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U.S. METRIC STUDY INTERIM REPORT

COMMERCIAL WEIGHTS AND MEASURES

U.S. METRIC STUDY

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U.S. METRIC SUBSTUDY REPORTS

The results of substudies of the U.S. Metric Study, while being evaluated for the preparation of a comprehensive report to the Congress, are being published in the interim as a series of NBS Special Publications. The titles of the individual reports are listed below.

REPORTS ON SUBSTUDIES

NBS SP345–1:	International Standards (issued December 1970, SD Catalog No. C13.10:345–1, price $1.25)
NBS SP345–2:	Federal Government: Civilian Agencies (issued July 1971, SD Catalog No. C13.10:345–2, price $2.25)
NBS SP345–3:	Commercial Weights and Measures (this publication)
NBS SP345–4:	The Manufacturing Industry (issued July 1971, SD Catalog No. C13.10:345–4, price $1.25)
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NBS SP345–7:	The Consumer (in press)
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COMPREHENSIVE REPORT ON THE U.S. METRIC STUDY

NBS SP345:	To be published in August 1971

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U.S. METRIC STUDY INTERIM REPORT

COMMERCIAL WEIGHTS AND MEASURES

Third in a series of reports prepared for the Congress

U.S. METRIC STUDY
Daniel V. De Simone, Director

U.S. National Bureau of Standards Special Publication 345–3

UNITED STATES DEPARTMENT OF COMMERCE
Maurice H. Stans, *Secretary*
NATIONAL BUREAU OF STANDARDS
Lewis M. Branscomb, *Director*

Nat. Bur Stand. (U.S.), Spec. Publ. 345–3, 116 pages (July 1971)
CODEN: XNBSA

Issued July 1971

For sale by the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402
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LETTER OF TRANSMITTAL

THE HONORABLE PRESIDENT OF THE SENATE
THE HONORABLE SPEAKER OF THE HOUSE OF REPRESENTATIVES

SIRS:

I have the honor to present the third in the series of interim reports stemming from the U.S. Metric Study, prepared by the National Bureau of Standards.

This Study was authorized by Public Law 90-472 to reduce the many uncertainties concerning the metric issue and to provide a better basis upon which the Congress may evaluate and resolve it.

I shall make a final report to the Congress on this Study in August 1971. In the meantime, the data and opinions contained in this interim report are being evaluated by the Study team at the National Bureau of Standards. My final report to you will reflect this evaluation.

Respectfully submitted,

Maurice H. Stans

Secretary of Commerce

Enclosure

LETTER OF TRANSMITTAL

Honorable Maurice H. Stans
Secretary of Commerce

Dear Mr. Secretary:

I have the honor to transmit to you another interim report of the U.S. Metric Study, which is being conducted at the National Bureau of Standards at your request and in accordance with the Metric Study Act of 1968.

The Study is exploring the subjects assigned to it with great care. We have tried to reach every relevant sector of the society to elicit their views on the metric issue and their estimates of the costs and benefits called for in the Metric Study Act. Moreover, all of these sectors were given an opportunity to testify in the extensive series of Metric Study Conferences that were held last year.

On the basis of all that we have been able to learn from these conferences, as well as the numerous surveys and investigations, a final report will be made to you before August 1971 for your evaluation and decision as to any recommendations that you may wish to make to the Congress.

The attached interim report includes data and other opinions that are still being evaluated by us to determine their relationship and significance to all of the other information that has been elicited by the Study. All of these evaluations will be reflected in the final report.

Sincerely,

Lewis M. Branscomb

Lewis M. Branscomb, *Director*
National Bureau of Standards

Enclosure

FOREWORD

This report explores the probable effects of a metric changeover on commercial weights and measures activities. It primarily concerns two aspects of commercial weights and measures that would have to be dealt with in any metric changeover:

(1) The cost of adapting or changing commercial weighing and measuring devices to record and/or indicate in metric units.
(2) The effects of metrication on state and local weights and measures jurisdictions.

Reports covering other substudies of the U.S. Metric Study are listed on the inside front cover. All of these, including this report, are under evaluation. Hence, they are published without prejudice to the comprehensive report on the entire U.S. Metric Study, which will be sent to the Congress by the Secretary of Commerce in August of 1971.

This report was prepared by Mr. Stephen L. Hatos of the Office of Weights and Measures, National Bureau of Standards.

The Office of Weights and Measures is grateful for the contributions made by the Scale Manufacturers Association, the Gasoline Pump Manufacturers Association, the National Scale Men's Association, and the Task Force on Metrication of the National Conference on Weights and Measures.

In this as in all aspects of the U.S. Metric Study, the program has benefited from the independent judgment and thoughtful counsel of its advisory panel and the many other organizations, groups, and committees that have participated in the Study.

Daniel V. De Simone, *Director*
U.S. Metric Study

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SUMMARY AND RECOMMENDATIONS

PURPOSE

The purpose of this report is to:

1. Identify and describe the impacts (cost, time, etc.) of changing selected commercial weighing and measuring devices to record and/or indicate in metric units.
2. Analyze the problems that increased metric usage would have on state and local weights and measures jurisdictions (e.g., laws and regulations, testing equipment, and training programs).

BACKGROUND

Evidence indicates that evolutionary metrication in the commercial weights and measures area is unlikely. Consequently, it is felt that a national metrication program would be needed in order to advance the usage of metric units in this area.

SUMMARY: FINDINGS OF FACT AND CONCLUSIONS

ATTITUDES TOWARD METRICATION

A. Sixty-seven percent of the 15 weighing and measuring device manufacturers responding to our industry questionnaires were in favor of metrication; a like percentage, of the same respondents, were in favor of a mandatory metrication program based on legislation.

B. Sixty-four percent of the 63 weights and measures jurisdictions responding to our jurisdiction questionnaire were in favor of metrication.

BENEFITS OF METRICATION

Device manufacturers, in fact, 73 percent of the respondents, and many weights and measures jurisdictions felt there would be benefits in using the metric system. However, benefits, even if substantial, are apparently difficult to express in quantitative terms and no respondent offered any analysis showing them in dollars and cents. In general, those surveyed felt that benefits would arise because the metric system is an easier system of measurement to understand and to use as compared with the U.S. customary one. Although, not mentioned directly, it appears that respondents were thinking in terms of more efficient use of personnel; for instance, the use of the metric system may reduce the amount of time spent by employees in doing measurement calculations. *Note:* Because of the problems of determining the benefits of metrication, the overall economic effects, positive or negative, are difficult to determine. In the absence of sound data on benefits, it was felt wise to avoid estimating net economic consequences. However, because cost data are easier to obtain than those for benefits, there may be a tendency to look only at the cost side. This could lead one to see little or no advantages to metrication.

METRIC ADAPTATION OF WEIGHING AND MEASURING DEVICES

A. The production of weighing and measuring devices to record and/or indicate in metric units does not represent a serious problem. In fact, a number of manufacturers already produce such devices in either their domestic or foreign plants, and thus they have already acquired some of the needed expertise in order to carry out a metric adaptation program.

B. The adaptation of devices now in use would present problems. The limited number of qualified service personnel coupled with the large numbers and varieties of devices now in use precludes quick field adaptation. The time that would be required to accomplish field adaptation is estimated at between 5 and 10 years with an accompanying cost of around $340 million.

WEIGHTS AND MEASURES JURISDICTIONS

A. Most weights and measures jurisdictions have little or no metric field testing equipment. In order to be able to efficiently test metric indicating and/or recording devices, it would be necessary for jurisdictions to either purchase new and/or adapt present testing equipment to indicate in metric units. The cost of such metrication nationwide would be about $1 million.

B. Weights and measures inspectors would have to undergo instruction in order to be able to understand and use the metric system of measurement in their operations. Each inspector would have to have about 40 hours of instruction. The cost (estimated to be about $3.1 million) of such training would include (1) educational materials, (2) loss of time from job, and (3) where necessary, instructors' salaries.

C. State weights and measures laws recognize both the U.S. customary and metric systems of measurement in commercial transactions. As a result, there is usually no legal impediment in using the metric system in the buying and selling of products. However, these laws usually require that certain packaged commodities (e.g., milk and bread) be sold in specified quantities in terms of U.S. customary units. Since a language change would result in inconvenient metric sizes, size changes for these commodities would be desirable.

D. A state's ability to legislate in the area of packaging and labeling has been restricted by Federal laws such as the Fair Packaging and Labeling Act, Public Law 89-755 (80 Stat. 1296). Federal laws, and the regulations issued under them, in some cases, preempt a state's authority in this area, or require that State laws and regulations cannot be less stringent than the Federal ones.

E. NBS Handbook 44, *Specifications, Tolerances, and Other Technical Requirements for Commercial Weighing and Measuring Devices,* would have to be revised to make use of metric units where none now exist. This Handbook has been promulgated in all but two states as the official regulation for determining the correctness and accuracy of weighing and measuring devices used in commerce.

RECOMMENDATIONS

1. It is strongly suggested that, in the event the United States should decide to convert to the metric system in commercial weights and measures, a coordinated program of metrication for this area be established with a required date(s) for ending the use of customary units on package labels and commercial weighing and measuring devices. It should be understood that such a program would have to have an appropriate transition period. Leadership for this program should come from the Federal Government and be coordinated through the National Conference on Weights and Measures (NCWM). (The NCWM is sponsored by the National Bureau of Standards via the Office of Weights and Measures.) This organization is an ideal body for such coordination since it has members representing all segments of the weights and measures community, e.g., weighing and measuring device manufacturers, retailers, food packers, weights and measures jurisdictions, etc.

2. In the event of metric conversion, the states should be encouraged, via the NCWM, to change the existing sections of their weights and measures laws and regulations dealing with specified quantities for certain packaged commodities (e.g., milk, bread, and butter). Revised sections could require the affected commodities to be sold in convenient metric units. Such changes would, of course, affect manufacturing practice and care would have to be

taken in specifying new metric quantities to make sure that industry could meet any new requirements without incurring large costs.

3. To achieve uniformity in the packaging and labeling area, it is suggested that Congress enact amendments to existing package labeling laws which would require that (1) most packaged products be labeled in both metric and U.S. customary units, and (2) provide that after a reasonable period of time, the use of customary units would be optional. It is felt that, since any metrication program would stress metric education in the schools and in society in general, after a period of years the metric system would be preferable to the consumer. Also, state laws should be in conformity with Federal legislation and Congress should so require.

A major exception to this dual labeling scheme would be random weight packages such as fresh meats and cheese. The labels for these packages are usually prepared by electronic prepackaging scales, and it is not economically feasible to adapt these devices to print labels in dual systems. Consequently, since consumers will need some aid in order for them to be able to relate to the metric labeling on these items, it is recommended that conversion charts be posted at the point of sale of such packages.

INTRODUCTION

PURPOSE

The purpose of this report is to:

1. Identify and describe the impacts (costs, time, etc.) of changing selected commercial weighing and measuring devices to record and/or indicate in metric units.[1] The process for changing devices in this manner is commonly called adaptation.[2]

2. Analyze the problems that increased metric usage would have on state and local weights and measures jurisdictions (e.g., laws and regulations, testing equipment, and training programs).

BACKGROUND

The U.S. Metric Study analyzes the possible impacts of metrication on the United States taking two different approaches. The first approach uncovers and explains these impacts assuming no action on the part of the Federal

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[1] A commercial device may be generally defined as one used in the buying and/or selling of products, services, etc. For a complete definition see NBS Handbook 44, *Specifications, Tolerances and Other Technical Requirements for Commercial Weighing and Measuring Devices* (1970), G.A. 1, p. 27 (see III. Suppl., p. 88).

[2] Adaptation does not mean that the device itself (internal components, housing, etc.) must be redesigned to metric specifications and tolerances, etc. Adaptation in this case means a language change from U.S. customary units to metric units; that is, the device will now record in metric units instead of U.S. customary units. Any new parts required to make this language change would be designed in the most convenient units and standards. The end result would, no doubt, be a device designed in U.S. customary units, which is the present situation, but said device will indicate and/or record in metric units.

Government to specifically increase the use of the metric system nationally. This is essentially an evolutionary approach. The second approach identifies and describes the impacts of increased metric usage assuming a nationally planned metrication program, for all sectors of the economy. However, for commercial weights and measures, it appears that government action will be necessary if metrication is to take place; i.e., the evolutionary approach will not work.

Commercial weights and measures can be defined as all matters involving the commercial determination of quantity. It includes any and all services and merchandise that are bought or sold. Historically, the control of commercial weights and measures has rested with state and local units of government.

The laws governing commercial weights and measures generally require that the determined quantity be stated in one of two systems of weights and measures—U.S. customary or metric. This is true whether the quantity is being determined at the time of sale with both parties represented, or whether the quantity is predetermined and presented on a package label or an invoice accompanying a bulk shipment.

Until recently, Federal laws in the commercial weights and measures area were also permissive in that either of two systems could be employed in quantity determinations for most products. With the advent of the Fair Packaging and Labeling Act (FPLA) in 1966, all consumer commodities subject to that Act are required to be labeled in the U.S. customary system. Prior to FPLA, most commercial transactions, governed by Federal law, were permitted to use metric. This option was clearly provided by the Act of July 28, 1866,[3] which allows anyone to use the Metric System who wishes to, but requires no one to do so. Most state weights and measures statutes also provide this option.[4]

For more than 100 years, then, the option to use the metric system has been available. Despite this, there has been little or no movement to use metric units in commercial transactions. "This status quo situation appears to be the result of the fact that neither consumers nor businessmen understand the metric system of measurement."

The findings of the U.S. Metric Study Report on the Consumer, NBS Special Publication 345-7, indicate that unfamiliarity with the metric system is widespread. Only 40 percent of the individuals surveyed in the Study were able to name even a single metric measure. Apparently, this situation has had a direct effect upon the users and manufacturers of commercial weighing and measuring devices. Retailers using scales and meters, and supplying packaged commodities, have little or no incentive to provide quantity information for consumers in a system with which both are almost totally unfamiliar.[5] The manufacturers and packagers, in turn, sense no demand for

[3] 15 U.S.C. 204 (see III. Suppl., p. 96).

[4] The weights and measures laws of 47 States, plus Puerto Rico and the District of Columbia, either recognize or authorize the Metric System for commercial transactions.

[5] The findings of the U.S. Metric Study Report on Nonmanufacturing Businesses, NBS Special Publication 345–5, indicate that there is major support for a planned conversion program. About 86 percent of the respondents favored a planned program; in fact, 62 percent

metric devices or metric quantity information on packaged goods and, therefore, have no incentive to supply it. If either the retailing or manufacturing segments in the commercial weights and measures area were to supply devices or packaged goods in the Metric System, it would have to be in response to consumer demand in order for the various enterprises to survive competitively.

Coupled with this is the fact that enforcement efforts are a direct result of conditions in the marketplace. Since only the customary system is used, the test equipment used by weights and measures officials are in that system. Moreover, the rules, regulations, and specifications, promulgated and enforced by state and local weights and measures agencies, also reflect marketplace conditions.

It can be seen that the use of the U.S. customary system in commercial weights and measures transactions appears to be self-perpetuating. The available historical evidence indicates that there is no incentive to change. So long as there is no change, there is no opportunity for the public to become acquainted with a new system of measurement in that area of their daily life most directly affected by measurement decisions. Distributors of goods and services are constrained to provide that which the public demands. Suppliers and manufacturers, in turn, are affected by the same constraints.

Historical evidence from Japan, the only major industrial nation that has undergone and, for the most part, completed a metrication program, tends to support the view that voluntary metrication in commercial weights and measures is not feasible. The Japanese experience with this approach over a 40-year period was unsuccessful. The public preferred the older more familiar Japanese units, and, thus, ". . . the government decided to establish a regulation to abolish the verification and use of instruments with nonmetric indications . . ."[6]

The exact approach to be used by Great Britain (which is now undergoing metric conversion) to bring about metric usage in the marketplace is uncertain at this time. However, it appears that Britain may take the voluntary one. Considering the Japanese experience it is questionable whether Britain will be able to bring about the widespread use of the metric system in the marketplace using this approach.[7]

In sum, commercial weights and measures in the United States are required by law to use one of two systems of measurement in the devices used to determine quantity, or the methods used to express quantity. This optional approach has resulted in overwhelming use of the U.S. customary system. Therefore, it seems highly unlikely that the use of the metric system in commercial transactions will increase without a prescribed program to bring about metric usage in this area.

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favored a mandatory approach. This represents the great bulk of the users of commercial weighing and measuring devices.

[6] Report of the 47th National Conference on Weights and Measures, 1962, p. 36 (see Suppl., p. 97).

[7] Going Metric—Progress in 1970, the Second Report of the Metrication Board 1971, London: Her Majesty's Stationery Office, pp. 29 and 100.

PLANNED METRICATION PROGRAM

(1) Under a planned metrication program for commercial weights and measures, it would be necessary to establish a date(s) for the required use of the metric system in the buying and selling of commodities (i.e., quantity descriptions only). In the case of package labels, a period of dual labeling would be allowed (customary and metric). Such a date(s) should be established far enough in advance, e.g., 10 years, so that the industries concerned with bringing about the necessary changes would have an appropriate period of time to accomplish them, and the public would have a chance to adjust to the new measurement system. (*Note:* The various segments (e.g., package labeling, metering and weighing) of commercial weights and measures may have different dates for completing metrication.) However, it is felt that industry and weights and measures jurisdictions should be free to develop the best method(s) for bringing about metrication in a voluntary cooperative way (within the time period prescribed). It is suggested that the National Conference on Weights and Measures (NCWM), sponsored by the National Bureau of Standards, be used as the main coordinating body for such a metrication effort, as the NCWM has representatives from every segment of the weights and measures establishment.

(2) The primary elements of a metrication program in this area would be as follows (not in any order of importance):

a. Replacing or adapting weighing and measuring devices and inspection equipment via a timetable.
b. Changing label quantity-of-contents statements first to dual measurement notation for a period of time and then to only metric units.
c. Revising laws, regulations, and technical specifications and tolerances in the weights and measures area where necessary at both the Federal and state levels.
d. Establishing training programs for persons engaged directly in commercial weighing and measuring activities (e.g., scale and meter service personnel, weights and measures officials, etc.).
e. Assisting the national effort to educate the public to be able to understand the metric system.

I. ADAPTATION OF WEIGHING AND MEASURING DEVICES

I-1. INTRODUCTION

There are two distinguishable levels where problems occur in the adaptation of weighing and measuring devices from one system to another; (1) the manufacturing or plant level, and (2) the field or user level. As a rule, the problems arising from metric adaptation at the plant level are not as great as at the user level. Many companies have had some experience in producing metric recording or indicating devices either in their domestic or foreign plants, but they have had little or no experience in adapting devices in the field.[1]

The problems arising out of field adaptation include the following:

1. The large variety and number of devices in use.
2. The limited number of qualified service personnel.
3. The large inventory of parts both for repair and adaptation purposes that service agencies would have to maintain.

In order to avoid undue complexity, the narrative discussions below on device adaptation have been limited to essential facts.

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[1] An exception to this general rule is a subsidiary of one U.S. meter manufacturer in South Africa. They have developed a procedure for adapting gasoline dispensers in the field as a result of the metrication program in that country.

I-2. STATISTICAL ANALYSIS: QUALIFICATIONS

Statistics for this chapter were gathered from questionnaires, interviews, and information request letters. The companies to be surveyed were arrived at by taking judgment samples of weighing and measuring device manufacturers as suggested by the Scale Manufacturer's Association, and the Office of Weights and Measures, National Bureau of Standards.[2]

The data presented should be considered as only approximate since (1) it is based upon respondent companies best estimates, and (2) in some cases, especially the cost data, figures have been rounded to convenient numbers. As a result of the uncertainties in the data (best estimates, rounding, etc.) it is suggested that the figures in the statistical summary table be viewed as representing the general magnitude of the actual universe figures.

In determining the costs and time required to adapt weighing and measuring devices to record or indicate in metric units at the manufacturing and user levels, the following conditions or assumptions were made: [3]

1. This survey is only interested in the impacts of adapting devices now being produced and/or in use. These devices will undergo changes and/or adjustments only so far as it is necessary to adapt them so that they will record or indicate in metric units. No other type of metrication will be considered.[4] That is, costs and time needed for metric adaptation will be based on these changes and/or adjustments plus related problems.
2. The design or engineering departments of a firm will not change their measurement usage. Any new parts required for adaptation will be designed using the present measurement system with associated engineering standards and "off the shelf" parts.
3. Production departments and service agencies will use the present measurement system except that there will be an increase in the use of metric mass and/or volume standards.

It must be clearly understood that the costs and time reported for the adaptation of devices is based on a very narrow form of metrication. Consequently, the initial plant costs, cost per device, and increase price per device could all increase substantially if other types of metrication are taking place at the same time.

In closing, the costs of field adaptation have to be viewed in a cautious manner. Companies have never undergone such a change as this, and therefore their costs are based on best estimates of what they think will be required. It is quite possible that costs due to unforeseen problems might arise which could alter the cost figures upward; or, in the alternative, the problems encountered may be less than anticipated and costs may be far less than expected. In any case, such unknown factors could alter costs signifi-

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[2] See app. I-1 for more information on the statistical base.

[3] These conditions or assumptions were made so that this survey would conform with the present practices of the scale and meter industries, as many of these companies already produce metric recording or indicating devices by adapting U.S. customary ones.

[4] The manufacturing survey is considering other aspects of metrication in the mechanical products industries.

cantly. As a result, to avoid giving a false impression of future costs, no attempt has been made to project present figures.

1-3. ADAPTATION OF WEIGHING DEVICES

DRUM AND FAN TYPE (MECHANICAL) COMPUTING SCALES

Drum and fan type computing scales (figs. 1-3) are generally used in grocery and candy stores to sell bulk items based on unit prices (cents/lb). These devices allow the user to determine, for a selected price per unit, the total price a customer must pay for any given weighed amount. For example, assume that potatoes are being sold at 39 cents/lb, and a customer has bagged potatoes weighing 2 lb 12 oz. The store clerk will weigh the bag, and the computing scale will enable him to quickly determine the total price to be paid. In this example that would be $1.07.

In order to adapt these scales, the price computation and weight indicator charts, if separate, would have to be replaced.[5] Present computation charts give total prices based on pounds and ounce fractions thereof for a range of selected prices per pound. Metric computation charts would compute total prices based on the kilogram and decimal fractions thereof for selected prices per kilogram. It now appears that if the new metric charts can be used within the present capacity of the devices leaving adequate adjustment capability, no other parts would have to be replaced. However, if new charts do not have their metric indications aligned exactly with ones now using customary units, recalibration would be necessary. That is, the linear distance on the customary and metric charts between any two equivalent points, measured either by linear or angular methods, (i.e., the linear distance from 0-10 oz on the U.S. customary chart and its equivalent 0-283.5 g on the metric chart) would not be the same. Also, in the case of drum computing scales, it will no doubt be necessary to replace the face plates just above and below the window openings. These plates contain the selected unit prices which refer to the total computed prices in the chart.

If, in order to adapt these devices, it is necessary to exceed their present capacity, new springs or pendulum weights would also be required for drum and fan scales, respectively. The additional parts would increase the cost as well as the service time needed to complete metric adaptation. It should be quite clear that recalibration would be necessary under these circumstances.

Before proceeding further, it should be noted that device users will have to inform scale manufacturers of the price ranges they desire on new metric computing charts. Scale manufacturers do produce several charts for these devices so that retail stores will have flexibility in choosing prices and it is to

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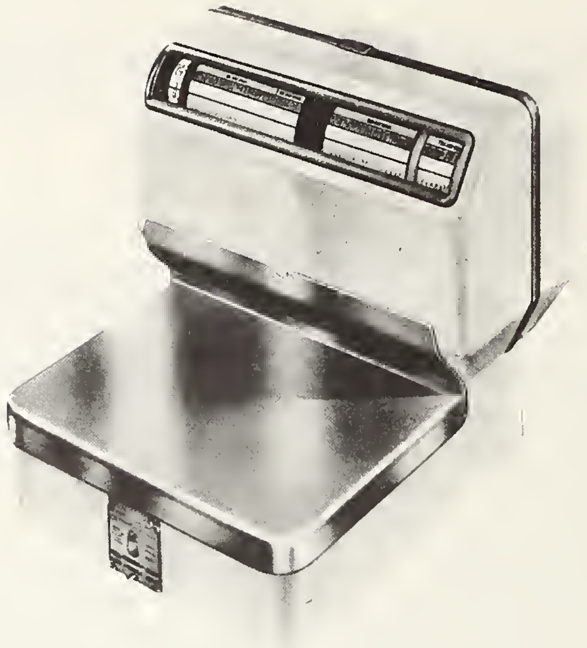
[5] Some manufacturers produce fan type scales which have weighbeams and poises. The weighbeam and possibly the poises would have to be replaced on these devices. On fan type scales the indicator arm usually contains the various per unit weight prices. However, since metric weighing would result in a new price structure (e.g., .39 cents/lb = .86 cents/kg) new indicator arms would probably be needed.



Drum Computing Scale

FIGURE 1

Drum Computing Scale

FIGURE 2

Fan Computing Scale

FIGURE 3

be expected that the same procedure will continue under metric usage. The price structures on metric charts, using the kilogram as a base, will be significantly different from the present ones. For example, 39 cents/lb would be 86 cents/kg, and 49 cents/lb would be $1.08/kg. Metric charts are now available for exported devices, however, it must be remembered that charts used in metric countries could not be used in this country since total prices are determined by using currencies other than the dollar. Thus, price structures could be radically different from those that would be used in this country.

