

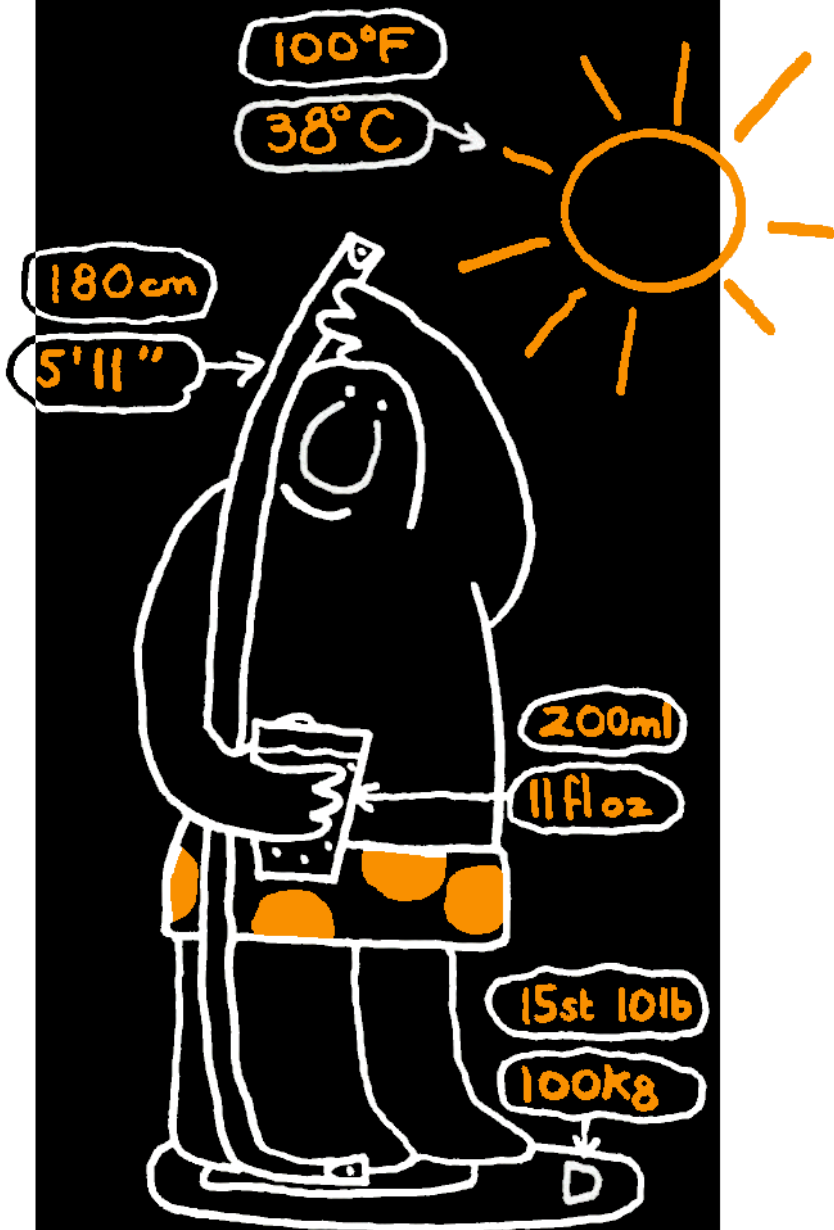


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Department of
INDUSTRY,
TECHNOLOGY
&
COMMERCE

METRICATION

IN AUSTRALIA



Department of Industry, Technology and Commerce

METRICATION IN AUSTRALIA

**A REVIEW OF THE EFFECTIVENESS
OF POLICIES AND PROCEDURES IN
AUSTRALIA'S CONVERSION TO
THE METRIC SYSTEM**

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- The text of the original copyright notice has been replaced by the Creative Commons licence and its associated icon, appearing at the top of this page.
- The table of contents has been expanded and altered to reflect the new page numbering, and references have been linked to the text.
- Minor changes in formatting have been made for clarity, and to eliminate a few instances of old-style “typewriter” typography.
- A few instances of inconsistent hyphenation and punctuation have been reconciled, when the meaning was unambiguous, and when this might facilitate text searching.
- A glossary of terms not explicitly defined in the text has been appended.

Extensive efforts have been made to make the text complete and accurate. However, some OCR errors may still remain. Inquiries and erratum notices may be directed to maven@thetricmaven.com.

FOREWORD

Metrication effectively began in Australia in 1966 with the successful conversion to decimal currency under the auspices of the Decimal Currency Board. The conversion of measurements — metrication — commenced subsequently in 1971 under the direction of the Metric Conversion Board and actively proceeded until the Board was disbanded in 1981. The process was a most significant event in Australia's integration with the modernising world.

This 1982 report documents this process and is a valuable historical record.

Many of the changes foreshadowed in this report have now taken place. The report is a fascinating account of this quite remarkable national project.

Metrication is still in its early stages in the USA which looks to Australia as an example and a model of how the process can be carried out. Because of the USA's strong cultural influence upon us, Australia's conversion can never be 100 per cent until that nation has also converted.

On reading this report one can't help being impressed by the magnitude of the task, by how much thought, planning and effort went into bringing it about, and by how many members of the general community participated in it. The change affected all Australians in both their private and professional lives and has been recognised as one of the great reforms of our time.

John D Bell
Deputy Secretary
Department of Industry,
Technology and Commerce

The author of this book, Kevin Joseph WILKS, B.Sc (Hons) Syd., was Senior Adviser to the Metric Conversion Board 1971–1981 and Board Secretary 1977–1981, and, following disbanding of the Board in 1981 was Director Metric Section, Department of Science and Technology until 1985. Before that he had extensive managerial and technical experience in a number of manufacturing industries.

Author's Note

In this text I have referred to both “soft” and “hard” conversions to metric. These can be defined as follows:

- Where a product is free-standing and its measurements do not need to match, or coordinate dimensionally with, the measurements of any other product, for example, a table, that product and the plant used to make it do not need to be changed, except for the documentation used to describe it. In such cases, all that is required is to give the product a metric name in sensible metric numbers, in which its measurement name appears to be neither more nor less accurate than its original, for example, a 5 × 3 (ft) table becomes a 1500 × 900 table, though it actually remains 1524 × 914 (mm). This is called a “soft”, or easy, conversion.
- Where a product is not free-standing, and its dimensions or measurements must interlock or coordinate with those of other products which have been changed for the purposes of metrication, for example, door sets or window sets, changes in the dimensions of the product in question and the plant used in its manufacture are unavoidable. Because of the greater difficulty and effort involved in doing so, this operation is described as a “hard” conversion.

