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**AUTHORIZATION FOR FIRE RESEARCH AND SAFETY
AND THE STANDARD REFERENCE DATA ACTS
(H.R. 7188-H.R. 7189)**

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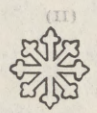
**HEARING
BEFORE THE
SUBCOMMITTEE ON
SCIENCE, RESEARCH, AND DEVELOPMENT
OF THE
COMMITTEE ON
SCIENCE AND ASTRONAUTICS
U.S. HOUSE OF REPRESENTATIVES
NINETY-SECOND CONGRESS**

FIRST SESSION

AUGUST 3, 1971

[No. 8]

Printed for the use of the Committee on Science and Astronautics



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**AUTHORIZATION FOR FIRE RESEARCH AND SAFETY
AND THE STANDARD REFERENCE DATA ACTS, H.R.
7188 AND H.R. 7189**

TUESDAY, AUGUST 3, 1971

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

The subcommittee met, pursuant to notice, at 10 a.m. in room 2325, Rayburn House Office Building, Hon. John W. Davis of Georgia (chairman) presiding.

Mr. DAVIS. The committee will come to order.

We have a prepared statement by our colleague, Hon. James D. (Mike) McKeivitt, of Colorado, which he had planned to present; but since he is unable to be here, without objection, I will place it in the record.

**STATEMENT BY HON. JAMES D. (MIKE) McKEVITT, OF COLORADO,
PRESENTED TO THE HOUSE SCIENCE AND ASTRONAUTICS SUB-
COMMITTEE ON SCIENCE, RESEARCH, AND DEVELOPMENT IN
SUPPORT OF IMPLEMENTATION OF THE FIRE RESEARCH AND
SAFETY ACT OF 1968**

August 3, 1971.

Mr. Chairman, I want to thank you and the distinguished members of this subcommittee for permitting me to present testimony in behalf of my proposed bill (H.R. 3977) to implement the Fire Research and Safety Act of 1968.

The subcommittee is well aware of the importance of the program which was described in considerable detail in testimony presented the subcommittee on April 22, 1970, by the Director of the National Bureau of Standards. At that time, the Bureau was testifying in behalf of H.R. 16538 which would have authorized funds to carry out the program for the fiscal years of 1971, 1972, and succeeding years. The bill, however, was not enacted by the 91st Congress.

Since that time, only a limited fire research and safety program has been initiated.

Naturally, I would be delighted if the subcommittee would endorse my bill, H.R. 3977, which would authorize \$3 million for the program for fiscal 1972 and \$3 million for the 1973 fiscal year. The Commerce Department favors enactment of H.R. 7188 which would authorize appropriation of such funds as may be necessary for fiscal 1972 and succeeding fiscal years.

In my mind, either bill would do the job. The important thing is that we move to implement a meaningful fire research and safety program.

The only reservation I have about H.R. 7188 concerns the intent of the Legislative Reorganization Act of 1970. Section 253 of the Act urges appropriations on an annual basis when possible for continuing programs in the Federal Government.

I only note the Act for the Subcommittee. As I stated, my major concern in this matter is that we implement the Fire Research and Safety Act of 1968.

Again, I want to thank the Subcommittee for the opportunity to present testimony today.

Mr. DAVIS. Dr. Branscomb, you can bring anybody to the table with you that you would like to.

This morning we meet to consider the authorization request for funds for continuing work under the Fire Research and Safety and the Standard Reference Data Acts.

(The information follows:)

[H.R. 7188, 92d Cong., first sess.]

A BILL To authorize appropriations to carry out the Fire Research and Safety Act of 1968

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That there are authorized to be appropriated to the Department of Commerce such sums as may be necessary for fiscal year 1972 and succeeding fiscal years to carry out the purposes of the Fire Research and Safety Act of 1968 (Public Law 90-259; 82 Stat. 34).

[H.R. 7189, 92d Cong., first sess.]

A BILL To authorize appropriations to carry out the Standard Reference Data Act

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That there are hereby authorized to be appropriated to the Department of Commerce such sums as may be necessary for fiscal year 1972 and succeeding fiscal years to carry out the purposes of the Standard Reference Data Act (15 U.S.C. 290-290f; 82 Stat. 339).

Mr. DAVIS. Although the amounts of money involved are relatively small, this has no relation to the importance of the bills. I have been personally involved as many of you know in my district in work on flammable fabrics and have closely followed the reports on the fires that have occurred in recent years.

I am fully aware of the need for research on combustion processes and the need for improved safety in this field.

Of course, the need for reliable data that can serve as a reference for research, manufacturing the production processing is equally important.

I am sure that the widespread dissemination of standard reference data is a technological and economic asset. Certainly it is the only way in which we can make meaningful progress.

We are happy to have you, Dr. Branscomb, and your colleagues this morning, and I will invite you at this time to go forward with your statement.

Dr. BRANSCOMB. Thank you, sir.

With the committee's permission what I would like to do is to highlight the prepared statement that I have submitted in the interest of saving a little time. I will omit a few paragraphs, and I would like to suggest you would include them in the formal record.

Mr. DAVIS. Very well.

(The biographical sketch of Dr. Branscomb follows:)

BIOGRAPHY OF DR. LEWIS M. BRANSCOMB

Dr. Lewis M. Branscomb has been Director of the National Bureau of Standards, U.S. Department of Commerce, since September 1, 1969.

Born in Asheville, North Carolina, on August 17, 1926, Dr. Branscomb was educated at Duke (A.B., 1945, summa cum laude) and Harvard Universities (M.S., 1947, Ph. D., 1949). After holding a Public Health Service fellowship, he was a Junior Fellow in the Harvard Society of Fellows (1949-51). Since then Dr. Branscomb has also taught at University College, London, the University of Maryland, and the University of Colorado, where he was Professor Adjunct of Physics.

He joined the National Bureau of Standards in 1951 after finishing his formal education. For ten years he directed the Bureau's work on atomic physics, and for eight years he was chief of the NBS Laboratory Astrophysics Division in Boulder, Colo., a unit of the Joint Institute for Laboratory Astrophysics (JILA)

of which he was chairman. JILA is a noteworthy cooperative venture between NBS and the University of Colorado. Dr. Branscomb was instrumental in the formation of JILA.

Dr. Branscomb was until recently a member of the President's Science Advisory Committee and the only working scientist ever to be selected from the staff of a directly operated Federal laboratory to serve on that committee. He is now a member of the President's Commission for the Medal of Science.

The National Civil Service League, in selecting Dr. Branscomb as one of the ten recipients of its Career Service Awards in 1968, cited him in particular for his demonstrated ability "to smooth the interaction of technology and our society," and for his contributions to the evaluation and planning of U.S. scientific programs and policies affecting national defense, space, and atomic energy.

This award to Dr. Branscomb followed many others, including the Rockefeller Public Service Award, 1957-58; a Gold Medal for Exceptional Service, Department of Commerce, 1961 (for contributions to basic knowledge of atomic processes of stellar atmospheres, terrestrial ionosphere and interplanetary space); the Arthur Flemming Award, District of Columbia Junior Chamber of Commerce, 1962; and the Samuel Wesley Stratton Award (named for the first director of the National Bureau of Standards), Department of Commerce, 1966.

Dr. Branscomb serves as a special consultant to the Secretary General of the Organization for Economic Cooperation and Development on matters of scientific and technical information.

The international scope of Dr. Branscomb's achievements is further indicated by his participation over the years in the work of three scientific unions: the International Union for Geodesy and Geophysics, the International Union of Pure and Applied Physics, and the International Astronomical Union. Currently he is the U.S. representative to the Committee on Data of the International Council of Scientific Unions.

Dr. Branscomb is a member of the National Academy of Sciences, the American Academy of Arts and Sciences, and the American Philosophical Society and serves on the Board of Directors of the American Association for the Advancement of Science and the American National Standards Institute.

Prior to his current position as Editor for *Review of Modern Physics*, he was Chairman of the Division of Electron and Atomic Physics of the American Physical Society.

Dr. Branscomb is married to the former Anne Wells of Milledgeville, Ga., an attorney. They have two children, Harvie and Katharine.

PREPARED STATEMENT OF LEWIS M. BRANSCOMB, DIRECTOR OF THE NATIONAL BUREAU OF STANDARDS

Mr. Chairman I am pleased to appear before you today in support of two of the important activities of the Department of Commerce—the Fire Research and Safety Program and the National Standard Reference Data System. Both of these activities have been delegated to the National Bureau of Standards for implementation and the managers responsible for them are here with me today, Dr. F. Karl Willenbrock, Director, Institute for Applied Technology, and Dr. Edward Brady, Associate Director for Information Programs. The principal statements for each of these programs will be presented by my NBS colleagues but I would like first to state briefly why these programs are so strongly supported by the Department of Commerce.

The mission of the Department of Commerce, as enunciated by Secretary Stans, is to foster, serve, and promote the nation's economic development and technological advancement. The National Bureau of Standards is one of the Department's major resources in fulfilling its mission responsibilities, having as its goal strengthening and advancing the nation's science and technology and facilitating their application for public benefit. This morning we shall look at two of the many ways by which NBS serves this mission.

FIRE RESEARCH AND SAFETY

Turning first to Fire Research and Safety, we believe that Public Law 90-259, enacted in 1968, is a proper legislative response to the problem of life and property loss from unwanted fires. It authorized the establishment of a comprehensive attack to reduce the annual losses of 12,000 or more lives, the hundreds of thousands of injuries, and the billions of dollars property damage. Although this Committee last year favorably recommended the authorization of future appropriations to

carry out the purposes of the Fire Research and Safety Act, as did the Senate Committee on Commerce, the authorization was not reached for final action in the press of business at the close of the 91st Congress.

In view of the discussions last year before this Committee I will not review the details of the Act. I would like to note that the NBS has a long history of work in fire problems. Since 1914 the Bureau has conducted a small program of applied fire research and has developed procedures for measuring fire resistance characteristics of building materials and components.

These test methods have been adopted by private organizations—such as the American Society for Testing and Materials—for incorporation into voluntary standards that are used by industry in buying and selling building materials. Such standards are really the language of the marketplace: they permit builders to specify the fire resistance characteristics of the materials they use in construction of buildings.

The tests are also used in the development of building codes which insure that buildings are constructed with an acceptable level of fire resistance characteristics and materials.

It should be noted that the National Bureau of Standards does not set the standards nor write the building codes; its role is to develop the technical knowledge and test procedures which industry may use in establishing voluntary standards, and which State and local governments may use in issuing mandatory building codes.

The Bureau also has a program concerned with the flammability of fabrics. In 1967, Congress amended the Flammable Fabrics Act of 1953. This amendment gave the Secretary of Commerce the authority and responsibility for the first time to issue mandatory standards for fabric flammability, including wearing apparel and interior furnishings.

The National Bureau of Standards is responsible for the technical aspects of this program, such as developing the test procedures that are incorporated in the standards. This is an important Bureau program in the fire field which is authorized by a separate act—the Flammable Fabrics Act—and the work is directed to a highly specialized purpose.

The Fire Research and Safety Act of 1968 gave the Bureau of Standards new authority and responsibility in the fire field. The new programs are, however, a natural extension of our existing activities.

During the hearings on the Fire Research and Safety Act in 1968, your Committee expressed the view that the program ultimately might require funding of as much as \$10 million annually to achieve maximum effectiveness. Progress to this end has been slow. Section 104 of the Act authorized a total of \$5 million to cover the period from enactment to June 30, 1970.

The Act was enacted in March 1968, too late for its funding to be included in the regular appropriation request for fiscal year 1969. A revised request was submitted in time for consideration by the Senate, which recommended an increase of \$500,000 "to finance the Fire Research and Safety Act of 1968," but this increase was not included in the appropriation that finally was approved in the conference.

In view of the urgency to reduce life loss and fire damage, the Bureau reprogrammed \$148,000 to start the program. One result of this first effort was the study "A Program for the Fire Research and Safety Act," published by this Committee. In this study we outlined the comprehensive plan of action we propose to follow in implementing the Act.

Funds to implement the program were again requested for fiscal year 1970. The appropriation that was finally approved for NBS provided only \$550,000 for all of the Bureau's program increases, including the urgently needed expansion of the flammable fabrics program which had been established in response to the 1967 amendments to the Flammable Fabrics Act.

The appropriation increase approved for the Bureau for fiscal year 1971 included \$700,000 for new elements of our fire program directly responsive to the Fire Research and Safety Act. This amount, combined with the Bureau's ongoing building fire research activity, and the reprogrammed funds I mentioned earlier, brought the operation of the program to a level of about \$1.03 million.

