and development. In dealing with this and other issues in research and development the Bureau of the Budget obtains assistance and advice from the Office of Science and Technology.

Normally, the Bureau of the Budget depends upon the agencies to set policies for their research and development facilities and to take those steps needed to insure competent management. However, when major management issues do arise or when problems affecting laboratories cut across agency lines we, in cooperation with the Office of Science and Technology, can take the initiative to deal with them. Also during the past few years we have found it most advantageous to participate in the work of the Committee on Federal Laboratories of the Federal Council for Science and Technology.

The Bureau's own most recent comprehensive assessment of Federal laboratories occurred in connection with our study of the broader question of Government contracting for research and development, which was prepared with the participation of OST, DOD, NASA, AEC, NSF, and the Civil Service Commission. We presented our findings in 1962 under the title "Report to the President on Government Contracting for Research and Development." This study is popularly known as the Bell Report. Some of the questions you have raised about Federal laboratories were also considered in that report. Therefore, I would like to mention several of the Bell Report's conclusions about Federal laboratories which I believe bear directly upon the issues being examined in these hearings. These conclusions are:

> Choices among the various means for conducting research and development work should be made on the basis of relative efficiency and effectiveness in accomplishing the desired work with due regard to the need to maintain and enlarge the long-term strength of the Nation's scientific resources, both public and private.
>
> A strong base of technical knowledge should be continually maintained within the Government service and available for advice to top management. Federal laboratories provide a useful source for such knowledge as well as a source of technical management for the agencies.
>
> Because the Government laboratory has a close and continuing relationship to its agency, it can provide maximum responsiveness to the needs of the agency and a maximum sense of sharing the agency mission.
>
> Government agencies should maintain a strong internal competence in research and development. By doing so, the agencies will be able to make the difficult and extraordinarily important program decisions which rest on scientific and technical judgments.
>
> Finally, it appears possible and desirable to make more use of existing governmental facilities and avoid creating duplicate facilities. However, there are certain problems which limit the extent to which it is possible to to make the facilities of one agency available for the work of other agencies.

Mr. Chairman, the Bureau of the Budget believes that these statements are still valid and that they form essential guidelines for the effective use of Federal laboratories. Basically they assert that Federal agencies greatly benefit from having their own laboratories to work on mission-related problems, but that duplication of facilities should be avoided, and that a laboratory's services should be available to other than the parent agency to the extent practical. Further, new laboratories should not be created without the most careful consideration of alternatives; the basic consideration is getting the job done effectively and efficiently.

You have posed a number of questions which bear on two major aspects of Federal laboratory management: (1) keeping a laboratory responsive to new needs and opportunities which strongly relates to the quality of the laboratory,

and (2) the utilization of existing laboratory resources to meet such pressing national problems as transportation, pollution, housing and crime.

With respect to upgrading the quality of Federal laboratories, the Bureau of the Budget feels that such matters are the prime responsibility of the agencies having jurisdiction over them. The mission of the agency prescribes its research needs. When particular research needs have been met, a laboratory should be appraised with respect to its capacity to undertake new research efforts. Good management dictates that constant attention be given to a laboratory's effectiveness and adaptability or capacity for redirection. The Bureau has no ready solutions to the problem of redirection. We do feel, however, that basically, agency management must consider the future of its laboratories in terms of their capacity to serve the research needs of the funding agency.

One suggestion advanced for keeping a laboratory responsive to new opportunities is to provide the laboratory director with some discretionary funds to undertake new projects of his own choosing. This Bell Report recommendation has been implemented to some degree by the agencies. We fully agree that some discretionary funds are needed if a laboratory is to respond promptly to new opportunities within the area of its research competence.

Earlier I indicated that the Bureau of the Budget concurs in the Bell Report conclusion that maximum use be made of existing research and development facilities to avoid needless duplication. While there is no doubt that laboratory services should be available across agency lines, Federal laboratories must support the mission of the agency which provides the major source of its funds. Thus, the sponsoring agency has first call on the services of its laboratories and sets the priorities of their efforts. The availability of any particular laboratory to serve the needs of any other Government agency depends largely upon the workload imposed by its own.

Whether or not the work of Federal laboratories should deliberately be redirected to meet the needs of other agencies is a difficult question. There should be no hard and fast rules on this because there is no simple answer. Conceptually and technically speaking, we know of no formal barriers preventing one Government agency drawing on the capabilities existing in a laboratory funded by another agency. However, a number of considerations or factors are relevant: current and anticipated workload in support of the parent agency's mission; the compatibility of existing laboratory skills for work on other agency problems; the amount of retraining of staff which is necessary; whether or not new leadership can be obtained expeditiously from the private sector or other Government laboratories; and the requirement for additional equipment and facility modification.

And of course Federal statutes, regulations, and procedures must be sufficiently flexible to make redirection of an existing laboratory a truly practical alternative to the establishment of a new Federal laboratory.

The Economy Act of 1932 provided the authority for agencies to place orders with other agencies for materials, supplies, equipment, work or services they can provide if funds are available and if this is in the interest of the Government. However, a major limitation on the use of this authority for any large-scale redirection of a laboratory's efforts is the Comptroller General's ruling that the performing agency should be in a position to supply what is necessary without adding new plant and equipment. The full implications of this interpretation must be examined case by case to determine the extent to which laboratories are prevented from doing work for other agencies.

Present funding arrangements do not inhibit agencies performing work for each other. A transfer of funds for services rendered is all that is required.

Where problems exist, they relate to Government laws and procedures for dealing with such matters as personnel, new construction and use of facilities as I mentioned earlier.

This Subcommittee has expressed concern about the capacity of mission oriented laboratories to respond to certain national problems—transportation, housing and crime. In short, the essential issue is the timely adaptability on existing Federal laboratories to do research in these areas.

The Bureau's basic position is that of the Bell Report. If there is a pool of talent in a Federal laboratory and it is available to work on such problems, the pertinent agencies should work out the necessary arrangements, subject to the basic interest and mission of the agency having jurisdiction over the laboratory.

By itself, this arrangement may not produce a large-scale assault on the national problem. In the absence of tight arrangements, the Department of Trans-

portation, Housing and Urban Development, and Justice, could find their priorities slipping if a servicing laboratory must divert its resources to work on new tasks assigned by its own agency.

Under the philosophy of the Bell Report the case can be made for the Departments of Transportation, Housing and Urban Development and Justice developing their own in-house research capability, As mission-oriented agencies, they now have similar research and development needs to their sister agencies. A decision to do this, however, must depend upon the most careful analysis of the range of alternatives. This analysis might lead to meeting the research needs of these agencies through any combination of their own laboratories, the laboratories of other agencies, and contractural relationships with universities and industry. If the agency can satisfy its research requirements without establishing one or more of its own laboratories, it should obviously do so.

With respect to the establishment of contractual arrangements, Bureau of the Budget Circular A–76 provides guidance to the agencies on the question of Government entry into commercial or industrial activity to provide a product or service obtainable from a private source. The essential purpose of the Circular is to further the Government's general policy of relying on the private enterprise system to supply its needs. Technically speaking, the Circular excepts nothing. Thus, research and development facilities come within its general purview, although other statements of policy such as the Bell Report affect decisions regarding research and development facilities. Obviously, however, and this is particularly true in the research and development area, program requirements and management considerations are the most compelling determinants.

Thus, the Circular clearly recognizes that there are circumstances under which the Government should provide a commercial or industrial product or service for its own use and provides the guidance for this determination. This is particularly true in the case of "new starts." Instructions are given for making cost comparisons of alternatives. Should an agency have authority to establish an in-house activity it must complete the cost comparison analysis prior to submitting its budget requests to the Bureau of the Budget. Thus, the budget process is a further check on the decision for a "new start."

Finally, I would like to say a few words regarding the establishment of personnel ceilings for laboratories. These determinations are made by the agencies, not by the Bureau of the Budget. With the assistance of the agencies, the Bureau does establish personnel ceilings for agencies as a whole. These are end of the year ceilings. Two figures are set—one for full-time employees, and one for total employees. The figures are based on an appraisal of current agency programs as compared with the previous year. The agency submits its request to the Bureau; this is examined in much the same manner as budgetary proposals. Once the overall agency figures are determined, the agency makes its final personnel allocations for all its units, including its laboratories. With respect to the flexible use of personnel in laboratories or other agency activities, Bureau policy as set forth in Circular A–64 encourages interagency sharing of personnel resources. Thus, agencies can arrange for personnel transfers where this is mutually advantageous.

QUESTIONS SUBMITTED TO PHILLIP S. HUGHES BY THE SUBCOMMITTEE ON SCIENCE, RESEARCH AND DEVELOPMENT

Question. 1. Please describe the type of "assistance and advice" which the Bureau receives from OST. Does it consist primarily of technical advice or does it include advice as to priorities, funding and duplication?

Answer. Contacts between the BOB and OST are extensive and occur at all staff levels. The Bureau's budget examiners frequently obtain substantive advice regarding agency scientific and technical programs. Sometimes such advice is strictly technical. At other times OST provides views on funding levels, priorities and on questions of balance in interagency programs. Occasionally OST staff participates in the preparation of special Bureau studies such as the Report to the President on Contracting for Research and Development (Bell Report) and The Administration of Government Supported Research at Universities. The Bureau continually seeks advice on R&D policy and budget issues from Dr. Hornig and his OST associates.

Bureau involvement in OST activities also provides a valuable input for performance of the Bureau's own functions. To illustrate, the Bureau has an observer on the Federal Council for Science and Technology and all FCST

committees. Thus, the Bureau is directly involved in discussions of the full array of R&D issues considered by the Council and its subunits, a number of which deal with interagency programs. The FCST recommendations are considered by the Bureau as well as by OST and the agencies, and the data collected by FCST study groups are a valuable addition to the information the Bureau requires in formulating its judgments.

Question 2. In your prepared statement you say that "new laboratories should not be created without the most careful consideration of alternatives." What do you consider are the alternatives, and what criteria are there to guide an agency in making a proper choice? How does, or should BOB oversee this determination?

Answer. In our judgment there are two principal alternatives for accomplishing the Government's R&D work. Either existing or new in-house facilities must be used or arrangements must be made to perform the needed R&D by contract or grant with industrial, educational, State or local governmental and not-for-profit organizations. In considering the first alternative an agency should determine the feasibility of using the facilities of another agency before seriously considering creating a new one of its own.

Precise criteria for choosing among alternatives are at best difficult to develop, but there are a number of guidelines which an agency can consider in making its choices. For example, BOB Circular A–49 requires each agency to establish criteria for the use of management and operating contracts and suggests guidelines for such criteria. The Bell Report of 1962 discussed the natural advantages of direct Federal operations and the various patterns of contracting now in use and included the following general guideline for choosing among alternatives which we believe is still valid:

". . . Not all arrangements, however, are equally suitable for all purposes and under all circumstances, and discriminating choices must be made among them by the Government agencies having research and development responsibilities. These choices should be based primarily on two considerations:

"(1) Getting the job done effectively and efficiently, with due regard to the long-term strength of the Nation's scientific and technical resources; and

"(2) Avoiding assignments of work which would create inherent conflicts of interest."

A number of specific factors must be examined by an agency in considering alternatives for satisfying its R&D needs. They include:

a. The requirement for and nature of the R&D effort to be undertaken in support of the agency's mission and programs.

b. The importance of maintaining or acquiring technical competence within the agency to do both an effective job of managing R&D programs and being a sophisticated buyer of the products and services the agency requires.

c. The availability of outside resources to perform the work, e.g., established university laboratories, Federal contract research centers, industrial laboratories, and other Government laboratories.

d. Comparative costs.

With respect to the factor of cost, BOB Circular A–76 provides guidance for agencies to decide among alternatives on the basis of cost comparisons. However, as was pointed out in Bureau testimony, program requirements and management considerations are the most compelling determinants for choosing alternatives in the research and development area.

In general, BOB reviews proposals for major new laboratories in the context of agencies' overall budget proposals—the programs proposed by the agencies, the means they propose to accomplish the programs and the resource implications (dollars, manpower, facilities). The Bureau obtains from the agency the information needed to identify alternative courses of action and relative priority for program funding. There is no specific procedure which singles out laboratories for special treatment from other programs and facilities. Depending upon the situation, however, the Bureau may ask an agency to complete a special study to identify alternatives to a laboratory proposal and provide other pertinent information.

Question 3. In your prepared statement you state: "We fully agree that some discretionary funds are needed if a laboratory is to respond promptly to new opportunities within the area of its research competence."

a. Generally speaking, what amount do you recommend as a percentage of the laboratory's budget?

b. Should discretionary funds be available to both Government operated and contractor operated laboratories? If not, what is your reasoning for drawing a distinction?

c. As a general policy, should discretionary funds be made available to all laboratories or only those which have demonstrated quality work (a reward for competence)?

d. Do you believe that discretionary funds should be used only in furtherance of an agency's mission or could some of the funds be used as seed money to explore how technology developed by a laboratory could be applied to other national problems, perhaps outside the jurisdiction of the sponsoring agency?

Answer. The referenced statement from the Bureau's testimony was intended to express a principle of sound laboratory management. Rigid programming of laboratory funds would deny flexibility to the laboratory in responding to targets of research opportunity. Desired flexibility can be achieved by giving the laboratory director reasonable latitude in reprogramming and by setting aside a quantity of discretionary funds for projects of his choosing. The amount of desired flexibility and method for achieving it would, of course, depend upon the nature and mission of the laboratory.

The Bureau does not recommend a specific percentage of a laboratory's budget to be set aside in the form of discretionary funds. Essentially this would be an operational decision to be more appropriately made by the laboratory director and agency officials reviewing his program proposals. The percentage of the budget designated in the form of discretionary funds would depend on a number of factors—size, competence, nature, mission and programs of the laboratory; degree of flexibility desired; and previous experience in the use of such funds based upon careful evaluation.

The agencies now have authority to reprogram funds for laboratory operations. In general, we feel there is considerable latitude available. Control of funding at the program or laboratory level is designed to give reasonable flexibility to follow promising avenues of research, particularly when some funds are not tied to specific projects.

Contractor operated laboratories also have reasonable flexibility in using funds. For example, AEC laboratory directors have considerable control over the use of funds within their programs, subject to after-the-fact review. Also, discretionary funds in the form of allowances for independent research and development or set-asides for undirected research already exist in DOD contracts with industrial laboratories. These funds are utilized in a similar manner to the funds which companies set aside for their own research efforts for product improvement. Further, some Federal Contract Research Centers are given considerable latitude in initiating their own research efforts under terms of the contract. Still other FCRC's rely for such purposes on use of their fees. The purposes of discretionary funds in a Government laboratory are basically the same as such funds used by a contractor. These funds can be justified for both.

As a basic policy, we believe that discretionary funds should be available to those laboratories of sufficient size and with missions, programs and quality of management which give promise of effective use of such funds. Quality of their use (determined by agency evaluation) should be a major factor in deciding the amount for subsequent years, but laboratories should be given the continuing opportunity to acquire and demonstrate their competence. Thus, a reward and penalty system would be (and is now) used.

In general, we believe that discretionary funds in the laboratory should be used in furtherance of the parent agency's mission. This does not preclude exploring new technologies which might also be applicable to the solution of a national problem falling primarily within another agency's jurisdiction. With such discretionary funds, the laboratory could pursue the new technology to the point where the other agency could evaluate it for sponsorship in terms of its own programs and priorities.

Question. 4. In your statement you state: "Under the philosophy of the Bell Report the case can be made for the Departments of Transportation, Housing and Urban Development and Justice developing their own in-house research capability." You also state: "If the agency can satisfy its research requirements without establishing one or more of its own laboratories, it should obviously do so."

a. Assuming each of these agencies proposed its own research laboratory, what steps or studies, if any, would the Bureau require the agency to take before approving the request?

b. If a disagreement arose between the agency and the Bureau concerning the need for the laboratory, how would the matter be resolved—or who would make the final decision?

Answer. The basis for the Bureau's first statement is our continued belief that some in-house research capability is essential to the efficient and effective performance of the missions of most agencies. We feel that an agency should have the capability within its own staff to identify research needs, to relate research findings to the solution of problems within its mission and to insure that it will be a wise purchaser of R and D.

A number of the comments we made in response to question 2 above are appropriate here also. The budget process is the principal vehicle the Bureau uses to consider new programs, facilities, manpower, etc. It should be recognized that agencies consider alternatives such as (1) having research work performed by others, and (2) using available Federal land or facilities—if a new laboratory must be established. If an agency's budget and program justification did not include information from the agency's study of alternatives, it would likely be reqested. If it appeared that an agency had not considered appropriate alternatives, the Bureau might ask that a study be done. We have no standard set of steps or studies for such situations. The content of a study would be determined by the particular situation involved and the specifications would be worked out with the agency. The study would, of course, be directed toward identifying alternative ways of getting necessary work accomplished and the related impact upon effectiveness, efficiency and cost.

The Bureau's procedures allow for full discussion of disagreements with the agencies on budget issues. The final decision on including funds for a laboratory (or any other item) in the President's budget is, of course, made by the President.

Question. 5. The Bell Report stated that a "continuing scrutiny" was needed to make sure that the facilities which the Government has are used to their fullest extent. Whose responsibility is it to provide this continuing scrutiny? What has BOB done in this area?

Answer. Utilization of laboratories must be evaluated by the agencies in the context of their mission needs and available funds. The extensive program in DOD under the guidance of the Office of Laboratory Management in DDR&E and its service counterparts illustrates agency efforts in this area. Closing and disposing of some excess laboratory facilities has occurred. For example, when the Connecticut Aircraft Nuclear Engineering Laboratory became excess to AEC's needs, the facility was promptly closed.

Bureau of the Budget reviews occur as a normal part of the budget process. The Bureau likewise has an observer on the FCST's Federal Laboratory Committee which deals with a number of general management issues.

Question. 6. As an indication of the extent of cross-agency work, please supply information showing the amount of funds transferred between Government agencies in FY 1967 for the conduct of research and development, such information should include the transferring agency, the receiving agency, the amount of funds transferred, and the project or purpose for which the funds were transferred.

a. What instructions or directives has BOB issued or plan to issue on the cross-agency use of Federal laboratories?

Answer. The Bureau and most agencies do not maintain data banks on cross-agency reimbursable efforts, but some basic information is available in the agencies. The attached tabulations * prepared at BOB's request provide a sizable number of examples of cross-agency efforts, general purpose and size of the dollar involvements.

The Bureau's principal pronouncements which have implications for cross-agency use of Federal laboratories include the Bell Report, BOB Circular A–76 and instructions to the agencies on implementation of the planning, programming and budgeting system (PPBS). The Bureau contemplates issuing no further directives on cross-agency use of laboratories at this time.

Question. 7. Since the Bell Report was published in 1962, what significant actions have been taken by the Bureau and the agencies to carry out the recommendations? What recommendations remain in need of action?

Answer. In summary, the following significant actions have been taken to implement the Bell Report recommendations. It should be noted that a number of these actions are continuing, so in some respect, they are unfinished items of business.

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*The tabulations referred to may be found in the committee files.

a. The Federal pay reform legislation enacted in 1962 and subsequent legislation has considerably improved the Government's competitive position in attracting top flight personnel into public service.

b. A number of agencies, e.g., DOD, AEC, Post Office, HEW, have strengthened their internal management arrangements for research and development particularly by giving key officials agency-wide responsibilities for such activities.

c. Agencies reported to the Bureau they have used the guidelines stated in the Bell Report regarding the inherent advantages of various R&D performers when selecting organizations to perform agency tasks.

d. Conflict of interest questions discussed in the report have been dealt with by conflict of interest legislation, Presidential memoranda and agency regulations with appropriate enforcement measures.

e. The Bell Report urged the improvement of Government specifications for R&D tasks through better feasibility studies and other means. The principal agencies involved, DOD, AEC and NASA, have taken a number of steps to obtain needed improvements. For example, DOD developed its concept of a "Program Definition Phase" with AEC and NASA following a similar pattern. All agencies report increasing the use of their own laboratory capabilities in developing improved specifications.

f. Most agencies, particularly DOD and NASA have taken steps to improve their R&D contracting through promoting greater competition for contracts and emphasizing the use of fixed price and incentive contracts in an effort to overcome some of the deficiencies of cost-plus-fixed-fee contracting cited in the Bell Report.

g. There has been major activity in the agencies in the complex area of improved contract administration. The principal agencies, DOD, AEC and NASA, have revamped their procedures covering the full spectrum of administration—contractor source selection, project control and monitoring, reporting systems and contractor performance evaluation. The agencies also have refined the PERT system as an aid in planning and controlling the three major variables in large systems development programs—time, cost, and technical performance.

h. Extensive work has been undertaken throughout the Government to improve Federal relations with universities. OST has taken leadership in this area in collaboration with the Bureau of the Budget, NSF and HEW. In particular, the work of the Federal Council's Committee on Academic Science and Engineering should be noted. Recently, the requirement for time and effort reporting for university professorial staff and other working on Government sponsored research has been eliminated. In 1966 the Bureau of the Budget issued its own report on "The Administration of Government Supported Research at Universities" in an effort to bring improvements to the complex area of agency administration which so vitally affects university programs.

i. The steps which agencies have and are taking to upgrade in-house laboratories are well known to the Committee. Testimony offered by DOD, NASA and other representatives have provided the specific details. The recommendations of the Bell Report dealing with the basic problems of Federal laboratories gave additional stimulus to efforts which were already underway, particularly in DOD which has the bulk of the Government's own research capabilities.

j. The Bell Report also proposed improvements in the technical information exchange system. Leadership in developing these improvements has come from OST with the extensive efforts of the Committee on Scientific and Technical Information (COSATI) of the Federal Council for Science and Technology. COSATI has a sizeable agenda of problems on which it is now working with broad participation of agency personnel.

Further implementation of the Bell Report recommendations continues. One additional area in which BOB has been involved is the complex problem of contractor compensation. Some reliance has been placed on incentive contracting to insure reasonableness of compensation. In addition, efforts are underway to improve agency policies and procedures, to secure personnel competent to review compensation and to provide more reliable data on prevailing rates of compensation.

Question 8. As the lead agency in the development of principles for Federal organization and management, what is the Bureau's view on organizational location of Federal laboratory directors in relation to the agency head? How can the number of administrative layers that exist in some agencies between the laboratory director and the agency head be reconciled with the director's need for flexibility, discretion, and quick response in the direction of his laboratory?

Answer. There is no one proper reporting level within agencies for all laboratory directors, nor is it possible to state what precise specified flexibility or discretion all laboratory directors should be allowed. The organizational location of an agency's laboratory directors in relation to the agency head must necessarily depend upon the size and complexity of the agency's missions and programs and the laboratory's role in their accomplishment. As a management principle, the Bureau favors as few administrative layers as are consistent with adequate management control.

