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90-54 INCREASING THE USE OF THE METRIC SYSTEM

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HEARING  
BEFORE THE  
COMMITTEE ON COMMERCE  
UNITED STATES SENATE  
NINETIETH CONGRESS  
FIRST SESSION

ON  
S. 441 and S. 2356

BILLS AUTHORIZING THE SECRETARY OF COMMERCE TO  
CONDUCT A STUDY AND TO MAKE RECOMMENDATIONS  
RELATIVE TO OUR NATION'S SYSTEM OF WEIGHTS AND  
MEASURES

NOVEMBER 15, 1967

Serial No. 90-54

Printed for the Committee on Commerce



U.S. GOVERNMENT PRINTING OFFICE  
WASHINGTON : 1968

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INCREASING THE USE OF THE METRIC SYSTEM

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HEARING

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U.S. HOUSE OF REPRESENTATIVES

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 Association, Washington, D.C.  
 Hood, Edwin M., president, Shipbuilders' Council of America, Washington  
 Ladd, John, 1410 E. 7th Street, Des Moines, Iowa  
 Miller, Joseph E., 8150 Sherman Road, Chestland, Ohio  
 McManis, W. A., manager, Industrial Standards Council, Electric Co.,  
 New York, N.Y.  
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 facturers Association, New York, N.Y.

## INCREASING THE USE OF THE METRIC SYSTEM

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WEDNESDAY, NOVEMBER 15, 1967

U.S. SENATE,  
COMMITTEE ON COMMERCE,  
*Washington, D.C.*

The committee met at 10 a.m. in room 5110, New Senate Office Building, the Honorable Robert P. Griffin presiding.

Senator GRIFFIN. The committee will be in order.

The Senate Commerce Committee today holds hearings on S. 441 and S. 2356, two bills which would authorize the Secretary of Commerce to conduct a study and to make recommendations relative to our Nation's system of weights and measures.

The two bills are similar in many respects. S. 441, introduced by the distinguished Senator from Rhode Island, Mr. Pell, is comparable to an earlier bill which he introduced and which passed the Senate during the 89th Congress. It is directed specifically at evaluating the advantages and disadvantages of increasing use of the metric system within the United States.

S. 2356, which I introduced in August, while also proposing an evaluation of the advantages and disadvantages of an internationally standardized system of weights and measures, incorporates some new points of emphasis, consistent with the Pell bill. It preserves for the Secretary more clearly the option of recommending retention of the existing system of weights and measures, as well as the standards used in connection therewith, in areas of the economy where it might be in the national interest to do so. It also requires the Secretary to recommend specific means of meeting the difficulties and costs of conversion in those sectors of the economy where a change in the existing system might be recommended.

Ninety percent of the world's population today lives in countries using the metric system of measurement. In 1965, the United Kingdom announced that it plans to adopt the metric system on a sector-by-sector basis over a 10-year period.

Canada has announced that it will study the effects of a similar conversion, and in April of this year, the Australian Senate created a select committee to investigate the desirability of adopting the metric system there. Almost all of the nations of the world—except the United States—are moving toward international uniformity in the use of the metric system of weights and measures.

It is important that we study the significance of this movement toward the metric system in the rest of the world, and that we consider the effects upon our domestic industry and our international trade position.

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Staff counsel assigned to this hearing: William G. Meserve.

These hearings may not be as glamorous as some, but their long-term significance can be as important to the future of our economy as any measure before the Congress. I look forward to hearing the testimony to be presented on these bills.

Before calling the first witness, I should like to emphasize and underscore one point: These hearings are concerned with legislation to authorize a study. At this point in time, the committee is not dealing with or attempting to prejudice what the study will produce.

Without objection, there will be inserted in the record at this point the texts of S. 441 and S. 2356.

(The bills S. 441 and S. 2356 follow :)

[S. 441, 90th Cong., first sess.]

A BILL To authorize the Secretary of Commerce to make a study to determine the advantages and disadvantages of increased use of the metric system in the United States

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That the Secretary of Commerce is hereby authorized to conduct a program of investigation, research, and survey to determine the impact of increasing worldwide use of the metric system on the United State; to appraise the desirability and practicability of increasing the use of metric weights and measures in the United States; and to evaluate the costs and benefits of alternative courses of action which may be feasible for the United States.

SEC. 2. In carrying out the program described in the first section of this Act, the Secretary, among other things, shall—

(1) investigate and appraise the advantages and disadvantages to the United States in international trade and commerce, and in military and other areas of international relations, of the increased use of an internationally standardized system of weights and measures;

(2) appraise economic and military advantages and disadvantages of the increased use of the metric system in the United States or of the increased use of such system in specific fields and the impact of such increased use upon those affected;

(3) conduct extensive comparative studies of the systems of weights and measures used in educational, engineering, manufacturing, commercial, public, and scientific areas, and the relative advantages and disadvantages, and degree of standardization of each in its respective field;

(4) investigate and appraise the possible practical difficulties which might be encountered in accomplishing the increased use of the metric system of weights and measures generally or in specific fields or areas in the United States;

(5) permit appropriate participation by representatives of United States industry, science, engineering, and labor, and their associations, in the planning and conduct of the program authorized by the first section of this Act, and in the evaluation of the information secured under such program; and

(6) consult and cooperate with other government agencies, Federal, State, and local, and, to the extent practicable, with foreign governments and international organizations.

SEC. 3. The Secretary shall submit to the Congress such interim reports as he deems desirable, and within 3 years after the date of the enactment of this act, a full and complete report of the findings made under the program authorized by this act, together with such recommendations as he considers to be appropriate and in the best interests of the United States.

SEC. 4. There are authorized to be appropriated such sums as are necessary to carry out the purposes of this act: *Provided*, That not to exceed \$500,000 shall be appropriated for the first year of the program authorized by this act.

SEC. 5. This act shall expire 30 days after the submission of the final report pursuant to section 3.

[S. 2356, 90th Cong., first sess.]

A BILL To authorize the Secretary of Commerce to make a study in order to recommend an improved system of weights and measures, and standards in connection therewith, for United States and international use

*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,* That the Secretary of Commerce is hereby authorized to conduct a program of investigation, research, and survey to determine and make recommendations with respect to—

(1) any existing or proposed system of weights and measures, and various standards to be used in connection therewith, which could be recommended for international adoption;

(2) the extent to which it would be desirable and practicable to increase the use of the metric system of weights and measures, and various standards used in connection therewith, in the United States;

(3) the extent to which the United States should retain and promote international use of the system of weights and measures, and various standards used in connection therewith, currently in use in this country; and

(4) costs involved and benefits resulting from any such recommendations.

SEC. 2. In carrying out the program authorized in the first section of this Act, the Secretary, among other things, shall—

(1) investigate and appraise the advantages and disadvantages to the United States in international trade and commerce, and in military and other areas of international relations, of the increased use of an internationally standardized system of weights and measures;

(2) appraise economic and military advantages and disadvantages of the increased use of the metric system in the United States or of the increased use of such system in specific fields and the impact of such increased use upon those affected;

(3) conduct extensive comparative studies of the systems of weights and measures used in educational, engineering, manufacturing, commercial, public, and scientific areas, and the relative advantages and disadvantages, and degree of standardization of each in its respective field;

(4) investigate the extent to which uniform and accepted standards are in use in the metric system of weights and measures in each of the fields under study and compare with the extent of such use and the utility of such metric standards with those in use in the United States;

(5) recommend specific means of meeting the practical difficulties and costs in those areas of the economy where any recommended change in the system of weights, measures, and standards would raise significant practical difficulties or entail significant costs of conversion; and

(6) delineate those areas, if any, in which it is recommended that the United States retain and promote international use of the system of weights and measures, and various standards used in connection therewith, currently in use in this country.

SEC. 3. In carrying out the program authorized in this Act, the Secretary shall also take appropriate steps to assure consultation with the segments of the United States economy which would be principally affected by any change in the system of weights, measures, and standards in use in the United States, and specifically shall—

(1) permit appropriate participation by representatives of United States industry, science, engineering, and labor, and their associations, in planning and carrying out the program, and in the evaluation of the information secured under the program; and

(2) consult and cooperate with other government agencies, Federal, State, and local, and, to the extent practicable, with foreign governments and international organizations.

SEC. 4. The Secretary shall submit to the Congress such interim reports as he deems desirable, and within three years after the date of the enactment of this Act, a full and complete report of the findings made under the program authorized by this Act, together with such recommendations as required by this Act and such other recommendations as he considers to be appropriate and in the best interests of the United States.

SEC. 5. There are authorized to be appropriated such sums as are necessary to carry out the purposes of this Act.

SEC. 6. This Act shall expire thirty days after the submission of the final report pursuant to section 4.

Senator GRIFFIN. Following the texts of the several bills, the reports thereon submitted by the various governmental agencies shall be printed in the record.

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COMPTROLLER GENERAL OF THE UNITED STATES,  
*Washington, D.C., February 10, 1967.*

B-140339.

HON. WARREN G. MAGNUSON,  
*Chairman, Committee on Commerce,  
U.S. Senate.*

DEAR MR. CHAIRMAN: Your letter of January 23, 1967, requests our comments on S. 441, a bill to authorize the Secretary of Commerce to make a study to determine the advantages and disadvantages of increased use of the metric system in the United States.

We have no particular information concerning the proposed legislation and therefore have no comment to offer.

Sincerely yours,

FRANK H. WEITZEL,  
*Assistant Comptroller General of the United States.*

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NATIONAL SCIENCE FOUNDATION,  
OFFICE OF THE DIRECTOR,  
*Washington, D.C., May 17, 1967.*

HON. WARREN G. MAGNUSON,  
*Chairman, Committee on Commerce,  
U.S. Senate,  
Washington, D.C.*

DEAR MR. CHAIRMAN: This is in further reply to your letter of January 23, 1967 requesting the comments of the National Science Foundation on S. 441, "To authorize the Secretary of Commerce to make a study to determine the advantages and disadvantages of increased use of the metric system in the United States."

Under the terms of the bill the Secretary of Commerce would be authorized to conduct a study to determine the desirability, practicability and cost of a general conversion to the use of the metric system of weights and measures in the United States. Adoption of the metric system in the United States could have very definite advantages. First, it would greatly simplify our system of weights and measures. In addition, since the majority of the countries of the world now use the metric system, cooperative efforts could more readily be conducted.

In our view it would be very desirable to have such a study undertaken. We therefore recommend enactment of the legislation.

The Bureau of the Budget has advised us that it has no objection to the submission of this report from the standpoint of the Administration's program.

Sincerely yours,

LELAND J. HAWORTH, *Director.*

---

GENERAL COUNSEL OF THE DEPARTMENT OF COMMERCE,  
*Washington, D.C., March 13, 1967.*

HON. WARREN G. MAGNUSON,  
*Chairman, Committee on Commerce,  
U.S. Senate,  
Washington, D.C.*

DEAR MR. CHAIRMAN: This is in further reply to your request for the views of this Department concerning S. 441, a bill to authorize the Secretary of Commerce to make a study to determine the advantages and disadvantages of increased use of the metric system in the United States.

The bill would authorize the Secretary of Commerce to conduct a program of investigation, research and survey to determine the impact of increasing worldwide use of the metric system on the United States. It would also allow him to appraise the desirability and practicability of increasing the use of metric weights and measures in the United States and evaluate the costs and benefits of alternative courses of action which may be feasible in this country. The bill incorporates the suggestions and recommendations offered by Dr. J.

Herbert Hollomon, who, as Assistant Secretary of Commerce for Science and Technology, testified during the 89th Congress at hearings by your Committee on July 14, 1965, regarding S. 774. This Department recommends enactment of this legislation.

The increasing use of the International System of Units (or the metric system as it is so often called) in the United States and abroad is likely to pose very serious problems for the economy of this country both in its internal development and its relationship to the economies of other nations. Indeed we have felt for some time a pressing need for a better understanding of the extent to which disparities in systems of measurement between the United States and metric-using countries may constitute a barrier to our international trade.

There has been an increasing trend over the last few years in various countries not only to make the metric system their legal system of measurement, but to prohibit the use of any other system. An example of this trend may be seen by the May 24, 1965, announcement of the Government of the United Kingdom that "... the Government considers it desirable that British industries on a broadening front should adopt metric units sector by sector until that system can become in time the primary system of weights and measures for the country as a whole." This was a unilateral decision of the British Government independent of any action taken by other nations of the Commonwealth or the United States.

Another development of significance in this area is the February 2, 1965, Report of the Panel on Engineering and Commodity Standards of the Commerce Technical Advisory Board to the Assistant Secretary of Commerce for Science and Technology, U.S. Department of Commerce. One of the recommendations made by this Committee, often called the LaQue Committee, was "Inclusion of the International System of Units equivalent of values in customary USA units wherever appropriate in standards, drawing, specifications and other documents."

Still a further development has been the fact that during the past few years many manufacturers have shown concern about the trend toward use of the metric system and have sought advice and guidance from the Department on appropriate steps to be taken to meet this challenge. The inquiries have come from large and small manufacturing organizations and from several trade associations as well. Our inability to give definitive answers to these inquiries for lack of sound factual information on which to base an answer may be taken by such organizations and others as an indication that the Department is not fulfilling its responsibilities of the technical leadership in the measurement problems of American industry.

Thus we believe that there has been a general lack of factual information needed to guide decisions in both Government and private sectors concerning increased use of the metric system in this country. Our limited understanding of the interaction between measurement systems and the increasingly important international product standards, which establish preferred sizes, shapes, and other physical characteristics of the articles of international commerce, is considered as an illustration of the many complex problems that should be investigated.

The Department of Commerce is fully convinced of the need for a broad and comprehensive study of this subject to be initiated as soon as possible. We currently are considering various means to assist and encourage industry toward voluntary self-examination with respect to some of these matters. Such activities by the Department might help to increase the awareness of American business and industry to the problems posed by the increasing worldwide use of the metric system, and might help to identify voluntary actions that can be taken in various industrial areas to adjust to this trend.

We strongly believe, however, that our national interest requires a much broader study of this very complicated problem to produce factual information for the establishment of a national policy with respect to utilization of the metric system. This will require the full cooperation of industry, commerce, labor, science, consumers, and numerous other sectors of our society. It will require also the investment of significant Government resources in terms of manpower and money. With this information we can better attend to the needs of American businesses in carrying out the assigned mission of this Department. We believe that the necessary national support for such an extensive and important study can best be assured through Congressional endorsement and authorization.

Finally, we note that while metric study bills introduced in the Congress in earlier years would have directed such study to appraise the desirability, prac-

ticability and cost of a general conversion to the use of a metric system of weights and measures in the United States. S. 441 focuses the direction of the proposed study on the aspects of possible increased use of the metric system by American industry in relation to international trade and commerce. This approach in our opinion would be very helpful. For the reasons expressed above, we support S. 441 and urge its enactment.

We have been advised by the Bureau of the Budget that there would be no objection to the submission of this report from the standpoint of the Administration's program.

Sincerely,

ROBERT E. GILES,  
*General Counsel.*

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NATIONAL AERONAUTICS AND SPACE ADMINISTRATION,  
*Washington, D.C., January 10, 1968.*

HON. WARREN G. MAGNUSON,  
*Chairman, Committee on Commerce,  
U.S. Senate,  
Washington, D.C.*

DEAR MR. CHAIRMAN: This replies further to your request for the comments of the National Aeronautics and Space Administration on the bill S. 2356, "To authorize the Secretary of Commerce to make a study in order to recommend an improved system of weights and measures, and standards in connection therewith, for United States and international use."

The bill would authorize the Secretary of Commerce, in consultation with those segments of the U.S. economy principally affected, to conduct a comprehensive study to determine the advantages and disadvantages of the increased use of the metric system of measurement in the United States.

NASA favors the conduct of such a study with the hope that it will lead to the institution of the metric system itself. The metric system is now the basic language of scientific measurement, but is used along with the English system in engineering and development. Standardization to the metric system would save the time and effort involved in translating measurements and in educating students in both systems, and would give recognition to the natural relationships between length, area and volume (meter, meter<sup>2</sup>, meter<sup>3</sup>), which are less apparent with the English units. The metric system itself is simpler to use, and for this reason fractions of the English-American units are being replaced by decimalized units. The fast-growing use of computers has made fractions even more obsolete.

The National Aeronautics and Space Administration can see definite time and cost advantages which would accrue to the space program through the adoption of the metric system in all phases of the Nation's economy. Accordingly, NASA favors the enactment of S. 2356.

The Bureau of the Budget has advised that, from the standpoint of the Administration's program, there is no objection to the submission of this report to the Congress.

Sincerely yours,

ROBERT F. ALLNUTT,  
*Assistant Administrator for Legislative Affairs.*

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CIVIL AERONAUTICS BOARD,  
*Washington, D.C., October 4, 1967.*

HON. WARREN G. MAGNUSON,  
*Chairman, Committee on Commerce,  
U.S. Senate,  
Washington, D.C.*

DEAR MR. CHAIRMAN: This is in reply to your letter of September 20, 1967, requesting the views of the Board with respect to S. 2356, a bill "To authorize the Secretary of Commerce to make a study in order to recommend an improved system of weights and measures, and standards in connection therewith, for United States and international use."

The Secretary of Commerce would be authorized in consultation with segments of the United States economy which would be principally affected, to conduct a comprehensive study to determine the advantages and disadvantages of the increased use of the metric system of measurement in the United States. According to the sponsor of the bill, the objective of such a study would be to provide

a basis for determining whether the United States should change from its present system of weights and measures to the metric system.

The Board understands that the Department of Commerce has submitted suggestions and recommendations to the Congress with respect to legislation having similar objectives. The Board defers, therefore, to the views of the Secretary of Commerce as to whether the bill is the most appropriate method for accomplishing its objective.

The Board has been advised by the Bureau of the Budget that there is no objection to submission of this report from the standpoint of the Administration's program.

Sincerely yours,

CHARLES S. MURPHY, *Chairman.*

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NATIONAL SCIENCE FOUNDATION,  
OFFICE OF THE DIRECTOR,  
*Washington, D.C., December 18, 1967.*

HON. WARREN G. MAGNUSON,  
*Chairman, Committee on Commerce,  
U.S. Senate,  
Washington, D.C.*

DEAR MR. CHAIRMAN: This is in further reply to your request of August 31, 1967 for comments on S. 2356 "to authorize the Secretary of Commerce to make a study in order to recommend an improved system of weights and measures, and standards in connection therewith, for United States and international use."

The National Science Foundation endorses S. 2356 and recommends that it be enacted. The Foundation has responded favorably in the past to proposals for such studies, with a view to the ultimate adoption in this country of the metric system. We perceive no objections to S. 2356.

The Bureau of the Budget has advised us that it has no objections to the submission of this report from the standpoint of the Administration's program.

Sincerely yours,

LELAND J. HAWORTH,  
*Director.*

---

DEPARTMENT OF THE AIR FORCE,  
OFFICE OF THE SECRETARY,  
*Washington, D.C., January 8, 1968.*

HON. WARREN G. MAGNUSON,  
*Chairman, Committee on Commerce,  
U.S. Senate.*

DEAR MR. CHAIRMAN: Reference is made to your request for the views of the Department of Defense with respect to S. 2356, 90th Congress, a bill "To authorize the Secretary of Commerce to make a study in order to recommend an improved system of weights and measures, and standards in connection therewith, for United States and international use."

The purpose of S. 2356 is as stated in the title.

The Department of Defense has previously commented favorably on S. 441, which proposes a study "To determine the impact of increasing worldwide use of the metric system on the United States; to appraise the desirability and practicability of increasing the use of metric weights and measures in the United States; and to evaluate the costs and benefits of alternative courses of action which may be feasible to the United States." The Department of Defense would support and participate in the study described in S. 441.

S. 2356 differs from S. 441 primarily in that it would include in the study "any existing or proposed system of weights and measures," and "the extent to which the United States should retain and promote international use of the system of weights and measures, and various standards used in connection therewith, currently in use in this country." S. 441 is a more direct attack on the basic problem—that of proposed full use of the metric system in the United States. Further, the study under S. 441 of "alternative courses of action" by a competent group would include consideration of the additional ideas embodied in S. 2356. The Department of Defense is firmly in favor of a study, and insofar as a choice is available between S. 441 and S. 2356, would choose S. 441. The Department of Defense, however, would participate in the study of S. 2356, if it is authorized.

If S. 2356 is favorably considered, it is recommended that Section 4 be changed to provide for the study to be completed within two years rather than the three years now as contemplated by the proposed legislation.

This report has been coordinated within the Department of Defense in accordance with procedures prescribed by the Secretary of Defense.

The Bureau of the Budget advises that, from the standpoint of the Administration's program, there is no objection to the presentation of this report for the consideration of the Committee.

Sincerely,

ALEXANDER H. FLAX,  
*Assistant Secretary, Research and Development.*

---

OFFICE OF THE SECRETARY OF TRANSPORTATION,  
*Washington, D.C., November 3, 1967.*

HON. WARREN G. MAGNUSON,  
*Chairman, Committee on Commerce,*  
*U.S. Senate,*  
*Washington, D.C.*

DEAR MR. CHAIRMAN: This letter is in reply to your request for the views of this Department with respect to S. 2356, a bill to authorize the Secretary of Commerce to make a study in order to recommend an improved system of weights and measures, and standards in connection therewith, for United States and international use.

The bill authorizes a study which would be carried out by the Secretary of Commerce. The Department of Transportation interposes no objection to the enactment of this legislation.

The Bureau of the Budget advises that from the standpoint of the Administration's program there is no objection to the submission of this report for the consideration of the Committee.

Sincerely,

JOHN L. SWEENEY,  
*Assistant Secretary for Public Affairs.*

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COMPTROLLER GENERAL OF THE UNITED STATES,  
*Washington, D.C., September 11, 1967.*

B-140339.

HON. WARREN G. MAGNUSON,  
*Chairman, Committee on Commerce,*  
*U.S. Senate.*

DEAR MR. CHAIRMAN: Your letter of August 31, 1967, requests our comments on S. 2356, a bill to authorize the Secretary of Commerce to make a study in order to recommend an improved system of weights and measures, and standards in connection therewith, for United States and international use.

We have no particular information concerning the proposed legislation and therefore have no comment to offer.

Sincerely yours,

R. F. KELLER,  
*Acting Comptroller General of the United States.*

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OFFICE OF THE DEPUTY ATTORNEY GENERAL,  
*Washington, D.C., January 31, 1968.*

HON. WARREN G. MAGNUSON,  
*Chairman, Committee on Commerce,*  
*U.S. Senate, Washington, D.C.*

DEAR SENATOR: This is in response to your request for the views of the Department of Justice on S. 2356, a bill to authorize the Secretary of Commerce to make a study in order to recommend an improved system of weights and measures for the United States and international use.

In general, the bill would authorize a study of and recommendations relating to the problems caused by the fact that some countries use the metric system and others, such as the United States, use other systems.

Whether this legislation should be enacted involves policy considerations as to which the Department of Justice makes no recommendation.

