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THE METRIC SYSTEM

GOVERNMENT
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HEARINGS
BEFORE
SUBCOMMITTEE NO. 1
AND THE
COMMITTEE ON
SCIENCE AND ASTRONAUTICS
U.S. HOUSE OF REPRESENTATIVES
EIGHTY-SEVENTH CONGRESS
FIRST SESSION

H.R. 269 and H.R. 2049

JUNE 28, 29, AND JULY 21, 1961

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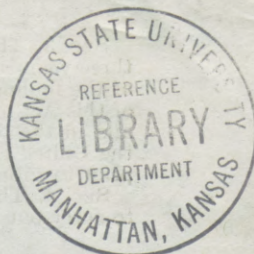
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THE METRIC SYSTEM

WEDNESDAY, JUNE 28, 1961

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND ASTRONAUTICS,
SUBCOMMITTEE No. 1,
Washington, D.C.

The subcommittee met, pursuant to notice, at 10 a.m. in room 214-B, New House Office Building, Hon. George P. Miller (chairman of the subcommittee) presiding.

Mr. MILLER. The subcommittee will be in order.

I want to apologize for being late. I had a gentleman in my office and I just couldn't get rid of him.

Mr. HECHLER. Off the record.

Mr. MILLER. No; I will put it on the record.

We are meeting today to consider a number of bills that have been introduced providing for a study of the metric system, or a study of the feasibility of adopting the metric system as a standard for weights and measures in this country. I am not going to labor the matter. I think you are all familiar with these bills. They would request the Bureau of Standards to make a study and report back to the Congress on the feasibility of changing our system.

As the author of one of these bills, I have long felt this is the best approach to the matter because it is highly technical, and I know of no more qualified agency in Government to advise the Congress in this matter than the Bureau of Standards. Therefore we have asked Dr. Astin if he will lead off in these hearings.

(H.R. 269 and 2049 follow:)

[H.R. 269, 87th Cong., 1st sess.]

A BILL To provide that the Secretary of Commerce shall conduct a study to determine the practicability and desirability of the adoption by the United States of the metric system of weights and measures

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the Secretary of Commerce shall conduct a study to determine the desirability and practicability of the adoption in the United States of the metric system of weights and measures.

SEC. 2. In carrying out the program described in the first section of this Act, the Secretary of Commerce shall conduct investigations, research, and surveys, consult with governmental agencies and private organizations, and cooperate with foreign governments to the extent deemed necessary to determine and analyze—

(1) standards and comparative advantages of weights and measures presently used in science, engineering, manufacturing, commerce and education;

(2) benefits which the United States might derive from general adoption of the metric system or application of such a system in specific fields, including consideration of the effect such a change would have on United States international relations, world trade, and military activities;

(3) practical difficulties which might be involved in achieving adoption of the metric system for use generally or in specific fields in the United States.

SEC. 3. The Secretary of Commerce shall transmit to the Congress, within three years after the date of the enactment of this Act, a full and complete report of the findings made in the conduct of the program described in the first section of this Act, together with such recommendations as it considers to be appropriate and in the best interests of the economic development and national security of the United States, and annual progress reports shall be supplied to the Congress prior to submission of the final report and recommendations.

SEC. 4. There are authorized to be appropriated such sums as may be necessary to carry out this Act.

[H.R. 2049, 87th Cong., 1st sess.]

A BILL To provide that the National Bureau of Standards shall conduct a program of investigation, research, and survey to determine the practicability of the adoption by the United States of the metric system of weights and measures.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the National Bureau of Standards (hereinafter referred to as the "Bureau"), in the exercise of its functions under the Act of March 3, 1901, as amended (15 U.S.C. 271 and the following), and other provisions of law, shall conduct a program of investigation, research, and survey to determine the desirability and practicability of the adoption in the United States of the metric system of weights and measures.

SEC. 2. In the conduct of the program described in the first section of this Act, the Bureau may—

(1) conduct extensive comparative studies of the standards of weights and measures used in scientific, engineering, manufacturing, and commercial areas and in educational institutions, and the advantages of each in its respective field;

(2) cooperate with other governmental agencies and private organizations in determining the economic advantages of a general change to the metric system in the United States or of a change to such system in specific fields;

(3) cooperate with foreign governments in determining the advantages in international trade and commerce, and in military and other areas of international relations, to be derived from a universal standardized system of weights and measures; and

(4) investigate the attitudes of the departments and agencies of the Federal Government and of the several States with respect to possible practical difficulties which might be encountered in accomplishing a change in the system of weights and measures for use generally or in specific fields or areas in the United States.

SEC. 3. The Bureau shall submit to the Secretary of Commerce for transmission to the Congress, within one year after the date of the enactment of this Act, a full and complete report of the findings made in the conduct of the program described in the first section of this Act, together with such recommendations as it considers to be appropriate and in the best interests of the economic development and national security of the United States.

SEC. 4. There are authorized to be appropriated such sums as may be necessary to carry out this Act.

Doctor, I am very happy to see you here again. I know of your interest in this subject. So will you proceed?

DR. ASTIN. Yes, Mr. Chairman.

MR. MILLER. In the interest of time, you have just a short statement, and I thought you might summarize, give us the benefit of your experience informally, too.

STATEMENT OF DR. A. V. ASTIN, DIRECTOR, NATIONAL BUREAU OF STANDARDS, ACCOMPANIED BY DR. A. T. McPHERSON, ASSOCIATE DIRECTOR, NATIONAL BUREAU OF STANDARDS

DR. ASTIN. Thank you, Mr. Chairman. I am pleased to be with you this morning and have the opportunity of commenting on this matter before your committee affecting the metric system and our basic units of weights and measures. The two bills H.R. 269 and H.R. 2049 before you both call for a study to determine the practicality

of the adoption by the United States of the metric system. Such a study is a basic necessity because much of the discussion for and against the adoption of the metric system by industry in the United States has been based on general considerations, limited evidence, and opinions rather than explicit factual data.

Any decision as to a sweeping change in units of measurement should be based on a carefully prepared balance sheet with the expected advantages and the corresponding disadvantages set down in parallel columns. Insofar as possible any anticipated direct or indirect gains and savings through the general adoption of the metric units in industry, commerce, and trade should be set over against estimated costs of the change in man-years, materials, and dollars.

These estimates in dollars of possible gains, on the one hand and costs on the other, should, insofar as possible, cover all major fields of education, industry, commerce, and trade. It should be recognized at the outset, however, that the determination to change or not to change should not necessarily be made on the side of the favorable balance in dollars since there may be intangible considerations of such overriding importance as to outweigh an estimated financial advantage or disadvantage.

Because of the broad scope and many ramifications of the proposed study, it could be conducted more effectively if a 3-year period were allowed, as provided by H.R. 269, rather than the 1-year period stipulated in H.R. 2049. The longer period would be needed especially for making a study of the experience of other countries such as Japan, India, and the Philippines, which have recently changed or are changing to the use of the metric system.

Although such a study is not explicitly mentioned in H.R. 269, we would hope that it could still be done. Perhaps it would be better if the bill were amended to provide for this study of the transition in other countries, as suggested by the Secretary of Commerce in his letter of May 8, 1961, sent to the committee stating the views of the Department.

A related area which could be studied with profit would be the experience of American industries—notably the pharmaceutical industry—which have voluntarily changed to the use of the metric system. The revision of H.R. 269 to provide for this study was also suggested by the Secretary of Commerce.

In view of the need for a broad study of these and other areas that would be affected, it would be premature to consider passage of the resolution, House Concurrent Resolution 44, calling on the President to promote the use of the metric system. Thank you.

I might say in summary on this that in my judgment the National Bureau of Standards should not be an advocate either for or against the adoption of the metric system. Our role should be that of a fact-finding organization trying to determine for those who must make the final determination what the relative advantages and disadvantages are of a possible change.

Mr. MILLER. Doctor, that is the role that I hoped, the position that I felt certain you would take. We are not asking you to become the advocate nor asking you to factually study this legislation or study the possibilities of this legislation, but give us the benefits of your advice, and I am certain that the Congress in the final analysis must make the decision in this matter.

Was the metric system ever considered as the basis for our standard of weights and measures?

Dr. ASTIN. Yes, sir; the metric system has been considered for widespread adoption very frequently throughout the history of this country. I think one of the early senior statesmen to give appreciable attention to this subject was Thomas Jefferson. Shortly after the establishment of the Republic he considered very seriously the implementation of the authority given to the Congress by the Constitution to fix the standard of weights and measures.

He was also interested in a system of weights and measures which would be international in scope and was a substantial student of the metric system.

He was an early advocate of its adoption in the United States, but somehow or other he appeared to cool on this a bit. It is my understanding from what I can read of the history of this subject, that one of the reasons he lost his major interest in advocating the adoption of the metric system in the United States was the decision to base the unit of length of the metric system on the quadrant of the earth's meridian. Thomas Jefferson was an advocate of a unit of length based on a second's pendulum, that is, where we would define the basic standard of length in the system of measurement in terms of the length of a pendulum which would vibrate at the rate of once per second.

There were a number of other advocates of this approach. But for a number of reasons it was decided that a more accurate and stable standard might be possible by using a fraction of the earth's meridian, but in order to make this a rather specific thing, it was necessary to select a specific meridian.

The decision on this during the French Revolution was to use the meridian which passed through Paris, or near Paris. Thomas Jefferson considered this gave the French an advantage and it would not become a completely universal system, and this is my understanding of why Thomas Jefferson then lost his interest in this.

He turned instead to become an advocate of a decimalized English system. His proposal was to decimalize the foot, redefine the foot so there would be 10 inches to the foot and use a decimalized English system within the United States. This, however, came to naught.

Somewhat later, actually in 1866, at which time the metric system had become well established in the world, the Congress passed a law legalizing the use of the metric system within the United States.

A little later the scientists on an international scale decided that the earth's meridian was not a good enough standard and they decided that a prototype standard based on a meter bar of a very special alloy would be more useful, more reproducible, and more accurate. But in order to arrive at such a prototype standard they would have to set up an international organization to have custody of it.

This led to the signing of the Treaty of the Meter in 1875 to which the United States was a participant. We have been a supporter of international standards of measurement through the refinement and extension of the metric system ever since, I should say, ever since 1878 when the Senate ratified the treaty authorizing U.S. participation in the work of the International Bureau of Weights and Measures.

This International Bureau then set up prototype standards for the meter and kilogram. I think 1889 was the date. In 1893 the United

States received its copies of the international metric standards, a meter bar and kilogram weight. The Office of Standard Weights and Measures in the Treasury Department then issued a statement defining the customary units; that is, the inch and the pound in terms of these new international standards which they had received. This was based—I mean the action of the Office of Standard Weights and Measures in 1893 was based upon the authorization of the Congress in 1866 to legalize the metric system.

Then the next step occurred about the time that the National Bureau of Standards was set up in 1901. That was a general awakening of interest in standards of measurement and accurate measurement techniques as an essential element in the growth of industrial nations about the time of the turn of the century.

The leading nation, or the pioneering nation in this connection was Germany. They set up the equivalent of a national bureau of standards in 1887. The Russians also did something, or extended their central bureau of weights and measures a few years later. About 1899 or 1900 the British established their National Physical Laboratory, the English counterpart of the National Bureau of Standards, and our own agency was established in 1901.

The purpose of all of these was to provide standards for physical measurement, particularly in the newer areas of technology in order to provide a basis for the sound growth of industry.

Along with this general interest in the creation of the National Bureau of Standards and a realization of the importance of uniform accurate measurement based upon sound standards in the growth of industry there was a general awakening of interest in wider adoption of the metric system in the United States. It is my understanding that a bill to require the Government to use the metric system nearly passed the Congress somewhere in the early part of this century. There has been no effort approaching that since that time, nearly 60 years ago.

One related activity did take place within the last 2 or 3 years. We had become concerned in the precision exchange of data and devices among the English-speaking or inch-using nations with the fact that there were at least three different inches in the world. Our inch had been based on the meter since 1893. The National Bureau of Standards has no independent standards for the English units. We derive them from the metric units by numerical ratio. The English on the other hand had an independent imperial yard and an independent imperial pound, and these things changed their values at a different rate and apparently more rapidly than did the international meter and the international kilogram.

So we found our inch and the British inch were gradually drifting apart. Concurrently the Canadians a number of years ago set up an independent inch based on the meter and we were confronted with the situation about 5 years ago, actually it was a problem during World War II, where the United States, the British, and the Canadians all had different inches.

As a result of discussions with the standards laboratories of these other countries and other standards laboratories among the English-speaking nations or inch-using nations, we reached an agreement on values for an international inch and an international pound. Since July 1, 1959, we at the National Bureau of Standards have used these

values for our calibrations involving the English units. An international pound was concurrently agreed to. So there is now in practical use throughout the world only one inch or pound.

We have effected a uniformity amongst the standards laboratories of the inch-using nations of the world.

Mr. MILLER. Are these related to the international meter?

Dr. ASTIN. Yes, sir. The yard is now defined, I should say the international yard is now defined as 0.9144 meters. In other words, the yard is slightly over 0.9 of a meter. Similarly the pound is defined in terms of a specific fraction of a kilogram. Actually the pound is equal to 0.4535924277 kilograms.

Mr. FULTON. Could I have a question?

Mr. MILLER. Yes.

Mr. FULTON. To what accuracy is your original meter length? I can see that you have related it very accurately to original meter length, but to what accuracy is that standard?

Dr. ASTIN. Standard meters in terms of the types of platinum iridium bars which for many decades were the national and international standards could be compared to an accuracy of perhaps one or two parts in 10 million. This was not of sufficient accuracy for a number of modern scientific and meteorological purposes. And because of that there were recent—there have been long-term efforts with a recent successful culmination to provide a new standard or new basis for the meter. The meter is now defined in terms of the wavelength of the radiation of an orange-red radiation from krypton 86. And when this particular radiation is used as a standard in an instrument called an interferometer one can effect accuracies of about 1 part in 100 million.

Thus the new standard for the meter is capable of accuracies about 10 times greater than the older one. This important transition of defining the meter in terms of a wavelength of light rather than a meter bar was effected by international agreement in Paris last October.

Mr. FULTON. Just put in the record the figure of translation into the wavelength so we will have it in the record. I have a long-distance call.

(The information requested is as follows:)

The 11th General Conference on Weights and Measures meeting in Paris France, adopted on August 14, 1960, the following definition of the meter:

"The meter is a length equal to 1,650,763.73 wavelengths in vacuum of the radiation corresponding to the transition between the energy levels of $2p_{10}$ and $5d_5$ of the atom krypton 86."

Mr. MILLER. Would there be an economic loss through manpower hours and otherwise due to the fact that the Bureau uses meters while the industry uses pounds and so forth?

Dr. ASTIN. I don't think this fact presents any serious problem. There is a very specific ratio between the two. There is no ambiguity at all in going from the meter to inch or yard measures. There would be a problem if there were uncertainties in the ratio, but there are none. It is a very exact, well-defined ratio.

Mr. MILLER. Mr. Hechler.

Mr. HECHLER. I want to compliment you on initiating these hearings, Mr. Chairman. They are of very great significance. If the National Bureau of Standards acts, as I believe it should, and you said it should, in an impartial capacity, what group or interest would

there be to present a case for the metric system? I think we have to face the fact that these things don't just come about automatically and in order to overcome the inertia of the established system it would seem to me it would have to have some interested parties who could present the case for the metric system.

I wonder if you could elaborate on who might at all be interested in this other than journalists, for example?

Dr. ASTIN. There are a number of groups that are interested in this, a number of the professional, scientific, and engineering societies have advocated on occasion wider use of the metric system, primarily because the metric system is the basic language for scientific measurements. In engineering the system is mixed, that is, within the United States I would expect that more engineering measurements are based on the customary English units than on metric units.

But both are involved. And to an appreciable extent, as near as I can determine, most of the professional engineering societies even though they would probably have more headaches associated with conversion, seem generally in favor of it.

However, I would think that the Department of Commerce might possibly, if the economic advantages were clearly pointed out, become an advocate. But this is highly conjectural.

Part of the problem involved in—or I would say one of the biggest problems involved in possible greater use of the metric system is the economic problem of actually converting. Since economic factors are apt to be very overriding in this, it would seem to me an agency with overall responsibility for the promoting of the Nation's industry and commerce might be the one ultimately, if the facts were developed, to take a position on this problem.

Another area that might take a position sometime if the facts were developed would be those concerned with foreign commerce or international relations generally, because we find now that the English-speaking people, and not all of these, are now about the only users of the customary English units. Most of the rest of the world is on the metric system or converting to the metric system. The metric system appears to be the system of measurement toward which conversions might be possible if we ever achieve a single system of weights and measures throughout the world.

Mr. MILLER. Wasn't this thought about a great deal starting with World War I? The metric system was used by France and our Army was forced to use it.

Dr. ASTIN. I am sorry, Mr. Chairman, I am not familiar with the impact of World War I upon the extension of the metric system. Maybe some of the Defense Department who are here could give you an answer on that question.

Mr. MILLER. World War II had the same impact——

Dr. ASTIN. It is my understanding there were a lot of problems on mapreading and translations, range tables and things of this sort because of differences, the fact that the English and the United States were using English measures and the French and other allies were using metric measures. I am not familiar with the details of the problem. The only part of this I do know is that there were problems in connection with various parts of the machine tool industry because our inch and the British inch were different. This was a problem we felt had to be resolved and fortunately it has been.

Mr. MILLER. All of our artillery now is calibrated in the metric system; isn't it?

Dr. ASTIN. I am not sure to the extent which it is. You will have to ask the Defense Department.

Mr. MILLER. As an old artilleryman in World War I, I recall the only American-made weapon we used was a 4.7 rifle. They never had ammunition for it when the troops arrived in France.

Mr. HECHLER. I would like to review the point that I think it is highly necessary that there be extended public discussion of this. I notice you expressed an opposition to my colleague, Mr. Fulton's, Concurrent Resolution 44. I would generally concur with the basis of your opposition. Yet I feel that one aspect of his resolution which relates to the stimulation of understanding of the metric system in our school system, for example, is useful.

Personally I would like to move a little bit faster and see if we could speed up the process of discussion. I wonder if you had any suggestions along those lines?

Dr. ASTIN. I would agree that greater and more extensive public discussion of this matter is highly desirable. Some of the professional societies have been doing this. For example, the American Association for the Advancement of Science has studied this problem and conducted symposia on the metric system in an effort to stimulate wider public discussion.

So far I don't think that any groups other than the professional scientific or engineering groups have made an effort to stimulate this type of discussion.

Mr. HECHLER. I think we have to take this out of the long-haired field and get it into the stream of public thinking. That was the point I wanted to make.

I noticed on my desk here a report of the metric study task force, which was appointed by the Director of the National Bureau of Standards in accordance with the memorandum of April 12, 1960, from Under Secretary Philip Ray. Would you have any objections if this preliminary report be made a part of the record?

Dr. ASTIN. No, I would not.

Mr. MILLER. Without objection it will be made part of the record. (The information requested is as follows:)

REPORT OF THE METRIC STUDY TASK FORCE

The task force on the metric system was appointed by the Director of the National Bureau of Standards in accordance with a memorandum of April 12, 1960, from Under Secretary Philip A. Ray in his capacity as Chairman of the Commerce Science Committee. The task force was instructed to examine the problems involved in conversion to the metric system by American industry, commerce, and trade; and to present a plan for action.

The task force, as a result of its inquiry, recommends that the Department of Commerce undertake a comprehensive, factfinding investigation on the advantages, disadvantages, and cost of conversion from the present U.S. customary system of units to the metric system. This report gives the reasons for undertaking the investigation, outlines the scope of the work to be done, and presents a plan for a 3-year study.

I. WHY CONSIDER CONVERSION TO THE METRIC SYSTEM?

The demands of the space-age industry for greater and greater precision of measurement and the needs of the newly developing nations for standardization have focused attention on the two major systems of units of measurement used

throughout the world—the English, or more precisely the U.S. customary system and the metric system. Japan, India, and the mainland China have recently joined the metric-using countries leaving only Great Britain, the Commonwealth nations, certain smaller Asian and African countries, and the United States on the inch-pound system. These countries, which are for the most part English-speaking, contain only about 20 percent of the world population but they now account for about 41 percent of the international trade of the world exclusive of the U.S.S.R. and satellites. This balance of production in nonmetric units will be affected by the rapid growth of industry in the metric-using countries of Asia and South America.

Consideration of the world situation has led, in the United States, to renewed interest in the metric system—as evidenced by bills introduced in the Congress, articles in the daily and scientific press, symposia at scientific and technical society meetings, and surveys of various kinds. One industry, the pharmaceutical industry, has converted the majority of its physical measurements to the metric system. The manufacture of antifriction bearings (except tapered bearings) has been on the metric system since its introduction into the United States from Europe. Agitation for a change is going on in other industries, notably the chemical industry.

Conversion to the metric system has been urged by some as a long-range aid in the expansion of the U.S. export market in Latin American and other countries where the metric system prevails. However, the extent, if any, to which our present system of units is an impediment to export trade is still a moot question.

Proponents of the metric system also call attention to possible savings to industry, business, and government through its use. Since the Government itself conducts one of the largest business-type operations in the world, this is a very cogent reason why the Government should institute a study of conversion. Not only because the issue is of national and international dimensions, but because of the scale of its own operations, the Federal Government is looked to for guidance.

II. NEED FOR A FACTFINDING STUDY

A broad, factual study is needed because any decision regarding a change in systems of units should be based on complete information as to the advantages to be gained and the costs involved.

The proposal for a comprehensive investigation does not mean that the subject has previously been neglected. To the contrary, a variety of studies of limited scope have been and are being made. However, no general investigation has been conducted in the United States since the extensive study made by the National Industrial Conference Board in 1921.¹

Foremost among the questions to be answered are those relating to the cost of initial conversion and the subsequent effect, if any, on prices. The cost would depend in many situations on the timing of the change and whether the two systems could satisfactorily be used together for a period of years until machine tools and weighing and measuring equipment in the U.S. customary system should be worn out and could then be replaced with metric equipment.

