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THE METRIC CONVERSION  
OF WEIGHING AND MEASURING DEVICES  
IN CANADA -

the Report of the Task Force  
on Weights and Measures

Metric Commission  
320 Queen Street  
Ottawa Canada  
K1A 0H5

January  
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General George S. Patton on Leadership:

Leadership is like putting spaghetti  
through a hole. Don't try to push it.  
Pull it!

## OVERVIEW

The purpose of the Task Force on Weights and Measures can be summarized in a single sentence:

Establish the minimum schedule on which the metric conversion of weighing and measuring devices can be accomplished.

The interests of the Task Force were primarily technological. Its specific proposals for schedule may well be modified by other inputs to the total process of planning metric conversion. It is hoped that its ordering of priorities will be accepted as valid.

While taking the measure of this technological problem, the Task Force became strongly aware of the psychological and philosophical overtones of metric conversion. The White Paper on Metric Conversion <sup>(1)</sup> established that metric conversion is to be a voluntary process; spaghetti can be pulled, not pushed. At which end of the spaghetti do we pull?

It seemed obvious that retail devices used in trade - principally gasoline dispensers, counter and label-printing scales in food stores, and Post Office scales - are a key element in metric conversion. They are highly visible, and if converted early in the game, and on a schedule carefully coordinated with a program of public information, would ensure that the Canadian public will rapidly come to "Think Metric". Given this climate of public acceptance, all other elements of metric conversion will slip into place with minimum friction. The spaghetti will be pulled, not pushed.

This basic premise was suggested to our 700-odd respondents in our survey of device manufacturers, service organizations and principal users, together with a suggested plan for conversion of retail devices by simultaneous geographic sweep through 21 Weights and Measures districts across the country.

Response was in general favourable and occasionally enthusiastic. There is some concern that if we do not tackle the conversion of retail scales promptly, we will be overtaken by metric conversion in the United States, the supply of essential conversion parts will become a problem, and we will be forced into indefinite postponement of this essential component of the conversion program.

Based on interviews and on written replies to our questionnaires, it appears that:

1. Conversion of scales and other retail devices could begin on a massive scale following a lead time ~~not~~ <sup>of about</sup> ~~exceeding~~ one year, and could be completed by ~~December,~~ <sup>mid-1978.</sup> 1977. If the oil companies were prepared to give the gasoline dispenser manufacturers an early statement of intent, and to reduce any conflicting demands on the service organizations to an essential minimum, the conversion of gasoline dispensers could be substantially completed during the summer and fall of 1974.
2. Conversion of industrial scales and meters, for which a sweeping geographical front approach does not in general seem feasible, could in some instances begin immediately. It could be accomplished if need be within the same time frame as retail conversion, but to some degree industrial conversion will share, and

compete for, the attention of the same manufacturers and service organizations. It would undoubtedly be more realistic to target for substantial completion of the conversion of industrial measuring devices by December, 1979 in order to permit a smooth integration with the conversion of individual industries.

3. The conversion of gas meters and water meters is a special case. Typically, utilities will convert their invoicing system to metric before undertaking the physical conversion of any of their meters. Individual meters will be converted when they are called in for overhaul at the time of expiration of their seal period, generally on a 6 year to 10 year time cycle.

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## REPORT OF THE TASK FORCE ON WEIGHTS AND MEASURES

### 1. GENERAL

This report is limited to the conversion of existing weighing and measuring devices to read or record in metric rather than in customary units. The design and construction of the devices using metric sized material and metric fasteners is a separate subject which will be part of metric conversion in the manufacturing industry.

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from p. 14)



Conversion of some devices, such as gasoline pumps, is not related to more than one industry. The schedule for such devices can be established on an availability of parts and service personnel basis. Some other devices, such as scales, may have to be converted on a schedule synchronized with metric conversion in each industry. For example, railroad freight scales should not be converted before the tariffs are converted to metric terms. Metric conversion schedules for most industries are not yet refined to the point that the schedule for the measuring devices can be determined. This report can only examine the magnitude of the problems of metric conversion for various devices, and propose minimum periods during which metric conversion can be accomplished provided definite and sustained efforts are made by all concerned.

This report is concerned primarily with devices used in trade, that is, used to measure quantity as a basis for payment for goods or services. Conversion must not be done in a slipshod manner. Parts equivalent in quality to the original equipment must be installed by skilled technicians. The converted devices must also meet Weights and Measures requirements. Methods of conversion should also be such that cost to the device owner will be minimum and benefits maximum. Factors involved have been



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Conversion to the metric or SI system in Canada is a voluntary program. In some segments of the economy conversion is necessary for survival. There will be benefits for all segments when conversion is complete. Costs of conversion will be borne by the owners of the various devices. Cost estimates included in the report are approximate figures for estimating purposes. Quotations for actual conversion or replacement cost must be obtained from the manufacturer or service organization by the owner of the device. The Canadian government will not subsidize conversion beyond furnishing the planning and follow-up services provided by the Metric Commission. This procedure is the same as that being followed in the United Kingdom, Australia and New Zealand. It is quite probable the United States procedure will be the same.

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discussed with manufacturers, service personnel and owners of the various devices. One important factor is the limited number of skilled technicians and the long training period required to substantially increase this number. It is generally agreed that the most satisfactory and inexpensive conversions will result from replacement with new parts rather than trying to re-work existing parts or make extensive modifications in the field. For example, it is better to replace a beam and poise assembly or a set of unit weights in a scale than to modify the lever system. Methods of conversion recommended for the different types of devices are best for most units, but there may be exceptions due to special circumstances.

Types of conversions requiring extensive modifications or an increase in capacity will require type approval review by the Directorate of Consumer Standards, Department of Consumer and Corporate Affairs. Following conversion, adjustment, and calibration by the technician, a high percentage of devices will be checked by the W & M inspectors to ensure that they meet the requirements of the Weights and Measures Act. Some increase in the number of field inspectors will be needed to cope with metric conversion, but it will not be necessary to add enough people to inspect every converted device before it is put back into service.

## 2. BASIS FOR REPORT

Population figures for the various types of devices were in general determined from records of Weights and Measures inspections of all trade devices. From a random sample of 1300 inspection certificates, percentage factors were developed for the more numerous

classes to provide figures of each type in each trade or industry. Cross-checks such as comparing the numbers of gasoline pumps with census figures for the number of service stations, comparing the number of retail scales with census figures for the number of food stores, and canvassing manufacturers and owners, showed the figures to be valid except in the case of postal or mailing scales. Figures for Post Office scales in use were obtained from the Post Office records. Figures for mailing scales owned by other users were obtained from scale manufacturers who "keep tab" because, when postal rates are changed, most of the mailing scales have corresponding chart changes made. is estimated to be 50,200. In the industrial scale population, The total population, it is realized, there are many "non-trade" scales which would not be included in the Weights and Measures inspection records. Owners of many of these scales will want them converted, preferably on the same schedule as the industry which uses them. Examples of "non-trade" industrial scales would be those used for batching ingredients to make the product, or for internal processing data. From considered opinions of scale manufacturers and service organizations and a questionnaire to typical industries, we estimate there are half as many non-trade industrial scales as there are trade scales in this category.

Scales are divided into three categories because there are three different schedules for their conversion. Retail food scales should all be converted in a minimum practical period, starting at a date selected by the retail food industry. Postal scales must be converted in a minimum practical period prior to or following the date established by the Post Office Department for conversion to postal rates based on the metric system. Industrial scales will be converted on different schedules synchronized with conversion in the industry owning the scales.

Weights and Measures devices other than scales are generally confined to a single industry. They will be converted on schedules suitable to the particular industry.

The numbers of service personnel available to convert the various devices were determined from an extensive canvas, including written questionnaires and personal and telephone interviews, of device manufacturers and owners and independent service organizations. The mailing list was provided by Weights and Measures field personnel. Estimates of time and cost to convert the devices were obtained in the same canvas.

### 3. DEVICE CONVERSION

#### 3.1 Retail Scales

Most retail food scales read in pounds, ounces and fractions of an ounce. Scales reading in pounds and hundredths of a pound are also approved. Most retail food scales will indicate or print kilograms by 0.005 kg, although increments of 0.01 kg will be permitted on scales converted from pounds by 0.01 or 1/64 of a pound, and smaller capacity scales may read in grams. Receiving scales which now read in pounds and ounces or fractions of a pound, will read in kilograms and decimal fractions of 0.1, 0.2 or 0.5 depending on the capacity of the scale.

Of a total of about 117,000 scales in retail food stores in Canada, about 76,000 are drum, fan or projection type computing scales. Since the computing charts are now based on cents per pound, new charts and price indicators, based on cents per kilogram, will have to be designed and produced for converting existing scales and producing new metric units. Scales will be converted by replacing the chart and price indicator and adjusting the scale to the new metric capacity. For some drum or projector scales, new spring units may be needed. Cost to convert a drum or projection scale will be about \$160 to \$180, and for a fan scale about \$90.