The budgetary pressures involved in development of the President's budget for fiscal year 1972 did not permit further expansion of the funding for this program, therefore, the fiscal year 1972 appropriation request merely maintains the current level of funding. However, we see fiscal year 1972 as a year for consolidation of our fire activities as a foundation for possible future expansion.

The bill H.R. 7188 calls for the authorization of an appropriation for fiscal year 1972 and thereafter such sums as may be necessary for the purpose of the program. The Fire Research and Safety Act is an amendment to the Organic Act establishing the Bureau. Such an authorization would be consistent with the authorization for the great majority of programs of NBS. The ongoing nature of the attack on the fire problems argues for planning and budgetary actions similar to that of other NBS programs carried on under the terms of our basic Organic Act.

Now, Mr. Chairman, with your permission, Dr. Willenbrock will describe the progress we have made to date in achieving the goal of a fire research and safety center.

NATIONAL STANDARD REFERENCE DATA SYSTEM

Mr. Chairman, we would now like to discuss the National Standard Reference Data System. Although some of the activities in this program have had long and distinguished histories at NBS, it was only in 1968 that Congress passed legislation which established the need for a systematic national program to provide reliable reference data to the nation's scientists and engineers. This Committee has a major part in writing the Standard Reference Data Act, Public Law 90-396, and we are glad to have the opportunity to appear before you and report on the progress of the program.

The quantitative facts about nature on which both progress and usefulness of science depend are recorded in scientific literature as numerical data about the properties of matter. Most of this data is not produced as the deliberate result of efforts to obtain accurate data for applications. Such programs are necessary, but they are slow and expensive.

Most of the numerical data on properties is the by-product of research exploring new phenomena. Properties are measured and recorded in the literature for others to use in the process of almost every scientific investigation into the physical world.

I would not want to startle any of the members of this distinguished Committee who might still believe in the infallibility of science, but I must confess that when scientists, or engineers too, make a measurement in the laboratory, they do not always get the right answer. More specifically, since no measurement is perfect, they do not always get as accurate an answer as they claim to have, sometimes by a large measure. Usually this is because reliably accurate data was not the investigator's main purpose. Nor, when they write up their work for publication, do scientists always explain what they have done in clear enough language for other scientists to understand them and objectively evaluate their work. The result is that the scientific literature is filled with numerical data, some good, some bad, others of unknown quality. The scientist or engineer who wants to use one of these numbers must possess the right combination of skill and serendipity in order to choose the best one. And the prolific output of the world's scientists, with their up-to-date instruments and faster computers, makes this problem worse every year.

The reason, of course, that we want to have the good results evaluated and compiled is that numerical data on important properties are useful for many applications in addition to the one that induced the original measurement. You need to know some of the same properties of tungsten whether you are making a razor blade or a light bulb, and these properties may have been measured by someone who had no interest in either razor blades or light bulbs. If you can find a reliable value in a handbook, you don't have to go into the laboratory and measure it yourself or trust your luck in a value found by a laborious search through the literature.

There is another reason for finding out how good the measurements in the literature are. Scientists don't want to produce unreliable data; they continue to improve their methods when deficiencies are pointed out. But critical self-examination does not necessarily come more easily to scientists than to other humans. It often takes a detached expert, looking objectively at the work of many different scientists, sometimes representing different disciplines, to pick up a major source of error which no one had taken into consideration before. Once these pitfalls are recognized and widely publicized, most scientists will take due care in avoiding them. Those who do not rapidly lose credibility among their peers and, hopefully, the support of their sponsors.

It is certainly unnecessary to remind this committee of the size of the national investment in research and development. A small increase in productivity or reliability of research output can enhance by a very large amount the dollar benefits resulting from this investment. In the fields of physics, chemistry, and related engineering disciplines, which are responsible for generating most of the data falling

within the scope of the Standard Reference Data Program, the annual funding of basic research alone by the Federal Government is at least \$600 million. This amount of money generates large quantities of physical and chemical property data which are buried in 30,000 or more scientific papers published each year. These data represent one of the major benefits of that \$600 million investment in basic research. A primary aim of the Standard Reference Data Program is to improve the effectiveness of that investment, first by selecting the best of the data and making them available for all to use, and, second, by upgrading the quality of future measurements.

There is another important factor to consider. The output of American scientists represents less than 30% of the world's research in these fields. If the other 70% can be made available for use by our own scientists and engineers, it will not be necessary for us to spend the money to do these measurements. However, it is hard enough to know how much confidence to place in measurements done by one's own friends and associates; evaluation of data obtained in other countries, usually with unfamiliar instruments, and often reported in a foreign language, is a very difficult task. The Standard Reference Data Program undertakes this job in a systematic and efficient manner, retrieving data from the entire world literature and subjecting them to critical standards of evaluation.

The bill under consideration by this committee, H.R. 7189, calls for authorization for an appropriation for FY 1972 and thereafter, such sums as may be necessary for the purposes of the program. Such an authorization would be consistent with the authorization for the great majority of the programs of NBS, which rest upon the basic Organic Act of the Bureau. As was discussed in the hearings before this committee on the Standard Reference Data Bill in 1966, NBS already had the authority to conduct the basic program; that is, to organize a systematic effort to evaluate and compile data on properties of matter needed by scientists and engineers. The major additional authorities provided by the Standard Reference Data Act were authority to copyright NSRDS publications, to recover proceeds from sales, and to use the proceeds for the purposes of the program. We now have devised a plan to use these additional authorities; it will be described to you shortly.

I do not ask for a continuing authorization from a desire to reduce this committee's review of the program. We regard the NSRDS as one of our high-priority activities, and I want it to be visible, both to you and the entire technical community of the U.S. I plan to help the program expand in scope and in effectiveness. But the value of this program steadily accumulates over the years as the enormous body of scientific data in physical properties is subjected to critical examination and put in the hands of those who can put this information to good use. A continuing authorization is appropriate to a program of continuing and accumulating value. If the Congress approves a continuing authorization, I hope that this committee would give us an opportunity to report occasionally on progress and problems in this program.

In a few moments a more detailed statement on the Standard Reference Data Program will be presented by Dr. Edward L. Brady of NBS. He is associate Director for Information Programs and is responsible for general supervision of the program. He is accompanied by Dr. David R. Lide, Jr., Chief of the Office of Standard Reference Data, who has direct responsibility for program management.

STATEMENT OF DR. LEWIS M. BRANSCOMB, DIRECTOR, NATIONAL BUREAU OF STANDARDS

Dr. BRANSCOMB. I am pleased to appear before you today in support of two of the important activities of the Department of Commerce: The fire research and safety program, and the national standard reference data system. Both of these activities have been delegated to the National Bureau of Standards for implementation, and the managers responsible for them are here with me today: Dr. F. Karl Willenbrock, Director, Institute for Applied Technology, accompanied by Dr. John A. Rocket, Chief, Fire Research and Safety Office; and Dr. Edward Brady, Associate Director for Information Programs, accompanied by Dr. David R. Lide, Chief of Standard Reference Data.

The principal statements for each of these programs will be presented by my NBS colleagues, but I would like first to state briefly why these programs are so strongly supported by the Department of Commerce.

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The bill H.R. 7188 calls for the authorization of an appropriation for fiscal year 1972 and thereafter, such sums as may be necessary for the purpose of the program. The Fire Research and Safety Act is an amendment to the Organic Act establishing the Bureau. Such an authorization would be consistent with the authorization for the great majority of programs of NBS. The ongoing nature of the attack on the fire problems, argues for planning and budgetary actions similar to that of other NBS programs carried on under the terms of our basic Organic Act.

Now, Mr. Chairman, with your permission, Dr. Willenbrock will describe the progress we have made to date in achieving the goal of a fire research and safety center.

Mr. DAVIS. Very well. We will be very glad to hear from Dr. Willenbrock.

(The biographical sketch of Dr. Willenbrock follows:)

BIOGRAPHY OF DR. F. KARL WILLENBROCK, DIRECTOR, INSTITUTE FOR APPLIED TECHNOLOGY, NATIONAL BUREAU OF STANDARDS, WASHINGTON, D.C.

As Director of the Institute for Applied Technology of the National Bureau of Standards, Dr. Willenbrock is responsible for activities in the research and development of performance standards for electronic technology, building technology, vehicle systems, paper and textile technology, voluntary industrial standardization procedures, conduct of the National Metric Study as a guide in determining future U.S. policy, technical work on toy safety standards, fire research and safety, flammable fabrics, policy studies on means of encouraging invention and innovation, and provision of a central basis for weights and measures in all the 50 States.

Educated at Brown University (Sc. B., electrical engineering, 1942) and Harvard University (A.M., applied physics, 1947, and Ph. D., electron physics, 1950), he went on to serve at Harvard as a faculty member, 1950-67, Director of Laboratories, 1960-63, and Associate Dean of Engineering and Applied Physics, 1960-67. He has served as a consultant to a number of industrial organizations, Federal agencies, and other universities. In 1962, he was awarded the Distinguished Engineering Award of Brown University.

A member of many professional societies, Dr. Willenbrock has been particularly active in the Institute of Electrical and Electronics Engineers, serving as Vice President for Publications in 1966-68 and as President in 1969. He is presently a member of the Board of Directors of IEEE. He headed a delegation of engineers to the Soviet Union, visiting laboratories and industrial organizations in Moscow, Leningrad, and Novosibirsk; and represented the United States as a member of the seven-man delegation of the Second World Congress of the World Federation of Engineering Organizations in Paris. Dr. Willenbrock has chaired and served on Federal Government panels and was appointed recently to a four-year term as a member of the National Science Foundation's Information Council.

STATEMENT OF DR. F. KARL WILLENBROCK, DIRECTOR, INSTITUTE FOR APPLIED TECHNOLOGY, NATIONAL BUREAU OF STANDARDS

Dr. WILLENBROCK. Mr. Chairman, I am pleased to have the opportunity to appear before this committee today to discuss the Fire Research and Safety Act of 1968.

As Dr. Branscomb has just reminded you, the problem of unwanted fires continues to plague the Nation; and in 1970, it is estimated that once again some 12,000 people were killed, many more were seriously injured or crippled for life, and property losses continued in the billions of dollars. We believe that the Fire Research and Safety Act affords the opportunity for a concentrated attack on this problem.

In view of the extensive discussions with this committee last year of our plans for implementing the act, I shall not describe the act in detail. Rather, I should like to direct your attention to some of the progress made to date in response to title I of the act, which states that it is the sense of Congress that there should be a fire research and safety center to provide more effective measures of protection against fire hazards.

On a personal note, I joined the National Bureau of Standards 7½ months ago as the Director of the Institute for Applied Technology (IAT). Responsibility for the Bureau's fire program is in IAT. In this relatively short time, I have become deeply concerned with the urgency of need for a sustained and effective program in this area.

Last spring I had the opportunity to visit the fire research station in the United Kingdom in Boreham Wood. Although the United Kingdom has only one-fourth the U.S. population, the fire research station has a staff of 170 people. Also noteworthy, the United Kingdom per capita loss of life and property from unwanted fires is one-half that of the United States. Clearly, there are many differences between the two countries; in Britain there is a greater use of masonry rather than wood construction, there are climatic differences, organized fire brigade training, and social custom differences.

However, there is the significant difference in losses and the fact is that the United Kingdom has a greater proportionate concentrated effort in fire research, safety, and fire service training than we do. I am convinced that we are underinvesting in our attack on the fire problem and a greater effort on our part would yield significant reduction in life and property losses.

Mr. DAVIS. May I pose a question, if you are not prepared with an answer, I wish you could supply one later.

Does it seem to be any connection between the rate of fire loss and the climate? Do the colder climates have more fire losses?

Dr. WILLENBROCK. Colder climates as such? I'd have to supply that information. I don't have any detailed information on that point at this time.

Mr. DAVIS. On a question suggested by your statement, one of the differences between the United Kingdom and our country is the climatic one?

Dr. ROCKET. If I may, Mr. Chairman, I have looked to see if there is any correlation in the available data between this country between degree days and fire loss and there is no statistically significant correlation.

I suspect, and this is purely an opinion, that in the parts of the country where there are severe heating problems, as in Minnesota, for example, we develop fairly good heating systems to cope with the problem and in Florida where it is not a particular problem, we have a more casual system for heating the house. The net result of that is that the total reliability is about the same. This is something I cannot confirm statistically, but a widespread feeling by fire chiefs in the northern part of our country, suggests that there is a high instance of fire with the first cold snap of the winter when the heating systems get wrung out for that year and later on if there is an even deeper cold snap, they will have another rash of fires.

Mr. DAVIS. I can suggest another reason, that is an added reason for that, at least from my personal observation it has been true in the fall of the year when you would have the first cold mass move in, it is usually a period of very high winds; it is also a period of time when your bushes have all turned brown and lots of people are raking leaves and many people set fires that become larger fires than were intended. I don't know whether that is one of the busiest times for the fire departments.