Sincerely,

WARREN CHRISTOPHER,  
*Deputy Attorney General.*

DEPARTMENT OF STATE,  
*Washington, D.C., February 2, 1968.*

HON. WARREN G. MAGNUSON,  
*Chairman, Committee on Commerce,  
U. S. Senate, Washington, D.C.*

DEAR MR. CHAIRMAN: I refer to your letter of August 21, 1967 inviting the Department to comment on S. 2356, a bill "To authorize the Secretary of Commerce to make a study in order to recommend an improved system of weights and measures, and standards in connection therewith, for United States and international use."

The Department of State has examined the proposed legislation from the standpoint of foreign economic policy and has no objection to its enactment.

The Bureau of the Budget advises that from the standpoint of the Administration's program there is no objection to the submission of this report.

Sincerely,

WILLIAM B. MACOMBER, JR.,  
*Assistant Secretary for Congressional Relations.*

Senator GRIFFIN. Now we are very pleased to have a distinguished colleague who has been a leader in bringing this subject to the attention of the Congress, whose name I have already mentioned and from whom we will be delighted to hear, Senator Claiborne Pell of Rhode Island.

Senator, would you give us the benefit of your testimony.

**STATEMENT OF HON. CLAIBORNE PELL, U.S. SENATOR FROM THE  
STATE OF RHODE ISLAND**

Senator PELL. Thank you very much indeed, Senator Griffin. I am most grateful for this opportunity to testify on behalf of this idea and am so very, very glad indeed that you have taken the interest and leadership in the Commerce Committee that you have in this field. Because in the final analysis, this bill, this concept of whether we should have a study and how it should be conducted, its success will be determined within your committee and we are very lucky indeed to have a supporter there.

As you know, in the previous Congress this idea and the bill I have introduced was passed by the Senate and failed in the House, with the Rules Committee failing to take it up. My recollection is that the Congress before that also pressed for this idea but it did not even get out of the committee at that time. The idea is obviously one that must be undertaken at some point. It is a question not of "if" but of when, because a decision as to whether or not we should go metric must be predetermined by such a study. We may well decide not to go, or we may well decide to go. The study must be made first. And I think the witnesses from industry and from the business community as a whole should be aware of the fact that this bill is not a metric conversion bill, but as you have so correctly stated, Mr. Chairman, in your opening statement, it is merely a bill to determine what the results would be if we did convert, and also if we decided to convert, what the best way would be to do it.

The able and expert people who are scheduled to appear before you later on this morning will I believe provide far more professional and competent and excellent arguments in connection with this bill than could a generalist like myself.

The real question to ascertain is are we ahead or behind the times when it comes to our system of measurement. The fact is today that most of the world now has changed to the metric unit of measurement. Great Britain, whose system we have copied for so long, has actually made the decision to change. And it will have finally gone on that system by 1975. Canada is waiting for us to see what we do.

Only the United States of the great technologically advanced nations of the world remains unconvinced and really unknowing, since such a study has not been made. Important segments of our scientific and industrial community in this country have already begun to switch. I mean of course the practitioners in pharmacology, photography, and oceanology.

In addition, the Geological Survey division of the Department of the Interior will now employ metric units in gathering and disseminating water quality data. Then, too, there is interest among many other scientific and industrial people. Mr. Ruzic of the magazine *Industrial Research* tells me that he polled nearly 3,800 scientists, engineers, and technical managers and found that 93 percent of them, more than nine-tenths, favored total or partial conversion to metric units in the United States. Another surprising source of support for a change has been the Ford Motor Co. in your own home State, Mr. Chairman, which this year published two exceptionally fine brochures on the subject and which I would like to have incorporated by reference into the hearings at this point, if I might.<sup>1</sup>

Senator GRIFFIN. Without objection, they will be so included.

Senator PELL. I am happy to note there has been such a good response to the Senate Commerce Committee's call for testimony at the hearing on the bills that we have introduced. I believe it is imperative that Congress act on this legislation for two reasons. First, we must know whether a switch to metric really would bring less or more efficiency to our society, and whether we will be able to compete in the export market less or more successfully, and whether it will increase or decrease our sales abroad. If, as I personally believe, such a study would show the conversion to the metric system is in our national interest, then we would also need a blueprint as to how one should go about making the change. Other nations that have achieved the conversion have allowed many years for the process in order to keep the costs and discombobulation to a minimum. Obviously if one made the decision to convert and did this in a year it would be a vast expense, but if you took your time about it and did it as they did in Britain in 10 or 20 years, the expense would be radically reduced. There are certain things that need never be converted.

For instance, there is no reason in my mind why if we did convert, why land measurements should be touched immediately. Past land measurements could remain as they were, titles would remain, and we would merely change in the future.

Although we are still seeking a lingua franca to make communications easier all over the world, we have already found one in weights

<sup>1</sup> The brochures referred to are in the committee files.

and measures. In fact its originators slugged it with the motto: "For all people for all time." Yet we ourselves, the commercial and cultural leader in the world, are reluctant to accept this system.

Those who estimate that we may be missing huge export sales because our products are not cut to metric measure may be right, but only such a study can give any truly accurate answer. If there is any possibility they are, then certainly this Congress should promptly move the legislation before us, for to delay will cost us more with each passing day.

The common purpose of Senator Griffin's and my bills is to assay the validity of all the arguments, both pro and con the idea of a change. There are sectors of the economy which are concerned lest this country be rushed into a conversion that will be costly and not productive of any advantage. Both bills before this committee are designed to allay these fears by inquiring into the practicable merits of whether or not our Government should mandatorily require the United States to adopt the metric units. I hope that the bill which emerges from your deliberations will, in its final form, emphasize that it does not prejudice the question which it promises to answer. In short, I think it reasonable that the basis of careful scientific investigation for which the Commerce Department is well equipped to implement.

In addition, I think we should bear in mind that we already are on an optional metric system in that since 1866 it has been possible, legal, permissible to use metric measurements. But in order for a country to go on the metric system, it would probably have to be mandatory, because that is the experience of history.

Also in connection with these bills, we have sought, at least I know I have sought to incorporate all of the suggestions of industry where they have been offered. In fact, my recollection is that in the last time around, as a result of the hearings, the witness from the Industrial Fastener Institute asked for certain changes in the bill and we put the gist of these changes in the bill that is presently offered to this committee.

In closing, I would like to once again express my very real thanks and gratitude not only for myself but I believe for all industry as a whole to you, Senator Griffin, for taking the interest you are in this subject and your willingness to take the time out to chair this meeting today. I thank you, sir.

Senator GRIFFIN. Thank you, Senator Pell. Senator Moss, do you have any questions or comments?

Senator MOSS. Well, I have a brief comment, Mr. Chairman. Thank you.

I want to commend you, Senator Pell, for joining with the chairman of this subcommittee in introducing these bills on this subject. It has always been a little incomprehensible to me why we have not addressed ourselves to this problem. As you point out, we are asking for a study to be conducted. We don't prejudice the issues in committee. I am, however, about ready to prejudice. For it seems astonishing to me that we have not made a move toward adoption of the metric system which almost the whole world is now using. And it is underlined a little bit by our reading in the papers recently that Sweden has finally got around to driving on the right-hand side of the road. I feel much the same way about that. I don't know why Britain doesn't come around and drive on the right-hand side of the road.

The world has become more integrated, and we exchange more commodities all of the time. If we have a common means of measurement it would certainly facilitate our commerce and our communication. I don't have any questions, but I just wanted to give you a word of commendation and to assure you that as far as I am concerned, I will try to push this along.

Senator PELL. Thank you, sir. I think part of the problem is there is a misconception about it. For instance, the automobile industry had real worries in the last Congress. Yet today I am delighted to see two Senators here from Michigan, where most of the cars in the country are made, interested in this project—

Senator HART. Where all of the good cars are made.

Senator PELL. As I said earlier, it is very encouraging to note the new position that the Ford Motor Co. has evidently taken, and I hope both Senators from Michigan as well.

I think also some think that maybe everything will have to be redone and you will have new products standards. But for instance in the screws that are made, you would not necessarily change the size at all. They would just be labeled in centimeters instead of inches. Even their present inch measurements are decimalized.

In other cases we are making two lines of products, one in the metric system for sale abroad and one in inches here. This would save a certain amount of money in those two lines of products.

I think it is more based on misapprehension than on knowledge and this is why the study is so very, very important.

Senator GRIFFIN. Senator Pearson?

Senator PEARSON. Thank you, Mr. Chairman. I don't have any questions. The Senator makes a valuable contribution, as he always does.

Senator PELL. Thank you, sir.

Senator PEARSON. I am sorry I was late, but he will understand as well as anyone the problems we have these days.

Senator GRIFFIN. My senior colleague from Michigan?

Senator HART. I have apologies to my colleague for being late, too.

Senator GRIFFIN. I am delighted that all of you are here. I know that I speak for the committee, Senator Pell, when I say that we are particularly pleased to have you here this morning, and delighted at the leadership you have provided over the years on this subject.

We would be pleased, if you have the time, to have you sit with the committee, and I am sure if you had questions to ask of any of the witnesses that follow, you certainly would have that opportunity. We would be very happy to have your participation as though you were a member of the committee, in view of your leadership in this field.

Senator PELL. I would be very honored. That is very, very nice of you. Thank you.

Senator GRIFFIN. Now we would like to hear from Mr. John F. Kincaid, Assistant Secretary of Commerce for Science and Technology, who, I understand, is to be accompanied by Dr. Allen V. Astin, Director of the National Bureau of Standards of the Department of Commerce.

STATEMENT OF DR. JOHN F. KINCAID, ASSISTANT SECRETARY OF COMMERCE FOR SCIENCE AND TECHNOLOGY; ACCOMPANIED BY DR. ALLEN V. ASTIN, DIRECTOR, NATIONAL BUREAU OF STANDARDS; ROBERT ELLERT, ASSISTANT GENERAL COUNSEL, DEPARTMENT OF COMMERCE; AND CLARENCE COATES, ASSISTANT TO THE DIRECTOR, NATIONAL BUREAU OF STANDARDS

Dr. KINCAID. Thank you, Mr. Chairman.

I might say that in addition to Dr. Astin, I am also accompanied by Robert Ellert, Assistant General Counsel, Department of Commerce; and Clarence Coates, Assistant to the Director of the National Bureau of Standards.

Senator GRIFFIN. Gentlemen, we are pleased to have you.

You may proceed in any way you see fit.

Dr. KINCAID. I first want to say I am delighted to be here before this committee. I am long convinced, myself, that the United States should adopt the metric system. So I guess to that extent I am guilty of prejudging the results of the study, also.

The Department of Commerce has long recommended a study. The information that we need to make intelligent decisions in this field has not yet been developed. We feel that the studies proposed in these bills would be a very important step in the right direction and should be made. I will make a brief statement on the international aspects of the metric system, and Dr. Astin will then discuss the overall picture in greater detail.

I am sure you are aware of the fact that Dr. Astin perhaps knows as much as anybody in the United States about the metric system conversion and what is involved, even though he is the first to admit that our information is incomplete in many respects.

The consideration of these bills by the Congress is ample evidence that this Nation is aware of the growing use of the metric system of measurement both outside and within its borders; that we are aware, in a qualitative way at least, that there are problems associated with this increasing use; that we are aware of our lack of information on the shape and magnitude of these problems.

On an international basis the United States stands more and more alone in its use of the English or customary system of measurement. About 90 percent of the earth's population is committed to the use of the metric system. Within the past 10 years, France and Venezuela made the metric system mandatory within their countries. India and Japan have begun full conversion to exclusive use of the metric system.

Perhaps the most important event in this chain was the recent announcement by the United Kingdom that it intends to convert to metric use in progressive steps over the next 10 years or so. One thing that motivates them is their desire for closer relations with nations of the Common Market, all of whom use the metric system.

As Britain makes the change, it is almost inevitable that the other Commonwealth countries will follow. With that, the United States will become the last nonmetric country of any size in the world.

We think this is important. We are not making the case that the United States will crumble away and lose its standing, power, and prestige if we don't adopt the metric system. We do say it is worth doing and it is something that should be studied.

One aspect of this is a matter of international trade. We are beset by a chronic balance-of-payments deficit which would be far worse if it were not for the trade surplus we now maintain. But even here we must realize that the U.S. share of the world's total exports of manufactured goods has dropped about 25 percent in the last decade. The extent to which this is due to our nonstandard system of measurements is not known, but it could possibly have a substantial impact.

We must carefully guard our place in the world markets, even though we export only about 4 percent of our gross national product. Our economy is based on the concept of mass production and mass distribution over large market areas. For the future development of our economy, we can no longer limit ourselves to markets circumscribed by our own national boundaries. The fullest growth of our economy requires the fullest use of global markets.

Add to these considerations that the U.S. products which are most successful on the world market are those of high technological content—electronics, measuring instruments, aircraft, automated manufacturing equipment, and the like. In the future these products will be a major factor in our success as a trading nation.

By 1975 the European demand for telecommunications equipment alone is expected to be over \$40 billion. Even now, high-performance scientific and production apparatus which we export is more sophisticated, in some cases, than the same type of apparatus installed domestically. For these foreign markets, even as for our domestic markets, we can make high-technology products of higher quality and greater versatility. We can be more innovative and bring new ideas to the production line more rapidly, with our unsurpassed industrial sophistication.

But it is just these high technology products in which the measurement language is most important. It takes more measurements, and more complex measurements, and more accurate measurements to describe a television set than it does to describe a bushel of wheat. Again, we can intuitively see that there is a question of what isolation in our measurement language would do to our trading capacity in this area. But again, we have no good information on the prospects and problems involved.

If measurement is the language of trade, the grammar of trade is embodied in the various voluntarily national and international product standards. These standards define configuration, quality, and performance levels of manufactured goods and raw materials. Measurement is the foundation of these standards. Pipes are so many inches or centimeters in diameter, for example. Right now our Department is advocating increased national effort in international standards-making because the development of standards which do not take into account established U.S. manufacturing procedures can bar U.S. goods from international trade.

I want to point out that the question of product standards is something that we want to promote vigorously on an international basis, regardless of what is done about use of the metric system. These would be companion efforts. For example, as Dr. Astin will point out, on the question of screw fasteners, the possibility exists that the present American ABC standard may well be adopted internationally.

As you can see, I am asking many questions, and offering not many answers. My inability to give you good solid facts and figures on the problems and opportunities which go along with metric usage reflects the very lack of such hard fact. We cannot quantify the benefits to be gained from increasing our own usage of the metric system. We cannot say what the cost of any large-scale conversion will be, or who will have to pay the bill. To remedy this lack of knowledge, the U.S. Department of Commerce strongly supports the initiation of a comprehensive study as proposed in the bills which you are now considering.

While we believe that either S. 441 or S. 2356 would provide adequate authority to conduct the necessary study, we have a distinct preference for the language of S. 441. This bill would focus the study on determining the broad impact of increasing worldwide use of the metric system on the United States. We believe that this is the fundamental question that must be answered to provide a basis for meaningful recommendations concerning the alternative courses of action available to industry and government in the United States. These alternatives include a broad spectrum of possible actions ranging from indefinite continued use of customary U.S. units, through selected conversion in potentially profitable industrial areas, to accelerated national conversion to metric units.

S. 2356, in contrast, would authorize the Secretary of Commerce to make a study in order to recommend an improved measurement system for both the United States and international use. We believe that if this language contemplates the encouragement of the use of the inch-pound system in the international community, it would give an unfortunate direction to the proposed study.

My own feeling is that the metric system is so firmly entrenched that it is certainly going to be the international language of measurement.

On the other hand, we are in full agreement with the suggestion, also contained in S. 2356, that every consideration be given to retaining and promoting international acceptance of the product and engineering standards currently used in this country. Many such standards might be retained irrespective of the measurement units in which they are expressed. Consideration of the extent to which increased use of the metric system would impair the usefulness of these U.S. standards or inhibit their international acceptance would also be a necessary part of the comprehensive study contemplated by S. 441.

In summary, we feel that there is urgent need for the United States to make a study to acquire the information needed to make an intelligent decision as to whether or not this country should increase its use of the metric system. To accomplish this, we urge prompt enactment of S. 441. Further, as I have indicated, we would support enactment of S. 2356 if it is amended in certain respects. We would be happy to work with the committee staff in developing these amendments.

As I understand it, you would like to have a question period later, and you would like to hear now from Dr. Astin.

So, I will present Dr. Astin now.

Senator GRIFFIN. All right. If that is the way you would like to proceed, that will be fine.

## STATEMENT OF DR. ALLEN B. ASTIN

Dr. ASTIN. Mr. Chairman and members of the committee, I am very happy to have the opportunity to discuss with this committee the need for a comprehensive study of the impact of increasing worldwide use of the metric system of weights and measures on the United States. Dr. Kincaid has outlined the problems we see from the standpoint of international trade. I would like to cover, for the most part, some of the problems we face domestically as a result of the ever increasing use of the metric system.

Like Dr. Kincaid, I would like to emphasize that in all the areas I will cover, we do not have the detailed information needed to give numerical reality to our statement of the problem or to the ideal solutions. The very reason we support the currently proposed study is to obtain such detailed information to provide a basis for decision and action.

I would also like to emphasize that we in the Department of Commerce have no preconceived ideas concerning the findings of the proposed study and the recommendations that would result therefrom. Quite frankly, we are frustrated by our present lack of factual information on this subject; by our inability to provide useful information and guidance in response to the increasing number of inquiries received from business and industry; and by our inability to recommend an appropriate course of Government action with regard to a significant national problem.

While I shall discuss certain advantages of the metric system, I do so primarily to explain some of the reasons for its wide acceptance throughout the world, and the reasons that many U.S. businessmen, educators, and government leaders are increasingly interested in the possible advantages of its wider use in this country. At the same time, I hope it is clearly understood that even our limited knowledge of the situation enables us to see numerous real and serious problems for U.S. industry in any extensive change in our measurement usage.

I shall attempt to identify some of these problems, but would stress the point that it is the lack of detailed factual information concerning their true nature and extent that makes it impossible for us to evaluate, at present, the advantages versus the disadvantages of increased metric usage. Only through a comprehensive national study with the full cooperation, assistance, and advice of industry and other sectors of our society can we hope to obtain a true picture of the situation. Only then will we be able to recommend appropriate courses of action for industry, and for government, should that be indicated.

Let me first, for the record, describe briefly this metric system of measurement, though I am sure you gentlemen are generally acquainted with it by now. The metric system is a decimal system of weights and measures based on the meter as the unit of length and the gram as the unit of mass. From its inception, the metric system was scientifically designed to suit all people for all time. The French scientists who devised it based it on a natural constant which would serve as an eternally available reference point. Their meter was defined as a ten-millionth of the distance from the earth's equator to the pole. To relate the unit of mass to the unit of length, they defined the gram as the mass of one cubic centimeter of water at the temperature at which water is most dense. Unfortunately, this neat relationship has been

lost over the intervening years, because the standard lengths and weights that had to be used in measurement did not have exactly the values intended.

In 1875, with the signing of the Treaty of the Meter, the United States and most of the other technically advanced countries gave international recognition to the metric system. Shortly after that time, our national measurement system was based on the meter and the kilogram, and remains so to this day. You will not find a standard pound or yard in the standards vault at the National Bureau of Standards. They are known only as fractions of the metric units.

Originally, the metric system embodied only units for measuring length, mass, area, and volume. To meet the needs of modern science and technology for a complete system of measurement units for a wide variety of measurements—time, temperature, electric voltage and current, light intensity, and so on—the metric system has been expanded into the international system—SI for *Système Internationale d'Unités*. It is the international system of which we are really speaking when we talk about increasing use of the metric system in the world.

#### ADVANTAGE OF THE METRIC SYSTEM

There are many real advantages to using the metric system which have resulted in its almost exclusive use in scientific investigations throughout the world. It does not, however, offer any advantage of increased accuracy of measurement. For example, scientists at our NBS laboratories can measure the length of a gage block in either inches or centimeters, according to the customer's preference. But they cannot certify its length to a greater accuracy in one system than in the other.

One of the main advantages of the metric system to the scientist is the logical and simple relationships among all of the units of the system. This permits scientific and engineering calculations to be made much more readily and with less chance of error than in a system where conversion factors must be employed. It is not merely a matter of decimalization, since any system can be decimalized. It is based on a recognition of certain physical laws and the compatible relationship of units for those laws. For example, in the metric system, the unit for power is the watt, no matter whether the power is mechanical, thermal, electric, or nuclear. In the U.S. customary usage, there are several different units for power, horsepower among them.

These advantages, as I say, are primarily to scientists and engineers. There are other advantages to the metric system which apply to all. The metric system is decimal, that is multiples and submultiples of a unit are related to the unit by powers of 10. For this reason, calculations in the metric system can be made more rapidly and the chances for error are reduced. For this reason also, the system is easier to learn.

Some educators have estimated a saving of about 25 percent in learning time for arithmetic because practice in the multiplication and addition of fractions may no longer be required. This simplicity and saving of time in calculations would have important advantages in our daily lives. The supermarket, for example, is now dominated by packing in customary units which can, and often does, lead to difficulties in value comparisons by the consumer.

In recent years there has been a great growth in interest in the United States "converting" to the metric system, and I say "converting" in quotes. Unfortunately, the problem cannot be stated in such simple terms either in present fact or in prospect. In the first place, "conversion" is a most ambiguous term unless the degree of conversion is clearly indicated. Secondly, it tends to ignore the fact that use of the metric system has been legally permissible in the United States since 1866 and many metric units are widely used in this country at the present time. As I have noted earlier, we are already on the metric system in the sense that all of our customary units are now derived from metric standards.

To understand clearly the nature of the problem confronting us, it is well to look briefly at the units of measurement used in this country. The United States is operating on a mixed system of units, partly customary units and partly metric. All electrical quantities, and the industries which derive from them, are on metric units, both legally and actually. The unit of time, the second, is a basic unit in the modern metric system. Thus, a significant portion of our measurement system is already metric. Only the units of length, mass, and temperature, such as the inch, pound, and degree Fahrenheit and all those which derive from them, are not a part of the metric system.

Nearly all engineering calculations in the United States are carried out in customary U.S. units except in electrical engineering where the engineer uses the electrical units of the metric system in all of his specialized calculations. Engineering textbooks in the United States are written almost entirely in customary units, except in the field of electrical and electronics engineering. Scientific textbooks, on the other hand, are written entirely or almost entirely in terms of the metric system thus the scientist is trained to think in terms of the metric system and the engineer, except for the electrical engineering, in terms of the customary system.

Because of the greater convenience of the metric system, its use has been voluntarily adopted in some fields in the United States. The pharmaceutical industry, the medical profession, and much of the optical industry are examples.

This mixed usage of units in our country undoubtedly results in needless confusion and inefficiency in many of our technical and industrial operations. However the real impetus for considering a change in our existing usage of measurement units arises, not so much from these internal problems, as from concern with the extent of impact that growing worldwide use of the metric system may have upon us.