The principal research agencies, DOD, AEC, and NASA, have realistically faced up to the problem of multiple administrative layering. DOD has created its Office of Laboratory Management with its three service counterparts to serve as focal points for the review of agency-wide laboratory problems and requirements. The contract laboratories of AEC now report to the AEC General Manager and NASA laboratories report to an associate administrator. In Commerce, the Director of the National Bureau of Standards reports to an assistant secretary, and in NSF the Director of the National Center for Atmospheric Research reports to the director of a major program division. The actions taken thus far to reduce the adverse effects of layering are considered steps in the right direction.

Question 9. Dr. Weinberg, Director of the Oak Ridge National Laboratory pointed out that the redeployment of Federal laboratories can run into difficulty if there is no fiscal flywheel to smooth out fluctuations or delays in funding. Speaking of experience with NASA, he said:

"However, with non-AEC funds we have much less flexibility. If because of a red-tape error, funds from NASA are delayed three weeks we are in serious difficulty if we do not close out the NASA-supported work—even though three weeks later it is to be resumed. Obviously some financial flywheel must be provided. I would think an overhead charge assessed against all research at the laboratory and designated as the laboratory director's overhead account could be used as a fiscal flywheel to smooth out fluctuations. . . ."

What is your view on the need for such a fiscal flywheel for laboratory directors? What would be necessary to put one into effect?

Answer. There are two aspects to the problem Dr. Weinberg describes—flexibility of operations for in-house laboratories and smoothness of operations for contractor laboratories when both have multiple sources of funding. In the case of the in-house laboratory, the Bureau believes that the requirement for a fiscal flywheel is minimal. The bulk of in-house laboratory operations for any one agency is usually financed by the parent agency which is responsible for adequately supporting these operations. In the case where an in-house laboratory depends upon several program managers whose allocation decisions regarding available resources are based more on programmatic requirements than institutional support, the laboratory conceivably may encounter some difficulty in maintaining a constant or fully predictable level of funding. Discretionary funds and reprogramming authority can mimimize the effects of fluctuations which might occur under such circumstances. This likewise dictates that program and budget reviews should include an appropriate institutional review to assure that decisions regarding laboratory support are made in the context of the laboratory's agency-wide relationship. Work performed for other agencies is normally done on a cost reimbursable basis with few problems encountered on transferring funds.

Contractor laboratories may have some difficulty in maintaining orderly operations, if they perform work for a number of sponsors. Unanticipated funding delays could cause management problems if contingency resources are not available. It is our understanding that management fees have been used in emergency situations. The Bureau believes that many of the benefits of a "fiscal flywheel" for contractor laboratories can be achieved by the sponsoring agency insuring that the laboratory contract incorporate sufficient administrative flexibility and permit the director to program his funds to cover such emergencies.

Question 10. Section 8 of Executive Order 10521 directed agency heads to encourage and facilitate the sharing with other Federal agencies of major equipment and facilities. It also directed that a Federal agency should procure major equipment or facilities only after taking suitable steps to ascertain that the need cannot be met adequately from existing inventories of its own or other agencies. To what extent were these provisions superseded by Executive Order 10807 which established the Federal Council? To what extent does Section 8 still apply?

Answer. The provisions of section 8 (a) and (b) of Executive Order 10521 continue to apply. Only Section 8(c) which specifically applied to the Interdepartmental Committee on Scientific Research and Development was superseded by Executive Order 10807 inasmuch as the ICSRD ceased to exist upon creation of the Federal Council.

Question 11. Based on your experience, what advantages and disadvantages would you see in an office of Government laboratory management located at the level of or within the Office of Science and Technology? Such an office would be analagous to the present Office of the Assistant Director (Laboratory Management), in the Department of Defense's Office of Defense Research and Engineering.

Answer. The basic premise for suggesting that multi-agency problems and programs including Government-wide utilization of resources be dealt with in the Executive Office of the President (by BOB, OST or a new agency) is that the Executive Office has a broader perspective for considering such matters. This premise may be generally valid, but practical considerations dictate a careful selection of the multi-agency matters in which the Executive Office becomes deeply involved. At present the Bureau feels it would be undesirable to establish an office of Government laboratory management in OST or elsewhere in the Executive Office.

There are several reasons for the Bureau's position:

a. That Government laboratory resources are sufficiently more important than various other resources to be given special treatment in the Executive Office has not yet been convincingly demonstrated.

b. The role that an office of Government laboratory management would play vis-a-vis the operating agencies is not at all clear.

c. It is very doubtful that such an office could be more effective in improving the utilization of laboratories (taking into account agency needs and funding) than could the agencies themselves.

d. If placed in OST, such an office would put OST in an operating role which is inappropriate for a staff agency for the President. Laboratory management and operations should be left to the agencies.

e. The proposed office could become another level of decision-making which could inhibit agencies from taking timely action.

As stated elsewhere, OST and BOB are now involved in a number of activities dealing with Government laboratory resources. Dr. Hornig has described for the Committee the efforts of the Federal Council's Committee on Federal Laboratories and other studies undertaken by OST. Perhaps the OST and BOB machinery can be strengtened to deal with interagency laboratory problems, but in our judgment such strengthening can be achieved without creating a special office to deal exclusively with in-house laboratory problems.

Question 12. What inventory information about research and development has been collected as specified in part r of Circular A–76?

a. To what extent is part 5–d a blanket exemption for research and development that is available from the laboratories of another department or agency?

b. Have the review provisions of part 7–c caused any in-house research and development to be transferred to an outside performer?

Answer. As stated in the Bureau's testimony, Circular A–76 technically does not exempt any Government commercial or industrial activity, i.e., an activity which is operated and managed by an executive agency and which provides for the Government's own use a product or service that is obtainable from a private source. We also pointed out, however, that decisions to conduct research and development or have the work performed by private facilities are usually based on factors other than those set forth in Circular A–76 and Circular A–49. These factors include considerations identified in the Bell Report and such basic issues as the need to maintain and enlarge the long-term strength of the Nation's scientific resources, both public and private.

Information included in the inventories required by section 7 of Circular A–76 generally relates to R&D testing laboratories where the service rendered is commercial or industrial in character.

Section 5–d of the Circular permits a Government commercial or industrial activity when the product is obtainable from another Federal agency. To the extent the suitable existing Government R&D facilities and capabilities are available it is expected, in the interest or economy, that such facilities will be used.

The Bureau has no information that reviews which are conducted under the provisions of section 7–c have resulted in the transfer of R&D from in-house to private performers. As previously stated, we believe such determinations would generally be made on the basis of considerations extending beyond the policies specified in Circular A–76 for acquiring commercial or industrial products and services for Government use.

Question 13. From the standpoint of effective agency management and full use of Government laboratories, what information about Federal laboratories should be collected and by whom?

Answer. A good data base to provide adequate management information about Federal laboratories should interrelate the program structure, technical content, appropriations, budget activities, and accounting data so that essential information can be summarized on either a programmatic or institutional basis and integrated into the agency managerial system.

Information about laboratories, whether in-house or contractural, should be collected by the sponsoring agency and should be available there for internal program/budget reviews as well as cross-agency reviews by BOB and OST. In general, agencies already have systems in effect for collecting basic management data on their laboratories. We do not feel that the collection and centralization of this data in BOB or OST on a regular basis would be very useful. However, a good data base maintained by the agencies can be very helpful when a particular problem has been identified for study by the Bureau or some other appropriate group.

The question of centrally collecting general purpose or inventory-type data has been raised on a number of occasions. At this point we are skeptical that the benefits of collecting such centralized information will match the cost of collecting it, maintaining it, and keeping it current. Unless reasonable use will be made of the information, it will not be worth the effort.

Under instruction of the Federal Council for Science and Technology, the Committee on Federal Laboratories is developing a plan for an inventory. Current agency information systems are being examined to determine the specific information which should be included. The effort will be experimental so that its potential value can be evaluated before proceeding with a full-scale effort.

Question 14. The Joint Committee on Atomic Energy published in its hearings on the AEC's authorizing legislation for FY 1968 an exchange of letters with the Bureau concerning Mr. Holifield's thoughts on the use of existing AEC laboratories for environmental pollution research (Part II, pp. 1285–7). He expressed his concern that:

". . . we may lose irretrievable lead-time in establishing new organizations and facilities, which will result in wasteful duplication and fail to achieve the desired results. We can and must make optimum use of the qualified people and facilities currently available to us."

Answer. The Bureau's reply of January 6, 1967 mentioned plans to make a detailed exploration of the possibilities identified in Mr. Holifield's letter as soon as the then current problems of budget preparation were out of the way.

Since then, what has the Bureau of the Budget done to furnish policy guidance to the AEC and other agencies with environmental pollution responsibilities about possible use of the AEC's existing research and development capabilities? What is the feasibility of the approach proposed by Mr. Holifield?

Details about the Atomic Energy Commission's efforts to undertake work for other agencies in the area of environmental pollution have already been described to you by AEC Commissioner Tape in his testimony on April 3, 1968, and in his letter to you of June 17, 1968.

Following our January 6, 1967 response to Congressman Holifield, the Bureau explored with the AEC the possibility of conducting particular programs of pollution R&D in the AEC laboratories. Since then, the Bureau has continued to monitor the activities and progress of the AEC on this matter, and we have informally advised and encouraged several of the agencies with environmental pollution responsibilities to use the AEC facilities whenever appropriate. The Bureau's efforts have occurred during our normal program and budget review activities. The Bureau has issued no formalized directive or guidance. There are at least two reasons for this. First, AEC laboratories are already rather heavily loaded with R&D projects in atomic energy and the opportunity for establishing non-nuclear pollution R&D programs in the laboratories has been limited. Second, we feel that AEC has vigorously pursued the course of action which Congressman Holifield recommended and that progress to date has been quite good.

The Bureau believes that there is continuing merit in Congressman Holifield's recommendation and we plan to continue watching AEC progress and encouraging other agencies to make appropriate use of AEC laboratories.

Question 15. In your statement you said that Circular A–64 encourages interagency sharing of personnel resources. However, you did not discuss the magnitude of the administrative effort required to effect a transfer of personnel ceiling between agencies. In speaking of requests for adjustments, the Circular states:

"In the agency's request for adjustment, it is not sufficient merely to justify the need for additional employment in a particular bureau or unit. The justification should indicate clearly why the increase cannot be absorbed through an internal adjustment in the agency's ceiling distribution, or why the need cannot be postponed to the next fiscal year."

To what extent do you think this requirement may bias Federal program administrators away from directly operated Federal laboratories and toward either contractor operated laboratories which have no personnel ceiling, or toward independent performers?

Answer. As of July 1, 1968, all Bureau of the Budget manpower ceilings have been superseded. This action was taken because of the mandatory manpower controls and reductions imposed by Title II of Public Law 90–364. Our comments are therefore addressed to the situation existing prior to July 1, 1968.

The section of Circular A–64 which you quoted clearly deals with the type of agency justification required for an *increase* in employment ceiling as opposed to a transfer of ceiling between agencies for the purpose of sharing personnel resources. At any rate, personnel ceilings are one of several management techniques designed to control resources in situations that might not otherwise be subject to effective constraints. P.L. 90–364 pointedly reminds the Executive Branch of this fact.

Prior to the enactment of P.L. 90–364, control of personnel ceilings probably has not been as significant a restraint as some have contended. In general, we believe that there has been sufficient latitude in the system to allow the agencies the flexibility they have needed.

We doubt that the administrative effort required to accomplish a transfer of ceiling between agencies has *in itself* interjected any bias in determining whether or not to use directly operated Federal laboratories. Transfers of personnel ceilings between agencies have occurred for a variety of purposes. The administrative effort does not appear to have interposed any significant difficulty or dictated a decision to contract the work. However, to the extent that agencies have been unwilling to consider shifting personnel spaces from lower priority activities, or to develop an acceptable personnel justification based on workload, there may have been some decisions to contract the work rather than perform it in-house.

Question 16. How does or can the Planning, Programming and Budgeting (PPB) system assist in assuring the goal of full and effective use of Federal laboratories? Does the system address itself specifically to this question? If not, should the system be modified to do so, and in what way?

Answer. The PPB system is designed to identify alternative courses of action and the benefits associated with each, to determine criteria for key programmatic and budgetary decisions, and to make the information available to persons with the final responsibility for selecting alternatives. Use of the system is expected to make incremental improvements in the management of Federal programs.

The PPB system does not, by itself, assure the full and effective use of Federal laboratories. Since laboratories are considered a category of resources related to specific purposes or programs, PPB does not specifically address the question of most effective utilization of laboratories. Normally, PPB is not addressed to this level of detail. When significant questions on the choice and use of resources involve laboratories, those questions can be and are dealt with within the PPB system. In short, the means of accomplishing objectives—selection among alternative combinations of inputs—are considered in some of the supporting analyses in the program memoranda. The program memorandum is not only concerned with what is to be undertaken, but also the most cost-effective means for achieving it.

The Bureau believes that PPB will contribute to better utilization of Federal facilities, including laboratories, because as program goals are clarified, attention must be given to the means for achieving these goals. Utilization of laboratories should be examined in this context. Thus, we see no need to provide for special treatment of laboratories in the PPB system. We know of no key problem which is concerned solely with the utilization of one or more Federal laboratories. Rather, their utilization must continue to be considered in the broader context of achieving agency programs.

Question 17. How many new laboratories are in the planning stages for the next five years? Of these, how many are in the newer agencies or resulting from new national programs? What dollar investment? How many Federal laboratories are scheduled for phase-out or closure during this same time period? How many are scheduled for transfer from one agency to another?

Answer. A survey of the principal agencies revealed the following with respect to the questions posed, exclusive of cost estimates:

a. The Department of Transportation is considering the need for two facilities—a Highway Safety Bureau research facility to carry out DOT responsibilities under the Traffic and Motor Vehicle Safety Act of 1966 and a high speed ground transportation test center which may be needed for evaluation and full scale testing of new systems or components being developed.

b. The Department of Commerce is considering the need for several building research facilities and a corrosion research laboratory.

c. With respect to the Department of Health Education and Welfare:

(1) The following major facilities are in the planning stages for the period 1969–1973:

NICHD Research Facility
Mental Health Child Research Center
Neurology—Child Health Facility, Puerto Rico.
Environmental Health Sciences Center, Research Triangle, N.C.
Neurology—Allergy Virus Facility
National Acarine Reference Center, Hamilton, Montana
Dental Health Center Addition, San Francisco
NIH Animal Center, Phase II
NIH Animal Center, Phase III

(2) Within the Health Services and Mental Health Administration there are 14 new laboratories in the planning stage, 4 involving newer agencies or new national programs. There are two laboratories scheduled for phase-out.

(3) There are two new Food and Drug Administration laboratories in the planning stages for the next five years, neither of which is in a newer agency or results from new national programs.

d. The Department of Defense is planning the consolidation of 10 Army medical laboratories into three major medical centers. The possibility of other DOD consolidations is being studied but no definitive information regarding these is yet available.

Several agencies report they are now considering the question of establishing, consolidating and phasing-out laboratories, but any discussion of future plans (including cost estimates) at this time would be most premature.

Question. 18. Can you explain in some detail why there are manpower ceilings in addition to funding ceilings for Federal agencies? Where did the initial requirement stem from and what has been the history of this control?

Answer. As stated in our response to question 15 above, we regard personnel ceilings as one of several important management techniques designed to control resources. The amount of funds available to an agency does not necessarily control the number of people employed. To illustrate, in the absence of some manpower controls, agencies could direct program funds to payrolls or delay recruiting until late in the year and thus increase the number of employees the Congress and the President actually provided for. This delayed recruitment could result in agency requests for funds to annualize this increased number of employees in the succeeding year. Thus, manpower ceiling serve as a tool supplementing funds control for more effective and economic use of resources.

With the expansion of Federal programs over the past few years, the Congress frequently has expressed anxiety about the number of Federal employees. One expression of this concern has been the monthly publication of employment statistics by the Committee on the Reduction of Non-Essential Expenditures. The clear implication drawn from congressional expressions is that the executive branch should firmly hold employment levels.

The Department of Defense has maintained its own system of employment ceilings for a number of years. In 1963, the President imposed personnel ceilings upon all executive branch agencies. Those ceilings, however, have not been rigid or arbitrary, and employment has been permitted to rise as needed to perform the tasks authorized by the Congress—from 2,490,000 in 1963 to an estimated 2,932,000 in 1968.

Question 19. How are manpower ceilings generally administered? By the BOB? By the agencies?

Answer. Again our comments are addressed to the situation existing prior to July 1, 1968.

With the assistance of the agencies, the Bureau establishes manpower ceilings for agencies as a whole. During the budget process, after a thorough-going review of planned work programs, a ceiling on the total number of employees and a ceiling on the number of full-time employees in permanent positions, for the end of the fiscal year, are established for each agency as a whole. Such ceilings are an extension of the program level decisions reflected in the President's budget. Since the ceilings are established for the agency as a whole, agency heads are permitted complete discretion in administering the allocation of positions among the units of the agency.

The employee ceilings which the Bureau imposes are mutable. Agencies have rquested and been granted increases because of changes in work assignment and for other mitigating circumstances. However, since the ceilings are given for the agency as a whole, the agency must demonstrate that an overall increase is required for the agency, i.e., that decreases in offsetting work, program cutbacks or deferrals, effects of congressional action on the budget, etc., have been taken into account.

The one exception to the two ceiling system is the Department of Defense. For example, the Bureau established only one ceiling for the Department for FY 1968—a ceiling of 1,248,000 on *total* employment (this represents about 43 percent of the current Federal civilian workforce). Thus, the Department of Defense has more flexibility in administering ceiling controls than any other Federal agency, if it cares to exercise it. So long as the Department stays within this total ceiling, the Bureau of the Budget does not prescribe at what level or to what extent the Department chooses to distribute its ceiling controls.

Question 20. Within Government we tend to force everything into one prescribed pattern whether it fits well or not. Do you believe that Federal laboratories operate most efficiently under the same current system of controls over manpower, dollars and facility acquisition as for other types of organization? Is it possible or desirable to tailor a system of controls for creative organizations that might differ significantly from the "standard" control system? What would be the advantages? The disadvantages? Cite examples.

Answer. The opening sentence of your question emphasizes the rigidity inherent in a large, complex, highly-structured, legally-based system of public administration which characterizes the Federal Government without also alluding to the flexibilities which must exist if the system is to be viable. The public administrator's objective must be to find flexibilities in applying general rules and to establish special rules or procedures which meet the requirements of public accountability.

Certain general rules exist within which the entire Federal Government must function. A number of these are established in law. Others reflect procedures required by the Congress and the executive branch in accomplishing programs and in maintaining control and accountability. Manpower limitations are a case in point. Public Law 90–364 directs the Federal Government to return to employment levels of June 30, 1966. No exception has been granted to research and development organizations. However, there is room for flexibility in the application of this control—which organizations to reduce to a greater or lesser degree. Nevertheless, within the context of implementing the law, a distribution of the ceiling will have to be made, and some form of control will have to be maintained to assure that it is met.

Experience makes it very clear that research management is a specialized area—that some procedures applicable to law and order, procurement, and logistics activities inhibit the effectiveness of a laboratory with its requirement for a creative environment. The Bureau believes it is both desirable and possible through prudent agency administration to tailor the system of controls to the mission and programs of the laboratory within the overall ground rules within which Federal agencies must operate.

The basic ingredients for effective research management have been stated many times by thoughtful students and experienced managers. Invariably these are listed as the need for well-defined objectives, choice of important work to do, high level participation of scientific staff in laboratory management, maximum flexibility in administration, reasonable autonomy within defined objectives, and insuring that the management of a research activity has the fullest possible command of the resources required to accomplish its tasks.

Question 21. The DOD witness proposed the elimination of manpower controls on cross-agency work similar to the AEC contract laboratories. What is your reaction to this proposal? If you agree, what action do you propose to take? If you do not agree, what is the basis for your position?

Answer. For the present, Public Law 90–364 removes the possibility of eliminating manpower controls on cross-agency work. Elimination of these controls even in the absence of the law would, of course, circumvent the budget process whereby a work level is agreed upon and resources are provided to meet the work level. The Bureau's views on manpower ceilings as one element in overall management controls were stated in response to question 18. However, some additional comments are in order.

The Bureau recognizes that a manpower ceiling might be seized upon as an excuse to contract out work, but we do not believe our ceilings prior to enactment of Public Law 90–364 have been so restrictive as necessarily to operate against cross-agency utilization of in-house laboratories and facilities. Obviously, any superimposed management control diminishes the laboratory director's latitude over his operations. But again, our objective has been to preserve maximum flexibility within present manpower allocation policies, principally through agency internal reallocation, through transfer of ceilings between agencies, or by increasing an agency's ceiling.

The DOD representative proposes a utopian solution for accommodating the increased demands upon any particular laboratory to perform cross-agency services when funds are available. Our immediate problem is that relaxation of manpower ceilings would probably lead to higher Federal employment at a time when the mood of the Congress dictates a curtailment.

Question 22. Some people believe that manpower ceilings for laboratories actually promote waste and inefficiency. They cite industrial practices as an example where such a technique is seldom used. If manpower ceilings are an effective management tool, why is it not used for control of contractors? Do you have any plans to apply such controls for contractors,

Answer. The circumstances under which a contractor operates are not the same as for a subordinate unit of a Government agency. The contractor is responsible for managing his own enterprise. The Government laboratory operates within the general rules and procedures which have been discussed in considerable detail above. It is not a self-contained, autonomous unit; it must be fully responsive to the mission and needs of the agency. Within that context, the laboratory's administrative system must be as flexible as possible so that the laboratory can function to its fullest capacity. We may have to move more and more toward the industrial approach to attain this objective, but in the process we will not be any less mindful of the elements of cost. When the Government decides to contract for research and development work, contractor costs must be carefully assessed in the selection process. The potential contractor's manpower cost estimates must be carefully evaluated along with all other elements of cost. A sharp rise in employment over what was anticipated at the time of negotiation would certainly be questioned, particularly if a net increase in the contract would result. Nevertheless, internal management decisions must remain with the contractor since he is responsible for performance in accordance with terms of the contract. It should be noted that some agencies do use manpower ceilings with contractor organizations. For example, NASA has done so for the Jet Propulsion Laboratory and AEC has used manpower ceilings with some of its contractors in the weapons and naval reactors programs.

Question 23. It has been argued that there is a lot of unused flexibility and extensive authority existing within the present manpower control system and therefore it is unnecessary to remove current manpower controls. Would you enumerate what these flexibilities and authorities are and cite examples of how they can be applied at the laboratory level so as to counteract on offset the problems imposed by the inflexibilities of manpower ceilings.

Answer. Prior to enactment of Public Law 90–364, the principal flexibilities were negotiation for a higher overall agency ceiling to accommodate additional work-load, agency internal reallocation of manpower spaces, and interagency transfer of manpower ceiling in the case of cross-agency work. Recognizing that there is now reduced flexibility, agency management at all echelons must be willing to utilize what is left to the fullest. For the laboratory director, this means that agency top management should give him as much latitude as possible, within present constraints, to manage his manpower resources.

Mr. DADDARIO. This committee will adjourn until Tuesday next at 10 o'clock in this same place.