Chairman MILLER. Would the gentleman yield for an observation?

Mr. DAVIS. Yes.

Chairman MILLER. I think what he says is technically true, but out in our area of the country, we put in an air pollution control board and it made us stop all types of burning. You can't even have a fire in your backyard.

Mr. DAVIS. I think that is becoming true everywhere, but that is very recent.

Chairman MILLER. I don't think there is any question.

Mr. CABELL. Would the gentleman yield?

Is there any significant difference in the moisture content of the wood structures in that climate than you generally have in the United States?

Dr. BRANSCOMB. The notable difference of course, is the point about using masonry construction for a lot more housing on a percentage basis while in the United States it is the other way around. I think 75 percent of the housing has wooden construction. I don't know if there is any significant difference in the wood.

Mr. DAVIS. All right, sir.

Dr. WILLENBROCK. As Dr. Branscomb noted earlier, our progress has been slowed due to funding problems. Nonetheless, we are now at a level of support that permits us to see the beginning of a true central role in the attack on the national fire problem.

With respect to the sense of the Congress that there should be a fire research and safety center, I am pleased to report several actions initiated toward this end. Dr. Branscomb referred to the several fire research activities of NBS. We have completed a management survey for the integration of the on-going building fire research studies, our flammable fabrics program, and the fire research and safety programs under the act. Joint projects are underway for the unified collection and analysis of data. Laboratory facilities are used for coordinated research projects and the research needs of all aspects of the Bureau's fire programs are considered in the decisions on which projects are to be carried out. For example, in the study of toxic gas and smoke

production in fires, the research is conducted with a view to the needs of research in building safety, fabric flammability, and the protection of firefighters.

We have taken steps for greater coordination of our fire programs with other Federal agencies. Negotiations are underway, and agreement in principle has been reached for the transfer of the Federal Fire Council from the General Services Administration to the National Bureau of Standards. The Council was established by Executive order in 1936 and it is the focal point for bringing together all parties in the Federal Government concerned with the protection of Federal employees and property from fire hazards. The Council is authorized to promote and assist in the establishment of standards, adequate fire safety programs, and fire safety criteria for all Federal agencies. More than 200 personnel from 53 Federal agencies participate, serving on nine standing committees dealing with various aspects of fire protection. It conducts investigations and is a source of information and analyses of fire loss data in the Federal establishment.

Mr. DAVIS. That would be, of course, nonmilitary Federal establishments; would it not?

Dr. WILLENBROCK. Yes.

Mr. DAVIS. That wouldn't include the Forest Service, either; would it?

Dr. WILLENBROCK. The U.S. Forest Service is a member of the Council.

Dr. ROCKET. There are Department of Defense members on the Federal Fire Council; every agency which has a major interest in fire has representation, but the interest is primarily nonmilitary.

The military is the largest single landlord in terms of residential housing in the United States, onbase housing and so forth. Many of the large military bases have large complex essentially municipal fire departments to protect their onbase housing.

There have been warehousing problems. The Bureau of Yards and Docks have the same problems that ports have. Many of our cities, Boston, New York, San Francisco, have large military port facilities under the control of the military with warehouses, docks and so forth. These are very analogous to the civilian problems, and to that extent they are concerned in the Federal Fire Council. But it is primarily concerned with what you would call the civilian type.

Mr. DAVIS. All right, sir.

Dr. WILLENBROCK. We see this transfer as a significant step in the building of a central point in the fire research and safety area for the Federal Government. With the Staff and laboratory support which the Bureau can give, the effectiveness of the Federal Fire Council will be enhanced.

We are seeking to augment our in-house and relatively short-range attack on the fire problem with a more fundamental attack on the very difficult scientific problems associated with fire. Surprisingly little basic knowledge is available about fire ignition, propagation, or the toxic products of combustion. We need to know more about flame retardants and how they work, particularly for thermoplastics.

Research in gas dynamics and heat transfer should extend our knowledge of how flames spread. We need to know more about the characteristics of smoke and toxic products of combustion and their

effects on human beings. Clearly, this basic information is applicable to the development of building safety standards, fabric flammability tests, and criteria for equipment for protection of firefighters.

Chairman MILLER. Mr. Chairman, while the gentleman is on this subject, at the Lawrence Radiation Laboratory in Livermore, Calif., they have a group under a man out there who is studying the effects and control of fire that may be caused through the use of nuclear fission. Have you given any thought to this, too?

Dr. WILLENBROCK. I have not been in touch with the gentleman from Livermore Laboratory. I have been in touch with the fire research program in Berkeley Campus, though, where they have an effort—

Chairman MILLER. I don't know whether this man, of course, has a close relationship between them, but the man out there is an old friend of mine. I say an old friend; I knew his father. He is a chemical engineer and he got interested in this and he has been riding the life out of me on this particular subject.

I think this is something that is very badly needed. I want to congratulate the Bureau and we will try to do what we can to stimulate it.

Mr. DAVIS. On that general subject, I learned only recently that the number of deaths that occurred to firemen every year exceeds the number of deaths of law enforcement officers.

Dr. WILLENBROCK. Yes, sir. It is now listed as one of the most hazardous professions, second only to coal miners.

Chairman MILLER. How many people do we lose each year in fire?

Mr. DAVIS. 12,000.

Dr. WILLENBROCK. Yes.

Chairman MILLER. How many did we lose in Vietnam in a year?

Mr. DAVIS. I don't know the figures on that.

Dr. ROCKET. In the peak year in Vietnam we lost more than we lose from fire in any 1 year.

Chairman MILLER. That is the peak year.

Dr. ROCKET. But since our involvement in Vietnam, we have lost more to fire than the total U.S. casualties in Vietnam.

Chairman MILLER. This is something that is quite interesting in bringing out.

Mr. DAVIS. All right, sir.

Dr. WILLENBROCK. Currently NBS is providing the chairman for a Committee for Government-Industry Research for Apparel Flammability (GIRAF) which is providing support for university research. The funds come from the National Science Foundation and from industry, for a total of \$150,000. This subcommittee is aware of this program, but I would reiterate that such research projects are directly beneficial to the technological aspects of our fire programs.

For example, I cite the work at Johns Hopkins University, supported by NSF, which is conducted by Dr. Robert Fristrom. This research is helping us to develop laboratory scale tests of real life fire hazards, which is essential if the standards and tests we develop are to have real meaning in protecting people from fires.

In his testimony before this subcommittee, Dr. Lewis M. Branscomb, Director of NBS, indicated our support for the National Science Foundation programs for research applied to national needs (RANN). We see this program as complementary to our work which

is more closely allied with the application of science based technology to the solution of fire problems. By linking the university research community to the basic research needs in the fire field, the overall attack on the fire problem will be strengthened. During the past year we have expanded our interagency relations in other ways. Through an agreement with NASA, NBS will assemble and provide the fire hazard information input for the Aerospace Safety Research DATA Institute. NASA will fund part of the development of this fire information data bank. It will serve as the nucleus of a center to include fire and safety information of broad interest to those in the fire field. A specific project with NASA involves the possible application of fire protective clothing technology, developed in the rocket program, for use by the fire services.

As our fire programs have developed, we have received increasing numbers of requests for assistance from other Federal Agencies. Recently the Bureau of Mines has consulted with us on the development of fire safety standards, and a mutual program is being developed.

The Department of Health, Education, and Welfare has sought assistance in the development of standards for floor coverings in nursing homes.

On a broader scale, HEW has asked the NBS to participate in its planning for research and development in life safety/fire safety activities.

We are encouraging these interagency efforts, particularly as it strengthens our efforts to serve as a fire research and safety center for a unified attack on the fire problem.

Our activities with nongovernment groups are expanding. We are working with the National Fire Protection Association on fire investigation techniques as a step in the improvement of information about fires. Our industrial contacts have been growing as we work with companies such as DuPont, Monsanto, and Motorola on firefighting equipment, communications equipment, extinguishing agents, and so on. We are working with the International Association of Fire Chiefs in devising fire service training programs.

At this stage, our total fire program has three main thrusts as we continue to build the staff and consolidate the activities in one management whole.

These are: (1) continue the improvement of measurement methods and standards to provide better safety in buildings; (2) provide technical assistance for public fire protection services to increase their effectiveness; (3) continue the hazard analysis, research, and test development for fabric flammability standards.

Mr. DAVIS. I am not sure I understand No. 1. You say "continue the improvement of measurement methods." How does that enter into fire safety?

Dr. WILLENBROCK. In the development of the standards for buildings, the direction has been to develop performance standards and performance criteria, and in the development of performance criteria it is essential to have good test method measurement techniques.

Mr. DAVIS. You mean more than just a linear volume or something like this; you are talking about stress, strain, torque.

Dr. BRANSCOMB. How would you test the ability of the steel girder clad with fire protecting material to withstand fire of a given heat for a given number of hours.

Mr. DAVIS. All right, sir.

Dr. WILLENBROCK. The ongoing program activities which are specifically responsive to the requirements of the Fire Research and Safety Act of 1968 include:

(1) Research: The turnout gear and clothing firefighters wear today provide only marginal protection. Full-scale tests are being conducted on instrumented mannequins wearing various coats, boots, helmets, when exposed to heat, and simulated back-draft explosions. Fabric properties of existing firecoats—flammability, abrasion resistance, tear strength, water repellancy—have been measured. These properties are to be the basis for new performance criteria as guides for stimulating manufacturers to improve present designs; in addition to their use in purchase specifications and regulations by fire departments. The development of an improved breathing mask is underway in a joint project with NASA. Performance specifications and tests for fire ladders are also under development.

At this point let me add that we are also conducting research to assure that new innovations in building technology will not be made at the cost of safety.

We are studying the nature of fire ignition and spread on walls; and the prevention of flashover. Flashover occurs when, in a burning building, entire rooms burst into flames spontaneously. It makes effective firefighting very difficult and hazardous. I mentioned this research, directed to building safety, because the findings of this research will bear definite implications to firefighting techniques. It is also an example of the coordination between our ongoing fire research activities, and the problem of implementing the Fire Research and Safety Act. Both of these activities are pertinent to our objective of achieving a fire research and safety center, and in their management we are controlling them as components of an overall fire program.

(2) Fire services support: There is little or no firefighting training available for first-level fire command officers in smaller cities in the United States.

In a project which responds to this need and is in keeping with the specific mandate of the Fire Research and Safety Act of 1968 to develop educational training programs, NBS has arranged for the cooperation of fire departments of 14 of the largest cities in the country that have command training programs, to provide training for officers in cities of 100,000 or less.

In the first phase, courses are planned for seven regions of the country. Subsequently, officers will be selected from those providing and receiving training to become a cadre to conduct additional courses at the local levels, thereby multiplying the impact of the program. The training will open to the local fire departments an opportunity to observe and consider the most advanced firefighting techniques and practices in the country.

We have also developed computer programs for optimum allocation of resources, fire station location, manpower development, and equipment replacement. The objective is to provide smaller communities with operation research techniques useful in planning and operating their fire services.

(3) Improved fire data reporting: A firefighter injury classification system has been developed by NBS in cooperation with the International Association of Firefighters, and several municipal fire departments.

This system will identify operational procedures and other causes of accidents by firefighters. The information will help establish the priority for equipment, clothing, and practices development. A pilot procedure for uniform fire accident reporting is being tested in the Washington metropolitan fire services.

In conclusion, I would like to say:

1. The national need is urgent. The loss of 12,000 lives a year is an appalling and unacceptable tragedy. Equally unacceptable are the hundreds of thousands of injuries sustained by our Nation every year.

Property losses are going up as the cost of building and replacement rise. The experience of other nations shows that a concentrated program can cut fire losses.

2. Elements of a strong program to reduce national fire losses exist at NBS. We are committed completely to the urgency of the task, and are marshaling all our resources in support of this program.

3. We are encouraged by the cooperation and participation of other Federal agencies. We believe that the foundation for a national fire center has been set, and with our efforts to consolidate the programs we are desirous of moving forward as rapidly as funding will permit.

Thank you, Mr. Chairman.

Mr. DAVIS. Thank you, Dr. Willenbrock, for a very good statement on the subject at hand.

Does any member have a question of Dr. Willenbrock?

Mr. CABELL. No, sir.

Mr. DAVIS. If not, we will hear from Dr. Rocket, then, who is chief of the Fire Research and Safety Office in NBS.

Dr. ROCKET. I don't have a prepared statement. I don't think I have anything to add unless you have specific questions you would like to ask.

Mr. DAVIS. I don't have at the moment.

Mr. Cabell, do you have a question of Dr. Rocket?