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A REVIEW OF THE EFFECTIVENESS OF POLICIES AND PROCEDURES IN AUSTRALIA'S CONVERSION TO THE METRIC SYSTEM

1. INTRODUCTION

Since 1970, Australians have witnessed and participated in a very remarkable technological and cultural change. This is the transition from the long-established Imperial System of weights and measures to the International System (SI), the most recent and most highly developed of the metric systems.

The only previous experience Australians have had of a change like this was the adoption, in 1966, of decimal currency.

Unlike decimal currency conversion, which was limited to two units of currency, the dollar and the cent, and which was effectively completed in little over 12 months (although a considerable amount of planning occurred before that period), metric conversion has been an all pervading exercise which has affected literally every aspect of Australian life.

It has been an emotional experience for some, arousing sometimes anger, sometimes admiration and always some fear and trepidation about how the change might affect personal life.

Despite the potential for disruption to normal life, the change has been surprisingly trouble free in both private and commercial spheres. A small band of enthusiastic anti-metricationists gained very little support, and the vast majority of people adopted a fatalistic and unruffled attitude to the change. It seems that with patience, most people have coped very well with it.

The change was largely voluntary and no new legislation, other than the Metric Conversion Act, was introduced by State or Federal Governments to enforce metrication. In some cases where compulsion was necessary, metric units were substituted for imperial units in existing Acts and Regulations.

It was sometimes asked why the decision to go metric was not reached by referendum. This would have presupposed that people would have had a comparable knowledge of both the imperial and the metric systems and of the impact such a change might have. While metrication has certainly had a massive cultural impact on people in their lives as ordinary citizens it is, nevertheless, a predominantly technical change, affecting commerce, industry, engineering, science and education. For referendum purposes, relatively few people would have had sufficient knowledge of both systems to make an informed decision.

The decision to go metric was achieved through an open committee of inquiry, appointed by the Government, which collected evidence from any person who felt interested or competent enough to give it.

Although the Board and its committees worked meticulously over 11 years, it was natural that there would remain evidences of imperial usage and incomplete conversion long after metrication was officially declared complete. Nevertheless, an irreversible change has occurred and, as with decimal currency, the logic of the decision to convert has impressed itself on serious-minded people, and the desire to return to imperial units has largely disappeared.

The change was remarkable, not merely for what was achieved but also for the very special way in which it was achieved. With its broadly based committee structure, decision-making by consensus rather than majority rule, its support by a skilled professional secretariat, and with authority and responsibility for conversion vested in the persons who would be required to carry it out, the project was a model of how other national projects might be planned and effected.

This report is a review of metrication policies and procedures from their inception in 1966 when the need for a decimal system of measurement was becoming generally appreciated, to 1982, a year after the Board was disbanded and the project was deemed formally to be complete.

2. WHY AUSTRALIA DECIDED TO GO METRIC

The International System of Units, known by the initials 'SI', standing for the French *Le Systeme Internationale d'Unités*, is the metric system to which Australia has converted. It was developed as recently as 1960 and is the sixth in the evolution of the metric system first introduced in France as the legal system of measurement in 1840.

Unlike the first metric system, which was designed to overcome the deficiencies of such systems as the imperial system, and the incomplete metric systems which developed from the first as new knowledge became available, SI is the first total, all embracing system of measurement designed for general measurement, trade and commerce, science and technology and educational use.

Because of the uniqueness of its design, SI was the system to which, in 1982, all the world's countries, including the traditionally metric countries of Europe, had converted or were in process of conversion. Only Brunei, Burma, and the South Yemen Republic had not yet made a commitment to change. Such a world movement towards a single system of measurement has never happened before. It would hardly have been reasonable for Australia to have stood aside from the change.

Following the success of decimal currency in Australia in 1966, it was increasingly recognised that Australia would not achieve the maximum benefits of that change until it also had a decimal system of weights and measures. It was against this background that the government of the day chose to inquire into the practicability of conversion to

the metric system. An all party Senate Select Committee under the chairmanship of the late Senator K A Laught was set up and heard evidence throughout 1967–68.

Though opinions differed as to the mechanism by which this should occur, the unanimous view was that Australia should go metric as soon as possible. The benefits which it was expected would flow from the adoption of the metric system were:

- an increasing internationality of measurements used in Australia leading, in the near future, to the establishment of SI as the world’s single language of measurement, for which the benefits would be:
 - simplification of international trade and commerce
 - greater international standardisation and interchangeability of machines and equipment
 - easier exchange of scientific information and technology
 - increased applicability of international textbooks, teaching aids and other educational equipment
 - simplification of general measurement communication between countries in regard to travel, news and sporting exchanges.
- The metric system is demonstrably easier to teach, learn and remember than the imperial system because all conversion factors between multiples are either 1, 10, 100 or 1000, and the units for different physical quantities are logically related to each other.
- The metric system is demonstrably easier to use in day-to-day commercial and technical calculations because all measurements are already expressed in terms of a single multiple in decimal form.
- In the imperial system most measurements are expressed as mixtures of two or more units and unit fractions such as yards, feet, inches and fractions of an inch which must be converted to a decimal number in terms of any one of these before even the simplest calculation can be performed e.g.

1 yd 2 ft 3½ in	=	5.29 ft
5 ft 3½ in	=	5.29 ft
2 lb 4½ oz	=	2.28 lb
1 ton 2 cwt 3 qt 4 lb	=	1.139 tons
2 gal 3 qt 1½ pint	=	23.5 pints
1 acre 2 roods 32½ perches	=	1.703 acres

- Because SI is an all embracing, conceptually accurate (which most other systems were not) system of units in which the unit of every physical quantity is derived from one or more of seven base units, and the meaning and definition of each physical quantity is explicit in the SI unit symbol, this

system forms the basis for a very significant improvement in the techniques of teaching physics, engineering and related sciences. Australia could not have afforded to have denied itself this opportunity.