(Whereupon, at 12:25 p.m., the committee was adjourned to reconvene at 10 a.m., Tuesday, April 2, 1968.)

UTILIZATION OF FEDERAL LABORATORIES

TUESDAY, APRIL 2, 1968

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

The subcommittee met, pursuant to adjournment, at 10 a.m., in room 2325, Rayburn House Office Building, Hon. Emilio Q. Daddario (chairman of the subcommittee) presiding.

Mr. DADDARIO. This meeting will come to order.

Today we begin our second week of hearings on the utilization of Federal laboratories.

During our hearings last week, the subcommittee heard from the Office of Science and Technology, the Bureau of the Budget, NASA, and from the directors of both Government-operated and contractor-operated laboratories. The hearings revealed that many of the problems identified by the Bell Report in 1962—problems of agency coordination, discretionary funds, personnel, and giving laboratory directors a voice in policy decisions—are still with us today. Although some progress has been made, there does not appear yet to have developed an overall coherent Government policy for the use of Federal laboratories.

Our first witnesses this morning are Dr. Donald M. MacArthur, Deputy Director for Research and Technology, Department of Defense, accompanied by Edward M. Glass, Assistant Director (Laboratory Management).

The Defense Department is the Government's largest supporter of research and development, and in fiscal year 1969 expects to spend $8.4 billion for this purpose. This amount is twice that which will be spent by NASA, the next largest Federal user, and more than nine times the entire Federal R. & D. budget at the conclusion of World War II.

The separate demands of the Army, Navy, and Air Force for research and development, and the changing scientific and technological nature of these requirements over the course of years have necessitated that the Defense Department take some unusual and innovative steps to manage its complex laboratory establishment, and we expect to hear some of these actions this morning.

Our second witnesses today are Dr. Leon Jacobs, Deputy Assistant Secretary for Science, Department of Health, Education, and Welfare, accompanied by Dr. G. Burroughs Mider, Director of Laboratories and Clinics, National Institutes of Health.

HEW is actively engaged on the frontiers of public health and safety. During the subcommittee's recent hearings on environmental quality, we had an opportunity to examine in some detail the research being sponsored by the National Center for Air Pollution Control, and

the work being done by the Public Health Service is well known and is to be commended.

Under the provisions of the House passed radiation control bill (H.R. 10790), the Public Health Service will take on additional responsibilities for research relating to the effects of radiation upon man. Since the Atomic Energy Commission and the Department of Defense have supported a substantial amount of this research in the past, it will be important to see how the existing competence of these agencies can be utilized in developing the Department's new program.

We are pleased to have you gentlemen here, and we will proceed with Dr. MacArthur and Mr. Glass.

(The biographies of Dr. MacArthur and Mr. Glass follow:)

DR. DONALD M. MACARTHUR

Dr. Donald M. MacArthur was born in Detroit, Michigan, in 1931. He received a B.Sc. (Honors) degree from St. Andrews University, Scotland, in 1954 and a Ph. D. in X-ray Crystallography from Edinburgh University, in 1957.

Afterwards Dr. MacArthur taught for a year at the University of Connecticut.

In 1958 he joined Melpar, a subsidiary of Westinghouse Air Brake. When he left he was Manager of the Chemistry and Life Sciences Research Center. In this position he was responsible for the management and direction of a large number of defense and space programs representing a broad spectrum of disciplines from instrumentation engineering to biology. These programs represented applied research in the physical and life sciences, in addition to development programs in space instrumentation, life support equipment, chemical and biological detection and warning equipment, and the development of large scale atmospheric diffusion experiments.

In February 1966 he accepted a position as Deputy Director (Chemistry and Materials), Defense Research and Engineering. In July 1966 he was designated Deputy Director (Research and Technology), Defense Research and Engineering in the Office of the Secretary of Defense.

As Deputy Director (Research and Technology) he is responsible for management of the DoD investment in research and technology relevant to military needs. The programs which he directs cover such diverse fields as rocket and missile propulsion, materials technology, medical and life sciences, social and behavioral sciences, environmental sciences, and chemical technology. He also oversees the 134 DoD RDT&E in-house activities which represent a fixed investment of $17.5 billion with an annual cash flow of $3.4 billion. Primary effort is devoted to policies, and innovating improved management systems to insure that they are organized most effectively to meet current and future military needs. Dr. MacArthur is a member of interagency committees and represents Dr. Foster on the Federal Council for Science and Technology. He was a member of the President's task force on the "Technology Gap."

EDWARD M. GLASS

Edward M. Glass was born at Providence, Rhode Island in 1917. A graduate of Rhode Island State University, he did work towards a Masters Degree at Virginia Polytechnic Institute. The major portion of his professional career was spent in the Air Force Materials Laboratory at Wright Field, assuming the position of Technical Director in 1958. His professional field of interest began with research and development in fuels and lubricants, subsequently broadening to the entire field of aerospace materials. In 1962 he was appointed a Special Assistant for Laboratories to the Assistant Secretary of the Air Force (Research and Development). His current position is the Assistant Director (Laboratory Management), ODDR&E, and is concerned with the policy and means of improving the in-house laboratories of the Department of Defense.

He has been active in a number of professional activities including the American Society of Lubrication Engineers, the Society of Aerospace Materials and Process Engineers, the Society of Automotive Engineers and the Materials Advisory Board, National Academy of Sciences. He is also a member of the

New York Academy of Science and Vice President of the Aerospace Chapter of the Research Society of America (RESA).

Dr. MacArthur. Thank you very much, Mr. Chairman. I would first like to introduce Mr. Ed Glass who is the Assistant Director for Laboratory Management in the Office of the Director of Defense Research and Engineering.

I would also like to add that I will be deviating in some places from my prepared statement.

STATEMENT OF DR. DONALD M. MacARTHUR, DEPUTY DIRECTOR, RESEARCH AND TECHNOLOGY, OFFICE OF THE DIRECTOR OF DEFENSE RESEARCH AND ENGINEERING, DEPARTMENT OF DEFENSE, ACCOMPANIED BY EDWARD M. GLASS, ASSISTANT DIRECTOR, LABORATORY MANAGEMENT

Dr. MacArthur. Mr. Chairman, members of the subcommittee, your hearings on the effective use of Federal laboratories are both timely and pertinent to the interests of the Department of Defense. It is an important question with which we have been concerned for some time. Today I would like to review for you some of the experiences of the Department of Defense and some of the lessons we think we have learned with respect to the questions which you are addressing.

Characteristics of Defense Laboratories

As you know, the Department of Defense has an annual R.D.T. & E. budget of about $8 billion. We employ about 60 percent of the civil service engineers and 35 percent of the civil service scientists in the Federal service. Thus, I believe that our experience in the management of R. & D. activities will be of some value in your discussions and deliberations.

We have 79 laboratories. In addition, there are 43 test and evaluation activities which are concerned with the evaluation of developed equipment. The fiscal year 1967 R.D.T. & E. obligations for these laboratories were $1.9 billion, of which $0.9 billion, 47.4 percent, was for actual in-house work as opposed to contract work. These laboratories employ about 72,000 people, of which 25,000 are scientists and engineers. Our investment in physical plant and equipment is about $2.2 billion based upon acquisition costs.

As you can see, this is quite an investment and we are quite anxious to see that it is managed judiciously and effectively and utilized in an optimum manner. This was a major reason for establishing our Office of Laboratory Management in 1965 which I will discuss later. In some respects, we have addressed many of the same questions—but on a smaller scale—which are before this committee, in order to assure that the capability of all of our laboratories are available for the highest priority needs of the three military departments and the six defense agencies.

I am not sure that we can examine laboratories in a meaningful way unless we place them in proper perspective, with respect to the other four types of performers we depend upon in DOD to accomplish our mission. Our laboratories represent about 12 percent of our obligations—industrial firms, 68 percent; colleges and universities, 12 per-

cent; nonprofit organizations, 5 percent; and Federal contract research centers, 3 percent. Each of these organizational types has a relatively unique, although not mutually exclusive, role to play in satisfying DOD requirements.

We have often asked ourselves the question, Why do we need in-house laboratories? Among the evident reasons underlying their need are—

1. The maintenance of national competence during peacetime, as well as times of conflict, in those areas of technology peculiar to military needs.

2. The necessity for maintaining a continuity of effort, free from commercial pressures and directed toward the conception and evolution of advanced weapon systems.

3. The need for competent in-house skills that can direct, monitor, and assess the performance of DOD contractors.

4. The requirement of having available to the military services a fast-reaction capability to solve critical, immediate problems that arise in connection with existing operational weapon systems, or when unexpected combat situations are encountered such as that currently existing in Southeast Asia.

DOD ACTIONS TO IMPROVE THE EFFECTIVENESS OF LABORATORIES

Many of the others who have testified before this subcommittee have highlighted many of the administrative problems of Federal laboratories. We have had our share of them also.

During the past 2 years we have had a concerted effort underway to improve the effectiveness of our in-house laboratories. The problems of our laboratories as we saw them when we started this effort can be stated rather simply:

1. Many laboratories have not been as heavily involved as they should be in the overall weapon planning process and in urgent military problems.

2. In many cases the laboratory structure was too fragmented to take on meaningful programs in an integrated way.

3. They did not possess the administrative flexibility to respond rapidly to changing needs, the changing state of technology, and changing nature of new tasks.

What are the rudiments of our strategy for dealing with these questions? We have attacked these problems, quite successfully I might add, by—

(*a*) Assigning important military missions and weapon planning responsibilities to major laboratories.

(*b*) We are taking some steps and planning orders to restructure fragmented organizations into more cohesive structures and centers with more meaningful missions.

(*c*) We have identified a number of administrative problems which inhibit the effectiveness of defense laboratories and have worked hard to develop solutions for them.

With your permission, Mr. Chairman, I would like to insert for the record, as tab A* some detailed information on the steps we have taken or which are underway.

Mr. DADDARIO. You may, of course, Doctor.

*Tab A appears starting on p. 171.

Dr. MacArthur. We are very encouraged over the progress we have made on a number of longstanding problems. This task has to be a continuing process of appraisal and action as there really is no finite solution. We hope to continue our rate of improvement and to be able to adjust to our changing patterns and needs. Otherwise we will retrogress.

A great deal of our energy is involved in the management of defense activities in support of our three military departments and the defense agencies. There is a continual ebb and flow of new goals and requirements similar to that for the total Federal establishment. We have been involved for some time with the same basic questions with which you are concerned. Are we using the laboratory capacity we have without regard to service loyalties? What patterns of growth should we permit or foster? How much should we perform in-house? On contract? How should the laboratories be structured? What should their relationships be within their parent service? To other services or defense agencies? I know that we have been able to develop many useful answers to these types of questions, but I will be the first to admit that we don't have all of the answers.

Within the DOD we have many examples of a laboratory performing functions for other services. Here are but a few of a great many examples. The Army's Natick Laboratory has the R. & D. responsibilities for food development for the Navy and Air Force. The Army's Harry Diamond Laboratory is providing the fuzing and arming for the Navy's Poseidon missile. The Air Force's Materials Laboratory has provided the thermal coatings for the Navy's Transit Satellite. The Army's Frankford Arsenal develops for the Air Force actuating devices for such applications as ejection seats.

Some of these arrangements are traditional, some are based upon a search by the customer for competence and still others are motivated by the policy levels within the services. We, within O.D.D.R. & E., also play an important role in this respect. We manage the Defense R.D.T. & E. program which determines to a great degree the financial support of laboratories. Financial control provides important leverage in placing corporate policies into effect. We are also in the mainstream of decisionmaking with respect to capital investments, such as military construction. Facilities are the lifeblood of expanding laboratories and control over them determines a laboratory's destiny. Through authority such as this, we can influence the nature of our laboratory system, the characteristics of individual laboratories and centers and the interaction of these organizations with other defense organizations.

Last year we closed three laboratories and consolidated four others. These actions are part of a continual appraisal of our laboratory system in terms of the changing pattern of defense needs. Although we have moved out aggressively in trying to fashion a viable laboratory system, there are some negative aspects also which have caused us some concern and difficulties. For example, several of our attempts to consolidate fragmented activities required movement of people to different geographical locations. We have learned that many people develop deep roots and will not move with their functions. As a result, the DOD has lost some important expertise. In one case not a single professional moved when his laboratory component was moved. On

the average about 50 to 60 percent of the professionals prefer to remain in their current locale. We try to take personnel factors such as this into account in our decisionmaking regarding consolidations.

Mr. DADDARIO. Could you provide for the record the names of the three laboratories that were closed, the way in which the others were consolidated, and a little bit of background material?

Dr. MACARTHUR. I certainly would be glad to do that.

(The information requested is as follows:)

LABORATORY CONSOLIDATIONS AND CLOSURES

We have taken the following actions over the past several years to consolidate or eliminate RDT&E activities. In the Army we have approved a long-range plan of all the medical facilities whereby there will be a reduction from 14 to 6. This plan calls for the establishment of three primary centers, an Eastern Medical Center, a Central Medical Center and a Western Medical Center. Consolidation will begin in FY 1970. We have already closed the Army Medical Unit in San Juan, Puerto Rico.

Other changes in Army activities include relocation of an explosives group from the Mobility Equipment Research and Development Center at Ft. Belvoir, Virginia, to Picatinny Arsenal, Dover, New Jersey; relocation of a Materials Handling function from Natick Laboratories, Massachusetts, to the Mobility Equipment R&D Center; and approval for consolidation of Deseret-Dugway into the Deseret Test Center in Utah.

There have been extensive consolidations within the Navy. For example, six centers have been established through consolidation of all or parts of a number of Navy laboratories. The Naval Undersea Warfare Center with headquarters in San Diego, California, was created from elements of the Naval Electronics Laboratory (San Diego) and the former Naval Ordnance Test Station (Pasadena). The Naval Weapons Center located at China Lake, California, was created from the combination of the Naval Ordnance Test Station (China Lake) and the Naval Ordnance Laboratory, Corona. The Naval Ships Research and Development Center located at Carderock, Maryland, is composed of The David Taylor Model Basin at Carderock, the Marine Engineering Laboratory, Annapolis, Maryland, and the Mine Defense Laboratory. They were combined to form the Naval Ships R&D Center (Carderock, Maryland). The Naval Air Development Center (Johnsville, Pennsylvania) is composed of the already established elements at Johnsville, Pennsylvania, plus combinations with the Aerospace Crew Equipment Lab, the Aeronautical Structures Lab, and the Aeronautical Materials Lab of the Naval Air Engineering Center, Philadelphia, Pennsylvania. The Aeronautical Engineering Laboratory of the Naval Engineering Center, Philadelphia, has been combined into the newly established Naval Air Propulsion Test Center in Trenton, New Jersey.

Two activities have been deactivated in the Navy: (1) the Naval Air Mine Defense Development Unit, Panama City, Florida; and (2) the Naval Supply R&D Laboratory, Bayonne, New Jersey.

Two activities in the Air Force have been closed out. One is the Arctic Aeromedical Laboratory, Ft. Wainwright, Alaska, and the other is the Research and Technology Division of AFSC. Elements of the Research and Technology Division were consolidated in AFSC Headquarters, eliminating one organizational echelon.

An additional significant action was the consolidation of several Air Force test activities with elements of the Navy, Army and NASA into national ranges, the Eastern Test Range in Florida, the Western Test Range in California and the White Sands Missile Range in New Mexico.

Mr. DADDARIO. Would you also discuss what was the general overall approach to this? What criteria did you establish? What were the standards you established as you looked over these laboratories and made a determination as to which ones ought to be closed and which ones ought to be consolidated?

Dr. MacArthur. Well, when we evaluate the quality of a laboratory there are many criteria we use. The three services, the Air Force, the Army, and the Navy have advisory groups which periodically review the programs of the laboratories and come up with recommendations in terms of whether they are above standards, below standard, fine, mediocre, whatever they might be.

We also look at whether they have meaningful missions.

Secondly, within the Department of Defense at the D.D.R. & E. level when I come from, we look at programs from a programmatic standpoint, from a technical standpoint, and at that point we look at the contributions the laboratories are making to that program.

Thirdly, as you no doubt know, some of our laboratories are involved at only one end of the R. & D. spectrum, research and technology. Other laboratories are involved throughout the whole R. & D. spectrum through engineering development and test and evaluation.

Now, one of the criteria we use when a laboratory is involved at the research and technology end of the spectrum is how much of their output over the last few years has been incorporated in some of our systems development programs.

In a laboratory that is involved in engineering development, we look at the effectiveness of the systems or hardware they have developed or managed, and, lastly, we look at the individual laboratory director's independent research program and look at how he has managed his funds, what he has done, where he has invested them, but the real test is how much business he got based on those investments he has made.

It really comes down in the end to a number of criteria, but an overriding criteria is mission. Does it have a sense of purpose? Does it have high-quality people, and are they performing well?

Mr. Daddario. This is an evaluation process that goes on continuously?

Dr. MacArthur. It is a continuing evaluation process.

Mr. Daddario. Do you find that it works more efficiently in making determinations during time of budget restriction?

Dr. MacArthur. I certainly think so. I think it can be made to work every effectively. Naturally, other parameters are superimposed upon these conclusions we come to because many of these laboratories perform vital functions in their community, and when we take the next step in trying to phase out activities we run into some roadblocks in terms of the community, and the objections they raise.

Mr. Daddario. The reason I ask about that is a natural one because when agency funds are short you do then begin to look for places to cut. However, shouldn't we do this at all times and wouldn't we then find ourselves with the laboratories always in a better condition and the quality would remain more constant?

Dr. MacArthur. Yes. We have to have a program of continual appraisal and at the same time we have to remember that in the DOD the amount of money we spend in our in-house laboratories, is only 12 percent of the 8 billion I mentioned.

Mr. Daddario. That is still a bit of money.

Dr. MacArthur. Yes, it is $900 million. But coming back to your point, I do believe it is a program of continual appraisal and reevaluation and as the defense needs change, we have to look at the mission of

the laboratories; are they involved in urgent military problems, and if they are not, we try to either get them involved or if they are not willing to get involved, we do something about it.

Mr. DADDARIO. You talk about judgment by peers. Who are they and how do you get them together?

Dr. MACARTHUR. There are three—let me address each service. In the Air Force we have a board of advisers which is a panel of the scientific advisory board and they are from the outside. They involve individuals from the industrial world, individuals from the universities, and from nonprofit organizations.

In the Navy we have the technical evaluation board which is a part of the Naval Research Advisory Council.

Again, all members of this advisory board or technical evaluation group are from outside the Department of Defense.

The Army is different in that they have a group which is composed solely of all in-house individuals and they perform an appraisal every 3 years. We call it the triannual survey group.

These are the advisory boards I referred to.

Mr. DADDARIO. How are the laboratory directors involved in the evaluation, if at all?

Dr. MACARTHUR. Well, these advisory boards, they do more than read papers. They actually visit the labs. They talk to the laboratory directors and the key people at the laboratories to see what they are involved in, what they are doing, what their mission is, what they have contributed in the last year, and what they intend to work on in the following years, and why.

One of the biggest problems we have been having in the past years was that some of these laboratories weren't involved in important questions. That is one of the things we have been stressing, that they have to get more involved in important military problems.

I painted a rather black picture of the problems we found with the laboratories and one might say, well, gee whiz, if they are that bad, we should do away with them all. How have these problems come about? Well, over the last 10 years, the DOD budget has multiplied by a factor of two to three as we have gotten much more involved in complex military systems.

Now, it is very difficult for a laboratory to manage an Atlas or a Polaris missile system. It is just too big a job with the result that what has happened is we have set up special project offices and system program offices in the services that manage these big programs.

Now, what result has this had over a period of time? It resulted in the labs just getting out of the mainstream of important problems because the systems offices were going ahead and depending solely on the contractors and they came to the laboratories only when they had a quick-fix problem and they were in trouble or when they wanted them to do long-term research.

Now, we, over the last few years, have tried to reverse this trend by getting laboratories involved not only in the long-term problems and the quick-fix problems, but also in the short- to medium-term problems.

There is one other aspect that I would like to mention and that is we have, in 1966, created the position of Director of Laboratories. Each service now has a Director of Laboratories and the individual in this position is responsible for appraising labs on a continuing basis

and, in fact, these advisory boards work directly with him. They don't actually work with us, but they work with the Director of Laboratories for each service.

Mr. DADDARIO. The ways in which you govern these activities are important. You talk about it being 12 percent, but that is about equal to the entire research development budget of the Department of Defense in 1946. So we are really talking about a tremendous growth area, and the importance of the way in which we manage these becomes more than obvious.

Dr. MACARTHUR. You are absolutely right in that, sir, and that is why we feel it has to be a program of continual reappraisal and special attention has to be continually paid to the labs to make sure they are viable and potent organizations.

Mr. DADDARIO. You mention your laboratory directors for each of the laboratories, do you discuss this morning the use of discretionary funds?

Dr. MACARTHUR. Yes.

Mr. DADDARIO. Let's keep going then.

Dr. MACARTHUR. I don't actually——

Mr. DADDARIO. Can we discuss that?

Dr. MACARTHUR. Yes.

Mr. DADDARIO. What is your attitude about this, and how does it work?

Dr. MACARTHUR. Well, we started the program of discretionary funds in 1962. I think it is a very important part of our laboratory program. As a rule of thumb we have approximately 3 percent of our total laboratory money in discretionary funds. In general, it differs from service to service.

For example, in the Navy it is between 5 and 8 percent. In the Army it is about 3 to 5 percent, and in the Air Force it is a little less.

In a way it depends on the flexibility the lab directors have to do work. In many ways the Air Force laboratory directors have more flexibility in financial affairs than the other service laboratories directors, and that is because of the way they are funded. Therefore, the discretionary funds that go to the Air Force is less than the other two services.

Mr. DADDARIO. You mean the Air Force would allow each of its laboratory directors to have exactly the same amount of discretionary funds, or do you establish a sliding scale mechanism where you allow some to have more authority than others?

Dr. MACARTHUR. They use a sliding scale. It is dependent on quality of the laboratory and what they have done the year before. We provide these discretionary funds, but we don't require any approval beforehand as to what they are going to do with them, but we have an after-the-fact appraisal at the end of each year. These funds are distributed by the Assistant Secretary for R. & D. in each service and depending on what the labs have done with them the year before and what the productivity has been, that determines to a great degree what they are going to get in the following year.

Mr. DADDARIO. You started off on a quality judgment when you initiated the program and then you used basically a reward system?

Dr. MACARTHUR. That is right.

Mr. DADDARIO. How good were you? Did it work out pretty well the way you expected?

Dr. MACARTHUR. We had to adjust as we went along and we do think it has worked very well. I think there are many things that have come out of discretionary funds. Many examples which because the laboratory director had funds that he could use right on the spot when the individual had an idea rather than going through the complicated, tortuous budget process. When a scientist or engineer had an idea that was good and the director funded it, gave him the resources, then we have many examples of things that have come out of the program.

Mr. DADDARIO. Could you provide examples of some of those programs?

Dr. MACARTHUR. I would be glad to.