Manufacturers foresee few problems in producing these scales so that they will indicate in metric units. Several manufacturers already produce such devices for export to countries using the metric system. Thus, many manufacturers already have the necessary expertise to accomplish metric adaptation at the plant level.

Manufacturers feel that adapting these devices in the field, even though not difficult, will be time consuming because of the large number of devices to be serviced, and the limited, already heavily burdened, service personnel.

Finally, manufacturers' estimates indicate that about 30 percent of these scales now in use will have to be completely replaced. But, because this represents devices which are over 15 years old, and thus at the end of their useful life, purchasing new metric devices would not be a metrication cost *per se*. That is, since these devices would be replaced anyway, their replacement cost would not be a cost of metrication.

PROJECTION SCALES

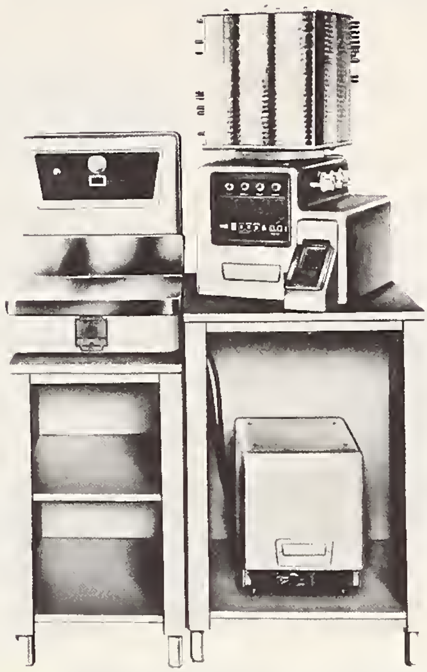
Another type of mechanical computing device is the projection scale (fig. 4). This type of scale usually contains a transparent chart with the required weight and price indications printed on it in extremely small type. These numbers are projected onto a screen via an optical system for viewing by both the customer (weight indications only) and by the user (weight and price indications). To determine the total price for a particular product using this scale, given the commodity's weight and unit price, the operator turns a selector dial to the proper unit price; then, on his screen in juxtaposition to the weight indication, the total price will come into view.

Adaptation of these scales essentially requires that the present charts be replaced with metric ones followed by recalibration. Of course, if the capacity of the device is altered significantly, other parts such as new levers may also be required.

Again, as with the mechanical computing scales discussed above, it would seem that adaptation of present devices in the field will be more troublesome than the production of such scales.

Projection Scale

FIGURE 4



Automatic Pre-Packaging Computing Scale
Electronic Type

FIGURE 5

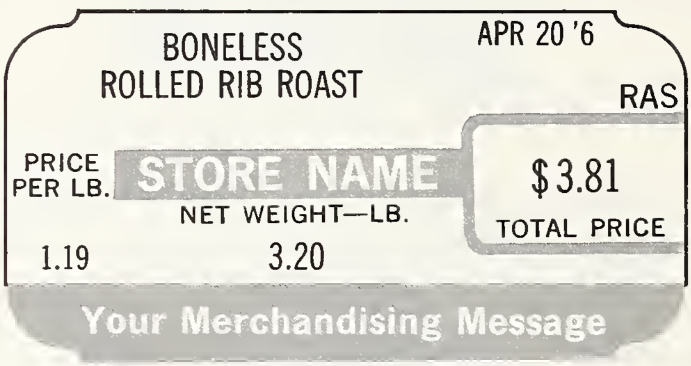
PREPACKAGING COMPUTING SCALES

Prepackaging computing scales (figs. 5 and 6) are used primarily to determine the total weight and price for random weight packages given any selected price per pound. These scales are for the most part used by supermarkets to label packages of fresh meat and cheese as packaged at the store. These devices automatically print a label which gives (1) the price per pound, (2) the total weight, and (3) the total price to be paid for a package.

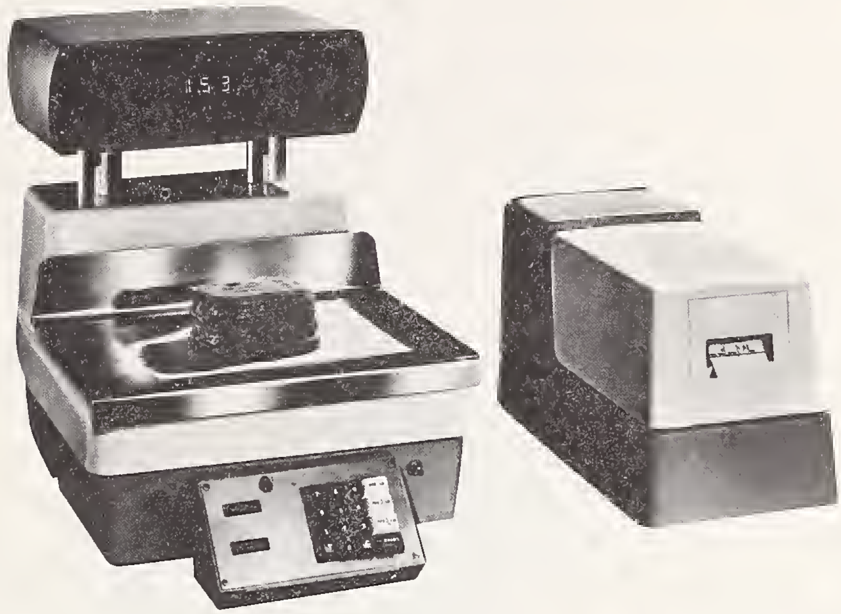
These scales, especially the newer models, are really a system composed of three elements: (1) a mechanical (spring type) weighing device, (2) a computer, and (3) a label printer. The weighing device moves either a transparent glass rectangular chart or rotating disc containing two types of weight indicators. The first type usually has weight indications which may be read by the scale operator through an optical device. The second type is a special computer language that is used by the computer via a photoelectric sensor (electric eye), and allows the computer to read the same weight indications as the operator. The computer calculates total prices based on a range of prices per pound from $.01 to $9.99. That is, the operator selects a price per pound within this range and the computer has been programmed to multiply the weight of the package as sighted by the electric eye times the price per pound to obtain the total price the customer must pay. Upon completion of the computer operation, the printer prepares a label. This type of label is preprinted and only the required numbers are placed on it by the printer.

It might be pointed out that these devices print all of the label information below the units indication in decimal fractions. This not only includes the money indications but also the weight figures. Thus, fractions of pounds are expressed in decimals, the smallest indication being \$.01/lb which is equivalent to 4.54 g. A typical label is illustrated below.

SAMPLE LABEL WITH IMPRINTS



In order to adapt these devices to indicate and record weights in metric units, and determine total prices based on dollars per kilogram, it will be necessary to install new charts, to replace electronic components in or install a new computer, and to alter or replace the elements in the printer (and possibly digital readouts if used). It is also possible that new springs will be needed for the weighing device. Needless to say, such changes will be expensive. However, such changes will be necessary if the adapted devices are going to record in approximately the same increments as the present ones; as noted above, present scales indicate to .01/lb or 4.54 g. Manufacturers now indicate that scales can be adapted so that they will record in 5 g increments, which certainly should be acceptable in commercial transactions. Thus,



Electronic Computing Scale
FIGURE 6

adapted scales, using present printers, would have a capacity of 9.995 kg (22.035 lb) instead of their usual one of 11.34 kg (25 lb).

Manufacturers indicate that the costs for producing these scales to record and indicate in metric units will not be great. In fact, some of these companies already produce metric-adapted devices for export to metric countries. Thus, although the problems mentioned above exist, the expertise for handling them is already present at the plant level. However, field adaptation will be very expensive and would take about 4 years to complete. Finally, it appears that 30 percent of these scales will have reached their life expectancy during any adaptation period and their replacement cost should not be considered a cost of metrication.

RAILROAD TRACK, MOTOR TRUCK, AND OTHER PLATFORM TYPE SCALES

Introduction

Platform type weighing devices differ greatly in capacity. For example, bench and portable devices may have capacities less than 1000 lbs (figs.

7–9); whereas, the capacities of railroad track and motor truck scales often exceed 100,000 lbs (figs. 10, 12, 13, and 14).[6]

All of these devices, despite their capacities, have two principal parts: (1) the load receiving element, and (2) the indicating and/or recording element. The load receiving element, to which the platform of the scale is attached, is usually a sophisiticated lever-fulcrum mechanism (i.e., mechanical scale) or electronic device employing load cells (i.e., electronic scale). The indicating and/or recording element translates the mechanical or electrical force on the receiving element into a weight indication. Such systems may be composed of one or more of the following items: weighbeam and poise, dial, printers, and digital readouts.

Finally, only scales using the lever-fulcrum mechanism employ mechanical dials, weighbeams, and poises; such devices may also utilize unit and tip weights.

Adaptation

Adaptation will affect only the items comprising the recording and/or indicating elements. It should be understood that scales do not have to use all of the items mentioned below. (As a rule, the smaller capacity scales use fewer indicating and/or recording devices.) Thus, since the adaptation costs in section I-7 are based on an average principle, individual scale metrication costs could be either higher or lower than indicated. *Note:* Because some companies produce metric recording and/or indicating scales for export, some of the parts needed for field and expanded plant adaptation, for certain types of devices, are already available (e.g., weighbeams calibrated in metric units).

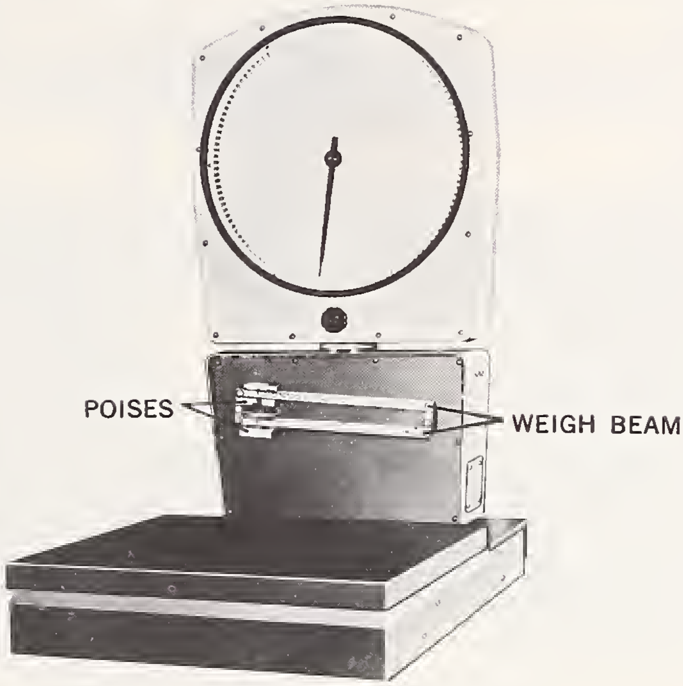
For such items as weighbeams, and unit and tip weights, adaptation will require that these items be replaced with metric ones. It is clear that weighbeams marked in customary units would have to be replaced.[7] Similarly, presently used unit and tip weights (used for increasing the capacities of scales) would be replaced so that scale capacities could be increased in multiples of the metric system. Whether poises will have to be replaced will depend upon whether the multiple factor of the beam changes. If this factor is unaffected by adaptation, poises will probably not have to be replaced.

For mechanical[8] and electro-mechanical printers, adaptation will essentially require gear or other mechanical changes regardless of the scales being adapted. In the case of electronic scales, there is, of course, a transitional

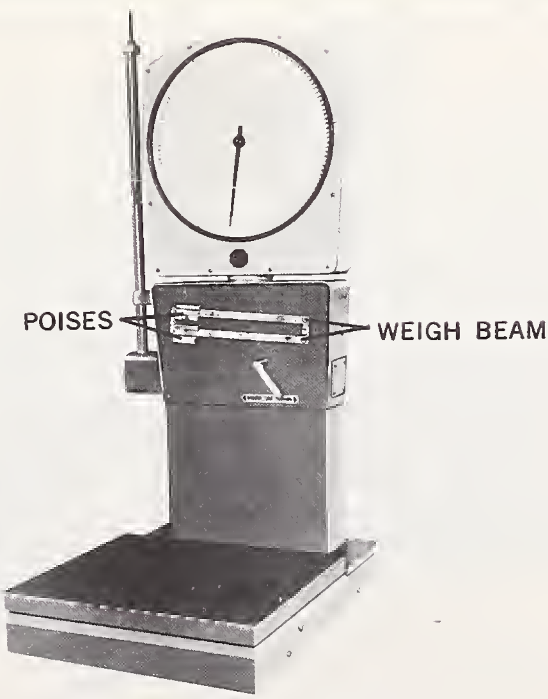
[6] Some large capacity devices such as railroad track scales and motor truck scales, must be assembled on-site. In some cases, preceding assembly, a pit has to be prepared to house the load receiving section.

[7] On large capacity weighbeams (fig. 11), used, for example, on railroad track scales, it is conceivable that only the reading scale would have to be replaced.

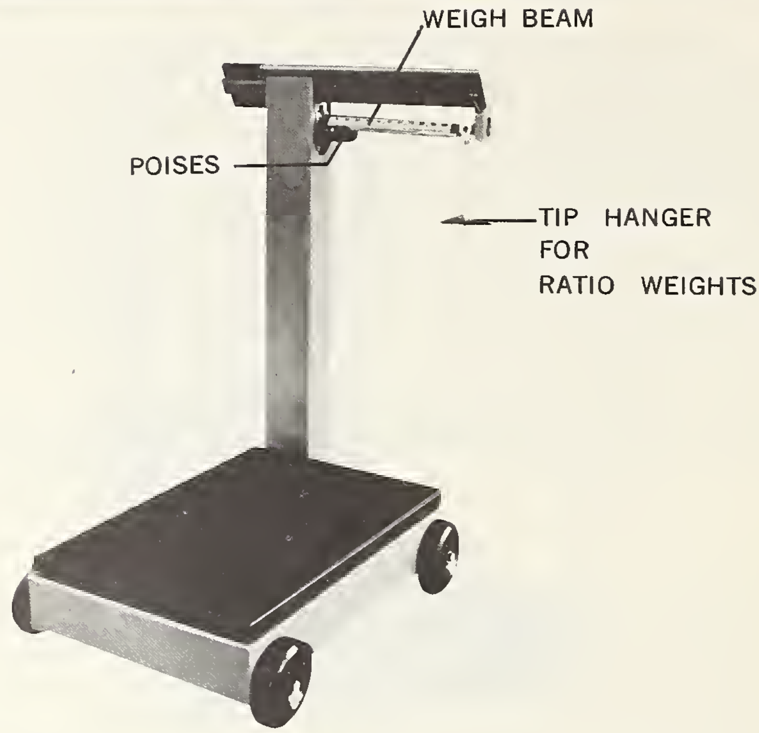
[8] Some large capacity weighbeam (see fig. 11) and poise combinations employ a mechanical hand operated printer. Used with this printer, are special type (print) bars attached both to the weighbeam and to the printer itself. In order to properly adapt scales, using this kind of printer, the type bars would, no doubt, have to be replaced with ones which would allow tickets to be printed in metric units.



Bench Scale
FIGURE 7

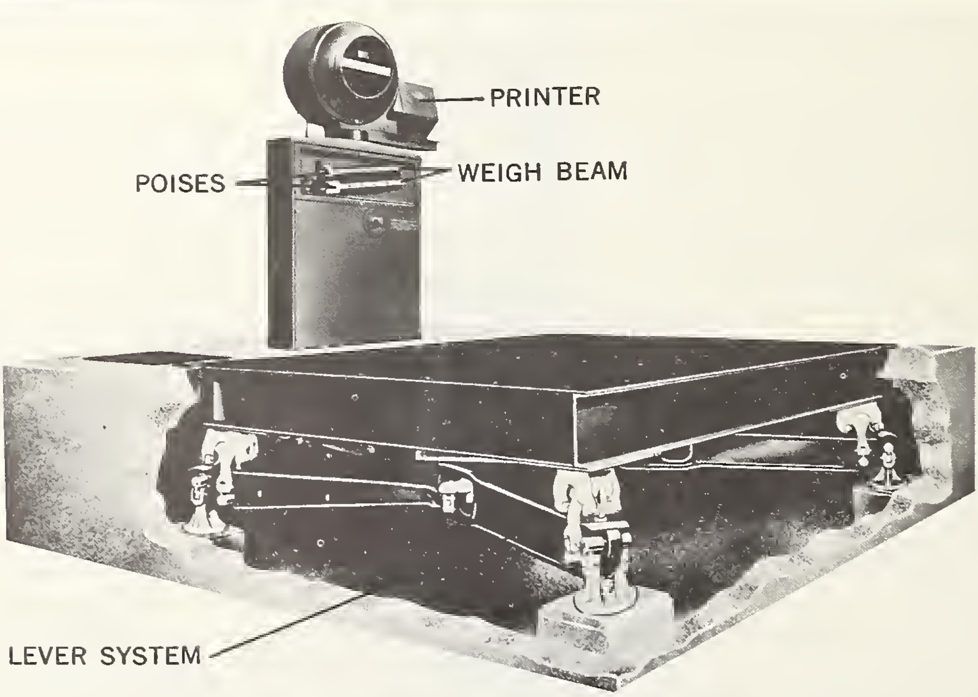


Portable Floor Scale
FIGURE 8



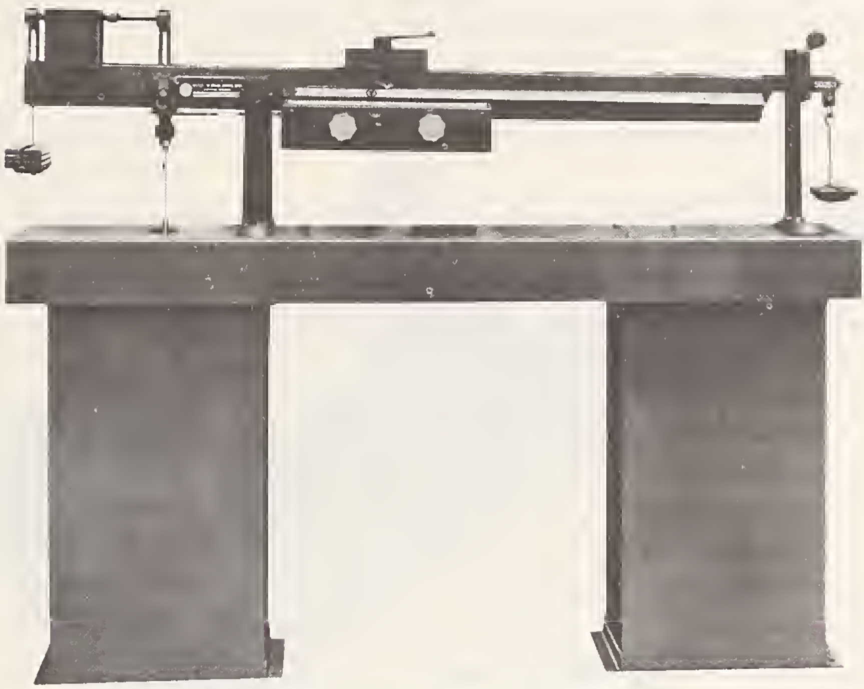
Portable Floor Beam Scale

FIGURE 9



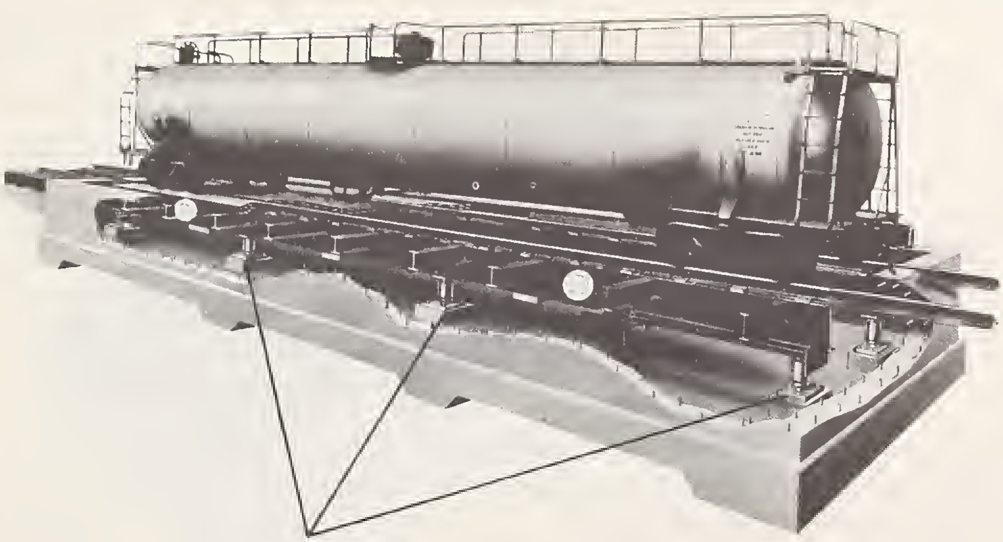
Built-in Platform Scale

FIGURE 10



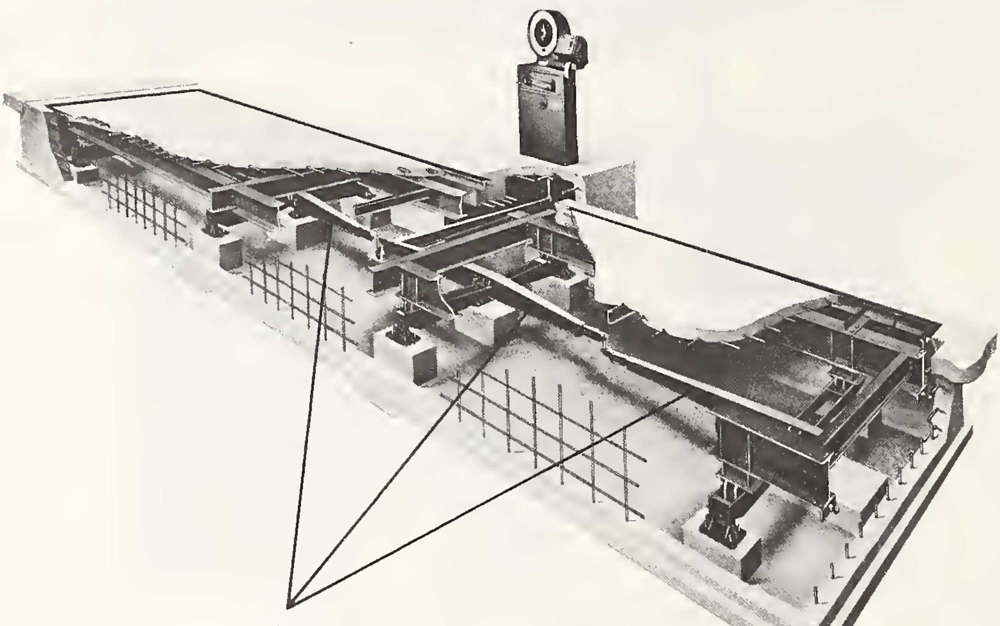
Large Capacity Weigh Beam
(As used with railroad track and other large capacity platform scales)

FIGURE 11

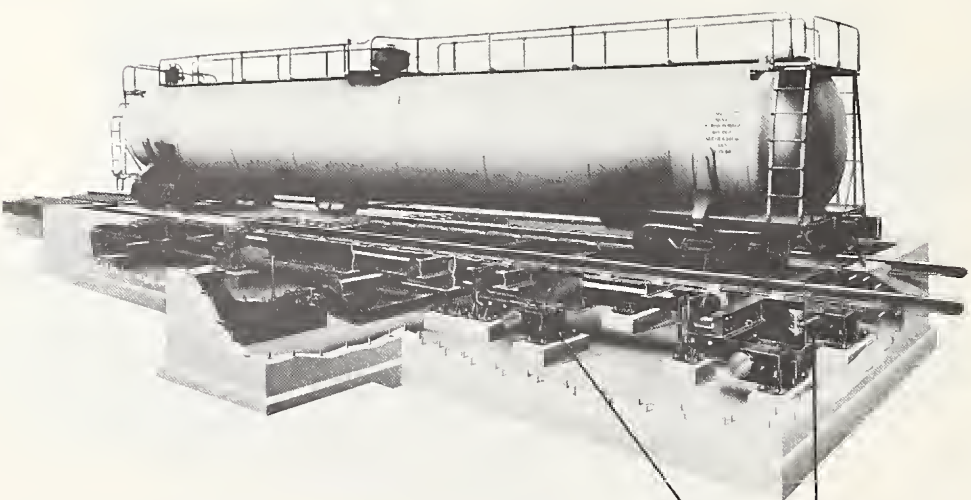


Railroad Track Scale
(Load cell)

FIGURE 12



Motor Truck Scale
(Lever-fulcrum)
FIGURE 13



Railroad Track Lever
(Torsion bar)
FIGURE 14

device which converts the electric impulses from the load cells to mechanical motion. For electronic printers, adaptation would most likely be accomplished by replacing electronic components, such as resistors; however, if these are used with the lever-fulcrum devices, a transition device to convert mechanical motion to electrical impulses would be required, and it is possible that mechanical changes to this device could bring about the desired units change.

For electronic dials (used primarily on load cell type scales), adaptation will require that the electronic components (particularly resistors) be replaced. Such components control the indicated capacity of the dial. Of course, present face plates with customary units would have to be replaced and the scale recalibrated. For mechanical dials, adaptation requires recalibration and, of course, new dial face plates.