#### PROBLEMS OF CONVERSION

Irrespective of the reasons for change, it is important to understand that any extensive change in our present measurement usage will encounter the vast momentum of existing investment and commitment based upon our present customary system. There are many very serious problems involved and our understanding of them is quite limited. Some of these problems were outlined in the statement presented to your committee by the then Assistant Secretary of Commerce for

Science and Technology, J. Herbert Hollomon in hearings on S. 774 conducted July 14, 1965. The problems have not changed, except perhaps to become more acute. Consequently, the description of problems that follows is taken largely from our earlier statement. We have found it convenient to divide these problems into two broad classes that we call software problems and hardware problems.

Software problems are essentially language problems whose solutions involve paperwork and training of people, such as retabulation of data and learning to think and work in terms of a different measurement system.

Hardware problems are those whose solutions require changes in existing physical entities, such as machines, instruments, devices, stock sizes, standard modules and the like. The two classes of problems are fundamentally different in nature, and a different strategy for solution must be sought for each class.

A measuring system may be likened to a language by which we express our quantitative concepts in commerce, engineering, and science. But from usage a measuring system becomes much more than merely a language. It tends to become rigidly embodied in the instruments, mass production machines, in stock sizes, and in devices and materials, and so becomes a part of our technology. The measurement system as expressed in our instruments and the things we make tends to dictate sizes because of an almost universal preference for nicely rounded numbers to express the size of an object. Nicely rounded numbers in metric units, however, are not also nicely rounded numbers in inches, and vice versa. This fact emphasizes what may be the most critical aspect of the impact of the growing use of the metric system throughout the world on American industry and commerce. In the United States the sizes of hardware parts which must fit one another are closely linked to our inch-based modules.

#### SOFTWARE PROBLEMS

There are a number of problems arising because of increased international and domestic use of the metric system which may involve only thinking and paperwork to resolve. Such problems arise in connection with shipment of bulk goods, where U.S. customary gallons or pounds can be converted readily to liters or kilograms by easy calculation, although some annoyance may be involved due to difference in unit usage and the usual problem of communicating in two languages will exist.

The increased usage of the metric system in domestic fields will require greater and more widespread familiarity with both the customary and the metric system units of measurement. Most scientific data are already expressed in the metric system or related units but in many engineering fields, the data are expressed in customary units. To bridge these two systems where they interact, conversions between the metric units and customary units are necessary. The problems involved in this aspect of the growing use of the metric system have not yet been adequately evaluated. Nonetheless, it appears evident that software problems are more readily solvable because they involve less serious economic impact than the hardware problems and because their treatment is primarily a domestic matter. However, they are not simple problems.

## HARDWARE PROBLEMS

The most serious problems exist in hardware. These involve standard sizes of parts and stock, machine tools of certain types, and measuring devices, among others. While there is sufficient information already available to recognize the seriousness of these problems, there is not enough to assess their seriousness nor to plan a strategy for coping with them.

## STANDARD SIZES

The great mass production capabilities of American industry have been possible because of industry agreement on certain sizes and shapes which many years ago were set on the basis of round number values in terms of inches. Metric based countries, emulating American industrial procedures, have in most cases adopted standard sizes and ratings based on round number values in metric units. Thus, parts manufactured in metric based countries are usually not compatible with the corresponding parts manufactured by industries using the customary U.S. units. In some cases, metric countries have adopted U.S. standard sizes where U.S. technology has dominated, as in automobile tires and the oil field industry. Particularly significant in this regard are screw fasteners, where the number of threads per inch is kept to an integral number in the American-British-Canadian (ABC) system, whereas the pitch in metric based systems is in terms of decimal fractions or multiples of millimeters. In the entire system of American screw threads, there is not a single one which is interchangeable with any metric thread. However, since the ABC screw thread standards constitute by far the most sophisticated system that has ever been developed, their use for high precision fasteners such as are employed in the aircraft industry is accepted throughout the world and the specifications are now being incorporated in ISO (International Standards Organization) standards.

## MACHINE TOOLS

The overwhelming majority of machine tools in use in the United States, particularly such machines as mills, shapers, lathes, jig borers, and so on, are designed to operate using the customary U.S. length units. Thus, if a part is to be manufactured with one of these machines, dimensions of that part would have to be given in inches, because it is only in terms of inches that the setting devices on the machine can position the cutting tool or the workpiece. Very few machine shops in the United States have machines that can cut metric threads, although practically all of them have machines that can cut ABC threads. Practically all taps and dies in the United States are on the ABC system and are not adaptable for cutting metric threads.

Some of these machines could be converted to working in metric units at costs considerably less than the cost of the machines. For example, a recent invention permits a simple conversion of an inch based lead screw for a lathe or related device to metric measures.

At the conclusion of my statement, Mr. Chairman, I would like to demonstrate this machine to you. However, the cost of conversion for some machine tools probably could approach the cost of the machine itself. In some cases, the machine might have to be discarded and new ones substituted in order to work in metric dimensions.

There were about 3 million machine tools in operation in 1963. They cost some \$30 billion when installed. These figures give an idea of the magnitude of the problem.

#### MEASURING INSTRUMENTS

Practically all measuring devices involving mass, length, and temperature—ranging from grocery scales and fever thermometers to gage blocks and screw measuring machines—in the United States are designed to work only in terms of customary units. The conversion of these measuring devices, some of which are extremely expensive, from one system of measurement to another may be exceedingly costly. In some cases, this conversion may be accomplished by simply replacing recording paper charts or indicating scales, as in the case of thermometers or of machines measuring surface finish and roundness. In other cases, the entire device or machine would require replacement to accommodate the metric system. Many of these devices are personal property of the individual workmen, tradesmen, and householders, whose interests must be considered.

#### POSSIBLE SOLUTIONS OF THE PROBLEM

From even this brief review of some of the major difficulties associated with changing our measurement system it should be apparent that we are confronted with far reaching and complex problems. Only through much additional study of these problems can we hope to recommend appropriate solutions. It is important to understand that our choice is not simply between total mandatory conversion and total inaction. Numerous other alternatives are open for consideration including:

- (a) Voluntary extension of metric usage, industry by industry—possibly with a system of financial incentives to those who convert.
- (b) Regulated partial conversion, segment by segment, in identified areas over an extended period of time.
- (c) Solutions other than adoption of the metric system to mitigate crucial problems.

The proposed study should explore these and other options in depth. It should ascertain the extent to which our general welfare would be improved by encouraging or discouraging more widespread use of the metric system in this country, and the effects of such action on our economic and technological development. It also should produce recommendations for specific courses of action from both a short- and long-term point of view.

While either of the bills before your committee would provide authority for a suitable study, I believe that certain of the requirements set forth in S. 2356, as presently stated, are unnecessary, and may be confusing to many people in this country and abroad. I refer specifically to the requirement for study of the extent to which the United States should promote international use of U.S. customary measurement units and related standards.

Certainly no additional study is needed to determine that it would be advantageous to retain and promote international use of our customary product sizes and shapes to the maximum extent possible.

Similarly, no additional study is required to predict the futility of encouraging others to adopt our admittedly cumbersome inch-pound measurement units. Fortunately, however, the one objective is not necessarily dependent on the other. It may be possible to retain many customary U.S. products sizes, even though we might find it advantageous to describe these sizes in metric language to promote their acceptance in foreign markets, or in some cases, just to facilitate domestic production of the product.

There is no question that this matter of obtaining international acceptance of U.S. product and engineering standards is vitally important to our economic welfare, and I see no need to study further the desirability of doing this as required by S. 2356. The question of how best to accomplish this objective is another matter, and properly is the subject of separate legislation pending before the Committee on Commerce as S. 997. That bill would provide the ways and means to strengthen U.S. participation in voluntary international standardization activities, and if enacted and supported, would assure adequate representation of U.S. interests.

In summary, we believe that the study proposed in S. 441, or S. 2356, if appropriately amended, is an essential step in obtaining the facts needed by Government and industry to make decisions and plan intelligent courses of action concerning measurement system usage in the United States. I think it is important to realize that this information is needed, whether we use it to take immediate corrective action or simply to respond intelligently to events as they develop. In our opinion, this study is long overdue. The approval of this legislation commits us to no particular course of action in response to the overall problem. However, the results of the study would enable us to be far more effective in dealing with a complex and insistent problem, which gathers force with the passing of time. We urge strongly that you give favorable consideration to enactment of S. 441, or S. 2356, if appropriately amended.

I would now like to demonstrate this device, which was invented by a former member of the staff of the National Bureau of Standards, Mr. Jacob Rabinow. It provides a simple, straightforward medium of converting feed screws on machine tools such as lathes, milling machines, and so on, from inch measurements to metric measurements.

Basically, the problem in these types of devices is to relate rotational motion in round numbers to linear motion. This device in this present setting advances the object along the screw 5 millimeters for each revolution of the handwheel. By this simple adjustment, I have now converted it to an inch device, and one revolution of the wheel advances the bench two-tenths of an inch exactly.

It is a simple internal planetary gear, involving a gear ratio of 125 to 127. With this device it will be possible to solve the problem on many of the machine tools in this country.

Senator GRIFFIN. I don't think I understand it, but it is very interesting. Maybe some of my colleagues do.

Dr. Astin and Dr. Kincaid, we appreciate your testimony.

Senator Moss, do you have any questions?

Senator Moss. I, too, appreciate the testimony of Dr. Kincaid and Dr. Astin. Dr. Astin is from my hometown, and he has done an outstanding job as Director of the Bureau of Standards. I am glad to have you here today.

Isn't it true that already measurements on many things are published in magazines, even, in two measurements—the customary and the metric?

I think I see this on engines, like the cylinder volume, and so on.

Dr. ASTIN. Yes. This is true. There is increasing use of both the inch-based and the metric-based measurement units in describing properties. For example, the American Society for Testing and Materials, one of the leading private standardizing organizations in this country, now publishes most of its standards both in customary units and metric units.

Senator Moss. I often wonder if the problem might be solved if we simply withheld from our children all of these customary measurements and taught them metric measurements in school. Pretty soon they would crowd the rest of us over into the metric system. That is facetious, of course, but I do wonder about our reluctance to change, because I have had my own children come to me and say, "What is the matter with us? Why don't we use the metric system in this country?" I think it is because they are required to make these conversions at times in their schoolwork, and they find the problems of making conversions which do not fall into any ready pattern, like the decimal system that applies in metric measurements, difficult. When you go from one to the other, the difference is normally a very odd amount, isn't it? That is, you try to convert a yard into a meter, and they are about 3 inches different, or something like that?

Dr. ASTIN. Yes, the meter is three and a fraction inches longer than the yard.

Senator Moss. It doesn't even come out to an even 3 inches, you see, it is so perverse in that respect.

As I take it, Dr. Astin, you would support the study because it would give us a blueprint that we could begin to operate against even though we didn't begin to convert in any sizable area. Is that it, basically?

Dr. ASTIN. Yes, sir.

Senator Moss. It seems to me that that makes so much sense there ought not to be any opposition to the study. Certainly, we ought to have the study, we ought to know what the problem is and have it delineated. We should identify the problems now, and we can make the decision later on whether we really want to plunge into large-scale conversion.

Thank you very much for your testimony.

Senator GRIFFIN. Senator Hart?

Senator HART. You gentlemen were involved in the earlier efforts to obtain approval for a study. This committee has reported such studies favorably, and the Senate has passed them. Now the general public has a deep conviction that any time a difficult problem is presented to Congress, it can be counted upon to do a study—not to resolve it, but to do a study.

Now here did we just get contrary and decide that we would make an exception to what the public accepts as our normal rule, or was

there a good reason why the House didn't go along with us? What happened over there?

Dr. ASTIN. I don't think I am the right person to explain why the bill was not passed in the House. The study bill has been reported out of the Science and Astronautics Committee at least twice. But they have never been able to get a rule to get it debated on the floor of the House. Why this has happened, I don't know.

Senator HART. Senator Pell got one bill out of here.

Senator PELL. Well, actually the leader in the House has been Congressman Miller, and long before any of us really were in the Senate he was carrying the load on the House side for this proposal. He is chairman of the Science and Astronautics Committee. And what happened last time is exactly what Dr. Astin said; it was reported out of the committee and then Judge Smith, who was in his last session as chairman of the Rules Committee, objected to the idea of, as he put it, the "meetric" bill and was not convinced of its merit. But I think in general in the committee where the arguments were taken, it was reported out without any problem.

Senator HART. I hope we will give them another opportunity to review the desirability of at least studying the problem, so we will behave consistently with what the public always assumes about us anyway; that is, that we study these problems.

Senator GRIFFIN. Senator Pell?

Senator PELL. I have no questions. One point—my memory has been refreshed—we did have definitely two other hearings before this committee on it, one on January 7, 1964, in the 88th Congress, and one on July 14, as you know, 1965, in the 89th Congress. So there is quite a history before the Commerce Committee.

The other point I was struck with is the book you so kindly lent me on the measurements of screws. I am struck by the fact that even when measured in inches, that there are five decimal points in inches in each screw measurement that is here. Is this correct as a general rule, all screws go into five decimal points now?

Dr. ASTIN. In some of the most precise screws, yes; the characteristics are given to that extent.

Senator PELL. Why would there be any additional difficulty in using it in the metric system, the same screw, no change whatsoever, the same lathe, the same everything, but just instead of 2.65734, calling it something else?

Dr. ASTIN. There is no problem of describing the characteristics of inch-based screws in metric measures. This is being done now in the International Standards Organization.

Senator PELL. Would it be too simple a statement to say if the study showed it to be to the advantage of the United States, the national interest, and we went metric, it would mean no change in the ABC screw system would be necessary in the characteristics of the screw, just a change in the labeling? Would that be correct?

Dr. ASTIN. That is correct.

Senator PELL. In your view, does the screw industry recognize this fact?

Dr. ASTIN. Well, I believe they do. But there are many misconceptions, I think, on the part of some people when we talk about this

ambiguous term, conversion to the metric system. They think we have to change sizes. We can adopt the metric language, if we consider it advantageous, without changing a single size. There is no reason why we should change all sizes, as I see it, although the study might develop reasons in some cases. But I see no reason at present why we should change the ABC screw if we use the metric language. As far as I can determine, more of the world's hardware is held together with ABC screws than any other similarly standardized type of fastener. Because there is such a tremendous worldwide investment in these fasteners, there would have to be some compelling arguments to change these sizes.

Senator PELL. One final point.

You mentioned in the course of your testimony that you would support S. 441 or S. 2356 as amended. Did you mean both bills should be amended or just one?

Dr. ASTIN. No. In our judgment S. 441 is fine as it stands. We have submitted to the staff of the committee some suggestions for amending the other bill.

Senator PELL. Right. Thank you very much.

Senator GRIFFIN. Dr. Astin, as I understand the thrust of your statement, you make it clear on page 11 that it is important to understand that our choice is not simply between total mandatory conversion and total inaction. You are recognizing there, I take it, that we shouldn't stand still just because there are or may be serious difficulties and perhaps disadvantages associated with conversion to the metric system in some sectors and in some areas of our economy. Is that a fair statement?

Dr. ASTIN. Yes.

Senator GRIFFIN. I think many people when they look at this subject think in terms of total conversion, and assume that is all we are talking about. But your statement, I think, is encouraging in that you recognize that perhaps, if we approach this on a sector by sector basis, perhaps there are many areas where we can quickly convert, other areas where it may take a little more time, and conceivably some areas where maybe we wouldn't want to convert. Is that possible?

Dr. ASTIN. That is exactly our intention, sir.

Senator PELL. Mr. Chairman, may I interrupt there?

Would this area where we wouldn't convert be the land measurement system?

Dr. ASTIN. Without prejudging the issues, it could very well be. It is my supposition that we will identify some areas where it makes no sense whatever to convert.

Senator PELL. Thank you.

Excuse me, Mr. Chairman.

Senator GRIFFIN. Yes.

Well, I keep hearing this, that we are not prejudging, but I sometimes get the impression that maybe there are a lot of judgment already made. In light of your statement, would you agree, then, Dr. Astin, that a study, among other things, should investigate the extent to which uniform and accepted standards are in use in the metric system of weights and measures in each of the fields under study and compare the extent of such use and the utility of such metric standards with those in use in the United States?

Dr. ASTIN. Yes. I think that this sort of evaluation is necessary to identify effectively areas where conversion is desirable and areas where it is not desirable, and to outline appropriate courses of action.

Senator GRIFFIN. Don't you believe that a study of this type should recommend the means of meeting the practical difficulties and costs in those areas of the economy where a recommended change in the system of weight measures and standards would raise significant practical difficulties or entail significant costs of conversion?

Dr. ASTIN. This is the heart of the problem, sir. We should certainly deal with these factors.

Senator GRIFFIN. And then if it is conceivable that there are some areas in which we should not recommend conversion, at least at the outset, or maybe at any time, don't you think your studies should delineate those areas, if any, in which it is recommended that the United States retain and promote the international use of the system that we use?

Dr. ASTIN. I believe, sir, that the software and hardware elements of the problem are mixed up in that question. I don't believe that it is practicable to partially convert with respect to language. That is to realize national benefits, I think we would have to use the metric language almost completely to describe characteristics. On the other hand, we can make a separate decision or recommend a course of action in individual cases with respect to size. For example, if we decide to use the metric language, and agree to describe the characteristics of ABC screw threads in the metric language, this is one decision. But at the same time we might decide that it is to our advantage to promote the use of ABC screw threads throughout the world instead of adopting metric screw sizes. That is a separate decision.

Senator GRIFFIN. I believe it is important to have that point made and clarified for the record. I think you have served an excellent purpose in making it clear just what your position is in that regard. We appreciate your testimony. If there are no other questions, we will go to the next witness, Mr. Richard B. Belford, technical director of the Industrial Fasteners Institute.

I understand Mr. Belford is to be accompanied by Mr. Harold B. Smith, vice president of operations of the Illinois Tool Works.

Mr. BELFORD. And Mr. John Walker, who is counsel for the Industrial Fasteners Institute.

Senator GRIFFIN. Gentlemen, we are glad to have you. Please proceed in whatever manner you desire.

**STATEMENT OF RICHARD B. BELFORD, TECHNICAL DIRECTOR, INDUSTRIAL FASTENERS INSTITUTE, CLEVELAND, OHIO, ACCOMPANIED BY HAROLD BYRON SMITH, JR., VICE PRESIDENT OF OPERATIONS, ILLINOIS TOOL WORKS, INC., AND JOHN S. WALKER, COUNSEL, INDUSTRIAL FASTENERS INSTITUTE**

Mr. SMITH. I think we might proceed in the same fashion that those who preceded us did and I will make a statement and then Mr. Belford will make a statement and I think together we can answer any questions that arise.

Senator GRIFFIN. All right.

Mr. SMITH. My name is Harold B. Smith, Jr. I am vice president of operations for Illinois Tool Works, Inc., which is headquartered in Chicago and has 11 manufacturing plants in six States. ITW manufactures a wide variety of industrial and consumer products, including machine cutting tools, specialty gears, industrial fastening devices, plastic containers, and electronic components. In 1966 we had gross sales slightly in excess of \$84 million. ITW is an active member of the Industrial Fasteners Institute, under whose auspices I appear here today.

In a very real sense, our company is a sort of microcosm of American industry, as it would be affected by conversion to the metric system. In our electronics division, for example, we have engineers who could appear here today to make a very good argument in favor of conversion. They would tell this committee that the metric system is easier to use and that, as a matter of fact, in their particular area of manufacturing industry, conversion has in some cases already taken place. Those in our tool and instrument division could make an equally persuasive argument that conversion would cause practical difficulties and cost a substantial amount of money. Our fastener division people, representing still a third area of our economy, could point out to you that, for them, conversion would present an even greater problem, for in some areas of American manufacturing industry, our technology and degree of standardization is so superior to that used elsewhere in the world, that there is, in fact, no comparable or universally satisfactory accepted metric standard to which we could convert, if we wanted to.

Thus, even within our moderate-sized company, a variety of attitudes, each special to a particular phase of American industry, are held relative to conversion. I do not, therefore, appear here today as a proponent or opponent of conversion. I appear as one who believes very strongly that this entire question must be subjected to the most intensive and complete study possible.

Such a study must, to be sure, take into account theoretical questions, such as the comparative "ease of use" of the two systems. Such a study must, to be sure, examine carefully the foreign policy considerations presented by conversion and by our present course. But the study must do much more.

It must do much more, if it is to be accepted by broad segments of American industry, who have, by using our current system, achieved the greatest technological and economic progress in the history of mankind.

The study must, I believe, look carefully into the hard questions, as well as the easy ones. Which system, for example, offers the more advanced technical standardization in a particular field? What would be the practical costs and difficulties presented by abandonment of our current system and conversion to another? How should these costs and difficulties be met? Have we done enough to promote international usage of our system and our standards, in those fields where they are technologically superior to other systems used elsewhere in the world? What is the degree to which standardization has taken place under the metric system in specific areas of manufacturing industry?

In order to be certain of providing the answers to those questions,

the Congress must exercise its legislative authority and responsibility and provide the Commerce Department with some firm guidelines and require of the Department some specific recommendations in specific areas. I would submit that for the Congress merely to give to the Commerce Department a "blank check" and \$500,000 per year for 3 years will not necessarily provide the kind of detailed and comprehensive study both Congress and American industry want and need.

For this reason, I support the approach taken by S. 2356, and I commend Senator Griffin for the leadership he has exercised in this field. Section 1, subsection (4), for example, specifically instructs the Secretary of Commerce to study and make recommendations with respect to the costs and benefits of full or partial conversion. In section 1, further recommendations are called for with respect to the extent to which full or partial conversion would be desirable and practicable and the extent to which our country's representatives in international standards organization conferences should retain and promote international use of our system of weights, measures, and standards.

In section 2, subsection (4), the Secretary is specifically instructed to investigate the extent to which uniform and accepted standards are in use in the metric system in each field under study and to compare the extent of such use and the utility of such standards with the standards in use in this country.

In subsection (5), the Secretary is again directed to recommend specific means of meeting practical difficulties and costs, where conversion would cause significant practical difficulties or entail significant costs.

In section 4, the Secretary is specifically directed to make a full report to the Congress, complete with the recommendations called for elsewhere in the act. In short, the Secretary is given some pretty firm guidelines, and he is specifically directed to follow them.

S. 2356 is a sound exercise of legislative responsibility. It requires that the agency conducting the study report specifically to the Congress what it—the Congress—wants to be appraised of. Congress is not, in this study, merely authorizing the expenditure of public funds for a theoretical excursion by members of an executive agency. If you adopt S. 2356, you will be authorizing the expenditure of public funds for specific purposes, upon which you, as the public's representatives, want and need to have detailed information and recommendations—and you will, under the language of S. 2356, get the information and recommendations you asked for when you authorized the money for the study.

Gentlemen, at a time when many people—and for that matter, many Congressmen and Senators—are seriously disturbed by the gradual erosion of authority and responsibility from the legislative to the executive branch of our Government, the approach taken in S. 2356 signals a firm and determined retention of legislative authority and responsibility by the Congress in this very important field.