Mr. DADDARIO. Why don't you give us one that you think would be an outstanding one for the record?

Dr. MACARTHUR. An outstanding one has been mentioned before. That was the Sidewinder missile at NOTS. That is an outstanding example of an individual where if he had followed the rules, I doubt if we would have arrived where we are now, but he was able to somehow get some money and put it in to demonstrate the basic idea which he thought would be very successful, and it was.

Another example was the early work on the Walleye which has seen some real success in Southeast Asia.

These are two examples. I would be glad to furnish you others for the record. We evaluate all these projects at the end of the year.

(The information requested is as follows:)

IN-HOUSE INDEPENDENT RESEARCH FUNDS (IHIR)

The IHIR funds were established as line items in the FY 62 DoD budget as a result of a Secretary of Defense decision on October 14, 1961, as follows:

"Depending upon the mission and nature of the work of the particular laboratory, a fraction of the annual laboratory budget shall be set aside for work judged by the laboratory director to be of promise or importance without need of prior approval or review at higher levels. The results of this work shall be reviewed by the Assistant Secretaries for Research and Development of the Military Departments."

While this concept was new for the Army and Air Force, it had been in effect within the Navy for over a decade prior to this time.

Listed below are a number of examples of IHIR efforts which have resulted in useful products or applications. In addition, we have included a comprehensive list of completed IHIR efforts to provide the Subcommittee a better insight into the scope and flavor of this program.

ARMY EXAMPLES

Severe shock

The Walter Reed Army Institute for Research conducted basic studies to find improved methods of treatment of patients in severe refractory shock. It was found that enormous amounts of fluids could be given to patients, when the exact amount is known; and that vasodilators given after adequacy volume addition are not only safe but dramatically effective. At Walter Reed General Hospital during a specified period, the mortality of shock cases with usual treatment was about 700. The mortality, during the same period, with treatment derived from this study, was 120.

Laser transmitter

The U.S. Army Electrical Components Laboratory designed and constructed a laser transmitter, consisting of an arrary of seven injection laser diodes, with a peak power output of 150 watts. The transmitter, when combined with an eight-inch telescope and photomultiplier tube, was tested as a range finder and exhibited a useful range of 500 meters.

Large air samples

The U.S. Army Biological Laboratories and the U.S. Army Walter Reed Institute for Research jointly demonstrated the feasibility of using a Large Volume Air Sampler (LVAS) to recover small numbers of bacteria and viruses from large air samples. Meningococcal meningitis and respiratory diseases of adenoviral origin, in military recruits in barracks and hospitals were studied.

Supercharged engines

The U.S. Army Mobility Equipment R&D Laboratory conducted studies to determine if greater power and altitude capacity could be obtained from 10 and 20 HP military standard engines by utilizing the turbo supercharger principle. This work led to the proposal that a turbocharged "10 HP" engine (20 HP output) be used on the CHAPARRAL missile system in an application where the standard 10 HP military engine would not produce the required specific output (HP/FT^3).

Stratospheric tides

The U.S. Army Atmospheric Sciences Laboratory investigated Stratospheric Tides on a Seasonal Basis. Analysis of rocket soundings verified the existence of a significant year-round diurnal oscillation. A qualitative description was made of the phase and amplitude of the oscillation during the summer season. Certain recommendations were postuated on how the tide affects meteorological rocket network climatological data. The discovery of atmospheric tides in the stratosphere has led to new concepts of the atmospheric electrification process and the origin of large-scale electrical fields in the atmosphere. These findings will have an impact on the photochemistry of the upper atmosphere and the structure of the ionosphere with attendant effects on the propagation of electromagnetic energy.

Microwave food preparation systems

The U.S. Army Natick Laboratories, in 1965, initiated a study to determine the feasibility of developing an ultra rapid, lightweight food preparation system which would utilize microwaves, thermoelectric units, ultrasonic fuel vaporizers and multipurpose plastic packages which could also function as heating and serving vessels. A two-year study proved the feasibility and overall potential advantages to the military of microwave cooking in the field. As a direct result of this work a development project, in the regular budget, was initiated for the design and construction of a field kitchen and bakery units.

Test drug transfer

The U.S. Army Medical R&D Laboratory designed and fabricated an accessory kit for the standard hypodermic jet injection devices to permit a quantitative transfer of test drug into the skin intradermally for such tests as T.B., histoplasmin, etc.

Electro-mechanical hand models

The U.S. Army Medical Biomechanical Laboratory designed and fabricated six electro-mechanical models of the hand with automatic proportional control of grasp. One hand has been fitted to an amputee. The other five hands have been submitted to New York University and the Veterans Administration. All are now undergoing clinical testing.

Ozone concentration

The U.S. Army Atmospheric Sciences Laboratory, in 1966, provided to the scientific community the first *in situ* measurements of the change in ozone concentration in the atmosphere during a total solar eclipse. The increase in ozone by 100% during total eclipse was abrupt; a sudden decrease in concentration was noted as the sonde emerged from the shadow; and in less than 20 seconds, the ozone had reached its equilibrium value.

NAVY EXAMPLES

New high-temperature explosives

Navy chemists at Naval Ordnance Laboratory (White Oak) have synthesized more than a dozen new and potentially useful explosives that are heat resistant. Several of these have already seen use in military weapons and space vehicles, and several others are being considered for similar applications. Success in this area is due primarily to extensive fundamental studies of the relationship of

molecular structure and content to explosive properties conducted under the Independent Research Program. It is now possible to predict *a priori* many of the properties of an explosive before it is synthesized. This has led to the synthesis of high-energy materials capable of withstanding temperatures much higher than was previously considered possible. The first two explosives to stem from this program are capable of withstanding temperatures above 500 degrees F. Both have been used in explosive cutting devices in the Gemini space capsule and are contained in the mild detonating fuses and flexible, linear, shaped charges used to separate the crew module from the F–111 aircraft in emergency situations. It is now reported that these systems are capable of lasting the lifetime of the aircraft eliminating the frequent maintenance and replacements required when explosives of lesser temperature capabilities are used. It is estimated that use of these explosives will save the Government nearly $90,000,000 during the life span of the aircraft now on order. Three more, promising, high-temperature explosives have been developed. The first two are able to withstand temperatures 35 to 40 degrees higher. These are currently being screened for applications by the military, NASA, and AEC.

Biomolecular variations induced by stress

Observations at the Navy Air Development Center (Johnsville) on animals exposed to different lethal stresses such as ionizing radiation and high acceleration stress have shown chemical changes in the blood. After these observations on animals, the experiments were extended to humans. Volunteers were subjected to accelerations of from 3 to 4½ G, sufficiently long to produce grayout or blackout. All the men exposed to this stress showed a significant increase of the phosphatidyl glycerol level in the blood plasma. Correlations of the control levels of phosphatidyl glycerol with anxiety about the acceleration procedure directed attention to the effects of emotional factors on the chemical changes induced in the blood. As an example of extreme emotional stress, blood samples from schizophrenic patients hospitalized for a long time at a psychiatric institute were analyzed and also showed high concentrations of phosphatidyl glycerol accompanied by changes in the levels of other phospholipids that distinguished the stress in schizophrenia from the physical stress of acceleration. Extension of the study to volunteers who had been deprived of sleep for 36 hours confirmed the previous findings relative to phosphatidyl glycerol and again revealed changes that differentiated this fatigue stress from the others. After these results were made public, the experimental approach was included in a joint Navy, NASA, and Air Force study of combat pilots. Data were taken on Navy carrier pilots flying high-risk, active combat missions during a 22-day line period, near the end of a 7-month deployment. These studies were repeated again when the pilots were returned to the United States to non-combat duty. The concentration levels of phosphatidyl glycerol and other phospholipids again made possible the statistical separation of the combat stressed pilots from normal individuals and from the other stressed populations. After the pilots returned to the United States, the phospholipid levels began to return toward normal, but the reversal was not as complete as was found in acceleration or sleep deprivation. The data obtained with humans coupled with the information found in the tissues of stressed animals suggest that some center of the brain can interpret certain sensory inputs as threats to survival and reacts by mobilizing biochemical factors at a molecular level to meet the threat. Techniques are now being developed so that analyses for these plasma components can be made in the field. It is expected that the onset of combat fatigue in fighting men may then be anticipated by these procedures.

Cartography by computer

The time will come when most maps will be printed with the aid of a computer and a cathode-ray printer. Based upon work at the Naval Weapons Laboratory, it will be possible to print in a few seconds a map which now requires days to trace by land. Essential to mapping by cathode-ray printer is a collection of data which contains the geographic coordinates of points on coast lines and boundaries. There is available at a Navy Laboratory a collection which includes 10,000 points for the United States itself and 8,000 points for the world as a whole. The points were selected to portray the salient features of coast lines and boundaries without exceeding prescribed limitations on accuracy. Once the latitude and longitudes of the points had been recorded on magnetic tape, it became possible to construct maps by connecting the points in any automatic plotter which is under the control of a digital computer. Any desired mapping transformation may be used in the conversion of geographic coordinates to map cordinates. The data

have many applications and have been acquired by a number of agencies. The data are basic to maps in earth sciences where distributions of economic value or population density are presented against a geographic background. They are useful in the preparation of updating of highway and weather maps. In a significant military application, the data are used by defense commands to display the position and motion of potential targets in relation to coast lines. Such displays constitute an important part of any decision to take countermeasures. In one interesting application the data are used at the Houston Space Craft Control Center to show astronauts just how the coast lines on the earth will appear to them when they are in orbit. Soon there will be a need for maps to show how the crators of the moon will appear to astronauts!

The data have applications in the Navy in connection with the optimization of the allocation and scheduling of shipping. Currently under consideration is an application to maps which show the paths of the shadows of eclipses of the sun. Another application is in the development of new methods for mapping the earth.

Effects of water on bearing fatigue

The presence of water in hydraulic fluids and in lubricating oils has a deleterious effect on naval machinery. Interaction of the water with stressed metal surfaces accelerates failure of bearings and gears. The presence of 0.01 percent dissolved water in the lubricant has caused reductions of 27 to 78 percent in surface fatigue life depending on the applied stress. Independent Research at the Annapolis Division of the Naval Ships R&D Center has led to a possible mechanism for this remarkable phenomenon. It is as follows: Microcracks in the surface of the ball act as capillaries. Water in the lubricant at a concentration that permits capillary condensation forms a water-rich phase in the cracks. Aqueous corrosion in the cracks and dynamic stress on the surface then combine to cause the reduced fatigue life. With this understanding of the phenomenon, research has been initiated to find means to minimize such effects.

Delivery of airborne weapons

In the past the designer of weapons to be launched from aircraft assumed a specific dive angle, speed, etc. Wind-tunnel tests were made for the assumed conditions to verify the design. However, these tests were not extended to determine the limits at which a given weapon could no longer be safely launched by a given aircraft. Both in experimental flight tests and in combat missions under conditions different from those assumed by the weapon designer, improper separation of weapon and aircraft caused damage to or loss of the aircraft or failure in delivery of the weapon. The Navy laboratories were called upon to correct each case as it occurred. At the same time, however, they recognized the necessity for better design data and for an ability to predict the limits of safe delivery for various combinations of aircraft and weapons. To enhance prediction capability, all experimental data available have been collected in a data bank, and computer orograms have been developed for the launch of conventional weapons. In addition to the problems of separation, the current methods of shaping, carrying, and delivering weapons increase the drag of the system significantly and reduce aircraft performance. Accordingly, the feasibility of using unconventional shapes which can be carried on the aircraft in a low-drag configuration was explored at the Naval Ships R&D Center (Carderock). Analytical studies and wind-tunnel tests at subsonic, transonic, and supersonic speeds confirmed that weapons which are rectangular solids can be carried at a drag level which is a small fraction of that of present weapons. Static and dynamic wind tunnel tests also established the technical feasibility of aerodynamic stabilization of rectangular solid shapes. With these demonstrations of feasibility and of the potential of these studies to solve many of the problems of stores separation, these developments have been transferred from IED funding to support by the Naval Air Systems Command.

AIR FORCE EXAMPLES

Laser night photo reconnaissance

The potential applications of the laser technology are many and varied. The Laboratory Director's Fund permitted the Air Force Avionics Laboratory to finance an in-house effort in 1963 to explore the use of lasers as an illuminant for night photography. The narrow beam capability of coherent light can achieve 10 times more illumination per unit area than any other source with the same input power. Moreover it could be essentially a covert means of reconnaissance.

The ruby laser beam is in the red end of the visible spectrum but the extremely short time duration—a millisecond—and the narrow beam makes it invisible to all except those looking directly either at the target or the source. The use of a neodymium doped glass rod can be fully covert since its burst is in the invisible part of the spectrum.

Experiments were conducted with a portable 2 joule ruby laser with associated mirrors, filters, and optics. A variety of subjects ranging from 250 foot slant range to 5000 foot slant range were recorded on 70 mm film using a conventional camera. Weather conditions varied from clear nights with a light ground haze to rain showers with fog and snow showers. Films were evaluated for optimum sensitivity, contrast, and resolution to the 6943-angstrom wavelength energy.

Very successful, high resolution, photographs were obtained. Data regarding the optimum film types for use with laser beams have been developed as well as the film processing details. Means of using optics to improve the photographic quality without excessively destroying the narrow characteristics of the laser have been evolved.

Radio frequency (RF) probe

During an in-house investigation of various means, electrical and mechanical, of detecting intermittent faults in equipment, Air Force Aeropropulsion Laboratory engineers noted that, characteristically, all faulty electronic equipment produced a 24KC nose signal.

Using Laboratory Director's funds, a portable, self-contained probe capable of pinpointing this signal was developed and subsequently field tested by the using commands. The field testing has been extremely successful, and procurement data for the RF–204/u Detector, Radio Frequency Interference, was forwarded to the Air Force Logistics Command.

Quick fix applied to F–100 IFF radar antenna problem

A quick-fix to a critical Air Force problem in Vietnam was researched and successfully developed in-house by the Air Force Materials Laboraory. IFF radar antennae on the F–100 were failing after about six hours of aircraft operation from acoustical vibration generated by the plane's own cannon fire. Air Force Materials Laboratory scientists simulated the service failure in the laboratory, and developed a small, low cost, easily attachable prototype viscoelastic damper as a quick-fix. Field evaluation of the damper in Vietnam showed a twelve-fold increase in the life of the radar antennae. A sufficient number of dampers manufactured in-house by Air Force Materials Laboratory personnel were shipped to completely fit the F–100 fleet in Vietnam.

Nitroso terpolymer

The deterioration of elastomeric seals, hose and fluid container linings in contact with nitrogen tetroxide (a high performance oxidizer used in liquid rocket propulsion systems) has posed a difficult problem for which a solution has been sought for several years with little previous success. The Air Force Materials Laboratory effort has resulted in a major materials breakthrough in the development of an elastomeric material resistant to nitrogen tetroxide. This newly developed material is a nitroso terpolymer (nitroso rubber). In evaluation tests this material has remained intact after total immersion testing in liquid nitrogen tetroxide for 1½ years at 165°F, and is expected to be good indefinitely at 100°F. Under these test conditions, the best commercially available material (a butyl rubber) lasts only 1 hour at 165°F and 7 days at 100°F before it deteriorates. The nitroso terpolymer has passed hardware evaluation tests and has been qualified for use on the Apollo. Because the nitroso terpolymer will not burn in air of oxygen, this material also has other potential uses such as fireproof protective clothing or, since the nitroso terpolymer can also be made in liquid form, as a sprayed-on fireproof coating for spacecraft interiors.

Supersonic turbojet engine study

The Air Force Aeropropulsion Laboratory has completed a study effort on a new turbine engine concept—a supersonic combustion non lift type turbojet engine.

The study results showed the following: (a) Ratio of engine thrust to installed engine weight (F_n/W_t) of 10.2—nearly three times present installations, (b) Installed engine length reduced by about 60% and (c) Installed engine weights reduced by 50%. A further accomplishment of considerable merit is the combination of all rotating compressor and turbine stages in one wheel.

Advanced air launched missile propulsion study

This Air Force Rocket Propulsion Laboratory (AFRPL) study evaluated the performance of advanced solid, liquid and air-augmented propulsion systems against well defined missile survivability criteria in order to allow a clear impartial comparison. The most striking result was the great increase in low level, high mach number capability which might be attained with air augmented systems. The detailed design studies performed revealed definite areas within the materials, propellants, thrust chamber assembly, pressurization and expulsion technologies which possessed the most significant growth potential. The ultimate worth of this study can be measured in the positive manner in which it has aided the AFPRL in pointing defense contractors toward the major significant problems in the air launched propulsion field and the fact that propulsion requirements from this study have been used directly in defining and implementing present AFRPL exploratory development contracts in the air augmented rocket and prepackaged liquid, solid and hybrid rocket areas.

Oxygen concentrator

In 1964 the Air Force Flight Dynamics Laboratory undertook an effort to fabricate and test an oxygen concentrator module which produces pure oxygen using air taken from the ambient atmosphere. This system combined with a carbon-dioxide and water vapor removal unit and recirculation system could replace the high pressure gas storage system presently employed in Air Force Aircraft.

The feasibility of the oxygen concentrator concept has been demonstrated to the point where it is currently undergoing engineering development.

Bandwidth expansion by redundant transmissions

Under this effort, undertaken by the Rome Air Development Center, an experimental spread spectrum anti-jam communications system, using frequency redundancy, was designed; and the breadboard was completed and tested. A theoretical evaluation of the system was compared to the experimental results. The main object of this experimentation was to determine whether or not significant loss would occur through implementation of the Bandwidth Expansion by Redundant Transmissions (BERT) technique.

This effort has provided a significant technique for improvement of stored reference, spread spectrum systems, and has reduced the theory to practice. The technique now is available for incorporation into prototype equipments where system constraints would indicate a benefit by utilization of this bandwidth expansion system.

Mr. DADDARIO. Do you have any estimate that you could provide for the record as to how you believe time and money has been saved as a result of this? Do you make any estimate of that?

Dr. MACARTHUR. I would like to think about that a little further.

Mr. DADDARIO. If it would be a difficult thing to do, is your overall judgment that it has saved considerable time?

Dr. MACARTHUR. That is right. We have ideas and products that have come out that normally wouldn't have come out or if they did it would be at least 2 years later.

There is another thing that we shouldn't overlook and that is that it is a very useful tool to attract scientific talent. If a scientist knows, that if he has an idea and that he can go to work on it tomorrow rather than waiting for 18 months while it goes through the many echelons of review and approval of the Department of Defense, the Bureau of the Budget and Congress is a very important factor in attracting him. A lot of our scientists like to feel that if they have a good idea they can get to work on it right away.

Mr. DADDARIO. During the course of these hearings it has been the judgment of all of the witnesses that it adds immeasurably to the quality of these laboratories. Whatever the percentage is, this discretionary authority allows the whole laboratory to operate more effi-

ciently and the laboratory makes better use of the total funds spent. You could agree with that?

Dr. MACARTHUR. I would certainly agree with that. It comes down in the end to the laboratory leadership. It comes down to the laboratory director himself because he has to make the final judgment on these programs as they are presented to him by his staff. Where we have a good laboratory director, the program has been very successful. In cases where you don't have a good laboratory director, it won't be as successful because he is probably supporting ideas that aren't very good. Through after-the-fact evaluation, the one who does well, should get more money next year.

Mr. DADDARIO. Have you come to any judgment over the course of time as to the percentage necessary? You are under some constraint there to spread out beyond these figures apparently because of your problems with the Congress. Do you think the amount is about right, or do you think you should have more or less?

Dr. MACARTHUR. I don't think we should have less. Whether we should have more, I really don't know. I think it should be in the ballpark of somewhere between 3 to 6 percent. I don't think it should be 20 or 25 percent. Looking at industrial analogs which we have looked at there is even a very wide variation there, but, in general, it varies between 3 and 10 percent for the big corporations.

Mr. DADDARIO. As you view the entire laboratory establishment in other agencies, would you support as a matter of policy that this should be a prevailing situation? Would you say that laboratory directors should have such discretionary authority, taking into consideration that some criteria mechanism to judge the quality of the work must be established?

Dr. MACARTHUR. I certainly would with one caveat, provided they have the same problems that we have in terms of the budget process and the many echelons of review and approval.

Mr. DADDARIO. Yes, taking that into consideration.

Dr. MACARTHUR. Yes, I certainly would.

Mr. DADDARIO. How about echelons of review? What is your view on that?

Dr. MACARTHUR. Well, as far as independent research programs are concerned?

Mr. DADDARIO. Yes, do you have a problem because of these layers of review which inhibit your activities?

Dr. MACARTHUR. We certainly have a problem in management of our labs because of many echelons of review because what generally happens is that the laboratory director is given a lot of responsibility many times, but doesn't have the authority to go with it because as you go down the echelons of review there is a little taken away here and a little bit taken away there. This is one of the administrative problems I pointed out that we have. We try to delegate as much responsibility to the laboratory director as we can and at the same time appropriate authority to go with it. If he has authority when things go wrong we know where to place the blame. Right now it is very difficult to place the blame because many times it pervades the whole process.

Mr. DADDARIO. Keith Glennan, who is now president of the Associated Universities, has said the Federal laboratories should compete

for some part of its funds as a way to develop this quality. Do you have any judgment on that?

Mr. Glass can pitch in here anytime he wants.

Dr. MacArthur. We certainly agree on that point. Nothing beats competition. Within our laboratory structure we cover the entire spectrum from no competition for funds to almost totally competitive. There are those which really do not have to compete for customers to keep the laboratory going to those which have become "job shops" for their customers, with few, if any, longer range programs. The optimum is somewhere between these two extremes.

Mr. Glass. We believe that a laboratory should have to compete for at least 25 percent of its funds in order to stay healthy. In the Navy, many laboratories have to compete for 80 to 90 percent of their funds from various sponsors. This is considered to be too high a percentage and we now have a program underway to provide most of their research and exploratory development funds on a less competitive basis. On the other hand, within the Air Force, we have a system of "block funding" of laboratories. The Air Force laboratories are not dependent at all upon customers for their support. We feel that if we can inject a greater element of competition here, it will probably create a healthier situation.

Mr. Daddario. Again, considering the objective being to upgrade the quality of laboratories and keep them there, this kind of makes up for the difference.

Mr. Glass. It couples these laboratories more closely with their customers; the customer has a feeling of responsibility for them, a feeling of using them more effectively also when they have to pay for that service.

Mr. Daddario. Could you give us an example of why you believe that to be the case?

Mr. Glass. The case of, let's take Dr. McLean's laboratory where a great deal of his money comes from the Navy Systems Command and he can work very closely with a Navy systems command because he is, in essence, their major performer. They will bring him into the planning stages, the discussion stages on new systems early in the game and thereby give the laboratory more direction as to what they should do and give the sponsoring agency a better interface with the laboratory during these initial stages. It also gives a laboratory an effective way of injecting new ideas into a new program.

I think that when a laboratory works for a customer such as a systems command in the Navy or a special project office in the Air Force, they have a tendency to work more effectively and much closer together toward a common goal.