For digital indicators, adaptation will require either mechanical or electronic component changes. There is a similarity in the adaptation concepts for digital indicators and printers, even though the specifics of the changes are different. (1) Digital indicators which contain a mechanical to electrical transition device[9] can be adapted by modifying the mechanical elements (e.g., gear changes) therein. In the alternative, adaptation may be accomplished by replacing electronic components. This type of indicating system may be used with either lever-fulcrum or load cell scales. The latter types of scales require a transitional device, opposite in purpose to the one in the indicator, before this type of digital system can be used. This procedure allows load cell scales to use existing mechanical-electrical indicating devices. (2) For completely electrical indicating systems, adaptation would require only electronic component changes. These systems may also be used with lever-fulcrum scales provided a load cell or similar device is attached to the appropriate part (e.g., steelyard rod, or transverse extension lever) of the lever system.

Manufacturers feel that adapting digital indicators or printers to indicate or record respectively to the nearest kilogram will be less troublesome and costly than to the nearest 0.5 kilogram, although the 0.5 kg would be closer to the 1 lb minimum graduation most often used. It should also be noted that adaptation to the smaller indication (0.5 kg) would result in a loss of one significant figure. Thus, the capacity of the indicator or printer would be reduced. For example, a four digit indicator or printer has a capacity of 9,999 lbs, whereas its adapted capacity to the nearest 0.5 kg would be 999.5 kg or 2,203.52 lbs. Such a reduction in capacity would affect the usefulness of the scale.

Finally, manufacturers feel that production and/or assembly of adapted devices will not be difficult, but that adaptation of scales now using customary units would be expensive (sec. I-7). It seems that a majority of the latter costs stem from: (1) manhours spent installing needed parts and recalibrating

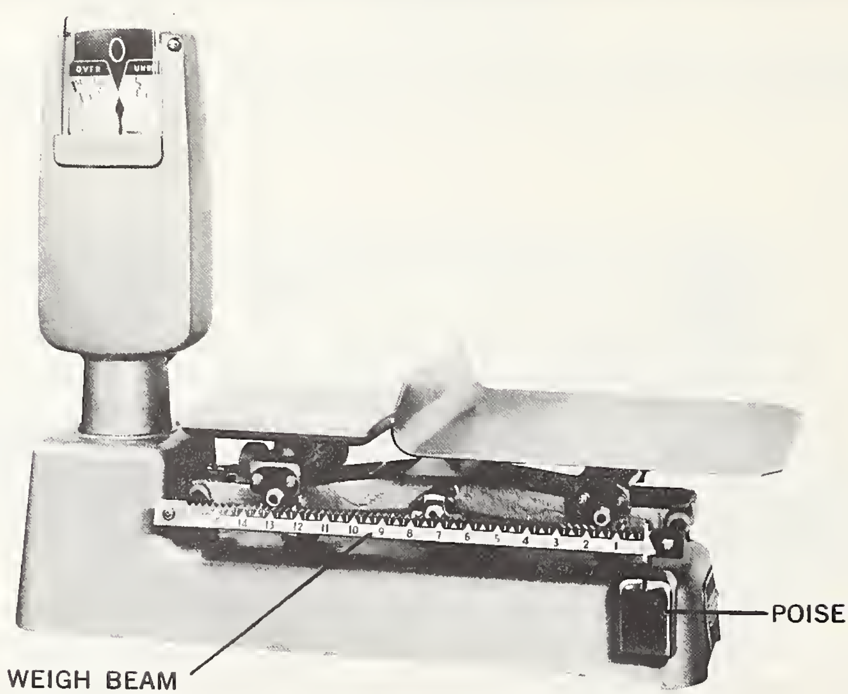
[9] One method which may be used to translate mechanical action into electronic impulses is to use a rotating disk which contains indications in coded form and a group of photoelectric cells. An optical system projects the disk's indications onto the photoelectric cells which in turn provide the necessary electric signals for the digital readout device. *Note:* A similar concept is used on prepackaging electronic computing scales.

any device; (2) the purchase of new dials, unit weights and beams for lever scales; and (3) the replacement of some printers and indicators where it is more economical to replace than to adapt.

OVER AND UNDER AND PACKAGE CHECKING SCALES (figs. 15 and 16)

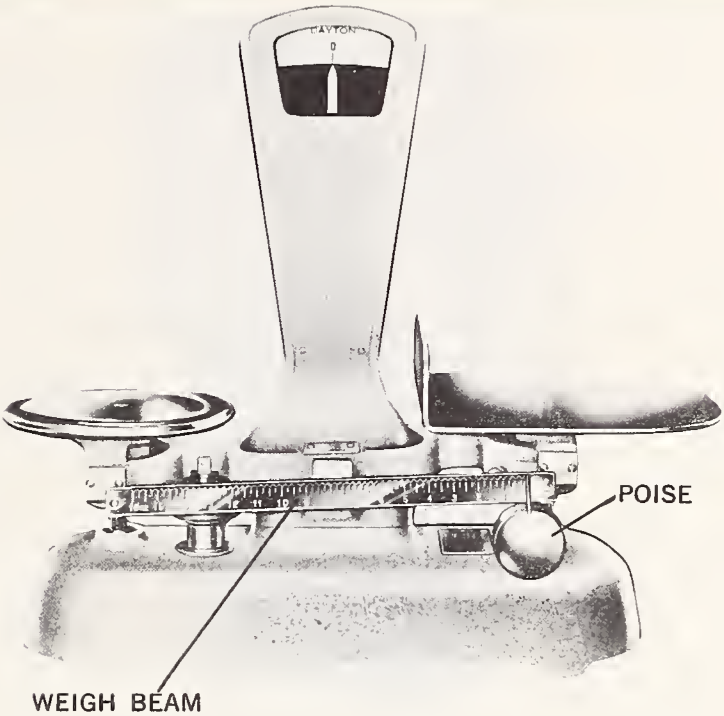
Over and under and package checking scales are essentially balances, and are used in both industrial and commercial applications. For example, one of the uses of over and under scales is to check packages in a production process to determine if they are within prescribed fill tolerances. Similarly, package checking scales are used primarily by weights and measures enforcement officials to determine the accuracy of quantity of contents statements on packaged consumer commodities.

Metric adaptation of these devices would be desirable if packaged consumer commodities were required to be sold in metric terms (labeled with metric units). That is, since the quantity statement and the scale would be using the same measurement language, metric units, the possible errors which may be caused by the use of conversion factors in production and testing operations would be eliminated.



Over and Under Scale

FIGURE 15



Over and Under Scale

FIGURE 16

The adaptation of these devices essentially requires that the weighbeam and possibly the poise be replaced, and that a new chart (e.g., over and under type) be installed in the tower indicator.

Finally, most manufacturers of these devices feel that the problems of metric adaptation would be slight at both the plant and field levels. Apparently, this was due to the fact that these are relatively simple devices.

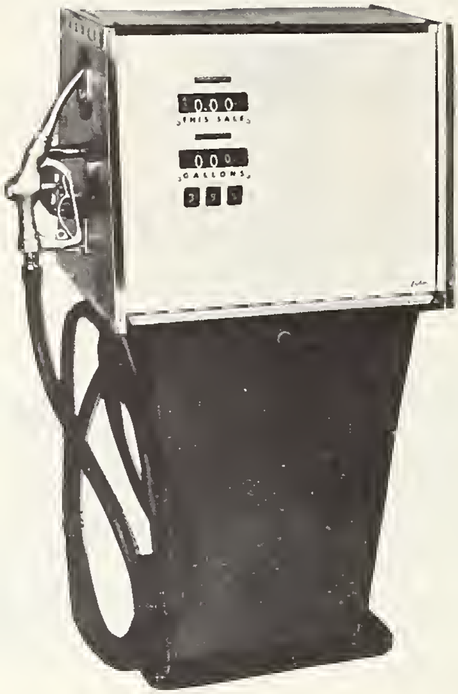
I-4. ADAPTATION OF METERING DEVICES (MECHANICAL)

INTRODUCTION

Since the changes required to metricate present commercial mechanical metering systems are about the same, despite the fluid being dispensed, this section will confine its attention to the metric adaptation of retail gasoline pumping systems, and meters on gasoline and oil delivery trucks.

GASOLINE DISPENSING SYSTEMS (RETAIL)

Certainly, one of the most recognizable sights to the average American driver is a gasoline pump (fig. 17). What is not generally known is that these



Gasoline Pump
FIGURE 17

devices in 1969 dispensed over 82 billion gallons of gasoline. The vast majority of this gasoline was purchased from 220,000+ gasoline stations in the country at an annual expenditure of about $25 billion.[10]

A mechanical gasoline dispensing system is composed of three basic parts: (1) a pump, (2) a meter, and (3) a mechanical computer[11] (fig. 18). The pump, usually a positive displacement type, forces the liquid (gasoline) through the meter (which contains a series of rotating adjustable calibrated chambers). As the chambers rotate they drive a shaft-gear mechanism which is connected to the computer. The computer records, for any set price per gallon, the total gallons delivered and the total sale in dollars and cents.

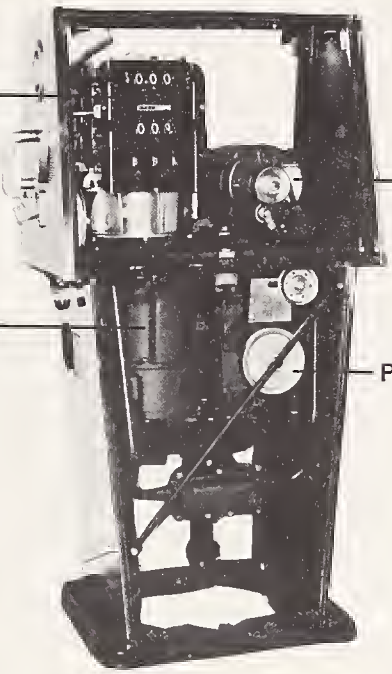
In order to adapt these systems to indicate in metric units, the following changes will be necessary:

a) The shaft-gear mechanism between the meter and the computer would have to be changed so that the input into the computer would be 3.785 times faster than at the present time. This is essentially a gear change only.

b) Computers that indicate to only three places in the quantity section allow readings only up to 99.9 and this indication would not be adequate if metric units are used, as such devices would be only able to indicate a

[10] Statistics were obtained from National Petroleum News (NPN), Factbook Issue, mid-May 1970, (McGraw-Hill Inc., New York 10036).

[11] There is only one manufacturer of this type of computer.



Gasoline Pump

FIGURE 18

capacity up to 99.9 liters (26.39 gal). It is clear, that this capacity would not be adequate for filling large capacity vehicles. However, kits are available from the computer manufacturer which allow servicemen to change the left wheel indicator in the quantity section on three wheel computers to read from 0 to 14. This would allow the device to have a capacity of 149.9 liters (39.60 gal) which would be suitable for most retail operations. There would, of course, be no such problem with computers that indicate to four places since they would be adapted to record up to 999.9 liters (264.15 gal).[12] *Note:* (The following is new information which was received from the Gasoline Pump Manufacturers Association just prior to closing for press. Time did not permit an in depth analysis of this information to determine the possible economic impacts.)

It appears that a change in NBS Handbook 44 by the 55th National Conference on Weights and Measures may have precluded this type of adaptation for 3-wheel registers. The applicable provision is as follows:

[12] The conversion kits allow present three-wheel registers to increase their capacity from 99.9 gal (376.16 liters) to 149.9 gal (567.43 liters). However, adaptation would reduce the capacity to 39.60 gal (149.9 liters), which is 26.4 percent of the present capacity. Likewise, four-wheel registers would have their capacity reduced to 26.4 percent of their capacity. This reduction in capacity could limit the usefulness of these devices.

> G–S.5.2.3. SIZE AND CHARACTER.—In any series of graduations or recorded representations, corresponding graduations and units shall be uniform in size and character. Graduations, indications, or recorded representations which are subordinate to or of a lesser value than others with which they are associated shall be appropriately portrayed or designated. (This specification will become retroactive as of January 1, 1975) [1970]

The O–14 wheel of necessity has smaller characters than other standard wheels. Consequently, these smaller numbers would probably conflict with the requirements of the above provision.

Under these circumstances, adaptation will, no doubt, require the installation of a 4-wheel computer (for a 999.9 liter capacity) along with the appropriate gear and face plate changes.

Using this approach, it is estimated that adaptation costs (only for pumping systems using 3-wheel registers) will increase between $100–160 per device. This increase would be due primarily to the cost of purchasing and installing a new or rebuilt 4-wheel computer.

c) Face plates would have to be changed. That is, the present "gallons" and "price per gallon" indications would be changed to "liters" and "price per liter."

Most companies feel that metric adaptation of these devices at the plant will not be difficult. In fact, some companies have acquired, either through their foreign subsidiaries or domestic plants, expertise in producing metric indicating gasoline dispensing systems.

However, adaptation at the field level will be difficult. Again, as with weighing devices, the problem is the large number of devices to be adapted, but only a limited number of qualified service personnel to accomplish the job. As a result, manufacturers estimate that it will take 3 to 10 years to complete field adaptation.

In order to avoid having a long period of time in which gasoline is being sold in both the U.S. customary and metric units, it might be advisable to adopt a metric field adaptation procedure as developed by one meter manufacturer. This procedure was developed especially for their foreign subsidiaries who are in countries undergoing metrication. Basically, their procedure was to equip meters with dual gearing systems (for the measurement system in use and the metric system) and to install new face plates with the new plates having the metric units permanently embossed on the plate with pressure sensitive decals over them giving the old units. Thus, when the time came for the changeover, it was a relatively easy matter to (1) change the gear ratio into the computer by locking the metric gear ratio into place (much like shifting gears in a car), and (2) removing the old units by pulling off the decals. *Note:* This dual gearing system was designed so that only one change of the gear ratio could be made, that is, from the ratio that allowed the computer to record in the old units to the one for metric units.

BLENDING PUMPS

In blending pumps, two fuels (two different grades of gasoline, or, in the case of marine fuels, gasoline and oil) are drawn separately from two tanks.

Each fuel flows through its own pumping unit, its own meter, and into the blend control valve, where the flow of each is increased or decreased in accurate proportion to provide the desired blend. This blend control valve maintains the correct blend ratio. Outside the pump, the two controlled volume fuels continue to flow through separate hoses—actually a hose-within-a-hose arrangement. In the nozzle, the two fuels are blended into one grade. Each fuel can, of course, be dispensed separately.

The blend (mechanical) computer is an expanded version of the usual one. The commonly used computer has only one predetermined unit price (price per gallon) setting indicator (unit from which the total sale is calculated); whereas, the blend-computer has several such units. Present blend computers may have up to nine separate unit price indications; thus making possible the dispensing of a corresponding number of different grades of fuel. The gearing system in this computer, in conjunction with the blend control valve, computes, for a predetermined unit price, using the speeds of the rotating shafts of the meters the total sale price and number of gallons delivered. It is clear that the gearing system in the blend computer is far more complicated than in the regular type.

Adaptation would essentially require that the computer's gearing system be altered. One manufacturer feels that such changes will be relatively more extensive in nature than those required to adapt regular computers. Consequently, metrication costs for these devices will in all probability be higher than those for regular types.

In addition to multiple blending pumps, some pump manufacturers produce fixed blend pumps which deliver only one blend. A special valve blends the fuels before they are metered, and only one meter is used. Except for the special blend control valve, these pumps are similar to regular pumps and, therefore, metric adaptation would be the same as that for regular pumping systems.

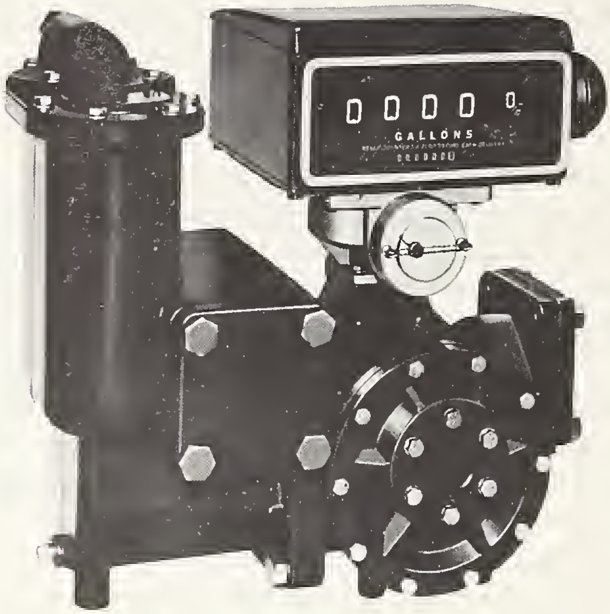
Comment: New prototype gasoline metering systems feature electronic readout devices (e.g., digital indicators) in conjunction with or as a replacement for the mechanical computer. At the time of closing for press, no information had been received on the difficulties and costs of adapting such systems.

METERING SYSTEMS (MECHANICAL) ON TANK TRUCKS

Adapting pumping systems used on oil and gasoline tank trucks will not be too much different from the above discussion (fig. 19). As a rule, these systems can be adapted by making (1) gear ratio changes between the meter and the computer (fig. 12), and (2) face plate alterations.

Even though manufacturers feel that adaptation will be harder in the field than in the plant, tank trucks have the advantage of mobility and may be taken to a convenient place for metrication.[13]

[13] Capacity reduction due to metrication keeping the decimal point in the same place of the register may also limit the usefulness of fuel and gasoline delivery truck meters. A typical meter register may have its capacity reduced from 9,999.9 gal (37,853.7 liters) to 2,641.7 gal (9,999.9 liters). Thus, e.g., filling a 7,000 gal (26,497.9 liter) tank would require three separate metering operations.



Tank Truck Metering System

FIGURE 19

I-5. ADAPTATION OF FABRIC MEASURING DEVICES

INTRODUCTION

There are over 40,000 fabric measuring devices (fig. 20) in use in the United States and these are produced by only one manufacturer. Such devices are primarily used by concerns that sell yard goods.

These devices usually have a dial which indicates in yards, and an attached computation chart which computes a total price given fixed lengths in yards for any given price per yard (i.e., the chart contains various lengths and prices per yard). The fabric to be measured is pulled through the device which, in turn, drives a shaft which is connected via gears to the dial.

ADAPTATION

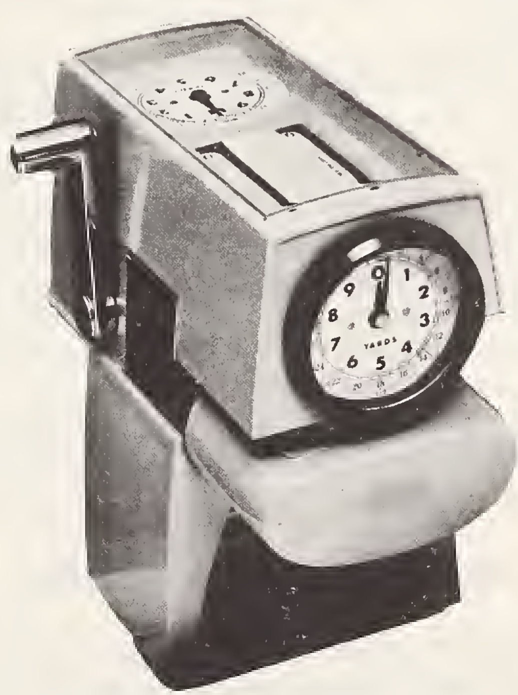
Metric adaptation of these devices essentially requires two things: (1) the gear mechanism must be replaced in order to have the dial[14] record in meters instead of in yards, and (2) the price computation chart must be replaced

[14] Of course, a new dial face, which indicates in metric units, would also be required.

with one which will give total prices based on fixed meter lengths and prices per meter.

Production of metric indicating devices does not appear to be a problem as they have been available for a number of years. Recently, a prototype was developed, which can be easily adapted to indicate in metric units at the plant or in the field.

However, the manufacturer feels that field adaptation for present devices would not be economical; i.e., replacement of present devices would be more practical. In fact, they feel that even plant adaptation of devices now in use would not be realistic, and we quote from their response to our questionnaire: "Adaptation of field machines could be done at the plant, but would require total disassembly, and measure roll, which would cost as much in labor and material as a production model." Thus, the total cost for field adaptation, as noted in the cost analysis chart, is based on a per unit replacement cost, assuming that metric indicating devices would sell at the same price as present machines. Also, no turn-in allowance for present devices has been accounted for, and, as a result, cost estimates are probably higher than should be actually encountered.



Fabric Measuring Device

FIGURE 20

I-6. ADAPTATION OF MISCELLANEOUS WEIGHING AND MEASURING DEVICES

INTRODUCTION

The information contained in this section was derived from (1) responses to letters of request for information (sent only to taximeter and cordage and wire measuring device manufacturers); (2) telephone interviews with trade association personnel; and (3) discussions with knowledgeable persons on the staff of the Office of Weights and Measures, National Bureau of Standards, who are familiar with the devices below. *Note:* The response to the request letters was disappointing as only one firm in each of the product areas concerned replied. This represented only 18 percent of the 11 firms contacted (six taximeter and five cordage and wire measuring device manufacturers).

From information received, it was felt that the metric adaptation problems for these devices would be slight. Therefore, elaborate discussions were considered unnecessary.

TAXIMETERS[15]

Taximeters indicate the total fare to be paid in dollars based either on distance (now indicated in miles) or on time, or on a combination of both. As a rule, most taximeters have a control device which allows the operator to decide the basis of the fare.

Metric adaptation of taximeters would require gear as well as face plate changes in order for distance indications to be in kilometers instead of miles. Since metric indicating devices are already being produced for export by several companies, it would seem that device adaptation at the plant level will not be a problem. Field adaptation does not appear to be a problem either since (1) most taxicab companies have adequate meter repair facilities, and (2) taximeter repairmen are familiar with gear change problems as such changes are required in order to make rate adjustments.

There are approximately 130,000 taximeters now in use and adaptation would cost about $20.00 per device. This would result in a total metrication cost of around $2,600,000. The time period required to complete adaptation has been estimated to be 2 years.

CORDAGE AND WIRE MEASURING DEVICES

Cordage and wire measuring devices indicate length via a gear and dial mechanism. Thus, in order to adapt these devices to indicate in metric units, gear and face plate changes will be required.

It appears that plant adaptation may not be severe since some of these devices are already being produced to indicate in metric units. However, the

[15] Some of the information contained herein was obtained from the International Taxicab Association, 222 Wisconsin Avenue, Lake Forest, Illinois 60045.

one respondent indicated that its metric devices did not meet present accuracy tolerances as provided by most states.[16] Thus, for the most part, these machines cannot be used commercially in this country.

Field adaptation, it seems, will present some problems. The respondent felt that devices now in use would have to be returned to the plant for adaptation. If plant adaptation is required, costs will arise from transporting the devices to and from their place of use, as well as from the labor and material expended on the actual metrication. Finally, this method for accomplishing metrication might require an exchange of devices by the manufacturer, since device owners would probably still want one while theirs was being adapted. To acquire and maintain an inventory for such an exchange operation, could prove to be expensive for the device manufacturer.

VEHICLE TANKS USED AS MEASURES

Adaptation does not appear to be a problem for vehicle tanks used as measures (over 40,000[17] are now in use). Such tanks[18] are calibrated by using provers which discharge a known amount of liquid (usually water) into the tanks. A marker on the tank is then adjusted and sealed indicating this amount and the tank is used only to discharge this fixed amount of liquid. In order to adapt these devices, either the markers now in use would have the customary units converted to metric ones (this would not require calibration) or the devices would be recalibrated to indicate in even metric units. Recalibration for these devices does not appear to be expensive.

OTHER FIXED MEASURED CONTAINERS NOW IN USE (FARM MILK TANKS, MILK BOTTLES, ETC.)

The fixed dimensions of these devices limit metric adaptation to either (1) translating present capacities into equivalent metric terms (probably hard to use figures), or (2) reducing capacity levels to SI units having convenient numbers. Like the vehicle tanks above, metrication for these devices appears to be inexpensive.

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[16] NBS Handbook 44, *Specifications, Tolerances, and Other Technical Requirements for Commercial Weighing and Measuring Devices* (1970) pp. 141-144 (see Suppl., p. 91).

[17] This statistic was obtained from the National Tank Truck Carriers, Inc., 1616 P St. NW., Washington, D.C. 20036.

[18] In some cases tank compartments are calibrated individually.