It has sometimes been suggested that Australia could have stood aside from this world movement towards adoption of the metric system which, of course, she could have done. In that case it would be increasingly necessary to live with the irritations of endless conversion associated with international communications, trade and new technology and some of the major problems would be:

- Exports would have to be increasingly repriced and repackaged for sale to metric countries.
- Imports would be increasingly from metric countries and would have to be repriced and repackaged or overprinted in imperial for use in Australia where metric designations would be meaningless.
- Repair and maintenance of imported equipment, cars etc., would become increasingly difficult, requiring special tools and special trade training.
- Manuals and instructions related to imported equipment would have to be converted for use by tradesmen, technical colleges etc. or employees retrained to use them.
- News items from overseas would tend to be less meaningful as also would be Australian news sent abroad.
- People travelling or working abroad would need to obtain a working knowledge of the metric system.
- Children being taught science at school and university would need to be taught the metric system to cope with overseas developments and technology. For much science there are no imperial units and teaching of electrical science would not be possible in imperial.
- Textbooks from overseas would generally be less useful than they are now because they would be in the wrong units.
- Craft books from overseas would have little application here because they would not relate to Australian measurements and materials.

3. THE STAGE REACHED IN CONVERSION (IN 1982)

Between 1971 and 1982, industry after industry conformed to metric and with the leadership of the Board practically every industrial product and process was converted to metric. Many were “hard”-converted to dimensions more appropriate to the metric era but many were “soft”-converted simply by being described in metric terms. The origin and meaning of these terms is explained on page 26.

Throughout Australia, in the stores and supermarkets, all goods sold by weight or measure, such as foodstuffs, textiles and furnishings, floor coverings, building materials and hardware, were sold in metric quantities only by 1982. Weights and measures regulations in the States were amended to make it mandatory to use metric measurements only for these goods and all weighing and measuring devices used for trade were metric.

Also by 1982, all packaged goods produced in Australia were packed in standardised metric quantities and, except for imports, quantities like 454 g, 568 mL, and their multiples, had all but disappeared. Imported packaged goods were required to show a metric statement of quantity although the original non-metric statement could be retained.

Although it was not mandatory to do so, many major retailers insisted that goods which they sold which were described by measurement, as distinct from sold by measurement, be labelled and advertised in metric only and this effectively converted all goods described by measurement. Clothing and electrical appliances and furniture by this time were predominantly metric.

On the roads, all distance and speed signs, traffic regulations, touring information and maps were metric, all new cars since 1974 had kilometre speedometers and odometers, fuel and oil capacities in litres and claimed fuel consumption was in litres per 100 kilometres.

Freight, postage and telegraphic charges had been converted to metric as had been fares and travelling allowances. Aeronautical maps and altimeters still showed heights in feet. This was not expected to change until a new generation of metrically instrumented civil aircraft appeared. Nautical miles and knots were still being used for air and ocean navigation and, as units of angle rather than linear distance, it was likely these would remain indefinitely. All weather reporting was in metric except that the old metric unit, the millibar, had not yet been replaced by the kilopascal. Only when temperature and rainfall reached extremes recognisable in old units was reference made to °F and inches.

Most sporting rules had been converted, usually without change in actual dimensions, and sporting commentators regularly described play in metric.

Journalists, reporters and commentators on newspapers, radio and television used metric predominantly in news reports and documentaries.

Conditions of employment and rates of pay in industrial awards were largely in metric units.

Pharmaceuticals had been sold in metric quantities since 1965 and, by 1982, all health and medical services were substantially metric, although baby birth weights are commonly given in both measurements. Dietary foods were increasingly rated in kilojoules instead of kilocalories of the old metric system.

Building regulations in all States had been metric for many years. All plans and specifications, development applications, building materials and promotional literature for project homes were metric, although a few project builders, selling principally to retired people, saw some advantage in giving imperial equivalents.

SI was being taught in all schools, colleges and universities and textbooks produced in Australia were written in metric. An increasing number of imported textbooks were also in SI units. Most, but not all trade courses were taught in metric and apprentice training in metric had been so complete that several companies operating and maintaining imperial plant and equipment had requested some reverse training in imperial so that apprentices entering the industry would be able to work from original drawings and specifications.

Existing Acts of Parliament and Regulations in which measurements were significant had been largely converted and conversion was continuing.

By 1982, the use of metres and square metres to describe house and land sizes was reasonably well established, although the continued appearance of metric measurements with an unwarranted number of decimal places was a clear indication that the user was still thinking in imperial and had not yet gained a practical appreciation of sizes in metric. Most people had few opportunities to learn, by experience, the metric units used in real estate. Therefore conversion of this industry, without the support of legislation, was necessarily slower than many others. It was expected to be several years before the square metre and the hectare replaced the square of 100 square feet and the acre as the index of house and land sizes.

Regardless of the degree of conversion, it has always been recognised that, long after the metric conversion program had officially ceased, there would be imperial plant and equipment such as ships, aircraft, trains, vehicles, major industrial plant, defence equipment etc., which it would be impractical to convert. It would be necessary to operate and maintain this plant and equipment in imperial for the remainder of its working life. It was also recognised that new plant and equipment would continue to be imported in imperial designs until such time as metrication had occurred in its country of origin.

With regard to conversion of the ordinary citizen, away from his profession or place of employment, this was, in 1982, understandably far from complete.

Metrication, while predominantly a technical change, is also a major cultural change affecting the skills and habits of a lifetime and obviously no attempt was ever intended or made to convert the past knowledge and past experiences of individuals to metric. From this point of view, it was no more likely that people should suddenly forget about feet and inches than a person from another country, on coming to Australia, should suddenly forget the language and customs of the land of his birth.

Public education was directed at teaching people the *11 little words* which would make up their metric vocabulary and at encouraging them to develop new mental

images of some five or ten familiar objects in metric numbers which would serve as benchmarks for metric sizes.

The learning and use of conversion factors was strongly discouraged because it required people to have a good memory for figures and be good at mental arithmetic. Further, continued use of conversion factors kept that person firmly tied to imperial benchmarks and effectively prevented the establishment of similar benchmarks in metric numbers.

The support of the media was exceptional and, undoubtedly, a key element in the success of metrication but it was disappointing to find individual journalists sometimes trying to use a person's inability to do rapid in-the-head conversions to demonstrate the failure of metrication.