Mr. CABELL. No, I do not.

Mr. DAVIS. We would like the privilege of submitting questions to you, if we may, so the answers might be supplied for the record.

All right.

Mr. BOONE. May I ask some questions where required by the rules?

Mr. DAVIS. About submitting questions in the future?

Mr. BOONE. No, sir; we need a forecast of funding for the next 5 years, which might be pertinent at this point, according to the rules of the House.

Mr. DAVIS. May I just ask the gentlemen to submit that for the record, then. I will let you confer with Mr. Boone after this is over. We had not conferred previously. You can supply that for the record.

Dr. BRANSCOMB. I have such a formal statement.

Mr. DAVIS. All right, sir. Now, let's see as to the format here.

(The statement follows:)

ANSWERS TO ADDITIONAL QUESTIONS SUBMITTED TO NBS FOLLOWING HEARINGS ON H.R. 7189, AUTHORIZATION OF APPROPRIATIONS FOR STANDARD REFERENCE DATA ACT, AUGUST 3, 1971

Question 1.—What is the organization within the Bureau of Standards to carry out this work? How many personnel are involved? What will be the future requirements for personnel?

Answer.—The organization within the Bureau of Standards concerned with standard reference data activities consists of the Office of Standard Reference Data and a number of specialized data evaluation projects located in other divi-

sions of the National Bureau of Standards. In addition, there are several other data evaluation projects, located at laboratories in universities, research institutes and in private industrial organizations.

The Office of Standard Reference Data provides a management function and other central operations for the entire Standard Reference Data System, within the National Bureau of Standards and outside. The Office has a staff of sixteen (eleven professional and five clerical). Professional staff are distributed as follows:

Central and data program management—6

Information services and publications—2

Data systems design group—3

Most of the professional personnel working on NBS data evaluation projects directly are involved on a part-time basis. About 50 NBS staff members are involved. The outside projects include about 50 more people working full-time or part-time. With the FY-1973 expansion proposed, about 40 additional people would be working on Standard Reference Data projects. The staff of the Office of Standard Reference Data would be increased by only one or two persons.

Question 2.—How are the funds utilized within the Bureau? What amount is used for outside contract? For goods and supplies? For salaries?

Answer.—Most of the funds utilized within the Bureau of Standards support data compilation activities in specialized technical areas. About two-thirds of the data compilation work supported by the Standard Reference Data System is performed by NBS divisions and one-third by outside organizations under contract. Both NBS divisions and contracting organizations spend most of their funds for salaries, and relatively small amounts for goods and supplies. Some data projects require substantial expenditures for computer time. A typical budget is presented here:

<i>Budget—Typical NBS Data Evaluation Center</i>		<i>Percent</i>
Direct salaries.....	-----	46
Overhead expense (includes a share of general administration, administrative services, personnel benefits, equipment, and plant operation and maintenance).....	-----	42
Computer time.....	-----	6.5
Technical services, goods, and supplies.....	-----	5.5

Question 3.—What is the organization within the Bureau for checking results of outside researchers? How extensive is the work duplicating results obtained by others?

Answer.—Manuscripts of data compilations submitted to the Office of Standard Reference Data are reviewed carefully by scientifically qualified people inside and outside of the National Bureau of Standards. However, NBS does not usually undertake to check the results of outside experiments by duplicating experimental work. This would be done only under circumstances when:

(a) The experimental value in question was a crucial one, and

(b) NBS scientists had capabilities to perform a highly accurate measurement.

Such work is referred to as "benchmark experiments," since the values obtained provide the point of reference for many other experimental values. A few benchmark measurements have been or are being made. This is regarded as a significant NBS contribution to the SRD program.

Question 4.—What measure does the Bureau have of the usefulness of the results published so far? Are there widespread requests for documents?

Answer.—The best indication of usefulness is case histories provided in letters and other statements volunteered by technical users of the documents and by anecdotes recounting their value. Three examples are given below:

Laser development.—When the theoretical concept of the laser was proposed in 1958, no one knew whether any real materials had the properties required to build a working device. Reference tables of atomic energy levels, prepared at NBS many years before the idea of a laser was even suggested, proved invaluable at this time. Professor W. R. Bennett, of Yale University, who built the first working gas laser, wrote in 1966: "The monetary value of the material provided through the Standard Reference Data program and the concurrent program of measurement of key data is probably least adequately appreciated. In particular, we wish to emphasize that the economic value of this type of material goes far beyond the cost of equivalent time to repeat the measurement or look up the data in the library. In some instances the availability of compilations of critically evaluated data has served an extremely important role in the conception and development of entirely new areas of technology. For example, the three volumes of critically compiled data on Atomic Energy Levels (NBS Circular No. 467) played an essential role in

the development of the gas laser. Without the existence of these data the development of the gas laser field (which is about 5 years old and currently represents an industrial business volume in excess of \$20 million a year) would have been delayed for many years."

Ethylene pipelines.—Petrochemical companies in both the U.S. and Europe are now pumping multi-ton quantities of ethylene and propylene through pipelines. These gases are the raw materials for production of plastics and other chemical products. Accurate metering of the material flow is essential for internal accounting, customer billing and, at national boundaries, for customs and other purposes. Reliable and internationally agreed-on data on the pressure-volume-temperature relationships of these substances are essential to the metering process. Such data have been compiled and evaluated through an international project in which the National Standard Reference Data System has played a major part. Reliable data were ready when the need arose.

Radioastronomy.—One of the most exciting frontiers of science today is the study of molecules in interstellar space. The first discovery of an organic molecule in space came in 1969, almost exactly in coincidence with the publication of NBS Monograph 70, a five-volume set of reference data on microwave spectra of molecules. These volumes were immediately adopted as the basic reference source by all research workers in the field. Professor C. H. Townes, a Nobel Laureate and leader in this research, has written:

"The existence of the NBS tables has made it possible for a large number of radio astronomers and almost every suitable telescope to turn attention to the discovery and examination of molecular microwave lines, even though most radio astronomers have not previously been very familiar with molecular spectra. For those of us having more experience with microwave spectra, the tables have also been very valuable. The literature is now so large that it would be very time-consuming for anyone to try to search the literature for all the molecular information needed to assess the most promising astronomical searches. Now that I am myself getting back into the field, I realize how discouraging the job would have been without the existence of the NBS tables. This brings up the question whether there are plans to update these microwave tables. I certainly hope that they can be revised and brought up to date periodically. There are, of course, many other applications for these tables besides their recent use for astronomy. It seems to me that one of the Bureau of Standards' primary and more important roles is to provide a modern assembly and critical judgment of information in the literature, which will facilitate further scientific progress."

As to the distribution of Standard Reference Data documents, since 1964, the Standard Reference Data Program has published thirty-six compilations of data in its primary series, the NSRDS-NBS series. The total number of documents produced on behalf of the Standard Reference Data System (including the NSRDS-NBS Series identified above, plus bibliographies, monographs, computer programs, expository publications and status reports) is 90. The total distribution of all documents is estimated to be approximately 200,000 copies.

We have not been wholly satisfied that the output is optimally available to the technical community. This is one of the principal reasons why we sought additional operating flexibility through legislation, which we are utilizing through the new publication procedure.

Question 5.—How are the documents published and disseminated? What is the status of the agreement to work with engineering societies to publish these data? What is the form of publication?

Answer.—As indicated in Dr. Brady's statement, most of the documents have in the past been published and disseminated through the Government Printing Office. The National Bureau of Standards has recently formalized a cooperative program with the American Institute of Physics and the American Chemical Society under which these two organizations will handle the printing, distribution and marketing of a Journal of Physical and Chemical Reference Data. This Journal will be similar in appearance to other scientific journals. Initially, it will appear four times a year and will provide a minimum of 1200 pages of compilations of reference data. Compilations on individual subjects will probably also be available for individual purchase as hard-bound books. It is anticipated that this new form of publication will provide not only wider distribution of the output of the Standard Reference Data Program but a substantially higher level of actual use by the scientists and engineers who need this kind of technical information.

Question 6.—What is your estimate of fund requirements for the next five fiscal years?

Answer.—The attached fiscal projections have been prepared in accordance with prevailing guidelines and are subject to the limitations noted thereon.

DEPARTMENT OF COMMERCE—NATIONAL BUREAU OF STANDARDS
STANDARD REFERENCE DATA PROGRAM—5-YEAR PROJECTION ¹

[In thousands of dollars]

	Fiscal year—				
	1972	1973	1974	1975	1976
Data evaluation:					
In-house.....	1,086	1,537	1,537	1,537	1,537
Contracts.....	583	1,266	1,266	1,266	1,266
Total.....	1,669	2,803	2,803	2,803	2,803
Data systems and design: In-house.....	116	185	185	185	185
Information services: In-house.....	100	100	100	100	100
Management:					
In-house.....	320	317	317	317	317
Contracts.....	41	41	41	41	41
Total.....	361	358	358	358	358
Special foreign currency program (grants).....	178	178	178	178	178
Summary:					
In-house.....	1,622	2,139	2,139	2,139	2,139
Contracts and grants.....	802	1,485	1,485	1,485	1,485
Total.....	2,424	3,624	3,624	3,624	3,624

¹These estimates represent projections of cost expressed in constant dollars at prices existing at the time the estimates are prepared. They are not intended to predict future economic conditions, and do not reflect possible changes in the scope or quality of the proposal which might result from experience gained in actual practice. Further, the resources which might appropriately be applied in later years will require a reexamination of the relative priorities of this and other Government programs, in the light of economic and other circumstances then prevailing. Thus, the estimates do not represent a commitment as to amounts to be included in future budgets.

Dr. BRANSCOMB. We would now like to discuss the National Standard Reference Data system. Although some of the activities in this program have had long and distinguished histories at NBS, it was only in 1968 that Congress passed legislation which recognized the need for a systematic national program to provide reliable reference data to the Nation's scientists and engineers. This committee had a major part in writing the Standard Reference Data Act, Public Law 90-396, and we are glad to have the opportunity to appear before you and report on the progress of the program.

The quantitative facts about nature on which both progress and usefulness of science depend are recorded in scientific literature as numerical data about the properties of matter. Most of these data are not produced as the deliberate result of efforts to obtain accurate data for solving the problems of scientists and engineers. Such programs are necessary, but they are slow and expensive.

Most of the numerical data on properties are the byproduct of research exploring new phenomena. Properties are measured and recorded in the literature for others to use in the process of almost every scientific investigation into the physical world.

I would not want to startle any of the members of this distinguished committee who might still believe in the infallibility of science, but I must confess that when scientists, or engineers too, make a measurement in the laboratory, they do not always get the right answer.

More specifically, since no measurement is perfect, they do not always get as accurate an answer as they claim to have, sometimes by a large measure. Usually this is because reliably accurate data was not the investigator's main purpose. Nor, when they write up their work for publication, do scientists always explain what they

have done in comprehensive terms, so that other scientists can understand them and objectively evaluate their work. The result is that the scientific literature is filled with numerical data, some good, some bad, others of unknown quality. The scientist or engineer who wants to use one of these numbers must possess the right combination of skill and serendipity in order to choose the best one. And the growing output of the world's prolific scientists, with their up-to-date instruments and faster computers, makes this problem worse every year.

The reason, of course, that we want to have the good results evaluated and compiled is that numerical data on important properties are useful for many applications in addition to the one that induced the original measurement. You need to know some of the same properties of tungsten whether you are making a razor blade or a light bulb, and these properties may have been measured by someone who had no interest in either razor blades or light bulbs. If you can find a reliable value in a handbook, you don't have to go into the laboratory and measure it yourself or trust your luck in a value found by a laborious search through the literature.

There is another reason for finding out how good the measurements in the literature are. Scientists don't want to produce unreliable data; they continue to improve their methods when deficiencies are pointed out. But critical self-examination does not necessarily come more easily to scientists than to other humans. It often takes a detached expert, looking objectively at the work of many different scientists, sometimes representing different disciplines, to pick up a major source of error which no one had taken into consideration before. Once these pitfalls are recognized and widely publicized, most scientists will take due care in avoiding them. Those who do not take care rapidly lose credibility among their peers and, hopefully, the support of their sponsors.

It is certainly unnecessary to remind this committee of the size of the national investment in research and development. A small increase in productivity or reliability of research output can enhance by a very large amount the dollar benefits resulting from this research and development investment. In the fields of physics, chemistry, and related engineering disciplines, which are responsible for generating most of the data falling within the scope of the standard reference data program, the annual funding of basic research alone by the Federal Government is at least \$600 million. This amount of money generates large quantities of physical and chemical property data which are buried in 30,000 or more scientific papers published each year. These data represent one of the major potential benefits of that \$600 million investment in basic research. A primary aim of the standard reference data program is to improve the effectiveness of that investment, first by selecting the best of the data and making them available for all to use, and, second, by upgrading the quality of future measurements.