Mr. Daddario. Are you in agreement with Dr. MacArthur regarding this discretionary authority?

Mr. Glass. Absolutely.

Mr. Daddario. I think we had better move along.

SUPPORT ON NON-DEFENSE AGENCIES

Dr. MacArthur. The performance of work on a reimbursable basis has been rather significant within the DOD both among the services, as I indicated earlier, and particularly with the AEC and NASA.

We interact continually with other Government agencies both on a reimbursable and a nonreimbursable basis.

For example, the AEC program includes $849 million for military applications to support our nuclear weapons and naval reactors programs, which represents 35.1 percent of their total budget. AEC laboratories are involved in many of our conventional weapon programs in such fields as explosives research and aspects of personnel armor development. We have had many Defense personnel actively working in AEC facilities and there are many interactions between the Special Weapons Center and the Weapons Laboratory of the Air Force with the Los Alamos Scientific Laboratory and Sandia Corp., which are located nearby.

We are closely allied with NASA in many aspects of their space and aircraft programs and use each other's talent and unique facilities quite freely. Our national ranges have NASA as a principal customer. They use our unique facilities at Tullahoma and we support a great deal of research in aerodynamics, structures, and propulsion at NASA centers, which is directly utilized by DOD. A number of our systems and subsystems have been adopted by NASA in connection with their launch vehicles and they have developed a number of critical components for our MOL program. We performed services in fiscal year 1967 for NASA estimated at $400 million.

I would like to submit for the record as tab B* a few examples of programs carried out by our laboratories for agencies other than NASA and AEC.

How do agencies get together on programs? Like most areas of government activity it depends on aggressive individuals who know their problem and where to go for help. Our job is to let other agencies know what capabilities we have. As an example we publish an annual report which summarizes information on each of our in-house R.D.T. & E. activities." These are distributed through the Federal Council on Science and Technology, DDC and the Commerce Clearing House to other agencies. Also each of the services has developed a "technical facility capability file." These assist the people with a problem in locating technical expertise, suitable facilities, and major equipment within DOD. I would venture to say that any individual looking for special capabilities in DOD could locate them with a minimum of two or three telephone calls.

I recognize the committee is interested in national policies for use of Federal laboratories. We feel that we have a permissive environment with respect to the reimbursable use of other agencies' laboratories, and vice versa. We have just reviewed the pertinent laws, Executive orders, and other statements of policies and procedures which we believe represent our guidelines in the full and effective use of Federal laboratories. I would like to insert this review into the record as tab C**.

The existing laws and executive instruments are quite permissive and encourage the full utilization of existing facilities and Federal laboratories. The so-called Economy Act of 1932 appears to be keystone legislation in this respect. Executive Order 10521 is also quite pertinent to the efficient use of Federal equipment and facilities. In addition, there exists frequently general authorization for coopera-

*Tab B appears starting on p. 172.
**Tab C appears starting on p. 173.

tion between a specific agency and all other agencies. Such is the case with NASA, AEC, FAA, and the National Bureau of Standards.

There appear to be some constraints, however, resulting from a decision of the Comptroller General in 1954 concerning the addition of new plant and equipment to accommodate interagency services. While I don't believe this has affected us seriously, it could be somewhat of a deterrent. This question should be examined further.

Mr. DADDARIO. Why do you think it would be a deterrent?

Dr. MACARTHUR. I believe it could be a deterrent if this finding by the Comptroller General is literally interpreted where we are one agency and a laboratory from another agency could do some of our work but that work requires special equipment and special facilities. This interpretation says that you can't do that. As an example, if I am going to NASA asking one of their labs to do a special job for me because they have special expertise in terms of personnel to do the job or the task, but they have to acquire special equipment or special facilities to do it, I believe the interpretation that the Comptroller General put on it inhibits this.

Mr. DADDARIO. You support, as you seem to indicate here, the idea that there should be as much flexibility as possible between the agencies and when you find either personnel or facilities which may be suitable for you to perform some of your mission objectives, that you ought to take advantage of what exists?

Dr. MACARTHUR. That is right.

Mr. DADDARIO. Your theory is that we have a ruling which, if strictly interpreted, even though promulgated in the first instance to save money, and in the final analysis will not?

Dr. MACARTHUR. Yes; but I don't think it has affected us seriously.

Mr. DADDARIO. Continue, please.

INTERAGENCY TRANSFER OF LABORATORIES AND PROGRAMS

Dr. MACARTHUR. We have probably had as much or more experience than most agencies in the interagency transfer of laboratories and programs. I can recall two cases which are quite well known and from which we can gain some insight. A historical case in point is the transfer of fuze R. & D. from the National Bureau of Standards (NBS) to the Department of Defense in 1953.

During and after the end of World War II, NBS performed the R. & D. on proximity fuzes under the sponsorship of the military departments. NBS initiated action to have their ordnance division transferred due to the increasing magnitude of ordnance work being performed by the NBS, coupled with the apprehension that "the concurrent growth in applied engineering work might detract from the Bureau's main function in the broad areas of standards and standardization." These were considered compelling reasons for transferring the activity to the Department of Defense. This resulted in the creation of the Army's Harry Diamond Laboratory.

Thus, we must always be concerned with the balance of agency assignments and outside assignment in a given laboratory because the focus of a laboratory cannot be blurred if it is to remain a viable and productive organization.

On the other hand, there are also instances where a laboratory could be transferred from one agency to another when the laboratory mission is no longer considered vital or when a new agency requires a rapid capability to satisfy a new national goal. A case in point is the space program.

The Space Act was signed into law on July 29, 1958, and thus NASA was created. The DOD transferred Project Vanguard from ONR to NASA on October 1, 1958, and the Jet Propulsion Laboratory, on December 3, 1958. On October 21, 1959, President Eisenhower approved a plan submitted by Secretary of Defense McElroy and T. Keith Glennan, Administrator of NASA, to have part of the Army Ballistic Missile Agency transferred to NASA.

These two examples certainly represent two of a number of options available to us in assuring the full utilization of laboratories. Some consideration should also be given to a different way of handling the phasing down or closure of a Federal laboratory. When a laboratory has lost its purpose or the priority of its work has diminished or disappeared, we should offer to transfer it to another agency or at least consider assigning to it other agency work if it has retained the required level of quality. I know that some people would have reservations about such a step. Their approach would be to close it down because once the laboratory has lost its purpose, it generally loses its best people first. Something can be said on both sides. There is really no magic formula. I believe one must examine this question on a case-by-case basis.

TRANSFER OF TECHNOLOGY

I also believe that we have a moral, if not a legal responsibility, to assure to the degree possible the transfer of defense-developed technology to other agencies and to new programs.

Of course, one of the best technology transfer agents we have is people. Although there are a number of major technology transfer programs within the Government, one of the simplest approaches is to motivate the mobility of people. In fact, I can cite a number of cases to illustrate my point.

Dr. E. M. Reilley, the Assistant Director for Research in my office, left us recently to become the Director of Research and Development of the Post Office Department. He brings to that position all of his background in solid state and nuclear physics, computer technology, electronics and R. & D. management which he developed both at Fort Monmouth and in OSD. What is almost as important is that he knows the on-going programs of the DOD and knows the laboratories and the people who can provide knowledge and inputs to important Post Office Department R. & D. problems.

In a similar vein, Mr. T. F. Rogers, the former Deputy Director of Electronics and Information Systems in OSD has taken the position of Director of Research and Planning in HUD. His experience at the Air Force Cambridge Research Laboratory, Lincoln Laboratory and in OSD will proivde HUD the benefit of a great deal of available technology and methodology which will be directly applicable to the technical solution of urban development problems.

I also know of many other cases of transfers of people at the laboratory level from Defense to other agencies in which they have assisted in the exploitation of Defense-developed technology.

Such situations are not limited solely to Government personnel. Contractors of the DOD, industry, nonprofits and universities are excellent sources of expertise and performance for new agencies and new programs also.

A number of our Federal contract research centers are being used by civilian agencies to help define some of their problems. Many aerospace companies are actively planning or performing programs utilizing their defense systems and technology background for HEW, HUD, DOT, OEO, et cetera. Others are working in the field of oceanography in support of Commerce and Interior needs, applying technology and know-how derived from Defense-supported program.

Such technology transfer mechanisms far transcend technology transfer through information centers. As was mentioned last year in DOD testimony before the Subcommittee on Science and Technology of the Senate's Select Committee on Small Business, there is a high degree of mobility from Defense connected industry to nondefense organizations. Our estimate is that this approaches 10,000 scientists and engineers each year. I believe that newer agencies can, with the proper motivation and judicious actions, take full advantage of these natural dynamics in the technical work force and even influence them more in the direction of their more urgent needs.

Mr. DADDARIO. You mention people of high competence who move from one department to another and between Government and industry and how the knowledge that they have developed can be directly applicable. It appears that when these men work in the Defense Department laboratories the development of weapons systems is the important thing, but that they develop a knowledge which, in fact, can be helpful in solving some of our social and economic problems even though this is not fundamentally the Defense Department's business.

What do you do about taking advantage of this knowledge that is developed, the social and economic uses to which it can be put, and how to properly utilize it and not let it wander simply because its birth is not given in an agency which can support it?

I do get concerned about this because I think the Department of Defense has developed an ability to apply knowledge quicker and to apply technology which could be directed to the solution of many of our other problems.

Dr. MACARTHUR. Let me answer that question this way.

First of all, let me deal with the work done under Department of Defense sponsorship outside the Department of Defense by the private sector which is 68 percent in private industry. I don't think there is any problem there. When we are talking about defense technology developed by industry which is applicable to the problems that other agencies have in terms of attaining their national goals because the private sector is very competitive, the situation takes care of itself. These nondefense agencies, once they define their problems, the defense industries who have the necessary expertise will exploit it to solve the problems. Industry will move quickly because it means more contracts and money for them.

Mr. DADDARIO. You are not saying that the marketplace is going to determine those things necessary to solve our problems?

Dr. MACARTHUR. I would say a great deal of them.

Mr. DADDARIO. Yes, I understand that, but the fact remains that we still have environmental pollution problems and in many instances the technology is available if properly applied to solve these problems. Therefore, the market cannot be relied upon in this particular instance. I do believe there is tremendous commercial advantage which has not evolved as yet, but the problem can run away from us unless we develop techniques to take care of it.

Dr. MACARTHUR. One of the problems is that each agency defines its problem very specifically—what they are looking for. I happen to have come from the defense industry before I came to DOD 2 years ago and what I could see with some of the non-DOD agencies, was that many times they didn't define their problems precisely enough. When the private sector comes in, and they don't have a well-defined problem staring them in the face, then they are not going to invest. It becomes necessary to come up with the answers to the problem. But understand once you have a well-defined problem, you will find that the marketplace will take care of it if the resources are available to put in the R. & D. necessary to solve it. It is a two-way street, to define the problem clearly and to let the private sector know what the problem is and then industry will attack it.

Mr. DADDARIO. You can more clearly define the problem, and my question gets back to that particular point. Where do you allow this to grow rather than depress it?

Dr. MACARTHUR. I was coming to that point a little later on in that I belive in the long run every agency has to have an in-house R. & D. capability. You just have to have it, if you are going to be most effective, you have to do some of the R. & D. yourself. You cannot solely rely on the private sector or other Government agencies.

Mr. DADDARIO. Mr. Glass, do you want to say something?

Mr. GLASS. I was agreeing with Dr. MacArthur. You need both. You need a very, very strong in-house group in order to help define your problems. I think that is part of the strength we have in the Department of Defense, the ability to define it both in technical and other terms. Once you do that and work with the industry, acting as sort of the leaders and the coaches of the private sector, you can solve these problems very rapidly together. I think you were right in pointing out the importance of a strong in-house capability in order to capitalize on the private sector.

Mr. DADDARIO. With the flexibility and the authority to do these things?

Mr. GLASS. That is right.

Mr. DADDARIO. Do you define within that authority the necessity for discretionary funds and the requirement to compete for funds and this type of thing?

Mr. GLASS. That is right. All of these factors are a part of it.

Dr. MACARTHUR. When you define technological requirements, it is not just sufficient to say we want something. In air pollution, for example, you want to define what compound you want to monitor, in what concentrations and what response time and, what kind of

gadget. That is defining the problem. It is not good enough to say that I want something to monitor air pollution.

Mr. DADDARIO. I understand that, but you are talking to a layman in this area. We can judge how you are doing after we take a look at it, and in this particular area our judgment must be that our laboratories, private and public, are not doing as well as they might.

Dr. MACARTHUR. I was coming to a statement which was not in the prepared text.

Mr. DADDARIO. Good.

Dr. MACARTHUR. Let me address myself for the moment to the problem of personnel ceilings.

PERSONNEL CEILINGS—A MAJOR DETERRENT

Probably the most serious deterrent to interagency work in R. & D. is the current system of personnel ceilings. Personnel ceilings limit the flexibility available to Federal laboratories. I believe that the elimination of manpower ceilings for cross-agency work would motivate a much greater utility of existing laboratory capabilities and would be a major step forward in achieving the objectives of this subcommittee. I would only establish financial controls but at the same time would insist upon a meaningful after-the-fact appraisal. I also believe that others are opposed to this concept because they feel that growth would be excessive and the laboratory would lose its focus toward their prime mission. But I believe that growth would be minimal.

Mr. DADDARIO. You are talking again about a reward mechanism. You would be——

Dr. MACARTHUR. I would remove the manpower ceilings for work that is done internally in an in-house lab for another agency.

Mr. DADDARIO. I see.

Mr. MOSHER. Refresh my memory on the source of these ceilings. What is the history of these ceilings?

Dr. MACARTHUR. I would like Mr. Glass to address himself to that question.

Mr. GLASS. Each agency has a manpower ceiling. I believe they emanate from the Bureau of the Budget. There is a total manpower ceiling established for the Department of Defense. Each echelon of management has to allocate a certain number of spaces or billets for each organizational entity within the Department of Defense. They cannot exceed their ceiling without going to the top, either to obtain readjustments within the Defense Department or ask to request the Bureau of the Budget for additional manpower spaces. If a piece of work comes to the laboratory from the Department of Transportation and additional manpower is required the lab cannot immediately take it on unless he drops some of his defense-related work or obtained additional ceiling. He must go up through his chain of command to get the additional manpower. It is similar to the procedure used for funds.

Mr. MOSHER. Dr. MacArthur is objecting to the rigidity of this?

Dr. MACARTHUR. I am saying if you have a laboratory fully occupied performing its own mission and everybody is busy and if they have technological expertise that can be utilized by another agency when that agency comes and asks for work to be done, the manpower restrictions that are presently applied should not be applied in such

cases. A lot of people are against this because they feel that the system would mushroom out of control. I don't personally believe this. I think Oak Ridge is an example where agencies other than the AEC have asked Oak Ridge to help them with some of their problems. I don't think Oak Ridge has grown out of control.

Another example is System Development Corporation which used to be a nonprofit organization for the Department of Defense, and a few years ago broke away from the Department of Defense at which time 100 percent of their work was for the Department of Defense. Years later over 90 percent of their work is still done for the Department of Defense and they are in the private sector.

Mr. MOSHER. What sanction has Congress given to these manpower ceilings? Have we insisted on this or have we gone along with this implicitly?

Mr. GLASS. I think the feeling of the Congress is there must be manpower controls within the Federal Government. As long as the executive branch maintains controls such as these, there is no need for specific congressional action—I think that if there were no controls exerted by the executive branch that Congress possibly would institute such controls.

Mr. DADDARIO. Recognizing that this is a problem, and that the Congress does look at it this way, would you support the idea that rather than to have this as an overall policy that certain of them be given this authority?

Mr. GLASS. I think that would be a very good approach.

Dr. MACARTHUR. Yes. I think the best ones should be given such authority.

Mr. DADDARIO. You two gentlemen are quite candid about this. Everybody else seems to shy away from it. You both give the indication that this would not be too much of a job.

Mr. GLASS. I think we have to do it.

Mr. DADDARIO. It might not be pleasant.

Dr. MACARTHUR. We have been wrestling with it for sometime.

Mr. DADDARIO. You are saying we must develop the proper techniques through which quality judgments can be made and give laboratory directors the opportunity to compete for funds, and give some of them funding limits as you have proposed rather than personnel ceilings.

Dr. MACARTHUR. Yes. This is the attack we followed last year in the Department of Defense where we have laboratories which are clearly qualitywise above others. We give them a certain degree of flexibility. We don't give to every laboratory this. This comes back to incentives and awards. The ones who don't get it say, look, we better shape up, and I think it is a very good system.

Mr. DADDARIO. There is no doubt that it would have that effect.

Dr. MACARTHUR. Yes.

Mr. BROWN. Isn't the process we are talking about similar to, for example, the evaluation of universities. The universities which have the quality and the capacity are the ones that get the research grants contracts, and it is not impossible to evaluate where this capacity for excellence exists.

Now, at the same time we are seeking to stimulate the development of what we call centers of excellence to improve the quality of our

educational institutions. A laboratory is not too distinct or too different from this, and if it is desirable to do, I am sure that the quality of a laboratory can be changed by a conscious decision to change it by the infusion of new leadership or new talent.

Dr. MACARTHUR. We certainly agree to that. I think one of our biggest problems in trying to get new and strong leadership in DOD laboratories for personnel. In Government organizations, it seems to me that the primary objective is to protect the individual's right and the secondary objectives is to the productivity of the organization. In the private sector, it is the reverse. The primary objective is the productivity of the organization, and the secondary consideration is protection of the individual's rights.

Now, under the civil service system it is very difficult to get rid of marginal people, they have to be incompetent before you can "fire" them, and it is very difficult to prove that people are incompetent. We are after a system where we can get rid of marginal people. In striving for this to achieve a higher degree of excellence, this is a very difficult job where the individual's right is protected.

Mr. DADDARIO. In one way or another this is a problem that exists everywhere, in industry as well. Many industries have some people who admittedly are incompetent and they keep them on forever.

Dr. MACARTHUR. But they don't have to.

Mr. DADDARIO. They don't have to, but they do.

Dr. MACARTHUR. I was talking about marginal people. Incompetence we can get rid of, but with fair or marginal people, it is very difficult to do anything.

And it is the same thing in a university once you have tenure, but in the industrial sector it is a little easier if you want to get rid of somebody. You can get rid of them pretty easily if the desire is there.

Mr. BROWN. This point you make is one of the main reasons where a competitive system is better. If it is a profit reward you have to get rid of those things which inhibit the profit ability.

Dr. MACARTHUR. I should add that where we have a strong laboratory director, anybody who is asked to leave or look for another job, in 90 percent of the cases they will. In 10 percent of the cases, they won't. They will say, "prove it," and then you go through various appeal mechanisms, and to get rid of one individual might take 20 percent of your energy for 1 whole year. What you do then is you develop——

Mr. DADDARIO. You insulate.

Dr. MACARTHUR. That is right.

Mr. DADDARIO. Proceed.

GUIDELINES FOR INTERAGENCY SUPPORT

Dr. MACARTHUR. I believe, in the long run, if you (as an agency) need an R. & D. capability, to be most effective you have to do some of it yourself—you cannot solely rely on other Government agencies.

My reasons are:

(1) You need people who have your interests and priorities.

(2) You need people whom you can directly control.

(3) You need people who are working in, just not watching, the technology in areas you need.

(4) You need people who can couple R. & D. results to your mission.

When a new agency begins to attack a major national problem, and begins to build the necessary R. & D. capability, it is probably necessary for it to depend primarily on other agencies and private contractors for a few years.

But I cannot overemphasize the fact that we must exercise considerable care in assigning nonagency missions to existing labs. In our review of our own DOD labs, we found generally that those which tried "to cover the waterfront" were much less productive and of lower quality than those which were focused toward a well-defined meaningful agency problem. A key objective for our new weapon centers is a specifically defined, challenging mission. The question of balance for any single laboratory must be a decision shared by both the laboratory director and his management agency. I really don't think we should attempt to set an arbitrary figure or a range. Each laboratory director must examine his own local situation to determine the level of effort he can perform for other agencies using local criteria to make this decision.

In general for busy productive laboratories with clear-cut missions, I would say the following principle applies to interagency lab support: The greater the match between the actual technical work that needs to be performed and the performer's ongoing programs, the more the laboratory can assimilate. Dr. McLean's example of his work for the Bureau of Fisheries on sonar signatures for schools of fish illustrates this point. For such cases, laboratories might be able to absorb 15 to 20 percent.

In specialized test facilities, like computer centers or wind tunnels, the percentage could be much higher depending on the capacity of the facility. On the other hand, we must recognize that each agency will have some labs that are highly specialized; for these, as much as a 10-percent diversification might be unwise or even impossible.

In summary, I believe that if the motivation and need are there, people will know or find the capabilities and unique facilities and competence in Federal laboratories. We certainly encourage others to use any of our available capability. The cross-servicing of major programs should be thought out very carefully in advance, however, so that the primary mission of a laboratory is not so diluted that performance for either their parent agency or its customer, or both, is not degraded. Modifications to our system for accounting for manpower and manpower ceilings are in need of critical review if we are to make optimum use of our in-house capacity.

There are a number of advantages in using existing Federal laboratories instead of establishing new ones: (1) avoidance of unnecessary duplication; (2) overall reduction in costs; and (3) the ready availability of expertise. There are a number of disadvantages also: (1) dilution of laboratory mission; (2) the lack of close coupling between the performing laboratory and the customer agency; and (3) the resultant lack of R. & D. continuity and experience in the new agency or program. The tradeoff among considerations such as these must be weighed carefully in determining the most appropriate course of action to be taken.

THE OFFICE OF LABORATORY MANAGEMENT

The progress we have made in the improvement in the effectiveness of our in-house laboratories stems from four factors. A continual interest of the three Directors of Defense Research and Engineering (York, Brown, and Foster) in the health of laboratories; the sustained recognition of the importance of laboratories by the Secretary of Defense over the last several years; the support of the past two Directors of the Office of Science and Technology; and finally, the establishment of an Office of Laboratory Management within the Office of the Director of Defense Research and Engineering.

Within the services, the establishment of the positions of Director of Laboratories (DOL) has been an important step in improving the quality of our laboratories and in bringing the laboratories into much closer interface with the policy levels.

I would like to insert in the record as tab D* a brief review of the origins, present functions, and some past accomplishments of the Office of Laboratory Management. Mr. E. M. Glass, the Assistant Director for Laboratory Management, who is with me, will be pleased to answer any questions the subcommittee is interested in asking him concerning his functions and activities.

The Office of Laboratory Management is the organizational arm of D.D.R. & E. with respect to in-house laboratories. Its primary purpose is to assist the Director of Defense Research and Engineering in the planning and the execution of a positive program which assures that the Defense laboratories of the future play key roles in shaping, carrying out, and administering the complex R.D.T. & E. programs upon which our defense posture depends so heavily. This office is the focal point of the DOD laboratories and has been heavily involved in most of the issues I have discussed today.

Thank you.