Moreover, it may well represent the only way in which a study of this important subject can be achieved in this Congress. I am told that one of the reasons why metric study legislation has not been reported by the House Rules Committee is the lack of such direction and responsibility in the bill currently before that committee. Passage by the

Senate of S. 2356 would remove at least this obstacle to passage of a metric study bill by the 90th Congress.

I strongly urge you to recommend passage of S. 2356. I can assure you of the support of my company and others who think as we do, should the type of study authorized in S. 2356 be adopted.

Thank you very much.

May I introduce Richard Belford, who is technical director of the Industrial Fasteners Institute. Mr. Belford has more than 17 years' experience in standard work in the screw manufacturing industry and is a recognized expert in this field.

Senator GRIFFIN. Mr. Belford.

Mr. BELFORD. Thank you, sir. Mr. Chairman and members of the committee: The Industrial Fasteners Institute deeply appreciates the committee's invitation to testify with respect to the metric study legislation proposed by S. 441 and S. 2356. The Institute was one of the first industry groups to favor a metric study, and we are pleased to have this opportunity to restate our support and our hope that legislation can quickly be adopted and funded by Congress.

I am Richard B. Belford, technical director of the Industrial Fasteners Institute. IFI is an association of U.S. manufacturers of bolts, nuts, screws, rivets and all types of special industrial fasteners. The current annual production of our industry approaches 200 billion pieces, with shipments valued in excess of \$1.5 billion. Our industry uses about 2 percent of U.S. steel production, as well as substantial tonnage of aluminum, copper, nickel, titanium, and other nonferrous and nonmetallic materials. The fasteners industry serves literally every other industry in this country, and provides them with the parts needed to assemble products and structures ranging from children's toys to skyscrapers, and from household appliances to aerospace vehicles.

Our Institute is technically oriented, and has played a leading role in all standardization activities related to the products of our industry. During the past 20 years our representatives have attended every international standards meeting on fasteners in which the United States participated. I personally have attended 17 international technical meetings, and at eight of these I served as leader of the U.S. delegation. These responsibilities have obligated us to study and become thoroughly familiar with the engineering, production and standardization practices of the more industrialized countries of the world.

We have carefully examined the provisions of S. 441 and S. 2356 and have noted some basic differences between them which we believe will have a significant effect on the acceptability of the recommendations which will result.

S. 441 is essentially similar to legislation introduced in the 89th Congress. In previous hearings before the Senate Committee on Commerce and the House Committee on Science and Astronautics, our institute expressed its support of a study to develop all of the facts necessary to permit a rational judgment of whether or not, and to what extent, the United States should broaden its acceptance and use of the metric system of measurement.

S. 2356, while similar in its objectives to S. 441, introduces new and more clearly stated provisions which would enlarge the study from one

which would be largely limited to scientific and academic matters to one which would also focus its attention on problems related to the design, manufacture and use of physical products.

As representatives of one of the many mass producing "hard goods" industries, our institute strongly favors S. 2356 because we believe it provides for a more complete study which will probe into and reveal many interrelated issues some of which might be overlooked if the study is conducted within the terms of S. 441.

To explain our preference for S. 2356, we would like to briefly discuss three of the principal differences between it and S. 441.

(1) Section 2, paragraph 6 of S. 2356 instructs the Secretary of Commerce to:

Delineate those areas, if any, in which it is recommended that the United States retain and promote international use of the system of weights, measures and various standards used in connection therewith, currently in use in this country.

This provision implies that the study will include an evaluation of the level of technological advance now employed within American industry compared to that of other countries. It further implies that in those instances where U.S. technology is provably superior, this leadership be recognized and that instead of the United States changing to some other practice it keep its own system and actively encourage other countries of the world to more closely examine U.S. practice.

J. Herbert Hollomon, then Assistant Secretary of Commerce for Science and Technology, in his testimony on S. 774 before the Committee on Commerce on July 14, 1965, cited examples of the superiority of U.S. technology and urged that any metric study include an assessment of the prospects of expanding international acceptance of existing U.S. standards.

Senator GRIFFIN. I hesitate to interrupt you, Mr. Belford, but I think it might serve a useful purpose at this point.

You will recall that Dr. Astin focused upon that language in S. 2356. I asked him to comment upon it. As I recall his testimony, he said well, he would distinguish between promoting standards in effect, U.S. standards, and using the metric language to express them.

Before we go on, while we are right at this point, I wonder if you can comment on that response by him?

Mr. BELFORD. We heard Dr. Astin's comments and we basically agree with them. I think that the language problem is one of secondary importance. The really important issue is the change in size, shape, form and rating of hard goods products and this is brought out later in the statement.

I think that the language of S. 2356 emphasizes the need that this investigation of the technical differences and technical level of the standards of this country versus those of other countries, I think this is an extremely important part and it is emphasized and brought out very clearly in the language of S. 2356, whereas in S. 441 it is not quite as clearly stated.

Senator GRIFFIN. As I get the picture, apparently there isn't such great difference of opinion here except on the fact that you ask that this be written into the law authorizing a study that this feature be recognized.

Mr. BELFORD. This is true, Senator.

Senator GRIFFIN. I see; thank you.

Mr. BELFORD. While such an assessment may be interpreted as being an inherent part of the study defined by S. 441, this bill contains no mention of examining the desirability of retaining any part of current U.S. technical practice, nor promoting its acceptance by other countries.

Within many important segments of American industry, there is an apprehension that the study outlined by S. 441 is in effect a prejudgment that conversion to metric is inevitable and that the only unresolved issue of real substance is the establishment of a changeover timetable. Provisions such as those outlined in section 2, paragraph 6, of S. 2356 give this legislation a character of neutrality and objectivity which will appeal to American industry and encourage its generous participation in the conduct of the study.

(2) Section 2, paragraph 5, of S. 2356 instructs the Secretary of Commerce to:

Recommend specific means of meeting the practical difficulties and costs in those areas of the economy where any recommended change in the system of weights, measures and standards would raise significant practical difficulties or entail significant cost of conversion.

While S. 441 recognizes that cost of conversion is an issue of genuine concern, it fails to require the development of recommendations with respect to means for meeting these costs or means for easing the burden of transition.

Much has been written in recent years on the cost to our economy to accomplish a conversion to metric. Estimates range all the way from modest to bankruptcy. Despite such widely differing opinions, there are two points of common agreement—there will be an expense, and the major portion of this expense will be borne by the manufacturers of hard goods.

The cost problem is very real, and if it is ignored, it could jeopardize the success of the study. S. 2356 meets the issue headon, and because it does, the chances of acceptance by American industry of recommendations which the S. 2356 study may yield are enhanced immeasurably.

Senator GRIFFIN. Here again I would like to interpret the testimony, I asked Dr. Astin specifically whether or not such a study should include such recommendations and he indicated agreement.

Your point is, if that is the case, it ought to be in the bill; is that correct?

Mr. BELFORD. This is true, Senator.

Senator GRIFFIN. Thank you.

Mr. BELFORD. (3) The third point of difference we wish to comment on is, in our opinion, the most important. It goes right to the heart of the problem with which hard goods manufacturers would be faced if we elect to convert to the metric system.

Section 2, paragraph 4, of S. 2356 instructs the Secretary of Commerce to:

Investigate the extent to which uniform and accepted standards are in use in the metric system of weights and measures in each of the fields under study and compare the extent of such use and the utility of such metric standards with those in use in the United States.

The design of physical products having size, shape, and form—such articles as fasteners, gears, shafts, structural shapes, and so forth—is

normally based on round number values of units within a measurement system. These designs are communicated through drawings and written specifications, and when sufficient consumer demand develops, a standard is prepared and published. Standards are technical documents which define the dimensional, material, metallurgical, mechanical, and other properties and features of a product. They instruct the manufacturer on what is to be produced, they inform the user on what he can expect to receive.

Each industrialized nation of the world now has its own system of national standards. The system of standards in the United States is extensive and extremely sophisticated. Because designs of products are normally based on round number values, products manufactured to inch standards are not interchangeable with similar products manufactured to metric standards.

Senator COTTON. Would you pardon another interruption?

Mr. BELFORD. Yes, sir.

Senator COTTON. I want to make sure I understand what you have just been saying. With a nontechnical mind, it is sometimes hard to grasp these things.

Under the present situation a 3-inch screw carries with it a whole description of the screw, how wide apart the threads are, and how much metal there is in it, how much of it is steel or how much is aluminum or something else. The composition of the screw, the physical description of it, is all encompassed in the term "3-inch screw"?

Mr. BELFORD. Basically this is true, sir.

Senator COTTON. But now your contention is that if you changed the name of the 3-inch screw to so many millimeter screw that this would not carry with it all these other descriptive items? Is that the difficulty? Or have I oversimplified it?

Mr. BELFORD. It would be a very simple matter to redesignate the description of a fastener in terms of the metric language. But as I point out in the next paragraph, the great reward of conversion is in the development of interchangeability between the manufactured products of the world, so that the products that are manufactured in this country are completely interchangeable with those manufactured in other countries of the world, and vice versa.

To just change designations, to change language, we do not accomplish interchangeability.

Senator COTTON. I think I understand. Thank you. And pardon my interruption.

Mr. BELFORD. The rewards of conversion to another measurement system are the adoption of one language of communication and the development of interchangeability between manufactured products.

For the scientific and educational communities and in the production and distribution of soft goods, conversion to a different measurement system would be a relatively painless exercise involving little more than the juggling of numbers. However, for the manufacturers and users of hard goods, and this touches the lives of all Americans, conversion means redesign and change in physical size, shape, and form.

Changing product sizes means revision of technical standards. Where the standards of the one system exist, they can be adopted to replace those of the obsoleted system. However, and this is a point which is often overlooked, such documentation is not always compatible with

U.S. mass production techniques, nor to engineering use practices. In many instances equivalent documentation just does not exist.

Let me give an example. Prevailing torque type nuts, commercially known as locknuts, are nuts with a special feature built into their design so that when the nut is assembled on a bolt, there is a positive resistance to nut loosening in service. These nuts are carefully engineered products, manufactured to rigid quality requirements and used in engineering applications requiring reliability of performance. In each production year the U.S. automotive industry uses over a billion prevailing torque type nuts in the assembly of motor vehicles.

Technical standards for locknuts were first written over 20 years ago. These have been periodically upgraded as technology advanced until today U.S. standards for locknuts are as technically sophisticated as any yet written for fastener products.

There is no comparable documentation in any metric country of the world. There are no international standards for locknuts; in fact it was only in June 1967 that the need for such standards was first discussed at an international meeting.

If conversion to the metric system became a fact, the U.S. locknut manufacturing industry would be obligated to prepare entirely new standards defining the properties of locknuts designed to metric sizes. Such a task would neither be simple nor inexpensive as in addition to the actual writing, extensive testing and product research to determine the performance capabilities of the new sizes would also be involved.

Senator GRIFFIN. As I understood the testimony of Dr. Astin—maybe we will have to call him back for rebuttal or something here—he said, oh, no, this would just be a matter of changing the language to the metric system, that all of this other would not be required.

Now is there something that is not clear?

Mr. BELFORD. In the fasteners industry—and this is one of the hardware industries which we are discussing—all of our products are based on nominal sizes and then all of the properties, all of the dimensions, the tolerances, the capabilities, and so on of the product are developed by formulation from these nominal sizes.

In the metric countries, they have their nominal sizes also. Unfortunately—and this point has been brought out so many times—the nominal sizes in the metric countries are not the same as the nominal sizes that are now in inch countries.

And as I point out again, and I think this is a very basic point, the great reward of a conversion is the development of interchangeability between manufactured products. In order to achieve this interchangeability, somebody has to give. There has to be a change.

Senator GRIFFIN. Well, you are pointing out that merely using the metric language will not achieve the great benefits of conversion that many people think it will. I mean that many people are thinking in terms of interchangeability. If all we do is just adopt the metric language, these benefits will not flow. And you are trying to put your finger on that, to make the Government recognize it and realize that really it is the adoption of standards that will result in interchangeability; is that correct?

Mr. BELFORD. This is very true, Senator.

Senator GRIFFIN. And that when it comes to standards, there are some sectors and some situations where we would be foolish as a nation if we don't try to promote the U.S. standards because we have devel-

oped the technology and standards in wide use throughout the world. Is this correct?

Mr. BELFORD. We feel this should be properly a part of the study.

Senator GRIFFIN. And you want the Commerce Department to recognize that, and you want us to put it into the bill?

Mr. BELFORD. Yes.

Senator MOSS. Could I ask something, Mr. Chairman?

Senator GRIFFIN. Yes.

Senator MOSS. Isn't the sine qua non though that we change to the terminology of the metric system and subsequently see if our standard, which would then be expressed in metric terms, would be adopted by them?

Now I can see the point that we shouldn't just throw our standard away if it is superior and go to their standard in order to get the common terminology. But I don't see that that is necessary. It seems to me that if we begin using their terminology for describing the product that we have, which we say is a superior product, then the chances of getting them to come to our standard are much improved.

In fact, that would have to be. We would have to have their terminology before they would come of it. We can't just go out and say, using Senator Cotton's 3-inch screw example, that the 3-inch screw is the best, so you fellows have to have it. We have got to have a common terminology before we move to this international standardization; don't we?

Mr. BELFORD. That is the first step, of course. As I said earlier, the change in language, the change in dimensioning, the changes to drawings, in other words erasing numbers and substituting other numbers, that is a problem which can be accomplished. This can be done and in some industries in some instances it is now being done. Dual dimensioning is something you have heard of and this is a common practice. This is a problem of very secondary importance to us. It is this other problem where you have to negotiate a change in size and shape and form with problems that go far beyond just the rewriting of documents, this is the problem that concerns American industry. And we feel that it is properly a part of the study, that it would be only half a study to divorce the examination of technical standards from the metric study.

Senator COTTON. Would the Senator yield?

Senator MOSS. Certainly.

Senator COTTON. In other words, your suggestion is that before you agree to convert a 3-inch screw to a millimeter screw, you have to have the agreement that all over the world the 3-inch screw or the millimeter screw will have the same qualities of resistance, durability, design as the 3-inch screw has? Otherwise, a foreign product that wouldn't have any of the qualities, or different qualities, could easily be substituted if all you did was change the name. Is that correct?

Mr. BELFORD. This is true. The thing we would like to work toward is interchangeability of manufactured products. And this encompasses change in size, shape, and form on the part of one system to the other. But it does get into areas that go beyond just dimension and size; it gets into material grades, strength properties, performance capabilities, engineering use practice, and all of these things should properly be looked at and the technology of this country evaluated against the

technology of other countries to see which system is superior from a pure engineering and technical standpoint, and then countries should be encouraged to work toward the better system.

Senator COTTON. In short, a standard is something more than a mere measurement?

Mr. BELFORD. Yes, sir.

Senator COTTON. Thank you.

Mr. BELFORD. May I continue?

Senator GRIFFIN. Yes.

Mr. BELFORD. The perceptivity of the author of S. 2356 is commendable in recognizing that a documentation gap may exist, and that a metric study should explore this possibility by examining the current technical standards of this country and comparing them with those of other countries.

There are no similar provisions in S. 441.

The importance of this phase of the study can't be emphasized too strongly. Any study which does not include within its scope such an appraisal of technical documentation would be tragically incomplete and its findings and recommendations would be suspect by the industrial community.

In summary, our institute believes in the need for a one-world system of measurement. We believe there is a need for true interchangeability between engineered parts as manufactured throughout the world. These needs grow more urgent every year, and the problems attendant to the changes which would be necessary magnify in difficulty with the passage of time. Initiation of a study within the provisions proposed in S. 2356 is a first major step toward satisfying these needs.

The Industrial Fasteners Institute strongly supports S. 2356. We look forward to its early passage by Congress, and offer our services in assisting the conduct of the study when it is organized. On behalf of our member companies, I wish to thank the committee and its members for the opportunity to present these views.

Senator GRIFFIN. Thank you, Mr. Belford and Mr. Smith.

Senator PELL?

Senator PELL. You are very kind; thank you.

I am delighted that you believe foursquare, as you just said, in a worldwide system of measurements and interchangeability. Do you see any possibility that that worldwide system might be along the lines of the former English system?

Mr. BELFORD. You mean in units of measure, sir?

Senator PELL. Yes.

Mr. BELFORD. I think that any technical man in this country who has been exposed intimately would have to realize that if the whole world was going to work toward one system of weights and measures that it must be the metric system.

Senator PELL. Right. But there can be cases, as with the ABC screw system, where because of the qualities that Senator Cotton mentioned, we might find that the ABC characteristics are the best. And in such cases there is no reason why they should not acquire worldwide acceptance, in addition to whatever acceptance they now have. Wouldn't that be correct? Even though they are in inches?

Mr. BELFORD. Senator Pell, I have been a member of the U.S. delegation to the screw thread meetings, the international screw thread

meetings during the past 10 years and I am very, very familiar with what has been accomplished, with the pro and con arguments that have been presented as they relate to screw threads. There is an international screw thread system now. It was adopted in 1964. It is a two-part system. There is one part that relates to inches, and these are screw threads that would be placed on inch standard products. There is a different system known as the ISO metric screw thread system and these threads would be used on metric standard products.

The formulation of the two screw thread system is different. And the one that is used for inches, if we did make a conversion to the metric system, it in effect would be abandoned and this country would then work to the ISO metric screw thread system. I am not going to get into a technical comparison of the two screw thread systems. But they are different.

Senator PELL. My thought was that one could keep the ABC system even though we are on the metric system by giving it simply metric measurements. I noticed in going through your testimony, the testimony of your institute the last time this bill was up for discussion—I noticed you didn't testify the first time—but the second time you did and you made several suggestions for specific changes, the gist of which we incorporated in the bill that now appears as S. 441.

I was wondering why these other changes which you just enlarged upon now you did not advance a year ago or 2 years ago when you came before the Commerce Committee?

Mr. BELFORD. The testimony that was submitted by representatives of our institute applied strictly to the bill which was under discussion at that time. I think that the feelings that have been expressed here today commenting on the two bills, 441 and 2356, are views that our industry has held ever since the first discussions started on the possibility of a metric study.

Senator PELL. Yet at that time, just a year or 2 ago, 2 years ago, your chairman said that with the changes, the proposed study could prove useful and valuable. So these changes were incorporated in S. 441, as you know.

Mr. BELFORD. Yes, sir, and we appreciated it very much.

Senator PELL. Thank you.

Now with regard to the point you made about the differences, do you believe that it would be practical to delineate those areas, if any, in which it is recommended that the United States retain and promote international use of its system of weights and measures? Isn't this in a sense seeking to roll back the metric carpet?

Mr. BELFORD. Again I think our interest as an industry relates to the standards with which we must work. Whether it is possible to encourage or expand the use of inch-pound units of measurement in other countries of the world, this is perhaps questionable at this time. But very definitely we would like to see the promotion, and very active promotion of the standards of this country, where they are shown to be technically superior to any of those which we might be asked to convert to.

Senator PELL. I think there is no argument on that. We all believe when the standards are superior, they should be promoted abroad. But we are not talking about standards, we are talking about measurements. What you are saying here is that you prefer that the United States should retain and promote the international use of the system of

weights and measures currently in use in this country. I agree with you about standards. But I am wondering if you really mean what I think you are saying, that you believe the measurements should be promoted, the inches, quarts, et cetera?

Mr. BELFORD. No, I don't think the testimony that was offered, Senator Pell, suggests the promotion necessarily of units of measure.

Senator PELL. You say use of the system—

Mr. BELFORD. Again our interest of industry groups relates to standards, our technical documentation.

Senator PELL. To my mind S. 441 does not get at the question of standards. It is only concerned with measurements. I agree with you if the ABC system is superior, it should be promoted. But there is no reason why it can't be labeled under the metric system. Would you not agree with that? Particularly in view of the fact that there are five decimal points or digits, units, whatever it is called, of measurement under the present ABC system.

Mr. BELFORD. The unified screw thread system has already been translated into the metric language and it has been published.

Senator PELL. So there is no problem there.

Mr. BELFORD. This is true as far as language.

Senator PELL. Another point you say is that S. 441 seems to you a prejudgment and yet again I think it was with the consultation with industry representatives we changed the original bill which called for a study of the advantages to the phraseology, a study of the advantages and disadvantages of conversion. And I would think that is not a prejudgment. Why do you feel that S. 441 prejudices? I personally would like us to go on the metric system, you are quite right. But the bill itself attempts not to be a prejudgment.

Mr. BELFORD. In reading the two bills side by side we felt that S. 2356 encompassed more of the interests that must be properly studied before a final judgment can be made. In this respect, in our opinion, S. 441, because its language was perhaps not as complete or as precise, led us to believe that S. 2356 was perhaps preferable. Again from our interests.

Senator PELL. I thank you and I thank you very much, Mr. Chairman, for giving me this opportunity to question the witness.

Senator GRIFFIN. Thank you very much, Mr. Belford and Mr. Smith. Your testimony has been very helpful.

Senator GRIFFIN. Now we will hear from Mr. Samuel H. Watson of the Electronic Industries Association.

**STATEMENT OF SAMUEL H. WATSON, MANAGER OF CORPORATE STANDARDIZING FOR THE RADIO CORP. OF AMERICA AND CHAIRMAN OF THE GENERAL STANDARDS COMMITTEE OF THE ELECTRONIC INDUSTRIES ASSOCIATION, ACCOMPANIED BY EUGENE HATFIELD, MANAGER OF ENGINEERING, ELECTRONIC INDUSTRIES ASSOCIATION**

Mr. WATSON. Mr. Chairman, I have with me Mr. Eugene Hatfield, who is manager of engineering for the Electronic Industries association.

Senator GRIFFIN. You may proceed.

Mr. WATSON. Gentlemen, my name is Samuel H. Watson. I am

manager of corporate standardizing for the Radio Corporation of America, and I am also chairman of the General Standards Committee of the Electronic Industries Association (EIA). It is in this latter capacity that I appear before this Commerce Committee.

The Electronic Industries Association is the national organization of electronic manufacturers and is composed of about 300 manufacturers of electronic equipment, systems and components who do a major share of the industry's \$20 billion annual business.

EIA has for many years maintained and financed a comprehensive domestic standardizing program as well as supported substantial participation in the worldwide activities of the International Standards Organization (ISO). Many electronic companies and their operating divisions who are included in the EIA membership are directly involved in international trade on a global basis and have an important interest in existing and proposed measurement systems as they affect both domestic and international operations. These direct EIA member company activities involve, in many cases, the maintenance of plants and facilities and working agreements with subsidiaries and associated companies in many nations of the free world, both developed and developing.

As an industry we are closely following experiences in Great Britain as that nation implements its decision of early 1965 to adopt metric units of measure. This developing record provides a wealth of information which should be viewed as a valuable input to the proposed U.S. study.