A study of individual areas might disclose some areas in which an early change to the metric system would be feasible and profitable, others in which a change might be desirable if made over a period of years, and still others in which no change whatever would be warranted on the basis of available facts and estimates.

There is also the question as to whether conversion in industry would be made by private initiative or whether it would be required by law, perhaps with part of the cost being borne by Government. The problem of duplicate stocks of products, particularly replacement parts, would be large and complex, as has already been clearly pointed out by a recent survey in the Department of Defense pertaining to military supplies.²

III. SCOPE OF THE STUDY

The study should include all major segments of the economy that utilize or are affected by units of measurement. This means that it should deal with Government, industry, public utilities, commerce and trade, engineering, and education.

¹ "The Metric Versus the English System of Weights and Measures," National Industrial Conference Board, Research Rept. 42 (October 1921).

² "The Metric System and the Department of Defense," by John J. Riordan and Charles J. Brzezinski, prepared for presentation at 1961 SAE International Congress and Exposition of Automotive Engineering, Detroit, Mich., Jan. 9-13, 1961.

1. Government

The Federal, State, and local governments are concerned with units of measurement in three respects. First, many laws and regulations contain requirements that are explicitly stated in terms of measurements in U.S. customary units. Second, land and coastal surveys and records are also in U.S. customary units except in some areas in the Southwest where early Spanish units still persist. Third, nearly every operation of government from the purchase of office supplies to highway construction makes direct or indirect use of measurements that again are almost invariably in U.S. customary units.

Typical of Federal statutes that would come under consideration are public laws such as those that fix standard thicknesses of steelplate (for purposes of duties and taxes) in numbered gages defined in ounces per square foot, and those that prescribe the dimensions in inches and contents in cubic inches of containers for lime, fruits, berries, vegetables, cranberries, and other products.

State statutes relating to similar matters are very numerous and prescribe in some jurisdictions the weight of a loaf of bread, the size of a brick, the length of thread on a spool, the content of milk bottles, the size and subdivision of butter cartons, and the weights and dimensions of many other items. Practically all of these are requirements in round numbers as pounds, ounces, inches, gallons, quarts, etc.

Building codes such as the National Electrical Code, the National Electrical Safety Code, the Plumbing Code, and numerous other building and safety codes are developed nationally and adopted by States, counties, and municipalities. These, again, nearly all contain stipulations in the customary units.

Conversion of all these laws and regulations to the use of metric units would have a very widespread effect on business, industry, and everyday life. The problems that would be involved, however, would not be as difficult or expensive to solve as those which would be encountered in changing geodetic measurements, land records, and charts of waterways and airways to the metric system. The difficulty of making any change in these was evidenced recently in connection with the adoption of the international inch as 2.54 centimeters exactly instead of 2.54000508 centimeters. Because of the very great time and expense that would be required for changing, it was decided to retain the latter value as the basis for a special unit known as the survey foot.

The construction and operation of highways and waterways constitute one of the major expenditures of both the Federal Government and State governments. If there are advantages in expressing distances in kilometers instead of miles, and in putting engineering specifications in meters instead of feet, and quantities of materials in metric tons or cubic meters instead of long or short tons and cubic yards—these advantages should be significant in connection with the Nation's highway building and other major construction operations.

The Post Office Department conducts a business amounting to nearly \$4 billion a year on the basis of measurements in pounds, ounces, and inches. If a general change to the metric system should be determined advisable, the post offices would be in a very favorable position to aid in educating the public because they reach nearly every citizen.

The control of crops and the support of prices of farm products are also activities of the Federal Government that touch large numbers of people, hence their conversion to the use of metric units would serve an educational purpose as well as saving the Government money if there should be any economic advantage attendant on the use of metric units.

The Federal Government, in its manifold operations, is the Nation's largest consumer and purchases the products of nearly every industry. Thus, it would be in a position to wield large influence if it should determine upon a policy of adopting the use of metric units and should change its more than 3,500 Federal specifications to metric units. The influence of such a change would be reflected in a very large volume of purchases by States, counties, municipalities, and private agencies that also utilize Federal specifications. Such a change would lead to an increase in the cost of the items purchased unless industry should also change.

2. Industry

The exploration of problems likely to arise from conversion to the metric system in industry can be greatly simplified, at least in the initial phases of the study, by dividing the products to be considered into two broad categories—those in which the product itself would be changed, and those in which there would be no change in the product but only a change in designation, label, package, or unit of sale.

(a) *Products in which significant changes would be involved in conversion to metric units.*—Machinery and appliances generally would present the greatest problem and would involve the largest expense in conversion. Machine tools would have to be changed and in many instances there would be the problem as to whether it would be more economical to scrap particular machines or to rebuild them at considerable expense. The problem would be most acute with machine tools especially those having lead screws such as lathes and thread grinders, and other precisely dimensioned items. The major industries most affected would be the automotive and aircraft industries, and the machine tool industry.

Nuts and bolts and the more sophisticated threaded fasteners made in inch units would be useless for most applications to metric products. The same would be true of many replacement parts for machines and appliances. Thus there would be the problem of deciding in many individual cases whether it would be more economical to scrap the appliances and stocks of parts or to maintain dual inventories and service activities.

(b) *Products that would not be changed significantly by conversion to metric units.*—The greatest dollar value and the largest quantity of the products of industry are bulk materials and include the following: Agricultural products; construction materials such as cement, sand, gravel, plaster, etc.; chemicals and fertilizers; and fuels including oil, coal, and gas. Conversion to metric units for these products could be effected by changing weighing and measuring devices along with records of inventories and business transactions. At the wholesale stage the cost of transition would not be large or the problems difficult, but in retail operations a great deal of expense would be involved. The education of the consumer would also be a factor and even with the best preparation that it would be practical to make, there would undoubtedly be confusion that would involve direct or indirect expense.

Many industrial products other than bulk materials would not have to be changed in a conversion to the metric system because they are designated either by numbered sizes or by nominal dimensions in round numbers which are not the actual dimensions. Thus, wire sizes are given in numbers which bear no relation, in round numbers, to any system of units. Tables in engineering handbooks usually give the actual sizes both in inches and in millimeters. The nominal thickness and width of planed lumber depart so far from the actual dimensions that round numbers in metric units would be as close to the actual dimensions as the present designation in inches. This, however, is not true of the lengths for the better quality of finished lumber nor is it true of plywood sheets.

Sizes of steel pipe afford another illustration of a product in which the nominal dimensions may depart considerably from the actual measurement. The inch sizes of pipe could be converted to round numbers in centimeters that would serve equally well for purposes of designation without changing the actual dimensions.

A number of manufactured products are made with equipment which can readily be adjusted to change the thickness, width, or diameter. One illustration is the rolls that are used to make sheet metal or sheet plastic. The width of textiles and the width and thickness of paper, likewise, could be changed within moderate limits without any large or difficult change in setting.

3. Commerce and trade

At the retail level, conversion to the metric system would involve the twofold problem of changing or replacing vast numbers of scales, gasoline pumps, and other measuring devices, and at the same time acquainting the public with the new units.

It is not known whether a widespread change in measurement systems would have a minor or profound effect on prices in general or for specific groups. Our economy is characterized by "sticky" prices which stem in part from the convenience of prices in multiples of 5's or 10's and in part from price strategy which dictates that quantities be varied and customary charges remain fixed. Any study regarding the widespread introduction of change in physical measures should consider also the correlative problem of price change.

Prepackaged commodities, such as loaves of bread or bottles of milk that are required by law to be sold in round units such as 1 pound or 1 quart, would have to be changed as indicated in a previous paragraph. Many other prepackaged quantities, however, that are now sold in a wide range of quantities and sizes that are not expressed in round numbers would simply need to be remarked in metric units.

The service trades, particularly those concerned with maintenance and repair, are accustomed to flexibility in adjusting to the products with which they deal, but would be required to expand their range of tools.

4. *Public utilities (other than transportation)*

Public utilities, in connection with their services to the public, would not encounter any major problem in conversion to the metric system other than the very considerable cost of changing the indicating mechanism of millions of water and gas meters.

Telephone service, where measured in quantity, is expressed in dimensionless message units. Electric service is conventionally measured in kilowatt-hours as in metric countries, hence would require no change.

In construction, maintenance, and the various other operations that public utilities must perform, they would encounter a larger number of problems in conversion to the metric system just as any other industry.

5. *Engineering*

Engineers would probably be affected more than any other group by a change to the metric system. In the United States engineers are trained in the use of the U.S. customary units; their handbooks, textbooks, and periodicals are all in the customary units. Only small specialized groups of engineers have occasion to employ the metric system. Aeronautical engineers are such a group and they have indicated in a recent survey that they would favor a change to the metric system as a means of saving time now spent in making the conversion from one system to the other.

The change of all of the engineering literature to metric units, and the reeducation of engineers to think in metric units would be a very large undertaking, but the change of the millions of engineering drawings from one system of units to another would be a project of colossal magnitude. It could not be done by any simple mechanical conversion because the changes in thickness, weight, and tolerances that would necessarily be involved would require, in many cases, a recomputation of loads and stresses, and even a reconsideration of the design.

6. *Education*

The metric system is currently taught in schools along with the U.S. customary system of units, with emphasis on the latter. Studies have been made both in Britain and the United States on the saving in time if only the metric system should be taught. Some proponents of the continued use of the U.S. customary units counter this proposed advantage by pointing out the training in arithmetic gained by the use of the system.

In the event of any widespread change to metric units, a major problem would be the education of adults to become familiar with metric units and learn to think in terms of them.

IV. CONDUCT OF THE STUDY

The most effective and economical plan for the study seems to be one in which a small professional staff, of say five or six, would undertake to analyze the problems involved in conversion, and design a study in which they would enlist the fullest practical collaboration of governmental agencies and industrial and scientific organizations. This collaboration would necessarily involve more than the filling out of questionnaires asking opinions. Qualitative information would be required together with the pertinent numerical data wherever possible. It is to be hoped that many of the data sought could be derived from existing census figures and business statistics. However, some data would probably have to be obtained by first-hand studies. Because of the time and expense likely to be involved in such studies, they would be undertaken only with careful planning and the fullest possible use of modern sampling techniques.

It would be highly advantageous in the course of the investigation to determine and analyze the experience of countries such as Japan and India which are now converting to the metric system, and the Philippine Republic which has only recently made the change. It would also be important to determine, more definitely than has as yet been done, the influence of systems of units on export trade, with particular attention to long-range considerations.

In view of the time that may be required for the recruitment of qualified staff, the analysis of the problem, and the collection of data at home and abroad; it appears that 3 years should be allowed for the study with provision for annual reporting to the sponsoring organization.

It is recommended that the staff include a scientist with a background in standards to act as project leader, a broadly trained engineer, a business economist, a statistician, and an educator, supported by a small staff of research assistants, clerical, and secretarial personnel. Assuming that the project should be authorized for work to begin on July 1, 1961, it is estimated that \$75,000 would be required for the first year, and \$125,000 to \$150,000 for each of the 2 succeeding years.

V. REVIEW OF PROPOSAL

Because of the broad scope of this proposed study and the possible significance that may be attached to the findings, it is suggested that this report be submitted to representative groups in Government and in the business community for advice and comment before a decision is reached as to whether to undertake the work.

Respectfully submitted.

BUREAU OF CENSUS,
JACK J. GOTTSEGEN.
BUSINESS AND DEFENSE SERVICES
ADMINISTRATION,
CHARLES F. HUGHITT.
OFFICE OF BUSINESS ECONOMICS,
JAMES W. McNALLY.
BUREAU OF FOREIGN COMMERCE,
JOSEPH W. VANDER LAAN.
NATIONAL BUREAU OF STANDARDS,
A. T. McPHERSON, *Chairman*.

Dated March 16, 1961.

Mr. HECHLER. I ask the letter of May 8, 1961, which the Secretary of Commerce sent to the committee be made a part of the record.

Mr. MILLER. Without objection, that will be done.

(The information requested is as follows:)

THE SECRETARY OF COMMERCE,
Washington, D.C., May 8, 1961.

Hon. OVERTON BROOKS,
*Chairman, Committee on Science and Astronautics,
House of Representatives, Washington, D.C.*

DEAR MR. CHAIRMAN: This letter is in reply to your request dated January 23, 1961, for the views of this Department with respect to H.R. 269, a bill to provide that the Secretary of Commerce shall conduct a study to determine the practicability and desirability of the adoption by the United States of the metric system of weights and measures.

The bill would provide that the Secretary of Commerce shall conduct a study to determine the desirability and practicability of the adoption in the United States of a metric system of weights and measures. A full and complete report of the findings is to be submitted to the Congress within 3 years after the date of enactment of the bill.

This Department recommends enactment of H.R. 269 if amended as indicated.

The Department believes that a program such as proposed in the bill would be appropriate.

We believe, however, that the program should provide specifically for a study of changes to the metric system that are currently being made in American industries, such as the pharmaceutical industry, and also for a study of the transition in foreign countries that have recently adopted, or are in the process of adopting, the metric system.

Subject to your consideration of the suggested amendment, this Department recommends enactment of H.R. 269.

The Bureau of the Budget advised there would be no objection to the submission of this report from the standpoint of the administration's program.

Sincerely yours,

EDWARD GUDEMAN,
Acting Secretary of Commerce.

Mr. HECHLER. This is some of the things that I have discovered.

Mr. MILLER. They have reports on these bills and they will all be made part of the record

Mr. HECHLER. Do you have any preference as between the bills introduced by Mr. Miller and Mr. Roosevelt so far as who should conduct this study? I notice Mr. Miller's bill provides that the National Bureau of Standards shall make the study and the Roosevelt bill provides it be made by the Secretary of Commerce.

Dr. ASTIN. To some extent I think this may be a legal problem and it may be a semantic one. Under the current Government organization all the responsibilities and authorities of the National Bureau of Standards are given by the Congress to the Secretary of Commerce. He in turn delegates them when desired to the National Bureau of Standards.

Mr. HECHLER. Wouldn't the study be broader and cover such areas as foreign trade if made by the Secretary of Commerce?

Dr. ASTIN. It is my feeling, and this task force report which you introduced to the record bears it out, that any study of this sort should involve extensive consideration of the economic factors. It is my feeling that the NBS cannot do this alone. It must draw upon other resources in the Department of Commerce.

Mr. HECHLER. Dr. Astin, would you submit for the record a list of those countries that now have the metric system and the date of its adoption with particular reference to the more recent countries that have adopted the metric system? I wouldn't want you to go back into ancient history and try to ascertain when all the countries adopted it, but particularly I would like to see the more recent adoptions in the 20th century.

Dr. ASTIN. I will be glad to do that. It should not be too difficult, because a recent report on this subject in England made such a list and we can use their list. We will prepare it for the record.

(The information requested is as follows:)

Countries in which the use of the metric system is required by law¹

Country:	Effective date ²	Country—Continued	Effective date ²
Afghanistan.....	1926	Jordan.....	1954
Albania.....	1951	Korea.....	1949
Algeria.....	1843	Lebanon.....	1935
Argentina.....	1887	Libya.....	1927
Austria.....	1876	Liechtenstein.....	1876
Belgium.....	1816	Luxembourg.....	1820
Bolivia.....	1868	Malta.....	1921
Brazil.....	1872	Mauritius.....	1878
Bulgaria.....	1892	Mexico.....	1896
Cambodia.....	1914	Monaco.....	1854
Chile.....	1865	Morocco.....	1923
China (Taiwan).....	1954	Netherlands.....	1816
China (mainland).....	1949	Nicaragua.....	1912
Colombia.....	1854	Norway.....	1882
Congo.....	1910	Panama.....	1916
Costa Rica.....	1912	Paraguay.....	(³)
Cuba.....	1882	Peru.....	1869
Czechoslovakia.....	1876	Philippines.....	1917
Denmark.....	1912	Poland.....	1919
Dominican Republic.....	1955	Portugal.....	1852
Egypt.....	1951	Rumania.....	1884
Ecuador.....	1871	Saar.....	1872
Finland.....	1892	Salvador.....	1912
France.....	1840	San Marino.....	1907
Germany.....	1872	Seychelles.....	1880
Greece.....	1959	Spain.....	1871
Guatemala.....	1912	Sudan.....	1955
Haiti.....	1922	Surinam.....	1917
Honduras.....	1912	Sweden.....	1889
Hungary.....	1876	Switzerland.....	1877
Iceland.....	1907	Syria.....	1935
Israel.....	1954	Thailand.....	1936
India.....	1958	Tunisia.....	1895
Indonesia.....	1938	Turkey.....	1933
Iraq.....	1938	U.S.S.R.....	1927
Iran.....	1933	Uruguay.....	1894
Italy.....	1863	Venezuela.....	1914
Japan.....	1959	Yugoslavia.....	1883

¹ Principal source of information: "Report of 10th General Conference on Weights and Measures," pp. 59-72, International Bureau of Weights and Measures, Paris (1955).

² In many of the countries listed above, the laws relating to the use of the metric system have not been actively enforced.

³ Date uncertain.

Mr. HECHLER. Would you like to expand any further on the statement that you made on the top of page 2 of your statement about "intangible" considerations?

Dr. ASTIN. Without prejudging it, I might make a few guesses. It is my feeling that in terms of the leadership role that the United States must take in the world, and particularly a leadership role in the technological development of less developed countries, we are at a disadvantage by not using the system of measurement that most of these countries use. South America is a particular case in point here. All of the countries in South America use the metric system.

When we go into South America to try to assist them on some technological development problem, any effort to try to extend the use of English or U.S. customary measures in these countries I think would be resented. So we have, to an appreciable extent, to convert our technology to their system of measurement in order to provide effective assistance to them in technological growth.

I think this is one example of the sort of intangible factor that is involved in this.

Mr. HECHLER. I want to make my position clear on this. I think these hearings are useful. I would like to see personally the metric system adopted in the next few years. I think a study is necessary. I think it is also necessary that we get considerably more public discussion on this. I think it is necessary at an early point that we even incite to action those groups which would be opposed to it so that, for example, those groups that oppose the fluoridation of water can release their emotional energies and oppose the metric system now.

I believe the resolution that Mr. Fulton introduced is a little bit premature but I think it is good to contribute to public discussion.

Mr. FULTON. Could I be heard on that?

Mr. MILLER. We are a little pressed for time. I would say this would be better taken up in executive session here.

Mr. FULTON. On the comment that it is premature, may I explain that I would not like the record to remain in that form. Is there any doubt in any scientist's mind, I am speaking of a scientist of competence in this field, that a uniform system for all nations based on a metric system is the better way for measurements?

To me the idea of having a 1- to 3-year study to decide whether the metric system is the better system, than a study to decide that all the nations of the world should be on one uniform system is a rather unproductive course. I know of no one of scientific competency, who would not say that the metric system in most every instance would be a decided advantage.

Do you know of any?

Dr. ASTIN. No. I think this statement of yours is correct. And I think it is demonstrated primarily by the fact that the metric system is the universal language of science.

Mr. FULTON. The second point is this: Then if we decide on that philosophic base as a course of action that is best suited for science, the question then comes, how do you implement it, rather than should we adopt the metric system.

My House Concurrent Resolution 44 presupposes that scientific philosophic basis, that a uniform metric system for all the countries and peoples of the world is the best, and then it says that it is the sense of Congress that we move ahead with some sort of a plan, and by appropriate steps, the counsel of the Nation's leaders, educators, and scientists, under the leadership of the President, to effect the adoption of the metric system of weights and measures as the Nation's official system of measurement in all appropriate fields of endeavor.

My resolution doesn't put it under a mere department head, but says that Congress feels that we should proceed with some sort of plan or plans and appropriate steps under the President's direction. That is really saying to the President, "If you make the decision as an Executive policy, we in Congress will then be willing to receive your messages, to give you adequate legislation in the various fields where you feel it should be applied and at the times that it should, in consultation with the various industries and sciences."

I wanted to give you the philosophy of my resolution, so that it is not that we are going to jump into something overnight on a great scale, but that we have a top level direction by the President as to method and as to the appropriate steps in conjunction with the sciences and business. That is all. Would you comment on that?

Dr. ASTIN. I don't think it calls for a comment. You have announced you plan. I don't think that this is——

Mr. FULTON. I would like to have him say.

Mr. MILLER. We are very much pressed for time, Mr. Fulton.

Mr. FULTON. Would you just agree or not agree? Do you agree generally with that?

Dr. ASTIN. There were a lot of things covered in your statement, Mr. Fulton. I would agree with the general objectives. However, I think a study would tend to point up some of these problems or things which might be tackled if, after the study, it was concluded that your resolution was the proper one.

Mr. HECHLER. Would the gentleman yield? Wouldn't a study also contribute toward public education?

Dr. ASTIN. Yes, sir; it would. There is another aspect of the study which I think we should not overlook. It is my feeling that neither the United States nor the United Kingdom should act unilaterally on this matter. It is my feeling I would also include Canada and the other major English-speaking people, but one of the things that a study would bring out might be a mechanism of cooperation for a change, if it is agreed to, among these major users of the English unit.

Mr. MILLER. Thank you very much.

Mr. FULTON. Shall we start with a conference? That is a very good point.

Mr. MILLER. It is a good point. This is one of the things that when we get into the bills and we come up and consider them, in executive session, and——

Mr. FULTON. Should we start with a conference among those nations on the English standards?

Mr. MILLER. Let's study our own and we will see what they come up with.

Mr. MOSHER. Just briefly, I certainly salute you for introducing H.R. 2049 and also Mr. Fulton for his resolution. I think that it is extremely important that Congress consider what is best to do here. My inclination is to agree with what evidently all of us believe, that the metric system should be adopted.

Being a newcomer to the Hill, I am not familiar with recent legislative history. I judge that you introduced a similar bill——

Mr. MILLER. Yes, last year. But we didn't get around to having hearings.

Mr. MOSHER. Is there any outright opposition indicated?

Mr. MILLER. There has been no outright opposition. As a matter of fact, at one time during the meeting of our board of consultants here, we had 12 outstanding scientists, and I just threw the matter on the table and if you have ever seen a bunch of fishing after the fly, they went after this and we nearly lost sight of everything else because they wanted to discuss it.