Section 1–7. Statistical Analysis Chart* (See App. I–1 for Information Concerning the Statistical base, p. 40, and Comments, pp. 35–39)

Type of device	Total of devices now in use	Number of devices produced in 1968	Number of devices produced in 1969	Retail prices for new devices (given either as price range or as an average)	Average life of a device (years)	Percentage increase in retail prices for new production devices recording or indicating in metric units	Percentage of total number of devices to be adapted (generally age precludes the adaptation of the rest of the devices)	Number of devices to be adapted	Field [12] adaptation cost/device (labor and parts)	Total cost for field adaptation for each classification	Time required to accomplish or complete field adaptation (years)
Drum computing scales	298,600	12,423	13,393	$275–525	17.5	5	60	179,160	$150	$26,874,000	5
Fan computing scales	74,800	2,606	3,073	150–425	15	6	70	52,360	90	4,712,400	4
Projection scales	50,000	[5] n.a.	[5] n.a.	[1] 800	[1] 10	[5] n.a.	[1] 75	37,500	[1] 150	5,625,000	[1] 5
Prepackaging computing scales	29,000	3,320	3,985	3,200–5,600	11	10	70	20,300	1,500	30,450,000	4
Package checking and over and under scales.	48,500	6,679	7,511	225–243	19	5	70	33,950	90	3,055,500	2
Railroad track scales: Load cell	574	34	36	16,000–30,000	20	5	100	574	1,200	688,800	2
Railroad track scales: Mechanical	[1] 7,000	43	31	17,000–40,000	25	5	80	5,600	[10] 2,500	14,000,000	4.5
Motor truck scales: Load cell	121	12	29	[2] 3,000–7,000	15	5	100	121	[10] 1,800	217,800	5
Motor truck scales: Mechanical	54,500	1,894	1,939	3,000–10,000	20	5	85	46,325	[10] 1,300	60,222,500	6
Other platform scales: Load cell and mechanical.	[9] 282,894	18,391	22,810	225–20,000	15	10	70	198,026	[11] 400	79,210,400	5
Gasoline pumping systems	[3] 1,750,000	[8] n.a.	[8] n.a.	465	11.6	10	70	1,225,000	70	85,750,000	7.5
Fuel oil meters (truck)	77,000	5,562	5,785	410	10	10	70	53,900	100	5,390,000	5
Gasoline truck meters	24,000	2,088	2,173	451	10	10	90	21,600	70	1,512,000	5
Liquid petroleum gas (LPG) meters	29,000	2,310	2,492	650	10	8	90	26,100	150	3,915,000	5
Fabric measuring devices	[4] W	[4] W	[4] W	425	[5] n.a.	[6] N/A	[6] N/A	[6] N/A	[6] N/A	[7] 19,125,000	[5] n.a.
Total										340,748,400	

COMMENTS

Comment 1—Some of the devices appearing in the statistical analysis chart are also used in noncommercial activities, e.g., production line filling operations, quality control operations, etc. This is especially true of package checking, over and under, and bench scales. Thus, not all of the devices within any category will have to be adapted under a metrication program, since they will not fall within the definition of a commercial weighing and measuring device. Therefore, the total cost for field adaptation in the commercial weights and measures area should be less than indicated.

Comment 2—The magnitude of the costs appearing in the statistical analysis chart are seen with a better perspective when compared with the output of the various industries concerned. Only the scale (SIC Code 3576) and meter (SIC Code 3586) industries will be analyzed since, as already noted, the field adaptation cost for fabric measuring devices is their replacement cost. Field adaptation costs will be compared via percentages using the aggregate value of shipments for these industries over a 10-year period, 1958 through 1967. Data were obtained from 1967 Census of Manufactures preliminary reports as published by the Bureau of the Census, U.S. Department of Commerce.

SIC code	Aggregate value of shipments (10-year period)	Total field adaptation costs	Costs as a percentage of the aggregate value of shipments
3576	$967.0 million	$225.1 million	23.3
3586	$1,572.4 million	$96.6 million	6.1

Comment 3—*Initial Costs.* Initial or "one time" costs for device manufacturers would include but would not be limited to:

(1) Purchasing metric weights and measures for testing purposes. Many companies have metric standards but these are usually available only in limited quantities for plant use. Also, those companies with

* Statistics have been taken from the responses to the questionnaires unless otherwise indicated.

[1] Office of Weights and Measures estimate.

[2] Some scales sell for $50,000.

[3] American Petroleum Institute estimate.

[4] Withheld to avoid disclosing figures for an individual company.

[5] Not available.

[6] Not applicable.

[7] Total replacement cost.

[8] Not available; there were 133,100 gasoline dispensing systems produced in 1967. This figure was obtained from the 1967 Census of Manufactures Preliminary Report on Measuring and Dispensing Pumps, SIC Code 3586, published by the Bureau of the Census, U.S. Department of Commerce.

[9] A conservative estimate. One manufacturer felt that the total number of devices in use exceeded 500,000. However, most of the devices in this classification are used for industrial purposes (i.e., not considered commercial devices). A conservative estimate was used in order to keep metrication costs realistic (see Comment 1).

[10] One major manufacturer of railroad track and motor truck scales felt that adaptation costs, per device, would be $4–5 thousand and $2–2.5 thousand, respectively.

[11] One manufacturer felt that adaptation costs, per device, for large capacity built-in-floor scales would be $2,500.

[12] Approx. averages.

service agencies would incur initial expenses in the purchase of test weights and measures for their service personnel.

(2) Designing the necessary parts (e.g., new charts, beams, and poises for scales, and gears for meters) for device adaptation in the field or in the plant.

(3) Preparing the plant for producing the necessary parts above and making any needed production line or associated changes in order to be able to manufacture metric recording and/or indicating devices.

(4) Training needed to familiarize company personnel with the metric system.

Not enough data were received from device manufacturers so that definite initial costs could be determined. However, the following general comments may be made:

(a) The scale and balance industry: One industry representative has estimated that the overall initial costs for the scale industry would be between $3 and $5 million. Evidence indicates that the larger companies will account for most of these costs. In fact, one large scale company has estimated its "one time" cost at over $500,000, and another large concern estimated such a cost for its service department alone to be about $200,000 (see app. I-4, p. 54).

(b) The meter industry: No data were received from this industry concerning initial costs. Apparently, the impacts of such costs are not substantial, as most companies indicate that metrication difficulties at the plant level would be slight and it is at the plant level where the majority of the initial costs would probably occur.

(c) Fabric measuring device industry: No data were received on initial costs. However, since a device has been developed which can be readily adapted to indicate in metric units, it would be reasonable to assume that initial costs will not be large.

Comment 4—Per Unit Field Adaptation Costs for Scales. Some scale companies are of the "opinion" that a required field adaptation program for commercial weighing devices, using a fixed period of time of reasonable length, could result in lower per unit field adaptation costs than if a voluntary-evolutionary approach were used. Such an "opinion" appears to be reasonable.

A required adaptation program, as previously described in the introduction, would probably result in a fixed demand situation; i.e., within reason, the number of scales to be adapted would be known. Given the economic conditions of a fixed demand situation, it may be possible for companies to utilize their resources in a more efficient manner, thus making possible lower unit costs. Under a voluntary-evolutionary approach it is doubtful that such a known demand situation would exist since scale users would be free to decide when they wanted their devices adapted. As a result, the number of scales to be adapted in any given time period would be in doubt. Under these uncertain conditions, it is doubtful whether efficient use of resources could be achieved. (*Note:* It seems reasonable to assume that this same reasoning could also be applied to other manufacturers of weighing and measuring devices.)

The information for this comment was obtained from a meeting between representatives of the Scale Manufacturers Association and the National Bureau of Standards to consider the impacts of metrication as they would affect the scale industry. This meeting was held on May 28, 1971 at the NBS site in Gaithersburg, Maryland.

Comment 5—Postal Scales (SIC Code 3576051. Postal scales (i.e., scales used primarily to determine postal charges) are not within the definition of commercial devices as used in this report. In brief, this definition excludes devices that do not come under the testing authority of state and local weights and measures officials. The major reasons why these scales are considered non-commercial are as follows:

(1) Scales used by the U.S. Postal Service, even though used to sell a service to the public, are Federal property and, consequently, it is felt that state and local governments have no authority over them. (See note.)

(2) Scales used, for example, by private concerns do not, as a rule, render a service to the public for a price, but instead are used primarily for internal operations. Therefore, these devices do not come within the definition of a commercial weighing and measuring device as found in NBS Handbook 44. (See part II, and suppl.)

Many different types of postal scales exist. These vary from the very inexpensive office types, e.g., small desk spring scales selling for under $10 each to fan-type computing scales costing several hundred dollars a piece. Data on postal scale categories, and the number of scales per category now in use, are not available in any detailed form; however, from data appearing in the 1963 and 1967 Census of Manufactures, Bureau of the Census, U.S. Department of Commerce, the following table was prepared:

Year	Number of postal scales produced (SIC code 3576051) (1,000)	Value of shipments (SIC code 3576051) (in millions)	Total value of shipments for scales and balances only (SIC code 3576) (in millions)	Average shipment value for postal scales (rounded to the nearest dollar)	Value of shipments of postal scales as a percentage of the total value of shipments (percentage)
1958.....	126	2.0	71	16	2.8
1963.....	326	2.9	90	9	3.2
1967.....	n.a.	3.2	131	n.a.	2.4

n.a. = not available.

From the above table the following two inferences may reasonably be drawn:

(1) For the 10-year period 1958-1967, approximately 2.5-3.0 million postal scales (of all types) were produced, and the aggregate value of

shipments was about $27 million. This represented about 2.8 percent of the total aggregate value of shipments, (i.e., $967.0 million), for the entire scale and balance industry for that period of time.

(2) The low average value (col. 5) apparently indicates that the vast majority of the postal scales produced are of the inexpensive type.

From information received from various scale companies, it appears that field adaptation for the inexpensive devices is not very economical; that is, new devices could be purchased for what it would cost to adapt the old ones. Of course, for the expensive scales (i.e., fan computing type) it would be more economical to adapt; adaptation for these devices will require the same, or similar, types of changes as mentioned early in the report for commercial scales, e.g., metric charts, beams, poises, etc. (See app. I-2, p. 45 for more details.)

Finally, no attempt has been made to determine the total metrication (replacement and/or adaptation) cost for postal scales. Such a determination would be questionable, since as already noted, sound data on the types and number of devices in use are not available. However, it is highly unlikely that such costs would exceed the total replacement cost for these scales. At the present time, such a replacement cost is estimated to be $30 million. This estimate excludes the replacement cost of devices older than ten years, as these scales are probably obsolete and should be replaced anyway, and, therefore, their replacement cost should not be considered a cost of metrication.

Note: The reorganization of the Post Office Department into the U.S. Postal Service, a type of public corporation, (P.L. 91-375, 84 Stat. 719), may have ended that agency's immunity to state and local weights and measures law enforcement. A recent court case in Great Britain will illustrate the point as Britain's post office is now such a corporation. On May 14, 1970 in the Poole Magistrates' Court a plea of guilty was entered by the post office to the charge that one of its scales was incorrect. (From the Monthly Review, Nov. 1970, published by the Institute of Weights and Measures Administration, Great Britain, Vol. 78, No. 11, p. 298, Title: "Post Office—Unjust Scale.") Apparently, in Great Britain, the post office is now being treated, at least in some respects, as if it were a private corporation. Whether or not the U.S. Postal Service can be so treated (at least with respect to device testing) is difficult to say at this time, and a court test may well be required to establish whether or not that agency is subject to state and local weights and measures laws.

Comment 6—Cost of Adapting Scales for the U.S. Postal Service. Because the U.S. Postal Service (USPS) is probably the largest single user of scales in the country, it was thought desirable to determine the approximate cost of scale metrication upon that agency alone. This cost data has been segregated from the other statistical data, because postal scales, as already noted in *Comment 4*, are not considered commercial devices.

Even though most of the Postal Services' scales are of the postal type, SIC Code 3576051, it should be pointed out that some devices used by the USPS may not fall within this SIC classification, for example, 10 ton capacity vehicle scales.

The chart below was prepared from data submitted to the National Bureau of Standards by the U.S. Postal Service and various scale companies. It should be understood that metrication unit costs are approximate averages only.

Type	Number in use	Type of metrication adaptation/replacement	Metrication cost/unit	Total cost for each type (col. 2 times col. 4)
Beam scales which have capacities between 100–1,250 lbs.	4,720	Adaptation	300.00	$1,416,000
Drum type computing and automatic meter scales.	3,320	Adaptation	150.00	498,000
Fan type computing scales	36,000	Adaptation	75.00	2,700,000
10 ton capacity vehicle scales	50	Adaptation	500.00	25,000
16 oz beam scales	205,000	Replacement	[1] 35.00	7,175,000
500 lb parcel post dial scales	220	Adaptation	100.00	22,000
Totals	249,310			11,836,000

[1] Retail price. Through contract bidding, this unit price may be significantly reduced.

Finally, since many postal scales will be replaced due to obsolescence, and so forth, new metric ones could be purchased in their place. Since the cost of replacement is really not a metrication cost and since the number of scales to be replaced may be as high as 25 percent of the total number (mostly small capacity scales which have a short life), the total metrication cost estimate is probably higher than should be expected. *Note:* It is estimated that at least 5 years will be required in order to complete postal scale metrication.

GENERAL STATISTICS

INTRODUCTION

The statistics for this appendix (as well as for I-7) were based on a 75 percent return on questionnaires as sent to twenty (20) manufacturers of weighing and measuring devices chosen by a judgment sampling process.[19] The questionnaires for each of the three industries surveyed (scale, meter, and fabric measuring) were not perfectly identical since certain technical information needed from each of these industries would obviously vary. However, the format of the questionnaires was basically the same, and certain general information questions (some results of which appear in this appendix) were the same. Finally, the comments section of this appendix also incorporates information obtained from interviews with various industry and trade association personnel.

It has been estimated that scale (SIC Code 3576) and meter (SIC Code 3586) manufacturers, responding to the industry questionnaires, represented approximately 50 percent of the yearly value of shipments for each of these industries.

STATISTICS

Number of service personnel:	
1. Scale industry	2,955
2. Meter industry	2,370
Total	5,325
Estimates of the increase in service personnel that would be needed if device adaptation were required.[20]	
1. Scale industry	33.3%
2. Meter industry	54.0%
Benefits to metrication:	
Opinion	*Percentage of responses*
Yes	73.4
No	13.3
Do not know	13.3
Total	100
Attitudes toward metrication:	
Opinion	
Strongly for	27
Mildly for	40
Neutral	27
Mildly against	6

[19] Nine (9)s scale and balance companies, ten (10) meter manufacturers (two of these companies merged), and one (1) fabric measuring device manufacturer. See also I-1 for the organizations who helped prepare the judgment samples.

[20] Sixty-three percent of the scale and 50 percent of the meter companies indicated that they would have to increase service personnel due to a metric adaptation program.

Strongly against	0
No opinion	0
Total	100

Courses of action to be taken in the event that the United States should decide to increase the use of the metric system:

Opinion	
No national program of metrication	0
A coordinated national program based on voluntary metrication	33
A mandatory program based on legislation	67
Total	100

COMMENTS

From respondent questionnaires and from interviews with industry representatives (company and trade association personnel) the following areas of concern became apparent:

1. The problems of retraining or educating plant and field personnel to understand the metric system. *Note:* Considering the fact that thousands of people would have to be involved in metric education programs, it is not difficult to see that man-hours lost from regular work for such new training, computed in dollars and cents, could be substantial.

2. The problems of planning and coordinating any metrication program. Before any metrication program could begin, careful planning would have to take place. For adaptation, especially field adaptation, to be accomplished efficiently, all of the elements of the weights and measures system (industry, service agencies, and enforcement jurisdictions) would have to work smoothly together. For example, (1) A scheduling plan would have to be established so that devices could be adapted conveniently. Such a schedule would probably have to be approved by device manufacturers and owners and service agencies or departments. Weights and measures jurisdictions would, no doubt, also have to approve such a schedule, since adapted commercial devices would have to be retested for accuracy and resealed for commercial use. (2) The necessary infra structure would have to be in existence before adaptation could begin. This would include (this is not meant to be all-inclusive); (a) new test weights and measures for service agencies and enforcement jurisdictions; (b) the proper metric education programs; (c) revision of tolerance tables and similar publications such as NBS Handbook 44; and (d) the publication of instructions describing how to adapt particular devices. (3) Manufacturers would need time to prepare (design and produce the necessary parts for adaptation; and (4) Parts inventories for service agencies would have to be increased at the proper time to include the necessary materials for adaptation.

3. The feeling that chaos might result in the adaptation of devices. Such confusion would almost certainly lead to higher metrication costs.

4. The cost of buying new metric testing equipment for plant and service personnel. It should be understood that such testing equipment is expensive. For example, one company sells a metric test weight kit ranging from 20 kg

to 1 g for $1375. In fact, one scale company estimated new metric testing equipment for field personnel *only,* would require an investment of at least $200,000. It would, therefore, be reasonable to project that the aggregate costs for metric field equipment for scale companies alone would be over $1 million. Whether or not similar costs would exist for meter companies is unknown since no meter manufacturer advanced cost figures for this area. However, it is felt that such costs for these companies should not be anywhere near those for scale manufacturers. The reason being that meter servicemen do not need a lot of testing equipment in their work, maybe only one or two provers. In the case of service agencies that use large capacity provers, these may be adapted to indicate in metric units with very little cost.[21]

5. Independent service agencies, usually under contract to scale or meter companies would, of course, face the same cost problems in purchasing metric testing equipment as company operated ones. However, for the most part, they would have less monetary resources to purchase such equipment and thus metrication may cause them severe economic hardships. Also, given the reasons as mentioned before, the scale repair agencies would, no doubt, face far higher costs than the meter ones.

[21] See II., pp. 66–67.

SCALE MANUFACTURERS ASSOCIATION PRESENTATION OF VIEWS ON WEIGHING SCALE CONVERSIONS TO METRIC SYSTEM (September 15, 1970)

GENERAL INFORMATION

1. This presentation is prepared by the Scale Manufacturers Association, Inc., 1 Thomas Circle, Washington, D.C. 20005.

2. Arthur Sanders, Executive Secretary of the Association is responsible for the contents of the presentation. His address is the same as that shown for the Association in item 1.

3. Arthur Sanders, Executive Secretary of the Association (as named in item 2) will appear at the National Conference for the oral presentation on weighing scales.

4. The Scale Manufacturers Association, Inc., is a nonprofit voluntary membership Association in which all U.S. manufacturers are entitled to participate. It is composed of some 31 scale manufacturers who are estimated to produce about 75 to 80 percent of the total U.S. production of weighing scales.

The general objective of the Association is to provide the means for cooperative endeavor in the interest of its members, the scale industry as a whole, the owners and users of scales, and the general public which is entitled to accurate and dependable weights.

A copy of the 1970 Information Handbook of the Association is enclosed listing members, directors, officers, the types of scales produced by each member as well as information about the Association and the industry (not included in this appendix).

5. The entire membership of the Association was consulted through a questionnaire seeking information and views to serve as the basis of this presentation. In addition, a meeting was held of the Association's Metric Study Committee and the officers of the Association.

THE BASIS OF THIS PRESENTATION

The study by the scale association and this presentation are almost wholly based on information and views as to U.S. conversion of weighing scales to indicate and record weights in metric units. It was assumed that the invitation for the scale association to make written and oral presentations at the National Conference was to obtain information and views of scale manufacturers on the conversion of new production of scales and existing scales to reflect weight indications and recordings in metric units rather than the customary system generally used in the U.S.

For the most part U.S. scale manufacturers produce parts and components and design scales in the customary system of linear measurement.

We feel that our situation in this regard is similar to other manufacturers of metal products who are better qualified to advise about the problems and opportunities in this area.

The scale industry of the U.S. with long experience in producing and distributing scales with U.S. customary and metric weight indication and recordations strongly favors U.S. conversion to the metric system of weights and measurement for several reasons: The metric system based on decimal mathematics is very much simpler than the U.S. customary system of pounds, ounces and common fractions of ounces such as 1/8th or 1/16th ounce; scales can be much more efficient and effective in design in the decimal metric system than in the pound, ounce and common fraction system; weights and measures can be much better understood and computed for comparisons with the metric-decimal system than with the pound-ounce-common fraction system presently in use; in the long run U.S. conversion to the metric system will further influence a universal system of weights and measures and will increase U.S. exports of weighing and measuring devices. Even with its manifold problems of converting to the metric system the U.S. scale industry still feels it is best for the nation.

For the greatest part weighing scales in domestic use in the U.S. and our scale production indicate and record in the customary system of weight. There are outstanding exceptions, of course, such as the pharmaceutical and chemical industries, the research and scientific industries, educational and industrial laboratories, etc. However, most replies to our questionnaire to members indicated that metric domestic sales of U.S. made scales are only 0 to 4 percent of the total.

There are many millions of scales in use in the U.S. and several millions are being produced each year, practically all of which are in the customary system of weight indication.

Thus, we have two big problems with respect to conversion of weighing scales to the metric system of indication and recordation, namely, conversion of scale design for new production and conversion of the many millions of scales, now in use, to metric indications. These will be covered separately in this report.

DESIGN AND PLANT CONVERSION FOR NEW PRODUCTION

1. A great many models of scales produced in the U.S. are produced with weight indicators and recorders which reflect weight in the metric system. These are for export to metric usage nations and for sale to U.S. industries or companies which utilize the simpler metric system. This is not to say that all scale producing companies and all models of scales are produced to the metric system. The scale industry of the U.S. produces scales to meet the demands of its customers. Many models of scales used in the U.S. in our customary system of weights are not produced in metric measurement and would require some redesign for metric production.

Also, numerous small manufacturers and those who do not export to metric nations, would be rather severely affected by cost of conversion to metric indications. We have no cost figures on the design and plant conversions of such models but must predict that it will be substantial, considering the size of the industry.

Weighing scales of course, will weigh the mass applied to the weighing platform, in the measurement system used in the indicator system of the scale. However, it is not always as simple as applying a new weight indicating chart, weight indicator beam or recording device.

For example, our attention has been called to the fact that it may be necessary in converting new scale production to metric indicating units to redesign the weighing elements such as levers, springs and load cells for the appropriate capacities and calibration. Also, computing scales for retail food and postal computations may require some costly redesign. Manually operated retail food computing scales are presently produced for export, with metric weight charts but are in foreign currency and not in U.S. dollars and cents; automatic prepackage price computing and labeling scales (there are possibly 30,000 in use in food supermarkets today) are designed to record weight in decimal hundredths of a pound to two decimals such as 2.24 pound. The smallest metric unit which could be recorded readily would be 0.01 kg (10 g). This is over twice the present smallest indication which is 0.01 lb (4.54 g). This may not be acceptable to weights and measures officials who promulgate specifications and tolerances for commercially used scales.

With respect to postal computing scales (there are several millions in use—the U.S. Post Office Department is undoubtedly the owner of the largest number of scales in the world) the design of the indicators and weighing elements for capacities and calibrations to meet the over-under breaking points for postal charges, will have to depend on the postal charges set under the metric system by Congress or the P.O. Department. The charges set for postage will very much affect the design requirements for new postal scales.

2. In addition to the cost of design conversion for new scale production there is the cost of such matters as reeducation of plant and service personnel in the metric system, the redesign and republication of all catalogs to reflect both metric and customary weights and most important, the dual inventories of parts and new scales required during the changeover periods.

CONVERSION TO METRIC OF SCALES IN USE

1. Probably the most serious problem of U.S. conversion of weights to the metric system is the adaptation of existing scales to metric indications and recordations. This is the situation because there are millions of scales in use today which may need to be converted to metric under a *planned-arrangement* of U.S. conversion. As long as these "in use" scales continue to reflect the customary system of indications they will continue to be used in this manner, even though inexpensive conversion charts are made available. In this connection most scale manufacturers have indicated in our survey that conversion charts (customary to metric) can be prepared.

2. All scale manufacturers answering our survey have indicated that if U.S. conversion to metric weights is to be successfully and economically ac-

complished it should be done on a *mandatory planned schedule* and not on the present practice of allowing each sector of the economy to increase its metric usage if and when it sees fit to do so. There must be planned mandatory conversion or we will find that another hundred years will pass with little conversion (as in the past century during which metric has been legal). It might also be pointed out that Japan is now successfully converting to the metric system after pressure from the U.S. Army of Occupation, but that for several decades prior thereto little success had been achieved under a law which did not establish a planned schedule of mandatory conversion.

3. Planned scheduling of conversion to metric weight indication must mean not only conversion of new scale design, production and distribution, but also conversion of existing scales to metric indication.

As has been indicated heretofore, there are quite a few millions of scales in use now that would need to be converted. For example, it has been estimated by responsible scale manufacturers that there are two to three million mail scales in use, all of which will need to be converted to metric usage when and if the government changes the mail rates to metric breakpoints instead of the present customary system breakpoints.

Excluding bathroom and other household scales (which may not be practical to convert to metric from an economic and practical standpoint), our survey indicates there may be some five million scales which could be converted to metric under a planned schedule, over a period of years. Most but not all, of these scales could be converted to reflect metric indications, at a price, provided the parts and qualified personnel are available with the understanding that the conversions can be accomplished on a *planned schedule*, meaning a stretch-out for the conversions. It is obvious that all conversions of a particular type scale in a particular area cannot be converted in the last month before the final deadline.

4. In the United States there are several thousand field scale servicemen—possibly 4,000. Some of these servicemen are fully qualified to convert many models of scales to metric indications, but not all. Many have never had experience in such work and almost all would need rather extensive training for converting the very wide variety of scales used in the U.S. (there are several thousand models of scales in use in the U.S.).

In addition, it must be remembered that the several thousand scale servicemen presently operating in the nation even if qualified to convert most models to metric, are presumably busy at present with servicing scales and thus could not devote full time to a new program of converting to metric. Therefore, it becomes significant that there be a *planned schedule* of conversion to metric weights if the program is to be successful.

In estimating the number of scales in use above, at five million or more, we purposely excluded bathroom and household scales, of which there may be 25 to 40 million in existence in the U.S., all with customary weight indications. We have excluded these scales from the discussion of converting existing scales to the metric system for the reason that the conversion of such a scale may be more costly than the purchase of a new scale produced with metric indications. In addition, the availability of qualified personnel to convert these scales to metric indications is almost nil. And, the question can be asked, how many owners of these inexpensive scales would be willing to pay for conversion? There is also the matter of the ownership of most of these scales by mature citizens who are steeped in the U.S. customary measurement system, who may be willing to continue to use the scale for their time, and until they are required to use metric indications.

If there is no planned schedule for converting scales in use to metric they simply will not be converted. The public and business will not demand use of the metric system in commercial transactions and a competitor who converts before his competition may be at a serious disadvantage.

5. In our questionnaire to members we asked for estimates as to the years needed for conversion of existing scales to the metric system. Most companies estimated that existing scales could be converted in 5 years, but some important answers indicated that as much as 10 years would be needed on a planned schedule.