There are about 5,000 automatic label-printing scales in use. They print and compute to 25 lb. by 0.01 lb. New metric units will be either 10 or 12 kg by 0.005 kg. To convert existing scales to the equivalent of new ones, the scale, computer and printing unit require extensive changes. Although a unit in

"mint condition" might be converted for about \$1500, manufacturers are reluctant to quote less than about \$3000, realizing that many units will require replacement of worn parts at the time of conversion. For about \$300 a 25 by 0.01 lb. unit could be converted to a 11.5 or 12 by 0.01 kg unit. Only the scale unit would be affected. A stiffer spring would be installed, the scale adjusted to read in kilograms instead of pounds and the overload stop set just over 11.5 or 12 kg instead of just over 25 lb. With the present scale, a 2.205 lb. piece of meat at \$2.00 per lb. would be priced at \$4.40 or \$4.42 depending on whether the scale read the weight as 2.20 or 2.21 lb. On the converted scale, a 1.005 kg piece of meat at \$4.40 per kg would be priced at \$4.40 or \$4.44, depending on whether the scale read the weight at 1.00 kg or 1.01 kg. The labels would be pre-printed "Net weight, kg" and "Price per kg" instead of "Net weight weight, lb." and "price per lb.". This simpler method of conversion might well be considered, particularly for scales which do not have many years of life remaining.

About 3500 even-arm or "over and under" scales are used, such as for sale of candy in small specialty shops. Most are equipped with a notched beam and poise to weigh ounces and fractions of ounces. Conversion will be by replacing the avoirdupois weights with metric and installing a beam and poise to weigh in grams. Conversion cost, including metric weights, should be less than \$100.

About 2600 spring hanging scales are used for produce and "customer checking" scales. Conversion, by replacing charts and re-adjusting the scale, should not exceed \$40.

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There are about 3000 dormant scales <sup>in use</sup> in the retail food industry, primarily as receiving scales. Beam scales will be converted by replacing the beam and poise assembly, at a cost of about \$500. Dial scales will be converted by replacing dial and tare beams and unit weights, if used. Cost will vary from \$200 to \$800, or more if the scale has a printer.

An additional 26,600 scales, primarily portable platform and track type, are used as receiving scales or for general weighing such as at locker plants and warehouses. Many portable beam scales now have avoirdupois graduations on one side of the beam and metric on the other and are furnished with both avoirdupois and metric counterpoise weights. Beam scales reading in avoirdupois only will be converted by replacing the beam and poise assemble and the counterpoise weights for about \$250. It will be more economical to replace than convert small beam type bench scales which sell for \$20 to \$50. Many dial scales of the portable or track type can be converted by installing a dial with metric equivalent graduations so the scale will indicate both avoirdupois and metric units. The cost would be about \$100 to \$200 depending on whether or not tare beams were to be converted. For conversion to round metric dials, such as converting a 1000lb. scale to 500 kg, the scale would require adjustment and the cost would be about \$400. If the scale has a printer the conversion cost would be about \$1000.

Many of the scales now in use are about at the end of their useful life, and some of them were made by companies no longer in business so conversion parts would not be available. These scales will be replaced rather than converted. Some types of scales have a longer useful life than others so the percentage to be converted will be higher. Table 1 shows an

estimate of the number of scales in the various categories to be converted as well as an estimate of the cost of such conversion.

TABLE I

TYPE OF SCALE	<u>NUMBER OF SCALES</u>			CONVERSION COST
	<u>TOTAL</u>	<u>CONVERT</u>	<u>REPLACE</u>	
Computing Drum or Projection	61,000	48,000	13,000	8,200,000
Computing Fan	15,000	12,000	3,000	1,080,000
Auto. Label to 0.005 kg (Auto. Label to 0.010 kg)	5,000	3,500	1,500	5,200,000 (1,000,000)
Even-Arm	3,500	3,000	500	270,000
Spring hanging	2,600	2,000	600	80,000
Dormant	3,100	2,700	400	1,300,000
Miscellaneous	<u>26,600</u>	<u>18,000</u>	<u>8,600</u>	<u>5,400,000</u>
Totals	116,800	89,200	27,600	\$21,530,000

Our canvas indicated there are about 730 scale service technicians in Canada. About 440 specialize on retail type scales or can work on retail and industrial. The remaining 290 specialize on industrial type scales. For the various types of scales in the retail food industry, a man should average two scale conversions per day. Considering the first five types of scales above as "retail", the total is 68500 scales or 34250 man days. Assuming 240 days per year and a two year period, 72 retail scale men would be required, or 16.5 percent of the 440 man force. Similar calculations indicate 22 men or 7.5 percent of the 290 man industrial scale force would be required, to convert the last two types



of scales. Since other industrial type scales could be converted at the same time, it would seem an increase of about 16 to 20 percent in the service technician work force, or an equivalent amount of overtime, would suffice for a retail scale conversion program extending over a two year period.

It is not necessary, and may not be advisable, to convert the whole country in a two year period. A suggested program would be to start in Ontario and British Columbia, possibly in Toronto and Vancouver. After conversion is well under way in these two provinces, work would progress to Quebec and the Maritimes from Ontario and to the Prairie Provinces from British Columbia. Working from cities to towns to villages by advertising areas, it should be possible to have even the cross roads stores converted within three years of the actual start of conversion. There would be an advantage to starting retail conversion in the major metropolitan centres having high-volume retail stores so that any scales replaced could, after rebuild, be made available for "trade-up" by smaller retailers. Considering the design and tooling required, a lead time of at least a year would be required before sufficient parts would be available to start the conversion in the field. It should be possible to start conversion by mid 1975 and have it completed by mid 1978.

In order to meet this schedule, prompt and sustained effort will be required by all involved:

Scale manufacturers must consult with their customers, the scale owners, to determine specifications for converted and new metric scales. The manufacturers must then design the new charts, get approval of the Directorate of Consumer Standards of the Department of Consumer and Corporate Affairs,

provide tooling, order raw material, and manufacture parts for conversion and new scales for replacement on a suitable schedule.

Scale owners must place orders for conversion of specific scales and for new replacement scales on a suitable schedule. It should be noted that if metric replacement scales are ordered well in advance of the date they are needed, these scales can be used as a rotating reserve to facilitate the conversion process.

Associations and co-operatives should keep their members informed on progress towards metric conversion, and the district offices of Weights and Measures should inform each retailer of detailed plans for conversion in the retailer's area so that he can place orders on a suitable schedule.

The Director of Consumer Standards of the Department of Consumer and Corporate Affairs must approve new designs and conversion plans without undue delay. Plans and forms for field inspection and for reports of conversions by service organizations must be available when needed.

The Weights and Measures field force must be ready to coordinate the conversion program within each region and district and to conduct inspections as required.

Service organizations must obtain instructions from the manufacturers as to methods of converting and parts required for the scales they intend to convert. They should order parts required for conversion or assist the scale owners to order the parts, and they must also obtain metric test weights.

Steering Committee 6 of the Metric Commission must make sure the entire retail food industry is aware of the approved schedule and must monitor action by the various groups to make sure the schedule is being followed.

The Director of Information and Education in the Metric Commission must make sure the public is properly informed before conversion starts, and must prepare suitable publicity to encourage the small store owner to "get on the band wagon". The metric system has been legal for use in trade transactions in Canada for over 100 years, but there remains a general lack of familiarity with it. To reduce confusion during the time of metric conversion in retail trade, conversion charts showing price per kg versus price per pound should be made available by the metric commission for posting in retail stores.

### 3.2 Postal Scales

Scales used for determining the postage payable for letters and packages read in pounds, ounces and fractions of an ounce. Many scales are equipped with a computing chart which shows directly the postage payable for any letter or parcel within the weighing range of the scale. Rates for the different classes of mail and for various destinations, including international rates, may be shown on some scales. When the Post Office Department converts to rates based on metric units, the scales will have to read in kilograms and grams and the computing charts will have to show the new rate structure.

There are thousands of \$3 to \$5 postal scales, sold in drug and department stores, used by individuals and small offices. These will be replaced or used with conversion tables.

Another type of scale which will undoubtedly be replaced is the simple 8 or 16 ounce beam letter scale. The Post Office has 9520 in use and it is estimated there are about 12000 in private offices and small industries. The replacement cost of \$20 to \$25 is less than the conversion cost in the field.

In addition to the beam letter scales, post offices have 6340 beam parcel scales, 25 or 35 lb. by 1 ounce. Some of these are also used in industry. These scales could be converted at the factory, or in a few "conversion shops" set up in various provinces, for about \$40 each. Since some old scales are due for replacement, new metric scales could be ordered somewhat in advance to provide a reserve for rotating scales into conversion centres.