By 1982, as a result of the support and cooperation of the many sectors of Australian life, the metric system was established as the predominant language of measurement in this country. With the passage of time it would, almost certainly, become the only system of measurement in use.

4. BACKGROUND TO THE CHANGE

Before Federation, weights and measures and the units of measurement which could legally be used for trade were controlled by the States. In general, the only quantities involved were weight, length, volumetric capacity and, occasionally, area. Other quantities of considerable technical significance but of little direct concern to trade, such as density, pressure, electrical voltages, and temperature, had no legally defined units.

Under the Constitution of the Commonwealth of Australia, the Australian Government is empowered to make laws with respect to weights and measures but it was not until 1948 that the Weights and Measures (National Standards) Act was passed. The objectives of this Act were to provide for the establishment and use, throughout Australia, of uniform units and uniform standards of measurement of physical quantities.

The Act provided that the regulations could prescribe the units which would be the only legal units of any physical quantity.

This Act was amended and extended in 1960 and the current (1982) Weights and Measures (National Standards) Regulations cover a much wider range of physical quantities than those previously covered by the States' weights and measures laws.

The Commonwealth legal units contained in the Regulations include a full range of both imperial and metric units and, in fact, the imperial units are defined directly in terms of metric units.

Although metric units were listed as Commonwealth legal units, metric units were not permitted for use in trade in the States and, indeed, prior to the commencement of

metrication it would have been impractical to do so. The States first made metric units permissible for pharmaceutical purposes in 1963 and for general trading activities in 1967. From 1975, when weighing instruments in use for trade became predominantly metric, the States, individually, amended their regulations to permit sole metric trading only.

In the schools and universities, while the imperial system continued to be taught for trade and general measurement purposes, the deficiencies of this system for scientific and technical work had already been recognised and as far back as 1879 the so called British absolute system of units had been developed. This system adopted the poundal as the unit of force to replace the gravitational pound weight. The British absolute system, the foot–poundal–second system was coherent over the range of mechanical units but it had already been superseded by the more comprehensive and equally coherent metric CGS (Centimetre–Gram–Second) system which was adopted by the British Association for the Advancement of Science in 1873. This system included compatible electromagnetic and electrostatic units. Although it was subsequently shown that practical electrical units such as the volt, ampere and ohm could be used with this system, except for its general use in the teaching of physics and chemistry, no serious attempt was ever made to adapt the CGS system for general use in Australia.

Other countries did continue to adapt this system for practical use. In France the MTS (metre–tonne–second) system was used from 1919 to 1961. Another variant, the MKS (Metre–Kilogram–Second) was also used in Europe. The MKfS (Metre–Kilogram force–Second) or Technical Metric System was widely adopted in Europe for industrial and engineering use and, in 1982, is only slowly giving way to SI. The MKfS is a gravitational system of limited applicability and suffers from the same disadvantages as the imperial gravitational system.

An improved practical system known as the MKSA (Metre–Kilogram–Second–Ampere), adopted in 1950, combined mechanical and electrical units in a coherent system.

In MKSA, the possibility of constructing a single coherent system of measurement of all physical quantities was recognised. It was this which caused CGPM (General Conference on Weights and Measures) to seek the development of such a system. Thus, in 1960, with the addition of a further three base units, the kelvin, the candela and the mole, the world's first comprehensive, coherent, practical system of measurement, *Le Systeme Internationale d'Unités*, SI, the International System was developed.

The practical, technological and educational consequences of the new system were immediately recognised around the world and an almost spontaneous world movement towards the adoption of SI resulted. In the 21 years to 1982, all those countries which were not already metric, with the exception of Brunei, Burma and South Yemen, had converted to SI or had committed themselves to the change. The traditionally metric

countries of Europe, also, were in process of adopting SI and the EEC Council had indicated final dates for the use of certain non-SI units in member countries.

In Australia, metric units had been used in the teaching of science and in research and development in the chemical industry for years, but processes and formulae used in production had usually been converted to imperial.

In 1965 the Australian Pharmaceutical industry converted to metric.

In the schools students were taught to memorise, largely by rote, the relationships between inches, feet, yards, chains, furlongs, miles, ounces, pounds, stones, quarters, hundredweights and tons etc. because there was no consistent way of determining these from first principles.

Computation of lengths, areas and volumes in the imperial system was difficult because imperial dimensions in multiple units e.g. feet and inches, pounds and ounces, gallons and pints, acres, roods and perches, for example, had to be converted to a decimal number in a single unit before it could be used in calculations.

The change to CGS metric in the school science curriculum helped simplify measurement but the inconsistency between the unit and the definition of some physical quantities left much to be desired. For example, the mass–weight problem existed because the same unit and the same numerical value was used for both. Pressure was defined as force per area but the units were pounds per square inch, kilogram per square centimetre, in which pressure was apparently measured in mass units, or millimetres of mercury, in which pressure was measured in length units. Work and energy were said to be related but were measured in different units for mechanical and thermal energy. Prior to SI, the older metric systems and the imperial system contained numerous conceptual inaccuracies of this kind which were generally ignored in the teaching of sciences. Thus, while students were given the benefit of a decimal system of measurement, the system they were using was not always in accordance with the definitions of the physical quantities concerned.

Against this background, Australia decided, in 1966, to convert to a decimal system of currency.

There can be little doubt that the unqualified success of this national project was a determining factor in Australia's decision to convert to a decimal system of weights and measures.

Again, at that time, the growth in the use of electronic calculators by ordinary people was accelerating and these were more appropriate to a decimal metric system than a system based on fractions as is the imperial system.

The context, therefore, in which, in 1967, the Government decided to appoint a committee to look into the practicability of an early change to the metric system was that:

- a highly sophisticated yet simple and practical system of measurement, SI, had recently come into existence.
- a vigorous world movement to adopt SI was already in progress.
- the shortcomings of Australia's traditional system of weights and measures were rapidly becoming apparent.
- Australia's ability to plan and implement a change as far reaching as metrication would be, had already been proven by the success of the decimal currency conversion.