I am not wedded to the language in any one bill. We are holding hearings to try to bring out some data, how we can best cooperate to get this job done.

Mr. MOSHER. Mr. Chairman, does Dr. Astin have any estimate of what the cost of the study recommended in your bill would be, what appropriations would be required?

Dr. ASTIN. There are some tentative numbers given on this in the task force report which was introduced into the record. Roughly our

estimate of the total cost would be between \$400,000 and \$500,000 for the 3-year study.

Mr. MILLER. This would have to be authorized, if this bill were passed, and placed in the next budget.

Dr. ASTIN. This would include not only what effort we would have to put in, but that of other agencies in the Department of Commerce which I think should also be involved, the economists and statisticians.

Mr. MOSHER. I know you want to move on to the other witnesses so I will reserve my other questions.

Mr. MILLER. Mr. Casey.

Mr. CASEY. No questions.

Mr. MILLER. Mr. Counsel.

Mr. CARSTARPHEN. No questions.

Mr. MILLER. You have Dr. McPherson, Associate Director, with you. Does he have a statement?

Dr. ASTIN. He has no statement to make. He would be glad to answer any questions that you may have.

Mr. MILLER. Doctor, you have had a long experience in this field. I am certain that you could give us a little enlightenment on the field.

Dr. McPHERSON. I think Dr. Astin has covered the activities of the Bureau, the work that we might do. I look forward to carrying out, personally participating in, any study that might be undertaken.

Mr. MILLER. Dr. Astin, I would like to ask you this question. If this bill, one of these bills authorizes the Bureau of Standards to undertake this investigation, is the Bureau willing to accept this responsibility?

Dr. ASTIN. Yes, we would. We have already concluded internally if it comes about that Dr. McPherson here would head our part in it. He is the member of our staff who has given most attention to this matter to date. He would continue to be our leading participant in the effort, depending on how deeply we get into it.

Mr. MILLER. I hope we can put him to work.

Mr. MOSHER. One further question, Mr. Chairman. Dr. Astin, on page 1 of your statement it refers to this carefully prepared balance sheet with the expected advantages and the corresponding disadvantages set down in parallel columns. I realize, Dr. Astin and Dr. McPherson, that the Bureau's position on this has to be impartial at this point. That is the attitude of scientists before they are certain. What is your personal expectation as to what such a balance sheet should show?

Dr. ASTIN. I think it is difficult to make a guess on this. My own feeling is that the costs would be greater than—on the dollar column, the costs would be greater than the expected savings. I don't know. I would prefer to withhold judgment. This would be my guess. If one does it, one would do it for the intangible advantages, rather than the physical.

Mr. MOSHER. The dollar costs may be more than the savings—

Dr. ASTIN. This is a very tentative guess on my part.

Mr. HECHLER. You mean, Doctor, immediately? You don't mean in the long run?

Dr. ASTIN. I think if one were able to extrapolate maybe 40 or 50 years in advance, it might change. This would tend to be an offsetting factor.

Mr. MOSHER. Among the intangibles you referred a moment ago to our leadership role. This gets into the political area.

Dr. ASTIN. This is correct.

Mr. MILLER. You just came in, my good friend.

Mr. CHENOWETH. I had another meeting.

Mr. MILLER. Do you have any questions?

Mr. CHENOWETH. I believe not.

Mr. MILLER. Thank you very much, then, Doctor. Col. Walter Woodard, Office of Deputy Chief of Staff, Research and Development, Air Force Systems Command.

Colonel, you have a statement, I believe.

Colonel WOODARD. Yes, Mr. Chairman. Would you care that I read the statement or summarize?

Mr. MILLER. Is it very long?

Colonel WOODARD. A page and a half statement.

Mr. MILLER. Suppose you read it.

**STATEMENT OF COL. WALTER W. WOODARD, ASSISTANT FOR
RELIABILITY ENGINEERING, DEPUTY CHIEF OF STAFF, RE-
SEARCH AND DEVELOPMENT, AIR FORCE SYSTEMS COMMAND,
U.S. AIR FORCE**

Colonel WOODARD. With regard to H.R. 269 and H.R. 2049, 87th Congress, and similar bills which propose that there be carried out under the Secretary of Commerce a study of the desirability and practicability of the adoption of the metric system of weights and measures, the Department of Defense supports the proposed study.

It is clear that the adoption of the metric system would have such extensive effect on the military services of the United States that it would be impractical for the military services to remain on the English system while the country changes to the metric system, or for the military services to change measurement systems in a substantial degree while the country adheres to the English system. Accordingly, the Department of Defense would oppose any proposal to make the change without adequate advance preparation.

Service studies in the past have turned out varying results; in general, basic research people either are already using metric units or are willing to make an early change; development and engineering people would rather see a time-phased change which allows for wearing out and using up existing equipment over a period of 10 to 20 years; while procurement and supply people are less enthusiastic for the change, because of anticipated increased costs, production delays, spare parts, stock problems, retraining, and the like. There are, of course, specialized areas, such as medicine and geodesy in which the conversion is already effective.

The subject is admittedly controversial; but the consensus in the Department of Defense indicates that the proposed study would be a substantial step toward settling the controversy.

Many of our military allies use the metric system; and if the United States makes the change, the British Commonwealth nations would be under heavy pressure to follow suit. It would be highly undesirable for the United States to make the change without consultation with the British Commonwealth.

If it is decided that a study should be made, it is recommended that participants include industry and the general public, in addition to the educational, scientific, and governmental agencies.

Mr. Chairman, that concludes my prepared statement. I shall be happy to respond to any questions the committee may have.

Mr. MILLER. Colonel, the Defense Department then, I take it, feels that such a study is desirable at this time and should be undertaken.

Colonel WOODARD. We certainly do.

Mr. MILLER. Mr. Hechler?

Mr. HECHLER. Does the Defense Department have any general feeling at the present time about the metric system and its advantages and disadvantages that would indicate its position? For example, if the study reveals a recommendation to adopt the metric system?

Colonel WOODARD. If the study reveals that we should adopt the metric system, I think, as we stated, the military services must follow the Nation. We are so intertwined with all industry that we could not have a military service operating on a metric system and the country operating on a British system, nor could we think of any portion of the military system going off in any substantial change in measurements.

Mr. HECHLER. From what you say, it sounds like a kind of reluctant support. I wonder if you had any—

Colonel WOODARD. I am sorry if I make it sound as a reluctant support. I don't think we have any reluctance in this support at all. I think all three services are enthusiastic for this study. And we hope that this study will get this on a basis of facts, rather than on a basis of emotions as we have seen in the past.

Mr. HECHLER. You mentioned that participants should include industry and the general public. Do you have any suggestions?

Colonel WOODARD. Sir, I am referring to the fact that we are dealing in the military services with scientists, surely, but much of our dealings are with the industry, the manufacturers, the producers of small machine shops, such that those with inch-type lathes move to a metric system would be hard pressed to get contracts for future developments.

These are the people that I think you must hear in the determination of whether this Nation does adopt the metric system.

Mr. MILLER. I think you also consider such things as the Society of Automotive Engineers that have adopted voluntarily in the automotive industry—has adopted the standard for measurements for all of its parts. This is a big factor in the country. And I assume that they would be opposed to making the cutover too fast; isn't that correct?

Colonel WOODARD. I believe, sir, that our scientific societies, including the automotive engineers, would be rather enthusiastic in moving toward the metric system but not on an immediate basis. They would like to make this a rather gradual change.

Mr. MILLER. I think they would want to move toward it, but there would be an impact if you tried to do it overnight, if you moved too fast. I think this is the thing that has to be looked into. That is one of the reasons why I felt that the Bureau of Standards was best equipped to do this study.

Mr. HECHLER. You mentioned at the bottom of page 1 that the procurement and supply people are less enthusiastic. Is there any-

thing that you could do in the next 3 years while the study is going on to speed their possible acceptance of the metric system?

Colonel WOODARD. I feel, sir —

Mr. HECHLER. When I say "you", I mean the Department.

Colonel WOODARD. Those items that we buy that are developed by the medical profession, in our aircraft, our oxygen supply system today is in terms of liters of liquid oxygen.

We encourage the scientist who works in the metric system to carry this through a unit of supply. This does bring the metric system into being without a great impact on our normal supply system. But when you do get into such things as raw metals, bar stock, and so on, the conversion from the inch to the centimeter presents them additional problems, duplicative stocking.

Mr. HECHLER. What I am getting at is that sooner or later we are going to adopt the metric system anyway, that there should be steps taken by the Department of Defense over this intervening period to educate, to ease the shock, to make the transition easier.

For example, I believe it would be very helpful for the service schools to examine the implications of the use of the metric system. I think that a wide discussion among procurement officers would be useful. Anything that could be done to stimulate this discussion, to ease such a transition, I think would be helpful.

Colonel WOODARD. Right, sir. I feel we have made a number of service studies. As I point out, they are with varying results, depending on primarily who of the military system was queried.

As you get into the people who are interested in what we have on the stock shelves today, they are less enthusiastic for the change.

Mr. CHENOWETH. You say this is a very controversial issue, there is a wide difference of opinion concerning the proposal. Am I not correct in this inference from what you say?

Colonel WOODARD. I feel the controversy is not among an element of our military organization, or an element of our scientists. We are generally in agreement in the scientific community, that the metric system is the language and we should use it. I do wish to point out that the Defense Department operates across the length and breadth of our Nation dealing with all of the public. We find many of them who do not wish to change to the metric system.

Mr. CHENOWETH. There would be substantial opposition to any such change.

Colonel WOODARD. I feel there would.

Mr. CHENOWETH. You have encountered that in the surveys you have made?

Colonel WOODARD. Yes, sir.

Mr. CHENOWETH. You say with varying results, some favorable and some unfavorable?

Colonel WOODARD. Yes, sir.

Mr. CHENOWETH. That is all.

Mr. HECHLER. I notice, Colonel Woodard, in your prepared statement you refer to the position of the Department of Defense. I assume that you were representing the Department of Defense, yet the statement lists that you are an Air Force officer, Deputy Chief of Staff, Air Force Systems Command.

Are you speaking for the Department of Defense?

Colonel WOODARD. Yes, sir; this morning I am speaking for the Department of Defense, not merely for the Air Force.

Mr. MILLER. Mr. Casey.

Mr. CASEY. Colonel, do you have any idea of what the British Commonwealth nations' attitude would be toward this change? Have you had any discussions with them?

Colonel WOODARD. Yes, sir. We have participated with the British in our international standardization programs.

As you know, the British are thinking of a decimalized monetary system. The British have not been particularly enthusiastic about a metric system. I think that certainly if we move in this direction the British Commonwealth will be more enthusiastic to the metric system, but I wouldn't look for real support from the British Commonwealth to move in this direction.

Mr. CASEY. I believe you suggest a 10-year phaseout or did you have that in mind?

Colonel WOODARD. I mentioned our engineers and development people feel that it would be about a 10-year period to do away with the material that we have in being today and bring in new types of systems.

Mr. CASEY. As far as the general public was concerned, it would be longer than that?

Colonel WOODARD. I feel it would, sir.

Mr. CASEY. They are now buying piece goods by the yard. The ladies with patterns for their dresses are on the yard basis. Land is sold by the square foot.

Colonel WOODARD. This is why we say that we feel that you should bring the general public and industry into this study and not have it a study of only the educators and scientists to render an opinion.

Mr. CASEY. I know moving from Texas where houses are figured on a square-foot basis, I notice up here it is usually on a cubic-foot basis. If I asked a builder what size house this is, he would give me cubic-foot measurements and he figures costs on a cubic-foot basis and at home it is a square-foot basis.

I could see where the cubic foot is more realistic due to the fact that ceiling heights may vary in computing what would be the basic cost of a house. But it is difficult for me to make that minor switch in trying to figure out whether I was getting my money's worth or not in making a comparison.

I can readily see where 10 years as far as the scientific end, or military, in phasing out equipment, might be an optimistic time, but as far as the general public is concerned it might take a lot longer than that.

Thank you, Mr. Chairman.

Colonel Woodard, what is the attitude of the scientific community in the British Isles? Are they about the same as our people?

Colonel WOODARD. I believe that I am not familiar enough with the scientific community there to speak for them. Perhaps our Bureau of Standards people here have more knowledge of the scientific community of Britain.

Mr. MILLER. Dr. Astin can bring that out.

Mr. Mosher.

Mr. MOSHER. Colonel, on page 2 you refer to the fact that conversion already is effective in specialized areas such as medicine and

geodesy. What was the experience in the transition period in those specialized areas? Were there practical difficulties or were the costs excessive?

Colonel WOODARD. No, sir. I think the transition made in pharmaceuticals, is an example. As a new batch of material came up for processing, the formula was submitted back to the scientist to recompute this in a metric system, and then presented to the processors. It was not a matter of trying to do all of the changes at one time; so it was rather easy in this area.

If you talk about changing such things as the drill sizes in our trades, of just simply saying, "Next year we are going to use metric drill sizes," this has all kinds of implications of duplicate equipment throughout the Nation for a long time.

Mr. MOSHER. These specialized areas are not necessarily then—it doesn't indicate completely the problems that would exist in some other areas?

Colonel WOODARD. I think that is so, sir. These are specialized areas in which the elements are quite closely controlled.

Mr. MOSHER. The transition was easier?

Colonel WOODARD. I might say today we have the conversion being made in both directions. For example, the Germans are now building our F-104 aircraft and converting this to a metric standard.

On the other hand, we are buying the Turbo Mecca designed engines from the French and converting the dimensions to the English system. It is not an impossible conversion. We are doing it. It is being done today and being done in both directions. It is rather costly, however.

Mr. MILLER. In World War I, didn't we have to convert all of our artillery to the metric system?

Colonel WOODARD. I don't know that we can say that we had to convert to the metric system.

Mr. MILLER. We didn't have to convert, but in order to get artillery in World War I, we had to buy it from the French because we couldn't produce it. We had to train our people in the use of the French-firing tables, and we carried that on in the interim between the two wars, didn't we?

Colonel WOODARD. Yes, sir. I think you will find later in your hearings the Army will tell you about their regulations on the use of maps and artillery tables using the metric system.

Mr. MILLER. I know I had the privilege of going to the school of fire in World War I. It was quite a shock, even in the beginning, to have to convert to the metric system. Many of the people who were in the Army quite early, when our basic training had been in American materiel to fire in yards, and when we got the finished training we had to disregard it and throw out all our own textbooks and everything else and substitute French publications and translations for it.

As far as I know, we continued that after the war. I think all of our artillery today is calibrated in the metric system. I may be wrong. As far as I know, I believe this is the case.

Are there any other questions, Mr. Counsel?

Mr. CARSTARPHEN. Colonel Woodard, if these metric study bills were passed by the Congress, should the Department of Defense have a representative on the study group?

Colonel WOODARD. If the Department of Commerce desires a Department of Defense member, I am sure we would be more than

happy to furnish one. If there is any way we can contribute to this I am sure you will get the enthusiastic support of the three services and the Department of Defense.

Mr. CARSTARPHEN. You do not have any feeling then it would assist in the conduct of the study by having a Department man, or service personnel on it?

Colonel WOODARD. No, sir; because I think you are going to be looking at the industry and the commerce of the Nation——

Mr. CARSTARPHEN. As goes the industry so goes the Department of Defense?

Colonel WOODARD. Yes.

Mr. CARSTARPHEN. Have you any thinking with regard to the composition otherwise of this study group?

Colonel WOODARD. No, sir; I hadn't considered it.

Mr. CARSTARPHEN. All scientists? Should they be all scientists?

Colonel WOODARD. I recommend not, sir. I think, as we pointed out here, that we feel that your study should go across the public and industry and not be slanted to the scientific community specifically.

Mr. CARSTARPHEN. You would recommend perhaps economists as well as teachers. Are there any other personnel you might suggest?

Colonel WOODARD. Some good businessmen.

Mr. CARSTARPHEN. Colonel, in the event a conversion were to be the consensus of the Congress and such legislation is passed, made mandatory, how would industry make the conversion and at the same time retain the high degree of alertness for mobilization?

Colonel WOODARD. I believe that this would have to be done by selecting certain weapons for adopting the metric system. Any weapon that is in being you will not try to build future spare parts to a metric system, but rather retain the English system until this weapon is scrapped; only in the newer weapons would you have the metric system.

Mr. CARSTARPHEN. You are speaking of a weapons system now. You are actually touching many industrial fields but dealing with only one system though, are you not, sir?

Colonel WOODARD. Yes, sir; I recognize that I am. There would have to be changes made through all of the industries that affect this system. This is not going to be a real easy matter.

Mr. CARSTARPHEN. Thank you, Colonel. I don't believe I have any other questions.

Mr. MILLER. Colonel, you are making this transition now; we did it during the war. You have just told us that the Germans are building our planes and they had to make the transition.

This isn't an impossible thing to do if you wanted to; instead of boring a hole three-sixteenths of an inch, you look on a table that can be furnished to give you the decimal equivalent to the fourth place or so and we get along pretty well.

The changeover takes a little time.

Colonel WOODARD. We get along pretty well, sir. We also recognize when you make this change you have to go back and to do a pretty decent stress analysis and a redesign of some of our parts. Gear teeth, is one that comes to mind particularly.

Mr. MILLER. This would be very difficult.

Colonel WOODARD. You just don't convert to another measurement system and have them come out exactly as they did before.

Mr. MILLER. Of course, the people who have been using the metric system have very successfully made gear teeth.

Colonel WOODARD. Yes.

Mr. MILLER. When you see the influx of small cars from certain European nations that come over here, and machinery that is built there, machinery that we use commonly now must have been worked on the metric system?

Colonel WOODARD. What I meant to say was that you cannot take the drawing of one system and run through it with a table and change dimensions and expect this thing to work perfectly.

Mr. MILLER. It is not an impossible task. It is one that would meet with some resistance. I am afraid that you are giving some of us the impression that this is a very terrible undertaking. I think if you go back into the history of this country we all had a lot of confusion with Mr. Washington's birthday, whether it was on the 11th or the 22d of February. I assume for 40 years after—while the generation that was alive when the transition took place, and we changed the calendar and brought it under a more scientific one, that the people who talked about old style and new style were quite confused, but it doesn't confuse us today, does it?

Don't we look down our noses a little bit at some of the people who maintain an unscientific type of calendar today, that we are a little bit ahead of them?

Colonel WOODARD. If my words have indicated that we are not enthusiastic for this, I don't wish to leave that impression, sir. I think we are very enthusiastic for this study.

Mr. MILLER. We realize there are certain very definite problems to be met, but they are not insurmountable.

Mr. CHENOWETH. You say you are enthusiastic. You mean you personally or the Department of Defense?

Colonel WOODARD. The Department of Defense is enthusiastic for this study to be made, sir.

Mr. CHENOWETH. The longer this study is continued, the better off we will be? There should be no time limit on this study, should there?

I got the impression that there would be serious, substantial opposition to this, and if I support this I am going to recommend that the study be continued, not in perpetuity, but for a considerable length of time.

I don't think we will be rushed into anything like this. Doesn't the Department of Defense have enough problems over there without taking on more problems?

I think in the world situation today we should be engaged in something more important than about revolutionizing our own system of measurements. I say that in all deference to the chairman of this committee. He and Mr. Roosevelt seem to have some idea we should make some changes. I respectfully submit that there should be some limit to the changes that we ought to be making.

We probably have enough problems before us now. That is just an observation.

Mr. MILLER. I would say to my good friend, we want to eliminate some of the difficult problems we have with the rest of the world by adopting this system and bringing us more in harmony with the other parts of the world, particularly where it has already been done in the scientific community.

Mr. CHENOWETH. Mr. Chairman, I would just like to observe there that certainly in recent years it hasn't been very popular in this country to make any move that doesn't meet with the approval of our friends across the water, particularly in Great Britain.

The witness has stated there will be substantial opposition to this there. Certainly we don't want to offend our allies by engaging in studies of this type in this critical period in world history. I just don't know. I was wondering about who had all the enthusiasm for engaging in this.

Colonel, I am just curious.

Colonel WOODARD. Mr. Chenoweth, our statement from the Defense Department, first of all this is a study to be made by the Department of Commerce. This is not one of the studies we are taking on ourselves.

Next, I think that this study is needed to get away from the emotionalism that has been shown concerning the adoption of the metric system. If we had some facts as to what the impact of this would be on our entire Nation, then I think that the Congress would be in much better position to move in a proper direction.

Mr. CHENOWETH. Over what period have you made these studies of your own?

Colonel WOODARD. Our studies in the past, recent studies have been over the past 3 or 4 years. I am sure if we dug back into our records we could find studies back about World War I.

Mr. CHENOWETH. I think the studies are an excellent idea. I think they should be continued for a long time. I don't know how much they will cost. There might be some objection to the cost involved. In these days that is a rather sensitive subject in Congress. I just have the impression that this enthusiasm for a change is not shared generally.

Your statement indicates that it is not. So I don't know whether this is the right time to stir up any more controversies than we have right now. I didn't detect from your statement that there was this enthusiasm for it.

Colonel WOODARD. Understand, sir, I made the statement that the enthusiasm was for the study, not for the immediate change.

Mr. HECHLER. Would you also extend this to include enthusiasm for adoption of the system if the study indicates desirability?

Colonel WOODARD. I am sure I could not speak today for the Defense Department with words like that, sir. If this study shows that we are going to make a change, I am sure that the Defense Department would not have an overwhelming enthusiasm for this any more than you will find in the rest of the Nation. Our studies, as we have made them in the past, have shown that groups of people within the Defense Department favor adopting the metric system if they are working with the scientific community. If they are developers, they are in favor of it but would like to effect the adoption more gradually.

Mr. CHENOWETH. Outside the Department of Defense, has there been any other studies made, any other interest in change?

Colonel WOODARD. The studies of the scientific societies, professional societies are the ones that I know of.

Mr. CHENOWETH. They have been continuing over the years.

Colonel WOODARD. Yes, sir; I think this is a rather perennial thing.

Mr. CHENOWETH. You mentioned the Department of Defense studies go back to World War I.