There is another important factor to consider. The output of American scientists represents less than 30 percent of the world's research in these fields. If the other 70 percent can be made available for use by our own scientists and engineers, it will not be necessary for us to spend the money to do these measurements.

However, it is hard enough to know how much confidence to place in measurements done by one's own friends and associates; evaluation

of data obtained in other countries, usually with unfamiliar instruments, and often reported in a foreign language, is a very difficult task. The standard reference data program undertakes this job in a systematic and efficient manner, retrieving data from the entire world literature and subjecting them to critical standards of evaluation.

The bill under consideration by this committee, H.R. 7189, calls for authorization for an appropriation for fiscal year 1972 and thereafter such sums as may be necessary for the purposes of the program. Such an authorization would be consistent with the authorization for the great majority of the programs of NBS, which rest upon the basic Organic Act of the Bureau. As was discussed in the hearings before this committee on the standard reference data bill in 1966, NBS already had the authority to conduct the basic program, that is, to organize a systematic effort to evaluate and compile data on properties of matter needed by scientists and engineers. The major additional authorities provided by the Standard Reference Data Act were authority to copyright NSRDS publications, to recover proceeds from sales, and to use the proceeds for the purposes of the program. We now have devised a plan to use these additional authorities; it will be described to you shortly.

I do not ask for a continuing authorization from a desire to reduce this committee's review of the program. We regard the NSRDS as one of our high priority activities and I want it to be visible, both to you and the entire technical community of the United States. I plan to help the program expand in scope and in effectiveness. But the value of this program steadily accumulates over the years as the enormous body of scientific data in physical properties is subjected to critical examination and put in the hands of those who can put this information to good use. A continuing authorization is appropriate to a program of continuing and accumulating value. If the Congress approves a continuing authorization, I hope that this committee would give us an opportunity to report occasionally on progress and problems in this program.

In a few moments a more detailed statement on the standard reference data program will be presented by Dr. Edward L. Brady of NBS. He is Associate Director for Information Programs and is responsible for general supervision of the program. He is accompanied by Dr. David R. Lide, Jr., Chief of the Office of Standard Reference Data, who has direct responsibility for program management.

I would like to be joined by Dr. Brady and Dr. Lide.

Dr. Brady has prepared for you a fairly detailed statement and I believe it is his plan with your permission this morning to highlight that statement in the interest of brevity.

Mr. DAVIS. That will be perfectly fine.

Dr. BRADY. Thank you, Mr. Chairman.

(The biographical sketch of Dr. Brady follows:)

BIOGRAPHY OF DR. EDWARD L. BRADY, ASSOCIATE DIRECTOR FOR INFORMATION PROGRAMS, NATIONAL BUREAU OF STANDARDS, U.S. DEPARTMENT OF COMMERCE

Dr. Edward L. Brady was born in Charleston, South Carolina, on April 21, 1919. He was educated at the University of California at Los Angeles (B.A., 1940, and M.A., 1942, in chemistry) and Massachusetts Institute of Technology (Ph. D. in physical chemistry, 1948).

Dr. Brady began his professional career in 1942 as a Research Assistant in the Fission Chemistry Group at the Metallurgical Laboratory at the University of Chicago, one of the major laboratories of the war-time atomic bomb project. From there he went to Clinton Laboratories at Oak Ridge, Tennessee, the forerunner of the present Oak Ridge National Laboratory. At Oak Ridge he was a member of the group that designed and operated the first large scale hot laboratory facilities ever built. While a graduate student at Massachusetts Institute of Technology, 1946-1948, he was in charge of chemical separations of cyclotron irradiated materials. During the years 1948-1959 he was employed by the General Electric Company at its corporate Research Laboratory and at the Knolls Atomic Power Laboratory (KAPL). While at KAPL he led a research group on coolant chemistry and a group developing equipment for in-pile tests of reactor materials. From 1956-1958 he took a leave of absence to serve as U.S. Atomic Energy Commission Representative to the United Kingdom, stationed in London, England. In 1959 Dr. Brady became the Senior Advisor on the staff of the U.S. Mission to the International Atomic Energy Agency in Vienna, Austria. He left Vienna in 1961 to become Assistant Chairman of the Chemistry Department of the General Atomic Division of General Dynamics Corporation (now Gulf General Atomic), where he had responsibility for various projects connected with chemical and materials problems of nuclear power plants.

Dr. Brady came to NBS in 1963 to serve as Chief of the Office of Standard Reference Data. In this position he was responsible for directing the National Standard Reference Data System (NSRDS), established at the National Bureau of Standards in June of 1963 in response to a recommendation of the Federal Council for Science and Technology. The NSRDS program produces critical evaluations of measurement methodology in the physical sciences and compilations of evaluated data on the properties of substances.

In December of 1968 NBS reorganized its technical and public information programs to combine all of the major NBS units which gather, analyze, publish, and distribute scientific and technical information under an Associate Director for Information Programs. Dr. Brady assumed this position upon its creation, and now directs the activities of the Office of Standard Reference Data, the Clearinghouse for Federal Scientific and Technical Information, the Office of Technical Information and Publications, the Library Division, the Office of Public Information, and the Office of International Relations.

Throughout his scientific career, Dr. Brady has specialized in physical chemistry and radiochemistry. His publications are in these fields and on the problems of handling technical information. He is a member of the American Chemical Society, the American Nuclear Society, the American Physical Society, the American Association for the Advancement of Science, and the Cosmos Club. He has served as member of committees of the Department of State, the National Research Council, the American Chemical Society, the American Institute of Physics, and the Organization for Economic Cooperation and Development (OECD).

Dr. Brady and his wife, the former Evelyn Padway, reside in Washington, D.C.

(The full statement of Dr. Edward L. Brady is as follows:)

PREPARED STATEMENT OF EDWARD L. BRADY, ASSOCIATE DIRECTOR FOR INFORMATION PROGRAMS, NATIONAL BUREAU OF STANDARDS

Mr. Chairman, Members of the Subcommittee, I am happy to have this opportunity to appear before you today to support the authorization bill for appropriations for the National Standard Reference Data System. I want to report on its accomplishments and tell you why we consider it to be a major service to the people of this nation. It is a means of systematizing, managing, and enhancing the usefulness of a small, but important, portion of the national scientific and technological enterprise.

Every day we hear the word "data" used in many ways: the ubiquitous phrase "ADP" stands for "Automatic Data Processing"; people collect "data" on automobile accidents; we say that the observed "data" support a particular conclusion. Since the word "data" is used so frequently and with so many connotations, let me first clarify the meaning as we use it in the phrase "Standard Reference Data." What we mean by "data" is *none* of the meanings implied by "ADP" or "accident data" or "supporting data." In our usage, "data" refers to quantitative numerical values of physical and chemical properties of substances. The boiling point of a liquid, the mass of an atom, the amount of heat released when a given substance burns, the rate at which an undesirable pollutant decom-

poses in water—these are examples of the kind of quantitative numerical data that we focus on. Since substances behave the same way in Laboratory B as they do in Laboratory A, such data, once accurately measured, can be used over and over by scientists and engineers throughout the world. When data of this kind are extracted from the technical literature of the world, evaluated by a specialist, and compiled for convenient use, we call them "Standard Reference Data."

Now, what are we trying to accomplish in the Standard Reference Data Program? And why should the National Bureau of Standards be the logical focus of this effort? The mission of NBS is "to strengthen and advance the nation's science and technology and to facilitate their application for public benefit." In pursuing this mission, NBS operates several programs that promote accurate, meaningful, and compatible scientific and technological measurements. We are the guardian of the good health of the nation's measurement system. An essential feature of this task is to find out how well the measurement system is working. Can mass, length, temperature be measured as accurately and reliably as necessary? How good are the techniques used to measure thermodynamic properties, optical properties, and magnetic properties? How accurate and how reliable are the results of measurements of these properties using available techniques?

Today we are discussing one of the means used by NBS to investigate these questions, the Standard Reference Data System. The mission of this program is to evaluate measurement techniques and measurement results, and to provide the evaluated data to the nation's scientists and engineers. Operationally, then, the NSRDS consists of two distinct efforts: an analytical part and an information dissemination part. The analytical part is a research program; only technically sophisticated specialists have the knowledge and the judgment to evaluate techniques and data and identify the highest quality, most reliable work. The NSRDS data centers at NBS and other laboratories are under the direct supervision of research management and are located in components conducting active experimental and theoretical investigations. The information dissemination part of the effort consists of the preparation of publications, computer tapes, programs, and other records of results and also the provision of individualized services, such as special searches of our files or selections of data needed for special purposes by user groups.

The two-fold operational program has a two-fold objective: first, to improve the quality and productivity of scientific and technological measurements, and second, to provide reliable data that are needed by scientists and engineers in their everyday tasks of putting science to work.

Let us examine the first goal in more detail. Improvement in quality and productivity is a direct result of the analytical effort just mentioned—that is, the critical evaluation of data. NSRDS publications contain detailed discussions of the sources of error in each type of measurement, and recommendations are made for the generation and reporting of data of that type. Pitfalls that could lead to uncontrolled, systematic errors are pointed out.

By studying the contents and citations of papers in a number of fields of science, we have found that NSRDS evaluations are having a major impact. For example, we found that the publication, Atomic Transition Probabilities, NSRDS-NBS-4, by Dr. Wolfgang Wiese of NBS was cited 20 times as often as the average major publication in this field and that his results were frequently referred to as the "standard" data.

I would like to give another example of the use of data from an NSRDS center, an example involving an event of special interest to this Committee. Two members of the NBS Cryogenics Division served as part of a six-man board of consultants to establish the sequence of events leading to the Apollo-13 incident. Several possible alternative explanations to account for the observations telemetered back to earth from the spacecraft were advanced by the investigating team. Through calculations based on reliable and accurate data on the physical properties of oxygen and its compounds, the investigating team concluded that the combustion of teflon insulation used on internal electrical wiring created the observed rapid pressure rise and eventually led to tank failure. Some of the property data used for this analysis had been determined experimentally by the staff of the NBS Cryogenics Division. All data had previously been subjected to critical evaluation, taking into account data from several other laboratories throughout the world, in the Cryogenics Data Center, a charter group of the NSRDS. On the reliability of this conclusion rested the redesign of the oxygen tank. If the data had not been on hand when needed, costly delays and uncertainty might have resulted.

Formal efforts to improve standards of measurement have been made in several cases. A set of criteria for measuring infrared spectra was established several years ago and has been widely accepted throughout the world. Other projects now active will lead to similar criteria in the fields of Mossbauer spectroscopy and nuclear magnetic resonance. A major aim of these efforts is to establish criteria for obtaining reliable data on commercially produced instruments that are widely distributed in U.S. laboratories. These instruments are used for chemical analysis and industrial process control, for research on new products, for identification of trace contaminants, and for many other purposes. In the study of nuclear magnetic resonance spectrometers, more than 200 laboratories are taking part in a comparison of measurements on the same standard material.

The participation of so many chemists and physicists in the project shows that scientists are eager to improve their techniques under the coordinating influence of NBS. The study is expected to show whether the way these instruments are being used will produce reliable data of known accuracy. Preliminary results already have pointed out certain sources of error which were previously unsuspected. The instruments which are actually being used in this survey represent a capital investment of over \$13 million; the total inventory of instruments of this type in the United States is estimated at about \$55 million, and the annual operating budget to use these instruments effectively is approximately the same figure. Thus an NBS investment of several thousand dollars is making it possible for an investment of tens of millions to be significantly more productive. This illustrates the great leverage which exists for improving the effectiveness of the national investment in scientific research.

Similar examples to illustrate the impact of the NSRDS program on the quality and productivity of measurement laboratories can be given in each of the many fields in which we are active. Within NBS, the NSRDS data centers help management decide how NBS resources for measurement research can best be used. By helping to identify needs for improved techniques and more reliable data, the NSRDS centers locate weaknesses in our national measurement system, pointing out where strengthening is needed.

Now I would like to turn to the second goal previously mentioned—that of providing data found to be reliable to the scientists and engineers who need them in their everyday work. We believe that the Standard Reference Data program, even at its present modest level of activity, contributes directly to the achievement of almost every technical objective of our society. To illustrate the universal need for property data, let us consider what kinds are required in making progress toward a few specific goals. I have chosen only two illustrative goals; almost any others could be selected that involve a technological fix to the problems of society. The two goals are pollution abatement and improving the national supply of power.