We also asked for estimates of the percentages of time of presently employed service personnel which would be needed to convert scales now in use over a reasonable planned schedule. The answers for the most part were 20 and 25 percent.

An important point about conversion of existing commercial scales is whether, after conversion, such scales are required to meet new scale accuracy tolerances or used scale tolerances. New scale tolerances are called "acceptance" tolerances and are in the general range of 1/20th of 1 percent of the test load applied. Used scale tolerances are called "maintenance" tolerances and are double the acceptance tolerances or about 1/10th of 1 percent. The Specifications and Tolerances for commercial scales followed in all states stipulate that "acceptance" or new scale tolerances shall be applied on official tests for the first time within 30 days after major reconditioning or overhaul.

A conversion of a commercial scale to metric indication would not be a "major reconditioning" or overhaul, but if weights and measures officials of the states, counties, and cities require such converted scales to meet "acceptance" tolerances considerable time and parts must be used by servicemen in overhauling the scale. Probably two to three times as many manhours will be needed to bring the scale to acceptable tolerance as would be needed to meet the maintenance tolerance. Actually, if acceptance tolerances are required on the official tests after conversion to the metric system probably 75 to 80 percent of commercial scales would require a full overhaul. The additional service manpower would be staggering.

6. The cost of converting scales in use to the metric system was one of the questions asked in our questionnaire. The companies replied only with estimates for the types of scales they produce and thus an overall estimate for all scales is not possible. Also, as indicated previously many inexpensive scales (such as bathroom and household scales of which there are some 30 to 40 million in use) will not be converted because the conversion costs would make it uneconomical to convert and as a practical matter the mature owner would as soon have the device continue to reflect the customary system. In addition, there is a large percentage of scales in use which are old and in poor

condition or which are obsolete and thus can or should be replaced with new and up-to-date scales rather than be converted at rather high cost.

However, the cost of converting scales in use can still come to rather staggering figures. For example, the two most knowledgeable companies who produce retail food computing scales estimate that there are several hundred thousand in use in the United States, possibly 500,000 or more. To convert the manually operated and manually read price computing scales (of which there are several hundred thousands in use) might cost as much as $75 million. The more complicated automatic weighing, pricing and label printing computation scale which is the heart of the production line operation of the modern supermarket (there are about 30,000 units in use) would cost more per unit to convert and the conversion cost has been estimated at $30 to $35 million.

In another example it has been estimated that there may be as many as 700,000 bench and portable scales in use in the U.S. and that the cost of converting all these scales may be over $100 million. Railroad track and motor truck scales, with some 50,000 to 70,000 in use, may cost $50 to $70 million to convert.

Thus, we cannot make an overall estimate of the total cost of converting existing scales to metric system of indicating and recording weight but from the estimates of knowledgeable people in the scale industry, the cost may total $200 million or more, stretched out over the planned schedule of 5 to 10 years.

7. Test Weights and Unit Weights—In our study of the matter of U.S. conversion to the metric system of weights our attention has been called to the conversion of static test weights used in testing scales officially for accuracy by federal, state, and local agencies, by field service agencies of the scale industry and "unit weights" which are a part of the scale itself for extending upward the weighing capacity of large capacity scales. All of these test weights and unit weights would have to be replaced when tests are made in the metric system or when the scales utilizing unit weights are converted to metric. During a conversion period test weights of both the metric system and the customary system would be needed by testing officials and by field service repair agencies—as some scales may have been converted and others may not.

It has been estimated that there are at present several million test weights in use by weights and measures officials, factories and repair agencies in the nation. It has been estimated also that from 3 to 5 years would be required to produce metric weights for the same use. In addition, since these weights range from 1/16 ounce or less, to 1,000 pounds or more, the transportation of duplicate sets of weights (metric and customary) will constitute a problem for weights and measures officials and service agencies, unless a system of conversion by supplementary weights between the two systems can be developed.

Unit weights are frequently used to extend the capacity to higher capacities, of a scale for which larger capacities are needed than is shown on the beam or dial indicator. In such a situation, as many as ten drop weights of specified capacity—say 1,000 pounds or 10,000 pounds each—may be applied to the mechanism, with an equivalent increase in the capacity of the weight indicator and recorder. Also for load cell weighers special capacity extension arrangements can be applied to extend the capacity of the dial. In these situations, to convert these scales to metric, special arrangements would be needed—either new metric drop weights or converted load cell capacity extension arrangements. Whether or not special conversion arrangements can be made to continue to use the old drop weights and load cell capacity is questionable.

8. Duplicate Inventories—During the conversion period of 10 years or so scale companies expect that there will be the quite costly necessity of maintaining duplicate inventories of new scales and replacement parts in both metric and customary indications. There seems to be no way to avoid this situation as scales of both systems will be in demand. The serious impact can be lessened, apparently, only by a short period of planned, scheduled, mandatory conversion.

In this period the scale companies would also have to maintain duplicate engineering drawings for such large capacity scales as railroad track, motor truck, built-in, and dormant scales.

9. Effect on Exports—Most of the companies responding to the questionnaire felt that U.S. conversion to metric would have no appreciable effect on the volume of U.S. scale exports. However, about one-third of the respondents thought our conversion to metric would result in an increase in U.S. scale exports. The U.S. is the world's second largest scale exporter—second only to Germany. But less than 10 percent of U.S. scale production is exported.

CONCLUSIONS

The scale industry is in favor of U.S. conversion from customary to metric weights. However, there will be some rather serious problems including design and production of some models of scales and the conversion of existing scales with the great use of qualified servicemen which would be necessary. Also, there will be the costly replacement of test and unit weights and the use of test weights in both customary and metric during the conversion period.

There will be a costly period of duplicate inventories of new scales and parts, during the conversion period, even under a planned schedule of mandatory conversion.

If mandatory use of the metric system is not required for metric weights it is doubtful that there will be a significant trend toward metric weights. History in this and other nations has proven this to be the case.

While there may be some modest increase in U.S. scale exports after conversion to metric it is not expected that this will be substantial.

NATIONAL SCALE MEN'S ASSOCIATION PRESENTATION OF VIEWS ON CONVERSION TO THE METRIC SYSTEM [22] (October 30, 1970)

The National Scale Men's Association (NSMA) 214½ South Washington Street, Naperville, Illinois 60540, appreciates this opportunity to express the views of its members on the issues before the U.S. Metric Study.

The National Scale Men's Association is a nonprofit voluntary membership association composed of more than a thousand (1000) persons who are organized into local divisions. Membership is open to any individual whose activities relate to weighing devices or weighing practices. Consequently, the Association houses members of widely divergent backgrounds and responsibilities. For example, there are servicemen, engineers, and state and local weights and measures officials.

The general objectives of NSMA are:

(1) to promote the knowledge and application of weighing devices,
(2) to foster legislation that will improve weighing practices, and
(3) to set up performance standards in the servicing, selling, and use of weighing equipment.

DATA COLLECTION PROCEDURE

The information for this report was obtained from a questionnaire as circulated among the membership. The questionnaire, because of the diverse backgrounds of the members, had to cover many facets of metrication as it affects, or would affect, their (the members') responsibilities. As a result, many respondents had neither the knowledge nor interest to answer all of the questions submitted; thus, most members answered only those questions which were of importance to them.

SUMMARIZATION OF QUESTIONNAIRE RESULTS

Present or Anticipated Use of the Metric System, Assuming Current Conditions Continue, e.g., No Formal Metrication Program

1. Eighty percent of the respondents said they had no intention at present to stock additional metric units.

2. Sixty-four percent of the respondents said they had no plans to expand their service facilities to handle increased metric business.

3. Seventy-nine percent said their businesses had not experienced an increase in market demand for either new metric scales or for the servicing of metric devices. Such increased demand, when it occurred, was attributed

[22] This report was prepared by C. G. Gehringer, Chairman, Technical and Legislative Committee under authority granted by the Association's Board of Directors.

specifically to the expanded use of the metric system in the paint, chemical, and ink industries, and generally to the increased use of the metric system by companies who are (1) expanding their export markets and/or (2) using more metric units in their laboratories.

4. On the whole, companies have encountered very few difficulties in using the metric system. The difficulties which did arise were centered around changing the recording elements of devices to print out in metric units. For example, weighing systems which use computer printouts encountered some interfacing problems between the weighing device and the computer-printer. However, our members report that the personnel of scale users have adjusted to the unfamiliar metric system rather well and, as a result, few problems have arisen in the use of metric units.

Attitudes Concerning and Problems Arising from Metrication

1. Eighty-five percent of the respondents indicated their preference for a fixed time period of 10 years for converting to the metric system of measurement. A like number favored a planned conversion schedule as opposed to one allowing each sector of the economy to increase its metric usage if and when it sees fit to do so.

2. The estimated time required to convert existing scales varied considerably with 54 percent estimating 10 years, 35 percent 5 years, and 10 percent 3 years.

3. Respondents were almost equally divided as to whether or not converted scales should be required to meet maintenance or acceptance tolerances. Fifty-eight percent favored maintenance tolerances and 42 percent acceptance tolerances.

4. Even if domestic demand for more metric scales increased, 53 percent of the respondents felt there would be no significant changes in their operations unless there was a Federal program to encourage metrication.

5. Twenty-two percent felt if the conversion period was very long, thus reducing the impacts of metrication in any one year, there would be very few diverse effects on their operations.

6. Seven percent felt metrication would result in quite a bit of confusion.

7. Also, 7 percent felt that:

(a) double sets of standards would be required for all servicemen and weights and measures officials;

(b) the demand for scales indicating in both metric and U.S. customary units would increase;

(c) the use of two measurement systems simultaneously would result in enforcement and servicing problems.

8. Problems that might arise due to the metric conversion of scales were commented on as follows:

(a) Forty-four percent felt there would be additional problems in training personnel;

(b) Sixty-four percent felt increased inventory would result;

(c) Forty percent felt there would be problems with existing laws.

(d) Other areas where problems might arise were freight computation schedules, tariffs, etc.

9. In order to convert to the metric system, respondents felt they would have to (in order of importance):

(a) establish metric education programs;
(b) make provisions for using dual measurements;
(c) plan for converting or replacing equipment now in use; and
(d) know when metric equipment, tools, and parts would be readily available.

Costs of Converting to the Metric System

Companies' costs in converting to the metric system, including weights, tools, dyes, fixtures, equipment and pit drawings, gauges, linear measuring devices, stock of parts for two systems, training of personnel, instruments, etc., were estimated as follows:

Cost range:	*Percentage of companies*
$5,000–$10,000	37½
$10,000–$25,000	12½
$25,000–$50,000	8.3
$50,000–$100,000	8.3
$100,000–$200,000	8.3
$200,000–$300,000	4.2
Over $300,000	20.8

Miscellaneous Opinions and Data

1. Respondents gave the following areas, in order of importance, in which they feel the Federal Government should act in order to relieve the impacts of metrication coming from both domestic and foreign sources:

a. The Government should authorize metric conversion as soon as possible.
b. The Government should provide:

(1) the necessary educational material to all, (*Note:* Some respondents felt that the Federal Government should conduct seminars on the metric system throughout the country for various industries and groups.)
(2) interim double standard equipment, and
(3) a detailed metric conversion program. Such a planned program should (a) take into account the ability of industries to convert and (b) provide that industries in similar lines of business convert at the same time.

2. Respondents felt that the U.S. Metric Study staff and the Secretary of Commerce should consider the following areas as they examine the metric issue:

a. The cost of metric conversion and the cost of delaying metrication.
b. The U.S. position in international trade if no change is made.

c. The problem of education and publicity on the metric system.
d. The time required to educate people in the metric system.
e. The possibility of arranging loans to small businesses to assist them in changing to the metric system.
f. The capability of the scale industry to make a changeover.

3. The estimated number of new metric test weights that would be required showed 5,800 units for weights and measures enforcement jurisdictions and 15,600 units for service agencies.

4. Members estimated that 94.1, 5.2, and 7 percent of the scales now used by industry indicate or record in the customary system (avdp. weight), the metric system, or other measurement systems, respectively.

CONCLUSIONS

No attempt will be made to draw conclusions. The information presented herein is a compilation of answers as received from the membership and reflects their views on the metrication problem.

SERVICE AGENCIES[23] (GENERAL DISCUSSION)

INTRODUCTION

This appendix will identify the major cost areas that service agencies (either owned by device manufacturers or independent) will face due to metric adaptation of weighing and measuring devices to record and/or indicate in metric units.[24] It should be understood that the major cost areas will only be identified, and that estimated costs herein were not developed by a detailed cost analysis and are included only as an aid to the reader so that he may better understand the extent of the economic impacts of metrication upon these agencies.

Service agencies in general will face costs arising from the need: (1) to purchase new and/or adapt present testing equipment in/to metric units; (2) to establish education programs for their personnel to understand the metric system (SI); and (3) to be able to adapt devices now in use where practical, to indicate or record in metric units.

EQUIPMENT—GENERAL

The equipment used by servicemen is similar to or the same as that used by weights and measures inspectors. Thus, the equipment problems due to metrication faced by service agencies will be about the same as those encountered by weights and measures jurisdictions.[25]

The following conditions apply to the discussions that follow:[26]

1. Service agencies will have to purchase new small metric weight kits to be able to efficiently test small capacity devices.
2. Because of the cost involved in either replacing large mass standards or adapting them to convenient metric units, correction weights should be used.
3. Provers, except glass, can usually be adapted by replacing the scale plate. This can be done at a nominal cost of about $10 each.

EQUIPMENT—SCALE SERVICE AGENCIES

The cost of metrication to scale service agencies could easily be over $1 million. In fact, one scale manufacturer estimates its costs would be at least $200,000 to re-equip its service personnel and repair shops.[27] Even though there is no accurate breakdown of the different types of test weights now used by repairmen, the National Scale Men's Association estimates that

[23] See comments section of app. I-1.

[24] Costs arising from other types of metrication have not been included.

[25] See II-3, p. 61.

[26] For a more complete discussion of these conditions, see II-3, p. 62. (Cost Analysis: Introductory Comments).

[27] See comments section of app. I-1, p. 41 for more details.

there are over 15,000 individual weights of all types now in use.[28] However, it is reasonable to assume that most of these weights are of the small mass type in convenient U.S. customary units. High costs would therefore arise due to the fact that these mass standards would become obsolete under a metrication program and new metric standards would have to be purchased to take their place.

EQUIPMENT—METER SERVICE AGENCIES

It does not appear that meter service agencies would face severe cost problems in adapting their testing equipment, mostly nonglass provers, to indicate in metric units. Provers, as mentioned previously, can usually be adapted for $10 each, irrespective of type. Even though there is no accurate accounting for numbers or types of provers now used by repairmen, it is doubtful that there would be more than 6,000 provers (of all types); weights and measures jurisdictions have only 5,123 nonglass provers, and it is reasonable to assume that since the total personnel forces of both the meter service agencies and weights and measures jurisdictions are about the same, the total number of provers used would be about the same also. As a result of the above deduction, it is estimated that the total equipment adaptation cost would be around $60,000.

TRAINING—SCALE AND METER REPAIRMEN

Service agency personnel will have to undergo a training program that will enable them (1) to understand and use the metric system of measurement in their work and (2) to be able to adapt presently used devices, where possible, to indicate and/or record in metric units. It now appears that the cost of educational materials to be used in these training programs will be small compared to the man hours spent by repairmen in such programs. Using (1) the training time estimated for weights and measures officials as a guide, i.e., 50 to 80 hours of instruction per man, and (2) 6,000 servicemen as a base, the total amount of time spent on training would be between 336,000 and 480,000 hours. The total economic cost would be, using $15 per man per hour as an average estimate of labor and overhead, between $5,040,000 and $7,200,000.

CONCLUSION

The impacts of the above costs will, it appears, fall most heavily on independent service agencies, especially the scale ones. These agencies may not have the financial resources to incur such costs unless they are spread over a reasonable period of time, say 5 to 10 years.

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[28] See app. I-3, p. 53.

GLOSSARY

1. *Customary System:* the system of measurement units (yard, pound, second, degree Fahrenheit, and units derived from these) most commonly used in the United States. Often referred to as the "English system" or the "U.S. system." Our customary system is derived from, but not identical to, the "Imperial system"; the latter has been used in the United Kingdom and other English-speaking countries, but is being abandoned in favor of the metric system.

2. *Metric System:* the measurement system that commonly uses the meter for length, the kilogram for mass, the second for time, the degree Celsius (formerly "Centigrade") for temperature, and units derived from these. This system has evolved over the years and the modernized version today is identified as the "International System of Units," which is abbreviated "SI."

3. *International System of Units (SI):* popularly known as the modernized metric system, it is the coherent system of units based upon and including the meter (length), kilogram (mass), second (time), kelvin (temperature), ampere (electric current), and candela (luminous intensity), as established by the General Conference on Weights and Measures in 1960, under the Treaty of the Meter. A seventh base unit, the mole (for amount of substance) is being considered as another SI base unit. The radian (plane angle) and the steradian (solid angle) are supplemental units of the system.

4. *Metrication:* any act tending to increase the use of the metric system (SI), whether it be increased use of metric units or of engineering standards that are based on such units.

5. *Planned Metrication:* metrication following a coordinated national plan to bring about the increased use of the metric system in appropriate areas of the economy and at appropriate times. The inherent aim of such a plan would be to change a nation's measurement system and practices from primarily customary to primarily metric.

6. *Cost of Metrication:* that increment of cost, monetary or otherwise, directly attributable to metrication over and above any costs that would have been incurred without metrication.

7. *Benefits of Metrication:* monetary and other advantages accruing as a result of increased use of the metric system.

8. *Measurement Standard:* a device or physical phenomenon that is used to define or determine a characteristic of a thing in terms of a unit of measurement established by authority. Examples are gage blocks, weights, thermometers, and mean solar day.

9. *Engineering Standard:* a practice established by authority or mutual agreement and described in a document to assure dimensional compatibility, quality of product, uniformity of evaluation procedure, or uniformity of engineering language. Examples are documents prescribing screw thread dimensions, chemical composition and mechanical properties of steel, dress

sizes, safety standards for motor vehicles, methods of test for sulphur in oil, and codes for highway signs. Engineering standards are often designated in terms of the level of coordination by which they were established (e.g., company standards, industry standards, national standards).

II. REPORT OF THE TASK FORCE ON METRICATION (DECEMBER 17, 1970)

NATIONAL CONFERENCE ON WEIGHTS AND MEASURES

The National Conference on Weights and Measures, sponsored by the National Bureau of Standards, is an organization of approximately 500 members. The membership is comprised of state and local weights and measures officers, Federal officials, and representatives of business, industry, and consumer organizations.

The objectives of the National Conference of Weights and Measures are:

(a) To provide a national forum for the discussion of all questions related to weights and measures administration as carried on by regulatory officers of the States, Commonwealths, Territories, and Possessions of the United States, their political subdivisions, and the District of Columbia.

(b) To develop a consensus on model weights and measures laws and regulations, specifications and tolerances for commercially-used weighing and measuring devices, and testing, enforcement, and administrative procedures. To further this objective, the Conference has developed and recommends the adoption of such publications as "The Model State Law on Weights and Measures," "The Model State Packaging and Labeling Regulation," and NBS Handbook 44, "*Specifications, Tolerances, and Other Technical Requirements for Commercial Weighing and Measuring Devices.*"

(c) To encourage and promote uniformity of requirements and methods among weights and measures jurisdictions.

(d) To foster cooperation among weights and measures officers themselves and between them and all of the many manufacturing, industrial, business, and consumer interests affected by their official activities.

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II–1. INTRODUCTION

AUTHORITY AND AREA OF INVESTIGATION

The National Bureau of Standards, under authority granted by Public Law 90-472 (82 Stat. 693), requested the National Conference on Weights and Measures to assist it by investigating the impacts (costs, time, etc.) of metrication upon weights and measures jurisdictions. As a result, the 54th National Conference authorized the establishment of this Task Force and the Conference's Executive Secretary formally instituted this committee on April 20, 1970.[1]

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[1] Report of the 54th National Conference on Weights and Measures, 1969, NBS Special Publication 318, Resolution on Metric Study, p. 236 (see III. Suppl., p. 87).

Ibid, Motion on the Establishment of a Metric Task Force, p. 161 (see III. Suppl., p. 87).

Ibid, The Role of Weights and Measures Officials in the Metric Study, A. G. McNish, pp. 108-111.

App. II-3, Organization of the Task Force on Metrication.

BACKGROUND

Historical evidence indicates that evolutionary metrication in commercial weights and measures is unlikely. The proof of this prediction rests primarily on the fact that since 1866, when the U.S. Congress legalized the use of the metric system for commercial transactions (15 U.S.C. 204, Supp., p. 96) there has been almost no movement to adopt the use of metric units in the buying, selling, or primary labeling of products. (*Note:* The Fair Packaging and Labeling Act (FPLA), P.L. 89-755, precludes the exclusive voluntary use of metric units on package labels; i.e., U.S. customary units must be used to describe the quantity of contents of a packaged consumer commodity as defined in this law. However, FPLA does not prohibit the use of metric units on labels. Thus, both metric and customary units may be used together on a label.) One reason for this appears to be a reluctance on the part of both retailers and consumers to change, or, for that matter to want to change, existing measurement traditions. Since weights and measures officials prefer to operate with the measurement system used in commerce, now the U.S. customary system, it is doubtful that they will change to the metric system until that system becomes, or will become dominant in commercial use. (*Note:* Mr. Akey of Wausau, Wis. was of the opinion that under present conditions, weights and measures officials had to use the customary system in their testing operations.)

It has, therefore, been concluded that legislation requiring the use of metric units in commercial transactions will be needed in order to bring about metrication in commercial weights and measures, i.e., measurements made in conjunction with commercial transactions would have to utilize metric units for determining length, volume, and weight. The immediate statement should not be construed as a Task Force endorsement for such legislation (Federal or state) nor is such legislation a subject of this report. However, it does appear reasonable to foresee that any action requiring metric usage in such a sensitive area would, no doubt, have to have a great deal of citizen support before it was taken.

To conclude, the impacts of metrication mentioned in this report were determined assuming there would be a required metrication program, since it is doubtful that few if any measurement changes and their associated impacts would occur without one.

II-2. WEIGHTS AND MEASURES JURISDICTIONS

"The primary function of the weights and measures official is to see to it that equity prevails in all commercial transactions involving determinations of quantity."[2] Whenever goods or services are bought and sold by weight or measure, it is his duty to eliminate unjust transactions which may be caused by intentional fraud or misrepresentation, carelessness, or ignorance.

The Congress has left the control and regulation of commercial weighing and measuring devices and activities almost exclusively to the states. How-

[2] NBS Handbook 82, *Weights and Measures Administration*, p. 1.

ever, weights and measures statutes and the degree and form of regulatory controls are not alike in all states. *Note:* The National Conference on Weights and Measures is promoting uniform laws, etc. Despite the fact that the Conference can only make recommendations, it has earned a reputation as an authority in the weights and measures area, and many jurisdictions do accept its proposals. Thus, through voluntary cooperation, uniform regulations and test methods are being established.

To protect the interests of both the buyer and the seller, the official does work in two major areas—mechanical and supervisory. The mechanical activities of the official consist of testing at regular intervals, all commercial weighing and measuring devices in his jurisdiction. Equipment which does not meet the necessary standards is removed from use until it is corrected.

In his supervisory activities, the official checks the quantity of contents of packaged goods put up by manufacturers, and he also checks bulk commodities. It is his job to investigate complaints, educate buyers and sellers to their rights and duties under weights and measures laws, and to try to develop cooperation between his office, consumers, and industry.

Finally, there is diversity in the forms of weights and measures organizations in the states, but they generally follow one of three basic plans as follows: The first plan is for all supervision to be exercised by the state government through a state office of weights and measures. This allows for uniform test methods throughout the state by inspectors who are responsible directly to the state office.

The second plan combines the use of both state and local (city and/or county) officials. The state officials usually work in areas not under local supervision or in testing operations where local officials do not have the necessary expertise or equipment required. Under this form of organization the state generally has some control over all weights and measures activities.

The third plan calls for all inspections and testing to be conducted by local officials, with the state office performing such functions as supervision, promulgation of rules and specifications, and the testing of standards of local officials.

II-3. INSPECTOR'S EQUIPMENT[3]

INTRODUCTION

The vast majority of weights and measures jurisdictions in the United States have little or no metric field testing equipment. Present equipment would have to be adapted to metric units, where possible, or new metric equipment would have to be purchased.

Note: It is more desirable to test weighing and measuring devices in the system in which they are indicating or recording. Similarly, package quantities should be checked in the system in which they are labeled. This practice

[3] Equipment is defined as scales, balances, and standards (mass, volume, and length) used by weights and measures officials in their field operations.

would avoid errors caused by converting from U.S. customary units to metric units in testing operations, thus enhancing the correctness of such operations.