TAB A: DOD ACTIONS TO IMPROVE THE EFFECTIVENESS OF DEFENSE LABORATORIES

We have established new weapon centers with clear and broad responsibilities over a number of military problems and functional areas. These centers and major laboratories have been given important assignments in threat analysis and development of requirements; planning for future weapons; assessment of vulnerability of proposed major systems; and important roles in the research and development cycle. Thus the in-house laboratories are beginning to emerge not only as an R&D performer, but an important source of technical judgments and advice to the top level planners and decision makers. Here are several examples:

UNDERSEAS WARFARE CENTER

Created from NOTS (Pasadena) and elements of the Naval Electronics Laboratory, NOTS (China Lake) and an ASW Analysis Group at NOL (White Oak). This Center will be responsible for the over-all ASW systems analyses, hardware development for surface systems, system integration of air, surface and sub-surface systems and fleet engineering support. Because of the importance of this area, we are providing for three centers devoted to ASW and associated weaponry. The Naval Air Development Center (Johnsville) has been given responsibility for hardware development of airborne ASW systems. We intend to combine organizationally the Naval Underwater Weapons Research and Engineering Station, Newport, Rhode Island, with the Naval Underwater Sound Laboratory, New London, Connecticut, forming a new center for the development of sub-surface systems. In this fashion, the major ASW systems and hardware responsibilities will be focused in three principal Navy centers.

*Tab D appears starting on p. 174.

SHIPS R&D CENTER

The David Taylor Model Basin Marine Engineering Laboratory and the Mine Defense Laboratory have been combined organizationally to create a ships' R&D center. It is responsible for advanced ships concepts, high speed ships, deep ocean vehicles from research to project formulation.

A number of fragmented activities involved in similar technologies have been combined into more viable arrangements. For example, an Army Materials and Mechanics Research Center is being created from elements of eight RDT&E activities. The Secretary has approved a long-range program to consolidate ten of the Army's medical laboratories into three major medical centers.

There are always difficult administrative problems in any large organization. We believed, however, that we had more than our fair share of them. I have always felt that if we could provide the management of our Defense laboratories with the same degree of flexibility as is possible in the high technology organizations in the private sector, we could achieve an immediate and substantial improvement in effectiveness and output. With this model as our goal, we have identified a number of administrative problems and have worked hard to develop solutions for them. A large number of the problems have either been solved or we have implemented a time-phased solution for them. We have also made a major dent in the unsolved ones. The problems run the entire spectrum from recruitment, career development and training, personnel mobility, compensation, to dealing with the marginal employee. We have had a great deal of excellent assistance from the Civil Service Commission in coming to grips with these problems.

In addition, we have been concerned with such non-personnel problems as facility modification, support services, procurement, supply and laboratory maintenance. For example, greater authority has been given to Laboratory Directors in the reprogramming of funds and personnel to adjust to changing work situations. Techniques have been developed to foster greater mobility of people among technical organizations to bring the best talent to the problems as they arise. Career development programs have been tailored to meet the specific needs of scientists and engineers.

TAB B: SOME EXAMPLES OF INTER-AGENCY COOPERATION

Army

NIH and the Walter Reed Army Institute of Research jointly staff in Panama the Middle American Research Activity and carry on joint programs in indigenous diseases. The Postal Department uniforms are designed by Natick together with the research work in the textiles used in these uniforms. The Army has joint programs with the Department of Agriculture on insecticides and also joint programs between Civil Defense and Agriculture in fires and control of fires. There are also programs between AEC, Commerce and DoD in the area of irradication of food. There are many, many civil work programs conducted by the Army Corps of Engineers for other agencies.

Navy

A number of surveys are conducted at Point Barrow by the Navy for other agencies. This is part of an Office of Naval Research (ONR) program:

Agency	*Project*
U.S. Geological Survey.	Gravity Studies.
National Science Foundation.	Snow Studies.
U.S. Geological Survey.	Oil Shale.
National Institute of Health.	Arctic Biology.
Federal Aviation Agency.	Flight Service.
Interior Department.	Polar Bear Survey.
National Institute of Health.	Marine Biological Chemistry.
Department of Agriculture.	Diseases of the Caribou.
Public Health Service.	Zoonotic Diseases.
Bureau of Standards.	Ionospheric Studies.
Coast and Geodetic Survey.	Geodetic Management Surveys.

Other examples of inter-agency cooperation are listed below:

National Health Institute—Pays ONR to operate the Tissue Culture at Naval Biological Lab at Okland, Calif.

Interior contributes to an Oceanographic Project of the Navy.

Other types of fund transfers:

Recently ONR transferred money to Geological Survey for specialized project—Trace Analysis in Water.

National Bureau of Standards—transfer of funds to NBS for various research projects for ONR.

David Taylor Model Basin—Navy work for Maritime Administration, Coast Guard, private sector, etc., on reimbursable basis.

In the shipbuilding business, private industry and Coast Guard—exchange of computer aided ship design.

Air Force

Work performed for FAA.—The Air Force Materials Laboratory performed a huge effort in support of the Super-Sonic Transport (SST), amounting to $3.2 million. The work included such efforts as the following:

Screening test program for evaluation of stress corrosion susceptibility of alloys under consideration for skin materials.

Laminating Resins.

High temperature hydraulic fluids.

High temperature seal and sealant materials.

Screening tests and evaluation of lubricants for propulsion and secondary power systems.

Performance of jet engine fuels.

Fatigue behavior of materials.

The Air Force Flight Dynamics Laboratory redesigned the nose cone of the total inflight simulator (TIFS) vehicle in support of the SST program.

The Air Force Aeropropulsion Laboratory.—Carried out an engine component development program in support of the SST.

Defined a suitable jet fuel specification for the SST.

Defined a jet lubricant for the SST.

Investigated crash fire prevention techniques for the SST, including development of a high temperature extinguishing agent.

The Air Force Weapons Laboratory performed work to determine dose, dose rate and depth, dose patterns of high altitude radiation and its hazard to pilots and passengers.

The Aeromedical Research Laboratory performed studies to determine injury patterns arising from the use of different types of restraint harnesses.

Work performed for the Food and Drug Administration.—The Aeromedical Research Laboratory performed studies to evaluate the biological and pathological effects of drugs.

Work performed for the Department of Transportation.—The Aeromedical Research Laboratory performed work on an anthropometric definition of vehicle safety in which the relationship of size and design of passenger compartments affects safety at impact.

Work performed for the National Bureau of Standards.—The Aeromedical Research Laboratory performed dynamic testing of seat belts.

Work performed for the National Science Foundation (NSF).—The Air Force Cambridge Research Laboratories participated in a cooperative program sponsored by the NSF in Project Hailswath. The program was concerned with hailstorm modification.

The Air Force Cambridge Research Laboratories (AFCRL), participated in a cooperative program for the Cerro Tololo Inter-American Observatory in Chile, AFCRL funded the 16-inch and 60-inch telescopes and the NSF funded the domes.

Tab C: National Policies for the Use of Federal Laboratories

Much of the legislation which established the function of Department of Defense and the Military Departments contains language which either permits or fosters the use of services of other agencies.

The general authority authorizing agencies to perform work for another agency is the so-called Economy Act which states "any executive department . . . if it is determined by the head of such executive department . . . may place orders with any other such departments . . . for materials, supplies, equipment, work, or services of any kind that such requisitioned federal agency may be in a position to supply or equipped to render and shall promptly pay . . . the estimated or actual cost thereof as determined by such department . . as may be requisitioned." (31 U.S.C. 686(a)). In addition, 41 U.S.C. 23 provides "all orders or contracts for work or material or for the manufacture of material pertaining

to approved projects heretofore or hereafter placed with government-owned establishments shall be considered as obligations in the same manner as provided for similar orders or contracts with commercial manufacturers or private contractors."

Frequently, there exists general authorization for cooperation between a specific agency and all other agencies. For example, NASA by statute may use the services, equipment, personnel and facilities of federal agencies with or without reimbursement and on the similar basis cooperate with agencies in the use of services, equipment and facilities. Each federal agency is also directed to cooperate fully with NASA. (42 U.S.C. 2473(6)) AEC may utilize services and personnel of another agency (42 U.S.C. 2201(f)) and the FAA has similar authority with respect to facilities, equipment and personnel of civilian and military agencies. (49 U.S.C. 1343). The National Bureau of Standards is also directed to cooperate with other government agencies in the establishment of standard practices incorporated in codes and specifications. As may be seen, there is both general and specific authority for interdepartmental cooperation to conduct research.

As far as executive statements of policy pertaining to the utilization of federal facilities, Executive Order 10521, as amended, dated March 17, 1954 is perhaps the most basic statement concerning the efficient use of federal equipment and facilities:

"Sec. 8. To facilitate the efficient use of scientific research equipment and facilities held by Federal agencies:

"(*a*) the head of each such agency engaged in scientific research shall, to the extent practicable, encourage and facilitate the sharing with other Federal agencies of major equipment and facilities; and

"(*b*) a Federal agency shall procure new major equipment or facilities for scientific research purposes only after taking suitable steps to ascertain that the need cannot be met adequately from existing inventories or facilities of its own or of other agencies; and

"(*c*) the Interdepartmental Committee on Scientific Research and Development shall take necessary steps to ensure that each Federal agency engaged directly in scientific research is kept informed of selected major equipment and facilities which could serve the needs of more than one agency. Each Federal agency possessing such equipment and facilities shall maintain appropriate records to assist other agencies in arranging for their joint use or exchange."

In addition, Executive Order 10807, as amended, dated March 13, 1959 creates the Federal Council for Science and Technology which provides as a function of the council the consideration of problems and development in the fields of science and technology including "to achieve more effective utilization of scientific and technological resources and facilities of federal agencies, including the elimination of unnecessary duplication."

Finally, the report to the President on Government Contracting for Research and Development dated April 30, 1962 (The Bell Report) also provides a basic statement concerning the role of federal laboratories in the conduct of research and development. The Bell Report has been our most authoritative source of guidance since 1963.

Tab D: The ODDR&E Office of Laboratory Management

The Office of Laboratory Management was formally established in September of 1965. The functions it assumed at the time of its establishment were performed prior to that time on an ad hoc or special arrangement basis.

Although concern for the quality and productivity of Defense laboratories goes back many years, great impetus was given to this question in 1961 when the DoD began taking a hard look at its in-house capability.

When Mr. McNamara became Secretary of Defense in 1961, he asked 120 questions to provide the basis for the future posture of the Department of Defense. Question 97 was: "Advise me ways in which to improve the operations of the in-house laboratories." To answer this question and to develop solutions to problems that might arise, a task force was set up with the title of "Task 97."

Task 97 visited many laboratories, talked to many people, and turned in a report which was endorsed by Mr. McNamara by his memorandum of 14 October 1961. In this memorandum, he reiterated the importance of in-house laboratories to furthering the Department of Defense's mission and proposed a number of

positive actions to be taken by the Military Departments to upgrade their in-house capabilities. Out of this came—

1. A sensible approach to taking full and complete advantage of the PL–313 provisions and a more rational approach to compensation rates under this authority.

2. The establishment of a Laboratory Director's Fund for work judged by the laboratory director to be of promise or importance, with only after-the-fact review by higher authority.

3. The pinpointing or responsibilities with the Assistant Secretaries (R&D) of the Military Departments for the health and environment of the in-house laboratories.

However, other actions recommended were not implemented as readily. These included: (1) that Department of Defense (DoD) in-house laboratories would be used as a primary means of carrying our Defense Department programs; (2) delegating greater decision-making authority to the laboratory directors; (3) solving the many administrative difficulties that prevented laboratories from being as effective as they should be; and (4) establishing clear lines of technical management and responsibility for each in-house laboratory.

Just as Task 97 was completing its report, the Bureau of the Budget began organizing an interdepartmental task force to study the problems of government contracting for R&D. This activity, which must be familiar to most of you, became the first broad Executive Branch Policy on R&D activities in the history of this country.

This "Bell report," [1] superimposed upon the Department of Defense findings, placed even greater emphasis on taking constructive actions in many areas. In fact, the Bell Report specifically cited this task force's activities as an appropriate procedure to follow.

On 30 March 1963, the Director of Defense Research and Engineering, reconstituted "Task 97" as the "Task 97 Action Group," in recognition of the fact that strengthening the in-house laboratories "is not only a matter of study but one of action." Its concept of operations was to establish a core of permanent members, generally six, with the responsibility for its continuing operation. These members were from ODDR&E staff and from the Office of the Assistant Secretaries (R&D) of the Military Departments. Additional members, problem-area specialists, were to be added, depending upon the problem being examined. Also every level of management was represented in all visits to laboratories so that, as a problem was raised, we could follow the problem up the chain of command on the spot and either obtain an immediate solution or find a basis for pinpointing an individual for action. It also provided a rare opportunity to communicate the rationale behind many decisions to the people directly affected—the laboratory personnel.

The "Task 97 Action Group" dealt with many administrative problems affecting the creative climate of laboratories. Listed below are several examples of the actions which resulted from the activities of the Group:

Important input, based upon specific examples, was provided to the Civil Service Commission, and thus had direct influence upon many features of the Salary Reform Act of 1962 and subsequent legislation.

Some relief was obtained for laboratories in securing foreign periodicals and scientific equipment vis-a-vis the gold-flow problem.

Security review of scientific papers was delegated to the laboratory level.

New policies relating to air-conditioning equipment or laboratories, treating them the same as any other type of technical equipment, were established.

There were more favorable interpretations of the Government Employees Training Act, 7 July 1958, particularly in the restrictions on the 1-year-in-10 rule.

The need for some relief in the rigid manpower ceilings to enhance training and career development was dramatized. This is now represented by central pools of manpower spaces and dollars to support technical training without hampering laboratory operations.

Block funding or "core funding' of Air Force laboratories in Research and Exploratory Development.

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[1] Bureau of the Budget (David E. Bell, Director), *Report to the President on Government Contracting for Research and Development,* 30 April 1962.

Special assistant for laboratories

During 1964 it became increasingly apparent that the Task Force approach to handling "The Laboratory Problem" had about run its course. A consensus was developing to the effect that the in-house laboratories lacked meaningful problems, management stability and prominence, and recognition, and they also failed to impact at the highest policy levels. While administrative improvements were valuable and should be pursued diligently, they were not considered, in themselves, sufficient to make laboratories effective tools of the organizations they served.

A position of "Special Assistant for Laboratories" was created in the Office of the Deputy Director, Research and Technology to assist in planning the future of the DoD laboratories and to develop policies concerning their operations. The functions for this position were stated in the form of a series of questions:

1. On what scientific and technical efforts should the Department of Defense put it greatest effort? Its least?
2. What laboratories are to be expanded or upgraded for the foreseeable future?
3. Are any to be phased out or discontinued?
4. What new laboratories should be created? Or what missions of existing laboratories should be changed significantly?
5. How should the laboratories be organized?
6. How should laboratories interact with other RDT&E performance and the decision-making process?
7. What administrative reforms are needed for laboratories?

It is the answers to questions such as these which make it possible to set priorities, to plan laboratories' expansion and construction on an orderly basis and to relate them to programs, money, people, workloads and facilities.

As a result of the initial studies recommending new organizational concepts for Defense laboratories, Dr. Brown, then the Director of Defense Research and Engineering, currently the Secretary of the Air Force, formally established the Office of Laboratory Management in 1965.

Organizational relationships of Defense laboratories

I think that we must first establish the relationship between DDR&E and the in-house laboratories before we can discuss functions of the Office of Laboratory Management in a meaningful way. Almost without exception, the in-house laboratories are organizationally integrated into the Service structures, some at high levels, such as the Naval Research Laboratory, others at relatively low levels like the Army's Night Vision Laboratory at Fort Monmouth. None of these laboratories have a direct line relationship with DDR&E. Their financial support is derived from the programs approved by DDR&E but the operation of these laboratories is under the control of the Military Departments. Each of the Military Departments has a Director of Laboratories, or equivalent, who is directly responsible for the quality and productivity of his Service's laboratories. Each Director of Laboratories has ready access to his Assistant Secretary (R&D) who sets the over-all RDT&E and laboratory policy for his Service.

Because of the important of Service laboratories in carrying out the Defense RDT&E mission and related activities, DDR&E plays a vital role in establishing the policies and objectives for these organizations. These are placed into effect by the Assistant Secretaries (R&D) and the Directors of Laboratories. They also utilize the laboratories as a source of expertise and advice in the decision making process.

DDR&E is directly involved in many activities affecting the RDT&E of two or more Services, however. Also, his duties include the "directing, controlling, assigning, and reassigning research and engineering activities that the Secretary considers needs centralized management". The area of laboratory management has been designated by the Secretary as requiring DDR&E's attention and concern.

Functions

The Office of Laboratory Management is the organizational arm of DDR&E with respect to in-house laboratories. Our primary purpose is to assist DDR&E in the planning and the execution of a positive program which assures that the Defense Laboratories of the future play key roles in shaping, carrying out, and administering the complex RDT&E programs upon which our Defense posture depends so heavily. An important aspect of this is to see that laboratories are intimately involved in the mainstream of urgent Defense needs, providing the

solutions to vital problems and offering technical judgments highly relevant to the needs of top level planners and decision-makers.

While these words may at first sound much too general to have much meaning, they truly represent the goals and the "job description" for the office. It interacts on a continual basis with the Service Directors of Laboratories and with the Offices of the Assistant Secretaries (R&D). It is considered the "Washington Representative" of the in-house laboratories and it tries to represent their positions and points of view at the corporate level. It is a "champion" for laboratories within the DoD.

The scope of activity varies from minutia to major problems directly affecting the productivity of technical organizations. During the earlier phase of its development it concentrated on the development of a quantitative data base for laboratories which would give DDR&E insight into current and planned operations of these organizations and to provide a sounder basis for action. Working with our Army counterparts, it assisted in the development and approval of an Army 10-year plan for its laboratories. Its activities in refining the "weapon center concept" helped the Navy develop and place into operation an organizational plan, which we expect will pay many important dividends in the future of the Navy. Its close working relationship with the Air Force has resulted in a number of innovations which have strengthened the Air Force's in-house capability. Much of its effort is motivational and indirect. An important role is acting as the "conscience" of the R&D community of the DoD, the pre-testers of new ideas and innovations about laboratories.

It is the focal point for special studies aimed at improving the productivity, environment and utilization of laboratories. As a result of its recommendations, a number of laboratories has been phased out, consolidated or rejuvenated. It has been the interface with the Civil Service Commission in attempting to set the required personnel climate for technical organizations. It has played an important part in helping to define the role of laboratories in transition of laboratory-developed systems and equipment from development to production. These are but a few examples of the kinds of activities in which it is involved.

We should not leave the impression that the Office of Laboratory Management is the sole source of improvements in our in-house laboratory system, as this is far from the truth. It takes many people and organizations to achieve the goals established for improving the DoD laboratories. Its principal job is to provide the required degree of leadership and "coaching" which will assure that we are going in the right direction and at the proper pace.

Progress in the solution of laboratory problems has been gratifying during the past two years. Solutions to problems once thought to be unattainable are on the horizon, or well in hand. We seem to have gained a great deal of momentum particularly in the past six months which will have tremendous impact upon our Defense capabilities in the years ahead. It is the job of the Office of Laboratory Management to see that our progress continues.

Mr. DADDARIO. Thank you, Dr. MacArthur. It is a very excellent statement and your discussion about it has been extremely helpful.

Mr. Brown?

Mr. BROWN. How do you distinguish, if you do distinguish, between these two ambiguous terms of basic research and applied research as far as the laboratories are concerned?

Dr. MACARTHUR. Sure. Well, basic research, we define it as that research that is carried out to develop new knowledge.

Applied research is research that is carried out to solve a problem.

Now, though we don't think that research should be carried on for research's sake in the Department of Defense, we do support basic research that is relevant to our needs. That is, we support basic research that develops new knowledge in areas of prime interest to us and so research can be both basic and relevant.

Mr. BROWN. Basic and relevant to a mission?

Dr. MACARTHUR. Or a technological problem, because in many mission areas we have technological problems and the only way we can solve them is by having more basic knowledge in that particular area

before you know how to go about solving it. In developing that knowledge is basic research and it is relevant because it is directed toward getting more information that will help us in solving this technological problem that we have.

Mr. BROWN. Have you figured any way of estimating relative levels of effort or dollars in these two areas? Do you make an effort to do so for budgetary or planning purposes or anything of that sort?

Dr. MACARTHUR. A quantitative measure of how much you should spend in basic research is very difficult, even in the private sector.

Let's take the private sector. Private industry which has a good measure of success, a profit-and-loss statement, has been struggling with this problem for many years, and you will find that they haven't come up with a magic formula as to how much they should put in research. It is strictly intuitive and to a certain extent based on what they can afford to put in from their profit margin for that year. The way we go about it is we look at each area and get an idea of what the problems are, what the opportunities are and how much we feel is necessary to capitalize on what we have. I must say it is a qualitative judgment of how much should be spent in basic research.

Mr. BROWN. This would vary from laboratory to laboratory also, I presume?

Dr. MACARTHUR. Yes, indeed. Some of our laboratories like NRL do a great deal of basic research, other laboratories do very little basic research. It depends on the mission of the laboratory, it depends on how much they are doing with universities.

Mr. BROWN. When you brought up this question of 3 to 6 percent discretionary funds, the thought occurred to me as to whether this could or is used on basic research or whether it is all directed at some developmental type of problem.

Dr. MACARTHUR. Well, let me answer that question this way. Although the money that we give in discretionary funds comes out of our research budget category we also give the lab director the freedom to spend it on basic, applied, or technological problems. We don't attach any strings to it because in certain cases some of the most successful work—because you can see a product at the end of the work—comes out of the applied work.

On the other hand, some very good scientific work has been done with this type of money. It is up to the individual lab director how he will utilize it. This determination, and its success determines how much he gets the following year.

Mr. GLASS. I would say about 30 percent of the dollars are at the very fundamental end of the spectrum, about 70 percent of these discretionary funds are used in the more applied area.

Mr. BROWN. The examples you gave, and this is probably good judgment in the situation since you are presenting it to Members of the Congress, the examples dealt with hardware results.

Dr. MACARTHUR. That is right, more componentry than fundamental work.

Mr. BROWN. But there are, I suspect, many examples of basic research which is difficult to evaluate, and I presume you have the responsibility to evaluate the excellence of new knowledge?

Dr. MACARTHUR. The quality of the work.

Mr. BROWN. Yes; as well as the hardware results which might develop.

Dr. MACARTHUR. That is very true. Hardware innovations that come out of basic research usually come 5 to 10 years later so you have got to wait for a period of time to see what the result of that work is. At the time the work is done, you just have to go on the quality of the work, and its relevance, in general, to DOD's needs.

Mr. BROWN. So you consider this factor when you are making your continuing evaluation process? It seems to me it would be rather difficult to look at a man engaged in some fundamental research at the end of a year and say, well, you have not produced any results. Basic research does not conform to that kind of a pattern.

Dr. MACARTHUR. That is right.