The study program should be designed to produce adequate specific and factual information pertaining to advantages or disadvantages accruing to the United States in world trade as a result of changes, if any, in its measurement standards. Heretofore much of the available information has been generalized, vague, and poorly suited for informed decisionmaking.

The Electronic Industries Association recommends the passage of legislation which would authorize the Secretary of Commerce to make the study as delineated in the bills. As a result of its deep involvement in national and international technology and standardization, EIA is uniquely qualified to contribute from its wealth of experience to the proposed study. We are eager to participate in the study and would welcome an opportunity to do so.

Senator GRIFFIN. Senator Pell, do you have any question?

Senator PELL. No, except I am sure—you are so kind to let me be with you here—I might be interested in which bill he prefers of the two.

Mr. WATSON. I think we would prefer the specifics of S. 2356.

Senator GRIFFIN. Thank you very much.

Now we will hear Mr. John Graham of the International Harvester Co.

**STATEMENT OF JOHN D. GRAHAM, INTERNATIONAL HARVESTER  
CO., HINSDALE, ILL.**

Mr. GRAHAM. Mr. Chairman, Senators:

I would like to preface my formal comments by stating that—and I am sure you are used to this—what I have to say will be a great deal of repetition of what has been said. And it would be interesting to be

able to rewrite my remarks in the next 5 minutes while you wait, but I don't believe this is tolerable.

My name is John Graham. I am manager of engineering research for the International Harvester Co. I appreciate the opportunity to address this hearing with a statement on the growing problem of different measurement systems, and to give you information that may assist you in considering the legislation in question.

My company produces trucks, farm equipment, construction equipment, and other products, and has been involved in manufacture of these products in many parts of the world for well over half a century. This worldwide effort has involved the manufacture of the same or similar machines in widely separated parts of the world, and frequently in both the "inch pound" and "metric" systems.

This experience in the use of both systems has made it clear that either is satisfactory for industrial use. We are not expressing a preference for either of these systems. It is the existence of two different measurement systems that poses serious problems.

In the first place this situation makes communications difficult. Conversion from one system to the other creates confusion and extra effort, and technical difficulties of maintaining proper tolerances when converting are sometimes severe. Industry and others here and overseas have done much to minimize this problem by publishing conversion charts and technical guidance. Along with other industries we have created our own standard techniques for "dual-dimensioning"—the practice of placing both inch and metric dimensions at the same time on design drawings to permit use of these drawings in either system of measurement. This practice is a major factor in overcoming the communications difficulty.

The remarks concern only the two systems of measurement, the language problem which Dr. Astin addressed himself to.

However, of greater concern is the fact that each system of measure has lead standard sizes based on the units of measure—and sizes of material, threads, holes, and standardized hardware in general, vary between metric and inch using countries. These differences are a real obstacle to exchange of design and products.

We have been able to operate in two systems, in spite of considerable handicap and extra expense. We have established necessary rules for converting units of measure and have done considerable design work to accommodate differences in sheet metal thicknesses, bar sizes, and other standards. We have used our U.S. threads in most fasteners, even when building machines in metric countries such as France and Germany. And such fasteners are available in these countries.

However, much has happened in the last decade that has convinced us that a more practical solution to the measurement problem must be sought:

(1) The confusion surrounding the various metric measurement systems has been resolved by the development and recognition of the International System of Units, referred to as "SI."

Dr. Astin as a major proponent in the effort to develop the finalization of this system.

This single coherent metric system of weights and measures has been recognized and published by ISO, the International Organization for Standardization. The SI is now the basis of all formal recognition of the metric system.

(2) In 1965 after considerable Government-industry communication, the British Government issued a statement advocating that, and I will quote, even though it has been quoted before today, "British industries on a broadening front should adopt metric units sector by sector, until that system can become in time the primary system of weights and measures for the country as a whole." This program is well along in its initial phases.

(3) World communication of both information and goods is growing rapidly. More and more U.S. industries are establishing subsidiaries or licensees outside our borders with which they exchange both design and product.

As you gentlemen know better than I this communication need is also urgent in military matters.

In light of these factors we believe that in the future a single system of measurement will be used throughout the industrial world. Most of the world outside the United States is already either committed to the International System or considering it carefully. Because of these events and trends my company has been studying the problem for some time and actively engaging in conversations on this subject with other industrial organizations, with technical societies, and with the Federal Government.

Any attempt on the part of U.S. industry to change its units of measure or the size of standard parts must involve careful planning, close cooperation, and coordination. For these reasons we favor a careful unbiased study to assess the problems our country faces as worldwide use of the metric system grows, and to provide a sound basis for cooperation of U.S. industry, technical societies, and Government toward the best solution.

I want to thank you for this opportunity to make these comments.

Senator GRIFFIN. Thank you, Mr. Graham.

You speak from a wealth of experience, and we are glad to have you here.

Senator Cotton?

Senator COTTON. I will gladly yield to Senator Pell, because he is one of the interested parties.

Senator PELL. I want to play Russian roulette again and ask you if you have studied both bills and if you have, do you have a view, or do you have a preference?

Mr. GRAHAM. I have studied both bills very carefully. In my opinion either of them accomplishes the purpose which we are very anxious to accomplish and this is to launch a study.

I have some personal comments perhaps on certain things, but one of these you have already brought out. I think these relate principally to language. And I feel sure that S. 2356 does not mean what it says in its opening comment, No. 1, where it suggests some other system of weights and measures than is now in use, or the promotion of our own. I believe it is intended to mean standards as was brought out by Mr. Belford.

I think the comments in S. 2356 which urge that the study delineate areas where our commercial standards should be promoted for world use is very important, but again the language I believe is somewhat faulty in that it also says our system of weights and measures. I don't believe this was intended.

The point, however, is a very important one and is one of the most important factors I believe in the future of standardization in our country.

Senator PELL. Thank you. I believe the purposes of both bills are almost identical and the objectives are very much the same. I think as you point out the difference here is between measurements and standards. And this is the point that some of us who are laymen are having a hard time getting through our heads. I know I myself spent several years before I finally vaguely saw the difference.

Mr. GRAHAM. May I address myself very briefly to this point?

Senator GRIFFIN. We would like to have you do so.

Mr. GRAHAM. Of course this is a longstanding discussion, and sometimes controversial unfortunately and I think much of the reason for misunderstanding of the situation surrounding the future of measurement in this country stems from the failure to divorce these two problems.

I am being a parrot, because this has already been brought out strongly, but it can't be said too often, that the world, I firmly believe, will be a metric world in the foreseeable future, and this country must also be so, or we cannot exist in any kind of industrial operation. But this is a separate problem from the matter of the size that things are, what kind of threads, what sort of keyways and splines we utilize.

As a quick example, our standards for splines are undoubtedly superior to anything else in the world, they should be promoted, they probably have good chances of success in promotion as an international standard providing we take the first logical step which is to express them in metric units rather than inch units, which doesn't change the spline itself at all in any way.

And unless these two problems are kept separate in discussion, in the study, and in points that are made pro or con on any factor involved, we cannot understand the terms of the discussion and chaos results.

Senator PELL. I think you have clarified my own thinking in your response there, because basically S. 441 concerns itself exclusively with measurements and nothing else. I think S. 2356 is a broader bill because it concerns standards as well as measurements. This is the important difference between the two.

Thank you.

Senator GRIFFIN. Mr. Graham, you make the point that it is important to keep the distinction between the system of measurements and the standards. I wonder if you feel that the impact on standards should be ignored and that the relationship of standards should be ignored in any study which involved our conversion to one system or another?

Mr. GRAHAM. No, sir; I do not. I think it is important that this be included. I think however—I don't know why I say however—I think that the problem of what standard in a particular area—and screw threads is a good example—becomes an internationally accepted standard which everyone uses is not going to be a matter that will result from the study, it is going to be a matter that will result from salesmanship, from economic evolution, from ISO meetings and so forth.

This problem of promotion of our excellent standards for utilization

throughout the world is an extremely important factor. Certainly this has got to be part of the study, because economically it is the worst problem that industry faces in the future, what will the standards be. But my point that I feel is so important is that this is completely independent of the units in which we express them. The only problems that interchange the two and that produce an interface are where nominal size terminology is desired and this is a prominent factor in the screw thread situation. It interferes. But there is no reason that I can see why screw threads can't be given letters or new numbers or anything else. This is not an insuperable problem. The real problem is that we use different threads in France than in the United States. And this must be resolved.

Senator GRIFFIN. Thank you very much.

Senator Cotton?

Senator COTTON. Do you feel that any translation of our own measurement here to the metric system, in justice to certain segments of industry, would necessarily have to be a piecemeal change? That is, that there should be a different time for changes for those industries where it is simply a matter of changing measurements as distinguished from those to which it poses a very difficult problem?

Mr. GRAHAM. I agree with the statement that has been made earlier that there may well be segments of U.S. industry in which there is no reason for any change in units of measure. As far as detailed problems I can only speak for my industry, where the sequence of course is putting design on drawings, which then become the part to a man who must now make this and here the language is of extreme importance.

The matter of changing language is a very serious one and would be complete chaos if this change were attempted rapidly, if we must, for example, start next year as France attempted to legislate, measuring and drawing only in the metric system. I would only say it would be great cost and a tremendous problem. We have taken many steps, dual-dimensioning is probably the most important, in an attempt to prepare for the eventuality of a change in fashion that will minimize such cost and confusion. And if we can accomplish placing our design into dual-dimension drawings prior to an effort to convert machine tools as they wear out, changes in measuring tools, we will have a very minor influence from the language. So that while the language is a problem we can attack, we must have time, careful planning, and I would think guidance from technical societies and coordination of different industries.

The problem, however, that we can't now foresee and don't know how to approach is that of the standard size of commodities which may change due to world commerce. These are things where we have real problems ahead of us.

I think it is important to make one other statement. I believe it is related to your question, Senator Cotton. And this is that we would not choose to change any of our standards. Even—and I was asked this question earlier—even though we found a certain standard which perhaps had some superiority in the metric system of modules, that was different sizes, we would not attempt to embrace this without a great advantage. Our changes, if they occur, in the standards we

use, will be dictated by international commerce, economics, and availability. This is the simple statement.

Senator COTTON. Thank you.

Senator GRIFFIN. Senator Hart?

Senator HART. No questions.

Senator GRIFFIN. Thank you very much, Mr. Graham.

Our final witness is Mr. Fred Ewert, manager of the Standards Division of Deere & Co.

**STATEMENT OF FRED EWERT, MANAGER, STANDARDS DIVISION,  
DEERE & CO.**

Mr. EWERT. Mr. Chairman and members of the committee, as I came up here I noticed a pole between my chair and Mr. Graham's chair which had three letters, "S.O.B." I hope it didn't refer to either one of us.

As manager of corporate standards for Deere & Co., manufacturer of farm and industrial equipment, I have been privileged to represent my company and my industry in the committee work of various standards organizations, both in this country and overseas. My company appreciates this opportunity to testify concerning the proposed metric study legislation.

Deere has 14 factories in the United States and 10 more in various countries of the free world. Licensee arrangements exist in other countries. Principal products consist of 450 different basic models of farm equipment, five sizes of tractors in 30 basic models, and more than 50 different pieces of industrial equipment.

As a worldwide corporation, manufacturer of a particular machine may take place in two or more widely separated countries. It is our objective to distribute the products of these factories to any of the market areas in the free world. We must, for economic reasons, maintain a high level of interchangeability of components so as to insure satisfactory sales and service. Consequently, it is important that we coordinate our operations with both the inch system and the metric system.

While we have been able to operate within these systems with efficiency, yet it has caused extra expense, and we would welcome a study which might lead to the adoption of one accepted system worldwide, whether it be the metric system or a system which combines the best of the inch and the metric. May I give a few examples as to how our overseas expansion into metric areas has affected our practices on measurements and weights.

We dual dimension; that is, we put both the inch and millimeter measurements on the drawing, so that it can be used in any factory, and by any supplier, without redrawing.

Stock sizes of materials vary the world over and preliminary studies are made to insure that the design requirements will allow the use of slightly different stock sizes in other manufacturing areas.

We publish bulletins to keep our engineers informed as to how the stock sizes in their country correlate with those available in other areas. We follow the same course for the common materials which go into our products—we compare the properties, and availability, and recommend substitutions when necessary.

I have with me some copies of documents, in case you are interested, which illustrate our practice in dual dimensioning, in handling stock size and in converting back and forth from inch to metric.

Senator GRIFFIN. I believe they would be helpful if we could have them for the files for reference purposes. Thank you very much.

Mr. EWERT. In our concept of a worldwide organization, we do not believe that our American practices should always govern. Let me illustrate this by pointing out that in all countries, including the United States, we design to even half-millimeter measurements, letting the inch equivalents fall where they may. This does not apply in the case of stock sizes.

Another area beset with problems is that of drafting. Differing practices have been coordinated in a company drafting manual which is used by all factories.

Our problems are not with the inch system or the metric system per se, but rather with the modules or standards as has been pointed out here that result from the two systems. Good examples of modules which cause trouble in our worldwide operations are stock sizes, component sizes, and threaded fasteners.

Threads are a real problem, as has been brought out here today. The use of two thread systems is a major threat to interchangeability, and Deere management is convinced that the economic solution, for this point in time, is to insist on unified inch threads on all production intended for the worldwide market.

To summarize, gentlemen, we feel that we have coordinated the inch and metric systems fairly well in our operations. There will always be extra work and extra expense involved when dealing with both systems. We would like to avoid this work and expense; therefore, we would favor and encourage a comprehensive study which might serve as a guideline for the selection and promotion of one system—whether this be metric or the best possible combination of the inch and metric systems.

Thank you.

Senator GRIFFIN. Thank you.

Senator Hart?

Senator HART. No questions.

Senator GRIFFIN. Senator Pell?

Senator PELL. Do you have any views with regard to the two bills that are up for consideration?

Mr. EWERT. None whatsoever, sir. We would like to see a study.

Senator PELL. Thank you.

Senator GRIFFIN. We certainly want to thank you for your testimony and for the exhibits that you have brought with you. I believe we have heard all of the witnesses.

Before concluding the hearings, I would like to say—and I am sure Senator Pell, Senator Hart, and Senator Cotton will agree—that these hearings have been very helpful on this subject.

I would like to add my own personal opinion that the testimony has pointed up important areas of agreement and certainly there is unanimity on the point that a study should be undertaken. And, where there are differences, I think the testimony has pointed up that those differences, to some extent, relate to semantics, and perhaps, in another area,

the degree to which the Congress might see fit to direct and provide guidelines and specifics so far as the study is concerned.

Some at least want to make sure that those who conduct the study will look at the hard, practical questions as well as the theoretical questions that might be involved. I want to thank Senator Pell for participating and assisting.

If there are no other comments—Senator Hart?

Senator HART. I want to thank the chairman, my colleague from Michigan, for giving leadership in this committee on a problem which we ought to get resolved, and resolved in the fashion that he and Senator Pell have proposed.

Senator GRIFFIN. Somehow I have a feeling that now, in light of this testimony, we are going to be able to get together and come up with a bill that we can pass. I hope so.

Senator PELL. I would like to thank you very much, Senator Griffin, for your kindness in letting me be here and inviting me to participate. I am most appreciative. Thank you very much, very much.

Senator GRIFFIN. Thank you. The session is adjourned.

(Whereupon, at 12:25 p.m., the hearing was adjourned.)

(The following letters were received for the record:)

#### WRITTEN STATEMENTS AND LETTERS

##### STATEMENT OF HAROLD F. LARSON, P.E.

The Honorable Warren G. Magnuson, Chairman Committee on Commerce, and Members. The Committee on Commerce of U.S. Senate.

(1) I would like to suggest that the scope of the subject of the bills under consideration be slightly expanded, as follows: (Suggested language for 1st 4 lines of bill S. 2356, previous to line numbered 1).

(2) "To authorize the Secretary of Commerce to make *studies* in order to recommend improved *systems* of weights, measures, standards, and *appropriate symbols and languages* to be used therewith for the United States and for international use".

(3) Following passage by the United States Senate in 1965, of S 774, which directed studies to include: "to evaluate the costs and benefits of alternate course of action which may be feasible for the United States" studies have been carried out to accomplish precisely this course of action. The result is a: "proposed system of weights and measures and various standards to be used in connection therewith, which" can "be recommended for international adoption", and is substantially described in the following.

(4) But first let me say that in providing this proposed system, which constitutes a genuine improved version of the present customary system of weights and measures in use in the United States. I do this for two reasons as follows:

First, as an aid to the committee in writing a bill at this time by supplying the committee the necessary knowledge of what at least one genuinely improved measures system actually constitutes; and, secondly, the hope and expectation that the committee will produce a bill which will direct specifically: the adoption of at least some elements of this system at this time or that further studies will be directed towards adoption of a genuinely improved version of a system of weights and measures which retains the indicated structure which constitutes the major characteristics of the age old customary measures system, which is presently the popular measures system in use in the United States, as well as still in use in some substantial number of other countries.

(5) There exist some powerful historical reasons for the system which is proposed as an improved version of the customary system of weights and measures in use presently in the United States. These historical reasons can be summarized as follows:

(6) Over a century ago the decimal numbers language and symbolism acquired a mating systematic measures, techniques called the decimal-metric system. Together these two make an excellent working team. However they appear now to have met some inherent technical limitations, which make them powerless

to become transformed into a popular, all dimensions, measures system in even one country let alone in all the world. A blunder was made in number language development some 5000 years ago which has caused untold confusion ever since, and makes the decimal-metric system much the weaker and tremendously more expensive of two possibly widely used measures systems.

(7) In a parallel development, starting some 3000 years ago, there was set up a systematic measures technique, which did not contain a blunder, and which has been tremendously popular ever since. This, systematic structure for measures, has until recently, not been sufficiently studied and developed to its full potential. It's development is currently moving ahead at a tremendously accelerated speed, the same as so many other techniques are doing.

(8) This most excellent systematic measures technique, for some almost inexplicable reason, never until the last few decades ever acquired a mating Hindu-Arabic position notation numbers symbolism, nor any corresponding spoken numbers language. However, the vigorous demands of the modern electronic computer have developed a machine language which exactly matches the structure of this popular, 5000 year old systematic measures technique.

(9) The implications of these developments are only now beginning to become apparent, Recognition of the exactness of the match between these two and the tremendous potential power of these two, acting jointly as a well mated team, has suffered from lack of discerning studies. There has been a tremendous amount of half-truths published about all these matters, in spite of the fact that measures systems and technique and related languages are the language of science. The naming of computer machine language as "binary" is, accurate in a microscopic sense but, tremendously misleading in the overall implications. This has lead to educators' published judgements that this machine language is clumsy, lengthly and an inappropriate one for popular use.

(10) A deeper study will bring to light that this machine language can just as easily be said to constitute a four base system, a sixteen base system, a 256 base system, etc. When this is accomplished the resulting language is no longer clumsy, lengthly or inappropriate.

(11) Popular measures systems in widespread use over 3000 years have exactly and precisely the structure of computer machine language. English speaking people, and the United States especially, are today almost the sole custodians of widespread use of this excellent measures technique. Only a comparatively small amount of development work remains to wed the new numbers language to its appropriate popularly used measures techniques to transform these two into an unbelievably powerful complete measures system, the universal measures and language system.

(12) There exists no valid reason for not developing to their maximum utility two parallel systematic measures techniques with their respectively mating languages; the Universal System and the Decimal-Metric System. It remains the inadvertent duty of the United States to mankind to lead in the further scientific development of this second team, and for the rest of the world to sense the world-uniting value of this effort and to cooperate in setting up speech patterns which will communicate the structure of this language without national barriers.

(13) Probably the English speaking world will play initially the larger part before the others become articulate.

(14) The proposed system will be named the universal system. Portions of this system will be named as follows:

The technique of measurement will be known as the Universal Measures System. The communications, records keeping code, and language aspects, appropriate to this system, will be named: The Universal Measures Language.

(15) The system comprising both the measures techniques and its appropriate accompanying language will be named the Universal Measures and Language System and in shortened form, if misunderstanding is not thereby caused, as The Universal System.

(16) Measures systems are generally described as consisting of six elementary units and some 36 derived units. A seventh elementary unit is actually involved when economics is added to physics in measuring systems. The economic value system reflects the system in use for the physical dimensions and must be included in any popular measures system and its language.

(17) Popular measures system must be constructed upon the concerns of the majority of people who use measuring techniques. The elementary units which are of major concern to the majority of people are estimated to be the following and in the approximate order given:

- |           |                       |
|-----------|-----------------------|
| 1. money  | 6. distance           |
| 2. time   | 7. area               |
| 3. weight | 8. temperature        |
| 4. volume | 9. luminous intensity |
| 5. power  | 10. acceleration      |

(18) The Universal Measures System makes use of the following well known system which is in use most extensively:

TABLE I

16 tablespoonfuls equal 1 cupful	16 gallons equal 1 cask
16 cupfuls equal 1 gallon	16 casks equal 1 tun

(19) Table I constitutes a 16 base system. This system includes a four base system which is in use most extensively:

TABLE II

4 tablespoons equal 1 jack or jackpot	4 gallons equal 1 keg
4 jackpots equal 1 cup	4 kegs equal 1 cask
4 cups equal 1 quart	4 casks equal 1 hogshead
4 quarts equal 1 gallon	4 hogsheads equal 1 tun

(20) The Table II system contains an extensively used binary or two base measures system shown as follows in Table III.

TABLE III

2 tablespoons equal 1 handful	2 gallon equal 1 pail or peck
2 handfuls equal 1 jack	2 pails equal 2 peck equal 1 keg
2 jacks equal 1 gill	2 kegs equal 1 bushel
2 gills equal 1 cup	2 bushels equal 1 cask
2 cups equal 1 pint	2 casks equal 1 barrel
2 pints equal 1 quart	2 barrels equal 1 hogshead
2 quarts equal 1 pottle	2 hogsheads equal 1 pipe or butt
2 pottles equal 1 gallon	2 pipes or butt equal 1 tun

(21) The decimal-metric system uses the same volume units for liquids that it uses for dry measure. This is a convenient technique for every day use and is adopted in the Universal System.

(22) The decimal-metric system was constructed initially as defining the unit of mass as the amount of water contained in the elementary unit of volume. This is a useful concept for everyday use since material density tables related to water density are then most useful. The same principle is used in the Universal Measures system.

(23) During the 3000 years over which the above system has been in use in most of the world there has grown up a rather large number of measures which differ by only a small amount from each other, for example, there are several gallons which are not exactly the same. For universal use there needs to be only one gallon and this can be used for both dry and liquid measures.

(24) The best definition for a universal gallon will be found, on study, to be defined in terms of a certain exact number of so many cubic inches. The inch of length has been defined with utmost possible precision in terms of so many wave lengths of a particular color of light and this is also true of the centimeter. There are exactly 2.54 centimeters in one inch, unless further study shows the inch to be better defined, still as  $1/39.37$  meters. The difference is small.