Computing fan letter scales have capacities of 20 ounces or 3 lb. Metric units would probably be

500 g and 1.5 kg. Conversion will be by replacing the chart and adjusting the scale to the new capacity. Computing fan parcel scales have capacities of 10 to 35 lb., some with a beam and poise to expand the chart capacity. Metric units will probably be 5 kg to 20 kg capacity. Conversion will be by replacing the chart, and the beam and poise if used, and adjusting to the new capacity. Conversion costs for fan scales will be about \$90 to \$120. The Post Office has about 1850 fan computing scales and the private segment about 14500.

There are also computing drum or cylinder scales and computing dial scales of 25 to 35 pound capacity used for parcels. Conversion will be by replacing the drum assembly or the dial and adjusting the scale to the new metric capacity, probably 20 kg. Cost will be about \$200 per unit. The Post Office has about 800 and the private segment about 4500 of these scales.

In addition the Post Office has about 600 scales used for weighing bulk mail. Beam type portable scales will be converted by replacing the beam and poise assembly and the proportional or "tip" weight at a cost of about \$250. Portable or suspended platform dial scales will be converted by replacing the dial and beams and adjusting the scale at a cost of about \$400.

Table 2 shows an estimate of the cost to the Post Office Department and Table 3 to the private segment for converting or replacing scales to adapt to a metric postal rate structure.

Table 2 Post Office Department

<u>Type Scale</u>	<u>Number of Scales</u>			<u>Estimated Cost</u>
	<u>Total</u>	<u>Convert</u>	<u>Replace</u>	
Beam letter	9520		9520	200,000
Beam parcel	6340	5000	1340	310,000
Computing fan	1850	1850		185,000
Computing drum	800	800		160,000
Miscellaneous	<u>600</u>	<u>600</u>		<u>170,000</u>
Totals	19110	8250	10860	\$1,025,000

Table 3 Privately Owned Postal Scales

<u>Type of Scale</u>	<u>Number of Scales</u>			<u>Estimated Cost</u>
	<u>Total</u>	<u>Convert</u>	<u>Replace</u>	
Beam letter	12000		12000	250,000
Beam parcel	200	200		8,000
Computing fan	14500	14500		1,450,000
Computing drum	<u>4500</u>	<u>4500</u>		<u>900,000</u>
Totals	31200	19200	12000	\$2,608,000

There are about 440 service technicians in Canada capable of converting postal scales, but they are not available full time for conversion work. On a crash basis it probably would be possible to convert, in about a month, all the Post Office scales except the beam parcel type. Depending on the size of the reserve for rotating, it would probably take two to four months to convert these scales. Unconverted scales could be used with a conversion table. It would probably take six months to convert the privately owned postal scales, assuming retail food store scales were not being converted at the same time.

Scale manufacturers will need at least a year lead time after the metric rate structure is established by the Post Office Department. They will have to design and

tool for new charts, obtain raw material and produce the parts required for the conversion.

To meet a tight schedule, prompt and sustained effort will be required by all involved. The Post Office Department must set up the metric rate structure, obtain firm quotations and delivery schedules from scale manufacturers, establish the conversion date, place parts and conversion orders, publish the new rate schedule with effective date sufficiently in advance so other scale owners and manufacturers can prepare for the change, and issue the new rate schedules with conversion tables for use of owners of unconverted scales.

Scale manufacturers must design new computing scale charts and new beams and poises for non-computing scales, obtain approval of the Directorate of <sup>Consumer</sup> Standards of Consumer and Corporate Affairs for methods of conversion and possible increases in scale capacity, order raw materials, fabricate parts, prepare instructions for conversion, canvas private owners of postal scales and issue parts and instructions against purchase orders.

Service organizations must correlate with scale manufacturers and the Post Office Department to schedule conversions in the territory they cover, obtain parts and instructions and notify the District Inspector of Weights and Measurers as conversions are made.

~~The Department of~~ Consumer and Corporate Affairs ~~Department~~ must examine new charts and plans for conversion, issue approvals and inspect converted devices in the field.

The Metric Commission must monitor the conversion program, make sure it does not conflict with other programs, <sup>such</sup> as the conversion of retail food store scales, and make sure sufficient publicity and educational activity occurs at the proper times.

### 2.3 Industrial Scales

Small industrial scales generally read in pounds, ounces and fractions of <sup>an</sup> ounce . Some scales, such as for weighing precious metals, may read in troy pounds and troy ounces, or in grains. Intermediate scales read in pounds and ounces or pounds and fractions of <sup>a</sup> pound . Large scales read in thousands of pounds and pounds. Although large units, such as truck or railroad scales, may be rated in tons, very few scales in Canada read or print in tons and pounds. In recent years, in order to simplify entry of weight data into business machines, there has been a trend to purchase scales reading in pounds and decimal fractions of pounds. Some scales have been converted to decimal reading in the field. Small metric scales will read in grams or kilograms and grams. Larger scales will read in kilograms and decimal fractions or multiples of kilograms. All reading and printing will be in decimal units. This will be a definite benefit from metric conversion.

Of an estimated 191,000 industrial scales, about 6000 are now metric, so will not require conversion. An additional 5400 are classed as "combin-



ation metric". These are the small scales used for classifying grain. It will be more economical to replace than convert them. There are then about 180,000 industrial scales to be converted or replaced. Some scales will be replaced because parts to convert them are not available, others because they are worn out and due for replacement. In many cases, such as hopper, truck, railroad and other large scales, the lever system may be in good condition but the indicator may require replacement because conversion parts are not available. In other cases, conversion of the indicator may be quite inexpensive but the lever system may need a complete overhaul before the converted scale will be acceptable for use. In this report it is assumed conversion can be accomplished without overhaul of the complete scale. Maintenance expense should not be considered part of the cost of metric conversion.

About 28,000 scales are the even-arm or "over-under" type used with weights to offset the load. Most units also have a beam and poise to offset tare or part of the load. Conversion will be by replacing the avoirdupois weights and beam and poise with metric units. Many of these scales used in industry have a capacity of 100 lb. or

more. The cost of conversion will average about \$150.00. There are about 110,000 portable, bench or monorail scales with simple beam or dial indicator. Beam scales will be converted by replacing the beam and poise assembly and the counterpoise or "tip" weights for about \$350.00. Dial scales will be converted by replacing the dial and tare beams, if used, and adjusting the scale, <sup>at</sup> <sup>an</sup> cost <sup>of</sup> about \$400.00.

About 39,000 larger platform, hopper, crane and motor truck scales are used. Calibration of these larger scales will increase conversion cost. Beam scales are generally the "full capacity" type, with a more expensive beam and poise assembly, and most of the dial scales have unit weights. There are some hydraulic and some electronic scales in this category. Beam scales will be converted by replacing the beam and poise assembly, <sup>at</sup> <sup>an</sup> cost <sup>of</sup> about \$1000.00. Mechanical dial scales will be converted by replacing dial, beams and unit weights, if used, <sup>at</sup> <sup>an</sup> average cost <sup>of</sup> about \$1200.00. Hydraulic scales will be converted by replacing the dial and adjusting the indicator drive linkage to calibrate the scale, <sup>at</sup> <sup>an</sup> cost <sup>of</sup> about \$400.00. Electronic scales with dial indicators will be

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converted by replacing the dial and some resistors and re-calibrating, <sup>at an</sup> average cost of about \$1000.00. Digital indicating electronic scales will generally require only re-marking of the value of the digits, replacing some resistors and re-calibrating for an average cost of about \$800.00.

There are about 900 railroad track scales, some with beam, some dial and some electronic indicators. Replacement of indicator or components plus cost of calibration will probably average about \$3000.00

About 1400 automatic dump or belt conveyor scales can be converted by replacing beams and balance weights and identification plates. Re-calibration will be required. Average cost will be about \$2000.00.

Table 4 shows an estimate of the total number of industrial scales in the various categories with the approximate number to be converted and replaced and the approximate cost for conversion. Replacement is considered a normal cost of replacing capital equipment, so is not included. *For the larger scales, in most cases only the indicating unit will be converted or replaced.*

Table 4 Industrial Scales

Type of Scale	Number of Scales			Conversion Cost
	Total	Convert	Replace	
Even-arm	28000	22500	5500	3,400,000
Portable, bench and monorail	110000	77000	33000	28,000,000
Platform, hopper, crane, truck	39000	27000	12000	31,000,000
Railroad	900	600	300	1,800,000
pump, Conveyor or	<u>1400</u>	<u>1050</u>	<u>350</u>	<u>2,100,000</u>
Totals	179300	128150	51150	66,300,000

A skilled technician should be able to convert two even-arm scales or one portable, bench or monorail scale per day. The larger scales will require about two man days on the average. This adds up to about 146,000 man days. Considering six 240 day years, about 100 men would be required full time. The Task Force canvas indicates there are about 370 technicians qualified to convert industrial scales, but some would not be available during the retail scale conversion period. <sup>one hundred</sup> ~~100~~ men full time represents a twenty seven percent increase in the technician work force. Some industries will require that the conversion work be done on week-ends or holidays to avoid interference with production. Considering this overtime factor, an increase of fifteen to twenty percent in manpower is indicated, assuming that the work is scheduled properly. There are many industries ~~and~~

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and many factors involved. Ideal scheduling will not be possible. An increase in the work force of twenty five to thirty percent, with some overtime work, will be probably required.