Figure 1 lists some of the problems connected with air pollution abatement: (1) identification of pollutant molecules, (2) reduction of unburned molecules in auto exhausts, (3) cleanup of polluted air, (4) incinerator design, (5) transport of pollutants, and (6) identification of particulates. Finding solutions to these problems are major tasks facing us today. In Figure 2, the first problem is examined in more detail and some of the kinds of data needed to identify molecules are listed. The left-hand column shows that data on infrared spectra, microwave spectra, and reaction mechanisms help to identify molecules, while the right-hand column lists related NSRDS projects. The list of data needed for identification of molecules is not comprehensive, but most methods for identification of gaseous species are based on these data. In listing NSRDS projects which supply each kind of data, again I have been illustrative rather than comprehensive. Figure 3 shows that certain types of thermodynamic and kinetic data are needed to study the problem of unburned molecules in automobile exhausts and lists a number of related NSRDS projects.

FIGURE 1—DATA NEEDED FOR AIR POLLUTION STUDIES

PROBLEM

1. Identification of Molecules in air.
2. Reduction of unburned molecules in auto exhaust.
3. Clean-up of polluted air.
4. Incinerator design.
5. Transport of pollutants in air masses.
6. Identification of particulate matter.

FIGURE 2

Identification of molecules in air

<i>Data needed</i>	<i>NSRDS project or publication</i>
A. Infrared spectra-----	Coblentz Society IR spectra.
B. Microwave spectra-----	Microwave Spectral Data Center. Microwave spectral tables.
C. Reaction mechanisms-----	Chemical Kinetics Information Center. Tables of bimolecular gas phase reactions. Gas phase reaction kinetics of neutral oxygen species. Kinetic data on gas phase unimolecular reactions. Bond dissociation energies in simple molecules.

FIGURE 3

Reduction of unburned molecules in auto exhaust

<i>Data needed</i>	<i>NSRDS project or publication</i>
A. Heats of combustion-----	Thermochemical data project.
B. Free energy of formation-----	Thermodynamic data on organic compounds. Thermochemical data project.
C. Thermal conductivity-----	Transport properties of fluids.
D. Reaction mechanisms-----	Chemical Kinetics Information Center. Tables of bimolecular gas phase reactions. Gas phase reaction kinetics of neutral oxygen species. Kinetic data on gas phase. Unimolecular reactions.
E. Catalytic behavior	

FIGURE 4

Incinerator design

<i>Data needed</i>	<i>NSRDS project or publication</i>
A. Heats of combustion-----	ASME project on incinerator design. Thermochemical data project.
B. Free energies of formation-----	Thermochemical data project.
C. Reaction kinetics-----	Thermodynamic data—organic compounds.
D. Thermal conductivities-----	Transport properties of fluids.

In Figure 4 the problem of interest is incinerator design, an area where we have made a special contribution. Last year the Committee on Incinerator Design of the American Society of Mechanical Engineers asked us to prepare for them a special compilation of thermodynamic data needed for the design of incinerators. It was possible to do this rapidly and relatively cheaply by selecting appropriate data from the already evaluated storehouse in the NBS Thermodynamic Data Center, data that had been evaluated for other purposes. The ASME Committee paid us the full out-of-pocket cost of preparing the compilation—\$15,000. If the base of existing data had not been available, it would have been necessary to do the job from the beginning, at immensely greater cost in dollars and time. We estimate that not less than half a million dollars would have been required. This illustrates the great economies that result from the systematic approach to data compilation and evaluation which is the heart of the NSRDS program.

Figure 5 lists data needed for one aspect of attaining the next social goal—the improvement of electrical power generation and distribution. This Figure shows some of the kinds of data needed to design nuclear power plants for electrical power generation. Figure 6 shows some of the kinds of data needed for the development of fuel cells and batteries, and Figure 7 shows data needed for the development of power distribution systems.

As I mentioned earlier, similar lists of properties and NSRDS projects could be drawn up for almost every technological problem of society. Perhaps the most important point to emphasize is that the *same properties* would appear on many lists. This is evidence of the broad usefulness of our program. One of the reasons the Federal Council for Science and Technology originally requested NBS to

assume responsibility for managing the program was that only NBS within the government laboratory network has the mission of supplying data of general applicability to science and technology. Indeed this is one of the activities specifically authorized in the NBS Organic Act.

FIGURE 5

Data needed for power generation studies—Nuclear energy as a source of power

<i>Data needed</i>	<i>NSRDS project or publication</i>
A. Neutron cross-sections-----	National Neutron Cross-Section Center (AEC).
B. Decay half-lives-----	Table of Isotopes.
C. Thermal conductivities-----	Thermal conductivities of selected materials.
D. Heat capacities-----	
E. Corrosion behavior-----	Diffusion in Metals and Alloys Data Center.
F. Coolant viscosities-----	

FIGURE 6

Data needed for power generation studies—fuel cells and batteries

<i>Data needed</i>	<i>NSRDS project or publication</i>
A. Free energy of formation-----	Chemical thermodynamic materials.
B. Heat capacities-----	
C. Thermal conductivities-----	Thermal conductivities of selected materials.
D. Reaction kinetics-----	Thermodynamic properties of electrolyte solutions.
E. Diffusion coefficients-----	Molten Salts Data Center electrolyte solutions.
F. Electrical conductivities-----	Molten Salts Data Center.
G. Viscosities, densities-----	

FIGURE 7

Data needed for power generation studies—power distribution

<i>Data needed</i>	<i>NSRDS project or publication</i>
A. Electrical conductivities-----	Compilation of energy gap data.
B. Insulator properties-----	Compilation of static dielectric constants.
C. Thermal conductivities-----	Transport properties of fluids.
D. Cryogenic properties-----	Cryogenic Data Center.
E. Superconductor properties-----	Superconductive Materials Data Center.

FIGURE 8—ENTRIES IN ABSTRACT JOURNALS

	Physics abstracts	Chemical abstracts
1957-----	10, 001	101, 027
1962-----	24, 236	169, 465
1967-----	40, 788	239, 481
1968-----	50, 477	251, 884
1969-----	49, 619	282, 803
1970-----	79, 830	309, 712
1971-----	80, 000	330, 800

The NSRDS program has been in existence since 1963. Although the program has been operating at a much lower level than was felt necessary even in 1963, a significant dent has been made in the backlog of published papers which contain useful data. However, the rate of generation of new data has increased sharply during this period. Figure 8 illustrates the growth of the literature in physics and chemistry, as reflected by the number of annual entries in the principal abstract journals in these fields. These figures show that the size of the job has at least doubled since the initial planning of the NSRDS program in 1962. The true increase in the amount of published data is even higher than indicated by these figures, since advances in scientific instruments have tended to increase the amount of quantitative data contained in the average paper.

It would be tempting to assume that the older scientific literature can always be discarded in favor of more recent measurements. However, evaluations carried out by NSRDS data centers show that this is not the case. Good data are often as likely to be 20 years old as 2 years. A good example is provided by a selected list of thermodynamic key values recently agreed upon by the Committee on Data of the International Council of Scientific Unions (CODATA). The NSRDS Thermochemical Data Center played a major role in establishing these best values. Of the references to the original literature which provide the documentation for this list, we find that one paper was written before 1900, three papers between 1900 and 1919, 21 between 1920 and 1939, 17 between 1940 and 1959, and 31 since 1960. Thus the number of significant references to literature more than 10 years old considerably outnumbered the useful material less than 10 years old. You may be wondering whether the papers mentioned constituted the complete world's collection of literature purportedly concerned with these key values. By no means! No less than 10 times as many papers were examined and found not worthy of considering in the derivation of the key values. We can therefore draw two conclusions: (1) old data are not necessarily bad data, and (2) of the total number of papers reporting thermodynamic data in the literature (in this specific instance, at least) less than 10% contained data of standard reference quality.

I would now like to describe briefly the progress the National Standard Reference Data System has made in its task of supplying critically evaluated data to the nation's scientists and engineers since its inception in 1963, emphasizing particularly the period since the authorization hearings two years ago. The critical reviews and compilations that constitute our principal output are prepared by specialists in data centers, some located in the laboratories of NBS, some in universities or other laboratories of NBS, some in universities or other laboratories outside NBS. The reason for this dispersion is that the task of critical evaluation can only be done properly by experts in the research discipline producing the data, men and women who have demonstrated their competence and who maintain that competence by continuing contributions to the progress of science in their fields. Twenty-four data centers receive full or partial support from NSRDS; of these, fourteen are at NBS. These centers have a continuing responsibility to compile and evaluate the data in their own technical areas in a systematic manner. In addition, there are about 30 active projects of a short-term nature; these are projects which are established to carry out a specific job of well defined scope. The program is under continuous review, and support is transferred to new technical areas as these individual compilation jobs are completed.

The tangible output of the NSRDS program is found in the tables of evaluated data, bibliographies, and other material which have been published. Figure 9 summarizes this output to date. After an initial induction period during which data centers were established and methods of operation developed, the output has reached a level of 1000-1500 pages of evaluated data per year.

FIGURE 9

	Data compilations		Bibliographies, etc.	
	Number	Pages	Number	Pages
1963-68.....	30	4, 151	37	4, 150
1969-70.....	19	2, 982	12	2, 472
Total.....	49	7, 133	49	6, 622

The majority of the publication issued so far have been published through the Government Printing Office and sold by the Superintendent of Documents. The direct sales of compilations of numerical data amount to about 65,000 documents; in addition, about 35,000 documents have been distributed to libraries under formal exchange agreements. Thus, about 100,000 documents containing evaluated numerical data have been distributed to the scientific and technical community since the establishment of the NSRDS program.

Attention has recently been directed to repackaging of data for certain user groups who are concerned with major technological problems. The collection of data on thermodynamic properties for design of incinerators has already been mentioned. These data are expected to play an important part in a program aimed at design of more efficient, safer, and pollution-free incinerators. Another current project involves the preparation of data sheets on chemical substances which play a significant role in air pollution. Many different kinds of data will be col-

lected in these sheets. Through this type of repackaging the most reliable physical property data will be made available to the growing number of scientists who are involved in air pollution research.

Although a considerable impact has been made in those technical areas where the available resources have been concentrated, a great deal remains to be done. We estimate that the present NSRDS funding level permits adequate coverage of only about 15% of the data currently published in the world scientific literature. Data programs sponsored by other government agencies and those operating in other countries fill a small part of this gap. However, the reduction in funding by agencies such as DoD, AEC, and NASA has already caused a worsening of the situation. This reduction is particularly unfortunate in view of the provision in the Standard Reference Data Act that "All agencies and instrumentalities of the Federal Government are encouraged to exercise their duties and functions in such manner as will assist in carrying out the purpose of this Act."

The Standard Reference Data Act (Public Law 90-396) gave additional authority to the Secretary of Commerce that makes possible a more flexible distribution mechanism for the output of the program. This Act provides for copyright of data publications and assignment of the copyright to non-government publishers. It also authorized recovery of some of the costs through the sale of data publications. Since receiving this authority, we have explored a number of ways to use it to maximum advantage, keeping in mind our obligation to make the program of maximum usefulness to the American people while simultaneously recovering as much of the costs as is "practicable and appropriate." We are now proposing to make a major change in our practices for publication and dissemination of our output.

Over the past several years studies of the "Information Problem" have been conducted by the National Academy of Sciences, the Committee on Scientific and Technical Information of the Federal Council for Science and Technology, the President's Science Advisory Committee, the National Science Foundation, and other organizations. Among other subjects these studies have examined existing distribution mechanisms for scientific information, the patterns of use of data by scientists and engineers, and the economics of primary publication of technical books and journals. A study of these reports and our own experience have persuaded us that the most effective means of distribution of reference data is through a serial publication, accompanied by reprinting and repackaging selected contents. We plan to initiate publication of a Journal of Physical and Chemical Reference Data, in cooperation with the American Institute of Physics and the American Chemical Society. An agreement has been concluded with these two societies under which they will handle the printing, distribution, and marketing of the Journal.

We believe that this Journal will quickly become a familiar holding of every technical library. It will provide a central focal point to which any scientist or engineer can go when he needs the most reliable reference data. Individual tables of data from the Journal are to be made available in off-print form to those who require access to a particular compilation. Special packages of data directed to particular user groups will be published in monograph form as supplements to the Journal. The association with the two professional societies, whose combined membership exceeds 150,000, is expected to result in much more effective distribution of the NSDS output.

In addition to making the output of the Standard Reference Data program more readily accessible to the technical community, this plan will permit a measure of cost recovery which is not possible through the Superintendent of Documents. Royalties from Journal subscriptions and sale of auxiliary publications will be returned to NBS for furthering the NSRDS program, as specified in Public Law 90-396.

The ability to recover a portion of the costs is one of the important reasons for the arrangement with a non-governmental publisher. I would now like to discuss the matter of cost recovery in more detail.