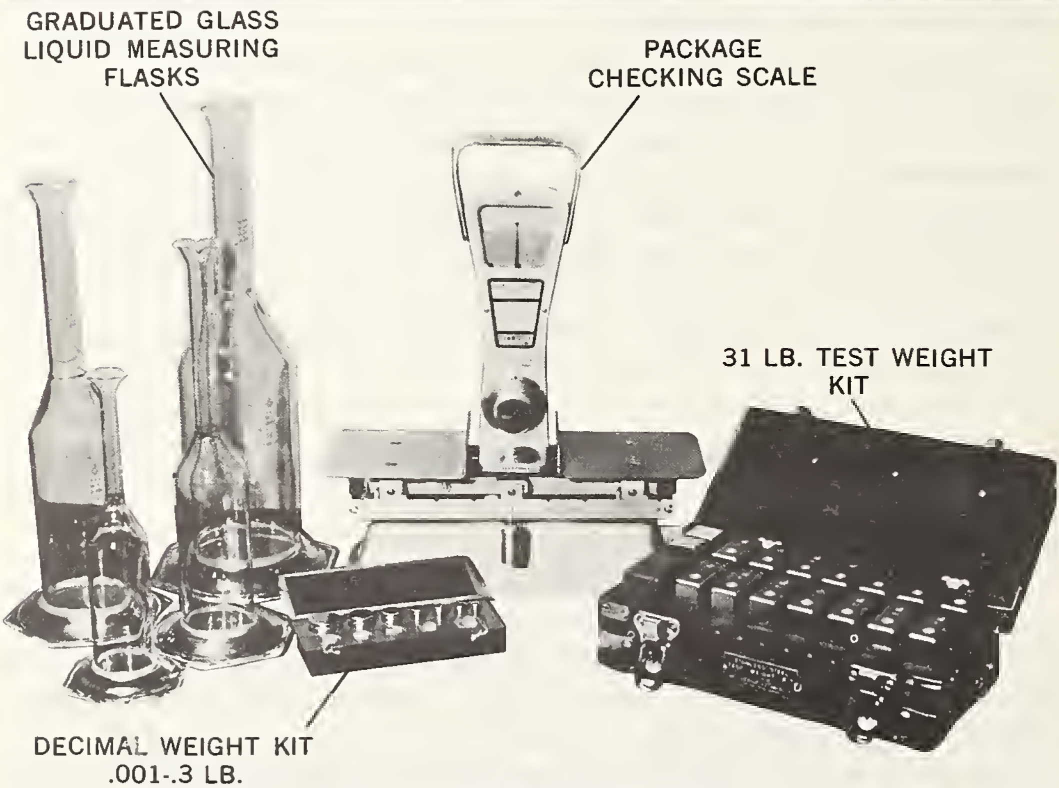
COST ANALYSIS

Introductory Comments

1. As a rule it is less expensive to buy new metric small capacity weight kits than to convert present U.S. customary ones. This fact has the added benefit of enabling jurisdictions to maintain, indefinitely, a dual system in small capacity weights. (See fig. 21.)

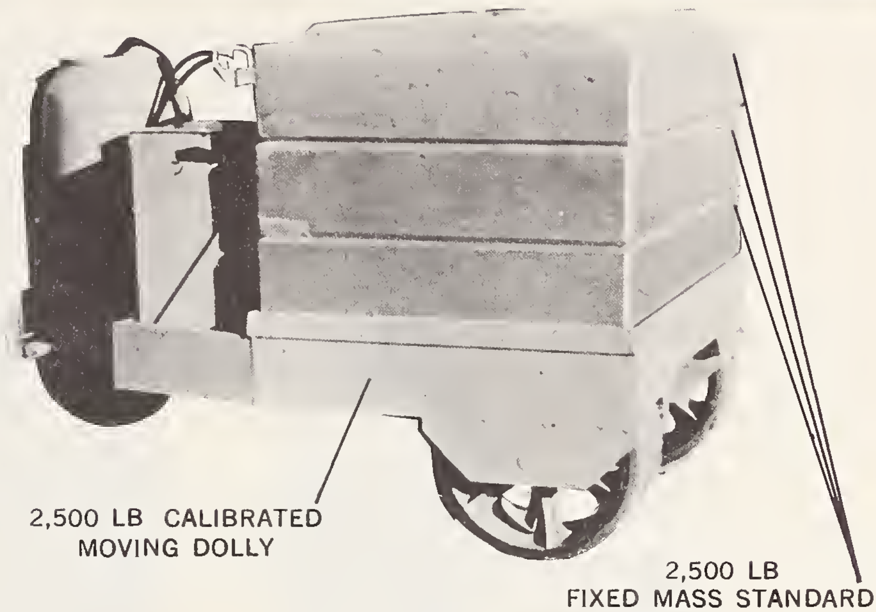
2. It is not possible to convert existing glass test measures to metric values. Thus, new metric glassware will be needed. Like small capacity weight kits, this will enable jurisdictions to maintain a dual system in small capacity volumetric measurements. (See fig. 21.)

3. Present package checking scales may be used to check quantities in the metric system provided the scale is used as a comparison device, a "null" or zero balance indicator only. This may be accomplished by (1) setting all poises at the zero indication and (2) adjusting the scale by using metric weights so that the tower indicator always reads zero. Thus, the metric



Inspector's Equipment

FIGURE 21



Large Capacity Testing Unit
FIGURE 22

weights would be read in order to find the weight of the unknown item.[4] This procedure could be used until devices could be adapted or until new ones could be purchased. The costs to adapt these devices will be given below so that a complete cost picture may be obtained. (See fig. 21.)

4. It is felt that adapting present, or purchasing new, large capacity field mass standards (fig. 22) would be prohibitively expensive for almost all weights and measures jurisdictions. Therefore, it is suggested that correction weights be used with present standards to achieve convenient metric weight units. This conclusion has been reached despite the fact that, even though the use of correction weights is a sound principle, it is generally discouraged because there is always the danger that the right number of correction weights will not be used in conjunction with present standards on any test. Thus, inspectors would have to be extremely careful in conducting tests when correction weights are required.

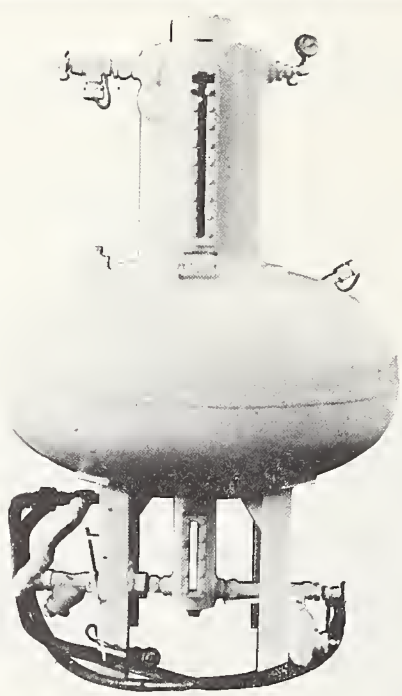
The procedure for using correction weights would be to use one correction weight of 51.116 lb (23.204 kg) for every 500 lb (226.796 kg) to achieve a mass of 250 kg. Thus a 1,000 lb standard would require two correction weights to achieve an even metric mass of 500 kg.

[4] Since this procedure works equally well with U.S. customary weights, devices which have been adapted could still be used to check packages labeled in the U.S. customary system.

These correction weights of 51.116 lb (23.204 kg) each could be prepared by adapting present 50 lb field standards. This adaptation, adding weight to the adjusting cavity, does not appear to be expensive and could be readily accomplished by state weights and measures laboratory metrologists as state primary mass standards include metric weights for calibration. These correction weights, being unique, should be specially marketed, such as by being painted red, so that they will not be confused with similar field standards. *Note:* Even though this approach may reduce metrication costs, it has the disadvantage of leaving jurisdictions with a complex testing procedure for large capacity scales for an indefinite period of time. Therefore, it would seem reasonable to conclude that most jurisdictions, sooner or later, would want to purchase metric field standard weights or adapt present mass standards to even metric units in order to avoid using inconvenient correction weights.

5. Other 50 lb (22.6796 kg) mass standards, not being used as correction weights above, could be adapted to 20 kg by, for example, machining or cutting down the bottom of the standards. This does not appear to be an expensive operation as the mass of material to be removed is not large (5.9075 lb or 2.6796 kg).

6. Finally, the adaptation of most field standard (test) measures or standard provers (fig. 23 and 24), except measuring flasks made of glass, could



100 Gallon Liquid Petroleum Gas Prover

FIGURE 23

Field Test Measures

FIGURE 24

be accomplished by changing the reading scale plate. However, this may introduce inconvenient numbers in metric units. Since it is less expensive to convert than to purchase new metric test measures, total costs will be estimated using the adaptation cost figures. The cost of new metric measures is noted.

Conditions

The following conditions limit the interpretation of cost figures and the types of equipment considered for discussion:

1. Cost figures given herein should be considered only as estimates of the magnitude of the costs involved. Too many economic variables, such as inflation, make precise estimates extremely difficult both for present and future costs.

2. Because of the large varieties of equipment used by weights and measures officials, it has become necessary to restrict this discussion to equipment which is widely used. Because of this limitation, cost estimates should be considered on the conservative side as equipment not considered may also have to be adapted.

3. The discussion excludes all equipment used in weights and measures laboratories. The National Bureau of Standards is supplying the states with new laboratory equipment and basic standards in both U.S. customary and

Analysis — Inspectors' Equipment

Type of equipment	Type of metrication (X)			Total[1] number in use	Unit cost to either convert or purchase	Total cost	Purchase price per item for new equipment if optional
	Purchase of equivalent metric equipment	Conversion of present equipment	Capacity of converted equipment				
Cube weight kits (1/16 oz to 2 lb)	X	Impractical	N/A	841	$235	$197,635	N/A
Decimal pound weight kits (.001 lb to .3 lb)	X	Impractical	N/A	455	50	22,750	N/A
Decimal pound ounce kits (.01 oz to .5 oz)	X	Impractical	N/A	127	40	5,080	N/A
8 pound test weight kits (stainless steel)	X	Impractical	N/A	163	100	16,300	N/A
50 pound mass field standard (cast iron)[2]		X	20 kg	27,048	10	270,480	$25
	X		20 kg	7,599	25	189,975	N/A
Over and under 5 lb capacity package checking scales		X	Approx. 2 kg	726	15	10,890	200
10 lb capacity field balance		X	Approx. 5 kg	305	30	9,150	300
500 lb mass field standard		X	250 kg using one correction wt./standard.	1,143	10	11,430	150
1000 lb mass field standard		X	500 kg using two correction wts./standard.	2,628	20	52,560	250
2500 lb mass field standard and calibrated dollies		X	1250 kg using five correction wts./standard.	158	50	7,900	1,000
5000 lb mass field standard and calibrated dollies		X	2500 kg using ten correction wts./standard.	41	100	4,100	1,400

1 gallon test measure		X	3.75 liters	1,312	10	13,120	25
5 gallon test measure		X	19.0 liters	2,793	10	27,930	60
100 gallon prover		X	375 liters	380	10	3,800	600
1,000 gallon prover		X	3,750 liters	24	10	240	2,000
100 gallon LPG prover		X	Change scale plate to read in liters.	47	10	470	6,000
Glass test measure kits	X	Impractical	N/A	160	160	25,600	N/A
2 oz graduated cylinder	X	Impractical	N/A	222	4	888	N/A
No. 8 size sieve, pan and cover	X	Impractical	N/A	42	50	2,100	N/A
16-foot length standard	X	Impractical	N/A	199	15	2,985	N/A
50-foot length standard	X	Impractical	N/A	373	15	5,595	N/A
100-foot length standard	X	Impractical	N/A	199	15	2,985	N/A
Fabric measuring test tapes	X	Impractical	N/A	454	15	6,810	N/A
Subtotal						890,773	
Contingency and miscellaneous costs[3] 25% of subtotal						222,693	
Total						1,113,466	

N/A = Not Applicable.

[1] These figures were based on a 93% return on questionnaires sent to 68 selected weights and measures jurisdictions (see app. II-1 for more details). If a state had local jurisdictions, except for the 16 large cities surveyed separately, the state director of weights and measures was asked to inventory the equipment owned by these jurisdictions.

[2] Since 7,599 50-lb standards will have to be used as correction weights with large capacity mass standards, an equivalent number of new 20 kg weights would be needed in order to maintain present testing capabilities.

[3] Contingency and miscellaneous costs include: (1) costs resulting from the needed to adapt (a) nonstandard testing equipment and (b) testing equipment (standard or nonstandard) existing in any one place in small amounts and inconveniently located; (2) costs for modifying auxiliary equipment, where necessary, such as large capacity test weight trucks to safely accommodate the needed correction weights; and (3) costs of preparing and printing new forms, procedural manuals, etc., using metric units if necessary.

metric units. See appendix II-4 for a list of the items being provided each state by the National Bureau of Standards.

4. Cost estimates are based on a direct changeover from one system to another with no allowances for any increase in testing capability.

5. Conversion or replacement costs were obtained from the Office of Weights and Measures, National Bureau of Standards.

6. The cost analysis reflects the fact that jurisdictions, during any measurement change process, are going to have to be able to operate in a dual measurement environment for some time.

7. Finally, the costs for purchasing new metric equipment were arrived at by assuming that such equipment will be offered for sale at or near present market prices for similar equipment in U.S. customary units.

To arrive at some estimate of the impact of equipment conversion and/or purchases upon individual state and local weights and measures jurisdictions, the total costs and costs per inspector, based upon the above equipment only, were determined nationally and for two states and three large urban areas separately.

To be in conformity with the State-County-City Service Center (see app. II-2), the States of California and Kentucky were chosen for individual analysis. Also chosen were three large urban areas within the State of California (City and County of San Francisco, the County of Los Angeles, and San Diego County).[5]

Jurisdiction	Estimated magnitude of costs	
	Total costs ($)	Cost/inspector ($)
1. State of California:		
With jurisdictions below	195,617	380.58
Without jurisdictions below	160,525	373.31
(a) San Francisco (city and county)	5,244	655.50
(b) County of Los Angeles	23,425	354.92
(c) San Diego County	6,423	642.30
2. State of Kentucky	16,213	324.26
3. National (compilation of all jurisdictions answering questionnaire).	1,113,466	371.77

II-4. WEIGHTS AND MEASURES LAWS, REGULATIONS, AND TECHNICAL SPECIFICATIONS

INTRODUCTION

Weights and measures laws have, as their primary objective, the protection of the buyer and seller from quantity misrepresentation in all commercial transactions. Therefore, these laws and the regulations and technical

[5] The Service Center is under contract to the National Bureau of Standards to supply an in-depth study on the possible impacts of metrication on state and local government operations.

specifications promulgated under them are measurement sensitive. The areas that appear to be the most measurement sensitive, and thus, subject to possible problems due to metrication are as follows:

1. Definition of the measurement system(s) to be used in commercial transactions.
2. Technical specifications for determining the accuracy of (a) weighing and measuring devices and (b) the labeled net quantity of contents of packaged commodities.
3. Requirements for labeling packaged consumer commodities.
4. Legal provisions requiring certain commodities to be sold in specified quantities.

MEASUREMENT SYSTEM

Most state weights and measures laws recognize both the U.S. customary and metric systems of measurement for commercial transactions;[6] thus, there is no general impediment to metric usage. However, there are many special cases in which measurement units are defined by these laws. For example, many weights and measures laws define the "barrel"[7] as 31 gallons and a "cord of wood" as 128 cubic feet. These terms would become obsolete and thus they should be removed from weights and measures statutes if the metric system were adopted. Liquid commodities now sold by the barrel would, using the metric system, be sold by the liter; and likewise, wood would be sold by the cubic meter instead of by the cord. *Note:* As a rule, the states accept the definitions of measurement units and the relationships between different measurement systems as established by the National Bureau of Standards.

NBS HANDBOOK 44

In all but two states[8] NBS Handbook 44, *Specifications, Tolerances and Other Technical Requirements for Commercial Weighing and Measuring Devices,* is recognized as the principal legal and technical document for establishing the accuracy that all commercial weighing and measuring devices must meet before they may be used. The technical requirements contained in this handbook were developed through, and approved by, the National Conference on Weights and Measures.[9] This Conference provides procedures for all interested parties, public and private, to participate in the development of the technical requirements. Amendments to Handbook 44 are made at the National Conference's annual meeting, and, upon approval by the voting delegates, these amendments become part of the Handbook.

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[6] Congress has never fixed the standards for weights and measures in the United States as provided by the Constitution (Art. I, sec. 8). However, the Congress by law (15 U.S.C. 204) has legalized the metric system for commercial transactions. Thus, in order to clarify their legality in commerce, the states have established definitions of measurement systems.

[7] When used in connection with fermented liquor.

[8] Arizona and Rhode Island.

[9] Sponsored by the National Bureau of Standards.

For the most part, this Handbook uses the U.S. customary system of measurement as a base for establishing its specifications and tolerances. To cite a few examples, (1) the minimum graduated interval for retail food scales with a capacity of 50 lb or less shall be not greater than one ounce;[10] (2) retail gasoline pumping systems must dispense gasoline within ± 7 cubic inches in 5 gallons (1,155 cu in.) order to remain in commercial use;[11] and (3) the physical dimensions of each graduation on scale recording or indicating elements and the intervals between such graduations must be designed so that the scale can be conveniently read. H-44 establishes the minimum width (.008 in.) for graduations and the minimum clear interval between graduations (.02 in. for money graduations and .03 in. for all other graduations). These minimums, as indicated in parentheses, are based on the U.S. customary inch.[12] H-44, however, does give the basic tolerances for certain types of scales indicating or recording in metric units,[13] and the maintenance tolerances for metric weights used in conjunction with commercial weighing devices.

If commercial weighing and measuring devices were required by law to record or indicate in metric units, it would be best if Handbook 44 were revised to include metric specifications and tolerances in convenient metric units where none now exist. The use of H-44 in its present state to test metric recording or indicating devices, except as noted, could result in the weights and measures inspector having to use a good many conversion factors. The use of conversion factors would, no doubt, result in replacing convenient numbers (customary units) with inconvenient ones (metric units).

Any revision of H-44 will require a good deal of effort on the part of both weights and measures officials and device manufacturers working through the National Conference on Weights and Measures. It is very difficult to predict or to decide what type of procedures should be used in revising this Handbook. One method of revision would simply adjust units where necessary to round metric units. Another method would be to prepare a second version of H-44 which would be used only for testing of metric indicating or recording devices.

The application of H-44 by weights and measures officials will be most difficult during any transition period. The present H-44, in many cases, would make testing metric recording or indicating devices difficult. Similarly, testing devices in customary units would be difficult if H-44 were revised to convenient metric units. One possible solution to the transition problem (as well as the revision problem), would be to express tolerances in terms of percentages of any test loads or measures. This would standardize tolerances and would eliminate the use of difficult conversion factors between measurement systems.

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[10] H-44; UR. 1.1.1. (see III. Suppl., p. 90).
[11] H-44; p. 81; table 1 (see III. Suppl., p. 91).
[12] H-44; S.1.2.2. and S.1.2.3. (see III. Suppl., p. 88).
[13] H-44; table 5, p. 56, and table 2, p. 68 (see III. Suppl., 88, 90).

PACKAGES

Two of the most important weights and measures operations are the inspection of packages to determine the accuracy of labeled net quantity of contents and the correctness of label statements. NBS Handbook 67, *Checking Prepackaged Commodities*, and the laws and regulations governing what must appear on the label of a packaged commodity would be the most important items affected by metrication.

NBS HANDBOOK 67

NBS Handbook 67 provides weights and measures officials and other interested parties with procedures for determining the accuracy of the net quantity of contents for prepackaged commodities. It appears almost certain that, in the advent of metrication, this publication will have to be extensively revised as H-67's testing procedures and tolerances are based entirely on the U.S. customary system. To give but one, for example, the table of reasonable variations (quantity) is based on pounds, ounces, or common or decimal fractions of the ounce.[14] Consequently, this table will have to be revised, not just translated, in order for the metric system to be easily used for package checking tests.

PACKAGE LABELING

In the area of package labeling, it appears that the Federal Government will have to take the initiative toward metrication.[15] Federal laws, in many cases, restrict the freedom of the states and local governments to legislate in this area. For example, the Fair Packaging and Labeling Act (FPLA),[16] and the regulations promulgated thereunder, supersede all state and local laws or ordinances, respectively, which are less stringent than or inconsistent with FPLA or its regulations as they apply to the labeling of the quantity of contents of a packaged consumer commodity as defined in the law.[17] For another example, the U.S. Department of the Treasury has authority to make regulations governing the labeling of tobacco and alcoholic beverages. These regulations again supersede state and local controls. *Note:* The effects of metrication upon the Fair Packaging and Labeling Act, Public Law 89-755 (80 Stat. 1296), are covered in the following U.S. Metric Study Reports: "Federal Government: Civilian Agencies," and "The Consumer," NBS Special Publications 345-2 and 345-7 respectively.

SPECIFIED QUANTITIES

Most weights and measures laws, as well as other statutes, require that some packaged consumer commodities be sold at retail in certain speci-

[14] H-67, p. 8 (see III. Suppl., p. 86).
[15] For example, requiring package labels to have their quantity of contents statements in metric terms.
[16] P.L. 89-755 (see III. Suppl., p. 94).
[17] Section 12 of P.L. 89-755 (see III. Suppl., p. 95).

fied quantities; for instance, in many states fluid dairy products are required to be sold in the following units: 1 gill, 1/2 liquid pint, 10 fluid ounces, 1 liquid pint, 1 liquid quart, 1/2 gallon, 1 gallon, 1 1/2 gallons, 2 gallons, 2 1/2 gallons, or multiples of 1 gallon; usually packages of less than 1 gill are also permitted.

The translation of these sizes to their metric counterparts would result in inconvenient metric units. This same situation applies to other staple commodities (bread, butter, flour, etc.) that are, as a rule, required to be sold in specified amounts. Thus, in order to eliminate awkward units, size changes would be desirable. However, since size changes would affect manufacturing practice, great care should be taken to insure that industry could comply with any new size requirements without incurring large costs (see III. Suppl., pp. 95-96).

II-5. EDUCATION AND TRAINING

INTRODUCTION

Since more than 85 percent of the weights and measures officials are unfamiliar with the metric system of measurement, it appears that a national metric education program, especially designed for them, will be required.

One possible metric education program is presented below.

BACKGROUND CONDITIONS

By assuming the two conditions listed below, it should be possible to keep the training program relatively brief and uncomplicated:

1. Since weights and measures officials, as a rule, use only the three basic units of measurement (length, mass, and volume) in their operations, they will only have to learn what these units are in the metric system (meter, kilogram, and liter respectively). They probably will not have to learn the more complicated derived units such as force (Newton), energy (Joule), etc.

2. A complete retraining program for weights and measures officials will not be necessary. This is because officials will essentially only have to adjust to using different numbers in their operations and, as a result, there will be little or no basic change to the inspector's work routine.

COURSE CONTENT

It is felt that the education program should include at least the following:

1. History of the metric system (SI).

2. Descriptions and explanations of the metric system including discussions on the relationships between length, mass, and volume, and the equivalences between the U.S. customary and metric units of measurement.

3. Application of the metric system to (a) testing weighing and measuring devices for accuracy, and (b) checking packaged commodities for the accuracy of their quantity of contents statements. (It would seem that NBS

Handbooks 44 and 67 would have to be revised and metric standards and equipment would have to be available before this part of a training program could begin.)

Note: In any training program, consideration will have to be given to the general education level of weights and measures officials. The data in appendix II-1 indicate that the vast majority of officials have completed high school. The program should be, of course, established accordingly.

PROGRAM ADMINISTRATION

The proposed education program, i.e., course content, could be administered by dividing the training course into two parts. In Part 1, instruction in SI understanding and usage would be given to laboratory metrologists and field supervisors. In Part 2 such instruction would be given to field personnel and private persons concerned with weights and measures enforcement.

In Part 1 it is suggested that the Office of Weights and Measures, National Bureau of Standards conduct training seminars for state metrologists and field supervisors who in turn will have the responsibility of training field personnel (and other interested parties) in their states in the use of the metric system. Part 1 seminars could be conducted at the National Bureau of Standards, and at regional state laboratories and should provide for 40 hours of instruction in the use of metric units and computations associated therewith. Instruction would also include examination procedures as they relate to the testing of packages and commercial weighing and measuring devices.

In Part 2, the metrologists and field supervisors would then schedule specialized training programs for state and local weights and measures field personnel, as well as for other parties concerned with metrication in the weights and measures field, e.g., the service personnel of scale and meter manufacturers and for persons connected with firms engaged in packaging and labeling. These training courses should consist of 40 hours of instruction in the use of the metric system with special emphasis on the application of this system to the examination procedures (i.e., H-44 and H-67) used in the testing of commercial weighing and measuring devices and packages.

Finally, it is felt that the Office of Weights and Measures should assume the responsibility for coordinating this nationwide program. In fact, the instruction in the use of the metric system could complement OWM's present technical education programs for weights and measures officials. It is estimated that this metric education program could be completed in about 1 year.

COST AREAS

Since a detailed analysis of both actual and overall economic costs of this education program would be purely speculative, only the *areas* where costs are likely to arise will be discussed. To repeat, quantitative analysis has been avoided because of the high probability of inaccurate or misleading results.

The purchase of needed educational materials and travel to training seminars, will represent the two areas where the states or local weights and measures jurisdictions will encounter actual costs. On the whole, it would seem that the above actual costs will be minimal.

However, other economic costs areas which would not require additional funding must be considered. The largest economic cost area appears to be the man-hours spent by officials in acquiring the necessary metric knowledge. This would include time spent in classroom instruction, on the job training, and the longer time required to complete routine operations until officials became proficient in using the metric system. As a result, economic costs arising other than from actual costs, above, could be rather high. Of course, if this training could be combined with present training programs its economic impact would no doubt be reduced.

COMMENT

In brief, the cost areas considered in this section may be classified as follows: (1) Those that will require additional spending (actual costs), and (2) those that do not but will indirectly result in a loss in productivity, i.e., man hours lost in training.

These cost areas and their magnitudes considered are judgment opinions only and may be interpreted as reflecting a feeling that costs arising from man hours lost in training (productivity loss) will be higher in a relative sense than the actual costs. On the other hand, the productivity loss may be insignificant with respect to the total economic impact of metrication.