Colonel WOODARD. I say I am sure if I looked at our records we could find studies back that far. The ones that I have presented to you people here are within the last few years.

Mr. CHENOWETH. This isn't a subject that is new and novel so far as the Department of Defense is concerned?

Colonel WOODARD. No, sir.

Mr. CHENOWETH. Do you know of any compelling reason, Colonel, why it is more important to consider it now than it was during World War I?

Colonel WOODARD. I feel, sir, only that as we are becoming more closely associated with other nations that use the metric system that we are inclined to look more closely at our own methods of measurement and see if there are advantages to moving to the metric system.

Mr. CHENOWETH. Don't you think we should retain something in this country that makes us distinctive or sets us apart? We shouldn't adopt everything else that the world has. We ought to keep some identity.

Next week we are going to celebrate a rather important day, the 185th anniversary of our independence. We don't want to forfeit everything. We want to have some independent claims of distinction of our own; would you agree with that?

Colonel WOODARD. I think the Fourth of July is one that we really should hold to in this country.

Mr. MILLER. Do you want to celebrate the Fourth of July by saying we are retaining the English system of pounds, inches, and furlongs?

Mr. HECHLER. We declared our independence on the Fourth of July 1776, to get away from the English system.

Mr. CHENOWETH. You can make a speech in your district on that.

Mr. MILLER. If we gave you some good English talk about how many rods of earth you needed out in Colorado to grow corn in, would you be able to interpret that?

Mr. CHENOWETH. I am afraid I might be covered up with some of that dirt—

Mr. MILLER. Yet the rod and furlong and some of the others are actually defined measurements in the British system and in our system; are they not? If I tell you the street out here is $1\frac{1}{2}$ chains wide, this can be legally interpreted; can it not?

Colonel WOODARD. I believe that it can.

Mr. MILLER. For your information—you have been in San Francisco—Market Street is 2 chains wide because at the time it was laid out they were using the chain as the unit of measure. This is 66 feet, so they made it 2 chains wide. I would hate to go out there and try to survey for some improvements in chains and rods which were one time used by surveyors, used successfully at that time, because I am afraid it would cost more to translate it back and then to bring it up for modern industry than it would be worth.

It would be rather archaic. It would be a little archaic for the Army if we wanted to go back to 6-inch field guns. Would you advocate this, 6-inch howitzers and 3-inch field guns, 4.7 rifles? This would be just as bad as the thing you anticipate now, if we asked industry to go back to that.

Colonel WOODARD. I don't follow your analogy.

Mr. MILLER. Would you want to go back and put our artillery in the Army on the terms of the English measurements?

Colonel WOODARD. I think you will find none of us are sponsoring any programs to move in the way of a metric system to an English system.

Mr. MILLER. That is why I say the Army, that the Defense Department favors this study. I am not going to anticipate, as my good friend has, what the study is going to bring out and prejudge it. I want the study made.

From the data that the study gives us, I think we can judge. We haven't the information before us.

Mr. CHENOWETH. I didn't mean to take so much time, Mr. Chairman. I think it should be very clear, when we finish with the colonel, that there may be some enthusiasm for the studies.

Apparently over the years, dating back to World War I, there have been these studies and apparently no objection to the studies being continued. As long as the studies are continued, then I think the Department of Defense would pose no objection. One of these days if we keep on someone may come up with some recommendation that won't meet with such approval and you will find determined opposition and you will have real controversy on your hands.

I don't know that this is the time to precipitate anything like that because of the problems we have at the present time.

Mr. MILLER. It is going to take a minimum of 3 years to make the study. By that time if it is not propitious we will not go through with it. If it is, we can let the study come in and let a future Congress determine whether it wants to adopt it. Maybe some of us won't be here at that time.

Mr. CHENOWETH. I feel, Mr. Chairman, that 3 years will not be adequate to complete those studies. I think probably it should be extended some.

Mr. MILLER. If we don't put a cutoff date, I don't think we will ever get an answer.

Thank you, Colonel Woodard.

Col. G. P. Grant, Chief, Standardization Branch, Standards Division Office, Deputy Chief of Staff for Logistics, U.S. Army.

Colonel GRANT. I have a statement, Mr. Chairman, which I will read. It is rather short.

**STATEMENT OF COL. G. P. GRANT, CHIEF, STANDARDIZATION
BRANCH, STANDARDS DIVISION, OFFICE DEPUTY CHIEF OF
STAFF FOR LOGISTICS, U.S. ARMY**

Since World War I, when the 75-millimeter gun entered our supply system, the Army has used two units of measure to describe weapons—that is, the millimeter and the inch.

For example, guns and howitzers included 105-millimeter, 155-millimeter, 240-millimeter, 280-millimeter, and so forth, while rockets have been described as 2.36 inches, 3.5 inches, and similar designations. To resolve this dual system, about 10 years ago it was decided to describe all new weapons in terms of millimeters. This resolution involved only the description of the item. All drawings from which the weapons were produced were, and are, still maintained in terms of

inches and decimal portions thereof. For example, the new .30 caliber rifle is now identified as the 7.62-millimeter M14, but the drawings for the rifle are still in terms of the customary units.

Early in 1957, consideration was given to the description of linear target distances in yards and meters. Some weapons systems had already been provided with a dual capability; that is, the range indicators and computation could be in terms of both systems. The Hawk is an example of such dual capability.

In an effort to simplify procedures and develop a better capability of working with the armies of friendly nations, the meter was selected as a common unit for linear distance measure. This policy was expressed in Army Regulations 700-75, copies of which have been forwarded to the committee staff.

The target date of January 1, 1966, was selected to reach the objective of this common unit in Army weapons and associated fire control equipment.

Again, I would like to emphasize, the drawings, machine tools, and gages from which the equipment is, or will be, produced will be in the English or inch system.

As a corollary to Army Regulations 700-75, Army Regulations 525-8 (copies of which were also forwarded to the committee staff) were issued to express policy concerning the operations and training aspects of the use of the meter for expression of linear distances in fire direction.

These regulations provide for training literature and for appropriate conversion of items such as training aids and firing tables.

The Army has been asked to comment on difficulties encountered.

The actions above-mentioned are of too recent origin to provide an adequate basis for opinion.

We anticipate no major obstacles and feel that the timely training of personnel will provide for smooth transition.

Gentlemen, this concludes my statement on Army use of the meter in linear measurement.

Mr. MILLER. The Army then has decided to go ahead and adopt the metric system as of January 1, 1956?

Colonel GRANT. May I reiterate, for its unit of linear measurement.

Mr. MILLER. I mean for actual operating effects?

Colonel GRANT. Yes, sir. I have been asked to say that the U.S. Marine Corps is joining us in the same date and time frame.

Mr. MILLER. You feel that this will give you more flexibility, easier to work with, the whole system?

Colonel GRANT. I can best quote right from the regulations:

It permits better use of the captured enemy material and it facilitates firing of weapons.

We are thinking, of course, working with our allies on this.

Mr. MILLER. The Army had to disregard both the circular measure and mils many years ago.

Colonel GRANT. Circular measure remains the same.

Mr. MILLER. Yes, and got away from the old 360-degree thing because it was a little too hard to work with.

Colonel GRANT. Yes, sir; the mil bears a particular relation to the range. In other words, it is a thousandth of the range.

Mr. MILLER. This is the position that the Army has taken?

Colonel GRANT. Yes, sir.

Mr. MILLER. Do you feel the Army would look with favor upon the study?

Colonel GRANT. Yes, sir; we follow the Defense Department in this regard.

Mr. HECHLER. I want to congratulate the Army in its presentation and its feeling toward the metric system. You mentioned that the Marine Corps had also set a target date of January 1, 1966, for conversion. What about missiles and weapons of the other services?

Have you had any late news from the front about them?

Colonel GRANT. You mean the other services, the Navy and—

Mr. HECHLER. Yes.

Colonel GRANT. And Air Force. I am not aware of their particular interest.

Mr. HECHLER. We can get testimony from them. What about the ease of training of troops? Do you have any recent reports what the reaction of troops in training would be?

Colonel GRANT. Yes, sir; I have talked to our operations people just recently, of course, in preparing for this hearing. And they anticipate no particular trouble. As a matter of fact, shall we say the training is already started. We have a limiting date quite a bit ahead. When that date comes, it is contemplated the Army will be completely converted.

Mr. HECHLER. When you say the training is already started, I wonder if you have had any reports from soldiers who were incapable of absorbing this sudden new development or have they been able to take it in their stride?

Colonel GRANT. I can only say our staff people have informed me we have run into no problems up to the present.

Mr. HECHLER. Wouldn't this changeover be of great advantage so far as our NATO forces were concerned and our cooperation with other nations of NATO?

Colonel GRANT. Yes, sir. We might say this is what we had particularly in mind when the Army made the conversion.

Mr. HECHLER. Would you care to comment on the relation of this change to the effectiveness of the United Nations forces?

Colonel GRANT. No, sir; I don't believe I am qualified on that. We have been dealing with the NATO people only.

Mr. HECHLER. Isn't there a rather direct analogy?

Colonel GRANT. In my personal opinion, yes.

Mr. HECHLER. Thank you.

Mr. MILLER. Mr. Chenoweth.

Mr. CHENOWETH. Do you recognize, Colonel, within the Army there would be some opposition, some resistance to this, this all-out change?

Colonel GRANT. There is quite a bit of literature on this. In reading up on it lately, in preparation for hearings and informing other people, I can assure you that there will be.

Mr. CHENOWETH. That is all.

Colonel GRANT. It has been well covered, actually.

Mr. MILLER. You will find a lot of enthusiasm for it —

Colonel GRANT. At the same time, yes, sir.

Mr. MILLER. Mr. Mosher.

Mr. MOSHER. No questions.

Mr. MILLER. Mr. Counsel.

Mr. CARSTARPHEN. Colonel, how long did the Army study the problem of the conversion before the A.R. was issued?

Colonel GRANT. In looking back old files I find that for some 4 or 5 years in which several conferences at which people discussed the problems inherent from World War II.

Mr. CARSTARPHEN. As a result of this study to have the A.R. issued, the time frame was certainly under investigation, too, was it not?

Colonel GRANT. Yes, sir.

Mr. CARSTARPHEN. The time frame for the completion of the conversion? My recollection of the A.R. is that it is a 5-year terminal date.

Colonel GRANT. Let me correct something.

The A.R. that you have, sir, is a revision. This has been an Army regulation since 1957, in which case it would have been about a 10-year period that was predicted ahead.

Mr. CARSTARPHEN. The A.R. issued in March of this year gives a terminal date of January 1, 1966, I believe.

Colonel GRANT. That is correct. This is the same date that was in the previous regulation that came out in 1957.

Mr. CARSTARPHEN. I am interested from the standpoint of time considered necessary for the change. There has been a lot of writing on the time period required to make the change.

Some people speak in terms of 10 years, 21 years and I have even read where they consider that a generation would be required to do such a conversion, 33 years.

In your opinion, can this conversion that you Army people are doing on your weapons systems as, you explained, be accomplished within the 5-year time frame?

Colonel GRANT. I want to point out again we have a number of weapons systems that have come into being since the original regulations were published which have already been changed. I can cite a simple one. The rifle. Our sights are in meters. The answer, of course, to your question is yes; we will be able to make it. We have enough time to plan on this and enough to be able to make it.

Mr. CARSTARPHEN. It is not such a major problem—

Colonel GRANT. We feel the training portion is quite important, and I wanted to stress that in our prepared statement.

Mr. CARSTARPHEN. What is the current status of the conversion, Colonel?

Colonel GRANT. Only the general statement that all systems that have been standardized since 1957 have been converted. Any we have in being, in the development stage, will also be converted.

Mr. HECHLER (chairman). Any further questions? If not, we want to thank you, Colonel Grant, for appearing before the committee. The committee stands adjourned until 10 a.m. in the morning.

(Whereupon, at 11:50 a.m., the subcommittee adjourned to reconvene at 10 a.m., Thursday, June 29, 1961.)

THE METRIC SYSTEM

THURSDAY, JUNE 29, 1961

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND ASTRONAUTICS,
SUBCOMMITTEE No. 1,
Washington, D.C.

The subcommittee met, pursuant to recess, at 10 a.m., in room 214-B, New House Office Building, Hon. George P. Miller (chairman of the subcommittee) presiding.

Mr. MILLER. The committee will be in order; other members of the committee will be late. These are rather strenuous times for Members of Congress. I can go ahead, and they will be in a little later, and they can read the record later on.

Our first witness this morning is Dr. Fischelis.

Will you give us your name, some of your background, Doctor, for the record, please?

STATEMENT OF ROBERT P. FISCHELIS, EXECUTIVE VICE PRESIDENT, THE METRIC ASSOCIATION, INC.

Dr. FISCHELIS. Mr. Chairman, I am Robert P. Fischelis.

I have been a member of the Metric Association for several decades and in the past 2 years have been one of the vice presidents and, more recently, chairman of its special committee on reorganization. From 1945 to 1959, I was secretary of the American Pharmaceutical Association, and since retiring from that office I have been a consultant in pharmacy to governmental and private agencies.

I am a graduate of the Philadelphia College of Pharmacy and Science, the College of Liberal Arts of Temple University in Philadelphia, and hold honorary degrees from Rutgers University in New Jersey and the University of Connecticut. I have taught pharmacy at the Philadelphia College of Pharmacy and Science, the New Jersey College of Pharmacy, and George Washington University, and served as dean of the New Jersey College of Pharmacy, Rutgers University. I have also been editor of professional publications issued by the American Chemical Society, the American Pharmaceutical Association, and the Pennsylvania and New Jersey Pharmaceutical Associations. I am an affiliate member of the American Medical Association and an active member of the American Pharmaceutical Association, American Chemical Society, American Society of Hospital Pharmacists, and numerous other scientific and professional associations.

Mr. MILLER. I think you are well qualified.

Dr. FISCHELIS. My statement in support of the proposal to authorize a study to determine the practicability and desirability of the adoption by the United States of the metric system of weights and

measures is divided into two parts. First, I wish to comment on H.R. 269 and H.R. 2049 from the standpoint of my professional experience in various phases of the practice of pharmacy, and, second, I would like to comment on the objectives of the Metric Association which has been interested since its organization in 1916 in promoting the adoption of the metric system as the official system of weights and measures in the United States.

I am a pharmacist by profession and during my professional career I have compounded and dispensed drugs in prescription pharmacies, in a hospital pharmacy, and have also had experience in the pharmaceutical manufacturing industry. I have taught pharmacy and have been an administrator of pharmacy law enforcement agencies and State and national professional pharmaceutical societies. During World War II, I headed the Division of Chemicals, Drugs, and Health Supplies in the Office of Civilian Requirements of the War Production Board.

In all of these capacities, I have passed through the periods during which drugs, medicines, and medical appliances have been supplied in terms of *avoirdupois* and apothecaries' systems of weights and measures and in terms of English linear measurements, and later in metric weights and measures. I have passed through the transition period from the traditional systems to the metric system and it has been my experience that once the transition has been effected that there is no desire to turn back to the older systems.

In medicine and pharmacy, the transition from learning and supplying dosages of drugs in apothecaries' terms to metric terms is rapidly nearing completion. The official compendia for drug standards under the Federal Food, Drug, and Cosmetic Act, namely, the U.S. Pharmacopoeia and the National Formulary, gave the dosage of drugs in the apothecaries' system when these compendia were first prepared. When the metric system was adopted, the dosage of drugs was given in both the apothecaries' and the metric systems, but since the 1955 issues of these official compendia they list dosage only in the metric system.

Medical students are taught dosage in the metric system and it is only because the older physicians, who learned dosages in the apothecaries system and have not all learned to think in terms of metric dosage, that we still provide conversion tables which have to be learned by pharmacists and nurses so that they can readily convert from one system to another when they interpret prescriptions and directions which are not written in the metric system or when they have to correlate between dosages given in metric units and drugs supplied by *avoirdupois* or apothecaries weights and measures. One cannot minimize the difficulty of transition; but conversion, both physical and in the application of mental processes required, is certainly not insurmountable.

When the younger generation is trained to think in metric units, the process will, of course, be accelerated. We do not seem to have too much difficulty when we participate in the Olympic games where metric measurements are used, nor do we have too much trouble in visualizing distances and quantities in terms of metric units when the equivalent of the older systems is also given.

Admittedly, there must be a period when conversion may be necessary to assist thinking, but judging by what has happened in

the practice of medicine and pharmacy and in the pharmaceutical industry, this is certainly not insurmountable. The important thing is to get started and there is considerable evidence that the younger generation of students is receptive and that modern business and technology are willing to move as rapidly as possible in the direction of a single simplified system such as the metric system provides.

Both H.R. 269 and H.R. 2049 provide that in the study to be undertaken by the Secretary of Commerce, through the National Bureau of Standards, there is to be cooperation with private organizations. I am certain that, as far as medical and pharmaceutical organizations are concerned, this cooperation will be forthcoming to the extent desired and that private studies which have been undertaken and would be undertaken, by request, would simplify the task of the Bureau of Standards in arriving at impartial conclusions.

With regard to the Metric Association, Inc., may I point out that this association, which was organized in 1916 and incorporated as a nonprofit organization under the laws of the District of Columbia on May 2, 1945, has very broad objectives and desires to be instrumental in assisting any surveys or studies which will promote the universal adoption of a metric system.

I should like to state the seven objectives of the Metric Association, based on the articles of incorporation, which constitute article II of the constitution of the association. This article reads as follows:

ARTICLE II. PURPOSE AND OBJECTIVES

The purpose and objectives of this association shall be—

(1) To furnish a national and international medium for uniting the efforts of individuals, societies, educational and research institutions, professional and trade associations, and corporations, interested in promoting universal use of a metric system of weights and measures to the eventual exclusion of other systems of weights and measures.

(2) To conduct such studies, researches, and investigations as may be necessary to determine the extent and use of existing systems of weights and measures and reasons for their continued existence with the view of taking such action as may be necessary to bring about uniform adoption of a metric system of weights and measures.

(3) To determine the best ways and means for the eventual adoption of a metric system of weights and measures as a substitute for other existing systems of weights and measures for the purpose of facilitating world trade, education, advancement of the sciences, the arts, and the general public welfare.

(4) To explore methods of accelerating universal adoption of a metric system of weights and measures without undue hardships or handicaps to industries now employing other systems of weights and measures.

(5) To prepare, publish, and otherwise disseminate by any available means of communication such information as will set forth the advantages of early substitution of a metric system of weights and measures for other existing systems of weights and measures.

(6) To broaden and sustain interest in the use of a metric system by means of meetings, lectures, debates, audiovisual education and publication of bulletins, pamphlets, newsletters, and by correspondence.

(7) To encourage individuals, educational institutions, professional and trade associations, as well as commercial and scientific organizations, to offer citations and awards for meritorious and outstanding contributions in the promotion of a metric system as the universal system of weights and measures.

In working out these objectives it is our feeling that the Metric Association could act as a catalyst in mobilizing the activities of all groups who are interested in the promotion of the metric system and to unify thinking and action in support of the metric system as a universal system of weights and measures.

Membership in the association is open to individuals and corporations interested in the objectives which have been stated.

We are particularly fortunate that Dr. J. T. Johnson, who has been president of the association for the past 25 years, was able to be in Washington today. He is from Claremont, Calif. I would like to share my time with him in answering your questions and, if it meets with your approval, I would like him to present the brief statement he has prepared, after which I shall be glad to answer any questions.

Mr. MILLER. Thank you very much, Doctor. We shall be very happy to have Dr. Johnson here.

Won't you come up and sit at the table, Doctor? We will be very happy to hear your statement.

Would you give your name and some of your background to the recorder, Doctor, so that we will have it in the record?

STATEMENT OF DR. J. T. JOHNSON, PRESIDENT, METRIC ASSOCIATION, INC.

Dr. JOHNSON. I am J. T. Johnson.

My field has been in education most of my life. The metric system was my hobby while I was teaching, and in later years has almost become my business, because interest in the metric system is growing so fast and I have been giving it so much of my time.

As Dr. Fischelis said, I have been president of the Metric Association for the last 25 years. The Metric Association was organized in 1916. I became a member in 1926 and president in 1936. Is that enough?

Mr. MILLER. I think so.

You live in Claremont?

Dr. JOHNSON. Yes. I just want to present three points of information with respect to the adoption of the metric system in the United States, on which I should like to focus your attention.

First, India has recently adopted the metric system to be completed in 1966. South Africa and New Zealand have adopted decimal coinage. The United Kingdom and Australia are at present engaged in studying the decimal coinage question. The United States and England have both had special metric committees during 1958 and 1959 studying the metric adoption question. Now with India on the metric system, we have more than 90 percent of both the world's population and its countries on a metric base. This constitutes the irrefutable fact that adoption of the metric system is not a fad but a world trend that cannot be stopped. Therefore, it is only a matter of time and the sooner the better, because the use of one simple system is better than using two or more.

Second, another irrefutable fact is that mechanics have decimalized the inch. Engineering is now considering this. Industry and manufacturing have to a large extent decimalized the foot. The surveyor's tape is graded to feet and tenths, not to feet and inches.

I might add that we all buy our gasoline in gallons and tenths, and aviation has decimalized the mile. We read the speed of a jet plane as 750.896 miles per hour, not as $750\frac{1}{2}$ miles per hour. Why are they doing this? The only reasonable answer is that it is easier and simpler to use and compute with the decimal. What could be better than the metric system which is wholly decimal throughout, all the way from the micrometer to the kilometer?

Third, none of the 88 countries on a metric basis have turned back after converting. This is another irrefutable fact. When we seek for its basis, the answer must be again that these countries find it simpler and easier to use the metric system than the English and this in spite of the fact that they have been trading with the United States and the United Kingdom which required the use of two systems. I mean, after they converted, if all the world had been metric, it would have been much easier for them. But they continued in their metric system in spite of the fact that they had to trade with the United States and England. Another reason for giving preference to the metric system is the growth of systems of computation in which IBM techniques and machines are now used when common fractions are not involved. This has been exemplified more recently in the conversion of operations in pharmaceutical plants from the traditional systems to the metric system.