The Standard Reference Data Act states that: "It is therefore the policy of the Congress to make critically evaluated reference data readily available to scientists, engineers, and the general public." In Section 5 of the Act the general policy on cost recovery is given: "To the extent practicable and appropriate, the prices established for such data may reflect the cost of collection, compilation, evaluation publication, and dissemination of the data, including administrative expenses."

We have given considerable thought to the problem of deciding what prices are "practicable and appropriate" in the light of the expressed intent of the Congress to make reference data readily available to all who need them.

I pointed out earlier that the Standard Reference Data program consists of two major elements—evaluation and dissemination services. At the present time

90%-95% of the total cost arises from the scientific tasks of data evaluation; it requires the participation of highly trained professional scientists and engineers, backed by information specialists, computer programmers, and other non-technical assistants. The cost of supporting these specialists is comparable with the cost of supporting any other type of experimental or theoretical studies.

Because both the nature of the work and its objectives are similar to those of other forms of research, we believe that these intellectual costs should be treated in the same manner. Since the critical evaluation process is part of the basic mission of the National Bureau of Standards in safeguarding the effectiveness of the national measurement system, it should be supported in the same fashion as similar programs, that is, from appropriated funds. On the other hand, we believe that costs of dissemination to the individual user should be covered, to the maximum extent practicable, by the price that he pays. We believe that this separation of costs into two categories, evaluation and dissemination, with the latter recovered from sales, is consistent with basic government policy and is the appropriate interpretation of the cost recovery clause of the Standard Reference Data Act. The policy differs from normal government practices in that the individual user will be expected to pay not only the cost of printing and distribution, as is the case with GPO publications, but also much of the editorial and composition cost, now normally borne by an originating government agency.

The first half of the phrase "practicable and appropriate" must also be taken into consideration. The laws of the market place apply to the sale of data compilations, just as they do to any other publications. If the price is set too high, the publications will be purchased only by a small number of technical libraries. The individual user will then obtain the data he needs by copying or extracting from the library volume. Thus an excessively high price will lead to lower sales and thereby reduce the financial return to the Government. Moreover, the dissemination of the reference data will be greatly reduced in efficiency, and some of the impact of the program on the Government investment in research and development will be lost.

Practical economic considerations, therefore, place definite restraints on the amount of cost recovery which can be achieved. The price level that will optimize the financial return to NBS is difficult to predict without more experience. However, we believe that the price-sales relationship for reference data compilations will be similar to that which applies to other technical information. Therefore, if we establish prices for standard reference data comparable to the prevailing price for technical information sold by private publishers, we will probably be close to the conditions for maximum cost recovery.

Our calculations indicate that such a price structure should permit the recovery of most of the dissemination costs of the program. That is, the royalties from the sale of data compilations should roughly offset the editorial, redaction, and composition costs incurred by NBS in preparing the material for publication. We therefore conclude that this pricing is "appropriate," in the sense that it seeks to recover most of the dissemination costs but not the cost of the critical evaluation, and that it is "practicable" from the viewpoint of marketing realities.

I would like to close with a few words about international cooperation in this field. Compilation of critically evaluated property data has traditionally been an international effort. For example, the "International Critical Tables," a compilation of most of the useful data in the world's literature then available, was prepared in the decade from 1920-1930 under the auspices of the National Academy of Sciences with contributions from hundreds of scientists all over the world. The establishment of the National Standard Reference Data System in the United States stimulated the Soviet Union to establish a organization with an almost identical name—the State Service of Standard and Reference Data—and the United Kingdom has incorporated a similar function within its Department of Education and Science. The International Council of Scientific Unions has established a "Committee on Data for Science and Technology," called CODATA for short, whose purpose is to coordinate and stimulate international efforts in critical evaluation and compilation. The Director of the National Bureau of Standards, Dr. Lewis M. Branscomb, serves as the U.S. representative to CODATA and is a member of its Executive Board. Through international cooperation, both to share the effort and to share the results, the needs of the world's community of scientists and engineers are being served, but a large gap remains.

As we look to the future we can see enormous and exciting work ahead. We have made a good start, and we believe that we can do much more both to make reliable data available and to increase the yield of reliable data from the nation's investment in science and technology.

STATEMENT OF DR. EDWARD L. BRADY, ASSOCIATE DIRECTOR
FOR INFORMATION PROGRAMS, NATIONAL BUREAU OF STAND-
ARDS, U.S. DEPARTMENT OF COMMERCE

Dr. BRADY. As Dr. Branscomb mentioned, I would like to present a few of the highlights and summarize the longer statement that we have prepared for introduction into the record.

Dr. Branscomb had pointed out in his introductory statement the kind of data we are talking about. I think that is very important because people use the word "data" in many different ways. What we mean when we use the word "data" are the numerical results obtained when people make a measurement in the laboratory of a property of some substance.

Mr. DAVIS. Even that could be the subject of much discussion. I am thinking of one of the habits of the lawyers of the State of Georgia and I suppose that habit extends to the other States when they convey a deed conveying real property, they use the phrase "more or less." I remember one time we were trying a case in court and the civil engineer was on the stand and some lawyer was taking him to task for saying "more or less." He asked, "Why can't you be more exact?" He wanted to know what he had used to measure with and he had used a chain, maybe you are familiar with the civil engineer's chain. It has many links in it and each link has a certain length, and the civil engineer said, "Well, now, let's take a day in the summer. We measure it with a chain or take a day in the winter the chain is going to shrink, and you just can't be exact in the measurement."

Of course, but as Dr. Branscomb pointed out in his statement, what you are doing basically is measuring accurately enough to suit the purpose for which you are measuring, for example, 10 o'clock this morning is one thing, but it is another thing to a man with a sextant in his hand who is trying to find out where he is in the ocean. And I can see that even that measurement might mean one thing to a man with a particular problem and mean quite another thing to another man with a problem.

Dr. BRADY. One of the purposes of our program is to put numbers on that statement "more or less," and to define how much more or how much less it might be.

Dr. BRANSCOMB. It is not satisfactory for an engineer to build a highway bridge and then to assure the citizens of the State that it will stand up "more or less."

Mr. DAVIS. I quite agree with that.

Dr. BRADY. There are several thousand different such properties reported in the world scientific and technical literature that are of potential interest to people with technical problems to solve.

When these reports are critically evaluated, we give the data a special name; we call them "Standard Reference Data."

I would like to leave with the committee a few samples of the kinds of products that we produce in the standard reference data program to clarify fully what we are talking about, if this would be useful. Incidentally, I point out that these compilations, printed by the Government Printing Office, are copyrighted by the Secretary of Commerce in accordance with the provisions of Public Law 90-396.

Mr. DAVIS. I wonder if we could examine them briefly at this time. Thank you.

Dr. BRADY. One of the reports that I have included is a status report on the Standard Reference Data program as of a short time ago. The other reports are examples of the kinds of reliable quantitative data that are needed by scientists and engineers constantly in their everyday work.

I would like to cite one particular instance that may be of special interest to this committee, the use of such data in the investigation of the Apollo 13 incident.

Two members of the National Bureau of Standards Cryogenics Division at Boulder, Colo. served on a six-man board of consultants to attempt to determine what happened.

Several possible alternative explanations were advanced to explain the phenomena that were observed.

Calculations based on reliable and accurate data on the physical properties of oxygen and its compounds showed that combustion of the Teflon insulation on the wiring used in the interior of the oxygen tank created the observed rapid pressure rise, resulting ultimately in failure.

These data had all been critically evaluated in the Cryogenic Data Center in the Boulder Laboratory of the National Bureau of Standards. As a result of the availability of these data it was possible in a short time to account in a reasonable fashion for the observed effects and to devise a means of preventing such events in the future.

This is only one of the thousands of examples that perhaps could be cited. It is safe to say that standard reference data are needed in the solution of nearly all the problems of modern society that have a technological base.

The statement submitted for the record lists several of these problems, and the types of data that are needed in their solution.

I will mention only one problem of those listed in the full statement. This concerns the incineration of trash. In the past few years a number of large new municipal trash incinerators have been found to give unsatisfactory performance. In some cases million dollar installations have had to be shut down because they were unsafe or performing inadequately.

The engineers who design this type of equipment concluded that they had not used accurate enough data in calculating the amount of heat given out in the combustion of various kinds of wastes.

A committee of the American Society of Mechanical Engineers that was developing a handbook for incinerator design, came to us for assistance in providing data on the heats of combustion to include in the handbook. Because we already had the evaluated data, compiled as part of the efforts of a standard reference data project, we were able to select and organize the appropriate information in a very short time.

The American Society of Mechanical Engineers paid the full out-of-pocket cost of preparing this special compilation of data—\$15,000.

This illustrates the basic policy of user charges that we apply in the program.

If a single individual or small group requests a special service that involves a substantial effort, we expect them to pay the full out-of-pocket costs of providing that service. We do not charge, however, for answering a simple inquiry that requires only a small amount of effort.

Our program has a second objective that we consider to be of importance equal to that of providing reliable data. This objective is to improve the quality of experimental measurement in laboratories throughout the Nation. The process of critical evaluation involves studying the sources of uncertainty in the measurement technique and errors that may have unknowingly been made in the interpretation by the experimentalists. Critical evaluations in turn are studied by the experimentalists, who change their procedures, if necessary, to improve their results. Dr. Branscomb pointed out that a scientist does not want to make an inaccurate measurement if he knows a better way to do it and these evaluations lead continually to improvements in laboratory techniques.

Further, we have a systematic program of developing criteria for making good measurements in the laboratory and reporting them in the literature. Some of these criteria developed have been adopted as international standards by the International Council of Scientific Unions.

Our program thus has two major elements in it; first, the evaluation process, and second, dissemination of the results.

We disseminate the results in the form of publications of the Government Printing Office, such as the samples I brought, as journal articles, and in other forms.

I want to describe now a new system that we have just established for dissemination of the critical reviews and data compilations that are our principal output. The Standard Reference Data Act Public Law 90-396 provided new authorities to the Department of Commerce that allow us increased flexibility in our dissemination practices.

The act authorized the Secretary of Commerce to obtain copyright and to assign that copyright to nongovernmental publishers. It authorized the recovery of a portion of the cost of the program and authorizes us to use the recovered funds for the purposes of the program.

In our new arrangement for distributing our output, we are working with the American Institute of Physics, an association of professional society in physics, and the American Chemical Society, to publish and market a new journal to be called the Journal of Physical and Chemical Reference Data.

Mr. DAVIS. May I refer back to a phrase you used a minute ago when you said the authority contained in the act, Standard Reference Data Act, contained authority to assign copyrights to nongovernmental entities.

Do you plan to discuss that a little more fully later? If not, I would welcome a little enlargement of that at the present time.

Dr. BRADY. Yes, sir. The act as passed authorizes the Secretary of Commerce to obtain copyright on the products of the standard reference data system. It does not specifically mention that the copyright may be assigned to other nongovernmental publishers, but it does state that he may authorize the reproduction and publication by others of standard reference data (referring to the Secretary.) The interpretation that our legal counsel has given to this wording in the act is that this constitutes authorization by the Secretary to obtain copyright, as specifically mentioned in the bill, and to use that authority to enable a commercial publisher or a private publisher to publish.

We have selected this consortium of professional societies to use that copyright authority to protect their investment in the program.

Mr. DAVIS. They treat the copyright authority as being assignable?

Dr. BRADY. Yes, sir.

Mr. DAVIS. You say Commerce to other entities?

Dr. BRADY. Yes, sir; in the normal fashion that a copyright may be assigned by its owner to other parties.

Mr. DAVIS. Well, to date that authority has not been exercised except toward a not-for-profit entity, is that right?

Dr. BRADY. That is true, with one exception.

Mr. DAVIS. All right, sir.

Dr. BRADY. For the foreseeable future we expect that the output of our program will be almost entirely distributed through the consortium of professional societies I just mentioned.

Mr. DAVIS. I might say just that first place, that seems to be a strained interpretation, that the authority to allow someone else to publish a copyright matter might include the right to assign to them the full protection of being copyrighted. But be that as it may, I don't mean to ask you to comment on that.

Dr. BRADY. If you wish comments, I would like to refer to legal counsel.

Mr. DAVIS. It is all right.

Dr. BRADY. It is planned that the journal published by the professional societies will be a quarterly journal with each of the professional societies marketing and distributing it to its own members. NBS will receive a royalty that will partially defray the editorial and publication costs. This plan and the rationale for the cost recovery schedule are discussed in detail in the prepared statement that has been submitted.

Dr. BRANSCOMB. Mr. Chairman, could I make a comment about this plan?