(25) The cubic inch is the best definition of the fundamental unit measure for volume. By making the gallon equal to 256 cubic inches, exactly, it is seen that all the other above volume measurement become so many exact number of cubic inches also. The result is a most simple and easy system to use since length and volumes are all exact multiples of the inch and the cubic inch.

(26) All these measures have all the precision needed for the most refined scientific use as well as the most easily useful relationship for everyday use for volume and distance measures of all kinds.

(27) A table of the above measures defining each of these measures in exact cubic inches is easy to set down and shown as follows in Table IV.

TABLE IV

1 cu in = 1 u tablespoon	512 cu in = 1 u pail, peck
2 cu in = 1 u handful	1024 cu in = 1 u keg
4 cu in = 1 u jack	2048 cu in = 1 u bushel
8 cu in = 1 u gill	4096 cu in = 1 u cask
16 cu in = 1 u cup	8192 cu in = 1 u barrel
32 cu in = 1 u pint	16384 cu in = 1 u hog'shead
64 cu in = 1 u quart	32768 cu in = 1 u pipe
128 cu in = 1 u pottle	65536 cu in = 1 u tun
256 cu in = 1 u gallon	

(Study will show these Universal units to be within about 10% of current definitions.)

(28) A very convenient and useful definition for the fundamental units of weight and of mass are obtained by defining the cubic inch of water as being the fundamental unit of weight as well as of mass. This principle was intended to be made use of in setting up the metric system of weight and measures. A slight error made the liter of water nearly one kilogram in place of precisely one kilogram.

(29) The English speaking world is accustomed to using the pound as the fundamental unit of weight. In the universal system of weights and measures the universal pound (u-lb) would be close to the customary English pound i.e. within about 15%. The universal pound would be  $\frac{1}{8}$  of a gallon of water or precisely 32 cubic inches of water equals 1 pint water.

(30) The universal ounce would equal  $\frac{1}{16}$  of a pound and equals 2 cubic inches of water. Since the cubic inch of water is taken as the fundamental unit of mass and weight it will be well in the near future to name this unit with an appropriate new name, in the meantime the unit will be called  $\frac{1}{2}$  a universal-ounce, 8 u-lbs. of water equal one gallon. A unit will contain 2048 u-lbs.

(31) Some of the very great simplicity inherent in the Universal Measures System can be seen in Table V following, which condenses the previous tables and their discussion. Quantities of the column head shown on any one line are all equal.

TABLE V

Table- spoon, cubic inches	Universal- ounce, handful	Jack	Gill	Cup	Universal- pounds, pint	Quart	Pottle	Gallon
1	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{1}{16}$	$\frac{1}{32}$	$\frac{1}{64}$	$\frac{1}{128}$	$\frac{1}{256}$
2	1	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{1}{16}$	$\frac{1}{32}$	$\frac{1}{64}$	$\frac{1}{128}$
4	2	1	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{1}{16}$	$\frac{1}{32}$	$\frac{1}{64}$
8	4	2	1	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{1}{16}$	$\frac{1}{32}$
16	8	4	2	1	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{1}{16}$
32	16	8	4	2	1	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{8}$
64	32	16	8	4	2	1	$\frac{1}{2}$	$\frac{1}{4}$
128	64	32	16	8	4	2	1	$\frac{1}{2}$
256	128	64	32	16	8	4	2	1
512	256	128	64	32	16	8	4	2
1,024	512	256	128	64	32	16	8	4
2,048	1,024	512	256	128	64	32	16	8
4,096	2,048	1,024	512	256	128	64	32	16
8,192	4,096	2,048	1,024	512	256	128	64	32
16,384	8,192	4,096	2,048	1,024	512	256	128	64
32,768	16,384	8,192	4,096	2,048	1,024	512	256	128
65,536	32,768	16,384	8,192	4,096	2,048	1,024	512	256

(32) Table V is true to the intentions of the creators of the English measures system back some 3500 years ago.

(33) This table restores the original simplicity of this system.

(34) This table represents the major contribution of the English measures system towards a truly universal measures system.

(35) This table lays the foundation and pattern for the truly universal system.

(36) This table makes precise use of certain proven principles of system construction:

(a) That a sequence of units of increasing size shall be related to each other by a constant whole number multiplier, 2, 4, 16, 256, 65536, in this instance, 10, 100, 1000, 10,000, 100,000, 1,000,000 in the instance of the decimal metric system.

(b) That mass and weight units are defined in terms of amounts of water for the volumes defined by the table as functions of cubic inches. This allows the use of specific gravity and density tables in a simple fashion the same as these tables function in the decimal metric system.

(37) This table represents a genuine improvement in the present U.S. customary system. This improvement is true to the designers intent of this system. This improvement leads to universal use for this system. This improvement overcomes the erratic historical influences which have obscured the original conception of this system. These improvements substantially remove the confusing aspects of measurements as practiced by the average citizen in the U.S. These improvements make the memorization work needed for efficient measuring system usage a minimum.

(38) Various other easy tables can be set-up as related to Table V such as Table VI for example :

TABLE VI

256 <sup>3</sup> equal 1 gallon	256 equal 1 peck
256 equal 1 cask	256 equal 1 hogshead
256 equal 1 tun	

(39) The universal system of weights and measures is seen to be based on certain powers of two as being given more prominence than the other powers of two. These are shown in Table VII.

TABLE VII

$2^2=2.2=4.$	$2^8=16.16=16^2=256.$	$2^4=4.4=4^2=16.$	$2^{10}=256.256=256^2=65,536.$
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(40) The above prominent powers of two are as follows: 0, 1, 2, 4, 8, 16, 32, 64, 128, 256, etc.

With a more complete development of the universal system of weights and measures it is expected that special names will be given to the numbers 2, 4, 16, 256, 65536, etc.

(41) It is suggested that adoption of the Universal Measures units as given above for the dimensions of Mass, Weight, Volume and Length be adopted for immediate use in the United States and for international use. It is also suggested that plans be set up to use the Universal Measures for Money, Coinage and Multiples of the dollar.

(42) It is suggested that plans be formulated which will gradually install the Universal System of Measures into universal use but possibly geared to a time span of one or two generations.

(43) For this longer forward look it is necessary to set-up a fairly permanent staff which will guide a dynamic development.

(44) For this longer look the following discussion will supply most of the guide posts which seem at this time to be fairly obvious.

(45) The first requirement which a measures system must fulfill to be useful as a *universal* system is that the same multiplier is used to relate the various sized units for any given dimension or set of dimensions, secondly that the same multiplier is used for all dimensions or set of dimensions, and third that the system be used by all people i.e. all nations. A fourth desirable but not necessarily necessary requirement is that all people speak measures with a common spoken language.

(46) For this longer look into the future the statement published in the Hearings on S774 in July 1965 are most relevant. (I am including some copies of my statement published at that time by the Committee on Commerce of the Senate.)

(47) Once it becomes well known that the English U.S. customary measures systems can be greatly improved by rather minor changes in unit definitions it is reasonable to expect a great deal of literature will be written for the purpose of advancing this system. I believe it is inevitable that this will become the major universal weights and measures system. I expect that the committee on commerce will write one or more bills which will result in releasing many efforts both public and private which will be aimed at evaluation and implementation of this system in both special fields and in world wide usage and in universal usage for all measurable dimensions.

(48) If this is a true evaluation of the present situation it follows directly that respecting S2356 Sec. 1 Item (2) on page 2 will be impossible of execution at this time; item (3) lines 5-9 will be highly confounded and will only be possible over a considerable time period, say, of one or two generations; and

item (4) line 10 and 11 will also require prior development of the possibilities as outlined in the Universal Measures and Language System.

(49) Section 2 item (1) line 15-19 should be changed to the plural *systems* in place of studying a single system. Item (2) line 20 to 24 needs to anticipate that the results of such a study are a function of rate of progress in implementing the Universal System. Item (3) line 25 to 5 on page 3 can be used specifically to uncover a tremendous usage of the ratios 2, 4, 16, 256 etc in many technical areas such as for one example: in the study of fine powders using standard sieves. Item (4) lines 6-11 is irrelevant so long as the customary units are in a state of dynamic transition to an improved and enhanced status. The decimal-metric system seems to have about come to the end of its expected development, i.e. become static. Item (5) lines 12-17 is probably more relevant to study in connection with the Universal System that it is to the Metric System. However it seems most obvious that the Universal System will result in very tremendous savings over one or several decades while a world-wide monopoly by decimal-metric measures will involve mainly tremendous costs, which will represent mostly loses, starting at well over 50 billion dollars for the United States alone. Item (6) line 18-22 can only be accomplished after the Universal System has been substantially implemented into world wide use.

(50) Sec. (3) needs to be expanded to give major support to a relatively permanent group of individuals who can guide, develop, coordinate, research, engineer, test out, and publicly promote and suggest legislation for improved customary measures along the lines outlined in this exposition of the Universal Measures System and who are not adverse to promoting to their fullest extent two internationally standardized systems. I wish to recommend that this group include individuals who have the talents which resemble those of the author of this Universal System, and of those of the author of the Minyon System described in detail in the hearings of the Committee on Commerce on S 774 in July, August 1965, and of the author of "Numado, an international pronounceable coding system for mathematics and symbolic logic" by Ivor Darreg 1960, published in Los Angeles 7 California. A study needs to be made to bring these kinds of people into a joint working effort and to support the creative nucleus with appropriate experts required for execution of the project by publications, by test work, by international language development work, and by an innumerable number of other different kinds of endeavors which can be indicated by initial intensified studies leading to dynamic improvements.

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STATEMENT BY ARTHUR SANDERS, EXECUTIVE SECRETARY, SCALE MANUFACTURERS ASSOCIATION

"Hard Facts Are Needed About The Metric System" is the title of this presentation, Mr. Chairman, and that is the sole point to which this statement is dedicated.

The Committee has heard in past . . . and doubtless will hear in future . . . much learned and expert testimony pro and con about the metric system.

Unfortunately, much of the debate is exactly that—a debate between ardent *advocates* and *opponents* of the United States abandoning measurements by pounds and ounces and switching to measurement by grams and kilograms . . . from inches, feet, yards and miles to meters and kilometers.

What would be valuable, I respectfully suggest, is NOT more debate—but the gathering of some hard facts upon which to base an intelligent and an informed opinion.

In other words, we've had lots of *heat* on this subject . . . for years. Why not try a new approach? Why not let a respected informed and impartial *study* be made . . . which would throw *light* upon this matter which is becoming more important with each passing year?

As this Committee is well aware, the United States finds itself pretty much standing alone in the matter of weights and measures. Far more than 90% of the world's population has now officially adopted the metric system. Recently, South Africa, one of a handful of "holdout" nations . . . along with us . . . has reconsidered its position. In September of 1966, South Africa announced that the Government had accepted the principle of a changeover to the metric system "as quickly as possible."

In a 1967 debate the matter was discussed in Parliament, with no dissent to the proposed change, and the Government is now organizing for a gradual changeover to the metric system.

Other recent converts to the metric system include Japan, Korea, India and Great Britain.

These bare facts . . . by themselves . . . would indicate to thoughtful people, I suggest, that it is time to take a meaningful look at the metric system . . . free from the heat and partisan cry of debate.

What really *is* involved . . . if the United States should adopt the metric system? I have been associated with the scale industry . . . and have known many of the nation's leading weights and measures officials . . . for more than twenty years. I don't know . . . and I don't know anybody knowledgeable in the field who will claim that *he* knows.

For many years . . . ever since Alexander Graham Bell said way back in 1906 . . . that "the metric system is a labor-saving device of the greatest importance and value" . . . ever since then, we've had lots of *debate*. Unfortunately, what we have *not* had is hard facts and figures . . . facts and figures which would indicate what problems might be involved . . . what the cost would be . . . what benefits we might expect to obtain.

The time has come to stop talking in loose, vague terms, I respectfully suggest. The Committee is to be commended for taking the time . . . in a period when war, taxes, race relations and other more dramatic subjects hold the headlines . . . to hold this hearing. In doing so, I believe the Committee is showing a correct sense of values. Weights and measures might not seem . . . to the uninitiated . . . to be either dramatic or important. But few things have so vast an impact upon everybody's daily life. Everything man eats, wears or uses has been weighed and/or measured at least once—and often many times.

As the Committee is well aware, the system of weights and measures used by the United States has vast importance upon manufacturing, trade, commerce, distribution, retail sales, taxes, transportation . . . it would take pages just to list them all.

The point is that improvements in weights and measures are of lasting importance—far more so, perhaps, than many things that will hold the headlines in tomorrow mornings newspaper. Weights and measures are *basic*.

The Scale Manufacturers Association would like to commend the Committee . . . and to recommend the passage of Senator Claiborne Pell's Resolution.

The approach suggested by Senator Pell is reasonable and correct, in our opinion. It is not legislation which compels anyone to do anything. What it *does* do . . . is to authorize a study . . . to seek facts in a field where, despite many debates, everything is slippery and elusive and facts are much needed.

Mr. Chairman, our association is able to warmly endorse the proposal now being considered by this Committee for another reason . . . because the study would be conducted by the National Bureau of Standards.

In the scientific and business community, the National Bureau of Standards holds a position of great esteem and respect. It is a credit to our government. It's findings and recommendations carry great weight among informed and responsible persons everywhere. It is one of the top-flight scientific organizations to be found anywhere in the world.

When one discusses the value of a study . . . one of the first questions that comes to mind is: "Who is going to conduct it?"

In the National Bureau of Standards, one finds an esteemed and respected institution which is *neither* an advocate of . . . nor an opponent of . . . the metric system. This is indeed fortunate, because this matter is too basic, too important to have any findings it might make tainted with charges of advocacy or prejudice. The high reputation of the National Bureau of Standards is the best guarantee one could ask for that any study it conducts would be accurate, impartial and would command as nearly universal respect as it is possible for any human institution to command.

Mr. Chairman, inscribed in stone above the National Archives Building in Washington is the motto: "What is past is prologue".

Let us hope that in this case that motto is wrong. The story of Congressional inaction in the field of weights and measures is long . . . dating back to the very founding of our Republic. Presidents George Washington, Thomas Jefferson, James Madison, and John Quincy Adams . . . to name only a few . . . have each repeatedly called upon Congress . . . in vain . . . to legislate in the area of weights and measures. It's an interesting story . . . and dramatically warns against continued inaction.

President Washington called upon the First Congress to adopt a uniform system of weights and measures. It was much needed . . . because Dutch, French, English and Spanish weights and measures were being used in different areas

of our country. These varied widely . . . with a consequent harmful effect upon trade and commerce.

The First Congress appointed a Committee. The Committee, in turn, asked Thomas Jefferson, the First Secretary of State, for recommendations. Jefferson wrote a scholarly treatise . . . but no action was taken. And there the matter rested for many years.

But in 1817 . . . exactly 150 years ago . . . Congress got around to looking into the matter again. Another Committee was formed. The Committee asked then Secretary of State John Quincy Adams for recommendations. Secretary Adams' report was a masterpiece. One of the best treatises ever written on weights and measures. It retains its value to this day. It is most interesting and Members of this Committee, who have a special interest in weights and measures, might find it good reading even today.

John Quincy Adams' study is a classic. But no action resulted from it, either.

Finally, the welter of conflicting standards of weights and measures became an intolerable burden on trade and commerce. And so the United States rather "backed in" to the nearest thing we have to a uniform system of weights and measures. A Treasury Department employee, Ferdinand Hassler, collected standards of weights and measures from Europe—and adapted them to American use. As John Perry entertainingly tells in his readable book, *The Story Of Standards*, Congress, instead of being annoyed at Hassler's invading its prerogative, promptly passed a resolution urging him to hurry along with his work:

To sum up briefly, Hassler furnished the states with copies of his standards of weights and measures . . . the states adopted them by law . . . and that is the way we got our weights. As you know, Congress in 1866, made the metric system legal—but not compulsory—in the United States by providing a conversion table from Hassler's weights and measures to those of the metric system.

Some, in the scientific and business communities, have criticized Congress for its legislative inaction in weights and measures. Others, including myself, have credited it with good horse sense . . . and caution. Wars may come and go . . . taxes may be raised or lowered . . . alliances made or broken . . . and none of these may have as much impact as a change in the weights and measures laws.

Still, times *have* changed. In the days of Washington and Jefferson, it might take a full year for a clipper ship to journey to China and back. Today, we can transmit intelligence with the speed of light. It's just a short airplane hop to Europe. As we are . . . sometimes painfully . . . aware, the world has become a very small place in terms of space and time.

If the rest of the world goes on the metric system . . . and the United States doesn't . . . then that is a matter of great and legitimate concern. Like it or not, we *are* isolated in a basic and important area.

These facts *alone* . . . our association suggests . . . are enough to cause thoughtful men to stop and take stock.

What would be involved by the greater use of the metric system? No man knows. Estimates and guesses vary wildly. No knowledgeable person underestimates the difficulty . . . or the expense.

Is it worth it? I don't know. The leading weights and measures officials in the United States don't know. Respectfully, I suggest that many who think they *do* know . . . really don't.

Isn't it about time we began getting some reasonably reliable answers? Not debate. Not partisan answers . . . pro or con . . . but some informed and responsible studies.

I think it is. The decision may be . . . after the facts are in . . . that the cost is too high. That it isn't worth it. On the other hand, it may be that the United States will *have* to convert sooner or later . . . and that the cost will be higher later.

At any rate, our association believes that the time has come to learn the facts . . . and for that reason, we urge the adoption of Senator Pell's Resolution.

Thank you.

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CHAMBER OF COMMERCE OF THE UNITED STATES,  
Washington, D.C., November 13, 1967.

HON. WARREN G. MAGNUSON,  
Chairman, Senate Commerce Committee,  
5202 Senate Office Building, Washington, D.C.

DEAR SENATOR MAGNUSON: The Chamber of Commerce of the United States supports enactment by Congress of legislation to authorize a comprehensive study relative to the increased use of the metric system in the United States. The ad-

vantages and disadvantages of such use of metric units of weights and measures need to be examined carefully before any wholesale conversion can be considered.

The Chamber testified in favor of such a study during Senate hearings held in 1965, although we proposed certain amendments to the bills under consideration. We now recommend the study as proposed in S. 441 and S. 2356, inasmuch as both of these bills meet the objectives which we requested in our 1965 testimony.

Members of the Committee are no doubt aware of the trend toward metric system usage throughout the world, and that there is some concern that the United States may be falling behind other industrial nations, such as Great Britain, Canada, and Australia, which are moving gradually into greater use of metric units. On the other hand, there is great concern that absolute and irrevocable conversion to metric usage may not be to our best advantage and that some aspects of present usage might be retained.

In addition to this trend among industrial nations, some of our domestic industries are moving toward metric usage, possibly anticipating eventual conversion as national policy. For instance, optical equipment manufacturers are working in metric units, while aerospace and pharmaceutical companies are progressing toward metric designations. The American Society for Testing and Materials has provided for the designation of metric equivalents along with the customary units, with the thought of eventual replacement by metric units. The U.S. Geological Survey recently announced a switch to metric reporting of certain chemical water quality data, as a step toward recognition of international standards in this field.

These and other examples indicate that, even in the absence of technical and economic answers, some degrees of conversion are under way. A clearer path ahead for all concerned can be provided through the study proposed in this legislation.

Of the two bills before this Committee, we believe S. 2356 provides a more specific congressional directive to the Secretary of Commerce in conducting the study. The Griffin bill (S. 2356) spells out the attention that should be given to standards as used in various designs and ratings. It also provides for the Secretary to recommend means of assisting industry in meeting the costs of various steps in conversion to metric usage. These additions seem desirable as provisions in the bill language, rather than as later decisions by Congress following any report in which possible conversion may hinge on problems of standards and/or cost.

Although it is not known how much the study may cost or how much time it may require, the Committee may wish to specify both dollar and time limitations.

We suggest also that the Committee might consider requesting the Secretary to determine alternative means for conducting the study, since some organizations might be able to produce results more quickly and at less cost than others. One such organization that might be considered is the National Academy of Engineering.

As indicated in our previous testimony, the Chamber is confident that industrial organizations and individual companies will gladly cooperate in any way possible in the conduct of these studies. We therefore urge the Senate Commerce Committee to report favorably on this legislation.

May I request that these views be made a part of the record of your hearings.

Sincerely,

DON A. GOODALL,  
*General Manager, Legislative Action.*

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INDUSTRIAL RESEARCH, INC.,  
November 1, 1967.

Senator WARREN G. MAGNUSON,  
*Chairman of the Senate Commerce Subcommittee,  
The Capitol, Washington, D.C.*

DEAR SENATOR MAGNUSON: In October 1966, Industrial Research Inc.—publishers of *Industrial Research* and *Oceanology International* magazines—took a stand in favor of adoption of the metric system in the United States. Well aware that “legal” approval had been given by Congress many years before, we urged a changeover to metric units as soon as possible by government, industry, and the public.

To acquaint readers with legislation recently proposed that would authorize a study of the metric system—and to state reasons for an early changeover—both magazines carried editorials relating metric adoption to the readers’

professional activities. We also began using metric expressions in our news and feature columns, and still continue this practice.

In addition, the advisability of changing to metric measurements was thrown open to all readers in an exclusive feature of both magazines called the "Opinion Poll." Here, readers were urged to complete a short questionnaire and submit additional comments concerning various aspects of the metric controversy.

In all, nearly 3,800 scientists, engineers, and technical managers returned questionnaires from the magazine. Some 93% of the respondents stated they were in favor of conversion to metric units of measurement in the U.S.—a conversion that would either partially or totally replace the currently used British system of weights and measures.

Hundreds of letters, comments, and suggestions for facilitating the conversion also were received by the editors of *Industrial Research* and *Oceanology International*.

Included with this report are copies of the two editorials, Opinion Poll questionnaires and tabulated results, and printed letters from both magazines. In addition, a sampling of the letters received in conjunction with the poll are enclosed for your information.

I think you will agree that there is substantial support in the research and oceanology fields for conversion to the metric system. I hope you will find the enclosed material helpful in securing passage of the metric bill.

Sincerely,

NEIL P. RUZIC, *President.*

[From *Industrial Research*, October 1966]

#### THE METRIC ROADBLOCK

Several years ago, *Industrial Research* took the editorial position that conversion to the almost-universal metric system is inevitable, and that steps should be taken to facilitate the change-over from the cumbersome British system of weights and measures.

We still feel that way—perhaps even stronger than before. There are innumerable advantages to the metric system, such as:

Its simplicity. There are only three basic units—the gram, the liter, and the meter—compared to 80 different units of weights and measures currently used in the United States. The metric system also uses the decimal system, with every measurement in multiples of 10.

It would reduce confusion among disciplines, industries, and nations. Today, American scientists use the metric system, while engineers cling to the outmoded English method. Although nearly all American industries utilize the British system, an increasing number of industries and government agencies are switching to the metric system. On a worldwide basis, above 90% of the population relies on the metric system.

It would open new markets for American business and industry. A recent study estimated that the United States is losing between \$10- and \$20-billion in foreign trade every year because she is not on the metric system.