I might mention also that a member of one of these pharmaceutical houses told me that after they converted to metric, they were able to use the IBM punchcards and the digital computer which they could not use before with fractions.

I shall be glad to submit to questions, and in conclusion I wish to emphasize that we are convinced that a study such as is proposed in the pending bills seems to us to be the proper approach to supplying an unbiased factual basis for adoption of the metric system as a universal system of weights and measures.

Mr. MILLER. Thank you very much, Doctor.

How long has the pharmaceutical industry been using the metric system?

Dr. FISCHELIS. They have been using it since about the turn of the century, when the official compendiums of the United States under the Food, Drug and Cosmetic Act, namely the U.S. Pharmacopoeia and the National Formulary, started to use the metric system. The monographs of drugs that appear in these books, the analytical tests and all the scientific procedures have been under the metric system for a long period. Formulas were given in the earlier days in the apothecaries' system, and then they began to give them in both systems. For a long time this double statement of quantities in both apothecaries' and metric units, was used, and then in 1955, when they began to revise these compendiums every 5 years, stopped using the apothecaries' system entirely and gave the dosage and everything else, only in the metric system.

Mr. MILLER. I don't know whether you feel competent to answer this or not, but I think it can be easily answered.

I believe in the field of biology, all the formulas used, are in cubic centimeters, so many grams per cubic centimeter or so many cubic centimeters in blood?

Dr. FISCHELIS. That is right.

Mr. MILLER. All of this is directly in the metric system?

Dr. FISCHELIS. That is right.

They sometimes express strengths of antibiotics in "units" but it is always on a decimal basis.

Mr. MILLER. I was just thinking, Dr. Johnson, the statement that you made of a plane traveling 750.896 miles per hour, if we told the average fellow it went $750\frac{1}{2}$ miles per hour and asked him how far it went in 15 minutes, he would reduce it to the decimal.

Dr. JOHNSON. He would.

Mr. MILLER. It would be a little intricate and long to have to do it by common fractions.

Dr. JOHNSON. It certainly would.

Mr. MILLER. You would have to do a lot of multiplying that you could get away from with one little change in the decimal point.

Dr. JOHNSON. It makes me think of a broker I contacted in Chicago. I forget the number of shares, but it was 12% per share. He multiplied it out. I watched him, and he sat there; he didn't use 12%, he used 12.65. I asked him why do you use it? He said, "We all do that. It is much easier."

I investigated further and found all the brokers that I could contact never used the fraction.

In the Chicago Tribune and other newspapers they quote them in fourths and eighths, but they convert them. Since that time, in the Chicago Tribune, putting the fraction halves and fourths, they put decimals there. If it is 0.8, it means $\frac{8}{10}$.

Mr. MILLER. I wonder how many people think, when they want to get a quarter of anything, they divide by four, that they are actually going through the decimal system to do this, 25 percent of 100 percent?

Dr. JOHNSON. I have been carrying on a lot of investigations; experiments in schools. I took time for 2 different years of having a fifth grade take the fractions but not add them as they are as fractions but convert them to decimals first and then do their adding and subtracting. I matched this fifth grade with the sixth grade a whole year ahead, and the fifth grade was way ahead of them both in time and accuracy, a year ahead.

Mr. MILLER. What difficulties were encountered by the pharmaceutical industry with the conversion?

Dr. FISCHER. The difficulties come in the manufacturing procedures. For years, in the manufacturing departments, the formula cards would be made out in avoirdupois weight or apothecaries' fluid measure because that is how the bulk chemicals and drugs were purchased. You would have a formula card that would show that you would use so many pounds, ounces, and grains of solids; or so many pints, fluid ounces, drams, and minims of liquids in the formula.

When the industry got into sending its products to South America and other foreign countries they had to convert to metric units and supply information on labels in metric units. Converting those formula cards and the whole system of manufacturing into the metric system was a difficult and intricate procedure and also somewhat costly.

Some manufacturers finally took the bull by the horns and decided to convert. They are very happy about it now.

I would say there are still some manufacturers who are not doing their manufacturing in the metric system. Of course, they have to do their labeling and give dosage information in the metric system.

Mr. MILLER. Out in my part of California we do a lot of canning. The industry is a big one. In our canning for export, the cans have to bear either the poundage and the weight in the metric system or the fluid contents and the weight of the contents in the metric system, in order to compete or get them upon the foreign market at all, so the people know what they are getting. It doesn't mean a lot to them, a 2½ can or 303 can, they look at the other figure when they go to buy it.

Mr. Hechler.

Mr. HECHLER. Dr. Fischelis, I note in your statement that the Metric Association was founded in 1916, and has been in existence now for 45 years. It seems to me that the silence that has come from the association is deafening. Perhaps the record ought to show that attending this hearing this morning are, aside from the witnesses and the stenotypist, exactly 12 people. Included in those 12 are Dr. McPherson, representing the Bureau of Standards, Colonel Grant, who testified yesterday, Colonel Salisbury, a representative of the Navy, and I daresay that many of the officers of the 12—now here comes No. 13 in the door—many of the rest are here because they have been designated by someone to come to attend.

What disturbs me about this is that it seems to me in order for any progress to be made toward the adoption of the metric system there is going to have to be widespread public discussion, widespread public interest, not simply the interest, if you will pardon the phrase, of the "long hairs."

And I would like to raise the question: Just what do you propose that the Metric Association do to carry out more effectively objective No. 6 in your statement of principles on page 4:

To broaden and sustain interest in the use of a metric system by means of meetings, lectures, debates, audiovisual education and publication of bulletins, pamphlets, newsletters, and by correspondence.

Evidently to this day that has been grossly ineffective.

What do you propose in order to stir up more interest?

Dr. FISCHELIS. May I say this:

My first contact with the Metric Association was somewhere around 1917 or 1918, after the organization had been started. I was asked to join the association, and at that time there was considerable activity and practically every pharmaceutical and medical organization and organizations in other fields of endeavor were urged to appoint committees on the promotion of the metric system, and a good deal of work was done.

As a matter of fact, I have a book here that is called "Twentieth Year Book of the National Council of Teachers of Mathematics," of which Dr. Johnson can tell you more than I can. But he got together a series of articles from various industries, in popular language, and undoubtedly they were distributed in various places.

Right now we have metric clubs in junior colleges and even in some high schools where the younger people seem to be interested in promoting the metric system. This and other educational activity have been fostered by members of the Metric Association in a quiet way, but the association has never had funds to go into promotion in a big way.

However, the idea of reorganizing the association at this time is to modernize its public relation efforts. We recognize fully that this is a job that has to be done, and this is what we are planning to do.

We are very happy that the Congress is going to make it possible, we hope, to get fundamental factual material which can be converted into popular language and circulated through the efforts of the Metric Association.

Maybe Dr. Johnson, who has been with this movement for 25 years, would like to supplement what I have had to say on this subject.

Mr. HECHLER. Let me interrupt.

I don't want to leave the impression here that all is sweetness and light in the progress we are making. We have Esperanto clubs, but Esperanto doesn't seem to have made any progress over the last 25 years.

Don't you have a feeling of frustration about this, that this really isn't getting through yet, that you have to do something more stimulating in order to make some progress?

Dr. FISCHELIS. I had a feeling of frustration until I got into this committee work here in the last year. We now have engineering representatives and others working with us who, at one time, were not too interested in the promotion of the metric system because of the obstacles that I mentioned in my formal statement.

I think there is a feeling now that with most of the rest of the world on the metric system this is a time when we should be doing something and that what we do probably will be much more effective than what we seem to have been doing in the past.

Mr. HECHLER. I don't want to be misunderstood. I would like to reiterate my personal position, which is that I am very much in favor of eventual adoption of the metric system. In fact, I would like to see it done just as soon as possible. I think it is a necessary thing in the space age. I think before it can be adopted, there is going to have to be a tremendous amount of aggressive work, if you want to call it public relations, or whatever you want to call it, in order that the public can understand, in order that this can be properly aired through our educational system, through our service schools and academies, and through our industrial organizations. I think that a good deal of work needs to be done before the public will either understand or accept a set of logical propositions which we here in this room may accept.

Dr. JOHNSON. I want to say this word that might clarify something.

When the Metric Association was organized they had something like three or four hundred members. It was carried on by Howard Richards, of Pottsville, Pa. I knew Mr. Richards pretty well when I became a member in 1926. He made me president in 1936, and 4 years later, in 1940, he died. It is a nonprofit organization. I didn't have the means to carry it on. I didn't have the money to keep it up. But I kept it alive from 1940 to 1950, answered questions in letters that came in. Something happened in 1957. That is the year, I think the Army people started their decision on using the metric system in their linear measures. That is the year that India started. There was something that happened in different localities. India went to metric coinage in 1957. Since then Africa—I mean South Africa—and New Zealand have gone to decimal coinage. And things are happening in Europe and other places. So there is something in the air, probably because of electronics and world changes that are emphasizing and taking a new interest in this metric question.

I find that I have to have some help. I have turned this over to a committee now, under Dr. Fischelis, here, and he is busy with this committee, meeting every month. Something is going to be done.

Out in California, in Fresno, among the junior college people, a new movement was started, and it has been going for about 3 years. Have you heard about it? It is called DECA, the Distributive Educators Club of America; they now have it in 21 States and have

6,000 members. I met the new president in Fresno, talked to him last month. They take projects on in different years. In Chicago, at the national convention this spring—and they meet every year in a big city—they decided that next year they are going to take on as their project the metric system.

You have a new force right here, the Distributive Educators Club of America. They publish two magazines. They have 6,000 members in 21 States, or it might be 31. It is surprising what they have been doing.

Mr. HECHLER. Maybe if we had the metric system we wouldn't have so much argument of where we stand in comparison with the Soviet Union. Maybe we would be able to figure that out a little quicker.

Dr. JOHNSON. Just one line from Edward Teller, you know, the father of the H-bomb. Here is what he says in the Los Angeles Times:

If we do not change, we shall lose in the economic competition with Russia.

Another quotation right there by Dr. A. H. Hughes. He was the deputy chairman of the British Metric Committee. They have had a study in England, just completed last year; got out a 40-page document. You have a copy of that.

Dr. Hughes says this. This was published in the New York Times, as a copy from the London Times. Here is the quotation. Listen to this:

The scientists and the engineers of the English-speaking nations are not, when it comes to measurement, speaking the same language.

Then this sentence:

It is probably no accident that the first earth satellite was sent aloft by the Soviet Union, a metric nation.

I have other quotations.

Mr. HECHLER. Let's get down to the facts of the bills before the committee.

I would like to get your comment, Dr. Fischelis and Dr. Johnson.

How long do you think this study ought to be that has been proposed in this legislation that is now being considered?

Dr. FISCHELIS. We know one bill provides for 1 year and the other for 3 years.

The general impression of our members, as we talk with them, is that they would hope it didn't need to take 3 years to get the study to a point where it could be useful.

On the other hand, it is recognized that as complete a study as is contemplated here would probably not be possible in a year.

But this time factor is what discourages a great many people. When you contact engineers and they tell you, "Well, it is going to take a generation to convert some of the industries and some of the activities that they are engaged in," people begin to lose interest and feel that "Well, if it is that far off, maybe we can't do too much about it."

I think what the situation needs now is some expression of hope that this could move more rapidly, and certainly it is needed, if we are going to keep up with our commerce and with our technology as it is developing worldwide.

We would hope that perhaps there could be a compromise.

There again let me say that we think that one of the functions of the Metric Association should be to stimulate activity outside of the Government. The work that the Bureau of Standards is going to do is fundamental and highly essential, but at the same time we would hope that we could encourage organizations, private organizations, to supplement what the Bureau would be doing and to go into other avenues that would stimulate interest in the field.

Mr. HECHLER. In view of the fact that the Bureau of Standards study is going to be impartial, it would seem to me necessary that you have an organization that could spearhead the stimulation of interest, through such things as a metric association beauty contest. One measurement might be 1.14.

Mr. MILLER. Off the record.

(Discussion off the record.)

Mr. HECHLER. To be serious, though, I feel that this is a necessary element in human progress. You don't have progress just by sitting around in an ivory tower and deciding this is logical.

Mr. MILLER. I can say, as far as H.R. 2049, the bill that I sponsored, I had a similar bill in last year, it is merely a vehicle on which we can work our will as far as time and place. The details of the bill were merely put in as a skeleton to get the matter underway.

Are you through?

Mr. HECHLER. Yes.

Mr. MILLER. Mr. Mosher.

Mr. MOSHER. Mr. Chairman.

Dr. Fischelis, on page 3 you say:

The important thing is to get started.

My own sympathy lies in that same direction, I might say.

I know you also say there is considerable evidence that modern business and technology—and I refer particularly to the modern business—is willing to move as rapidly as possible in the direction.

When you say "considerable evidence," could you be a little more specific regarding modern business? Are there business people that are anxious to get going in this direction? How broad is this movement?

Dr. FISCHELIS. I can speak with some knowledge of the food and drug industries, for example, because of my close association with the enforcement of the Food, Drug, and Cosmetics Act in the past, the labeling of containers in the two systems and the development of packaging.

For instance, we had the suggestion that oil, motor oil, which is sold in quart cans be supplied in cans large enough so they could hold a liter and the same size cans could be used to supply oil either in liters or in quarts.

You might run into difficulties by being accused of furnishing a slack-filled container under the Food and Drug Act if you use the same container for a liter and a quart or for a pound and 500 grams. Business people are interested in not having the additional expense of separate containers for nearly comparable major units of volume or weight. They see the logic of going on the metric system but they are looking for some help in overcoming the technical difficulties involved.

I think that the time is certainly ripe to encourage those in the industry who have a feeling that the metric system—

Mr. MOSHER. Do you think the enthusiasm within the world of business and industry is largely limited to food and drug people, or do you think it extends into the realm of the tool people and the machinery people?

Dr. FISCHELIS. The latter give you the idea of being confronted with more difficulty.

One of the members of our committee is connected with the American Society for Testing Materials. They serve maybe 50 or more industries. In each of those industries they have noted interest in the metric system and they have committees trying to ferret out what the problems are with regard to conversion and how to meet them.

This is what I had in mind when I talked about acceleration. There is no doubt that, as the investigation of the Bureau and others would proceed, there would be studies that would deal with certain factors which could be released perhaps a little ahead of a completed study of the whole situation.

What we need from time to time is the issuance of some encouraging finding which could be put into practice without too much difficulty. In any of these kind of studies you usually begin by gathering together all the information extant. That is more or less of a library research. I don't know that there is, gathered at any one place, at this time all of the basic information that we already have about advantages and disadvantages of the metric system. When this is completed the advantages can be proclaimed and the problems that are generated through the disadvantages can be attacked and overcome.

It is amazing when you delve into the literature how much you find that has already been done but has not been publicized properly. You have a public relations problem here which I hope we can do something about.

Mr. MOSHER. You don't know of any trade association, business-industry trade associations that have formally demanded the adoption of the metric system as yet? You haven't reached that point?

Dr. JOHNSON. I just happened to think of a Mr. Rand. He is in Ottawa, Canada, and he is organizing—I don't know all the details of that organization—he is selling motor oil in liter cans—that is right—between the English and the American quart. You know, the English quart is a fourth larger than ours. So he says he is selling that, and it won't be quite full because the liter is a little more than that. He has that going.

Mr. MOSHER. No further questions.

Mr. MILLER. It gets a little confusing when you get into it to even compare our own measurement and liquid measurements with Canada. You buy gasoline up there by the Imperial gallon, which is about a fifth larger than our gallon, and pay for it accordingly. It is a little bit confusing, I know, when you drive up there, to go in and get so many gallons of gasoline, and you think they short you, but you get more in the price.

Dr. FISCHELIS. I would be glad to go through the records that we have in further reply to Mr. Mosher's question, because I am sure there have been resolutions passed by some other organizations. If we could supplement our statement for the record with what we can find, I will be glad to do it.

Mr. MILLER. For your information, and for the sake of the record, I have talked to a good many engineers and scientists and people in

the field of science. I am not talking about pure scientists, research and development, but people who are plying this field. They all give you a great deal of encouragement. They recognize this is going to cause some trouble in the changeover, but they recognize that in the final analysis, once this changeover has taken place, that it is going to be good and give them more accuracy than they can possibly get under our present system, which has in basis of fact nothing attached to it.

How did we arrive at the gallon? How did we arrive at the foot? Once upon a time I believe they measured the foot by people leaving church and so many people meeting together and thus got the foot. And the inch was the length of the thumb in the beginning. It was fine for a primitive society, but I would like to see a digital computer operating on fractions.

Dr. JOHNSON. You can't do it.

Mr. MILLER. I contemplated asking Dr. Teller to come in, who has indicated he would come very willingly. But it is the information that these people might have to give to this committee. We are merely examining the data to see whether it is feasible or not to ask the Bureau of Standards to go into this, and then it is before the Bureau of Standards, this testimony.

Dr. FISCHELIS. I think your interest in this and the fact that the Congress would do something in the way of initiating a study would be a great impetus to the whole project.

Mr. MILLER. I think it will, too. We are not going to say this is good or bad or it should be done. I don't think that a committee of Congress, no matter how many witnesses it calls before it, is competent to make a decision in a field as technical and with the great impact it can have on our economy, our sociology and everything else. This is a little bit beyond us. It would be like going into your pharmaceutical field and calling a bunch of witnesses before us to determine what dosage should be given for some disease. We wouldn't know what we were doing.

That was the reason and the theory behind asking the Bureau of Standards to do it. That is why the bills are here. I had a bill in last year.

Have you any questions?

Mr. KARTH. I have nothing.

Mr. MILLER. Thank you very much, Dr. Johnson and Dr. Fischelis.

We appreciate your coming here and the time and interest you show in this subject.

Dr. FISCHELIS. Thank you.

Dr. JOHNSON. We are glad to be here.

Mr. MILLER. Mr. Floyd W. Hough, chairman, Special Committee of the American Geophysical Union for the Study of the Metric System in the United States.

Would you give us your name and some of your background, Mr. Hough?

Mr. HOUGH. Yes, sir.

STATEMENT OF FLOYD W. HOUGH, CHAIRMAN, SPECIAL COMMITTEE OF THE AMERICAN GEOPHYSICAL UNION FOR THE STUDY OF THE METRIC SYSTEM IN THE UNITED STATES

Mr. HOUGH. My name is Floyd W. Hough, of Geonautics, Inc., of Washington, D.C., and chairman of the Special Committee of the American Geophysical Union for the Study of the Metric System in the United States.

Mr. MILLER. The Geophysical Union, I am familiar with it, but would you define what it is, and what it does, for the record?

Mr. HOUGH. Yes, sir.

I would like, Mr. Chairman, if you do not mind, to ask the executive secretary of the American Geophysical Union, who is here, Dr. Waldo Smith, to do that, sir.

Mr. MILLER. Would you like to have Dr. Smith join you?

Mr. HOUGH. Yes, please.

STATEMENT OF DR. WALDO SMITH, EXECUTIVE SECRETARY OF THE AMERICAN GEOPHYSICAL UNION FOR THE STUDY OF THE METRIC SYSTEM IN THE UNITED STATES

Dr. SMITH. The American Geophysical Union was established by the National Research Council in 1919 as the U.S. National Committee of the International Union of Geode and Geophysics, to which the United States adheres. It has continued through this interval from 1919 in that capacity.

When the depression came along in 1928, the National Research Council could no longer carry the financial burden, though small, of the publication of the American Geophysical Union's work. So at that time authority was given to the American Geophysical Union to enlarge its membership and start assessing contributions or dues from the members.

Since that time it thus has taken on certain aspects of another scientific society, but it is not in fact a scientific society.

There are eight sections of the American Geophysical Union: Geodesy, seismology, meteorology, geomagnetism, aeronomy, oceanography, volcanology, geochemistry and petrology, hydrology and tectonology.

The details of those can be gone into if that is needed.

Mr. MILLER. Its primary interest, then, is in the earth science?

Dr. SMITH. The broad aspect of the earth's sciences, from the center of the earth to the outermost limits.

We now have an activity committee, planning committee on the planetary sciences, because we recognize that geophysical techniques are needed and used in the exploration of space and the exploration of the moon and the planets, and so on.

Mr. HOUGH. I think I should give you a few words as to my experience.

I am a civil engineer. I have specialized in the branch of geodesy of civil engineering. I have had 11 years with the Coast and Geodetic Survey, 7 as geodetic engineer for the Columbia River aqueduct, and 4 years with the Map Service. I retired in 1957.

Mr. Chairman, if it is agreeable to you, I have a short statement here that I would like to read and then answer questions following that.

Our special committee on the American Geophysical Union wishes you to know that it appreciates the invitation to be represented at these hearings.

The special committee was set up in May 1958 for an impartial and limited study of the metric system in the United States.

A letter and a questionnaire were sent to the editors of a number of prominent scientific and engineering journals throughout the United States. It was requested that they be published so that the committee could ascertain the current attitude of 18 categories among these groups toward the proposal to make the metric system the only official system of weights and measures in the United States. Ten items were included in the questionnaire as follows:

1. Indicate professional field of interest.
2. What approximate percentages of units used in your work are: Metric, British, other.
3. Would it be to your advantage if a complete conversion to the metric system could eventually be made? Yes, no.
4. How long a period of time (in years) should be allowed for the conversion? 10, 20, 30, 40, 50, longer.
5. Should the centigrade system of temperature measurements be adopted? Yes, no.
6. Do you believe that U.S. export trade is suffering as a result of the use of British units? Yes, no, no opinion.
7. Do you believe that the eventual adoption of the metric system is inevitable? Yes, no.
8. Do you believe that the cost of a long-time conversion to the metric system could be prohibitive? Yes, no.
9. In the event a joint committee were established to study the problem, circulate questionnaires, accumulate statistics, and report, it should be sponsored by (check one): Professional societies, educational institutions, industry, Government. How should the study be financed? Would you be willing to assist such a study group? Yes, no. In what way? Financially, as an adviser.
10. Additional remarks are welcome.