Such conclusions are reasonable. For instance, actual costs, Part 1 and 2 training costs, can be estimated as consisting of $29,950 for needed materials (based on $10 of training aids, such as booklets, for 2,995 inspectors), and travel expenses for metrologists and field supervisors estimated at $30,000 for 100 persons. The total cost would therefore be $59,950.

However, the costs due to man hours lost would be, not considering the time spent by officials acting as instructors, $3,054,900 (based on 68 hours of instruction per inspector for 2,995 inspectors, i.e., a total of 203,660 hours, at $15 per hour per inspector for salary and overhead). This figure is 51 times higher than actual costs and, therefore, the costs due to man hours lost in training may be considered high in a relative sense to actual costs.

Finally, such a productivity loss probably is insignificant with respect to the total national cost of metrication. *Note:* This comment is not a part of the Task Force Report.

SUMMARY OF STATISTICS

INTRODUCTION

These data are based on a 93 percent return on questionnaires sent to the following weights and measures jurisdictions: (1) All state jurisdictions; (2) The District of Columbia; (3) Puerto Rico; and (4) 16 major urban areas (see list at the end of this appendix).

Totals or percentages combine both state and local jurisdictions within any particular state (provided a state has local jurisdictions), except that data on the 16 major urban areas (listed as cities in the tables below) are not included in any of the state and/or local figures.[18]

PERSONNEL STATISTICS

The following is a breakdown of the total number of weights and measures officials in the United States by percentages into three distinct categories: (1) Full or part time personnel; (2) place of employment; and (3) level of education.

	Percent of total officials
(a) Total number of officials = 2,995	
(b) Type of employment:	
Full time	75
Part time	25
Total	100
(c) Place of employment:	
State/local	88
Cities	12
Total	100
(d) Level of education:	
Less than high school	4
High school graduate	65
2 years of college	15
4 years of college	12
University or college graduate study	4
Total	100

SUMMARY OF METRIC KNOWLEDGE

The following summarizes the general level of metric knowledge and attitudes toward metrication among weights and measures officials by general jurisdictions. Each questionnaire is treated as a unit and the answers represent a consensus among the personnel of the jurisdiction(s) covered.[19]

[18] The District of Columbia and Puerto Rico are treated as states in this data.

[19] The Directors of weights and measures in the states and large city jurisdictions, or their representatives, estimated these consensuses.

	Percent of jurisdictions		
	State/local	Cities	Total
(a) Knowledge of the metric system:			
Very well	2	0	1.5
Well	6	13	8
Slightly	90	87	89
Not at all	2	0	1.5
Total	100	100	100
(b) Attitudes toward metrication:			
Strongly for	13	27	16
Mildly for	46	53	48
Neutral	14	13	14
Mildly against	23	7	19
Strongly against	2	0	1.5
No opinion	2	0	1.5
Total	100	100	100

COMMENTS

The following summarizes the comments of directors of weights and measures jurisdictions (or their representatives). Only the most prevalent comments will be listed.

(a) The metric system was thought to be a simpler system of measurement to understand and use as compared with the U.S. customary one.

(b) However, there would be disadvantages (such as costs) of changing over to the metric system. Jurisdictions would need new equipment and their personnel would have to learn the new measurement system.

(c) Opinions among officials on who should pay the metrication costs varied. Most felt that the state and local jurisdictions should "pay their own way." However, others felt that the Federal Government should assume this cost, and, of course, there were some who suggested sharing the costs.

(d) Finally, if a measurement change should come about, many officials felt that state and jocal jurisdictions should definitely have a part in educating the public to understand the metric system.

LIST OF MAJOR URBAN AREAS

1. New York, New York
2. Chicago, Illinois
3. Los Angeles, California
4. Philadelphia, Pennsylvania
5. Detroit, Michigan
6. Baltimore, Maryland
7. Cleveland, Ohio
8. St. Louis, Missouri
9. Milwaukee, Wisconsin
10. San Francisco, California
11. Boston, Massachusetts
12. Dallas, Texas
13. San Diego, California
14. Seattle, Washington
15. Buffalo, New York
16. Cincinnati, Ohio

Equipment Statistics

Type of equipment or standard	Total number in use	Percent accounted for by jurisdictions		
		State	Local	Large cities
Cube weight kits (1/16 oz to 2 lb)	841	53	36	11
Decimal pound weight kits (.001 lb to .3 lb)	455	50	42	8
Decimal ounce weight kits (.01 oz to .5 oz)	127	61	28	11
8 pound test weight kits	163	29	9	62
Small individual mass standards:				
50 pound mass standard	34,647	37	57	6
25 pound mass standard	191	n.d.	n.d.	n.d.
Miscellaneous mass standard	140	n.d.	n.d.	n.d.
Total	34,978			
Scales, balances, etc.:				
Over and under 5 pound capacity package checking scales.	726	44	48	8
10 pound capacity field balance	305	46	41	13
Miscellaneous scales and balances	272	n.d.	n.d.	n.d.
Platform scales	97	n.d.	n.d.	n.d.
Total	1,400			
Large capacity mass standards:				
500 pound mass standard	1,143	60	38	2
1,000 pound mass standard	2,628	66	29	5
2,500 pound mass standard	122	91	7	2
5,000 pound mass standard	37	70	22	8
Miscellaneous mass standard	7	n.d.	n.d.	n.d.
2,500 pound moving dollies (calibrated)	36	86	11	3
5,000 pound moving dollies (calibrated)	4	75	0	25
Miscellaneous moving dollies (calibrated)	16	n.d.	n.d.	n.d.
Total	3,993			
Test measures and provers (except LPG provers):				
1 gallon	1,312	29	66	5
5 gallon	2,793	37	57	6
50 gallon	251	32	61	7
100 gallon	380	36	58	6
100 gallon (stainless steel)	5	100	0	0
500 gallon	58	48	38	14
1000 gallon	24	58	17	25
Miscellaneous test measures and provers	300	n.d.	n.d.	n.d.
Total	5,123			
LPG provers:				
100 gallon	47	66	34	0
Miscellaneous LPG provers	15	n.d.	n.d.	n.d.
Total	62			

n.d. = not determined.

Equipment Statistics—Continued

Type of equipment or standard	Total number in use	Percent accounted for by jurisdictions		
		State	Local	Large cities
Glass test measures (1 gallon–1 gill) (kits)	160	78	12	10
2 oz graduated cylinder	222	31	64	5
No. 8 size sieve, pan and cover	42	83	7	10
Length standard:				
16-foot	199	35	61	4
50-foot	373	21	72	7
100-foot	199	23	70	7
Fabric measuring test tapes	454	34	51	15
Miscellaneous length standard (except rules)	112	n.d.	n.d.	n.d.
Total	1,337			

n.d. = not determined.

STATE-COUNTY-CITY SERVICE CENTER
1612 K STREET, N.W.
WASHINGTON, D.C. 20006

The State-County-City Service Center is a coordinating body for the following organizations:

1. Council of State Governments
2. International City Management Association
3. National Association of Counties
4. National Governors Conference
5. National League of Cities
6. United States Conference of Mayors

ORGANIZATION OF THE TASK FORCE ON METRICATION

ESTABLISHMENT

Under authority granted by the Executive Committee on the 54th National Conference of Weights and Measures, a Task Force on Metrication is hereby established by the Conference Executive Secretary to study the possible effects that increased use or non-use of the metric system might have on the weighing and measuring field.

FUNCTION

The Task Force shall study the problems and costs associated with increased use or non-use of the metric system in the commercial weighing and measuring field.

MEMBERSHIP

1. The Task Force shall be composed of members appointed by the Executive Secretary representing the field of weights and measures.
2. Members of the Task Force shall be appointed for the duration of the study unless they voluntarily terminate such membership. In such cases, the Executive Secretary will select appropriate replacements.

ORGANIZATION

1. The Executive Secretary shall designate one member of the Task Force to serve as chairman.
2. The Office of Weights and Measures, National Bureau of Standards, shall serve as the secretariat of the Task Force, and as such it will provide clerical, administrative, and technical staff along with the necessary support facilities and materials to assist the Task Force in carrying out its objectives. The manager of the Commercial Weights and Measures Survey, U.S. Metric Study, shall be ex officio, the secretary of the Task Force.
3. The Task Force will meet at the times and places designated by its chairman, subject to the advance approval of the Executive Secretary, by means of written notices to the Task Force members.
4. Members of the Task Force will be reimbursed for travel and expenses (per U.S. Government per diem rates) connected with attendance at Task Force meetings.

PROCEDURES

1. Business will be transacted by the Task Force at meetings and by correspondence and telephone.

2. A majority of the members of the Task Force shall constitute a quorum for the transaction of business. A vote of the majority shall decide any question that may come before the Task Force. If at any meeting of the Task Force there shall be less than a quorum present, those present may act on the business before it subject to ratification in writing by a majority of the members.

3. The Task Force shall observe in all of its procedures the principles of due process and the protection of the rights and interests of affected parties.

REPORTS

1. The Task Force shall submit a report, including any recommendations it may have, to the Executive Secretary not later than November 30, 1970, unless another time shall be established by the Conference or the Executive Secretary.

2. The Task Force may also submit interim reports, data, and recommendations to the Executive Secretary for his information, advice, or action.

TERMINATION

The Task Force shall expire at the close of the 56th National Conference on Weights and Measures in July of 1971, unless it is decided to extend its existence beyond this date.

Harold F. Wollin, *Executive Secretary*
National Conference on Weights and Measures

April 20, 1970

NEW STATE STANDARDS
(authorized by Public Law 89-164)

1. Metric Mass Standards, 30 kg to 1 mg (5:3:2:1 Series)
2. Avoirdupois Mass Standards, 50 lb to 1 μlb (5:3:2:1 Series)
3. 500 Pound Mass Standards (2)
4. Precision Balances:

    160 g capacity, 0.02 mg precision
    1 kg capacity, 0.2 mg precision
    3 kg capacity, 1 mg precision
    30 kg capacity, 2 mg precision
    5000 lb capacity, 0.01 precision

5. Length Bench, 5 meter/16 feet
6. Tension Weights, 20 pound
7. Laboratory Microscope, 0.300 inch × 0.002 inch
8. Precision Steel Tape, 7 meter/25 feet
9. Steel Tape, 30 meter/100 feet
10. Precision Steel Rule, 18 inches x 0.01 inch
11. Metric Pipet-Buret Assembly, 5 liters to 10 milliliters
12. U.S. Customary Pipet-Buret Assembly, 1 gallon to 120 minims
13. Five Gallon Standard, slicker plate type

III. SUPPLEMENT

Public Law 90-472

An Act

82 STAT. 693

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 States; to appraise the desirability and practicability of increasing the use of metric weights and measures in the United States; to study the feasibility of retaining and promoting by international use of dimensional and other engineering standards based on the customary measurement units of the United States; and to evaluate the costs and benefits of alternative courses of action which may be feasible for the United States. Metric system. Study.

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

(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. In conducting the studies and developing the recommendations required in this Act, the Secretary shall give full consideration to the advantages, disadvantages, and problems associated with possible changes in either the system of measurement units or the related dimensional and engineering standards currently used in the United States, and specifically shall— Results of changes in measurement system.

(1) investigate the extent to which substantial changes in the size, shape, and design of important industrial products would be necessary to realize the benefits which might result from general use of metric units of measurement in the United States;

(2) investigate the extent to which uniform and accepted engineering standards based on the metric system of measurement units are in use in each of the fields under study and compare the extent to such use and the utility and degree of sophistication of such metric standards with those in use in the United States; and

(3) recommend specific means of meeting the practical difficulties and costs in those areas of the economy where any recommended change in the system of measurement units and related dimensional and engineering standards would raise significant practical difficulties or entail significant costs of conversion.

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 he considers to be appropriate and in the best interests of the United States. Report to Congress.

SEC. 5. From funds previously appropriated to the Department of Commerce, the Secretary is authorized to utilize such appropriated sums as are necessary, but not to exceed $500,000, to carry out the purposes of this Act for the first year of the program. Funds.

SEC. 6. This Act shall expire thirty days after the submission of the final report pursuant to section 3. Expiration date.

Approved August 9, 1968.

Excerpts from NBS Handbook 67, Checking Prepackaged Commodities

UNREASONABLE MINUS OR PLUS ERRORS

Labeled quantity	*Minus error Greater than*	*Plus error Greater than*
0 to 2 ounces	⅛ ounce	¼ ounce.
2+ to 8 ounces	3/16 ounce	⅜ ounce.
8 ounces+ to 2 pounds	¼ ounce	½ ounce.
2+ to 4 pounds	5/16 ounce	⅝ ounce.
4+ to 7 pounds	⅜ ounce	¾ ounce.
7+ to 14 pounds	½ ounce	1 ounce.
14+ to 24 pounds	¾ ounce	1½ ounces.
24+ to 36 pounds	1 ounce	2 ounces.
36+ to 51 pounds	8 ounces	1 pound.
51+ to 101 pounds	2 pounds	4 pounds.

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These tables have been superseded by the following:

Packages Labeled in Terms of Units of Linear or Square Measure

Minus errors greater than 3 percent of the labeled quantity, and plus errors greater than 6 percent of the labeled quantity should be considered unreasonable.

Packages Labeled in Terms of Count

Minus errors greater than 2 percent of the labeled quantity, and plus errors greater than 4 percent of the labeled quantity should be considered unreasonable.

Unreasonable Minus or Plus Errors

Labeled Quantity	Minus Error Greater than		Plus Error Greater than	
	Pounds	Ounces	Pounds	Ounces
0 to 2 ounces	.008	1/8	.016	1/4
2+ to 4 ounces	.012	3/16	.023	3/8
4+ to 8 ounces	.016	1/4	.031	1/2
8 ounces+ to 1 pound	.020	5/16	.039	5/8
1+ to 2 pounds	.023	3/8	.047	3/4
2+ to 3 pounds	.031	1/2	.063	1
3+ to 4 pounds	.039	5/8	.079	1 1/4
4+ to 5 pounds	.047	3/4	.094	1 1/2
5+ to 6 pounds	.063	1	.125	2
6+ to 7 pounds	.071	1 1/8	.127	2 1/4
7+ to 8 pounds	.079	1 1/4	.156	2 1/2
8+ to 9 pounds	.094	1 1/2	.188	3
9+ to 10 pounds	.110	1 3/4	.219	3 1/2
Over 10 pounds	2% of labeled quantity		4% of labeled quantity	

Unreasonable Minus or Plus Errors

Labeled Quantity	Minus Error Greater than		Plus Error Greater than	
	Dram	Ml	Dram	Ml
0 to 2 fl oz	1	3.7	2	7.4
2+ to 4 fl oz	1.5	5.5	3	11.1
4+ to 8 fl oz	2	7.4	4	14.8
8 fl oz+ to 1 pt	2.5	9.2	5	18.5
1 pt+ to 1 qt	3	11.1	6	22.2
1+ to 1.5 qt	4	14.8	8	29.6
1.5+ to 2 qt	5	18.5	10	37.0
2+ to 2.5 qt	6	22.2	12	44.4
2.5+ to 3 qt	8	29.6	16	59.2
3+ to 3.5 qt	9	33.3	18	66.5
3.5+ to 4 qt	10	37.0	20	73.9
4+ to 4.5 qt	12	44.4	24	88.7
4.5+ to 5 qt	15	55.5	30	110.9
Above 5 qt	2% of labeled quantity		4% of labeled quantity	

Excerpts from the Report of the 54th National Conference on Weights[1] and Measures 1969, NBS Special Publication 318

RESOLUTION ON METRIC STUDY

Whereas, the Congress of the United States has enacted Public Law 90–472 authorizing 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; and

Whereas, changes in the measurement system at home and abroad would no doubt have substantial impact on the weighing and measuring field; and

Whereas, the National Bureau of Standards, which has been assigned the responsibility for conducting this study, has requested that the National Conference on Weights and Measures assist it in gathering pertinent information in the weights and measures area: Therefore, be it

Resolved by the 54th National Conference on Weights and Measures, that the Executive Committee is hereby authorized to conduct a study into the problems that measurement changes might have on the weighing and measuring field and to coordinate its efforts fully with the National Bureau of Standards, and is authorized to take whatever action is deemed appropriate in this matter.

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Executive Committee Motion Establishing the Task Force on Metrication

The Executive Committee hereby authorizes the Executive Secretary to establish a task force on metrication, composed of the representatives from the active, advisory, and associate members of this Conference and such consultants as may be necessary to study the possible effects that increased use or non-use of the Metric System might have on the weighing and measuring field and to report such effects along with any recommendations it may have to the Conference in 1970.

Such task force would be expected to give special attention to, but not limit itself to, the impacts that metrication might have on (1) State and local laws, regulations, and on the duties of weights and measures officials; (2) device manufacturers; and (3) users of commercial weighing and measuring devices.

In carrying out its responsibilities, the task force would coordinate its efforts with similar ones at the National Bureau of Standards. The Executive Secretary is further authorized to take whatever action or actions deemed necessary and proper to aid the task force in its assignment.

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[1] The Conference Executive Secretary, because of budget restrictions, limited the scope of the Task Force's inquiry to investigating the impacts of metrication upon weights and measures jurisdictions.

Excerpts from NBS Handbook 44, Specifications, Tolerances, and Other Technical Requirements for Commercial Weighing and Measuring Devices (1970 version)

G-A.1. COMMERCIAL AND LAW-ENFORCEMENT EQUIPMENT.—These specifications, tolerances, and other technical requirements apply as follows:

(a) To commercial weighing and measure equipment; that is, to weights and measures and weighing and measuring devices commercially used or employed in establishing the size, quantity, extent, area, or measurement of quantities, things, produce, or articles for distribution or consumption, purchased, offered, or submitted for sale, hire, or award, or in computing any basic charge or payment for services rendered on the basis of weight or measure.

(b) To any accessory attached to or used in connection with a commercial weighing or measuring device when such accessory is so designed that its operation affects the accuracy of the device.

(c) To weighing and measuring equipment in official use for the enforcement of law or for the collection of statistical information by government agencies. [1968]

(These requirements should be used as a guide by the weights and measures official when courtesy examinations are made, upon request, of noncommercial equipment.)

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S.1.2.2. WIDTH.—In any series of graduations, the width of a graduation shall in no case be greater than the width of the minimum clear interval between graduations, and the width of main graduations shall be not more than 50 percent greater than the width of subordinate graduations. Graduations shall in no case be less than 0.008 inch in width.

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S1.2.3. CLEAR INTERVAL BETWEEN GRADUATIONS.—The clear interval shall be not less than 0.02 inch for graduations representing money values and not less than 0.03 inch for other graduations. If the graduations are not parallel, the measurement shall be made

(a) along the line of relative movement between the graduations and the end of the indicator, or

(b) if the indicator is continuous, at the point of widest separation of the graduations.

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H-44 (continued)

TABLE 5.—BASIC TOLERANCES FOR SCALES INDICATING OR RECORDING IN EITHER APOTHECARIES OR METRIC UNITS, EXCEPT FOR PRESCRIPTION, JEWELERS, CREAM-TEST, MOISTURE-TEST, ANIMAL, LIVESTOCK, CRANE, AXLE-LOAD, VEHICLE, AND RAILWAY TRACK SCALES, AND WHEEL-LOAD WEIGHERS. (See T.1., T.2., and T.3.)

Test load		Maintenance tolerances	Acceptance tolerances
From	to but not including	*Expressed in Grains*	*Expressed in Grains*
Ounces apoth.			
0	1	1	0.5
1	2	2	1.0
2	4	4	2.0
4	6	7	3.5
6	8	10	5.0
8	12	12	6.0
Grams		*Milligrams*	*Milligrams*
0	10	15	8
10	20	50	25
20	40	100	50
40	60	150	75
60	100	250	125
100	150	350	175
150	200	500	250
200	300	650	325
300	400	800	400
		Grams	*Grams*
400	500	1.0	0.5
500	750	1.5	0.75
750	1,000	2.0	1.0
Kilograms			
1	2	4.0	2.0
2	3	5.5	2.8
3	5	7.5	3.8
5	10	11.0	6.0
10	15	15.0	7.5
15	20	19.0	8.5
20	30	25.0	12.5
30	40	35.0	17.5
40	50	45.0	22.5
50 kilograms and over		0.1 percent of test load	0.05 percent of test load

H-44 (continued)

UR.1.1.1. FOR RETAIL FOOD SCALES ONLY.—The value of the minimum graduated interval on a scale used for the retail sale of foodstuffs, with a nominal capacity of 50 pounds or less, shall be not greater than 1 ounce.

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TABLE 2.—MAINTENANCE TOLERANCES FOR METRIC WEIGHTS

Nominal value	Maintenance tolerance
Milligrams	*Milligrams*
5 or less	0. 1
10	. 3
20	. 4
30	. 6
50	. 8
100	1. 0
200	1. 5
300	2. 0
500	3. 0
Grams	
1	4
2	6
3	8
5	10
10	15
20	20
30	30
50	40
100	70
200	100
300	150
500	175
Kilograms	
1	250
2	400
3	500
5	800
10	1, 000
20	1, 500
Carats	*Milligrams*
0. 25 (25 points) or less	0. 6
. 5 (50 points)	1. 0
1. 0	1. 5
2. 0	2. 0
3. 0	3. 0
5. 0	4. 0
10. 0	6. 0
20. 0	10. 0
30. 0	12. 0
50. 0	15. 0
100. 0	25. 0

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H-44 (Continued)

TABLE 1.—TOLERANCES FOR RETAIL DEVICES, EXCEPT SLOW-FLOW METERS AND EXCEPT ON ELAPSED-TIME TESTS [2]

Indication	Maintenance tolerance (On normal and on special tests)	Acceptance tolerance (On normal and on special tests)
Gallons	*Cubic inches*	*Cubic inches*
½ or less	2	1
1	3	1½
2	4	2
3	5	2½
4	6	3
5	7	3½
Over 5	Add 1 cubic inch per indicated gallon	Add ½ cubic inch per indicated gallon

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WIRE AND CORDAGE-MEASURING DEVICES

(See also General Code Requirements)

A. APPLICATION. (Pertaining to the application of code requirements.)

A.1.—This code applies to mechanisms and machines designed to indicate automatically the length of cordage, rope, wire, cable, or similar flexible material passed through the measuring elements.

S. SPECIFICATIONS. (Applicable with respect to the design of wire and cordage-measuring devices.) [1969]

S.1. UNITS.—A wire or cordage-measuring device shall indicate lengths in terms of feet or feet and inches. [1969]

S.2. DESIGN OF INDICATING ELEMENTS.

S.2.1. GRADUATIONS.

S.2.1.1. LENGTH.—Graduations shall be so varied in length that they may be conveniently read.

S.2.1.2. WIDTH.—In any series of graduations, the width of a graduation shall in no case be greater than the width of the minimum clear interval between graduations, and the width of main graduations shall be not more than 50 percent greater than the width of subordinate graduations. Graduations shall in no case be less than 0.008 inch, nor more than 0.04 inch, in width.

S.2.1.3. CLEAR INTERVAL BETWEEN GRADUATIONS.—The clear interval between graduations shall be at least as wide as the widest graduation, and in no case less than 0.03 inch.

[2] e.g., Retail Gasoline Dispensing Systems

H-44 (Continued)

S.2.2. INDICATOR.

S.2.2.1. SYMMETRY.—The index of an indicator shall be symmetrical with respect to the graduations with which it is associated and at least throughout that portion of its length that is associated with the graduations.

S.2.2.2. LENGTH.—The index of an indicator shall reach to the finest graduations with which it is used, unless the indicator and the graduations are in the same plane, in which case the distance between the end of the indicator and the ends of the graduations, measured along the line of the graduations, shall be not more than 0.04 inch.

C.2.2.3. WIDTH.—The index of an indicator shall not be wider than the narrowest graduations with which it is used, and shall in no case exceed 0.015 inch.

S.2.2.4. CLEARANCE.—The clearance between the index of an indicator and the graduations shall in no case be more than 0.06 inch.

S.2.2.5. PARALLAX.—Parallax effects shall be reduced to the practicable minimum.

S.2.3. ZERO INDICATION.—Primary indicating elements shall be readily returnable to a definite zero indication. [1969]

S.3. DESIGN OF MEASURING ELEMENTS.

S.3.1. SENSITIVENESS.—If the most sensitive element of the indicating system utilizes an indicator and graduations, the relative movement of these parts corresponding to a measurement of 1 foot shall be not less than ¼ inch.

S.3.2. SLIPPAGE.—The measuring elements of a wire or cordage-measuring device shall be so designed and constructed as to reduce to the practicable minimum any slippage of material being measured and any lost motion in the measuring mechanism. [1969]

S.3.3. ACCESSIBILITY.—*A wire or cordage-measuring device shall be so constructed that the measuring elements are readily visible and accessible, without disassembly of any supporting frame or section of the main body, for purposes of cleaning or removing any foreign matter carried into the mechanism by the material being measured.* [1969]

S.4. MARKING REQUIREMENTS.

S.4.1. LIMITATION OF USE.—If a device will measure accurately only certain configurations, diameters, types, or varieties of materials, or with certain accessory equipment, its limitations shall be clearly and permanently stated on the device.

S.4.2. OPERATING INSTRUCTIONS.—Any necessary operating instructions shall be clearly stated on the device.

S.4.3. INDICATIONS.—Indicating elements shall be identified by suitable words or legends so that the values of the indications will be unmistakable.

S.5. DESIGN ACCURACY.—Indications of length shall be accurate whether the values of the indications are being increased or decreased.