In April 1967, therefore, the Government appointed an all party Senate Select Committee on the Metric System of Weights and Measures with the following terms of reference:

1. That a Select Committee of the Senate be appointed to inquire into and determine the practicability of the early adoption by Australia of the Metric System of Weights and Measures, and to recommend such legislation and regulations and the amendments to existing legislation and regulations which, in the opinion of the Committee, ought to be effected.
2. That the Committee consist of Senators to be appointed pursuant to a subsequent resolution.
3. That the Committee have power to send for persons, papers and records, to move from place to place, to sit in open court or in private, and have leave to report from time to time its proceedings and the evidence taken and such interim recommendations as it may deem fit.
4. That the Committee have power to sit during any adjournment or recess of the Parliament.
5. That the Committee report to the Senate on or before 30 June 1968.

and constituted as follows:

1. That the Select Committee on the Metric System of Weights and Measures consist of eight Senators, four to be appointed by the Leader of the Government in the Senate, three to be appointed by the Leader of the Opposition in the Senate and one to be appointed by the Leader of the Australian Democratic Labor Party in the Senate.
2. That the Committee elect as Chairman one of the Members appointed by the Leader of the Government in the Senate.

Following their appointment to the Committee, in April 1967, two of the original appointees, Senator E W Prowse and Senator M F Breen OBE retired in May 1967 and

October 1967 respectively. Their places were taken by Senator Sir Walter Cooper MBE and Senator J P Sim.

The full committee consisted of Senators A M Benn, Sir Walter Cooper MBE, A J Drury, K A Laught, J E Marriott, F P McManus, A G Poyser and J P Sim. Senator Laught acted as Chairman and Senator Marriott as Deputy Chairman.

Mr A F A Harper MSc, F Inst P, FAIP, Senior Principal Research Scientist, CSIRO, was appointed Technical Consultant to the Committee. During his absence overseas, Mr T G Poppy BSc, OBE, acted as Technical Consultant.

Mr Harper was a member of the research staff of the National Standards Commission from 1940 to 1970 and Secretary of the Commission from 1965 to 1970. He was also Australia's representative on the International Organisation for Legal Metrology which specialises in the establishment and maintenance of standards of weights and measures.

Between 20 April 1967 and 22 May 1968, the Committee held meetings in all capital cities, which included 28 Public Hearings and 39 deliberative sessions. The Committee also had informal discussions with four organisations, and a delegation visited the Territory of Papua and New Guinea.

Evidence was heard from 141 witnesses and, in addition written submissions were received from 54 persons or organisations. Supplementary submissions were received from seven witnesses who had previously given oral evidence.

Following a full inquiry and a thorough examination of the evidence and other matter placed before it the Committee was of the unanimous opinion that it would be practicable and desirable for Australia to adopt the metric system of weights and measures at an early date and recommended accordingly.

The main considerations which lead the Committee to this conclusion were that:

- Submissions to the Committee from individual citizens, Commonwealth Ministers and Departments, State Governments and Departments, Commonwealth and State instrumentalities, and organisations, overwhelmingly supported an early change to the sole use of the metric system and clearly indicated that there would be no insuperable difficulties in effecting such a change.
- The metric system was already used by a large majority of countries of the world, representing about 90 per cent of the world's population and its use was extending further.
- The United Kingdom was actively converting to the metric system and expected to be predominantly metric by 1975.
- Approximately 75 per cent of world trade was being carried on in metric measurements.

- Already 70 per cent of Australia's export trade was to metric countries or to countries converting to the metric system and this proportion could be expected to increase as the nation's trade with South-East Asia grew. Some countries, including Japan, had made the use of the metric system mandatory for some of their import trade.
- Almost without exception, education authorities favoured the early adoption of the metric system on the grounds that this would simplify and unify the teaching of mathematics and science, reduce errors, save teaching time and lead to a better understanding of basic mathematical principles.
- A cost advantage could be expected in the purchase of imported materials from the broadening metric system market, rather than from the shrinking market using the imperial system.
- Because of its inherent advantages over the imperial system of weights and measures, particularly its decimal nature and the simple relationships between its units, all operations involving weights and measures would be greatly facilitated with, in many cases, a substantial increase in efficiency.
- The advantages of the metric system, referred to in the previous paragraph, were most evident in the system known as the International System of Units (SI) which is the internationally preferred system.
- The full advantages of decimal currency would not be experienced until decimal weights and measures were also used.
- The adoption of the metric system was widely accepted as a natural consequence of the currency conversion.
- The use of decimal fractions of imperial units, while giving some advantages in restricted applications, was not an adequate substitute for the adoption of the metric system because of lack of universal recognition and would lead only to proliferation of imperial units.
- Industrial standard specifications played an important part as a basis for industrial purchases. The standards of the International Standardisation Organisation, the International Electro-Technical Committee and the British Standards Institution were being increasingly expressed in metric units, so that a local manufacturer, hoping for overseas orders, must be prepared to work in both metric and imperial units, at the cost of efficiency.
- The adoption of a different system of weights and measures would provide an opportunity to rationalise industrial practices and to reduce the varieties of sizes of materials and components.
- The metric system had already been successfully adopted within Australia in many fields of activity without difficulty and with considerable satisfaction to its users.

- Australia had, at the time, a very large body of people who had experience of the metric system before coming to this country and who could greatly assist the dissemination of knowledge about the system and the building up of a confidence in its use.
- Although no meaningful estimate could be made of the cost and benefits which would result from the adoption of the metric system, the Committee was satisfied that the ultimate benefits would greatly exceed the costs of the conversion. The actual conversion costs could be considerably reduced by careful planning.
- Almost every witness expressed the view that the ultimate adoption of the metric system by Australia was inevitable. As it was also generally accepted that the cost of conversion was increasing substantially each year, it followed logically that conversion should be commenced with the minimum delay.

The Committee Report also gave detailed recommendations for the creation of legislation to provide for conversion to the metric system and for administration of the change.

Subsequently, in January 1970, the Prime Minister, the Right Honourable J G Gorton, announced the decision to change. On 12 June 1970, the Metric Conversion Act 1970 was given assent.

5. ORGANISATION FOR CHANGE

The Metric Conversion Act 1970 adhered closely to the recommendations of the Senate Select Committee. The Act defined the Metric System as meaning:

- (a) the units comprised in the International System of Units for the time being approved by the General Conference on Weights and Measures;
- (b) units decimally related to those units and for the time being so approved; and
- (c) such other units as the Minister declares, from time to time, by notice published in the Gazette, to be within the metric system.

Clause 5 of the Act stated that:

The object of this Act is to bring about progressively the use of the metric system of measurement in Australia as the sole system of measurement of physical quantities.