Some 1,150 completed questionnaires were received, the first 1,080 of which were electronically tabulated and analyzed. The resulting percentages are shown in table I of the article entitled, "Why Adopt the Metric System," which appeared in the November 1960 volume of the magazine *Civil Engineering*. A reprint of the article accompanies this statement. Your attention is directed primarily to the replies to questions 3 and 4, where 90 percent stated that the change to the metric system would be "advantageous" and the average period of transition recommended was 22 years.

It is recognized, of course, that the poll just discussed is confined to the scientific and engineering field. Its rather broad coverage in this area, however, appears to be significant.

The special committee of the American Geophysical Union agreed that it would advocate strongly a transition period of not less than one human generation, or 33 years, between the passage of a bill by the Congress and the effective date when the metric system would become the only official system of weights and measures in the United States. It is felt the smooth transition afforded by this 33-year period will remove much of the opposition which has defeated all previous

bills on the adoption of the metric system. It will provide ample time for the schools to adjust to the metric system, for almost all equipment in English units to become obsolete and to be replaced by equipment in metric units during this period, and for trades and professional personnel now using the English system exclusively to be retired and to be replaced by the younger generation thoroughly schooled in the metric system. It is believed that 80 percent of the changeover would be rapid, perhaps within the first 10 years.

May we emphasize the fact, already stated by Dr. Astin yesterday, that the meter and kilogram are already legal in the United States and have been so since 1866. Indeed, they are the legal standards to which our English units are calibrated. The comprehensive study proposed in H.R. 269 and H.R. 2049 can be expected to indicate clearly whether or not the metric system should be made the only official system of weights and measures in the United States, and if so, the proper transition period to avoid any appreciable economic loss.

This is the end of the written statement, Mr. Chairman.

I have with me this morning the vice chairman of the committee, Mr. Lansing Simmons, who is with the Coast and Geodetic Survey. I will ask him to come forward to assist in answering questions.

Mr. MILLER. You are with the Coast and Geodetic Survey. There is a comparable organization under the British Government; is there not? Do they have anything comparable to our Coast and Geodetic Survey or does it find itself—

Mr. HOUGH. They have their military surveys, of course. They also have their civil surveys, which are quite similar to ours.

They hold meetings every year and that sort of thing. They are very active over there in survey work, both civil and military.

Mr. MILLER. If these fields, oceanography, seismic work, and the other related fields; do the British do it in feet?

Mr. HOUGH. They are using the metric system in much of their scientific work. They are also using it in their military work. Otherwise, they are using the English system much the same way that we do here.

Mr. MILLER. You mentioned centigrade units for scientific work.

For the work we are doing in connection with outer space, we do it all in the centigrade, using the metric system.

Mr. HOUGH. That is correct. Centigrade units or what is preferably known as Celsius. The centigrade is used, which is 100° between freezing and boiling.

Mr. MILLER. Even now when they want to express it, you will find it in this system, and if you want it in the other, they have to translate it to Fahrenheit for you.

Mr. HOUGH. Yes; that is a bit of a formula, like five-ninths plus 32. It is not too difficult, but you have to make the change.

I have here a report of the British committee on this subject.

Mr. MILLER. Without objection, I would like to make "Why Adopt the Metric System" a part of the record.

(The document follows:)

[From Civil Engineering, November 1960]

WHY ADOPT THE METRIC SYSTEM

Floyd W. Hough, F. ASCE, Chairman, Committee for the Study of the Metric System in the United States, American Geophysical Union, Washington, D.C.

(Editor's Note: The United States, in fact the English speaking world, is falling behind by fractions, inches, and miles—because of its cumbersome system of weights and measures. To us, the British monetary system seems puzzling and complicated but we do not realize that our own system of weights and measures is fully as difficult for those who have not used it from childhood. The handicap this system presents to our technical and economic progress is perhaps not realized by the average person but it should be self-evident to the engineer. A purely decimal system—and this is what the metric system is—avoids these disadvantages. Engineers especially would benefit from the use of the metric system. Mr. Hough's proposal for a gradual transition to this decimal system over the span of a full generation is worthy of careful study.)

This country should seriously consider and probably adopt the metric system of weights and measures as a replacement for our heterogeneous English units. Technically the metric system is simpler to use because it is decimal and requires little translation. Commercially the metric system is essential so that the United States can compete with countries able to supply drawings and goods to metric standards.

Following a period of nearly three decades of relative dormancy there is renewed interest in a change to the metric system. This interest is due at least partly to international competition in trade and to greater contact with countries using the metric system.

Bills were introduced in the recent U.S. Congress to provide for a study of the "desirability and practicability of adoption in the United States of the Metric System of weights and measures." The bills were not considered, perhaps because of the politics of an election year, but it is expected that similar measures will be presented to the next Congress.

The question immediately arises as to why the metric system of weights and measures should be considered superior to the so-called English system. The metric system, introduced by the French in 1791, is fundamentally based on a single unit of length, the meter. This unit was originally defined as a ten-millionth part of the earth's meridional quadrant. Even the kilogram, the fundamental unit of mass, was derived from the meter in that it was defined originally as the mass of pure water at maximum density contained in a volume represented by the thousandth part of a cubic meter. In 1875, the International Metric Convention, signed by 17 countries including the United States, set up the International Bureau of Weights and Measures at Sèvres, France, and made it the custodian of the international standards.

About this same time, the meter was standardized so that it now has no continuing relationship to the earth's meridional quadrant or the former meter of the Archives, but is defined, rather, as the interval between the line markings under certain physical conditions of a platinum iridium bar known as the International Prototype Meter. Likewise, the kilogram was redefined simply as the mass of the International Prototype Kilogram. Each nation adhering to the International Metric Convention was furnished a National Prototype Meter and a National Prototype Kilogram, which are compared from time to time with the International Standards at Sèvres. The U.S. Bureau of Standards is the custodian of these two national standards. On October 14, the 11th International Conference on Weights and Measures adopted a new definition for the international meter in terms of wave lengths of orange-red light produced by burning of the gas known as KR 86.

The United States has debated the question of the metric system at intervals since its introduction by the French. Numerous bills for the adoption of the system have been before the Congress since George Washington forwarded to it a copy of the French report for study. Three highly significant actions have been taken:

1. The metric system was legalized for use in the United States in 1866 by an Act of Congress.
2. The United States, in 1875, as mentioned above, became a signatory to the International Metric Convention.

3. The Secretary of the Treasury, in 1893, approved the Mendenhall Order, which recognized the International Prototype Meter and Prototype Kilogram as the fundamental standards on which the yard and pound are based.

The metric system is inherently a decimal system. The so-called English system of yards and pounds has been decimalized to some extent but is not so used generally.

Engineers have done away with the troublesome inch in favor of decimals of the foot while architects, for instance, continue to employ fractions of the inch. (Purdue University this year graduated a class of mechanical and aeronautical engineers who had been trained to work entirely with decimals of the inch.) Some grocers now use pounds and decimals thereof, although the great majority are partial to the ounce. Most scientists and professional engineers use the metric system primarily but it is not unusual to find metric units and English units on the same page of a technical report, necessitating a mental conversion between the two systems.

Decimals are generally conceded to be far simpler to use than fractions. Suppose, for instance, it is desired to determine the area in square feet of the floor of a room that is 30 ft. 9 $\frac{1}{2}$ in. by 15 ft. 3 $\frac{1}{4}$ in. These dimensions, so stated, do not lend themselves readily to multiplication. On the other hand, the product of these same dimensions measured as 9.389 meters and 4.655 meters, respectively, is easily determined as 43.706 sq. meters. A similar problem in volume is even more of a contrast than the problem of area.

A highway engineer from Hawaii submits the following problem in English units and an equivalent one in the metric system:

ASPHALT NEEDED FOR A UNIT OF ROAD

Computed in English units:

1 mile of road 24-ft. wide.

$5,280 \times 24 = 126,720$ sq. ft.

0.35 gal. of asphalt per sq. ft. is to be applied.

Taking the average specific gravity of asphalt at 1.4,

1.4×8.345 (weight of 1 gal. of water) = 11.70 lb. per gal. for asphalt.

$11.70 \times 0.35 = 4.1$ lb. per sq. ft.

$126,720 \times 4.1 = 519,000$ lb.

$\frac{519,000}{2,240} = 232$ long tons

Three multiplications, one division, and reference tables were required.

Computed in metric units:

1 km of road 8 m wide = 8,000 m²

14 liters per sq meter is to be applied.

$14 \times 8,000 = 112,000$ liters*

= 112,000 dm³

$112,000 \times 1.4 = 156,800$ kg

= 156.8 metric tons

Two simple multiplications were required.

*1 liter = 1 cu decimeter (dm³) = 1 kg for water. In the metric system the specific gravity is the weight of 1 liter of the material.

The relative simplicity of solving this highway problem in metric units points up, in part, the outstanding advantages of the metric system: (1) that all five unit types—length, mass, area, volume and capacity—are interrelated and are based directly and solely on the two fundamental units, the meter and the kilogram; (2) that these relationships are entirely decimal in character. On the other hand, in the English system, if it may be termed a "system," there is little usable relationship among these five unit types, and customarily it is not decimalized.

In the educational field lies, perhaps, one of the greatest benefits which would accrue from our eventual abandonment of the English units in favor of the metric. Teachers of mathematics will agree that fully 25 percent of the child's time, and the teacher's as well, could be saved in arithmetic courses if the simple interrelated metric decimal units were substituted for the English. Such monstrosities as proper fractions, improper fractions, numerators, least common denominators, greatest common divisors, and mixed numbers, could be laid to rest with the celluloid collar and the oxcart. There can be no doubt among those familiar with both systems that the change from English units to metric would appreciably

relieve the teaching load in our grade schools and high schools in all curricula that involve both mathematics and the sciences.

In the matter of international trade, we are clearly at a disadvantage. Britain and the United States are isolated with respect to weights and measures. About 90 percent of the world's population is living under the metric system, or their governments are in the process of changing over to it. It has been called "Russia's not secret weapon." It is believed that the preference in South America for European imports may be due, in no small way, to their use of a common "language" in the metric system of weights and measures.

One correspondent writes, "My twenty-five years of diversified experience in engineering, architecture, construction, and university teaching in Europe and America had often let me wonder why this country with its otherwise progressive and revolutionary ideas in the fields of engineering, science and industry had not switched a long time ago to the kilogram-meter system. Anyone who knows something about the metric system will admit that the English system is cumbersome, terribly time consuming and less safe against calculation errors. How elegant (and safer) is the shifting of the decimal point only in the metric system."

Another says, "It has long disturbed me personally that of two systems of units—one reasonable, convenient, and practical, and one completely irrational—residents of this country must use the latter. I am convinced that the only reason there is such complacency about the British system in this country is that the general public is not aware of the complexity of the system under which they live."

In view of the necessity for simplification and speed in its field operations, the U.S. Army in 1947 adopted the metric units as basic to its design of the Universal Transverse Mercator and the Universal Polar Stereographic grid systems. (See "A Conformal and World-Wide Military Grid System," Paper No. 2813, ASCE Transactions, vol. 121, 1956, p. 633.)

Further, in 1957, following 10 years of experience with the meter as the unit of measurement in place of the previous national "yard," the Army published regulations to the effect that all U.S. Army weapons and related equipment will be converted to the international meter for the measurement of linear distances, this conversion to be accomplished by January 1, 1966. The North Atlantic Treaty Organization is solidly committed to the metric system, including, of course, all the defense agencies of Great Britain and the United States. The same has long been true for the Russian bloc.

The American Geophysical Union became actively interested in this problem of weights and measures following its meeting in May 1958. A special committee was appointed for the study of the metric system in the United States. This committee subsequently conducted a poll through the medium of eight of the leading scientific and engineering magazines of the country. The response was decidedly in favor of the metric system. Of the 1,080 completed questionnaires returned from 18 professional categories, 90 percent desired a changeover from the English to the metric units and the average transition period recommended was 22 years. A partial analysis of these questionnaires is given in the accompanying table 1, taken from the December 1959 Transactions of the American Geophysical Union.

The committee pointed out, in its letter to the editors accompanying the questionnaire, that bills for the adoption of the metric system exclusively in the United States have been more than once presented to Congress, but that they have not been enacted into law, the principal reason being that in each case the proposed effective date followed too soon after passage of the bill. An early effective date would undoubtedly work a severe hardship on the adult population not familiar with the metric system, and it would make obsolete a prohibitive number of everyday items pertaining to weights and measures.

A solution would appear to be to make the metric system the only official system of weights and measures in the United States, effective in one generation (33 years) after the passage of the legislation. Following this action by Congress, the grade schools and high schools would begin immediately to teach children the metric along with the English system and, during the transition period, would place more and more emphasis on the metric system. At the end of the transition period the English system would still be taught, but the emphasis would be just the reverse of what it is today.

A long transition period would result in a smooth change. In a generation most items of equipment involving weights and measures normally become obsolete or are worn out and replaced. Also, persons engaged in professions and trades now using the English system exclusively would normally retire during

this period and would be replaced by a new generation fully trained in the metric system.

When we recall that our founders saw fit to break away from the British nightmare of pounds, shillings, pence, guineas, and florins, and set the new country straight with a decimal monetary system, it seems strange that they retained the equally atrocious British system of weights and measures. Perhaps the pace of the times, unlike that of today, did not demand the efficiency and precision in calculations with which we are faced and which will become even more exacting in the years ahead.

Clearly, there is now in the United States a revival of interest in securing a better system of weights and measures following a period of some three decades of complacency. In this electronic age of accelerated progress and ever closer ties with other nations, it is imperative that something be done about the inexcusable complexity and nonconformity of the so-called English system of weights and measures. It must not be done overnight; our economy is too expansive. However, by providing a long transition period extending over a generation, we can readily convert without hardship or economic dislocation. We can adopt officially the simple interrelated units first presented to the Congress by President George Washington in January 1795, thus securing for our own country the very considerable advantages of the metric system of weights and measures.

TABLE 1.—*Analysis of questionnaire on the metric system*

[All figures are percentages except where otherwise noted]

Profession 1	Number answering	Present usage (question 2)				Change advantageous (question 3)			Period for change, years (question 4)		Use centigrade temperature (question 5)		
		Metric	British	Other	Answering	Yes	No	Answering	Average years	Answering	Yes	No	Answering
1.....	149	68	29	3	99	93	7	99	22	97	95	5	98
2.....	150	74	24	2	99	96	4	99	21	96	98	2	99
3.....	16	30	59	11	100	80	20	99	24	100	80	20	94
4.....	179	24	73	3	98	90	10	99	21	96	94	6	99
5.....	121	41	56	2	97	90	10	100	25	97	87	3	98
6.....	84	15	80	5	98	81	19	100	24	98	88	12	98
7.....	39	45	55	0	92	82	18	100	18	93	92	8	100
8.....	38	16	83	0	92	82	18	100	26	92	86	14	92
9.....	27	37	53	7	100	100	0	100	19	100	100	0	100
Total or average for above 9 categories.....	803	39	57	4	97	90	10	99	22	96	92	8	98
Total or average for full questionnaire.....	1,080	45	52	3	98	90	10	99	22	96	94	6	98

Profession 1	Export trade now suffering (question 6)			Metric system adaption inevitable (question 7)			Cost of gradual change prohibitive (question 8)			Sponsorship (question 9)			
	Yes	No	Answering	Yes	No	Answering	Yes	No	Answering	Prof. Soc.	Industry	Educational	Government
1.....	67	33	41	65	35	95	8	92	91	35	13	19	33
2.....	61	39	43	72	28	97	5	95	97	38	10	10	43
3.....	50	50	38	81	19	100	0	100	100	24	17	24	36
4.....	72	28	38	80	20	72	7	93	72	37	16	16	33
5.....	68	32	55	63	37	98	8	92	98	35	13	11	41
6.....	64	36	60	72	28	99	13	88	95	27	19	9	45
7.....	58	42	49	64	36	92	3	97	92	34	15	4	46
8.....	76	24	45	46	54	92	3	97	92	33	7	10	50
9.....	65	35	63	68	32	93	4	96	96	31	27	15	27
Average for above 9 categories.....	65	35	48	62	38	95	6	94	92	33	15	13	39
Average for full questionnaire.....	68	32	46	68	32	92	8	92	91	34	15	13	39

1 Key to professions (the original questionnaire covered 9 additional categories): (1) Physics; (2) Chemistry; (3) Mathematics; (4) Civil engineering; (5) Electrical engineering; (6) Mechanical engineering; (7) Geology; (8) Aerodynamics; (9) Photogrammetry.

NOTE.—This table I is from a progress report of the Committee for the Study of the Metric System in the United States of the American Geophysical Union.

SYMPOSIUM ON UNITS OF MEASUREMENT

The American Association for the Advancement of Science has recently published a compilation of papers from a symposium on systems of units of measurement. The volume, entitled *Systems of Units—National and International Aspects*, is edited by Carl F. Kayan. Discussed, and in some cases advocated, are English units (including the case for decimals of inches rather than fractions), metric units, and the MKSA system (meter, kilogram mass, second, and ampere). The latter has recently been adopted by a number of nations and currently is being considered by others. Some thirty papers are included in the volume, which is available at \$6.75 from the American Association for the Advancement of Science, 1515 Massachusetts Avenue NW., Washington, D.C.

Mr. MILLER. Go ahead. I just wanted to make sure we had that in the record.

Mr. HOUGH. The British, as I believe Dr. Johnson already mentioned, did make a survey throughout the British Isles, and in fact the British Commonwealth in connection with the metric system. That has been done within the past 3 or 4 years. They have made a very comprehensive survey and have issued this report, a final report, which is labeled "Decimal Coinage and the Metric System—Should Britain Change?"

It is a joint report of the committee appointed by the British Association for the Advancement of Science and the Association of British Chambers of Commerce.

Mr. MILLER. I suggest to the counsel that we obtain a copy of this. I think you can do it. And a copy of the book that Dr. Johnson had.

Mr. HOUGH. This report was sent to the committee by Dr. Hughes, who is deputy chairman of the British committee.

I would like, if I may, to call to your attention just a few things in here.

They are short statements that, as results and conclusions, show up in these reports.

In the first place, in regard to the period of transition, which our committee feels is very vital here, we felt this should be a long transition period. We were not in favor of a short transition period. We believe that is what has caused the difficulty in the past in getting these bills past Congress and the great opposition to the metric system.

We realize that the Americans just don't like to be regimented, don't like to be pushed too hard. We feel as though if the purpose of this can be published, without attempting to speed this up in a matter of 5 or 10 years, and say, "You must use the metric and nothing else," that we will go a lot further in getting this change across to the American people.

The British have this statement in here:

The replies to question 9 indicate that most firms could begin to make substantial use of the metric system within 5 years, but in most cases 10 years would be required for a complete changeover. Even so, about 10 percent of all firms would require from 15 to 25 years. A very few firms recorded periods up to 50 years.

We found in our questionnaires that we sent out, and the reply to this, as stated in the statement, that the average period of transition recommended was 22 years. Many of those, however, went up to 30 and 40 and some to 50. It was similar to the reaction from the British report.

It seems quite apparent that if Congress takes this action, if Congress passes an enabling act as a result of this study, that almost surely

the schools would immediately begin to emphasize the teaching in the metric system and deemphasize the English system. So in a short time the emphasis would be reversed and most of it on the metric and a smaller amount on the English system.

As I mentioned about the equipment becoming obsolete, people needing new machines, new equipment, would immediately purchase the metric equipment. We feel sure, after a period of 5 or 10 years, that a large percentage of this metric system would already be in effect. Then the balance of the 33 years would be simply for those people who perhaps have some very heavy equipment, very expensive equipment, that would not be in a position to make the change without a considerable economic loss, and it does then not come under the head of what we might say is a compulsory change, which we think would be anathema to the American people.

I think that the committee perhaps would be interested in just a few short statements here. We are going to give this statement to indicate to you, perhaps, that as we said in the beginning, we are making an impartial investigation. So we are going to give you the results of the British reports here, which are not entirely over-enthusiastic, as you will note. However, there are definite statements which indicate their feelings.

Another statement here in regard to the conclusions and recommendations:

There is a majority opinion that the United Kingdom should in any case keep in line with the Commonwealth and the United States of America.

It seems to me that statement is very important because of some statements that were made yesterday that perhaps there was some feeling that the British was opposed to it, and if the United States went ahead with it, the British would not like it.

I think that offsets that.

Furthermore, a general statement:

Eighty-four percent of the total respondents to our questionnaires were in favor of the principle of adopting the metric system.

They sent their questionnaires not only to professional and scientific people, as our committee did, but sent them out quite widely. The questions were fairly similar to ours.

Ninety-four percent of the respondents were in favor of adopting it. Two-thirds of the total gave qualified approval in one or more of the following ways:

Sixty-five percent of the total respondents did not wish to take action without the Commonwealth and the United States of America doing so too.

This indicates they are ready to follow, as far as appears here.

Next:

To move to the recommendations, the first one:

In view of the above findings, the committee cannot recommend compulsory adoption of the metric system by the United Kingdom at the present time.

That is the conclusion in this report.

Nevertheless, the following points must be investigated:

1. There is a general feeling that the metric system will in the course of time become more widely used in the rest of the world and in the United Kingdom.

Well, as you heard this morning, it is used by about 85 percent, or at least 85 to 90 percent of the population of the world are now using or under the metric system.

So when they speak of "more widely," it can't go much more widely.

2. The United Kingdom should therefore keep watch on the world situation. We recommend that this should be achieved by regular 2-year review by the Board of Trade in consultation with industry and commerce and in conjunction with corresponding bodies in the Commonwealth and the United States.

They go on to say:

So far as the United Kingdom itself is concerned, the metric system is legal—

In other words, the position there is exactly as it is in the United States. The metric system is legal, as in the United States—

and any organization is free to use it. Changeover on this voluntary basis has been slow and will be slow in the absence of any possible encouragement.

The above-mentioned review should indicate, in the light of the world trend observed, what stimulus might be given to more rapid changeover to the metric system in the United Kingdom.

That is the end of the quote.

I thought the committee might be interested, Mr. Chairman, in the actual report as given by the British.

Mr. MILLER. We are.