There will be no definite schedule for conversion of all industrial scales. Each industry will convert its scales when necessary according to metric conversion of its products or services. The grain industry has set August, 1977 as the target for completion of its scale conversion. Some industries are very seasonal, in others plants may have shut-down periods for major maintenance. With proper planning metric conversion of scales can be accomplished with minimum interference with production.

Most scale manufacturers already produce industrial scales reading or printing in metric units. Design of parts for metric conversion will not be a serious problem. Some engineering will be involved in adapting a new indicating unit to an existing lever system manufactured by a company which has gone out of business. Engineering will also be required to determine the best way to convert the various models and capacities and to ascertain that converted scales are within satisfactory performance limits of capacity and sensitivity.

For a smooth program of scale conversion in the various industries, the following will be required:

Scale manufacturers must make sure they have suitable designs for converting or replacing scales. They should determine the parts required and procedures to be followed and prepare parts lists and conversion instructions for all models to be converted. They should obtain, if necessary, approval of Directorate of <sup>Consumer</sup> Standards, JJA, for possible increased capacities and for combinations of indicating units with other lever systems. Raw materials will have to be obtained and parts and kits produced in quantities to meet orders and schedules from the scale owners.

Scale owners should request firm quotations and then place orders for conversion or replacement well in advance of the conversion date. "In house" test weights should be replaced or provided with conversion weights to facilitate calibration of converted and new scales.

Service organizations should plan on increasing and training personnel and providing suitable test weights. They should obtain parts lists

and conversion instructions for scales they plan to convert, and should order parts or assist the scale owner to order parts.

The Directorate of Consumer Standards  
~~Standards Branch~~ of CCA will be called upon to approve plans and kits for conversion of various units and lever systems. Requirements for converted scales and forms to report conversions must be issued.

The Weights and Measures field force must be equipped with suitable test equipment for metric scales. If necessary, the staff should be increased to meet the inspection program required.

The Metric Commission must advise the scale manufacturing and service industry on the schedules of the various industries and must see that schedules are adjusted if serious conflicts develop.

Education and training of scale operators should be done just prior to scale conversion.

3.4 Weights

Many weights are used with even-arm scales in the weighing of commodities. Such weights are in units of pounds, ounces and fractions of <sup>an</sup> ounce for ordinary commodities and in troy pounds, troy ounces and fractions or in grains for weighing such commodities as precious metals. "Test weights" used by service organizations, scale owners and Weights and Measures inspectors to calibrate scales may be in the same units. Some test weights for large scales may be 500 or 1000 lb. or larger. Test cars for railroad scales are adjusted to 30,000 to 100,000 lb. or more.

Of the total of about 260,000 weights, about 152,000 are ten pounds or smaller, 16,500 between eleven and thirty pounds, 89,000 between ~~thirty~~-one and two hundred <sup>and</sup> fifty pounds and 2,500 over two hundred <sup>and</sup> fifty pounds. About 14,000 weights are used with even-arm scales in the retail food industry, about 196,000 with even-arm scales in other industries and about 50,000 are used for calibrating scales.

Conversion undoubtedly will be more expensive than replacement for weights smaller than thirty pounds. For larger weights, action by the owner will depend on circumstances. Weights used frequently by unskilled personnel should probably be replaced. Examples are the weights used with larger even-arm scales in industry for filling containers or checking the filling operation.



such as for calibration of scales, can be used with add-on weights to arrive at round metric values. Service technicians and Weights and Measures inspectors will need, for some time, the capability of testing scales in both avoirdupois and metric units. They should have small scale kits in the metric system to supplement their present "thirty pound" kits. They should also have conversion weights for their larger weights to bring them to round metric numbers. As metric conversion progresses, the larger weights can be converted, by adding or removing material, or replaced.

Cost of the weights used with even-arm scales and cost of the proportional or "tip" weights used with small beam scales were included in the conversion costs of those scales. Cost to the scale service industry and scale owners for test weight conversion or replacement will be about \$800,000 but this can be spread over several years.

The schedule for weight conversion or replacement will depend on the schedules for converting scales in the various industries. Action required would be as follows:

Scale manufacturers will have to produce about 14,000 weights for use with even-arm scales and about 500 small scale test weight kits during the retail food store conversion program. About 196,000 weights for use with even-arm scales and about 45,000 test weights or conversion weights will be needed for the conversion of industrial scales. About 300 additional small scale test kits will be needed for the postal scale conversion program.

Scale owners should place their conversion or replacement orders for even-arm scales early enough to permit manufacturers to produce the weights as well as the <sup>parts and</sup> scales. Owners of large scales who have their own test weights should request quotations on conversion, add-on weights or replacement. They should place orders well in advance of the conversion schedule for their scales.

Service organizations should order metric test weights, add-on weights and conversions well in advance of the dates they will be needed. Weights and Measures should order metric test weights, add-on weights and conversions well in advance of the dates they will be needed, and should also be prepared to test and adjust a higher volume of weights than usual.

Metric Commission committees should remind the industries involved of the importance of the test weight conversion program in connection with the metric conversion of scales.

### 3.5 Gasoline Dispensers

Gasoline dispensers presently read in gallons and tenths of a gallon. They will be converted to read in litres and tenths of a litre by replacing a gear pair between the meter and the computer head. This will require the final wheel of the litre register, at a given rate of flow, to turn 4.546 times as fast as at present, but still well within the mechanical capability of the equipment. Additionally, faceplate markings will require to be changed from "gallons" to "litres" either by replacement of the faceplate or by use of self-adhesive vinyl overlays.

While all gasoline dispensers are basically similar in design, the problems of conversion differ somewhat. In one design, the gear pair requiring replacement is enclosed in a casing and bolted to the underside of the computer head. Replacement is quite straightforward, and in most cases, would be carried out on site. In another, the gear pair is mounted on top of the meter casing, either unenclosed or in its own casing. Replacement would again be straightforward. In a third design, the gear pair is mounted on top of the meter, but inside the main meter casing, and gear replacement is best accomplished by meter change-out and return of the replaced meter to the manufacturer's or another qualified shop. Alternatively, there might be sufficient vertical clearance to allow insertion of a new conversion gear casing between the meter and the computer head, and this arrangement would enable conversion to be done entirely in the field.

Of the six manufacturers from whom we have received verbal or written information, three are confident that all conversion work can be done in the field using manufacturer-supplied kits. Three expressed some reservations on field conversion, and thought that field exchange supported by factory conversion might be preferable.

They suggested a price for conversion kits, including mechanical parts, "gallons" to "litres" decals and instructions, varying from \$5 to \$50. Estimated field conversion time ranged from one half hour to two hours. Lead time required before shipment of kits in any required quantities generally ranged up to six months, although in the case of some model lines discontinued a number of years ago, the manufacturers would want to be assured of a reasonable volume of business before starting kit design. The manufacture of kits apparently presents no problem.

While the kits described would be technically adequate, the Task Force recommends that the manufacturers supply as a supplementary kit, one decal with the legend "One litre = 0.22 gallons; one gallon = 4.55 litres"; another with the legend "Equivalent price per gallon XXX.X cents" with individual figure overlays to permit display of a range of prices; and a printed price-per-litre to price-per-gallon conversion chart. Or in the case of blending pumps, a price conversion chart should be supplied in decal form for posting on the faceplate.

Weights and Measures inspection records indicate a present total of 116,000 gasoline dispensers in

trade use. While conversion will be a sufficiently minor expense that it will not be a significant stimulus to dispenser replacement, some dispensers will be replaced during the period of metric conversion on a normal retirement schedule, and others of three-wheel computer design, which have a read-out capacity of \$9.99 or in some instances \$14.99, will be replaced due to the rising costs of oil. On the other hand, there are probably 15,000 dispensers in non-trade use in Canada, a relatively small percentage of which would be converted before retirement. In total, perhaps 105,000 gasoline dispensers would require to be converted.