The Act also established the Metric Conversion Board which should consist of a full-time Chairman, an Executive Member, a Deputy Chairman and such number of other members as the Governor-General from time to time determines.

The Act gave the Board powers to engage persons to advise the Board on matters related to its functions. The Board exercised these powers by establishing a full-time professional Secretariat and by inviting people from industry and commerce to assist on its industry committees.

The tasks and responsibilities of the Board and the means by which conversion would be achieved were detailed in the Second Reading Speech on the Metric Conversion Bill by the Hon. N H Bowen QC, MP to the Parliament on 19 March 1970. This Speech was important in providing guidelines to the Board.

At the first meeting of the Board, in July 1970, Mr Bowen, as Minister for Science and Education, in accordance with powers given to him under the Act, formally and in writing delegated certain powers and functions to the Metric Conversion Board as follows:

**DELEGATION OF THE POWERS AND FUNCTIONS OF THE
MINISTER OF STATE FOR EDUCATION AND SCIENCE**

In the exercise of the powers conferred on me by section 7 of the Metric Conversion Act 1970, I, Nigel Bowen, the Minister of State for Education and Science of the Commonwealth of Australia, hereby authorise the Metric Conversion Board to exercise the following powers and functions:

- (a) To plan, guide and facilitate conversion to the use of the metric system of weights and measures within the Commonwealth with the aim that this should be effectively completed by the end of 1979;*
- (b) to prepare an overall program for conversion;*
- (c) on the basis of full and detailed consultation with interested parties, to facilitate the coordination and implementation of programs for conversion in individual sectors of the community;*
- (d) to ensure as far as possible that the programs for conversion in different sectors are coordinated and priorities are allotted on the basis that:
 - (i) optimum use is made of natural obsolescence and depreciation in the value of plant, equipment and the like to reduce conversion costs; and*
 - (ii) conversion as a whole is effected to the best advantage of the community.**
- (e) to set up, as appropriate, committees responsible to the Board to report on specific aspects of conversion;*
- (f) where authorised by the Minister, to enter into contracts with other bodies for specified activities related to conversion;*
- (g) to disseminate and make available appropriate information and advice in relation to conversion;*

- (h) to collect and analyse data relevant to conversion;*
- (i) to keep under review and report to the appropriate authorities any attempts to take unfair advantage of the public in the course of conversion;*
- (j) bearing in mind the Government's decision that the costs of conversion will in general be borne by those incurring them, to investigate and report to the Minister on any special circumstances in which the Board considers the payment of compensation may be appropriate and on the basis on which such payment could be made;*
- (k) to advise on the need for legislation to give effect to conversion; and*
- (l) to furnish to the Minister such reports relating to its operation as the Minister requires and report annually to the Minister on the performance of its duties.*

These powers and functions have been re-endorsed by all Ministers who have had responsibility for metric conversion.

Through the Second Reading Speech and through the powers and functions vested in the Board, and their re-endorsement by subsequent Ministers, it has always been clear that the Government intended that metrication should be achieved by consultative procedures and by detailed discussion with the industries and parties concerned. For this purpose the Board assembled a total of 160 committees, subcommittees and panels to analyse the problems likely to be encountered in various industries or activities and to plan a coordinated program for their conversion.

Early in the program the term "voluntary conversion" began to be used in this context, yet clearly, the Metric Conversion Act would be law for all Australians and the stated objects of this Act were that, progressively, all Australians would change to the sole use of the metric system.

The term "voluntary" was, therefore, taken to mean that, through industry-appointed sector committees, each industry would have both the right and the responsibility to plan and implement conversion in its own way and to its own schedule. At no stage would any industry or group be asked to implement a program designed other than by fullest consultation and voluntary cooperation with the Board.

In addition, the term "voluntary" meant that the Metric Conversion Act 1970 contained no penal clauses and that no new legislation would be enacted specifically to enforce metrication. Instead, the force of law would be achieved by amendment of existing State or Federal legislation to incorporate metric measurements whenever the measurements to be used in particular activities are specifically indicated.

Australian industry, government and other activities were analysed into 11 broad groups by type according to the Industrial Classifications Index of the Department of Customs to ensure that no industry or group was overlooked in metrication planning. These groupings were:

- Education and Industrial Training
- Primary Industry
- Consumer Goods and Service Industries
- Engineering Industry
- Building and Construction
- Industrial Materials
- Science and Technology
- Transport and Communications
- Land, Fuel, Power and Public Services
- Health and Recreation
- Public Relations

These 11 major groupings were, for metrication planning purposes, led and advised by an Advisory Committee of approximately 12 members, the Chairman of which was also a Board member.

Within the ambit of each advisory committee, conversion of specific industries, organisations or major companies was planned by an industry Sector Committee which programmed and coordinated metrication in its own industry.

On the rare occasion when a particular activity seemed to have been overlooked, or when a particular interest appeared to warrant closer investigation for report back to the Sector Committee, smaller subcommittees and panels were also formed.

The members of all committees were nominated by the industry, the industry association or by major companies, not as representatives without authority, but as experts in their own industry with sufficient executive standing to make personal decisions affecting their own industry without the need to seek prior approval for that decision from any other body.

This technique ensured a high level of competence of the decision makers, decisiveness in making the decisions, executive responsibility and strong leadership of other companies in the industry in implementing the decision.

Each Sector Committee set out to anticipate problems which might arise in metrication and to devise solutions to them. They produced a bar-chart program where there were several important elements to coordinate or simply agreed upon an industry M-Day where a less complex change was required.

The bar-chart method of programming with very flexible target dates was preferred to the seemingly more exact, but less flexible, Critical Path techniques as adopted in Canada. However, in hindsight, some applications of this technique would have been helpful in anticipating changes requiring long lead times. Critical Path planning in individual companies may well have been appropriate but the Board took the view that, provided the industry was moving forward as a whole, and since the complexity of planning varied with the size of the company, a loose target date would be more conducive to it being achieved than a rigid date in which companies would be frustrated by matters outside their control.

These bar-charts programs attempted to coordinate both suppliers of raw materials and end-users of an industry product in an industry's change.

As soon as a tentative program had been determined it was published in the media, the industry association's journal or trade press and in the MCB Newsletter. In the case of major changes, such as the time table for the building industry, road changes, postal changes and others, the changes were announced in Parliament. Provided there were no unresolved objections to that program, and there were very few, it became the accepted program for the industry.