We thank you for bringing it to us, sir.

Mr. HOUGH. Could I say just a few more words, and then I will be glad to attempt to answer questions.

Mr. MILLER. Go right ahead.

Mr. HOUGH. The Army reported yesterday. I would like to adjust a bit to what was said yesterday, since I was, as mentioned, Chief of the Geodetic Division of the Army Map Service for 12 years.

We call it the UTM, the universal transfer mercator grid, which is the official system of all NATO countries, which was made up—was designed by the Army in 1944, 16 years ago.

One of the first provisions in that design was that the metric system would be used in the coordinates of the universal transfer mercator. In 1947 this was adopted officially by the Army. From then on considerable negotiations with the various NATO countries, and so on, took place. Eventually the NATO accepted and the other three services also are using the universal transfer mercator grid. That is in metric coordinates and has been from the start.

You heard, of course, that the Army, in 1966, is going, as far as linear measurements are concerned, completely to the metric system by their regulations.

One other comment here:

It seems to me that when the—if I may refer to the wording in the bills—that when the words "adoption of the metric system" are mentioned, it seems to me it should be followed, if I may make the suggestion, by the words "as the only official system of weights and measures," for the reason that it has already been adopted in the United States. It is legal. Therefore, it seems to me it should be qualified, perhaps. It is just a suggestion.

Mr. MILLER. That would be more pertinent to the final legislation; assuming that the Bureau of Standards recommends favorably on this to the Congress, then the terminology in the final bill effected

in their recommendations would have to contain very definite statements that you have made.

Mr. HOUGH. I might say that, as was mentioned by Dr. Fischelis, we believe that once the Congress adopts this study provision, that certainly the newspaper publicity and the publicity all over the country for the metric system will be such that there will immediately be a very great impetus and interest in this, which has not, as Mr. Hechler, I believe, brought the point up a few minutes ago, seemed to be very great in the past. It will need this sort of thing to really spur the situation in this country.

Mr. MILLER. I am satisfied it will. I can see where some people are going to take a great deal of exception. They will have their court to which they can go and make their protest, their pleas, and their arguments.

Mr. HOUGH. Mr. Chairman, I will be glad to try, with the assistance of my cohorts here, I will be glad to answer any questions, if you have any.

Mr. HECHLER. Just keep pitching. That is all I have to say.

Mr. MILLER. Mr. Mosher.

Mr. MOSHER. No questions.

Mr. MILLER. Counsel?

Mr. CARSTARPHEN. No questions.

Mr. MILLER. I want to thank you, sir, for bringing this to us.

I may say, a few minutes ago I made the statement that I had talked to some engineers and some people who are actively in the field, who are concerned with getting the best job done. They are far from being educators or theoretical scientists. I had the pleasure last month of addressing the Society of Exploration Geophysicists at Oklahoma City. These are the people who go out and make the seismic studies for the location of oil over the world. I discussed it very briefly with them, told them what this committee was doing, and without exception they were very enthusiastic about it.

I imagine—I am not too familiar with their work—I imagine most of their work is done in the metric system.

Mr. HOUGH. I presume they are officially connected with our American Geophysical Union, for one thing.

Mr. MILLER. I imagine that they are. They are the working geophysicists, the crews that are out in the field making the seismic studies for oil.

I think they call themselves Doodlebugs.

Mr. HOUGH. Incidentally, after the reports came in from these questionnaires that were sent out, the American Geophysical Union then passed a resolution on May 6, 1959, which I will not take the trouble of reading, which put themselves squarely behind the adoption of the metric system as the only official system of the United States.

Mr. MILLER. Will you furnish a copy of that resolution for the record?

Mr. HOUGH. Yes.

(The resolution requested is as follows:)

RESOLUTION

Whereas scientists and engineers are generally agreed that the metric system of weights and measures is far superior to the English system in the ease of learning and of application to everyday uses; and

Whereas the United States is among the 10 percent of the people of the world not living under the metric system, thus suffering more and more in world trade and other international contacts; and

Whereas the meter and the kilogram are the legal standards of length and mass in the United States, to which are referred the English units; and

Whereas the current rapid strides in science and engineering seem to urge appropriate action in this regard with a transition period of sufficient length to avoid disruption in the economy: Therefore be it

Resolved, That the American Geophysical Union urges the adoption of the metric system as the only official system of weights and measures in the United States, effective one generation of 33 years subsequent to the passage of appropriate legislation by the Congress.

I think the question was asked, something about the business people, how they were reacting to this.

I have correspondence from various businesses that indicate clearly their interest in the metric system. In fact, the committee has quite a large amount of correspondence that it has received both in this country and many letters from foreign countries, such as South America, wherever countries down there are already on the metric system.

The people with whom we have the most interest, you might say, I believe, at the present time are in South America, and every one of those countries are already on the metric system, as brought out yesterday.

The correspondence that we have and the data that the committee has is certainly available to your committee, sir, in any way that you wish to use it.

Mr. MILLER. Thank you very much.

Have you anything that you would like to add?

**STATEMENT OF DR. LANSING SIMMONS, OF THE COAST AND
GEODETIC SURVEY, VICE CHAIRMAN OF THE SPECIAL COM-
MITTEE OF THE AMERICAN GEOPHYSICAL UNION FOR THE
STUDY OF THE METRIC SYSTEM IN THE UNITED STATES**

Dr. SIMMONS. No, but I might say that any people who compute will certainly go for the decimal system. The people that don't do any computing or who are not concerned with it are indifferent as to what unit is to be used.

There is only one unit recognized internationally and that is the meter. There is only one unit that the world could converge on and agree to with any hope for success, also, the kilogram and the centimeter and the gram.

The problem before us now is not adopting it, it is to provide funds to get a survey to see that it is worth while to adopt.

In our minds, of course, there seems to be no question that the small amount of funds that will be required for this survey are completely justified.

Mr. MILLER. I wonder, Mr. Hough, would you care to speculate as to what would happen if we decided that instead of using a decimal system for our money, we decided to adopt the pound, shilling, and pence, do you think we would get into trouble?

Mr. HOUGH. Yes; I would like to comment on that by stating a question that I asked Dr. Hughes when he was over here and the committee entertained him for lunch, Deputy Chairman of the British Committee. I asked him, when he took a taxi over in London and

the bill came to 1 pound 9 shillings and 6 pence, and he wanted to give the driver 15-percent tip, how he figured that.

Dr. Hughes hesitated to answer. Finally he said:

Well, I reduce it all to shillings or all pence, and I take an approximation of it.

That was the exact answer to that.

Here was a British scientist, asked how he got percentages from pounds, shillings, and pence. You can't do it without a lot of mathematical work involved. Whereas, with the metric system, it is a very simple proposition.

Mr. MILLER. The only system that I found that works over there is to get a lot of loose change in your hand and hold it out and trust the driver.

Mr. HOUGH. I have just one letter here, if I may have a couple of minutes.

This is perhaps a sort of sample letter from business people. This is from Burndy Corp. in Norwalk, Conn., signed by Dern Divner, chairman of the board.

He says:

I have noted in the press recently the concern about the metric system in place of the old English system to which we are committed. Such a change is imperative, and the sooner it is undertaken the better, and the least cost of transition.

That statement is important.

As was stated yesterday, George Washington sent forward the bill that had to do with the metric system to the Congress, and Mr. Jefferson recommended it. But if it had been changed at that time, it would have been a very simple matter. The longer we wait, as this gentleman states, of course, the greater the ultimate cost.

Then he goes on to say:

The first of these advantages is that as our international interest and trade expands to nations not using English units, we will be at a disadvantage by not speaking the otherwise universal metric language. The Russians, on the other hand, will have a common system in Latin America, Europe, and Asia. The limit is entirely unnecessary.

There is a letter here from the Canadian consumers. They are doing everything they can to move over to the metric system. They have requested information from us. There are many letters in our files.

Mr. MILLER. Thank you very much, Mr. Hough. You have made a very fine contribution to the hearings of this committee.

Mr. HOUGH. Thank you, Mr. Chairman, and members of the committee.

Mr. MILLER. I am very happy to welcome our colleague, Congressman Roosevelt, who is the author of one of the bills before us.

Congressman Hechler, before he left, Mr. Roosevelt, wanted to ask that he be allowed to insert a statement in the record:

I am pleased to join in welcoming Congressman Roosevelt, the able son of a great President. It is significant that Congressman Roosevelt should be here to testify in support of the bold, imaginative proposal like the adoption of the metric system. This is perhaps symbolic, because President Roosevelt has devoted so much of his life to imaginative programs to the advancement of mankind.

Mr. Hechler asked me to put that in the record. I am happy to do it. He had to leave. They are signing a contract of great value to the State of West Virginia, and he left for that.

I am very happy to see you here.

You may proceed in your own way.

MR. ROOSEVELT. Thank you very much, Mr. Chairman and members of the committee. It is a pleasure to be here.

**STATEMENT OF HON. JAMES ROOSEVELT, A REPRESENTATIVE IN
CONGRESS FROM THE STATE OF CALIFORNIA**

I think, if I may, I would like to express my appreciation to you and Mr. Hechler and the committee for the pleasure of being here.

I, frankly, don't think I am here really advocating a bold and imaginative new system. This is a system that has been in operation for quite a long time. I think I am advocating that perhaps we look around and we see whether something which is a pretty tried and tested system would not work better than the one we have.

I have always believed that, fortunately, we lived in a country that was not so wedded to any principle—or any way of doing things—that if something decidedly better came up and could be proven to be better, that we wouldn't make the change to adopt it.

I am principally here not to advocate particularly that this change be enacted at this time, but rather as the purport of your bill, Mr. Chairman, and others, including my own H.R. 269, reads, is primarily that the matter be studied to find out whether there is basic reason for making the change.

I would be the last person to pretend that I am an expert in this field. This is not my field of study or expertness, if I have one.

I do, however, and I would like the committee to know that I believe there is quite a widespread interest in this change from those who have taken the time and the trouble to study it rather carefully.

Some of my own constituents brought this to my attention about 3 years ago, and asked me to introduce a bill. At that time I didn't do so because, frankly, I didn't know enough about the subject.

However, I undertook to try to look into it. Since then I have read a good deal of the published material on this subject. Perhaps it has already been supplied or brought to the attention of the committee, and I don't want to burden the committee's time by again bringing something to their attention that they know all about, but in May of 1960, in the publication *This Week*, which is inserted in a good many Sunday newspapers, Dr. Edward Teller wrote a very interesting article. This came to my attention. I studied it. I conversed with him about it. And from that discussion I reached the conclusion that certainly this was a field that deserved more careful attention and more careful study.

If it has not been submitted, I would like to submit it for the record.

MR. MILLER. It has not been submitted.

I am familiar with the article. We would be very happy to have it submitted for the record.

(The article follows:)

WE'RE LOSING BY INCHES—BY FEET—AND BY YARDS—WE'RE HANDICAPPING OUR ENGINEERS, BUSINESSMEN, AND EVEN OUR SCHOOLCHILDREN WITH OUR ANTIQUATED WAY OF MEASURING—A WORLD-FAMOUS SCIENTIST TELLS WHY AMERICA MUST SWITCH TO THE METRIC SYSTEM AND HOW WE SHOULD GO ABOUT IT

(By Dr. Edward Teller as told to Allen Brown)

SAN FRANCISCO.—Our nation has embarked on one of the most tremendous and inspiring—but dangerous—enterprises in history: We have set out to build an industrialized and lawful world free from war and free from economic misery. We are now so involved in this undertaking that unless we succeed, we may cease to exist. The danger of being overtaken by Russia in our accelerating contest for world leadership is very real.

In this most important contest, it seems inconceivable that we would allow ourselves to be hampered by a situation which has hurt us in the past, is hurting us today, and will continue to hurt us in the future. But the fact is that the United States is out of step with most of the world in an immensely significant way: We measure things differently.

This at first may seem unimportant. But our clumsy system of measuring with inches, quarts, miles, and pounds actually could hobble our international trade, slow down our technological development, and lose for us the greatest contest in the history of the world—the contest for leadership of the world itself.

There is an obvious need for reform and the need is urgent.

Most of the world—including Russia—measures with the metric system, adopted by the French in 1791. Metric measurement is based on the meter, representing one ten-millionth of the distance between the earth's equator and the pole. At present there is no measurement system available to us that is so simple, so clear, and so universal.

Like our system of counting money, the metric system is a decimal system. All things are measured in simple multiples of ten. The metric system also recognizes natural relationships: It measures length by centimeters, area by square centimeters, and volume by cubic centimeters.

Russia adopted the metric system in 1927. The Soviet government then did away with their *verst*s and other absurd measurements that were as mysterious and unintelligible to the rest of the world as our inches and pounds are today. Since then, the trend toward the metric system has accelerated; China and Japan are adopting it, India is about to.

Who are the holdouts for the foot, pound, and quart? Such measurements are official only in the U.S., most of the British Commonwealth and Ireland.

By deciding to measure metrically with the rest of the world, Russia got hold of a weapon that is powerful because it is not secret. It helps Russia to understand and to be understood in a large part of the world. And it is helping Russia to forge ahead on three important fronts:

1. *Technological developments.*—New technologies and the development of new weapons demand the close cooperation of scientists and engineers. In Russia, scientists and engineers speak the same language. In America, they do not. When a measurement is used in a Russian laboratory, everyone knows that it is a metric measurement; there is no need to halt important work or interrupt a train of thought to translate from one system of measurement to another. But in this country, scientists use the metric system and engineers use the English system of inches, quarts, and pounds. So American scientists and engineers are squandering valuable time and energy on the tedious chore of translating inches to centimeters. It is laborious and tiring, but the measurements must be defined or our scientists and engineers would be talking at cross-purposes.

2. *Education of scientists.*—The simplicity of our decimal system of measuring money has meant a great deal to the economic strength of America. Every child knows that ten pennies make a dime and ten dimes make a dollar. From the time he is old enough to count, a U.S. youngster can have experience in finance. He can earn and spend money because he can understand it.

But when he first begins to be interested in science, the American youngster is faced with our confusing and forbidding methods of measuring length, volume, weights, and temperatures.

We measure length by miles, area by acres, and volume by gallons. There is no connection between these units. The ideas conveyed by the words we use to describe length and area do not suggest to a child the simple truth that by multiplying two lengths you get an area. Even if he thinks of nothing more in the world than simple distances, he must learn by rote that there are twelve inches in a foot,

three feet in a yard, five and one-half yards in a rod, and for an almost unbelievable reason there are 5,280 feet in a mile.

These totally impractical measurements wipe out the basic natural connection between length, area, and volume. They erect an artificial barrier than often diverts, blunts, and frustrates a youngster's interest in science.

The metric system is so straightforward that it can be understood by a child. As an example of how easily it works:

10 millimeters=1 centimeter
 10 centimeters=1 decimeter
 10 decimeters=1 meter
 10 meters=1 decameter
 10 decameters=1 hectometer
 10 hectometers=1 kilometer

Young Russians who understand and use it from the time they learn to count have an obvious advantage. Metric arithmetic is a window through which students are induced to get their first glimpse of the simple orderliness of geometry. They are stimulated to look further. Their interest in science is aroused, and they soon are prepared to get acquainted with the puzzling facts of the universe in which we live.

3. *Business Development.*—The English-speaking world so far has enjoyed a practical monopoly in world commerce. This is at an end. We are faced by a powerful competitor who has challenged us to an economic battle and who is going to come into his own in the next ten years.

In this economic battle, the metric system is like money in the bank.

Russian manufacturers and businessmen do not have to go into a whole new branch of learning to fill orders from customers in countries using the metric system. Americans must.

And it seems natural that industrial customers in a large part of the world will prefer to buy machines from a nation like Russia, which can supply replacements in a measure that the customer can understand, than from the United States, where orders must be translated from centimeters to inches.

The foreign customer is going to buy where it is easiest and most simple for him to buy, where there is no chance for error in translating the measurements of the things he orders.

But while Russia and other industrial nations of the world are enjoying these distinct and increasing advantages of the metric system, the U.S. stubbornly clings to a system of measurement that developed by chance.

The United States certainly will be using the metric system someday. The overwhelming forces of simplicity, easier communication, and commonsense will force us to adopt it. We are concerned about the education of our children, about the competition with Russia and about the problems of living with neighbors that only yesterday were strangers. Since we are concerned about these things, we surely will adopt the metric system.

The questions are when and how.

These are important questions. They can be answered only by a serious study such as that now being considered by Congress.

THREE SOFT STEPS

It is obvious, however, that the United States cannot adopt the metric system overnight. It will take time. It must be done in gradual steps.

The first step would be to start teaching the metric units of measurement in the elementary schools. This could be done right away. Pupils could be told about inches and feet and pounds, but these should be presented as items of only transitory interest.

The second step might be to change the measurement of geographic distances. It would be simple to put up new road signs and print new maps giving distances in kilometers instead of in miles.

The third step might be to set a target date after which metric measurements would be used for all legal and governmental documents. This would provide an accumulating pressure toward general adoption of the system.

Then another target date might be set: At the end of perhaps five years, all government orders for materials could use the metric system in the specifications. This would literally force companies selling to the government to adopt metric measurements. Since the government is the biggest buyer in the nation, most companies would have to standardize.

The adoption would not be complete, of course, until we changed the measurement of the billions of nuts and bolts and other parts of our industrial complex. This vast undertaking probably would be accomplished in two stages: The changeover first would be proclaimed, leaving industry with strange-sounding *dimensions*. The three-inch bolt, for instance, would suddenly have a length of 7.62 centimeters. For the sake of convenience, industrialists eventually would change the size of this bolt to an even number of centimeters. Thus, sometime in the distant future, a changeover to the metric system probably would actually change the size of most of our machines.

CHANGEOVER WILL TAKE 33 YEARS

It seems likely that a complete changeover to the metric system would take a full generation, 33 years. But these are the questions and the details that should be undertaken in an exhaustive governmental study.

This much is certain: The need for conversion to the metric system is urgent. The rate of conversion will depend only on the inertia of what I believe is the most inert thing in the world—the human mind. We simply must make up our minds to it and get used to it, because if in this battle between the inches and the centimeters we can make reason prevail, we will have a much greater chance to win the fight for our ideals.

Mr. ROOSEVELT. If I may just read a little piece on the side. I think sometimes a little sense of humor in these things is always good.

Dr. Teller, in telling his story to his collaborator, Allen Brown, quotes and says:

There is a story that the erudite German, Gabriel Daniel Fahrenheit, once waited in Danzig until it had got as cold as he thought it could get. Then on that very cold day, he stuck his thermometer out of the window and that became zero. Then he put it under his arm, and that became 100°.

So our system of temperature supposedly goes back to the fact that there was once, in a rather cold town, a rather hot guy.

If this is at all along the line of the basis of our system, I think it is time that we did look into it.

Mr. Chairman, I am simply here to lend my support to the proposal for this study. I believe it can be done with a relatively small outlay of funds in an effective manner. I believe that because of the advantages which have come, as the other witnesses that I have had the privilege of listening to mentioned, particularly when the Russians, as Dr. Teller points out, are using this today as a better means of communication with much of the world that they want to influence, if this is to be an important factor in that overall struggle, I think it is time we took a pretty good look at it.

I would like to lend my support to the legislation, Mr. Chairman.

Mr. MILLER. I think you and I are in accord on our approach to the matter.

I have made the statement that this is of vast importance to this country, to its economy, to its scientific effort, and I didn't feel competent to come in and say it should be done; but there is a scientific body created by the Congress that is competent to make such observation, and this is the Bureau of Standards.

Too long we have neglected them. We should give to the Bureau of Standards that which is its due in the field of standards and measurements, and they should undertake this study.

We haven't arrived at a time period, as to whether the study should be a year or 3 years.

There is a group of competent people who have suggested that the changeover perhaps should come in a generation, in 33 years. But this, again, I don't think we are competent to view. But the Bureau

of Standards in its study can come up with a time limit when this should be put into effect.

I believe that we should get this study started at the earliest possible moment, because I think the evidence before the committee indicates it is necessary.

We have been very fortunate to bring into this problem a group of scientists, the advisory panel of the committee. This subject was brought before them. They immediately jumped on it, about 16 of the foremost scientists of this country, and without exception they would have given the whole afternoon to a discussion of the pros and cons of the metric system.

I want to congratulate you on introducing the bill. I think the committee will consider the data that it now has before it, and I think it is sufficient on which to formulate a decision.

Do you have some questions?

Mr. MOSHER. Mr. Chairman, all I would like to say is that I would like to associate myself with the position you have just stated, and compliment Mr. Roosevelt in joining with you and Mr. Fulton in calling this very important question to the attention of Congress.

I agree with Mr. Roosevelt that the proposed use of the metric system is not because it is bold and imaginative but rather because it is already so commonly in use and already so proven in its practical value.

Mr. ROOSEVELT. Thank you, Mr. Mosher.

I quite agree with you.

Mr. MILLER. Eighty to ninety percent of the world are using it now. We have to speak a common language with them in trade, in commerce, as well as science. It certainly behooves us to go to the mountain and not ask the mountain to come to us, because the mountain may not move as readily as we do.

Thank you very much, Mr. Roosevelt.

I have a statement here, submitted by Capt. Edwin H. Schantz, Acting Assistant Chief of the Bureau of Design, Shipbuilding, and Fleet Maintenance, on behalf of the Navy, in which they support the position that has been taken.

We will make that part of the record.

(The statement follows:)

STATEMENT OF CAPTAIN EDWIN H. SCHANTZ, ACTING ASSISTANT CHIEF OF THE
BUREAU FOR DESIGN, SHIPBUILDING, AND FLEET MAINTENANCE

Mr. Chairman and members of the subcommittee, I am pleased to appear before you today in support of H.R. 2049, a bill which would direct the National Bureau of Standards to conduct a program of investigation, research and survey to determine the desirability and practicability of the adoption in the United States of the metric system of weights and measures.

There have been many studies made by various miscellaneous groups for a variety of reasons to determine the feasibility of conversion to the metric system. Enactment of this bill could result in the successful completion of a comprehensive and official U.S. study and could be used by the Congress as a clear, factual and realistic basis for determining the magnitude and desirability of converting our present measuring system to the metric system of weights and measures.