We received verbal or written replies from 30 service organizations out of a total of some 200 which service gasoline dispensers. Average number of servicemen available for gasoline dispensers, based both on written returns and on a statistically controlled phone survey, is about 4. A total serviceman population of 800 is then available for the conversion of gasoline dispensers. (Roughly 220 servicemen specializing in the servicing of bulk meters are employed by concerns which also service gasoline dispensers. If the two programs of conversion were not concurrent some limited transfer of resources would be <sup>possible</sup> available.) A minority of the service organizations plan to increase strength somewhat to cope with the workload of conversion.

The service organizations estimated the same range of man-hours required for a single field conversion as did the manufacturers. At a maximum of 2 hours per dispenser, and allowing for some amount of

travel time, it would seem that 4 dispensers could be converted per day by each man.

Some respondents asked about test measures for use in calibrating gasoline dispensers after conversion. While 20 litre test measures are available from two U.S. manufacturers, the more convenient approach, in the short term, would be use of the 5 gallon measures which all service organizations now have. Equivalent measure is 22.73 litres, and the final 0.03 litres would be difficult to estimate on the "tenths" wheel of the computer. It appears that one dispenser manufacturer will be prepared to supply W&M calibrated 30 ml displacers to be suspended by chain inside the measures for calibrations to the 22.70 indication on the dispenser register.

If the total attention of the service organizations could be devoted to metric conversion, the whole project could be completed in less than 7 weeks. This, of course, would be an unrealistic target, since the service organizations are already fully occupied. Phased into on-going work, and without special priority, the service organizations are in agreement that the metric conversion of gasoline dispensers could be accomplished in 18 months to 3 years. Some of our respondents also volunteered the opinion that, given adequate priority by their client oil companies, and assured of good parts supply, there is no particular reason why the job could not be substantially completed before the onset of winter weather in the current year.

At the time of our October written or verbal consultations with eight major oil companies, January

1977 was the favoured date for starting gasoline dispenser conversion; one thought that an 18 month period beginning January 1975 should suffice. There was some concern—apparently unfounded, judging from the response of the dispenser manufacturers—that supply of conversion parts would be a problem. Three companies thought that truck meters, loading rack meters and process meters in their respective organizations should be converted on the same schedule as their retail meters. *One thought that gasoline dispensers should follow other meters in the conversion schedule.*

More recently, some of the oil companies and their dispenser suppliers have been giving serious consideration to assigning a much higher priority to dispenser conversion.

In this project, the Department of Consumer and Corporate Affairs could be of assistance. The Directorate of Consumer Standards, on short notice, can mail guidelines on dispenser conversion to all manufacturers and service organizations of record. The Bureau of Field Operations, through the District Inspectors of Weights and Measures, could circularize all service station operators to urge them to submit name-plate data from their dispensers, with some expression of intent, through their normal purchasing channels to their service organizations so that a total inventory of conversion kit requirements can be prepared by each manufacturer.

The Task Force recommends that the conversion of gasoline dispensers begin not later than March, 1975 *and be completed before 1978, but* and that serious consideration be given to scheduling for the bulk of conversion to be completed during the summer and fall of 1974.



3.6 Self Measuring Pumps

Self measuring pumps are the second type of meter normally found at a service station. They are used for meterring lubricating oil, anti-freeze and other liquids. We received information from three of the four manufacturers in this field. It would appear that there are roughly 15,000 of these meters now in trade use in Canada. They presently register in either quarts or pints, and will be converted to register in litres. In the manufacture of new meters prior to conversion, and also in conversion of meters now reading in quarts and pints, there would be some advantage to dual read-out in both litres and quarts. A new meter with dual reading would not require to be converted, and for some time in the future, cars with radiators and lube system capacities quoted in quarts will continue to require servicing.

All respondent companies already supply meters to metric countries, however, and parts for metric conversion or complete meter heads with litres indication are available from stock. Either for immediate sale or for conversion, a meter reading in litres could be used for filling to capacities expressed <sup>in</sup> quarts using the formula "number of quarts plus 10%". Accuracy would be adequate for most purposes provided the charges were on the basis of litres dispensed.

One manufacturer proposed trade-in for factory rebuild to metric standards at a cost roughly 25% to 35% of purchase price. A second proposes conversion of the owner's meter in service depots at a cost roughly 30% of purchase price. A third proposes scrapping and replacement of the meter head.

The question which remains to be resolved is what percentage of the owners of these devices will wish to pay the price for conversion or replacement before the time of normal retirement. This will largely depend on the sales effort invested by the particular manufacturer. These are low visibility devices, not normally read by the customer and cannot be considered to have a high priority in metric conversion

Ideally, conversion of this class of device would be on the same schedule as gasoline dispensers. Conversion would be either by replacement of the meter head or by central depot rebuild and in both cases inspection would be at a central location and not dependent on field inspection schedules. A close tie-in to the conversion schedule of gasoline dispensers or of other retail devices is therefore not an overriding issue.

~~be used for filling to capacities expressed in quarts using the formula "number of quarts plus 10%". Accuracy would be adequate for most purposes provided the charges were on the basis of litres dispensed.~~

~~The question which remains to be resolved is whether owners of these devices will wish to pay the price for conversion or of replacement before the time of normal retirement. They are low-visibility devices, not normally read by the customer, and cannot be considered to have a high priority in metric conversion.~~

### 3.7 Tire Inflation Gauges

Tire inflation gauges are not formally a part of this study since they are non-trade devices. They are, however, highly visible, and frequently used by the general public. At present they register in pounds per square inch. The preferred units of registration in SI will be kilopascals, or kPa in abbreviated form. One pound per square inch is equivalent to 6.89 kPa, and a tire inflation pressure of 30 psi would be 207 kPa.

Tire inflators were discussed with one principal manufacturer who already supplies these devices to countries where the kPa is the unit of pressure measurement. Conversion involves replacement of the right indicator wheel assembly with one which reads in tens rather than in units, a small internal modification, and replacement of the face with one bearing a different legend and a pressure conversion table.

Conversion would not appear to be excessively expensive. But once again, the question remains - what percentage of the owners will wish to pay for conversion ahead of the normal time for device retirement?

It seems reasonable, however, that new installations should read in metric units, but carry conversion charts. At the time of gasoline dispenser conversion in any service station, older tire inflators should be "converted", as a minimum, by installation of a self-adhesive pressure conversion chart. There should be no problem in providing an adequate number to gasoline dispenser service organizations.

3.8 volumetric Liquid Meters

Volumetric liquid meters, commonly referred to as bulk meters, in the size range over about 30 gallons per minute, are used in the measurement of a wide range of industrial liquids, of food products including milk, but most importantly of petroleum products.

Bulk meters now register almost exclusively in gallons. The smallest sizes, used typically on tank trucks for the registration of fuel oil deliveries to domestic customers, have a final wheel reading in tenths of a gallon. On no bulk meter is registration to one tenth of a litre feasible because of the high speed of operation this would require in the final wheel. In some larger sizes of meter, not now registering to "tenths", installation of 4.456 step-up gearing would be feasible. In most cases, gearing would be step-down, to 0.2200 ratio.

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For bulk meters, the cubic metre is the preferred unit of registration under SI and in those countries, including all members of EEC, which adhere to the recommendations of OIM , "l'Organisation de Métrologie Légale". For the largest bulk meters, those of 3" size and larger, the cubic metre is the logical choice for registration in Canada, since the petroleum barrel will undoubtedly be displaced as a unit of measurement by the cubic metre. In smaller meters, the choice is less clear, particularly for the conversion of meters already in use.

For meters on domestic fuel oil delivery trucks, for instance, the final wheel now registers in tenths of a gallon, which are differentiated from the registrations of other wheels by contrasting colour, by a fixed decimal point, and by wheel spacing to emphasize the position of the decimal point. Shifting the decimal point two wheels to the left would approximately double the cost of conversion. And furthermore, for small deliveries, the cubic metre is a rather unhandy unit. A single cubic metre is more product than a domestic fuel oil tank can contain!

The register of a fuel oil delivery meter on conversion would be geared down, not up; the final, analogue wheel would read in whole litres and the first digital wheel would read in units of ten litres. In some countries, "litres x 10" is a permissible unit designation, but this terminology is quite confusing since one is never sure whether the "x 10" factor refers to the size of unit or is to be applied to the numerical reading.

The Task Force recommends that on the registers to calculate of meters topic

With some hesitation, the Task Force recommends that for the largest sizes of bulk liquid meters, the cubic metre be considered the mandatory unit of registration; for meters smaller than the current 3" size designation, it be an optional unit of registration; and that at least until Canada's policy on adherence to the recommendations of OIML is clarified, the decalitre (dal as abbreviated) be the alternative unit registration. Litres would also be an acceptable unit of registration in the smaller sizes; specialty food meters are generally imported from metric countries where the litre is the standard unit of measurement in smaller quantities. If at some future time it is decided that all bulk metering should be in terms of cubic metres, the bulk meters already registering in decalitres would be compatible by application of a 1/100 multiplying factor, and could be allowed to continue in use until their normal time of retirement.