By this method, a pyramidal organisation was established connecting individual companies, through their associations, with their Sector Committee, their Sector Committee with the Advisory Committee and their Advisory Committee with the Board, with two-way consultations on all matters. No industry was obliged to accept a program of conversion in which it did not have full say or which was devised by a body other than the industry Sector Committee or sub-committee.

To this degree, metrication of Australian industry would have been one of the most democratically executed national projects ever undertaken.

To support the committees and their individual members, the Board established a technical Secretariat consisting of engineers and scientists from industry or government service. At any one time there was a total of 10 to 12, supported by a maximum of 25 other staff. The fact that scientists and engineers were employed in the Secretariat was not intended to mean that understanding metric was so complex as to require professionally trained people. However, it was essential that members of this Secretariat, which acted not merely as minute secretaries to the committee but were full members of the committee on which they served, had the confidence, and respect and cooperation of the industries they would assist to convert. For this reason, it was essential that these officers had the expertise, the prestige and the presence to operate effectively in a wide variety of technical environments and the persons appointed acquitted themselves well in these tasks.

6. POLICIES ADOPTED BY THE BOARD

In addition to the clear guidelines set for the Board in the Second Reading Speech, and the powers and functions delegated to it by the Minister at the first meeting, the Board established for itself a number of other parameters within which it believed it should work.

To assist in the creation of these policies, the decision was made to see what could be drawn from the experiences of other countries already metric or in process of conversion. Accordingly the Chairman, Mr J D Norgard, and the Executive Member of the Board, Mr A F A Harper, made an overseas tour in August–September 1970 visiting Japan (recently converted), the United Kingdom, South Africa, South East African Community and New Zealand (in process of conversion), Canada (conversion intentions announced), and the United States of America where metrication was being considered. These visits revealed that in countries or sectors where conversion was completed or well advanced, the benefits had quickly become apparent and the problems had proved much less than expected.

An analysis of the task concluded that Australia would have been metricated when all public measurement related activities in the nation's material environment, which could otherwise inhibit or frustrate a change to working in metric or cause people to continually revert to imperial, had been converted.

This meant that, as far as practicable, conversion should be substantially completed in the following areas:

- the products, services, plant and processes of primary, secondary and service industries
- industrial awards and conditions
- governmental operations
- legislation, regulations, codes
- standards
- education
- health services
- sports and recreation
- media reporting.

Necessarily, a number of areas must remain incompletely converted in the finite time of ten years allocated to the Board to substantially complete its tasks. These would include:

The operation and maintenance of existing imperial plant which it would be unnecessarily costly or excessively laborious to convert, for example aircraft, ships, trains, vehicles, major industrial plant, and plant and equipment still

being imported into Australia from imperial countries which have not yet converted.

On this basis, the Board concluded that metrication would be essentially a technical exercise and that people would best learn metric in their places of work or by adaptation to the changing material environment. For this reason it was decided at the outset that the Board should limit public education to learning those metric units they would need to know in their jobs and professions.

While the decision to go metric was well founded, it was thought that the reasons would be difficult to explain to non-technical people and that attempts to do so could lead to unnecessary emotional argument and polarisation of attitudes. This was the basis on which the Board decided to try to maintain a low-key, low-publicity public image and to concentrate on public education by involvement in day-to-day transactions in metric units rather than by more formal methods.

Unfortunately, because of the need to confront people with amended legislation which would require them to use metric only, or with import prohibitions against certain types of non-metric measuring devices, or newspaper cut-offs for non-metric real estate advertisements, the decision to maintain a low profile and avoid undue public disputation seemed naive. Though metrication was truly a largely technical exercise and little opposition might have been expected from technical people, it was also a very significant cultural change affecting most people in their lives as ordinary citizens. It was from this area that opposition should have been expected and did come.

It was recognised that in the process of learning metric by involvement in normal transactions in which metric units were used, dual marking would hinder, rather than assist, because the continued presence of the imperial unit would make it possible for the user to participate in the transaction without working in metric. In the British conversion, daily weather temperatures were given on television in both °F and °C but a survey after years of exposure revealed that most people had totally ignored the metric. It was therefore agreed that the Board should strongly oppose the use of dual measurements where these were used for the purposes of public education.

Again, in accordance with its policy that public education should be through learning by experience with metrics in daily life, it was agreed that conversion should take place in all directions simultaneously rather than be concentrated on a particular activity until completion. Thus conversion in the retail area, industry, government, weather reporting and sports commentaries began more or less at the same time. In this regard, Australia would appear to have profited from the UK experience in which penetration in depth occurred in industry without significant attempt at the involvement of ordinary people.

7. THE METRIC SYSTEM

The metric system adopted by Australia, *Le Systeme Internationale d'Unités* (SI) or the International System of Units, is the metric system to which all the countries of the world have converted or are in process of adopting.

SI is a comprehensive and practical system of units of measurement of all physical quantities for technical, scientific and general use. The unit of measurement of every physical quantity is derived from, and described in terms of, one or more base units. The seven base units are the metre (m), kilogram (kg), second (s), ampere (A), kelvin (K), candela (cd) and mole (mol). More convenient larger or smaller multiples of these units are obtained by combining the unit with an appropriate prefix selected from a specified series.

The various units of measurement may be used alone or combined with a prefix to form a unit multiple of more convenient magnitude, e.g. kilo is combined with metre to form kilometre.

Physical Quantity	Unit
length	metre (m)
area	square metre (m ²)
volume	cubic metre (m ³)
volume	litre (L) (non-SI unit)
mass	gram (g)
mass	tonne (t) (non-SI unit)
density	kilogram per cubic metre (kg/m ³)
time	second (s)
velocity	metre per second (m/s)
acceleration	metre per second squared (m/s ²)
temperature	kelvin (K)
force	newton (N)
pressure	pascal (Pa)
energy	joule (J)
power	watt (W)
potential difference	volt (V)
resistance	ohm (Ω)
electric current	ampere (A)
frequency	hertz (Hz)
chemical substance	mole (mol)
plane angle	radian (rad)

Prefix	Factor
atto (a)	10^{-18}
femto (f)	10^{-15}
pico (p)	10^{-12}
nano (n)	10^{-9}
micro (μ)	10^{-6}
milli (m)	10^{-3}
kilo (k)	10^3
mega (M)	10^6
giga (G)	10^9
tera (T)	10^{12}
peta (P)	10^{15}
exa (E)	10^{18}

A number of so-called Non-SI Units have been retained because of their practical importance or their use in specialised fields.