We feel that the usefulness of this program lies primarily in its user orientation. It is designed to serve the practical needs of scientists and engineers for data they themselves cannot produce in their own laboratories. The two societies in question have a combined membership of well over 150,000 American scientists and engineers, scientists mostly in this case. Through this method of publication we are convinced that we will be able to put this material in the hands of scientists much more effectively than we have been able to do in the past, that it will be easier to find in the library and that the cost recovery will show an appreciable improvement over what we are able to do now. We do not visualize that it will be either possible, nor for that matter prudent, to attempt to recover the majority of the costs of the program, which are invested in research needed to evaluate the data. We do believe that it was the intent of Congress in the act that we should attempt to recover some of the costs of the actual publication, but primarily that it was the intent of Congress that we should get this data effectively in the hands of those who need it. It is to that end we propose this way of disseminating our data.

Chairman MILLER. With your permission, this act was passed in 1968, and it came out of this committee, as I remember it. The very argument that Dr. Branscomb has just given you was that which was used in support of allowing this thing to be—in other words, what good is this data if we don't get it to the public and to the people who can use it?

It is true that you have to buy books and one thing and another. We were more interested at that time in getting it to the public and I think we were justified in our position.

Mr. DAVIS. All right, sir.

Dr. BRADY. I would like to close with a final short word about international programs to promote and coordinate data evaluation and compilation.

Stimulated partly by our program, national authorities in the United Kingdom, in France, Germany, U.S.S.R., Japan, Canada, and a number of other countries, have begun to plan and organize activities similar to ours. We maintain close contact with all of these to insure coordination and overlap of effort.

Also, of course, we make sure that the products of all these other national efforts are available to U.S. scientists and engineers.

In addition, the International Council of Scientific Unions has established a Committee on Data for Science and Technology (CODATA), whose purpose is to stimulate and coordinate international cooperation.

Lewis Branscomb, the Director of NBS is the United States representative to CODATA and is a member of its executive committee. In the future, we can look forward to increasing efforts by other countries to help to meet the needs of the total world scientific and engineering community for evaluated data. As we look to the future of our own program we can see enormous and exciting opportunities to make major contributions to the efficiency and productivity of American science and technology and we are ready and eager to proceed with our effort.

We appreciate the opportunity to appear here today before you.

Thank you.

Mr. DAVIS. Thank you very much, Dr. Brady.

Chairman Miller, do you have any comment or questions?

Chairman MILLER. No. I am very much interested in what Dr. Brady had to say and what the data that we received so far is. This, I think, is one of the landmark pieces of legislation that can be passed and in effect it is another recognition of the work that is done at the Bureau of Standards which I am extremely proud of.

Mr. DAVIS. Mr. Cabell?

Mr. CABELL. Yes. I noted on the samples of publications that some of them were paperback; some were very nicely done in hardback.

Is there a difference between the importance of the material published or how do you arrive at the decision?

Dr. BRADY. It is not considered in most cases to be an indication of the significance of the work. It is partly the result of the normal practices of the Government Printing Office. At one stage we were told, I believe, that the material had to be a certain length in order to justify having hard covers on it. Our practice is to have hard cover volumes to the maximum extent possible because we consider that these are permanent additions to libraries and people would want to retain them for a period of several years. Some of our shorter compilations still appear in paper covers, because hard covers on a book of 40 pages, for example, are not appropriate.

We do prefer to have paper covers for the things that we consider to be of more transitory nature, For example, the status report of the

standard reference data program is in paperback. We put out a status report every couple of years or so. We consider it unnecessary to bind this report in permanent fashion.

Mr. CABELL. Thank you.

Mr. DAVIS. Dr. Lide, is there any comment you would like to make?

Dr. LIDE. No. I have nothing to add. But we will be happy to answer any questions you would like to submit to us.

Mr. DAVIS. Well, just a question on the general scope of the standard reference data that is included in our amassing the data. I assume it runs a whole gamut of measurement, to the point where it even gets down so small that even the process of measuring interferes with the measurement you get.

Dr. BRADY. Yes, sir. We have given a lot of thought to the scope. Operationally the scope is not as great as we consider it would be desirable to have, partly because of the rate at which the program has grown over the past few years. Our emphasis up to the present time has been on well-defined properties of well-defined substances; that is, a property that you can be confident is related to the composition, to the structure, to the energy content of the material being studied in some understandable way so that the measurement doesn't wander all over the map when you measure it. This emphasis on well-defined substances means that we have concentrated on the properties of nuclei, of atoms, molecules and of fairly well defined combinations of these in the programs.

However it also means that some of the important materials of commerce at the present time are not included in the program.

Dr. BRANSCOMB. It might be useful for Dr. Lide to comment on the directions in which we would like to see the program extended in the future, to improve its coverage.

Mr. DAVIS. All right, sir.

Dr. LIDE. Yes. As Dr. Brady said, up to now we have concentrated on either pure materials or else mixtures whose composition was very well defined. We have also concentrated on properties which are easily measurable, about which there is little misunderstanding.

Mr. DAVIS. When you say pure, are you speaking chemically or in some other sense?

Dr. LIDE. Chemically pure material.

Dr. BRADY. Pure enough so that the property being measured isn't affected by small amounts of impurities.

Mr. DAVIS. When you say pure, would you have to divide water into oxygen and hydrogen before you thought it was pure?

Dr. LIDE. We would consider water a pure material, if it did not have salt or other compound in it.

Mr. CABELL. It would be distilled and not out of the Potomac.

Dr. LIDE. That is right.

Chairman MILLER. Wouldn't you have a hard time in most places in the United States today getting pure water?

Dr. LIDE. The raw material is bound to be very impure. Our task of our data compilers is to ensure that the samples used contained such small quantities of impurities that they did not affect the property measurement by any significant amount.

Well, to proceed with the answer, we are now looking into the expansion of the scope of the program to include materials and properties which are not so easily characterizable, and perhaps properties which are of more practical engineering interest, but perhaps more difficult to measure. An example might be a property which depends on the previous history of the material, such as the strength of a particular alloy which is dependent not only upon the individual constituents of the alloy, but also on the way the alloy has been treated during and after its formation.

Clearly it is more difficult to characterize materials whose behavior depends on the previous history, but in some cases, it is certainly possible to do this in a way that can be reproduced from one laboratory to another. And, of course, it is just these properties and these materials which are often very important in practical applications. So we are in the planning stage for expanding our effort to include more data of this type.

Mr. DAVIS. Gentlemen, commenting generally on the bill, I want to say that I for one see no reason why continuing authorization shouldn't be enacted. There from time to time arises discussions as to whether or not we should put in a provision there that would limit the authorization to 1 year or 2 years or some other number of years. In this particular case, I think your case is well made for a continuing authorization and as you intimate, I see no reason why that should operate to diminish the degree of legislative oversight, and I hope that the bill will pass with this language intact as it stands now.

Dr. BRANSCOMB. We certainly welcome that continued legislative oversight, and indeed look forward to comprehensive hearings on the Bureau of Standards in the fall.

Mr. DAVIS. So do we.

Dr. BRANSCOMB. We certainly invite your further investigation into these programs or others as your committee wishes.

Mr. DAVIS. We also look forward to those hearings. And I am in hopes that a great deal of good will come out of them for all of us.

If there are no further questions or comments, that will conclude our hearings this morning. I want to thank all of you for having come before us and commend you for an excellent presentation. At this time, the committee will be adjourned.

ANSWERS TO ADDITIONAL QUESTIONS SUBMITTED TO NBS FOLLOWING HEARINGS ON H.R. 7188, AUTHORIZATION OF APPROPRIATIONS FOR FIRE RESEARCH AND SAFETY ACT, AUGUST 3, 1971

Question 1.—To what extent was the program contained in the report "A Program for the Fire Research and Safety Act" carried out during FY 1971?

Answer.—Most of the work that has been initiated was previously planned and described in paragraphs 3.1.1, 3.2, 3.2.2, 3.2.2.2, 3.2.2.3, 3.2.4, and 3.2.6 of "A Program for the Fire Research and Safety Act." However, only a very small fraction of the work called for by that Program could be implemented with the limited funding that was available during FY 1971.

Question 2.—Prior year requests for the authorization of funds have been in excess of the amount programmed. What is the true requirement for funds to carry out the needed program and what are the Bureau's plans to implement such a program? What is the FY 1972 fund request?

Answer.—Estimates of funding requirements have of necessity been made many months in advance of actual appropriation requests. The very limited appropriations received in prior years and pressures involved in the development of the President's budget have tended to limit the growth of the program.

Dr. Branscomb noted in his prepared statement that funding to achieve maximum effectiveness in this program might ultimately require as much as \$10 million annually. Support of these activities will increase in future years as rapidly as budgetary and management considerations permit. The appropriation requested for FY 1972 is \$1.059 million.

Question 3.—The President has recently appointed the members of the National Commission on Fire Prevention and Control that was established by Title II of the Act. What is the role of the Bureau in furthering the work of the Commission and what progress has been made to date?

Answer.—Two meetings of the Commission have been held. Dr. Willenbrock has participated as a representative of Secretary Stans. NBS plans to do all it can to further the work of this Commission and has offered through correspondence and through Dr. Willenbrock's participation to assist in any way possible. In addition, members of the Commission have been invited to visit and review NBS programs in the fire area either individually or by convening a formal meeting in Gaithersburg.

Question 4.—What are the critical areas of fire research that need immediate attention and what priority has been established in carrying out this work? Is this program coordinated with other agencies that are involved in fire research and how is the planning carried out?

Answer.—In his testimony, Dr. Willenbrock described plans for incorporation of the Federal Fire Council as a part of the NBS Fire Research and Safety Center. This would materially assist in implementing the mission called for by the Fire Research and Safety Act. It provides a direct line of communication on fire problems with other agencies and should assist in coordinating the NBS fire program with those of other organizations within the government. Interactions with firefighters, industry, and universities are described in Dr. Willenbrock's testimony.

The most pressing fire research problems are considered to be:

(a) Development of a firm technical understanding and predictive capability for defining fire ignition, growth and spread of fires in buildings, fabrics and other structures.

(b) Development of a comprehensive fire information center with a growing real-time data base that incorporated all available information on actual causes, injuries, and property damage due to fires in the United States. Rapid computer access and analysis will serve to help identify priorities of various types of fires and suggest tactics for reducing the associated losses.

(c) Definition of desirable performance criteria for tools and equipment used by the fire service and, following this, development of recommended specifications or draft standards defining design, construction or fabrication details appropriated to the achievement of such performance.

(d) Development of design construction and operating procedures characteristics for high rise buildings to achieve improved life safety for occupants in the event of a fire.

(e) Development of a national consensus on operational procedures in firefighting as a basis for initiation of demonstration training seminars as a way of improving fire command performance of newly promoted battalion chiefs. Such seminars would form the first phase of the training and educational responsibilities assigned by the Act.

Question 5.—What is the five-year funding forecast for this program?

Answer.—The attached fiscal projections have been prepared in accordance with prevailing guidelines and are subject to the limitations noted thereon.

These projections do not include funds for the Flammable Fabrics program, which is subject to separate authorization. Nor do they provide for the construction of facilities which may be necessary for current and future fire research and flammable fabrics programs.

DEPARTMENT OF COMMERCE, NATIONAL BUREAU OF STANDARDS, FIRE RESEARCH AND SAFETY PROGRAM—5
YEAR PROJECTION ¹

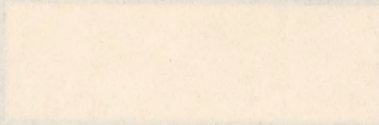
[In thousands of dollars]

	Fiscal year—				
	1972	1973	1974	1975	1976
Research:					
In-house.....	\$460	\$635	\$365	\$635	\$635
Contracts.....	87	212	212	212	212
Total.....	547	847	847	847	847
Information and reference services:					
In-house.....	307	367	367	367	367
Contracts.....	10	10	10	10	10
Total.....	317	377	377	377	377
Education and training:					
In-house.....	188	309	309	309	309
Contracts.....	7	127	127	127	127
Total.....	195	436	436	436	436
Summary:					
In-house.....	955	1,311	1,311	1,311	1,311
Contracts.....	104	349	349	349	349
Total.....	1,059	1,660	1,660	1,660	1,660

¹ These estimates represent projections of cost expressed in constant dollars at prices existing at the time the estimates are prepared. They are not intended to predict future economic conditions, and do not reflect possible changes in the scope or quality of the proposal which might result from experience gained in actual practice. Further, there sources which might appropriately be applied in later years will require a reexamination of the relative priorities of this and other Government programs, in the light of economic and other circumstances then prevailing. Thus, the estimates do not represent a commitment as to amounts to be included in future budgets.

(Whereupon, at 11:20 a.m., the subcommittee adjourned.)

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