Based on W&M inspection records, there are approximately 28,400 bulk meters in trade use in Canada, including 13,000 mounted on tank trucks, 14,600 large-capacity meters in fixed installations, 720 propane meters and 80 milk meters. A substantial percentage, particularly of truck-mounted fuel oil delivery meters, have ticket-printing registers and also pre-set registers which shut off delivery when a given quantity of fuel has been delivered.

It appears from an analysis of industry returns that there are roughly 3400 bulk meters in non-trade use. Perhaps half of these might be converted. One may also assume that a percentage of the trade meters will be approaching the end of their service

life during the period of conversion, and that roughly 20% would be replaced with new meters of metric registration. The number of bulk meters to be converted would then be 24,400.

Basically, meter conversion requires replacement of a gear pair, either to give a step-down of 0.2200 in register speed or, less frequently, a step-up of 4.546. The register face would be replaced. If the meter is of the pre-set register type, re-camming is also required to provide for the right speed of shut-off relative to the advancement of register numbers. If conversion is to other than decilitres, extensive re-wheeling of both the visual register and the printer is required.

Of the four manufacturers from whom we received verbal or written information, two envisage field conversion by service organizations using kits, one feels it would be preferable to supply complete replacement register heads, and one plans to return meters to service shops for conversion. Shop conversion has the advantage of conversion and recalibration under controlled conditions, and of minimum replacement of parts, but it has the potential disadvantage of excessive downtime in user operations and of becoming a bottleneck in the program of bulk meter conversion.

Costs of conversion, exclusive of field time, would vary from under \$50 to over \$300, depending on the size and type of meter and on the approach used. Two manufacturers could supply parts from export stock with very little lead time; one manufacturer estimated lead time at 6 months except for the

largest meters; a manufacturer of specialty food meters estimated lead time at one year.

Based on returns from 12% of the service organizations dealing with bulk meters, which on the average each have 2 1/3 servicemen devoted to bulk meter servicing, and allowing for servicemen employed by major manufacturers and importers, it appears that there are now nearly 300 servicemen in this industry in Canada. Present plans are to increase strength to about 350 to cope with the workload of metric conversion. In 55 locations across Canada, oil company meter users have service organizations capable of carrying out the repair of meters, but since meter servicing is probably a small percentage of the responsibilities of these personnel, they have not been included in the total.

Our questionnaire had suggested for discussion purposes that bulk meter conversion might "begin early in 1975, peak in mid-1978, and be largely completed by 1980". One hazard in having any suggestion associated with a questionnaire is that it tends to limit the range of replies. All respondents thought this schedule would be quite reasonable; one volunteered that a tighter schedule would be perfectly possible.

One manufacturer estimates a field change-out time for a register at half an hour, exclusive of recalibration. One service organization estimates 2 to 3 hours for "kit" conversion of a meter in the field, including recalibration. <sup>^</sup> Assuming one man could, on the average, convert 2 meters per day, 300 men could then convert 24,400 meters in ~~two~~ <sup>4 hours.</sup>



~~than 6~~<sup>8</sup> weeks. AS in the case of gasoline dispensers, such a tight schedule would be unattainable since service personnel are already fully occupied.

Recalibration of bulk meters following conversion requires some consideration. The arithmetic change in gear ratio provided by replacement of a gear pair would never correspond exactly to that desired; gear-up of the register would increase drag and tend to produce under-registration and over-delivery; gear-down would decrease register drag and tend to produce over-registration and under-delivery. Further, there is the possibility of human error in selection of conversion gears or in re-assembly of meter components. It is unrealistic to expect a meter to provide accurate measurement following conversion without recalibration against a fixed or trailer-mounted prover with a capacity at least equal to a one-minute delivery of the meter at its maximum rate of flow in the particular installation.

It is unlikely that more than half of the service organizations are equipped with provers which are adequate for proper calibration following conversion. Calibration of meters following conversion would then become a high priority demand on the Weights and Measures inspection service, which must also monitor a reasonable percentage of the calibrations by service organizations, and at the same time continue a program of scheduled inspections on meters. The Weights and Measures inspection service could well be the critical resource in bulk meter conversion. Close liaison will be required between the District Inspector of Weights and Measures and the service organizations of his district

to minimize inspection delays and dislocations in the routing of inspection vehicles.

Completion of bulk meter conversion before 1980 would be entirely possible and compatible with present plans of the meter manufacturers and service organizations. With assignment of adequate priority by the oil companies, isolated conversions could begin at any time, and conversion could begin on a broad front towards the end of summer, 1974. Provided a substantial percentage of the work of conversion were shifted from central service shops to the field organizations, and provided Weights and Measures inspection services were closely coordinated, substantial completion within a further 12 months seems an attainable target. No tighter schedule would be realistic.

3.9 Slow Flow Meters

Slow flow meters are volumetric liquid meters having a maximum flow rate below about 10 gallons per hour. Typically, they are installed in permanent residences or mobile homes for the measurement of fuel oil supplied from a community oil distribution system. They are owned and maintained by the utility, generally a subsidiary of an oil company, or sometimes the owner of the mobile home park.

An analysis of Weights and measures inspection records indicates a total population of about 8500 of these devices in Canada. They are required to pass W&M inspection at least once every 5 years. Slow flow meters are low-visibility devices, and are not of particular importance to the overall program of metric conversion provided the customer billing

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system is converted to metric units of measurement.

We received written or verbal information from only two manufacturers of slow flow meters. It appears that slow flow meters were conceived as a high-production, low-cost commodity selling for about \$50, and that conversion cost would be a high percentage of the cost of replacement. It also seems possible that because of the relatively limited size of the Canadian market, North American manufacturers of this type of meter might find it uneconomic to supply meters reading in litres in advance of conversion of the U.S. market. Supply of meters of European manufacture with litres registration would of course be no problem.

The Task Force recommends that by early in 1976, the fuel oil utilities convert their billing systems to provide customer billing in terms of litres, and that as of the same date, meters in new installations and meters which are replacements have litre registration where such meters can be supplied by the manufacturer. We see no virtue in converting meters which are already in service.

### 3.10 Tank Trucks

Tank trucks are used for delivery of a variety of industrial liquids, principally petroleum products. They may be used for intra-company deliveries, in which case there may be no requirement for determination of quantity. They may be used for delivery of quantities determined by meter-in at the loading station, or by weighing on a truck scale. They may be equipped with meters for determining the

quantity delivered to any single customer. Or they may have calibrated compartments, with one or more indicating "fingers" mounted and sealed in position at various heights on a threaded rod mounted at one side of the inspection part and extending down into the compartment about one foot. Some tank trucks having calibrated compartments may also be equipped with meters to permit deliveries to customers requiring less than a full compartment. This section is concerned solely with conversion of calibrated compartments.

Weights and Measures inspection records indicate that there are 7000 tank trucks having calibrated compartments in use in Canada at the present time. Also included in this total are calibrated tanks in fixed locations, but these do not represent a significant percentage of the total. Tank truck compartments will be subject to Weights and Measures recalibration on a 5-year cycle.

Tank trucks do not require "conversion" per se; it is simply a matter of changing the location of the calibration fingers so that they represent a "round" quantity in terms of litres. A 900 gallon compartment, for instance, contains 4091.4 litres. It might be recalibrated to a new capacity of 4100 litres provided there were still adequate expansion space, or otherwise to 4050 or 4000 litres, depending on owner preference. Recalibration would normally be done by the weights and Measures inspection service, but the vehicle owner should make his own arrangements for new capacity plates. These could show both the new "round" quantities in litres,

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and the mathematical equivalents in gallons for customers not yet converted. Or in advance of conversion of a particular vehicle, it could carry a chart showing the "litres" equivalents of the "gallons" quantities shown on the capacity plate.

The Task Force envisages tank truck calibration in terms of litres extending through one normal inspection period, between January 1, 1975 and December 31, 1979. If particular truck owners wished to have their vehicles calibrated ahead of the normal inspection schedule, this could be arranged. Purchasers of new vehicles may wish to immediately specify calibration in terms of litres.

### 3.11 Static Measures

Static measures for the measurement in trade of either liquid or bulk solid commodities are low cost devices which are not amenable to conversion. To the extent that present owners still require static volumetric measures, they would have to be replaced with measures calibrated in litres. Based on Weights and Measures inspection records, there would appear to be about 4000 still in use.

Replacement could pose an interesting problem. The Task Force received not a single reply from a manufacturer of static measures, and we presume this is not a booming business. The replacement market could, however, be of short-term interest to a manufacturer with suitable production equipment. Locating a supplier or suppliers of metric volumetric measures will be a research project for the Standards Laboratory.