It would help the balance-of-payments problem by increasing American exports and reducing the "gold drain."

A Stanford Research Institute study has pointed out a number of other benefits—faster calculations in many industries; less chance of costly errors; easier training of the young; and improved relations between scientists and businessmen.

The major objection to converting to the metric system is the cost of the change-over, particularly in such industries as automotive, appliance, and machine tooling. The SRI study placed the cost of conversion at \$11-billion over a 20-year period. However, it was emphasized, this cost would be more than recovered through increased business and productivity.

The logical first step in changing over to the metric system is the current bill (S 711) before Congress for a three-year study by the National Bureau of Standards on ways to solve some of the problems associated with the conversion. We believe it is a constructive move that deserves immediate passage.

As our part in the switch to the metric system, we intend to convert all references to weights and measurements—as far as practical at this stage—to metric

units, starting with this issue of *Industrial Research*. In addition, we are devoting this month's Opinion Poll (on page 95) to the metric question, and intend to forward the results to members of Congress and other interested parties.

You can assist in bringing about a change to the metric system by participating in the Opinion Poll, writing to your Congressional representatives, and supporting efforts by professional, industrial, and governmental groups interested in eliminating this unnecessary roadblock to science, industry and the national welfare.

#### HOW DO YOU FEEL ABOUT CONVERTING TO METRIC SYSTEM?

Industrial research has been a proponent of metric system adoption in the United States for many years. So have many scientists and engineers engaged in research and development.

Opponents of the metric system changeover generally are centered in disciplines or industries where English units have been used for a long period of time requiring replacement of standards, specifications, instruments and machines.

The opposition is somewhat understandable since a large amount of re-education and conversion would be necessary. However, if adoption of metric measurements is inevitable—and we believe it is—further delay will only make the transition more painful.

The following questions are designed to obtain your opinions about the feasibility and desirability of converting to metric, your ideas on the best way to implement the conversion, and your specific suggestions for accomplishing positive action toward this end.

Results of the Opinion Poll will be forwarded to the government officials responsible for pending legislation dealing with a metric system study. Please read this month's editorial on the subject before completing the questionnaire.

Results of the August Opinion Poll dealing with defense against nuclear attack are presented at the left.

1. Should metric units of measurement be adopted in the United States?
  - Yes
  - No
  - Partially
  - No opinion
2. What system of measurement do you use most often in your work?
  - Metric
  - English
  - Both
3. If adopted, do you think the metric system should be...
  - mandatory in all industries?
  - voluntary within each industry?
4. Please cite any obvious examples where you believe the English system should be retained.
5. Do you think that adoption of the metric system will...
  - Simplify calculations?
  - Improve science/engineering communications?
  - Be easier to teach in school?
  - Facilitate pricing of goods?
  - Aid the U.S. in world trade?
  - Reduce duplication in parts inventory?
  - Implement exchange of technical data with other materials?
  - Implement exchange of technical data with other countries?
  - None of these?
  - Other \_\_\_\_\_
6. What period of time—in years—do you feel will be required for a complete shift to the metric system?
7. What is your opinion of the proposed legislation authorizing the Dept. of Commerce to conduct a 3-year study concerning the effect of conversion to the metric system?
  - Worthwhile
  - Worthless
  - No opinion

8. In what area do you work?

- Basic research  
 Applied research  
 Development  
 Production  
 Service group  
 Management or administration  
 Other \_\_\_\_\_

9. Do you have any specific suggestions for action that would facilitate adoption of metric measurements in the United States? If so, please detail your ideas on a separate sheet and enclose with completed questionnaire.

We also would welcome letters commenting on the proposed adoption of the metric system for possible publication in our letters-to-the-editor column.

#### NINETY-FOUR PERCENT FAVOR CONVERSION TO METRIC UNITS OF MEASUREMENT

An overwhelming majority (94%) of the 3,100 scientists and engineers responding to the October "Opinion Poll" feel the United States should adopt metric units of measurement.

Only 3% of the respondents were against adoption, while the other 3% favored partial conversion.

Despite the fact that nearly all respondents favored metric conversion, the poll revealed that 20% presently were using only the English system. Metric units of measurement were employed by 37%, and both systems were used by 43%.

A three-to-one majority of survey participants felt the metric system, if adopted, should be mandatory in all industries rather than on a voluntary basis.

Nearly all respondents believed that adoption of the metric system offered definite advantages. Above all, they claimed, it would simplify calculations. It also would be easier to teach in school, improve science/engineering communications, and aid the U.S. in world trade and data exchange.

When asked to state their opinion of a proposed three-year study on metric conversion, more than two-thirds of the respondents felt such a study would be worthwhile. On the other hand, 23% thought the study was worthless, because it would not accomplish anything concrete toward the overall goal.

The last question solicited suggestions for action that would facilitate adoption of metric measurements in the U.S. Hundreds of letters and comments have been received, and as a result, the entire "Feedback" column in this issue is devoted to the subject.

Results of this "Opinion Poll" and all correspondence pertaining to the metric system are being gathered in a special report which will be forwarded to members of Congress and other interested parties.

Tabular results of the October Opinion Poll are given below:

*Q 1: Should metric units of measurement be adopted in the United States?*

Yes .....	93.5%
No .....	3.0
Partially .....	3.0
No opinion .....	0.5

*Q 2: What system of measurement do you use most often in your work?*

Metric .....	37%
English .....	20
Both .....	43

*Q 3: If adopted, do you think the metric system should be ...*

Mandatory in all industries? .....	72%
Voluntary within each industry? .....	28

*Q 4: Please cite any obvious examples where you believe the English system should be retained.*

Examples frequently mentioned were: in surveying and land measurement, consumer products, food, history books and documents, piping and screw threads, sports, and replacement parts.

Q 5: Do you think that adoption of the metric system will . . .

Simplify calculation?-----	92%
Be easier to teach in school?-----	85
Improve science/engineering communications?-----	80
Aid the U.S. in world trade?-----	76
Implement exchange of technical data with other countries?-----	71
Facilitate pricing of goods?-----	50
Reduce duplication in parts inventory?-----	33
None of these-----	2
Other-----	7

Q 6: What period of time—in years—do you feel will be required for a complete shift to the metric system?

10 years-----	35%
5 years-----	18
20 years-----	14

Other answers ranged from one to 1,000 years.

Q 7: What is your opinion of the proposed legislation authorizing the Dept. of Commerce to conduct a three-year study concerning the effect of conversion to the metric system?

Worthwhile-----	67%
Worthless-----	23
No opinion-----	10

Q 8: In what area do you work?

Applied research-----	45%
Development-----	34
Basic research-----	26
Management or administration-----	19
Production-----	10
Service group-----	10
Other-----	10

[FROM OCEANOLOGY INTERNATIONAL, OCTOBER 1966]

The American system of weights and measures is illogical and inconsistent; it is a confusing hodgepodge with little or no convenient relations or coordination between general and specialized uses.

The system—which we inherited from the English—has become a liability in relations between scientists and engineers, science and industry, and the United States and other nations.

Even the British have recognized the shortcomings of their own system, and have taken steps to convert to the more systematic metric plan (now used by 90% of the world's population).

The time has come for the United States to act on the long-delayed metric question, which has been debated in Congress and industry for more than a century.

We believe the current bill before Congress (S. 774) should be passed and that the proposed three-year study on conversion should begin immediately.

The study—to be conducted by the National Bureau of Standards—would seek to assess the consequences of the following alternative courses of action, as well as others: general adoption of the metric system by legislation; voluntary extension of metric usage industry by industry; regulated partial conversion; possible other solutions with mandatory conversion by law; and a system of financial incentives to accelerate voluntary conversion.

The major obstacles to metric conversion historically have been tradition, cost, and inertia.

There are those who object to changing to a so-called "foreign" system of weights and measures (the metric system was developed by the French about 1800). In reality, however, metric weights and measures are no more foreign than the antiquated English system.

The United States already utilized the metric system in many ways. Our monetary system is patterned after the decimalized metric system. Scientists, physicians, and pharmacists rely upon metric weights and measures. Many industries—including chemicals, power, photography, and electronics—make partial use of the system, as do a number of federal agencies.

The principal opposition to conversion comes from such industries as automotive, appliance, and machine tooling, which have billions of dollars tied up in machinery and other equipment based on the English system.

There is no question that conversion would be costly—perhaps \$10- to \$20-billion over several decades. However, a study by Stanford Research Institute has indicated that this cost would be more than recovered through increased business and productivity.

There are numerous advantages to the metric system. For example, it is much simpler with only three basic units—the gram, the liter, and the meter—compared to 80 different units of weights and measures currently used in the United States.

Other advantages include faster calculation; easier training of the young; reduction of confusion among disciplines, industries, and nations; opening of new overseas markets; curtailing of the “gold drain” through better balance of payments.

The biggest problem to overcome is inertia. We all dislike change. We hate to “rock the boat,” even when we know it is better for us.

But the time has come for change—and we must do everything in our power to facilitate conversion to the metric system. That’s why we have changed all references to weights and measures to the metric system starting with this issue. It also is the reason we are devoting this month’s “Opinion Poll” to the question, and plan to send the results to Congress.

You can do your part by participating in the metric survey and by urging your employer, your professional society, and your Congressional representatives to support bill S 774—the logical first step to conversion to the metric system.

#### HOW DO YOU FEEL ABOUT CHANGING TO METRIC SYSTEM?

As pointed out in the editorial statement on page 5 of this magazine, one of *Oceanology International’s* policies is to foster adoption of the metric units of weights and measures in the United States.

We feel this is particularly important in a field that is international in scope and purpose such as oceanology. Here is a relatively new discipline where we need not hold on to the foot, pound, and gallon because of long-standing tradition.

Certainly, general adoption of metric units in all disciplines, and industries will require a large amount of re-education and conversion. However, if adoption of metric units is inevitable—and we believe it is—further delay will only make the transition more painful.

This Opinion Poll—a unique feature of Industrial Research Inc. publications—is designed to obtain your feelings about the feasibility and desirability of converting to metric units in the U.S., your ideas on the best way to implement the conversion, and your specific suggestions for accomplishing positive action toward this end.

Results of the Opinion poll will be forwarded to members of Congress and other government officials responsible for pending legislation dealing with a metric system study. Please read the editorial on the subject in this issue before answering the questions below.

The next issue of *Oceanology International* will report the results obtained from this Opinion Poll.

The Opinion Poll feature enables *Oceanology International* to serve as a sounding board for the industry, gathering opinions and channeling them into a single voice that expresses readers’ views on controversial, important, and timely topics. Participate in the Opinion Poll and make sure *your* opinion is represented.

1. Should metric units of measurement be adopted in the United States?

- Yes  
 No  
 Partially  
 No opinion

2. What system of measurement do you use most often in your work?

- Metric  
 English  
 Both

3. If adopted, do you think the metric system should be . . .

- Mandatory in all industries?  
 Voluntary within each industry?

4. Please cite any obvious examples where you believe the English system should be retained. \_\_\_\_\_

5. Do you think that adoption of the metric system will . . .

- Simplify calculations?
- Improve scientific/engineering communications?
- Be easier to teach in school?
- Facilitate pricing of goods?
- Aid the U.S. in world trade?
- Reduce duplication in parts inventory?
- Implement exchange of technical data with other materials?
- Implement exchange of technical data with other countries?
- None of these?
- Other \_\_\_\_\_

6. What period of time—in years—do you feel will be required for a complete shift to the metric system?

7. What is your opinion of the proposed legislation authorizing the Dept. of Commerce to conduct a 3-year study concerning the effect of conversion to the metric system?

- Worthwhile
- Worthless
- No opinion

8. In what area do you work?

- Basic research
- Applied research
- Development
- Production
- Service group
- Management or administration
- Other \_\_\_\_\_

9. Do you have any specific suggestions for action that would facilitate adoption of metric measurements in the United States? If so, please detail your ideas on a separate sheet and enclose with the completed questionnaire.

We also would welcome letters commenting on the proposed adoption of the metric system for possible publication in our letters-to-the-editor column.

#### NINETY-THREE PERCENT OF OCEAN SCIENTISTS, ENGINEERS FAVOR CONVERSION TO METRIC SYSTEM

Adoption of metric units of measurement in the United States received almost unanimous (93%) support by 694 ocean scientists and engineers participating in the October "Opinion Poll."

The poll was designed to gage reader opinions concerning the feasibility and desirability of converting to metric units and to obtain specific ideas on the best ways to implement conversion.

The same strong support was voiced among 3,100 research scientists and engineers responding to an identical survey in *Industrial Research* magazine.

And in both surveys it was interesting to note that more than 20% of the respondents presently used only English weights and measures in their work.

If adopted, the metric system should be mandatory in all industries according to most of the ocean scientists and engineers. However, some respondents cited surveying and land measurement as an obvious example where the English system should be retained.

Nearly all survey participants claimed that adoption of the metric system would simplify calculations. Next, they felt it would be easier to teach in school, improve science/engineering communications, and aid the U.S. in world trade and technical data exchange.

Although two-thirds of the respondents believed that a three-year study on metric conversion would be worthwhile, 21% said it would be worthless. They indicated that similar studies already had been made and that another would only cause further delay.

The last question solicited suggestions for action that would facilitate adoption of metric measurements in U.S. Many respondents suggested that government contracts specify the use of metric units, and that the system be taught in schools. Another frequent suggestion was that tax incentives be given to industries with heavy financial burdens during the changeover.

Results of this "Opinion Poll," as well as the one in *Industrial Research* magazine, and all pertinent correspondence, will be forwarded to members of Congress and other government officials.

Tabular results of the October poll follow :

**Q 1: Should metric units of measurement be adopted in the United States?**

Yes.....	93%
No.....	4
Partially.....	3

**Q 2: What system of measurement do you use most often in your work?**

Metric.....	29%
English.....	33
Both.....	48

**Q 3: If adopted, do you think the metric system should be . . .**

Mandatory in all industries.....	72%
Voluntary within each industry.....	28

**Q 4: Please cite any obvious examples where you believe the English system should be retained.**

The most frequent examples given were: in surveying and land measurement, nautical mile, food, textbooks, and sports.

**Q 5: Do you think that adoption of the metric system will . . .**

Simplify calculations.....	87%
Be easier to teach in school.....	82
Improve science/engineering communications.....	80
Implement the exchange of technical data with other countries.....	74
Aid the U.S. in world trade.....	72
Facilitate pricing of goods.....	41
Reduce duplication in parts inventory.....	35
None of these.....	2
Other.....	5

**Q 6: What period of time—in years—do you feel will be required for a complete shift to the metric system?**

10 years.....	33%
5 years.....	19
20 years.....	13
15 years.....	6

Other answers to the question ranged from one to 5,000 years.

**Q 7: What is your opinion of the proposed legislation authorizing the Dept. of Commerce to conduct a three-year study concerning the effect of conversion to the metric system?**

Worthwhile.....	68%
Worthless.....	22
No opinion.....	10

**Q 8: In what area do you work?**

Applied research.....	45%
Development.....	36
Basic research.....	29
Management or administration.....	22
Production.....	8
Service group.....	7
Other.....	12

SHIPBUILDERS COUNCIL OF AMERICA,  
Washington, D.C., April 4, 1967.

HON. WARREN G. MAGNUSON,  
Chairman, Committee on Commerce,  
U.S. Senate, Washington, D.C.

DEAR MR. CHAIRMAN: I am writing in regard to Senate Bill 441 introduced by Senator Claiborne Pell, pertaining to the metric system of weights and measures, which has been referred to your Committee. Last year I sent you a letter in which I listed comments from our shipyards on a similar measure pending before the 89th Congress, Senate Bill 774. The position of our Members has not changed since then, and presuming that you and members of your Committee might be interested, I am again listing them herein for your convenience.

"The need to evaluate all aspects of such a proposed change is considered great, and it is believed that the resulting advantages of universal adoption of the metric system will be very significant."

"There is no argument against a system so simple as the metric system . . . It is realized that the disruption in the non-metric world to make the change over would be tremendous but maybe 20 to 50 years from now our survival in competitive world trade will be at stake. . . the bill should be supported."

"It would be most advantageous in the long run if this country adopted the metric system. The transition from English to metric units would initially be painful and expensive. Several examples of this would be the complete rewriting of the American Bureau of Shipping Rules and the rewriting of all structural handbooks."

". . . The idea is generally accepted that the eventual adoption of the metric system in this country is both inevitable and desirable. There is also no question that it will be expensive for the shipbuilding industry. It would seem therefore that the emphasis of the investigation under subject Bill should be toward the mechanics and economics of the transition rather than further checking its possibility.

"Questions immediately come to mind as to how the economic burden of the changeover will be borne by the industry and by individual segments of industry. If the burden is not evenly distributed throughout industry, can tax benefits or other means be suggested to remedy this inequity? During the changeover period how will jobs in hand be affected by the cost of changeover? How can the Government handle competitive bidding in a way that will not produce undue hardship on some companies? In short, it would appear desirable to have the scope of the investigation broadened to include the answers to such questions as these."

These reactions come from members of our Technical Committee who would be directly involved in their day-to-day operations with any changeover to the metric system, and we thought you might like to know that the consensus is favorable to passage of Senate Bill 441.

With all good wishes, I am,  
Cordially,

EDWIN M. HOOD, *President.*

AMERICAN METEOROLOGICAL SOCIETY,  
*Boston, Mass., June 14, 1967.*

THE SENATE COMMERCE COMMITTEE,  
*U.S. Senate,*  
*Washington, D.C.*

GENTLEMEN: The American Meteorological Society is interested in the metric study bill S. 441, and in that connection there is attached hereto a resolution that was adopted by the Council of the Society on April 19, 1967.

Sincerely yours,

DAVID F. LANDRIGAN, *Secretary-Treasurer.*

On April 19, 1967, the Council of the American Meteorological Society voted the following resolution regarding the adoption of the metric system.

*Noting* the adoption by most of the continental European weather services of the metric system for regular reporting of conditions to the public, except for wind speed (only the Soviet bloc uses meters per second), and

*Noting* that the metric system is coming to be universally used, throughout the world, in exchanges of weather data between weather services and for communications in atmospheric research, and

*Noting* that new international codes are being adopted by the WMO in January 1968, to provide uniformity in exchanges of data, and that these have explicit provisions for the metric system, and

*Noting* the concerted voluntary effort of several large segments of U.S. industry to introduce the metric system into their specifications and measures (for example, pharmaceutical, automotive, machine tool, electronic), and

*Noting* that any conversion from one established system of measures to another inevitably raises certain practical problems, involves a period of education for the public, and causes some expense to the agencies involved,

Therefore, the Council *recognizes* that the eventual adoption by the U.S. public and private weather services of the metric system in their external and internal reports is both desirable and inevitable, and

*Recommends* that a study of the many consequences of such adoption be made

by a government agency or the National Academy of Sciences or the National Academy of Engineering.

*Pledges the support* of such a study by the creation of a group of experts from the AMS membership to consult on the matter when it is called for.

AMERICAN METEOROLOGICAL SOCIETY,  
DAVID F. LANDRIGAN, *Secretary*.

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AMERICAN SOCIETY OF CIVIL ENGINEERS,  
*New York, N.Y., October 30, 1967.*

Senator WARREN G. MAGNUSON,  
*U.S. Senate,*  
*Washington, D.C.*

DEAR SENATOR MAGNUSON: We are in receipt of the dates of the proposed hearing by the Senate Commerce Committee on metric legislation currently before the Senate. Specifically to be considered are S-441 and S-2356.

One of the oldest policies of ASCE regards the adoption of metric standards of weights and measurements in the United States. A copy of this policy adopted in 1876 and officially reaffirmed in 1959 is enclosed. This policy is still valid and the statement is hereby offered for the hearing.

In addition, this matter is being brought to the attention of the ASCE Committee on Standards for possible development of further comments. If forthcoming in time, we will endeavor to forward these comments for the hearing as well.

Sincerely yours,

WILLIAM H. WISELY, *Executive Secretary*.

AMERICAN SOCIETY OF CIVIL ENGINEERS

POLICY REGARDING ADOPTION OF THE METRIC STANDARDS OF WEIGHTS AND MEASURES ADOPTED BY BOARD AT MEETING OF AUGUST 16, 1876, REAFFIRMED AT MEETING OF DECEMBER 6, 1876, AND AGAIN REAFFIRMED IN ESSENCE AT MEETING OF OCTOBER 19-20, 1959

Resolved, that the American Society of Civil Engineers will further, by all legitimate means, the adoption of the Metric Standards in the Office of Weights and Measures at Washington, as the sole authorized standards of weights and measures in the United States.

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THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS,  
*New York, N.Y., November 20, 1967.*

Mr. PETER E. HOLMES,  
*Legislative Assistant to Senator Robert P. Griffin,*  
*New Senate Office Building, room 5110,*  
*Washington, D.C.*

DEAR MR. HOLMES: We regret that the Annual Meeting of the Society in Pittsburgh, Pa. prevented our being represented at the November 15, 1967 hearing on the Metric Study Bill S. 2356. However, as the Society has from time to time given careful consideration to the complexities of converting to the metric system, we submit for the record the following resolution:

"The American Society of Mechanical Engineers supports Senator Robert P. Griffin's bill S. 2356 to study not only the extent to which the U.S. should increase its use of the metric system, but also the extent to which this country should retain and actively promote international use of its current system of weights and measures."

Sincerely,

LOUIS N. ROWLEY, *President*.

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METRIC ASSOCIATION, INC.,  
*Arlington Heights, Ill., October 31, 1967.*

Hon. WARREN G. MAGNUSON,  
*Chairman, Committee on Commerce,*  
*U.S. Senate,*  
*Washington, D.C.*

DEAR SENATOR MAGNUSON: The Metric Association has consistently supported metric study legislation which has come up in Congress.

We are of the opinion that a factual, objective study of metric conversion can best determine how the change can be made at the lowest cost and with the least disruption of our economy.

There are many companies in the United States who would like to make progress in converting to the Metric System and should obtain guidance from the Federal Government.

Our grade school teachers and their pupils know little about the Metric System which is already very important in many areas of our economy. They too are waiting for leadership from the Federal Government which would be provided by a metric conversion study.

Within ten years most countries of the world will be entirely on the Metric System and will demand that products they buy be made in metric units and to metric standards. Legislation which provides for a metric conversion study will help our industries determine the best way to meet that challenge.

We strongly recommend passage of S. 441.

Respectfully yours,

LOUIS F. SOKOL, *Secretary.*

WHIRLPOOL CORP.,  
Benton Harbor, Mich., October 31, 1967.

HON. WARREN G. MAGNUSON,  
*Chairman, Senate Commerce Committee,*  
127 Old Senate Office Building,  
Washington, D.C.

DEAR SENATOR MAGNUSON: Whirlpool's executive engineers and scientists have reviewed Senator Robert P. Griffin's bill, S. 2356, and subsequently we urge passage of this bill.

S. 2356 would authorize a study which would provide a basis for this country to decide whether or not to change from our current system of weights and measures to the metric system.