H-44 (Continued)

N. NOTES. (Applicable with respect to the testing of wire and cordage-measuring devices.) [1969]

N.1. TESTING MEDIUM.—A wire or cordage-measuring device shall be tested with a steel tape not less than ½ inch in width and at least 50 feet in length. The tape shall have a smooth surface or intaglio figures and graduations (i.e., the figures and graduations shall not be raised). When a wire or cordage-measuring device cannot be tested in such a manner because of the design of the device, it shall be tested with a kink-free length of No. 12 vinyl-covered electrical wire appropriately marked and compared at frequent periodic intervals with a calibrated steel tape at various increments from 20 through 50 feet. [1969]

N.2. MINIMUM TEST.—Tests shall be conducted at a minimum initial increment of 20 feet and appropriate increments up to at least 50 feet. [1969]

T. TOLERANCES. (Applicable with respect to the performance of wire and cordage-measuring devices.) [1969]

T.1. TOLERANCE VALUES.—Maintenance and accept-tolerances shall be as shown in table 1.

TABLE 1.—MAINTENANCE AND ACCEPTANCE TOLERANCES FOR WIRE AND CORDAGE-MEASURING DEVICES

Indication of device	Acceptance and maintenance tolerances	
	On underregistration	On overregistration
Feet	*Inches*	*Inches*
20	6	3
Over 20 to 30	8	4
Over 30 to 40	10	5
Over 40 to 50	12	6
Over 50	Add 2 inches per indicated 10 feet	Add 1 inch per indicated 10 feet

UR. USER REQUIREMENTS. (Applicable with respect to the installation and use of wire and cordage-measuring devices. [1969]

UR.1. INSTALLATION REQUIREMENTS.

UR.1.1. INSTALLATION. A wire or cordage-measuring device shall be securely supported and firmly fixed in position. [1969]

UR.2. USE REQUIREMENTS.

UR.2.1. LIMITATION OF USE.—A wire or cordage-measuring device shall be used to measure only those materials that it was designed to measure, and in no case shall it be used to measure a material that a marking on the device indicates should not be measured. [1969]

UR.2.2. RETURN TO ZERO.—The primary indicating elements of a wire or cordage-measuring device shall be returned to zero before each measurement. [1969]

UR.2.3. OPERATION OF DEVICE.—A wire or cordage-measuring device shall not be operated in such a manner as to cause slippage or inaccurate measurement. [1969]

UR.2.4. CLEANLINESS.—The measuring elements of a wire or cordage-measuring device shall be kept clean to prevent buildup of dirt and foreign material that would adversely affect the measuring capability of the device. [1969]

Pages 141-144

Excerpts from Various Laws

Fair Packaging and Labeling Act, Public Law 89-755 (80 Stat. 1296) Section 4 (80 Stat. 1297 & 1298)

SEC. 4. (a) No person subject to the prohibition contained in section 3 shall distribute or cause to be distributed in commerce any packaged consumer commodity unless in conformity with regulations which shall be established by the promulgating authority pursuant to section 6 of this Act which shall provide that—

(1) The commodity shall bear a label specifying the identity of the commodity and the name and place of business of the manufacturer, packer, or distributor;

(2) The net quantity of contents (in terms of weight, measure, or numerical count) shall be separately and accurately stated in a uniform location upon the principal display panel of that label;

(3) The separate label statement of net quantity of contents appearing upon or affixed to any package—

(A)(i) if on a package containing less than four pounds or one gallon and labeled in terms of weight or fluid measure, shall, unless subparagraph (ii) applies and such statement is set forth in accordance with such subparagraph, be expressed both in ounces (with identification as to avoirdupois or fluid ounces) and, if applicable, in pounds for weight units, with any remainder in terms of ounces or common or decimal fractions of the pound; or in the case of liquid measure, in the largest whole unit (quarts, quarts and pints, or pints, as appropriate) with any remainder in terms of fluid ounces or common or decimal fractions of the pint or quart;

(ii) if on a random package, may be expressed in terms of pounds and decimal fractions of the pound carried out to not more than two decimal places;

(iii) if on a package labeled in terms of linear measure, shall be expressed both in terms of inches and the largest whole unit (yards, yards and feet, or feet, as appropriate) with any remainder in terms of inches or common or decimal fractions of the foot or yard;

(iv) if on a package labeled in terms of measure of area, shall be expressed both in terms of square inches and the largest whole square unit (square yards, square yards and square feet, or square feet, as appropriate) with any remainder in terms of square inches or common or decimal fractions of the square foot or square yard;

(B) shall appear in conspicuous and easily legible type in distinct contrast (by typography, layout, color, embossing, or molding) with other matter on the package;

(C) shall contain letters or numerals in a type size which shall be (i) established in relationship to the area of the principal display panel of the package, and (ii) uniform for all packages of substantially the same size; and

(D) shall be so placed that the lines of printed matter included in that statement are generally parallel to the base on which the package rests as it is designed to be displayed; and

80 STAT. 1297
80 STAT. 1298

(4) The label of any package of a consumer commodity which bears a representation as to the number of servings of such commodity contained in such package shall bear a statement of the net quantity (in terms of weight, measure, or numerical count) of each such serving.

"Random package."

(5) For purposes of paragraph (3)(A)(ii) of this subsection the term "random package" means a package which is one of a lot, shipment, or delivery of packages of the same consumer commodity with varying weights, that is, packages with no fixed weight pattern.

(b) No person subject to the prohibition contained in section 3 shall distribute or cause to be distributed in commerce any packaged consumer commodity if any qualifying words or phrases appear in conjunction with the separate statement of the net quantity of contents required by subsection (a), but nothing in this subsection or in paragraph (2) of subsection (a) shall prohibit supplemental statements, at other places on the package, describing in nondeceptive terms the net quantity of contents: *Provided*, That such supplemental statements of net quantity of contents shall not include any term qualifying a unit of weight, measure, or count that tends to exaggerate the amount of the commodity contained in the package.

FPLA (continued)

Section 12 (80 Stat. 1302)

EFFECT UPON STATE LAW

SEC. 12. It is hereby declared that it is the express intent of Congress to supersede any and all laws of the States or political subdivisions thereof insofar as they may now or hereafter provide for the labeling of the net quantity of contents of the package of any consumer commodity covered by this Act which are less stringent than or require information different from the requirements of section 4 of this Act or regulations promulgated pursuant thereto.

Model State Weights and Measures Law, as adopted by the National Conference on Weights and Measures (1970)

(Almost all weights and measures statutes contain provisions which are the same as or similar to the ones listed below.)

SEC. 2. SYSTEMS OF WEIGHTS AND MEASURES.--The system of weights and measures in customary use in the United States and the metric system of weights and measures are jointly recognized, and either one or both of these systems shall be used for all commercial purposes in the State of __________________. The definitions of basic units of weight and measure, the tables of weight and measure, and weights and measures equivalents as published by the National Bureau of Standards are recognized and shall govern weighing and measuring equipment and transactions in the State.

SEC. 33. BREAD.—Each loaf of bread and each unit of a twin or multiple loaf of bread made or procured for sale, kept, offered, exposed for sale, or sold, whether or not the bread is wrapped or sliced, shall weigh 1/2 pound, 1 pound, 1 1/2 pounds, or a multiple of 1 pound, avoirdupois weight, within reasonable variations or tolerances that shall be promulgated by regulation by the director: Provided, That the provisions of this section shall not apply to biscuits, buns, or rolls weighing 4 ounces or less, or to "stale bread" sold and expressly represented at the time of sale as such, and that the marking provisions of section 26 shall not apply to unwrapped loaves of bread.

SEC. 34. BUTTER, OLEOMARGARINE, AND MARGARINE.--Butter, oleomargarine, and margarine shall be offered and exposed for sale and sold by weight, and only in units of 1/4 pound, 1/2 pound, 1 pound, or multiples of 1 pound, avoirdupois weight.

Model State Weights and Measures Law (continued)

SEC. 35. FLUID DAIRY PRODUCTS.--All fluid dairy products, including but not limited to whole milk, skimmed milk, cultured milk, sweet cream, and buttermilk, shall be packaged for retail sale only in units of 1 gill, 1/2 liquid pint, 10 fluid ounces, 1 liquid pint, 1 liquid quart, 1/2 gallon, 1 gallon, 1 1/2 gallons, 2 gallons, 2 1/2 gallons, or multiples of 1 gallon: Provided, That packages in units of less than 1 gill shall be permitted: And provided further, That sour cream and yogurt shall be sold in terms of weight, and sour cream shall be packaged for retail sale only in units of 4, 8, 12, 16, 32, 64, and 128 ounces avoirdupois. The effective date of the requirements for the sale of sour cream and yogurt by weight shall be July 1, 1971.

SEC. 36. FLOUR, CORN MEAL, AND HOMINY GRITS.--When in package form, and when packed, kept, offered, or exposed for sale or sold, wheat flour, whole wheat flour, graham flour, self-rising wheat flour, phosphated wheat flour, bromated flour, enriched flour, enriched self-rising flour, enriched bromated flour, corn flour, corn meal, and hominy grits shall be packaged only in units of 2, 5, 10, 25, 50, or 100 pounds, avoirdupois weight: Provided, That packages in units of less than 2 pounds or more than 100 pounds shall be permitted.

United States Code 1964 Edition

15 U.S.C. 204 - Metric System Authorized

It shall be lawful throughout the United States of America to employ the weights and measures of the metric system; and no contract or dealing, or pleading in any court, shall be deemed invalid or liable to objection because the weights or measures expressed or referred to therein are weights or measures of the metric system. (R.S. § 3569.) (Derivation: Act July 1866, ch. 301, Section 1, 14 Stat. 339.)

Excerpt from the Report of the 47th National Conference on Weights and Measures 1962, NBS Miscellaneous Publication 244

JAPAN'S TRANSITION TO THE METRIC SYSTEM

By Mitsuo Tamano, *Director, National Research Laboratory of Metrology, Tokyo, Japan*

It is a great honor for me to have been invited to this Conference and to have an opportunity to speak to you. I would like to report today on the recent transition to the metric system in Japan. The main reason why I chose this subject is that Japan, as a nation which has converted its confused measuring systems to the metric one, has a great interest in the advancement of the metric system in the United States. I think my brief address might give you further information useful in your examination of the adoption of the metric system.

The weights and measures in all of Japan have been regulated by one law. This law, the "Measurement Law" we call it, controls various kinds of measuring instruments and devices when these are manufactured, repaired, and sold. At the same time, the "Measurement Law" establishes the legal measuring units and, in commercial transactions and certifications, only these units are permitted. Since January 1, 1959, the metric system has been the unique measuring system authorized in Japan. Of course, there are some exceptions in the period of transition in which units of nonmetric systems can be used, as well as the metric ones. I will discuss these exceptions later.

First I will give you a brief history of the advancement of the metric system in Japan. It was in 1891 that the regulations of weights and measures were established for the first time in the form of law. Six years earlier, Japan had already decided to sign the Treaty of the Meter, and the Treaty had been enacted in 1886. In 1890, Japan received the prototype meter and kilogram from the International Bureau of Weights and Measures in accordance with the Treaty.

In the law of 1891, the traditional measuring units "shaku" and "kan" were taken as the fundamental units. At the same time, in this law the use of the metric system was approved, and the conversion factors between these two systems were also fixed. This law came into effect in 1893, the same year in which your country approved the use of the metric system and defined the yard and pound in terms of the meter and kilogram.

Since then, there have been several amendments in this old law, and in 1909 the units of the foot-pound system were adopted also as legal. So, since 1909, Japan had three measuring systems approved as legal. The actual measurements became more and more complicated and troublesome, and a desire to unify these measuring units arose.

In 1919, the Ministry of Agriculture and Commerce set up a Committee for Weights and Measures and Industrial Standards to investigate which measuring system was to be adopted in Japan and to study procedures for pushing the plan.

According to the advice of the committee, the Ministry decided to revise the old law and prepared a bill in which the metric system was taken as the unique measuring system. The bill passed the Diet in March 1921, and the revised law was promulgated in April of the same year. The date of enforcement of this law fixed by the Imperial Ordinance was July 1, 1924. But in the same Imperial Ordinance, the use of measuring units other than those of the metric system was also permitted as a transitional measure.

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The compulsory changeover to the metric system was to take place in two steps. In the first step, government offices, public services, and other leading industries were required to change their system to the metric one in 10 years. In the second step, all actives and enterprises other than those mentioned were required to convert during the second decade.

With these legislative arrangements, various preparative actions for the changeover to the metric system started. In education or public services such as railroads, postal services, gas, and city water, in which the changeover was possible by administrative directive, the conversion to the metric system began gradually. The promotion in this area was carried out positively with the aid of the national and local governments and the Japanese Weights and Measures Association. The preparation for the changeover proceeded rather smoothly at the beginning. But as the date of legislative compulsory changeover drew near, the opposition gradually became large. The opponents of the metric system believed that the adoption of a foreign measuring system would have a bad influence on the national sentiment, cause dislocations in the public life and needless expense of the nation, prove disadvantageous for foreign trade, and hurt the national language and classics. They claimed that the 1921 law had been made while the nation did not fully realize its consequences. At that period Japan had a very difficult time in foreign affairs, nationalism became powerful throughout Japan, and the opposition to the changeover became furious beyond all reason.

On the other side, the preparations in the official services and leading industries were not sufficient for the complete changeover, so in 1933, just one year before the compulsory changeover specified for the first group, the government postponed the date of conversion another 5 years for the first group and 10 years for the second group.

This resulted in the disappointment of those concerned with promoting the changeover to the metric system. A second postponement followed the first postponement. After the first postponement, the oppositions to the metric system became more and more strong. Pressed by these oppositions, the Investigating Committee for Weights and Measures System, newly organized in the government, advised in 1938 that the "Shaku-Kan" system should be adopted as well as the metric one.

Thus, the intention of the 1921 law of adopting the metric system as unique was largely changed. The Imperial Ordinance was revised in 1939. This revision did not exactly follow the committee advice, but it allowed customary units to be used in special cases indefinitely; that is, for special historical objects, houses, or treasures. Real estate and houses were allowed the customary units for the time being. The compulsory enforcement of the other items was postponed until December 31, 1958. But in spite of these obstacles, the state textbooks in primary school had been adopting the metric system since 1925. In Japan, primary school education is compulsory, so at the time of present changeover in 1959 the persons who were not over 40 years old had been educated under the metric system. The number of these—the "metric population," if I may so call them—amounted to 56 million; that means 63 percent of the whole nation. Thus, almost all of the people had come to know the metric system regardless of what they used in their daily life.

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The defeat of our country in 1945 brought considerable confusion in many respects because of the shortage in living necessities. But as the recovery proceeded, the economic activities gradually grew larger, and measuring instruments lost during the war were needed. It was just in this period that we could unify our confused systems to the metric one, but unfortunately our leadership for the unification and promotion among the nation was not strong enough to push the idea. We really regret that we lost our most suitable chance at that time. After the war, foreign armies and their families came and stayed in our country, and many materials for economic rehabilitation were imported from America or England. Because of this, the use of the foot-pound system in our country gradually increased. Materials previously sold in the metric system changed their indications to the foot-pound system—for example, gasoline from liter to gallon, cloths from meter to yard. Again we came to use a mixture of the three systems, Shaku-Kan, foot-pound, and meter-kilogram.

Meanwhile, there arose the necessity to revise the old weights and measures law completely, because it had become partly out of date. In the deliberation of the revision of the old law, the committee members agreed unanimously to unify the confused system to the metric one. It was very fortunate that the leaders of the occupation armies also believed that it was reasonable to adopt the metric system that had already spread widely in Japan.

The new "Measurement Law" passed the Diet in 1951, was promulgated in June, and enforced on March 1, 1952.

The measuring units in this new law were based on the metric system, and the use of the Shaku-Kan and foot-pound systems were allowed transitionally with some exceptions until December 31, 1958, the same date set by the old law after the postponement as the compulsory conversion day.

There was no serious opposition to this bill in the Diet. However, promotion activities were not undertaken immediately, as there was thought to be ample time before the conversion. But from the earlier bitter experiences, we felt the need of a strong campaign for the promotion of the metric system lest we should repeat the same failure as before.

So we organized the Metric System Promotion Committee in August 1955 and began to take practical action in preparing for the conversion. This committee is not an official one, but is composed of national and local government officials, scholars, members of the Japan Weights and Measures Association, and other representatives from private organizations.

Starting in 1956, the Ministry of International Trade and Industry shared a part of its expenses, and the promotion became more active in many fields. Even so, the largest amount subsidized by the Ministry was not more than $24,000 a year. In the first step, the committee tried to deepen the nation's understanding of the metric system in general, and issued many pamphlets and posters. The information media, such as newspapers, radio, and TV, were also cooperative in this compaign. Though the money available for the committee was limited, it could do many things effectively with the aid of these cooperating organizations.

The committee thought the best way to realize the compulsory changeover smoothly was to accomplish as much of the actual transition as possible before the specified day of transition. First, the committee attempted to convert to metric units the dealings of foodstuffs and cloths where the traditional system had been predominant, thus making the metric system familiar to the people through their daily shopping. The committee maintained close contact with various commercial bodies, especially department stores, which have great influence in cities upon the customers as well as the manufacturers and wholesale dealers, on account of their large-scale trading.

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On the other hand, the committee issued monthly pamphlets, "Way to the Metric System," for the general campaigns of metric system promotion. These pamphlets were designed to help the local campaigner to promote the metric system and were delivered to each city, town, and village free of charge.

An early fruit of this campaign was in the changeover of selling confectionery by the gram instead of by the former Monme in the Shaku-Kan system in Tokyo department stores since the first of September 1956. The success of confectionery sales was followed by the conversion of other foodstuff sales to the metric system. Gradually this conversion extended to the other goods. While the department stores began to sell goods in metric units, the fish or vegetable wholesale markets also began to use the metric system. Thus, the changeover to the metric system proceeded in many commercial transactions without waiting for the legal enforcement day.

The information industry, while cooperating with the Metric System Promotion Committee, organized their own planning committees and studied how to use the metric system in newspapers, radio, and TV.

For example, NHK, which has the largest radio and TV networks in Japan, published a brochure, "The Guide to the Metric System Adoption," and started to use the metric system in radio and TV before the legal changeover date. The other information media took the same stand.

This movement could not have been imagined during the preparatory period of the 1930's, and we cannot overestimate the role that the information media played for conversion in the past seven years.

On the government side, the bill "Metric Unit Law to Coordinate Metric Revisions in Other Laws" was drafted to change the nonmetric units used in other laws and regulations to metric ones. This law passed the Diet in 1958 and was promulgated. The biggest difficulty encountered was the rewriting of the registration list of land and buildings. As to this changeover, in the ordinance based on the Registration Law of Real Estate, the conversion is expected to be completed by March 31, 1966, and the rewriting already started in 1960. The metric Industrial Standards of constructing materials for houses and furniture were also introduced, and a new module of Japanese houses based on the metric system was also decided.

In industry, at the time of resumption of the metric campaigns in 1955, the percentages of adoption of the metric system differed for each enterprise—for example, in electric, gas, and city water enterprises 95 percent, chemical industry 90 percent, metal working industry 80 percent, machine industry 70 percent, textile industry 60 percent. The average of other industries was 60 percent. Among those which were still nonmetric, there were, for example, screw and pipe size in the machine industry and raw cotton and raw wool in the textile industry.

In industrial fields, the legal regulations were relatively few, but (1) the indication of quantity of products, (2) measurement for transportation or sale, (3) measurement in buying raw material, and (4) indications of quantity in giving or accepting orders were regulated by law and required to use metric units. The industrial rationalization and simplification should lead to benefits through the adoption of the metric system.

So, in spite of the difficulties induced by the large import of goods from Anglo-American countries just after the war, the percentages of adoption of the metric system were rather reasonable as mentioned before.

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The ultimate goal of unification of measuring units by the metric system should be that only the metric system is needed, regardless of whether the legal regulations are extended or not. But, in practice, it is difficult to make machines and apparatus metric at once, so here again a course of adopting over a period of time was taken. Industrial standards in Japan are regulated in the Japan Industrial Standards, and these regulations were also revised so as to be based on the metric system in accordance with the changeover. It was desirable in this revision to round off the conversion factors between the metric and nonmetric systems, but these procedures caused many difficulties in other areas, so we made only a few roundings in the present transition. In cases where the values converted to the metric system were too complicated—for example, for a quarter inch screw—we had to be satisfied with dropping the expression "inch," yielding in this example only "¼ screw." For some machine tools, the attached scales were changed to metric ones, or some gear mechanisms were inserted to make the machines fit the metric system. In manufacturers' drawings the metric system came gradually to be used. Though in some areas the changeover in the industrial field is not yet completed, the movement is expected to proceed steadily. This changeover in industry depended entirely upon the individual cooperation on the part of business circles, and there has not been any demand for compensation by the government of large expense in making their equipment metric.

As mentioned before, the educational campaign of spreading the metric system throughout the nation played an important role in the present transition, but you should also realize that in Japan most measuring instruments, even though they were not for metric measuring purposes, were also equipped with metric graduations. So it was unnecessary to buy new instruments based on the metric system at the time of transition. This was also very effective in the changeover.

However, in the course of the transition campaign, it turned out that the average person did not intend to become accustomed to the metric system as long as older, more familiar systems were indicated in the same instruments. So the government decided to establish a regulation to abolish the verification and use of instruments with nonmetric indications, and the date of the enforcement of this regulation was set at the end of 1961. This regulation was very drastic, and many measuring instruments and devices were forced to change their indications or weighing beams. These changes are expected to be accomplished in the near future, though they are not complete at the present.

At the beginning of the transition, the price cards at shops showed the quantities closest to customary expressions so as to make shopping convenient for housewives. For example, meat had been sold per 100 "Monme," which equals 375 grams in the metric system, so they sold the meat per 400 grams. But these indications were found unsuitable, because they lost the benefit of the decimal system. Through the enforcement of the transition, most housewives acquired good understanding of the metric system and preferred to buy things with the indication of price per 100 grams or per kilogram.

The complaints during the early period of enforcement disappeared in these days, with the exception of occasional complaints made by old-fashioned persons. But we still often express our body weights by "Kan" according to the custom. And in sports, especially baseball, football, boxing, wrestling, and golf, that are popular in America or in England, the foot-pound system is largely used.

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So the Metric System Promotion Committee published the Conversion Table for weights and measures for the convenience of the public. The complete conversion, therefore, was not achieved at the time of transition January 1, 1959. But a survey conducted in February 1959 and in December of the same year in the field of commercial transactions showed the average percentage of compliance throughout Japan was 85 percent. This means that there remain some elements where nonmetric units are used in daily life, and shows that we must intensify the campaign to make the nation understand the system.

In the Measurement Law, any person who has violated the provisions concerning legal units shall be punished with a fine not more than about $140, but we hope that the transition will proceed smoothly, not by enforcement with the penalty, but through the nation's voluntary using of the metric system.

Of course, in the import and export businesses, exceptions are permitted, though the imported goods are regulated by the measurement law when traded within Japan. Planes, flight navigation, weather observation for flight, and the munitions industry remain as exceptions. The reason for the former is that the flight has an international connection, and the reason for the latter is because of the special circumstances of our country after the war. Land and building measuring remains in transition.

This is the brief review of Japan's transition to the metric system. To make this system more complete in Japan, and also to unify the measuring units to one system throughout the world, depend largely on the adoption of the metric system in the United States and Great Britain. I hope the adoption of the metric system in the United States and Great Britain will be realized as soon as possible.

Pages 31-37

FORM NBS-114A (1-71)

U.S. DEPT. OF COMM. BIBLIOGRAPHIC DATA SHEET	1. PUBLICATION OR REPORT NO. NBS-SP-345-3	2. Gov't Accession No.	3. Recipient's Accession No.
4. TITLE AND SUBTITLE U.S. Metric Study Interim Report: Commercial Weights and Measures			5. Publication Date July 1971 6. Performing Organization Code
7. AUTHOR(S) Stephen L. Hatos			8. Performing Organization
9. PERFORMING ORGANIZATION NAME AND ADDRESS NATIONAL BUREAU OF STANDARDS DEPARTMENT OF COMMERCE WASHINGTON, D.C. 20234			10. Project/Task/Work Unit No. 4063129 11. Contract/Grant No.
12. Sponsoring Organization Name and Address			13. Type of Report & Period Covered Interim 14. Sponsoring Agency Code

15. SUPPLEMENTARY NOTES

16. ABSTRACT (A 200-word or less factual summary of most significant information. If document includes a significant bibliography or literature survey, mention it here.)

This publication, one of a series prepared pursuant to the U.S. Metric Study Act, explores the impacts metrication would have on commercial weights and measures activities. More specifically, the report, concerns: (1) the cost of adapting or changing commercial weighing and measuring devices to record and/or indicate in metric units, and (2) the effects of metrication on state and local weights and measures jurisdictions.

17. KEY WORDS (Alphabetical order, separated by semicolons) commercial weights and measures; International System of Units; metric conversion; metric system; metric usage; metrication; metrication, attitudes toward; metrication, costs and benefits of; metrication, impact of; SI; U.S. Metric Study

18. AVAILABILITY STATEMENT	19. SECURITY CLASS (THIS REPORT)	21. NO. OF PAGES
[X] UNLIMITED.	UNCLASSIFIED	112
[ ] FOR OFFICIAL DISTRIBUTION. DO NOT RELEASE TO NTIS.	20. SECURITY CLASS (THIS PAGE) UNCLASSIFIED	22. Price $1.00

USCOMM-DC 66244-P71

U. S. GOVERNMENT PRINTING OFFICE : 1971 O - 426-536

DEPARTMENT OF COMMERCE ★ NATIONAL BUREAU OF STANDARDS ★