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Static linear measures, typically brass-tipped yardsticks for surface or flush mounting on counters of dress-goods retailers, but also including limited numbers of tapes, are still widely used. Based on Weights and Measures records, we estimate a total population of some 38,000 static linear measures in trade use. These would have to be replaced with measures calibrated in millimetres (mm), centimetres (cm), and metres (m). Static linear measures are already available from export stock. Increasing production to meet conversion requirements in Canada will pose no problems.

### 3.12 Linear Measuring Machines

Linear measuring machines are used to measure the length of fabrics, wire screening, rope and electrical cable, and are in both retail and industrial use. Basically, the material to be measured is passed between an idler and a spring or gravity loaded active wheel which is connected directly or through gearing to a counter mechanism, generally graduated in feet or yards. After conversion, registration will be in metres and decimal fractions of a metre.

We received verbal or written information from four manufacturers of linear measuring machines. It is difficult to generalize. Such machines may be relatively inexpensive for retail use, or quite expensive in industrial versions. They may or may not be suitable for conversion rather than replacement.

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Two manufacturers of fabric measuring machines state that their retail machines of relatively recent manufacture could be converted for a reasonable percentage of new cost. A large industrial machine, it is presently envisaged, would require replacement of its main roller at substantial cost since the counter mechanism is of direct-drive design; but redesign for intermediate gears is a possible alternative.

A manufacturer of retail wire and rope measuring machines proposed to establish service depots for the conversion of these devices at 50% to 65% of replacement cost. A manufacturer of retail and industrial wire measuring machines does not believe conversion of existing devices would be economical, and would propose their continuing use until the normal time of replacement, with conversion charts.

It is generally acknowledged that conversion of retail devices would be carried out under the control of the manufacturer or importer in a centrally located service shop. Inspection could be carried out at the conversion shop before return to the owner. There is therefore no need for close coordination between the conversion of retail linear measuring machines, and the conversion of other retail devices which should be tied into the schedule of retail device inspection.

Conversion of industrial equipment will more often be carried out on the owner's premises, but these are typically not trade devices, and therefore not subject to weights and measures inspection.

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there would appear to be no technical problem in scheduling retail conversion for a two or three year period beginning early in 1975. Ensuring a steady work flow through the conversion shops would be largely a matter for sales initiative on the the part of the manufacturer and his representatives.

There would similarly appear to be no technical problem in scheduling conversion of industrial linear measuring machines for completion prior to 1980, but it may be that in a substantial number of cases, the owner may elect to use an unconverted machine with conversion charts until the end of its normal life.

### 3.13 Gas Meters

Gas meters, which are subject to inspection under the Gas Inspection Act, are a very numerous class of volumetric measuring device. There are now some 2 million individual gas customers in Canada.

The typical residential gas meter is of the positive displacement diaphragm type, and drives a register of either the cyclometer or multiple "clock" type through intermediate gearing. Positive displacement meters are available in quite large capacity sizes for industrial customers, and may be used in "pressure factor" metering, in which the direct volumetric reading is modified by a factor determined by the pressure, which may be substantially above "standard", to which the pressure is regulated upstream of the meter. Rotary or turbine meters may be used for higher flows, or orifice meters with more



sophisticated recording systems may be used up to the highest flow rates and pressures.

Conversion of any positive displacement or direct driven turbine meter is relatively simple, and involves gearing and faceplate changes. Conversion of an orifice meter may or <sup>may</sup> not involve replacement of the orifice run of piping and of the orifice itself--there is no inherent reason why these need be replaced. A new fixed scale and use of a different scale on the recording charts would in each case be required for an orifice meter conversion.

Billing is now in terms of mCF (1000 cubic feet), or of therms (100,000 BTU heat content) where heat content per cubic foot tends to be variable. It seems likely that the corresponding units will be the cubic metre (one mCF equals 28.317 m<sup>3</sup>) and the gigajoule (one GJ equals 9.478 therms). An industry agreement on the units of measurement will be required before metric conversion can proceed.

We received information from four manufacturers of positive displacement or turbine meters, two manufacturers of pressure regulators for use in pressure factor metering installations, and one manufacturer of flow recorders and transmitters for use with orifice meter installations. We also received fairly detailed information from five utilities which are already well advanced in their planning.

Four utilities plan on metric conversion in their own shops on a schedule tied in to the seal period of the gas meters. This is normally 6 years, but can be extended beyond this period if justified

by statistical sampling inspection.

Two utilities specifically mentioned conversion of orifice meters. They do not plan on replacing the actual orifices or orifice pipe runs. They would simply redefine the dimensions in metric terms and alter the scale constants of the recording devices to give readout in metric units.

In each case, prior to the physical conversion of meters, the billing system would be modified to provide billing in terms of metric units. One utility plans to begin conversion in 1976. The other three are prepared to begin conversion as soon as the question of billing units is settled and as soon as conversion kits become available.

The fifth utility also plans on early conversion of its billing system, and is equipped to do overhaul in its own shops, and also subcontracts a percentage of its overhaul work. But it raises an interesting question: provided the customer is billed in terms of metric units, and assuming the computer must in any case be programmed to accept readings from meters which are not converted, is there any real benefit to be gained from converting any meter before it is finally retired from service? We suspect that there would be some amount of "tidy up" conversion after the number of unconverted units was reduced to a small percentage of those in service, but if indefinite postponement of the physical conversion of a low-visibility device such as a gas meter makes economic sense, we can see no fault in the logic.

From our analysis of the replies from manufacturers, it appears that 6 months would be a typical lead time for shipment of conversion kits, but could be as high as one year if large numbers were to be manufacturer-converted rather than converted in the shops of the utilities. One manufacturer said he would wish to know the date for start of change-over one year ahead of time to permit adequate planning. Conversion kit cost could vary from under \$5.00 to over \$500., and the additional time for conversion of a meter undergoing overhaul could vary from several minutes to over one hour, with the higher figure in each case applicable to the largest and most complex meters.

Pressure reducers would be as applicable to meters reading in metric units as to those reading in present units, and would not require conversion. Pressure recorders, pressure transmitters and similar items of equipment would require relatively minor changes to scale, and would require to be used with different charts following conversion. If replacement orifice meters were required, cost could vary from under \$10.00 to many hundreds of dollars, based on size and pressure ratio, but it would appear from the replies from the utilities that existing orifice meters could be used without physical change.

There seems to be no major impediment to a relatively early change-over of billing procedures to use of metric units, and to an early commencement of the physical conversion of gas meters tied in to overhaul schedules. For the reasons stated above, and provided billing procedures are changed over, the Task Force makes no strong recommendation

that gas meters be physically converted other than by replacement at the time of retirement. Neither, since the distribution system of the various gas utilities are physically separate and deal with different customers, does it see any particular virtue in a simultaneous start in each utility across the country. It would suggest, however, that individual utilities target for conversion of billing procedure anytime after early 1975 and and before mid-1976, but advise their meter suppliers of their plans as soon as possible.

3.14 Water Meters

Water meters, next to electricity meters which will not require metric conversion, are undoubtedly the most numerous class of measuring device in trade use in Canada. We estimate the total water meter population in Canada at between two and three million. Water meters are positive displacement devices which drive a meter register through intermediate gearing. Typically, a water meter is returned to the utility shop for overhaul and recalibration about once every ten years.

We have received information from one major manufacturer of water meters and also from six water utilities. The Mississauga Water Commission is undoubtedly the leader in metric conversion, but by last October there were three other communities in Ontario and one in British Columbia which had begun installing meters with registration in cubic metres.

In the Mississauga Water Commission metric conversion is tied in both with the overhaul cycle and with updating register heads from the old style "clock-face" type to one with cyclometer read-out. This latter type of register has provision for read-out from an electric plug-in station outside the customer's residence or commercial establishment, and is also adaptable to an "Automatic Meter Reading" system using the telephone network on night shift when the telephone circuits are not heavily loaded. Metric Conversion at the time of meter updating is not an extra cost. Those meters already up-dated can be converted at very low cost by gear change-out and by a simple dial-face modification at the time of next overhaul.

Two water utilities plan on duplicate billing systems for metric and for the traditional units of measurement until all meters have been converted. Three other utilities plan on converting to metric billing before proceeding with the physical conversion of meters. A sixth has not yet developed plans. Out of five utilities reporting on overhaul facilities, all operate their own, but one contracts for the overhaul of their largest meters. Eight to ten years in the most common overhaul cycle, but one utility quotes a cycle of 20 to 25 years. All utilities would tie conversion to overhaul; one comments that a planned program of modernization may shorten its overhaul cycle during the time of metric conversion.

The comments of the Task Force on water meters are much the same as those on gas meters. Conversion of billing procedures should be scheduled for a date before mid 1976, and meter conversion would preferably be scheduled to coincide with the time fo normal overhaul, but there is no compelling reason why any individual meter should be converted before it is finally retired from service.