Our technical people feel that such a study is vital in view of the worldwide conflict in the field of weights and measures. We urge passage of this vital bill.

Sincerely,

A. J. TAKACS,  
*Director Governmental Affairs.*

AMERICAN CHEMICAL SOCIETY,  
OFFICE OF CHEMISTRY AND PUBLIC AFFAIRS,  
Washington, D.C., November 8, 1967.

HON. WARREN G. MAGNUSON,  
*Chairman, Senate Commerce Committee,*  
U.S. Senate,  
Washington, D.C.

DEAR SENATOR MAGNUSON: As you are undoubtedly aware, the scientific community in the United States is intensely interested in the deliberations now being conducted in the United States Congress in regard to the determination of the practicability of the increased use of the metric system in the United States.

The American Chemical Society is a non-profit scientific and educational association of more than 110,000 member chemists and chemical engineers, and it has become the world's largest member organization devoted to a single science. In 1937 the Society received a National Charter by the Act of Incorporation, Public Act No. 358-75th Congress, 1st Session. This Act was signed into law by President Franklin D. Roosevelt on August 25, 1937.

The Board of Directors of the Society is convinced that the adoption of the metric system in the United States would enhance the accomplishment of the Society's objectives as outlined in its National Charter. The formal unanimous action by the Board is as follows:

"On recommendation of the Committee on Chemistry and Public Affairs and with the endorsement of the Committee on Public, Professional and Member Relations, VOTED that the American Chemical Society endorse the adoption of the metric system in the United States."

It was felt that this information might be helpful to you and your committee in view of the November 15th hearing on S. 2356. The Society, through its Committee on Chemistry and Public Affairs, would be ready to discuss this subject in more detail with you at your convenience.

Sincerely yours,

STEPHEN T. QUIGLEY.

STANDARD NUT & BOLT Co.,  
Cumberland, R.I., November 9, 1967.

HON. JOHN O. PASTORE,  
4107 New Senate Office Building,  
Washington, D.C.

DEAR SENATOR PASTORE: As a manufacturer of industrial fasteners, we are vitally interested in two "Metric Study" Bills, S. 441, sponsored by Senator Pell, and S. 2356, sponsored by Senator Griffin. It is our understanding that both of these bills are scheduled for hearings before the Senate Commerce Committee on November 15.

We feel that S. 2356 provides for a more honest and complete study than that required by S. 441. In the past we have supported Senator Pell's Bill S. 441, but we feel that there are several specific additional advantages in S. 2356 and that there is so much at stake that the better bill should be supported.

The Industrial Fasteners Institute, of which we are a member, has prepared an analysis of the factors involved between the original Pell Bill and Senator Griffin's improved bill. They have done such a fine job that I offer it to you below for consideration:

"1. S. 2356 recognizes that measurement systems cannot be divorced from the manufacture of physical products. The design, sizes, dimensions, ratings and properties of products are outlined in technical standards and specifications. Conversion to the metric system would require USA to replace its technical standards and specifications with the technical documentation of metric countries. The bill, therefore, provides that the study investigate the utility of metric standards and compare them with those currently being used by American industry.

"This is the hard core of the 'conversion' question. Close exposure in ISO activities has convinced many of us that many of the standards of the metric countries are not as technically advanced, nor as sophisticated as those now in common use within our country. This is particularly true of fastener standards. I believe it is important that American industry should appreciate this 'documentation gap' before it unwittingly swaps a well-trained thoroughbred for a Shetland pony.

"2. S. 2356 specifically directs that recommendations be returned on suitable means to meet the practical difficulties and the costs involved in those instances where conversion would cause significant hardship.

"3. S. 2356 provides that those areas be delineated in which the USA has a provable technical superiority over that of the metric countries. The intent is that if such areas exist, the USA should not only retain its own system of weights, measures, and standards, but should actively promote their acceptance internationally.

"This is a strong point. It recognizes that full conversion may not be entirely wise, and that USA should be hesitant to surrender any part of its system in exchange for something known to be inferior. Rather, USA should take a positive stand to retain its best and encourage others to change their system to agree with ours.

"In summary, S. 2356 directs that a complete honest and objective study be conducted with all of the various elements of the "conversion" problem studied fairly and in depth. It is designed to get all of the facts out in the open so that when recommendations are developed, they will be truly representative and in the best interests of the USA."

Sincerely,

H. RANDALL SMART, *President.*

NATIONAL MACHINE TOOL BUILDERS' ASSOCIATION,  
Washington, D.C., November 15, 1967.

HON. WARREN G. MAGNUSON,  
Chairman, Senate Commerce Committee,  
5202 New Senate Office Building,  
Washington, D.C.

MY DEAR SENATOR MAGNUSON: The National Machine Tool Builders' Association is a voluntary trade association consisting of 231 companies engaged in the design, manufacture and sale of machine tools. Our members account for roughly 85 percent of the total production of the American Machine Tool Industry, amounting to approximately 1.6 billion dollars.

We are writing to indicate our support for S. 2356, currently under consideration by your Committee, to authorize the Secretary of Commerce to study and

make specific recommendations for an improved system of weights and measurements for United States and international use.

Our Association has long been concerned about the recurring question of conversion to metric measurement in the United States. This concern led us in 1965, when this Committee was considering proposed legislation for a study of the merits of the metric system, to issue the following statement:

"The National Machine Tool Builders' Association finds an overwhelming opinion among its members to continue the use of the 'decimal inch' system of measurement in the United States.

"In the opinion of United States Machine Tool Builders, there is no pressing need for, nor advantage in, a conversion to the metric system. To convert today would involve disruption of the over-all production capacity of the United States and monumental confusion and unbearable costs to the United States metal-working industry."

The National Machine Tool Builders' Association strongly endorses the approach taken in S. 2356 that any study of alternative systems of weights and measures should be comprehensive in scope, providing a full opportunity for those who would be affected by any change to present their views. Any such study should result in specific recommendations which take into account the viewpoints of those affected and the costs and practical problems involved in any conversion. We feel that the approach taken in S. 441 is insufficient in both of these regards.

Sincerely yours,

JAMES A. GRAY,  
*Executive Vice President.*

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AMERICAN BOOK PUBLISHERS COUNCIL, INC.,  
*New York, N.Y., November 16, 1967.*

HON. WARREN G. MAGNUSON,  
*Chairman, Committee on Commerce,  
U.S. Senate,  
Washington, D.C.*

DEAR MR. CHAIRMAN: This is with reference to the Pell bill, S. 441, "To authorize the Secretary of Commerce to make a study to determine the advantages and disadvantages of increased use of the metric system in the United States."

At its annual meeting on November 13 and 14, the Technical, Scientific and Medical Book Publishers Group of the American Book Publishers Council reviewed the subject of the increasing world-wide use of the metric system and its potential effect on the export market for American scientific, technical and medical books. We are convinced that this may evolve into a serious problem for our export market which has grown to the point where we, in recent years, have been the leading country in the international market.

The group passed a resolution endorsing S. 441 and instructed me, as chairman, to write you expressing our hope that your committee and the Senate will take favorable action on the bill. We would also like to have this letter incorporated in the printed record of the hearing which I understand was held before your committee on November 15.

Sincerely yours,

JOHN W. WIGHT,  
*Chairman, Technical, Scientific and Medical Book Publishers Group.*

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GENERAL ELECTRIC CO.,  
*New York, N.Y., November 17, 1967.*

HON. WARREN G. MAGNUSON,  
*Chairman, Committee on Commerce, U.S. Senate, 124 Old Senate Office Building,  
Washington, D.C.*

DEAR CHAIRMAN MAGNUSON: On behalf of the General Electric Company, I am submitting this statement in regard to S. 441 introduced by Senator Claiborn Pell and S. 2356 introduced by Senator Robert Griffin which your committee is considering.

The General Electric Company has been studying the question of a nationwide change to the metric system for several years and it has long recognized the many technical advantages of the metric system.

However, the problem of change to the metric system is not one that can be solved by simple agreement among scientists and engineers. Instead, it is an economic problem and conversion will have to be justified to a large degree by the economic payoff that will result.

It is clear that more information is needed about the effects of a change to the metric system. General Electric has in previous Congresses favored a federal study of the type proposed in S. 441 and S. 2356 and continues to do so. However, such a study should be carried out under the leadership of business and industrial people, in addition to scientists and engineers. American businessmen have been engaged in foreign trade and foreign manufacture for many years. We believe their knowledge of world business may be in greater depth than that of the specialists in scientific fields or in the basic standards laboratories. The study should take full advantage of the knowledge and experience which industry has acquired.

As for the study itself, we believe it should evaluate :

1. The cost of the change to all the various branches of business and industry, to the federal government itself, and ultimately to the private citizen.

2. The effect of the change on our foreign trade position from both a short- and a long-range viewpoint.

3. The effect of the change on future acceptance of U.S. modules, sizes, ratings, test procedures and practices in international documents of commerce, including especially international standards.

If the study gives favorable results on these questions, it should then attempt to develop a schedule for changeover and propose a set of recommendations to minimize the conversion costs.

General Electric can support either of the bills under consideration by your committee but would suggest that any final legislation include paragraphs along the lines of sections 1(3), 2(5) and 2(6) of S. 2356. If such legislation is approved, General Electric will give what assistance it can in making the study a successful one.

Sincerely yours,

W. A. McADAMS,  
*Manager, Industry Standards.*

*New York, N.Y., November 27, 1967.*

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION,

HON. WARREN G. MAGNUSON,  
Subject: Metric system (S. 441 et al.).  
*Committee on Commerce,*  
*U.S. Senate, Washington, D.C.*

DEAR MR. CHAIRMAN: The National Electrical Manufacturers Association, NEMA, wishes to record its support of pending legislation (S. 441 et al) whose purpose is to authorize the Secretary of Commerce to conduct a program of investigation, research, and survey to determine the impact of increasing worldwide use of the metric system on the United States; to appraise the desirability and practicability of increasing the use of metric weights and measures in the United States; and to evaluate the costs and benefits of alternative courses of action which may be feasible to the United States.

The question of the effects of increased use of the metric system is of substantial importance to the electrical manufacturing industry, whose products are highly technological and whose trade is worldwide. A carefully planned and detailed study, with appropriate participation by competent parties, is essential and overdue.

The Association wishes to offer its cooperation and participation under appropriate provisions of Section 2 of the proposed Act. NEMA, America's largest trade association for manufacturers of electrical products, has recognized leadership, at both the National and International levels, in the electrical technology and standardization field and feels that its broad coverage of the electrical industry can be most helpful to the Secretary of Commerce in implementing the Act.

Sincerely yours,

JOSEPH F. MILLER,  
*Executive Vice President.*

FORD MOTOR CO.,  
*Dearborn, Mich., November 27, 1967.*

HON. WARREN G. MAGNUSON,  
*Chairman, Senate Commerce Committee,*  
*U.S. Senate, Washington, D.C.*

MY DEAR MR. CHAIRMAN: I have been asked to comment for the Ford Motor Company on the various proposals before the Congress for study of the Metric System.

We believe that Congress should undertake a broad based study of the kind described in S. 2356 (Griffin), S. 411 (Pell) and H.R. 3136 (Miller) and that substantial participation by industry is important to the study's success.

The benefits of a single measuring system in a world-wide, interdependent economy are so great that we believe that the conversion to the metric system is inevitable. Although there may be short term costs and confusion such a far reaching change, the long term gains appear to be overwhelming for any country that expects to be an active participant in world commerce and trade. The basically simple structure of the metric system also carries with it many substantial benefits, even for an isolated user.

The magnitude of the conversion task in the automobile industry is such that any attempt at conversion on a crash basis would be chaotic, both physically and financially. On the other hand, a well planned conversion can minimize both the cost and confusion, and permit the benefits of the system to be realized at the earliest possible date.

The Company recently published a report entitled "Measuring Systems and Their History" which was the first of a series of reports under the overall title "Ford and the Metric System". The second publication in the series, "World-wide Use of Measuring Systems", was distributed to company management in March 1967. Copies of these two documents were mailed to members of the Senate and House at a later date.

Our purpose in preparing these reports was to set a frame of reference for our management so that they might be better prepared to discuss the metric system and assist in any objective studies of its use.

We are certain that any program for more extensive use of metric units in the United States must:

1. be based on a thorough study of all factors and costs involved,
2. have government participation and planning, and
3. be carefully scheduled over a long time period to minimize the impact of the change on day-to-day operations.

The Ford Motor Company already has a degree of involvement in metric usage because of its world-wide activity. We will welcome the opportunity of participating with you or other members of Congress in a further examination of this important subject.

Sincerely,

H. L. MISCH.

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AMERICAN PHARMACEUTICAL ASSOCIATION,  
*December 8, 1967.*

Re S. 441 and S. 2356, 90th Congress, first session.

HON. WARREN G. MAGNUSON,  
*Chairman, Committee on Commerce,  
U.S. Senate,  
Washington, D.C.*

MY DEAR SENATOR MAGNUSON: The American Pharmaceutical Association is the national professional society of pharmacists in the United States and represents about 45,000 members. The APhA comprises several subdivisions. One of these, the Academy of Pharmaceutical Sciences, provides an organization within the APhA for some 17,000 pharmaceutical scientists members who are associated largely with our colleges of pharmacy, the pharmaceutical industry, and government and private laboratories.

The APhA, on behalf of its members, its Academies and Sections, supports the objectives embodied in S. 441 and S. 2356. We believe that these proposals look toward use of the metric system in this country and the adoption of the metric system and the standardization achieved thereby would greatly benefit the public and industrial community. This view has been supported by most research and scientific bodies in this and other countries for many years. In this connection, representatives of our society testified in 1965 in favor of S. 774 and H.R. 2626, somewhat similar measures, before the Committee on Commerce of the United States Senate and before the Committee on Science and Astronautics of the House of Representatives.

Although not the oldest system of weights and measures, the metric system is the most universal and rational, as well as one of the most useful and easily learned since it is based upon the decimal system thereby allowing usage over a large range of magnitudes. It offers convenience and clarity.

All units vary regularly by a factor of ten. Even nomenclature is consistent and universally understood. In metric length, for example, a decimeter is one-tenth of a meter, and a dekameter is 10 meters; in metric volume, a deciliter is one-tenth of a liter and a dekaliter is 10 liters; in metric weight, a decigram is one-tenth of a gram, and a dekagram is 10 grams. Similarly, when the dose of a drug is one milligram and a supplier provides the drug in one gram vials, he provides 1,000 one milligram doses. When the drug manufacturer produces the drug in 10 kilogram lots, since one kilogram equals 1,000 grams, then 10 kilograms equals 10,000 grams; since one gram equals 1,000 milligrams, then 10 kilograms equals 10,000,000 milligrams or 10 million doses. Calculation to interchange units becomes a simple matter that is convenient and easily understood.

The APhA publishes the *Journal of Pharmaceutical Sciences*, an internationally known and respected scientific publication and the *Journal of the American Pharmaceutical Association*, a professional publication for practicing pharmacists. Today, manuscripts published in our journals, just as in many other scientific journals, exclusively employ the metric system for describing weights and measures. Not too many years ago, however, the English or apothecary system of weights and measures was popularly employed. The use of the metric system in scientific and professional publications in pharmacy, chemistry, and biology generally, has provided a standardization in print which is clear, concise, and universally understood throughout the world.

The metric system provides a common language, permits precise reproducibility of experimentation, and enables the development of similar standards.

The APhA also publishes the *National Formulary*, which is one of the official compendia recognized under the food and drug laws of the Federal and State governments. When the *National Formulary* first began publication in 1888, the system of weights and measures employed in the compendium then, reflecting the practice of pharmacy of that period generally, was the English or Apothecary system. Around the turn of the century, the pharmaceutical profession began recognizing the need for and value of a change to the metric system. This was reflected in the use of the metric system in the *National Formulary* published about 1900 which listed both metric and apothecary weights and measures, side by side in tabular form, under each monograph or description for drug substance or drug composition.

This was the first official step by the APHA to convert the practice in American pharmacy from the apothecary to the metric system of weights and measures. Subsequent editions of the *National Formulary* then emphasized the metric system, although for several revisions the equivalent to the metric dose was frequently given parenthetically in apothecary weight or measure.

Such steps provided for the orderly transition and familiarity with the use of the metric system in the practice of pharmacy over a period of some 40 to 50 years. The use of apothecary equivalents in the *National Formulary* was deleted entirely with the publication of the 10th edition in 1955. The transition was accomplished at this leisurely pace because:

- (a) The metric system was less well known and accepted then than it is today;
- (b) Many other countries and most of the other professions in this country utilized the English system;
- (c) Except for its obvious facility of use, there was little driving force toward its adoption in the pharmaceutical field.
- (d) Because of the precedent setting nature of the conversion by the entire pharmacy profession and industry, it would be expected that each step would be taken with great care and progress would be slower.

Under prevailing conditions of education, interest, and world conditions, we would anticipate that other professions and industries within the United States could achieve the conversion far more rapidly. Today the English system or apothecary system is so completely out-dated that it is being abandoned in favor of the metric system, even in the United Kingdom where it was founded.

In the past, the pharmacy profession in the United States has employed both the avoirdupois and the apothecary systems of weights and measures in the handling of medicines. In order to avoid confusion, the community pharmacist had to clearly establish in his mind that the avoirdupois system was used to buy and sell goods other than on prescription. The apothecary system, on the other hand, was used to dispense prescriptions and sometimes to compound bulk medicines. The pharmacist thus bought in the avoirdupois system and sold or dispensed in the apothecary system. These systems differ in that 1 pound avoirdupois is 7,000 grains and 1 pound apothecary is only 5,700 grains. Similarly, 1 ounce avoirdupois is 437.5 grains, and 1 ounce apothecary is 480 grains. Today, clearly,

because of the influence of the *National Formulary* and other scientific and professional publications, the pharmacist has been taught to use and does use the metric system. The medical profession also is employing the metric system. Doses are remembered, calculated, prescribed, and drugs are compounded in the metric system. In this regard the use of the metric system by the pharmaceutical manufacturers also has helped considerably in the conversion to metric practice. The 5-grain aspirin tablet is still familiar, but the official dose is 300 milligrams in the metric system, and the apothecary equivalent essentially is only popular nomenclature.

The pharmaceutical science employ the metric system in teaching, in textbooks, in research and development of drugs, in the synthesis of drug compounds, in the manufacture of drugs into dosage forms, and in dispensing drugs to patients. Practitioners who learned other systems of weights and measures have had to learn to use the more modern metric system.

It is interesting to note, however, that although the use of the metric system today is not compulsory in this country, its use has been legal since 1866. Since 1893 the National Bureau of Standards has been authorized to derive the yard from the metric, and the customary or popular weights are referred officially to the kilogram, both of which are metric standards. It is required that the metric system shall be used exclusively in the medical departments of the Army, the Navy, the Air Force, the Public Health Service, and the Marine Hospital Service of the United States. In 1890 the *United States Pharmacopeia* adopted the metric system of weights and measures exclusively, except for the statement of equivalent dosage, and then deleted even this in its 1955 edition. The metric system today is universally employed by all modern pharmacopeias. In 1944 the Council on Pharmacy and Chemistry of the AMA adopted the metric system for exclusive use in its publication, *New and Non-Official Remedies* (now titled *New Drugs*). The metric system now is taught exclusively in most of the medical schools of this country.

The metric system also is used by many other professional groups, although unfortunately not exclusively because of practices passed on from generation to generation in the fields of engineering, technology, and even commerce. Yet teaching every child the interrelationships between the English, the avoirdupois, the Troy, and the metric system and other miscellaneous equivalents is no small accomplishment. Most people attain adulthood without being able to convert these interrelated quantities with ease and confidence. Those who say that the housewife who has learned the present American (English) system of weights and measures would have difficulty in learning a new system do not give the housewife proper credit. If she could learn our present system, she should have no difficulty at all in learning the metric units.

The convenience of use and understanding of the metric system minimizes the possibility of error in calculations involved in many industrial operations. It simplifies record and bookkeeping, billing and purchasing. In recent years, most major American pharmaceutical manufacturers have converted their operations completely to the metric system. This has been done to provide better and more uniform control and thus greater assurance of safety to consumers of drugs from possible errors which might arise in converting between different systems. It also has been done to provide better manufacturing efficiency through more intelligent and easily readable manufacturing forms, inventory records, cost analyses and other recording devices which could be maintained more uniformly in the metric system. These standardized and uniform records today lend themselves readily to use in data processing equipment and modern business recording systems.

In pharmaceutical firms the conversion of manufacturing operations to the metric system generally has been a relatively easy matter. It was necessary to provide metric scales in place of avoirdupois scales, or reconvert weighing equipment to show metric subdivisions; it was also necessary to replace weights and measures with metric counterparts.

More difficulty generally was encountered in convincing chemical suppliers that a firm wanted to purchase all of its raw materials according to the metric system. But even here, the experience has been that suppliers have readily agreed to sell and bill their materials in metric equivalents because this was what the customer wanted. Frequently, even today, bulk containers of chemical and drug materials purchased for pharmaceutical manufacture will show both the metric quantity and the avoirdupois equivalent. Even sugar and salt, which are food staples, are purchased for pharmaceutical use by metric weight even though the bags might have to be stencilled to show the metric weight.

The conversion process in the pharmaceutical industry also necessitated changes in product labels, package inserts, catalogs, and other printed matter. This was accomplished over a period of time as new printing was required and frequently both the metric and avoirdupois or apothecary equivalents were shown.

Mr. Chairman, in the event that S. 441 is enacted, the APhA and the pharmaceutical scientists generally would welcome the opportunity to share further their knowledge and experience as to the advantages of increased use of the metric system in the United States.

The American Pharmaceutical Association appreciates the opportunity to present its thoughts on S. 441 to your Committee and respectfully request that this statement be incorporated in the record of S. 441.

Sincerely,

WILLIAM S. APPLE.

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NATIONAL SOCIETY OF PROFESSIONAL ENGINEERS,  
Washington, D.C., February 14, 1968.

HON. WARREN G. MAGNUSON,  
Chairman, Committee on Commerce,  
U.S. Senate, Washington, D.C.

DEAR SENATOR MAGNUSON: The National Society of Professional Engineers has reviewed the several bills pending before the committee to provide for a study by the Secretary of Commerce of the advantages and disadvantages of conversion to the metric system in the United States, and we urge adoption of legislation to authorize such a study.

Any shift to the metric system necessarily would directly involve all segments of the engineering profession. Accordingly, our Society—which is composed of 67,000 members, all of whom are qualified under applicable state engineering registration laws—is deeply interested in this important and critical subject. We favor a broad and thorough study which will impartially explore the feasibility, costs, problems and benefits of conversion to the metric system, as well as various possible alternatives, before any wholesale conversion is either undertaken or rejected.

We will be happy to cooperate with the committee and the Department of Commerce in any way possible to assure that the engineering aspects of this subject are fully presented and considered.

Very truly yours,

PAUL H. ROBBINS, P.E. *Executive Director.*

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