On the other hand, any lab director who comes in and says I spent all my discretionary funds on basic research and don't expect any answer for 7 or 8 years; we would not look very kindly on that.

Mr. DADDARIO. Mr. Mosher.

Mr. MOSHER. No questions.

Mr. DADDARIO. We have a series of questions which I will ask you to answer for the record, if I may.

Dr. MACARTHUR. I will be very happy to, sir.

Mr. DADDARIO. We would like to hear our next witness. We already have extended the time beyond which we had intended, but we appreciate your testimony and the comments of Mr. Glass. We will be in touch with you so we can fill out these questions for the record.

Dr. MACARTHUR. We will be very happy to. Thank you.

QUESTIONS SUBMITTED TO DR. DONALD M. MACARTHUR BY THE SUBCOMMITTEE ON SCIENCE, RESEARCH AND DEVELOPMENT

Question 1. In your testimony you indicate that one reason why industry has not become more involved with national problems such as crime or pollution is that government agencies have not defined the problems precisely enough. What do you propose to remedy this problem? How would you define problems with a large social factor involved so that industry could participate?

Answer. All mission-oriented agencies should have a supporting R&D program to improve their capability, to perform their missions more effectively and to define their specific needs. There is a general *misconception* that supply and demand, and the profit motive, will *always* lead industry to orient their efforts toward developments that will improve the agencies' operational capability. There are too many important situations where ths type of motivation just did not produce the desired results. In fact, legislative or executive action (or the anticipation thereof) by state and federal governments in areas such as pollution and health compelled industry to take the required action.

If industry is to be expected to invest its own resources, the specific technical goals to achieve the broad needs of governmental agencies have to be clearly delineated. These technical goals should include criteria and specifications for the developed products that will meet the agencies' needs. In the absence of specific technical goals and performance specifications, there is less incentive for industry to invest their own resources because of the high risks involved. Industry might, for example, be faced with a situation where they have invested substantial R&D funds to develop a product they think an agency needs, but if the agency has not defined its technical needs, product-development is clearly a high-risk venture. Government agencies do not need to guarantee production except in unique situations. In fact, such guarantees might inhibit long-range innovation and short-range competition. But the government must provide both direction and incentive for private participation.

Clearly, the next question is how to define the technical goals applicable to the complex social problems facing the country today. A "systems approach" can help to define our "operational" needs and the technologies to meet those needs. DoD and NASA have sucessfully developed systems techniques over the years

with the help of industry and Federal Contract Research Centers like RAND. Depending on the problem, these analyses require the application of many disciplines, including economics, sociology, physics, chemistry, and the engineering fields, But once these analyses are "complete"—alternatives considered, needs defined, and government departments committed to pursue these needs—industry would have a clear goal, an end point towards which its privately financed research and development efforts might be directed.

There are at least two general approaches to defining problems "with a large social factor involved". First, the government systems study teams should include social and behavioral scientists, consider alternative incentives for industrial participation, recognize policy constraints within the government by frequent interaction with senior officials, and, most important, should follow-up initial studies with research/evaluation so that the social-technological issues are continuously re-evaluated. Just as we have not yet exploited our industrial-technological capabilities for solving national domestic problems, we do not yet understand fully the limitations on "technological fixes" in many social situations. So social scientists should be involved in a continuing R&D effort.

Second, larger industrial firms having plants throughout the country could be encouraged to work directly with local and state governments to "define a problem" in a way that makes it meaningful locally and solvable by the industrial groups available and affected. After such a decentralized analysis, the Federal Government could provide incentives in the form of tax exemptions on "seed money" for pilot work by industry, and then could consider the degree to which the "local solutions" could be applied nationally. Thus, the "large social factor" would be introduced and evaluated locally, with industry directly, and without some of the policy constraints found at the Federal level.

Question No. 2. The Department of Defense has a well established system to rate the performance of its contractors that supply research and development. Would you please explain what this system is and how it works? To what extent does, or should, the Department use this system in appraising the work of its own laboratories? What other approach do you take?

Answer. The Contractor Performance Evaluation (CPE) program (Dod Directive 5126.38) is a system designed to provide an orderly and uniform technique of determining and recording the effectiveness of contractors in meeting their contractual commitments principally for hardware development and production contracts. The program provides a long-term incentive to contractors by creating within the Government a "memory" of their performance and means for considering this record in future actions relating to source selections and negotiations.

CPE reports are prepared by system/project managers for certain defense contracts. (See Tab A to this question for sample format.) The first report covers the period from the date of contract award to no later than one year after the award date. Subsequent reports are prepared at intervals of six months and upon completion or termination of the effort. These reports are submitted to the Services' Contractor Performance Evaluation Groups. The reports are reviewed to assure that meaningful time, cost and technical performance data have been clearly and objectively reported. The contractor also reviews the report and makes comments as he desires. The report is then returned to the CPE Group who makes a final review and resolves any mistakes of fact. The CPE Group may also make any independent field investigations that are considered necessary. The report is then sent to the Defense Documentation Center for storage and issue of performance evaluation reports for Source Selection Boards, etc.

For those contracts where the end product is new technology or new scientific findings, CPE can be utilized, if the Military Departments consider it desirable. However, a less formal evaluation of such contracts is generally utilized. This is usually in the form of a subjective appraisal by the project monitor.

The CPE System appears to be most suitable for evaluating specific programs for which there are meaningful performance standards and mileposts. I might add that similar criteria are utilized to evaluate the hardware development laboratories, although in a different form. In other words, the CPE System is designed to evaluate performance on a specific well-defined project or program. Its purpose is not to evaluate over-all organizational effectiveness.

Much of the work of Defense laboratories is in the areas of long-range research and technology. Thus, a system such as CPE would not be generally applicable. One advantage we see in the establishment of military problem oriented weapon centers is that the utility of their output can be measured fairly

directly almost on a real-time basis. Practically everyone knows and can measure the tremendous productivity of a NOTS, China Lake. Its output goes directly into the military inventory. On the other hand, the output or product of a research laboratory is much more difficult to assess. Many years may pass before the utilization of new science or technology can be measured meaningfully.

The principal method used for Defense laboratories is peer rating or evaluation, either by in-house people, those on the outside, or combinations of both. This is only part of the story, however. Program evaluation in terms of need, priority, technical content, and similar factors probably have a greater bearing upon the appraisal of laboratories than direct institutional evaluation. Through program evaluation, one usually makes decisions on resource allocation which ultimately determine the future of that laboratory responsible for the program execution.

TAB A—QUESTION NO. 2—SAMPLE CPE FORMAT USED FOR TRAINING EVALUATION

EVALUATION OF THE EDEN MISSILE CONTRACT

The following forms constitute a possible solution to your classroom project. Schedule and technical performance parameters most indicative of total contractual performance were selected. Normally, these criteria would have been listed on the evaluation plan.

FORM 1441—Contract Brief

This form identifies the contract being evaluated and describes in broad terms the kind of development or production being purchased, the technological and state-of-the-art problems involved, and the respective responsibilities of the contractor and the Government for furnishing major systems and equipment. On the reverse of this form is space for extended comments. No continuation sheet for the Contract Brief is permitted.

FORM 1446–1—Technical Performance

This is used to list the items selected for technical evaluation. The original contract commitment, adjusted by modifications and pending changes, but excluding performance losses for which the contractor is responsible, is displayed so as to show the "net" contractual performance requirements. Actual performance is then stated, and the variance between requirement and accomplishment is computed.

Known reasons for significant variances should be briefly recorded on the reverse of the form, as well as other entries that require collateral explanation. If the significance of the parameters selected is not self-evident, it should be briefly explained there. Report no more than 30 technical parameters (15 are usually enough).

FORM 1446–2—Schedule Performance

This form is used to list the items selected for schedule evaluation. The original commitment, adjusted through contract modifications and other changes for which the contractor is not responsible, is compared with the actual delivery or completion date, and the resulting variance is recorded.

Schedule goals are expressed as the number of months (Computed by dividing the number of days by 30) required to deliver an item or complete an event and are computed from the starting date to the date of actual accomplishment. Residual variances are then expressed as the number of months late or early. These figures should be rounded to the nearest month unless such a variation is critical to the project.

Known reasons for variance should be explained on the reverse of the form, as well as other entries that require collateral explanation. If the significance of the parameters selected is not self-evident, it should be briefly described there. Report no more than 30 schedule items or milestone events (15 are usually sufficient).

Form 1446–3—Cost Performance

This form is used for recording the cost performance of a contractor at the time of evaluation.

Since cost data are recorded in the aggregate, specific entries may require collateral explanation or enlargement to insure an objective evaluation. For example, when performance, schedule and cost incentives in fixed-price-incentive

or cost-plus-incentive-fee contracts, as well as value engineering provisions, constitute part of the contract price, these elements should be appropriately recognized on the reverse of the form. Also, reasons for significant variations between "net" contractual commitments and "actual" price data should be discussed.

Form 1446–4—Narrative

The major portion of the CPE report is devoted to the recording of factual data on the contractor's performance. In the Narrative, the opinion of the system/project manager is invited, since the information requested can only be obtained in this manner. Here also, the system/project manager may briefly explain data presented on other forms. His comments must not conflict with any data reported on DD Forms 1446–1, –2 or –3. No continuation sheets may be used to extend the Narrative.

SUMMARY OF EVENTS

NAME OF CONTRACTOR EDEN MISSILE COMPANY CONTRACT NUMBER 72-S142

Project Name DEIMOS MISSILE Period 1 May 65 - 10 Oct 67

EVENT NUMBER	DESCRIPTION OF EVENT	AMOUNT OF CHANGE	CATEGORY OF RESPONSIBILITY	STATUS OF CHANGE	REFERENCE DOCUMENTS
(1)	(2)	(3)	(4)	(5)	(6)
1	Gross Mtr Wt Target-Increase	150 lbs	Gov.	FIRM	Mod. 8
2	Case OD - Increase	2.5 cm	Gov.	FIRM	Mod. 8
3	20th Flgt Test Mtr OD Test Base - Extension	2 months	Gov.	FIRM	Mod. 9
4	Oper Explosive Class Program Plan-Extension	6 months	Gov.	Pending	Mod. 10
5	Cost Increase-Schedule	$2.0 M	Contractor	FIRM	Mod. 11
6	Cost Increase-Mtr Wt	$1.2 M	Contractor	FIRM	Mod. 12
7	Cost Increase - Design	$2.2 M	Gov.	FIRM	Mod. 13
8	Cost Increase - Design	$0.56 M	Gov.	Pending	Mod. 14

CONTRACTOR PERFORMANCE EVALUATION REPORT

CONTRACT BRIEF

1. CONTRACTOR'S NAME AND LOCATION: Solid Rocket Division, Eden Missile Company, Detroit, Michigan

REPORT CONTROL SYMBOL: DD-I&L(SA)699

PAGE 1 OF 6 PAGES

2. DATE (From - To): 1 May 65 - 10 Oct 67

3. CONTRACTOR'S PROJECT OFFICER: Mr. George Richards

4. ☐ ADV. DEV. ☒ ENG. DEV. ☐ OPERATIONAL SYSTEM DEV. ☐ PRODUCTION ☐

5. COMMAND, AGENCY, OFFICE AND LOCATION: Logistics Command, R&D Agency, Missile Office, Kansas City, Missouri

6. TYPE OF REPORT: PERIODIC — TERMINAL: X

7. CONTRACT NUMBER: 72-S142

8. ORIGINAL CONTRACT DATE(S) a. AWARD	b. EFFECTIVE	9. ORIGINALLY SCHEDULED COMPLETION DATE	10. CURRENTLY SCHEDULED COMPLETION DATE	11. ACTUAL COMPLETION DATE	12. TYPE OF CONTRACT
1 May 65	1 May 65	15 Feb 68	15 Feb 68	15 Dec 67*	☐ CPFF ☒ CPIF ☐ FPI ☐ FP ☐ OTHER

13. ORIGINAL CONTRACT PRICE ($ Millions)	14. CURRENT CONTRACT PRICE ($ Millions)	15. ACTUAL COST ($ Millions)
39.24	45.2	45.656**

16. SYSTEM/PROJECT NAME	17. PROGRAM ELEMENT AND RDT&E PROJECT NUMBERS	18. MAJOR END ITEM
Deimos Missile	654-321	First Stage Motor

19. BRIEF DESCRIPTION (What it is, its purpose, technology involved):
a. BRIEF STATEMENT OF CHARACTERISTICS OF MAJOR END ITEM.
b. STATE-OF-THE-ART ADVANCES REQUIRED OR NOT: COMPARATIVE DIFFICULTY: TECHNOLOGY THAT MUST BE DEVELOPED.
c. DEPENDENCE UPON GOVERNMENT-FURNISHED EQUIPMENT, DATA OR OTHER SUPPORT.

* Completion date estimated from the present rate of progress

** Estimated final price (including incentive fees) subject to final audit

(If additional space is required, continue on reverse side.)

20. EVALUATOR

NAME (Type)	SIGNATURE	TITLE	DATE

THIS REPORT CONSISTS OF _____ PAGES, ASSEMBLED IN THE ORDER PREPARED.

DD FORM 1 JUN 66 1446 PREVIOUS EDITION MAY BE USED.

CONTRACTOR PERFORMANCE EVALUATION REPORT			TECHNICAL PERFORMANCE	REPORT CONTROL SYMBOL DD-I&L(SA)699
CONTRACTOR'S NAME: Eden Missile Company	CONTRACT NUMBER: 72 - S142	PERIOD OF REPORT: 1 May 65 - 10 Oct 67		PAGE 2 OF 6 PAGES

LINE NO.	TECHNICAL PERFORMANCE INDICATOR ITEM a	UNIT b	COMMITMENT ORIGINAL c	COMMITMENT AS ADJUSTED CONTRACTUALLY d	COMMITMENT AS ADJUSTED PENDING e	PERFORMANCE ACTUAL f	PERFORMANCE VARIANCE (Contractor's responsibility) Col f − Col e g
1	Total Impulse (Minimum)	lb-sec	1,500,000	1,500,000	1,500,000		
	Total Impulse (Target)	lb-sec	1,600,000	1,600,000	1,600,000	1,700,000	100,000
	Total Impulse (Maximum)	lb-sec	1,700,000	1,700,000	1,700,000		
2	Average Thrust (Mean)	lb	38,000	38,000	38,000	44,000	6,000
3	Delivered Specific Impulse	$\frac{\text{lb-sec}}{\text{lb}}$	100	100	100	100	0
4	System Mass Fraction	--	0.7000	0.7000	0.7000	0.7090	0.0090
5	Gross Motor Weight (Minimum)	lb	4,600	4,600	4,600		
	Gross Motor Weight (Target)	lb	4,900	5,050	5,050	5,000	50
	Gross Motor Weight (Maximum)	lb	5,200	5,200	5,200		
6	Propellant Weight (Mean)	lb	4,800	4,800	4,800	4,800	0
7	Case Outside Diameter	cm	63.5	66.0	66.0	66.0	0
8	Design Acceleration (Minimum)	g	8	8	8		
	Design Acceleration (Target)	g	10	10	10	10	0
	Design Acceleration (Maximum)	g	12	12	12		

DD FORM 1 JUN 66 1446-1 PREVIOUS EDITION MAY BE USED.

CONTRACTOR PERFORMANCE EVALUATION REPORT				SCHEDULE PERFORMANCE	REPORT CONTROL SYMBOL DD-I&L(SA)699		
CONTRACTOR'S NAME: Eden Missile Company		CONTRACT NUMBER: 72 - S142		PERIOD OF REPORT: 1 May 65 - 10 Oct 67	PAGE 3 OF 6 PAGES		
LINE NO.	ITEM TO BE DELIVERED OR MILESTONE EVENT	COMMITMENT (Months from contract starting date)			PERFORMANCE		
		ORIGINAL	AS ADJUSTED		ACTUAL (Months from contract starting date)	VARIANCE (Contractor's Responsibility)	
			CONTRACTUALLY	PENDING		MONTHS (Col e - Col d)	PERCENT (Col f / Col d * 100 = %)
	a	b	c	d	e	f	g
1	Program Plan Submitted	5	5	5	8	3 LATE EARLY	60 LATE EARLY
2	Final Flight Readiness Motor Model					LATE EARLY	LATE EARLY
	Specification Submitted	7	7	7	10	3 LATE EARLY	43 LATE EARLY
3	R&D Flight Test Motor Model Final					LATE EARLY	LATE EARLY
	Specification Submitted	10	10	10	13	3 LATE EARLY	30 LATE EARLY
4	First Flight Test	13	13	13	16	3 LATE EARLY	23 LATE EARLY
5	Ship Inert Ground Test Motor #4	22	22	22	23	1 LATE EARLY	5 LATE EARLY
6	20th Flgt. Test Mtr. OD Test Base	23	25	25	24	1 LATE EARLY	4 LATE EARLY
7	Approve operational transportation					LATE EARLY	LATE EARLY
	and handling Program Plan	23	23	23	23	0 LATE EARLY	0 LATE EARLY
8	Ship Inert Ground Test Motor #5	25	25	25	24	1 LATE EARLY	4 LATE EARLY
9	Approve Operational Explosives					LATE EARLY	LATE EARLY
	Classification Program Plan	21	21	27	27	0 LATE EARLY	0 LATE EARLY
10	Tactical Design Completed	29	29	29	NOT MET	LATE EARLY	LATE EARLY
11	Complete Qualification Test	31	31	31	29	2 LATE EARLY	6 LATE EARLY

DD, FORM 1446-2 PREVIOUS EDITION MAY BE USED.

CONTRACTOR PERFORMANCE EVALUATION REPORT	COST PERFORMANCE	REPORT CONTROL SYMBOL DD-1&L(SA)699
		PAGE 4 OF 6 PAGES
CONTRACTOR'S NAME: Eden Missile Company	CONTRACT NUMBER: 72 - S142	PERIOD OF REPORT: 1 May 65-10 Oct 67

PART A - PERIODIC EVALUATION - OVERRUN/UNDERRUN STATUS

TARGET PRICE			TOTAL TARGET PRICE	VARIANCE (Contractor's Responsibility)	
	AS ADJUSTED				
ORIGINAL (a)	CONTRACTUALLY (b)	PENDING (c)	(d)	AMOUNT (OVERRUN) UNDERRUN (e)	(OVERRUN) UNDERRUN (Col e / Col c x 100 = %) (f)
$	$	$	$	$	%

PART B - PERIODIC EVALUATION - COST OF WORK

WORK PERFORMED TO DATE			TOTALS AT COMPLETION		
VALUE (a)	ACTUAL COST (b)	(OVERRUN) UNDERRUN (c)	PLANNED COST (d)	LATEST REVISED ESTIMATE (e)	PROJECTED (OVERRUN) UNDERRUN (f)
$	$	$	$	$	$

PART C - TERMINAL EVALUATION - OVERRUN/UNDERRUN STATUS

TARGET PRICE			ACTUAL	VARIANCE (Contractor's Responsibility)	
	AS ADJUSTED				
ORIGINAL (a)	CONTRACTUALLY (b)	PENDING (c)	(d)	AMOUNT (OVERRUN) UNDERRUN (e)	(OVERRUN) UNDERRUN (Col e / Col c x 100 = %) (f)
$ 39.2 Million	$ 41.9 Million	$ 42.5 Million	$ 45.7 Million	$ (3.2) Million	(7.6) %

REMARKS

DD FORM 1 JUN 66 1446-3 PREVIOUS EDITION MAY BE USED

COST PERFORMANCE (Continued)	CONTRACT NUMBER 72-S142	PERIOD OF REPORT 1 May 65-10 Oct 67	PAGE 5 OF 6 PAGES

BLOCK A

Target cost	36.0
Target fee	3.24
	39.24
use	39.2

BLOCK B

Entry in BLOCK A	39.24
Plus addt'l incentive fee	.456
Plus negot. fee bearing CCNS including fee	2.2
	41.896
use	41.9

BLOCK C

Entry for BLOCK B	41.896
Plus agreed to fee bearing CCNS including fee	.560
	42.456
use	42.5

BLOCK D

Entry for BLOCK C	42.456
Overrun for Weight	1.2
Overrun for Schedule	2.0
	45.656
use	45.7

BLOCK E

Overrun for Weight	1.2
Overrun for Schedule	2.0
	3.2

BLOCK F

Entry for BLOCK E	3.2
Entry for BLOCK C	42.456
Multiply by 100 to get 7.6%	

FEE BREAKDOWN

PARAMETER	TARGET FEE	ACTUAL FEE
Cost	$648,000	$488,000
Delivery	972,000	1,188,000
Performance	648,000	688,000
Performance Total Impulse	648,000	1,008,000
Performance Acceleration	324,000	324,000
	$3,240,000	$3,696,000
(fee bearing Mods) additional fee		125,000
TOTAL FEE		$3,821,000

CONTRACTOR PERFORMANCE EVALUATION REPORT	NARRATIVE	REPORT CONTROL SYMBOL DD-I&L(SA)699 PAGE 6 OF 6 PAGES
CONTRACTOR'S NAME: Eden Missile Company	CONTRACT NUMBER: 72 - S142	PERIOD OF REPORT: 1 May 65-10 Oct 67

1. TO PROVIDE A SUMMARY VIEW, GIVE YOUR OPINION ON THE FOLLOWING QUESTIONS:

a. HAS THE WORK OF THE CONTRACTOR GENERALLY PROGRESSED AS INTENDED BY THE TERMS AND CONDITIONS OF THIS CONTRACT? IF NOT, IN WHICH AREA(S) *(e.g., cost, schedule, technical performance, required obligations)* HAS IT DEPARTED?

b. AS INDICATED BY HIS PERFORMANCE ON THIS CONTRACT, WHAT DO YOU CONSIDER TO BE THE CONTRACTOR'S STRONG POINTS? HIS WEAK POINTS? *(Observations should be supported by factual data.)*

c. DURING THE REPORTING PERIOD, WHAT ACTION HAS THE CONTRACTOR TAKEN TO CORRECT ANY WEAKNESSES NOTED IN 1b?

No. The Contractor incurred a $1.2 Million overrun due to an extensive redesign program which netted the Contractor $40,000 additional fee over target. Prior to this, the Contractor requested an increase in the target gross motor weight which was negotiated after presentation of what the Government considered valid arguments for the change. The Contractor incurred a $2.0 Million overrun due to concentrating his overtime on bettering schedule which he did by 60 days. This netted the Contractor $216,000 additional fee above target. While bettering the target schedule on qualification tests, the Contractor slipped a significant number of other important milestones. As of this writing, the Contractor has not submitted the tactical design documents which were due 5 October 1967.

Strong Points: The Contractor was able to meet or better contractual requirements in the technical area.

Weak Points: The Contractor apparently could not meet schedule without incurring cost beyond target. He did not meet his cost target although he earned $200,000 over minimum fee on cost. The management status reports were in general ineffective in controlling the program and informing the Government of potential problems.

No corrective actions by the Contractor were observed during this period.

The Contractor has met his obligations under the "required Clauses".