4. Overall Schedule.

Except for scales and weights, most categories of Weights and Measures devices requiring conversion are limited to one industry. A small group of manufacturers and a specialized group of service technicians will make the parts and do the field conversion for each category. Within the petroleum industry the same service technicians may work on gasoline dispensers and tank truck meters. This will affect conversion schedules somewhat. Since some conversion parts will be manufactured in the United States, Canadian conversion ahead of U.S. conversion would assure availability of parts. Conversion schedules can be developed, making allowances for the lead time required by manufacturers to produce parts in the required quantities and for the service organizations and Weights and Measures staff to build up to the required numbers to meet the conversion schedule.

For devices which will be replaced rather than converted, such as yardsticks, <sup>and</sup> tape measures, ~~micrometers, etc.~~ it will only be necessary that metric units are available in sufficient quantity to meet the needs of each conversion schedule.

Scales, because they are used in fairly large quantities in many industries, require special consideration. There are not many manufacturers and service technicians capable of making the parts and doing the conversion work. Lead time required for most industries will be only the time required by the manufacturers to increase production of metric conversion parts. If there are many scales to be converted in a short period, it may be necessary for the service organizations and Weights and Measures field force to increase manpower. For conversion of retail food store scales the manufacturers will require a minimum of one year, preferably eighteen months, for design, tooling and initial production before field conversion can start. For conversion of postal scales the manufacturers will require a lead time of not less than one year for design, tooling and production before field conversion can start. Since the same manufacturing resources and the same service technicians will be used for these two categories of scales, it is important that the two conversion schedules do not conflict. If retail food store scales are to be converted first, postal scale field conversion should not be scheduled to start sooner than <sup>two</sup>~~three~~ years after the start of retail food store field conversion.



If postal scales are to be converted first, field conversion of retail food store scales should not be scheduled to start sooner than <sup>six</sup> ~~eighteen~~ months after the start of postal scale field conversion. There is an obvious advantage to scheduling the conversion of postal scales for as early a date as possible.

For seasonal industries, where many scales are to be converted in a short off-season period, the conversion schedule should allow a year lead time for the manufacturers to produce the conversion parts and replacement scales which will be required. An example is the fishing industry where most scales used are now cleaned and overhauled during the off-season. If conversion parts were available, the scales could be converted while being overhauled, at minimum cost to the owners. Even if scales are not overhauled periodically, conversion during the off-season of any industry is preferable. Conversion work will be more efficient and interference with production will be avoided.

Following is an estimate of the number of scales to be converted or replaced by the industries in each Steering Committee:

Committee	Scales to convert or replace
1	11000
2	36000
3	11000
4	20000
5	6000
6-Retail food	117000
6-Other	72000
7	6000
8	2000
9	10000
10	----
11-Postal	50000
11-Other	11000
Total	352000

These figures can be used by Sector Plan Managers to determine whether scale conversion will be a serious problem in planning their schedules.

Many conversion parts and replacement units are manufactured in the United States, where a similar metric conversion program is expected to start in 1974 or 1975. Canada has a lead time of three or four years in planning. It may be necessary for some industries to synchronize conversion with the United States. Some industries, however, such as petroleum, retail food and postal, where conversion affects only the individual consumer, should be able to convert early and avoid problems such as availability of conversion parts if conversion were on the same schedule as in the U.S. If conversion in these categories is delayed, it may have to follow the U.S. program and be delayed as much as ten years.

5. THE ROLE OF CONSUMER AND CORPORATE AFFAIRS

The Department of Consumer and Corporate Affairs has a key role to play in the metric conversion of weighing and measuring devices, through both the Directorate of Consumer Standards and the Bureau of Field Operations.

The Directorate of Consumer Standards, under the Weights and Measures Act and Regulations, establishes the technical specifications for weighing and measuring devices which are used in trade. It must approve the design of any such device before it can be inspected for use in trade, and it calibrates the standards against which devices are compared during field inspection.

The Directorate will be progressively establishing detailed specifications and guidelines under the new Weights and Measures Regulations, and these will include guidelines specifically applicable to metric conversion. It is anticipated that guidelines issued by the Directorate of Consumer Standards will in general be consistent with the "Proposed Guidelines for Metric Conversion of Weighing and Measuring Devices Used in Trade" which were issued by the Task Force to manufacturers, service organizations and principal users during September and October, 1973 as background information for questionnaires.

It is difficult to foresee, particularly in a program such as metric conversion which is without precedent in Canada, all possible questions which will require to be answered. Whenever a manufacturer is in doubt, before or after issue of formal guidelines on metric conversion, as to whether a scheme for metric conversion of a particular design of device will be acceptable for use in trade, he

should send details to the Directorate of Consumer Standards. In some instances, such as a substantial increase in capacity, formal reconsideration for approval will be required, but in most cases the written concurrence of the Directorate will suffice.

The Bureau of Field Operations will be responsible, through its regional and district offices of Weights and Measures inspection, for ensuring that converted devices comply with both the design specifications and the accuracy requirements under the Act.

During the time of Metric Conversion, the field organization must be prepared to inspect devices in either Canadian or metric units of measurement. Where possible, the same standard will be used for inspection in both systems of measurement. The heavy duty weight trucks, for instance, will continue to carry during the interim period 1000 pound and 50 pound weights, but also a set of "add-on" weights to permit convenient inspection of converted scales. Trailer volumetric provers can have capacity and tolerance lines for calibrations both in gallons and in litres. Such dual purpose standards will eventually be retired in favour of standards designed specifically for use in inspecting devices reading in metric units of measurement.

It is difficult to conceive of an effective alternative to the field organization of Weights and Measures as a channel of communication in coordinating the metric conversion of retail devices. It is an existing organization, already well known to all device owners and service organizations in each district, and from its record it can prepare the only complete lists of both groups.

It is proposed that each District Inspector, working with principal retailers and service organizations in his district, prepare a plan for metric conversion coordinated with the national plan, and with the cycle of zone inspections in his district. The plan would provide for a sweeping geographical front so that both service organizations, and the inspectors following behind them, would be able to progress rapidly and effectively without dissipation of effort in responding to calls first on one side of the district and then the other. Snags encountered by the inspectors could readily be rectified, again with a minimum of travel and delay. To add flexibility to the plan, gasoline dispensers, for instance, could be on a schedule different from that of retail scales if this seems desirable or necessary.

The conversion of industrial devices will generally be tied to the conversion plans of the particular industry. Monitoring inspection, with priorities established on the basis of the content of the conversion reports submitted by service organizations and on the basis of prior experience with the particular service organization, would best be handled by a separate "control inspection" team in each district.

When a district plan has been established, the District Inspector should use a mailing list prepared from inspection records to inform all traders of record in his district of the agreed plan. As the conversion proceeds, he can again notify the retail traders in each zone of the approximate date by which their devices should be converted and inspected.

Planning at the district level, involving both the Weights and Measures organization and representatives of retailers and service organizations, can give reasonable assurance that all retailers in a particular class of trade and in a particular geographical area will be converted on approximately the same schedule; without such assurance, conversion would be a much more painful and protracted exercise. The respondents in our survey were supportive of such planning.

## 6. Conclusions.

At this point in time conversion to use of the metric or SI system of measurement is a problem peculiar to the English speaking countries-present and former members of the British Commonwealth and the United States. The rest of the world is eager to use metric specifications as an artificial ~~tariff~~ or trade barrier against us. To avoid this handicap the United Kingdom, New Zealand, Australia and South Africa are well advanced in programs to convert to the metric system. Canada has declared a policy and is planning conversion. The United States Congress is considering enabling legislation. It looks as though there will be a race between Canada and the United States, the loser to have the dubious honor of being the last major country in the world to adopt the SI system of measurement. Canada can win this race, but only by serious and sustained effort by all involved.

In planning the change to metric products, sizes and quantities, one of the important factors is conversion of the measuring devices to read in metric units. This Report of the Task Force on Weights and Measures presents data which can be used by the various sector committees to include this factor in planning feasible schedules. To

sustain a conversion program over a number of years it probably will be necessary to increase the service technician force by about twenty five percent. Some device manufacturers have service training schools which can serve to augment the field force. Another source for skilled technicians is immigration. The United Kingdom and various European countries have excellent apprenticeship programs which turn out well trained men. Many service technicians now in Canada migrated after receiving training and valuable experience abroad.

The total cost of conversion in dollars may seem high, but it is only a fraction of a percent of the gross national product. It would have been a lot cheaper to convert before 1880. It will be a lot more expensive to convert in 2080. With proper planning by the various industries and diligent follow-up by the Metric Commission, it should be possible for Canada to be substantially metric by the end of 1980.