At the present time the United States and Canada are the only nations in the Western Hemisphere using the English system of weights and measures. Among the NATO nations only the United States, Great Britain and Canada are users of the English system.

From the point of view of international cooperation in technical matters, there is no question but that the adoption of a uniform system of weights and

measures throughout the world would be most desirable. In particular, uniformity among our Western allies and friendly foreign nations could lead only to improvement in our mutual defense program.

However, the innumerable and widespread commercial, industrial, educational, economical and procedural problems, and especially the cost, require that the most careful inquiry precede any decision to make such a change. It is primarily for this reason that we welcome a study which in effect could provide in a single package for competent review all the advantages and disadvantages, pros and cons, and probable effect of such a change. The Bureau of Ships would favor such a study.

Mr. MILLER. That completes the subcommittee hearings, gentlemen, and without objection the bill will be reported back favorably to the full committee. Mr. Carstarphen will prepare a report accordingly.

Without objection, the subcommittee will stand adjourned subject to the call of the Chair.

(Whereupon, at 11:55 a.m., the subcommittee adjourned subject to the call of the Chair.)

THE METRIC SYSTEM

FRIDAY, JULY 21, 1961

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

The committee met at 10 a.m., pursuant to adjournment, in room 214-B, New House Office Building, Hon. Overton Brooks (chairman) presiding.

The CHAIRMAN. The committee will come to order.

The first order of business this morning will be to take up the report of Subcommittee No. 1, which report is to accompany H.R. 2049. Mr. Miller is chairman of the subcommittee.

I recognize Mr. Miller.

Mr. MILLER. Mr. Chairman, Subcommittee No. 1, to which was assigned the metric study bill, H.R. 2049, met on Wednesday and Thursday, June 28 and 29, 1961, and heard the following witnesses during the 2-day period:

Dr. A. V. Astin, Director, National Bureau of Standards.

Dr. A. T. McPherson, Associate Director, National Bureau of Standards.

Col. Walter W. Woodard, Office of Deputy Chief of Staff, Research and Development, Air Force Systems Command.

Lt. Col. G. P. Grant, Standardization Branch, Office Deputy Chief of Staff for Logistics, U.S. Army.

J. T. Johnson, president, Metric Association.

Dr. Robert P. Fischelis, chairman, Committee on Reorganization, Metric Association.

Floyd W. Hough, chairman, Committee for the Study of the Metric System, American Geophysical Union, accompanied by Lansing Simmons, vice chairman of the Reorganization Committee, and Dr. Waldo Smith, executive secretary. Hon. James Roosevelt, Member of Congress.

The purpose of the bill is to provide for an investigation, survey, and study to determine the desirability and practicability of adoption of the metric system in the United States. The subcommittee also took into consideration a companion bill introduced by Mr. Roosevelt, H.R. 269.

Subcommittee No. 1 does hereby report favorably on H.R. 2049 with an amendment, and recommends that the bill as amended do pass. The amendment is as follows:

Page 3, line 1, strike the word "one" and insert in lieu thereof the word "three".

Although the metric system of measurement was legalized for use in the United States in 1866 by act of Congress, it has not been widely used by industry, the scientific community, or the public.

The demands of today's space age endeavors in research and development applicable thereto call for greater precision of measurement and are focusing attention on the two major systems of units of measurement, namely the English or United States customary system, and the metric system.

Since early in the history of our country there have been legislative measures calling for studies involving the use of the metric system; however, there has been no mandatory legislation forthcoming.

Today finds the pharmaceutical industry already converted to the metric system and other industries looking toward such conversion, as, for instance, the chemical industry.

The witnesses heard directed their remarks to a discussion of the merits of a study proposal as called for by the bill and did not propose to discuss the merits of the respective systems of measurement.

Testimony definitely showed that prior to making a decision to convert the system of measurements there should be a very broad study to determine the feasibility of such a conversion.

It was also stated that the studies should result in showing the anticipated gains and savings, both direct and indirect, that might be reached through the general adoption of the metric system in industry, commerce, and trade, and that there should be measured the estimated cost that such a change might require in man-hours, materials, and dollars and cents.

It is apparent that any immediate change to the metric system would meet opposition and that therefore a study bill is the only practicable way of laying any groundwork that may be required preceding the adoption of compulsory legislation.

There was testimony that the subject matter of conversion to the metric system is controversial, but the consensus of opinion of the witnesses appearing before the subcommittee indicated that the proposed study would indeed be a substantial step toward settling the controversy, for in this way the public generally as well as industry and educational, scientific, and Government agencies could have a part in contributing to the study.

It is the feeling of the subcommittee that it is only through education that any change may be forthcoming and education would receive the desired impetus through the study bill under consideration.

Numerous bills for the adoption of the metric system have been before Congress since George Washington forwarded to it a copy of the French report, which introduced the metric system, for study.

Three significant actions have been taken:

- (1) The metric system was legalized for use in the United States in 1866 by act of Congress;

- (2) The United States in 1875 became a signatory to the International Metric Convention, and

- (3) The Secretary of the Treasury in 1893 approved the Mendenhall order, which recognized the international prototype meter and prototype kilogram as the fundamental standards on which the yard and the pound are based.

It is said that the educational field is one of the areas that will most benefit by the adoption of the metric systems. Teachers of mathematics agree that a saving of 25 percent of the student's and the teacher's time would be saved in arithmetic courses if the simple metric decimal units were substituted for the English.

In the matter of international trade, it appears that the United States is clearly at a disadvantage. About 90 percent of the world's population is living under the metric system, or their governments are in the process of changing over to it. Some have expressed the belief that the South American preference for European imports may

be due in part to their use of a common language in the metric system of weights and measures.

In view of the necessity for simplification and speed, the U.S. Army in 1947 adopted the metric system, and in 1957 the Army published an Army regulation calling for the conversion of weapons and related equipment to the meter for measurement of linear distances.

The subcommittee, in considering the highly technical nature of the measurement skills required in today's technology, believes it is to the best interest that a study such as called for by the legislation under consideration be undertaken.

THE COMMITTEE AMENDMENT

The Department of Commerce in favorably reporting on H.R. 2049 expressed the opinion that 1 year was too short a period for the study proposed to be undertaken by this legislation.

Testimony of the witnesses before the subcommittee indicated, likewise, that a 1-year period would not allow the study to be conducted on a scale of sufficient magnitude to accomplish the desired result, and your subcommittee recommends that the bill be amended to allow a period of 3 years for the study in lieu of the 1 year contained therein.

Mr. Chairman, I move the adoption of the report.

Mr. HECHLER. Mr. Chairman——

Mr. FULTON. May I second it from this side.

Mr. HECHLER. I wonder how many people realize the number of nations that do actually have the metric system now. There are 76 nations that have the metric system in operation. India and Japan are the most recent that have added the metric system.

The thing that disturbed me about these hearings, however, was the fact that very, very few people understood the potentiality of the metric system in the country. I think it is all right for the long-haired scientist to come in and demonstrate logically why it is beneficial for our Nation to have it, but I think there is a lack of understanding and appreciation of the popular support that is necessary.

For this reason, I think we ought to have something like the metric system but at the contests or things that will help popularize this system and its great potentialities. I agree the study will help. But I think it will need a great deal more to stir public interest in this system and its potentialities, and a study.

I support the report and the bill, however.

The CHAIRMAN. You have heard the motion and duly seconded.

I think the report is an excellent report. I think, however, that under practices of this committee the bill should be read before we vote on the bill itself.

Mr. FULTON. I would like to have some discussion.

The CHAIRMAN. On the report?

Mr. FULTON. On the report and on the bill.

The CHAIRMAN. All right.

Is there any further discussion?

Mr. FULTON. My feeling on it parallels Mr. Hechler's, in that we must get action rather than just have a study over a long period of time that ends with a few findings and a few recommendations.

I would like to submit to Mr. Miller a compromise between his bill and the proposal of the Department of Commerce. For example, I would have an amendment, Mr. Miller, if you look at your bill, at page 3 at the top, so that the amendment would read this way, after the word "Congress," page 3, line 1, ",", insert "annual reports, and", and then in line 1 strike the words "one year" and insert "three years".

Mr. MILLER. That is the amendment I mentioned in the bill, recommended in the report.

Mr. FULTON. I didn't realize it.

The Bureau shall submit to the Secretary of Commerce for transmission to the Congress annual reports, and within three years * * *

I didn't realize you had that.

The CHAIRMAN. Is there any further discussion of the report, not the bill, now? If not—

Mr. FULTON. Just a minute.

Mr. MOELLER. May I ask a question, if the gentleman will yield?

Mr. FULTON. I yield.

Mr. MOELLER. This ties in with the report also.

Did the hearings bring out the fact that South America didn't choose maybe to carry on as much commerce with us and imports for fear of possible financial losses to them? Would the same obtain here with American industry and business as far as our own people are concerned?

The CHAIRMAN. Mr. Miller has reference to that.

We will recognize you, Mr. Miller.

Mr. MILLER. The statement was made that South America is going to the metric system, and there is an apparent tendency for them to favor countries that use the metric system, because it is common to both of them.

If you look, for instance, at our own canned fruit. I happen to be familiar with this item because we can a lot in my district. That which is set up for domestic sale shows a certain number of can, say a "303 can," and shows it containing so many pounds.

But for export we have to show its metric system equivalent.

There have been efforts made by one canning group to use a common size can, a quart and the liter, but this left a gap and there was some question as to whether this was good or not.

It seems that at the present time most of the countries of the world, as has been stated by Mr. Hechler, including Japan and India, are now going to this system. It leaves us alone. And England is making certain studies along this line, looking to the adoption of the metric system also.

I think if we go into the metric system they may follow us.

Mr. HECHLER. Will the gentleman yield?

Mr. MILLER. Yes.

Mr. HECHLER. I would like to put into the record 18 South and Central American countries that now have the metric system in operation.

The CHAIRMAN. Do you want to read those in the record now?

Mr. HECHLER. I will be glad to read them. I don't want to waste the time of the committee. I will put them in.

The CHAIRMAN. Put them in the record.

(The countries in South and Central America which have adopted the metric system are as follows:)

Argentina	Ecuador	Panama
Bolivia	Guatemala	Paraguay
Chile	Haiti	Peru
Colombia	Honduras	Salvador
Costa Rica	Mexico	Uruguay
Cuba	Nicaragua	Venezuela
Dominican Republic		

Mr. FULTON. On the point of bringing this education to this program, I have had a House Concurrent Resolution 44 that I would like considered as an addition to this bill. It could be put in as a new section 4. My resolution states:

Resolved by the House of Representatives (the Senate concurring), That it is the sense of the Congress that the President of the United States should take the appropriate steps, with the counsel of the Nation's leading educators and scientists, to effect the adoption of the metric system of weights and measures as the Nation's official system of measurement in all appropriate fields of endeavor, and direct that all departments and agencies of the United States (particularly those having functions related to education or schools) foster and promote the understanding and use of such system by all the people of the United States.

There are two points in that. One is that we authorize the President, and have a direction to all departments and agencies of the United States, to foster and promote the understanding and use of the system by all the peoples of the United States.

The second point is that it actually recommends the adoption of the metric system by having the President of the United States authorized through appropriate steps with the counsel of the Nation's leading educators and scientists to effect the adoption of the metric system of weights and measures as the Nation's official system of measurement in all appropriate fields of endeavor.

That goes one step further than a simple study resolution. I believe Mr. Hechler had made the point that he didn't want this just to end as a study.

My feeling on it is likewise that we should have some end result in sight. I can see that the committee might not want at this time to go so far as to recommend the adoption of the metric system of weights and measures.

But I do feel there would be a distinct addition if we had a new paragraph (4) that directed that all departments and agencies of the United States, particularly those having functions related to education or schools, foster and promote the understanding and use of such system by all the people of the United States.

That would be just inserting that part of the resolution, my resolution, House Concurrent Resolution 44, as a new section (4) of Mr. Miller's bill, H.R. 2049.

Mr. HECHLER. Much as I support the basic position that you have just outlined, I think in the interest of moving this thing forward we ought to take what the subcommittee has unanimously recommended and considered. I believe we will make greater progress.

Mr. FULTON. Would you not go so far as to have the U.S. agencies, particularly those having functions related to education or schools foster and promote the understanding and use of such system?

That means to get an educative process going that does not commit the United States to the metric system, but through our educa-

tional institutions and schools, to come up with discussions and really make a program so that the issue will be a broad issue rather than one just based on a Department of Commerce study.

Mr. HECHLER. I am so interested in the principle of your resolution that I find it difficult to argue against it. But we face a condition now, not a theory, of trying to get this thing through, and it seems to me the most practical way is to proceed with what the subcommittee recommended.

Mr. DAVIS. Mr. Chairman, I venture to predict a section worded as my colleague, Mr. Fulton, has worded it, might precipitate the charge of Federal control, which is quite a sensitive issue today in the field of education, as is well illustrated by this booklet which was issued by the Department of Health, Education, and Welfare on April 1.

It strikes me that might precipitate quite a furor and might imperil the fate of the entire bill. I just offer that comment.

Mr. FULTON. Let us not have issues and basic principles crippled by the fear of a furor.

Mr. DAVIS. I am talking about the fate of the bill. We don't want to kill the whole bill, unless you are against it.

The CHAIRMAN. It is an excellent bill. It is an excellent report from the subcommittee.

Mr. HECHLER. I move the adoption of the subcommittee report.

The CHAIRMAN. It has already been moved, and Mr. Fulton has seconded it.

Are you ready for the question?

Mr. ANFUSO. Previous question.

The CHAIRMAN. All in favor, then, of the adoption of the report, not the bill, adoption of the report as presented by the chairman of the subcommittee, Mr. Miller, will make it known by saying "Aye."

All opposed. The same——

Mr. FULTON. A rollcall, Mr. Chairman.

The CHAIRMAN. Is there a demand for a rollcall on this report?

Mr. FULTON. I want the subcommittee unanimous.

The CHAIRMAN. The committee will be polled.

Mr. Finch, will you call the roll?

Mr. FINCH. Mr. Brooks.

Mr. BROOKS. Aye.

Mr. FINCH. Mr. Martin.

Mr. Miller.

Mr. MILLER. Aye.

Mr. FINCH. Mr. Fulton.

Mr. FULTON. Aye.

Mr. FINCH. Mr. Teague.

Mr. Chenoweth.

Mr. FULTON. There is a slip on the rollcall.

Mr. FINCH. Mr. McCormack is at the bottom of my list.

The CHAIRMAN. Proceed.

Mr. MILLER. We will take care of this side.

Mr. FULTON. I will take care of Mr. McCormack.

Mr. FINCH. Mr. Teague.

Mr. Chenoweth.

Mr. Anfuso.

Mr. ANFUSO. Aye.

Mr. FINCH. Mr. Van Pelt.

Mr. VAN PELT. Aye.

Mr. FINCH. Mr. Karth.

Mr. KARTH. Aye.

Mr. FINCH. Mr. Bass.

Mr. Hechler.

Mr. HECHLER. Aye.

Mr. FINCH. Mr. Riehlman.

Mr. Daddario.

Mr. DADDARIO. Aye.

Mr. FINCH. Mrs. Weis.

Mr. Moeller.

Mr. MOELLER. Aye.

Mr. FINCH. Mr. Mosher.

Mr. King.

Mr. Roudebush.

Mr. Morris.

Mr. Roush.

Mr. Bell.

Mr. BELL. Aye.

Mr. FINCH. Mr. Casey.

Mr. Randall.

Mr. RANDALL. Aye.

Mr. FINCH. Mr. Davis.

Mr. DAVIS. Aye.

Mr. FINCH. Mr. Ryan.

Mr. RYAN. Aye.

Mr. FINCH. Mr. Corman.

Mr. CORMAN. Aye.

Mr. FINCH. Mr. McCormack.

Mr. MCCORMACK. Aye.

The CHAIRMAN. What is the total?

Mr. FINCH. On this vote, 15 members voted "Yes." No members voted "No."

The CHAIRMAN. The report is unanimously approved.

Now, let's take up the bill.

Mr. MILLER. I move, Mr. Chairman, the bill be favorably reported.

Mr. FULTON. I second the motion.

The CHAIRMAN. You have heard the motion duly seconded.

Any further discussion on the bill?

If not, I think we ought to have a rollcall on this——

Mr. MILLER. Before we discuss the bill, perhaps this is the proper time to take this up.

Since the writing of the report and the hearings, it appears that a new examination by the Department of Commerce shows, in a letter dated July 20, that the Organization Plan No. 5 in 1950 delegated to the Secretary of Commerce certain functions and operations that were heretofore delegated to other departments and agencies within the Department of Commerce.

The CHAIRMAN. You better let your bill go through.

Mr. MILLER. This is just a change that they overlooked——

The CHAIRMAN. I know what the gentleman has in mind. But the jurisdiction of the committee here includes the Bureau of Standards.

When the gentleman changes the wording to "the Secretary of Commerce," rather than "the Bureau of Standards," we are going to get into some awkward situations.

Mr. MILLER. I don't think so. This is the work of the Bureau of Standards to which we are referring.

Mr. FULTON. It is open to amendment, and I am going to put my amendment in.

The CHAIRMAN. You will have trouble and get amendments to the bill. Why not vote on the bill—

Mr. FULTON. I have an amendment. Page 1, line 1, after the word "Congress" and comma, insert "annual reports, and". Then strike the words "one year" and put in "three years". The section will then read:

The Bureau shall submit to the Secretary of Commerce for transmission to the Congress, annual reports, and within three years after the date of enactment of this Act, a full and complete report of the findings made in the conduct of the program described in the first section of this Act—

And so on.

That gives us interim annual reports where we can follow them up. I think that is a combination really of Mr. Miller's ideas and his bill and what the Department of Commerce has recommended.

The CHAIRMAN. There shouldn't be any difficulty on that.

Are you ready for the question on the amendment?

All in favor of the amendment as explained to the committee will make it known by saying "Aye."

Opposed?

The ayes have it unanimously and the amendment is agreed to.

Mr. ANFUSO. Previous question.

The CHAIRMAN. The previous question is requested on the bill itself, as amended, by the Fulton amendment—

Mr. ANFUSO. I move the previous question.

The CHAIRMAN. Motion has been made and duly seconded—

Mr. McCORMACK. Is there another amendment?

Mr. BELL. Do you want a rollcall?

Mr. McCORMACK. Isn't there another amendment?

Mr. MILLER. The Fulton amendment.

Mr. McCORMACK. I see.

The CHAIRMAN. All in favor of the bill as amended will make it known by saying "Aye" on the rollcall, and all opposed by voting "No."

Mr. FINCH. Mr. Brooks.

The CHAIRMAN. Aye.

Mr. FINCH. Mr. Martin.

(No response).

Mr. FINCH. Mr. Miller.

Mr. MILLER. Aye.

Mr. FINCH. Mr. Fulton.

Mr. FULTON. Aye.

Mr. FINCH. Mr. Teague.

(No response).

Mr. FINCH. Mr. Chenoweth.

(No response.)

Mr. FINCH. Mr. Anfuso.

- Mr. ANFUSO. Aye.
 Mr. FINCH. Mr. Van Pelt.
 Mr. VAN PELT. Aye.
 Mr. FINCH. Mr. Karth.
 Mr. KARTH. Aye.
 Mr. FINCH. Mr. Bass.
 (No response.)
 Mr. FINCH. Mr. Hechler.
 Mr. HECHLER. Aye.
 Mr. FINCH. Mr. Riehlman.
 (No response.)
 Mr. FINCH. Mr. Daddario.
 Mr. DADDARIO. Aye.
 Mr. FINCH. Mrs. Weis.
 (No response.)
 Mr. FINCH. Mr. Moeller.
 Mr. MOELLER. Aye.
 Mr. FINCH. Mr. Mosher.
 (No response.)
 Mr. FINCH. Mr. King.
 (No response.)
 Mr. FINCH. Mr. Roudebush.
 (No response.)
 Mr. FINCH. Mr. Roush.
 (No response.)
 Mr. FINCH. Mr. Morris.
 (No response.)
 Mr. FINCH. Mr. Bell.
 Mr. BELL. Aye.
 Mr. FINCH. Mr. Casey.
 (No response.)
 Mr. FINCH. Mr. Randall.
 Mr. RANDALL. Aye.
 Mr. FINCH. Mr. Davis.
 Mr. DAVIS. Aye.
 Mr. FINCH. Mr. Ryan.
 Mr. RYAN. Aye.
 Mr. FINCH. Mr. Corman.
 Mr. CORMAN. Aye.
 Mr. FINCH. Mr. McCormack.
 Mr. MCCORMACK. Aye.
 The CHAIRMAN. How does it tally?
 Mr. FINCH. On this vote, 15 members vote "Yes." No members voted "No."
 The CHAIRMAN. A quorum is present. The bill as amended is unanimously approved by the full committee.
 I will designate Mr. Miller to sign the report and bring the bill up on the floor of the House.
 Mr. FULTON. May I make the usual motion for Mr. Miller to have the power of the committee to act in his discretion?
 Mr. MILLER. I think the Chairman's designation carries that with it.
 The CHAIRMAN. Mr. Miller will manage the bill.

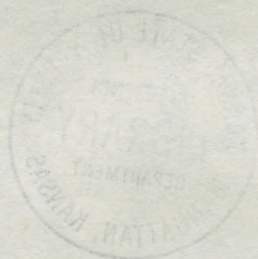
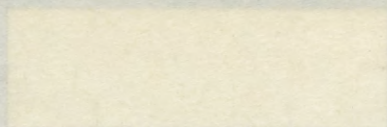
I would like the record to show, too, that this action by the full Committee on Science and Astronautics is being taken within an hour after the astronaut made a very successful flight down at Cape Canaveral. It shows the committee is so well organized at this time that regardless of that excitement we are still able to do business in an orderly manner.

Mr. MOELLER. Who is going to report on the capsule?

The CHAIRMAN. Mr. Moeller, you were down at Cape Canaveral—off the record.

(Whereupon the committee proceeded to further business.)







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