The contract contains a Value Engineering Incentive clause. No VECP's have been submitted or approved. Government costs have not been reduced as a result of the Contractor's V. E. efforts.

(If additional space is required, continue on reverse side)

DD FORM 1 JUN 66 1446-4 REPLACES EDITION OF 1 AUG 65 WHICH MAY BE USED.

Question No. 3. On the matter of independent funds for Government laboratory directors, we note that the Armed Services Procurement Regulations in Section 15, part 205, provides for reimbursement of a contractor's independent research and development effort as a charge to Government-paid overhead. How does this approach compare with DoD's system for providing an allowance for independent research funds to selected DoD laboratory directors? Does the overall percentage differ?

Answer. Independent research and development (IR&D) by definition is "that research and development which is not sponsored by a contract, grant or other arrangement". It corresponds closely to the research and development that all companies must conduct in order to improve their product lines and thereby remain competitive. Accordingly, it has been regarded as a necessary cost of doing business. At least four distinct benefits are derived from IR&D:

1. IR&D is used to develop and demonstrate complete prototypes of technically advanced hardware before a formally recognized military requirement exists.

2. IR&D is used to develop the requisite technology for a known forthcoming military requirement.

3. IR&D is used to upgrade the capabilities of important weapon systems.

4. Technology often precedes military requirements; but as a result of broad advances in technology from IR&D, new capabilities become possible and often give birth to military requirements.

IR&D is considered as an overhead cost to Government contracts which is recoverable by the contractor to the extent that is reasonable. Much of the funds spent by industry in this fashion is above the amount considered reasonable as an overhead charge. The difference is paid out of company profits. There is no fixed percentage which is allowed for this purpose. It varies from year to year and from company to company.

The purpose and expectations of the in-house laboratory director funds are very similar to the IR&D concept. In both cases, the intent is to keep technical organizations at the forefront of technology so that the best technically conceived systems and weapons will be achievable in a timely manner. Both are predicated on maintaining a high degree of independence and freedom of action at the performing level.

Question No. 4. The Subcommittee is aware that many observers of Federal laboratories call for measures to upgrade the quality of their personnel by training, particularly by sending scientists and engineers off to school for mid-career study. Dr. McLean spoke in support of this concept. On the other hand, we have heard that in some laboratories if a director sends a man off for training, the manpower people withdraw the man's position because he is no longer at the laboratory bench or at the drawing board.

What experience have you had with this problem in the administration of DoD's laboratories?

Answer. The educational program of a laboratory must compete with all other functions for its resources. During times of budget reductions and manpower retrenchment, the education and training activities of laboratories are also affected by the over-all environment. By and large, the Defense laboratories have strong programs in work-related educational programs and in continuing education for mid-career study under the Government Employees Training Act.

A recent (March, 1968) survey by the Committee on Federal Laboratories, Federal Council for Science & Technology, indicated a high degree of participation in advanced technical education by DoD laboratories. In certain cases the universities are brought to the site of the laboratories such as at Huntsville, Alabama for the Army Missile Command and NASA, at China Lake, California, for the Naval Weapons Center and at Wright-Patterson AFB, Ohio, for six Air Force laboratories and other technical groups. This provides a broader technical scope at a much lower cost basis.

Unquestionably there have been isolated cases where a manpower space has been withdrawn while an individual has been off for training because of manpower reductions in the organization. However, this is believed to be the exception rather than the rule in the Department of Defense.

We have also run into the problem where the pressure of the laboratory program is such that a Laboratory Director is reluctant to send his better, productive people off for educational purposes. To ease this problem somewhat, the Deputy Secretary of Defense established a "Pool of Spaces and Funds for Long-Term Civilian Training" (in excess of 120 days). This pool, which is still in effect, covers the manpower spaces and funds (tuition, salary and related ex-

penses) programmed by each of the Military Departments, Defense agencies and OSD. While individuals are at school, the laboratories can and have employed temporary replacements for these individuals. This program gives a laboratory more incentive to release his higher quality people with less impact upon his current program.

Question No. 5. We understand that the Air Force Systems Command has set up a criteria by which they judge the use that Laboratory Director makes of independent research funds. What are these criteria? How do they operate? What have been the results? In particular, do Air Force Laboratory Directors feel they are being second-guessed by someone at headquarters in the use of these funds? Are there comparable criteria for Navy and Army laboratory directors? If so, what are they?

Answer. There is no control by the Air Force Systems Command on the use which a laboratory director may make of independent research funds other than those dictated by Public Law, ASPR's and Air Force Regulations. The individual laboratory directors, just prior to presenting their work for review to the Assistant Secretary (R&D), do gather and discuss their programs among themseleves and with the AFSC Director of Laboratories, but not for the purpose of control or for comparison with a set of criteria. To my knowledge there are no criteria used in the Army or Navy. Each situation is judged on individual merit.

Question No. 6. The Subcommittee understands that the Navy Department makes use of departmental councils of laboratory directors. Could you tell us about the purpose of such laboratory director councils within the Defense Departments, how they operate, and of what value they have been?

Answer. The Navy does have an informal group known as the Navy Laboratory Directors Council, which was revitalized in March, 1967. Membership is restricted to the Commander/Commanding Officer and the Technical Director/Chief Scientist at the individual field RDT&E activities. There are three subgroups encompassing the Northeast, Southern, and Western areas of the continental U.S. and those activities which lie in those geographical areas. The purpose is to provide a mechanism and an organization whereby the Director of Navy Laboratories (DNL) and the RDT&E activities of the Navy can mutually serve to advance the Navy's R&D posture by providing an informal organizational base which will:

a. Support DNL communication link with the activities on subject matter requiring mutually considered positions. (This is not to be considered as an intermediate echelon for normal communications.)

b. Rapidly disseminate information on non-routine, non-recurring events which are of concern to all Navy laboratories, wherein further discussion and clarifications by activities are required.

c. Provide laboratory management an idea exchange mechanism for formulating or recommending policies concerned with laboratory operations.

d. Provide as required by DNL background information for assessment of total laboratory programs.

e. Provide an informal communication link amongst the directors of the laboratories.

These area groups are each headed by a member laboratory in that area, on a rotational basis, and meet at the discretion of the membership whenever pertinent matters arise which are of importance to the technical and scientific community. These matters are usually management oriented. As a case in point, effective use has been made in the use of the area council representatives during the formulation of an on-going Career Development Plan for Scientists and Engineers. These personnel represented the total Navy scientific and engineering professional community in their areas and thus were enabled to directly assist and critique the basic elements of the "career plan" during its formulation process. This functioning of the area council representatives greatly reduced the time span required to obtain a feeling of the probable reaction of the research community to the intent and purposes of the "plan".

In a similar vein, the Navy also has a large Antisubmarine Warfare R&D Planning Group whose membership is derived from the major in-house and contract laboratories engaged heavily in Undersea Warfare work. This was established April 6, 1966. The group provides an important means of interchange of technical information. More importantly, this group has provided a basis for the genesis and conduct of interlaboratory projects which would be difficult to handle through normal administrative channels.

Question No. 7. While the present Laboratories Committee of the Federal Council for Science and Technology is concerned with Government laboratories

as such, with the exception of Dr. Astin, its members are not working laboratory directors. What advantages and disadvantages would you anticipate for a small council of Federal laboratory directors that would represent their views at the Executive Office level for both directly and contractor-operated Federal laboratories?

Answer. With respect to the establishment of a small council of laboratory directors, I believe that there are a number of positive advantages which could result from such an arrangement. The Federal laboratory directors could be broadened by exposure to problems on a national scale. Further, their ideas and inputs could add greater breadth and insight for the activities of the Committee.

The representation of contractor-operated laboratories in the Committee is a moot question. There are those who believe that this would not be appropriate. Their motivation, needs, administrative arrangements, problems and relationships with their contracting agencies are considered quite different from Federal laboratories. This lack of commonality of specific needs and interest, together with the different framework for contract laboratories, makes their involvement in the Committee's activities of questionable value.

On the other hand, there are those who feel that an arrangement such as this might offer many benefits. Both types of organizations could learn from one another. Contract laboratories may have solutions to management problems which seriously concern Federal laboratories, and vice versa. I believe that the Committee on Laboratories should test this suggestion out and determine its utility even if it were only in a limited area.

Question No. 8. In what ways are the directors of your large, multipurpose laboratories kept informed of the scientific and technological content of new or changed Government functions, such as those of the Department of Transportation or the Department of Housing and Urban Development?

(a) What incentives are there for your laboratory directors to give thought to such matters in addition to their primary responsibilities to your program?

(b) Are DoD laboratory directors authorized to fund research relevant to national problems which may be outside the strict mission objectives of DoD?

Answer. I should begin by pointing out that there are few problems in other agencies which do not have Defense relevance. We have strong interests in health, housing, education, training, weather forecasting, oceanography, standardization, criminal investigation, etc., to name a few. We have had a three-year program in gun detection and are involved in riot control measures. With the exception of relatively few areas (e.g., air and water pollution), our broad interests are similar to those in most other agencies. We differ only in specifics.

As a natural consequence of these common interests, laboratories keep informed of new and emerging national programs. In addition, there is much high level collaboration with other agencies with resultant specific assignments to individual laboratories. For example, we participate in the Inter-Agency Committee on Atmospheric Sciences (ICAS) which involves collaborative efforts in oceanography, meteorology and such specific activities as clear air turbulence. We have participated and have close communication with HUD on an experimental housing program. As I mentioned in my testimony, the DoD laboratories work closely with NASA, AEC and DOT in areas of aircraft, space vehicles, nuclear programs, and transportation.

Another motivating factor is that our laboratories must keep up-to-date with science and technology which evolve from other agencies' programs also because of their potential use in furthering DoD's mission. Thus a great deal of the responsibility for keeping up with such programs rests with the individual laboratories.

The technical directors of these laboratories/centers are expected to maintain close contact with all new Federal and/or commercial work and developments which are related to their mission areas or may impact on their ability to accomplish their assigned missions, and in most cases do.

There are relatively few incentives for our laboratory directors to stimulate work in non-DoD relevant areas, nor in our opinion should there be. Most laboratories/centers are under heavy pressure by program sponsors to devote all their resources to the execution of agreed programs within the over-all mission of the activity. This pressure is reinforced by the common requirement to use appropriated funds for their intended purpose.

While DoD laboratory directors cannot divert mission funds to support programs outside of the DoD mission, the independent research funds provided to laboratories may be used for this purpose. However, the after-the-fact review on the utilization of these funds for such purposes would soon discourage it.

DoD laboratory directors can and do take on specific projects for other Government agencies on a fund reimburseable basis. In general, the decision to do so rests with the laboratory director, and is shared with his management agency. However, the major constraint here is personnel ceiling. If significant additional manpower is required, it must generally be obtained through the performing agency rather than the agency with the problem. It is for this reason I recommend that consideration be given to the elimination of manpower ceilings for cross-agency work.

Let me re-emphasize again that we must be careful in assigning non-agency missions to existing laboratories. We must not so dilute their performance that they lose the very focus which made them a quality laboratory.

Question No. 9. Based on your experience, what advantages and disadvantages would you see in an office of Government laboratory management located at the level of or within the Office of Science and Technology? Such an office would be analagous to the present Office of the Assistant Director (Laboratory Management), in the Department of Defense's Office of Defense Research and Engineering.

Answer. In terms of improving the ability of the DoD to accomplish its mission, I can see no advantage in the establishment of such an office in OST. In fact, it would add an additional echelon and would certainly retard our ability to take decisive action in a timely fashion. As far as I can determine, there has been no problem in obtaining the support of other agencies for the priority needs of the DoD. In certain areas the OST has been directly involved in assisting us to achieve our objectives either through studies by PSAC or the FCST. We will and have assisted new agencies in the performance of R&D to support their mission, at least during the early, formative years. The direct assistance of OST is seldom needed since the agencies involved can work out mutually acceptable arrangements with a minimum of difficulty.

There may be one function which OST could perform or for which it could provide leadership. When a new agency is established, a new, important program emerges, or an existing program takes on added importance or priority, OST could appraise their RDT&E needs in terms of existing capability and assist the new program or agency in obtaining the required assistance.

I must emphasize, however, that the day-to-day management and the decision-making process must remain with the agency heads who are really the only ones who can assure the proper balance, purpose and priorities of his laboratory structure in relation to the needs of his total mission.

Question No. 10. It has been said that within Government we tend to force everything into one prescribed pattern whether it fits well or not. Do you believe that Federal laboratories operate most efficiently under the same current system of controls over manpower, dollars and facility acquisitions as for other types of organiaztions? Do you believe it is possible or desirable to tailor a system of controls for creative organization which might differ significantly from the "standard" control system? What would be the advantages? The disadvantages? Cite examples.

Answer. The evidence is overwhelming that the standard patterns of Government operation are unhealthy for laboratories. We must find a way to create a management climate for the Federal laboratories equal to the most progressive, high technology industrial organizations. Virtually every study that has been made of the in-house laboratory system has been critical, in varying degrees, of the management of manpower, facilities, funding and personnel resources. Responsibility over these resources are fragmented among many staff agencies, whose concerns and interests are much broader than merely RDT&E.

Within the Government, RDT&E activities are bound too often by practices designed for logistical and operational activities—in contrast to the more generally recognized practices of industrial organizations, which are tailored specifically for the creative, laboratory-type organization.

In spite of these constraints, however, we find many successful laboratories which have found a way around the rigidity in the system or have been somehow protected from these patterns. We have also made a great deal of progress within the Federal Personnel System. Many special provisions have been provided to give flexibiltiy with respect to personnel administration. Part of the problem is that a great deal of the flexibility available just isn't being used. Within DoD we have initiated a concerted effort to see that these flexibilities are available to and utilized by the laboratory directors. Comparable increased flexibilities in other resource areas are also needed.

Part of the problem in Government is size, coupled with the check and balance system under which we operate. As a former manager of industrial R&D, I was given certain financial and technical objectives to achieve each year, a budget within which I had to operate, and a great deal of authority to carry out technical operations. If I did not meet the objectives, the penalty was spelled out, or at least understood—fired or shelved. The incentives for achieving or exceeding them were also well understood.

I was part of a larger organization and therefore had to interact with force and situations outside my own domain. We had a check-and-balance system like the Government's, but I believe we had more emphasis on the "balances" and less on the "checks". I had ready access to the policy level, which is more possible in a smaller organization, and I could always have my day in court. This doesn't mean that I didn't lose a few appeals, but the opportunity to appeal was there. Probably one of my greatest management flexibilities was that I could make the hire and fire decisions and had the authority to deploy my technical resources rapidly to meet new situations.

I believe that with the application of many of these same principles to the creative RDT&E functions within Government, we would soon see evidence of increased efficiency and effectiveness. The advantages could be in terms of more rapid decision-making and lower costs of operations through reduction in supervisory levels, unnecessary reporting, and administrative overhead. A major disadvantage could be the weakening of the organizational ties between a laboratory and its parent agency. Shifting the balance too far toward complete self-determination could tend to isolate a laboratory from the mainstream activities of its parent. However, I am positive that a proper and balanced relationship could be achieved.

Question No. 11. Some people believe that manpower ceilings for laboratories actually promote waste and inefficiency, and they cite industrial practices as an example where such a technique is seldom used. Do you believe that manpower ceilings are or are not an effective management tool? Why?

Answer. It is difficult to examine a single control in the context of the question asked. The problem generally is the multiplicity of many overlapping controls which seriously impede the optimum allocation of resources. I believe that too little attention has been paid to the combined impact of many individual resource controls upon the effectiveness of an organization. As an example, we recently made a theoretical study* of the impact on operational effectiveness of three overlapping controls which were in effect at the time:

1. Control of high-grade positions.
2. Control over average salary.
3. Control over manpower ceilings.

In our study, we used indifference curves and maximizing principles of economic analysis to demonstrate how management control over these three factors prevent the line manager from optimizing his organization's effectiveness. For the sake of simplicity and clarity, we restricted the analysis to a two-dimensional framework, although it can easily be extended to as many dimensions as desired, depending upon the number of inputs.

The details of the analysis are given in a tab to this question. As may be seen, particularly in Figures 5 and 8 of the Tab A, the general effects of these simultaneous constraints is to reduce the ability of a local line manager to achieve optimum effectiveness and productivity. Further, an important point to remember is that application of such simultaneous controls cannot increase effectiveness but can only reduce it.

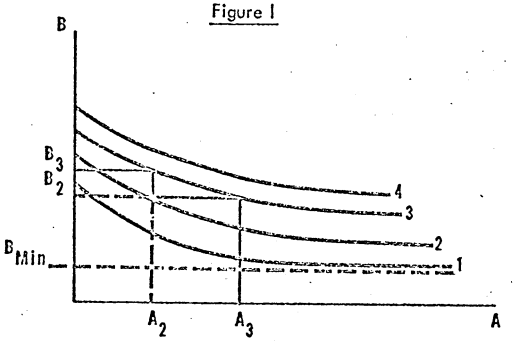
Manpower controls are really an indirect attempt to control dollars. I would prefer to attack the principal problem directly, rather than indirectly.

*Nicolai, F. A., Management Analysis Note MAM 65–2, ODDR & E, October 1, 1965.

THEORETICAL ANALYSIS OF IMPACT ON OPERATIONAL EFFECTIVENESS BY CONTROL OF HIGH GRADES, AVERAGE SALARY AND MANPOWER SPACES

Suppose that the professional personnel of an organization (e.g., a laboratory) can be divided into two subsets, the GS-13s and below (GS-13-) and the GS-14s and above (GS-14+). Let A represent the number of GS-13s- and B, the number of GS-14s+. Further, let us assume that the productivity of a typical employee within each grade range can be measured and that overall productivity varies according to the mix of A and B. On this basis, the following diagram (Figure 1) may be constructed:

Figure 1



The curves labeled 1, 2, 3 and 4 correspond to isoproductivity curves. Thus, line 1 represents the combinations of A and B that yield an equal level of productivity; line 2 represents a higher level of productivity than line 1, and so on. With an input mix of A_2, B_2, for instance, productivity is $E(A_2, B_2)$. If A_2 is held constant and the number of GS-14s+ is raised to B_3, then productivity increases; that is, $E(A_2, B_3) > E(A_2, B_2)$. Similarly, $E(A_3, B_2) > E(A_2, B_2)$.

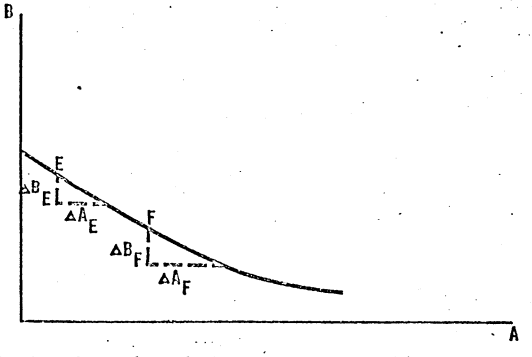
Several other important points about the diagram should be noted: The lowest level of productivity, represented by curve 1, is asymptotic to B_{min}, which represents the minimum of GS-14s+ that must be hired to reach any positive level of productivity. Moreover, all the curves have a flat, negative slope throughout. The negative slope indicates that both A and B have positive productivity, i.e., there is no negative productivity. The curve's flatness indicates that, in any possible input mix, the GS-14s+ are always more productive than the GS-13s−; that is, assuming that we seek to maintain the same level of productivity, if B is decreased by 1, we must increase A by more than 1.

Also, the isoproductivity curves are convex to the origin:

$$\left(\frac{dB}{dA}<0,\ \frac{d^2B}{dA^2}>0 \text{ for } A>0,\ B>0\right).$$

This property depends upon the assumption of diminishing marginal productivity. For example, refer to Figure 2: At point E on curve 1, a decrease ΔB_E in the number of GS-14s+ requires an increase ΔA_E in the number of GS-13s− in order that total productivity remain constant.

Figure 2

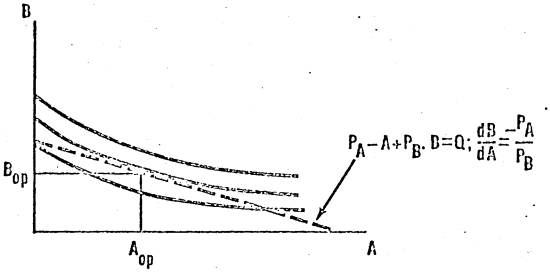


However, at point F, where the relative number of GS-14s+ is smaller, the same decrease in the number of GS-14s+ ($\Delta B_F = \Delta B_E$) requires a larger increase in the number of GS-13s− ($\Delta A_F > \Delta A_E$) to keep the total productivity constant. This condition does not appear unreasonable, for the GS-14s+ may perform some tasks more efficiently than the GS-13s−. If the curves were concave to the origin, this would be equivalent to making an assumption of increasing marginal productivity; i.e., as the GS-14s+ become relatively fewer, it will take fewer and fewer GS-13s− to replace the same number of GS-14s+.

Maximizing Productivity, Given a Budget Constraint

Suppose the isoproductivity curves are represented as in Figures 1 and 2. Let P_A = salary (cost) paid a GS-13−; let P_B = salary (cost) paid a GS-14+; and let Q = the total budget available for salaries. Then, $P_A \cdot A + P_B \cdot B \leq Q$. Now, superimpose this linear budget constraint on the productivity contour surface, as in Figure 3.

Figure 3



Given Q, we now maximize our productivity by hiring $A = A_{op}$, $B = B_{op}$, since at this point the budget line reaches—and is tangent to—the highest isoproductivity curve. This method vitally depends on the convex nature of the isoproductivity curves.

Effect of Limitation on Number of GS-14s+(B)

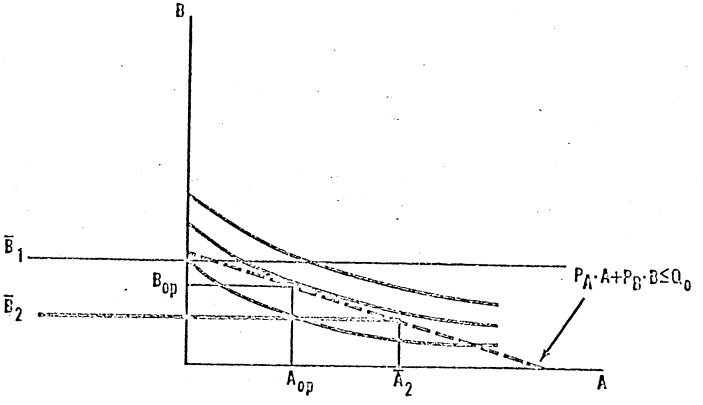
Let us state the constraint imposed by a limitation on the number of GS-14s+ in the following manner:

$\overline{B}$ = maximum allowable number of GS-14s+;

thus,

$$B \leq \overline{B}.$$

Figure 4



When $\overline{B} = \overline{B}_1 > B_{op}$, the constraint is irrelevant, because, given $Q = Q_0$, the optimum mix is A_{op}, B_{op}, with effectiveness (productivity) equal to $E(A_{op}, B_{op})$.