Unit	Definition	Value
minute (min)	1 min = 60 s	60 s
hour (h)		3600 s
tonne (t)	1 t = 1 megagram (Mg)	1000 kg
litre (L)	1 L = 1 cubic decimetre (dm ³)	0.001 m ³
hectare (ha)		10 000 m ²
millibar (mb) (meteorology only)		100 Pa
degree Celsius (°C)	°C = K – 273.15	
international nautical mile (n mile)	1 n mile = 1.852 km	1852 m
knot (kn)	1 kn = 1 n mile/h	1.852 km/h
kilowatt hour (kW.h) (electrical energy accounting)		3.60 MJ
degree of plane angle (...°)	1° = $\pi/180$ rad	0.017 45 rad

Of these, the minute and the hour, like all others except the knot and the nautical mile, are metric units but are considered to be non-SI units because they are non-decimal multiples of the second. The kilowatt hour is also a non-decimal multiple but as it consists of an energy flow of 1000 joules per second for 3600 seconds it should more properly be replaced by the joule. However, as the rating of many electrical appliances was in watts it was convenient to retain the kilowatt hour for electrical energy accounting commercially.

The tonne, litre, hectare, millibar, and degree Celsius are special names for special multiples of SI units and hence are not themselves SI units. The prefix hecto, meaning 100 times, was rarely used and was limited to hectolitre, used for wines, and in the determination of grain quality (kg/hL) and in hectare, meaning 100 ares of 100 m². The are has no particular use value and is not used in Australia.

The millibar is one thousandth of a bar which was defined in the CGS system as 10⁶ dynes per square centimetre. The bar and the millibar are not part of SI but the millibar was retained temporarily because a great deal of meteorological and navigational equipment was calibrated in this unit.

The nautical mile and the knot were likewise retained for the time being because of their obvious importance in air and sea navigation.

As the nautical mile and the knot are actually measures of the angular distance between places on a spherical surface, it is likely these could be redefined in angular terms, that is, a nautical mile is a second of arc and a knot is a second of arc per hour, and these units could then be retained for use with SI indefinitely.

One of the unique features of SI is that the symbol for every physical quantity can be, and usually is, derived and written in terms of the symbols of one or more of the seven base units or in terms of derived units which have been given special names and symbols.

The importance of this system of symbols is that each unit may be related algebraically to one or more of the seven base units and hence to other units. For this reason, SI rules for the writing of symbols are very strict, and improper use of capitals, dots, spaces and plural 's' is strongly discouraged. The inclusion of a plural 's' in a symbol can sometimes be interpreted as the symbol 's' for second and give the derived symbol a different meaning. Likewise the use of capital 'K' in the symbol for kilogram could lead a student to misinterpret the symbol. More importantly, it would indicate that the person using it did not understand the system and may not be able to derive maximum benefit from using it.

The rationalised spelling "gram" was adopted in preference to the old British spelling "gramme" which was originally adopted to avoid confusion with the unit "grain" which was still in use when metric units were incorporated in the British system. Again, the original spellings metre and litre have been retained. 'Metre' could be confused with 'meter', the one being a unit of measurement and the other a measuring instrument.

Over the years there has been much debate about the use of ‘litre’. Purists in some countries have endeavoured to avoid the litre as an inaccurate quantity, a view which has hung over from the days when the litre was defined as the volume of a kilogram of water at stated conditions of temperature and pressure. The litre is no longer defined that way. Its definition was changed in 1964 to be the special name for one cubic decimetre.

The Board’s view has been that as no SI multiple exists between the cubic centimetre and the cubic metre and no SI multiple exists between the cubic metre and the cubic kilometre, which is 1000 million cubic metres, both gaps can be filled ideally with the litre and its decimal multiples. The litre is, therefore, the preferred volume unit for all except formal calculations where the cubic metre must be used. In addition correct use of the cubic metre colloquially is very cumbersome relative to the litre. For example, a 423 L refrigerator (a four-twenty-three-litre fridge) is easier to say than a 0.423 m³ refrigerator (a nought-point-four-two-three-cubic-metre fridge).

In the days before the litre had achieved full unit status, attempts were made to designate the litre for fluid volumes or capacities only, with the cubic metre being used for rigid spaces, but this created an artificial distinction which SI had been designed to avoid. The litre is, therefore, a proper volume unit for all applications.

During the early stages of metrication, because of the use of lower case ‘l’ as the common symbol for that letter and the number one, attempts were made to get typewriter manufacturers to install a script or italic ‘l’ as the symbol for litre. These were not successful, and when the USA, in metrication pre-planning, opted for the capital ‘L’ as the symbol for litre and corresponded with CGPM on the matter, Australia decided to adopt that symbol without waiting for the final decision on the subject. In 1982, the situation was that CGPM had elected to retain both symbols for the time being with a view to selecting a single symbol after sufficient time had elapsed for a preference to become evident.

Adoption of a capital letter symbol for litre would appear to be a departure from one of the rules of SI that only symbols derived from proper names, for example, newton (N), pascal (Pa), joule (J), watt (W) would be capital letters. Many humorous efforts have been made to overcome this “difficulty” but, in all fairness the honour would appear to belong to A L Lavoisier who was attempting to determine with accuracy the mass of a cubic decimetre of water when his researches were abruptly terminated by his death on the guillotine.

Although the SI unit of temperature is the kelvin (K), the name Celsius was adopted by CGPM as the commonly used name for the unit of temperature difference. The old name ‘centigrade’ was still used in England but this name had been discontinued in Europe where it could be confused with a unit of plane angle, the ‘centigrade’ which was sometimes still used, especially for gun laying. The ‘centigrade’ is one hundredth of a grade which is one hundredth of a right angle.

The major subject of the spelling and pronunciation debate is the word ‘kilometre’.

It is sometimes argued that the word belongs to the series of such words as thermometer, speedometer, odometer, chronometer, micrometer, gasometer, altimeter, inclinometer, hygrometer and like words ending in meter. But these are all measuring devices or meters. They are the ‘o’clock words’ meaning ‘something-or-other (on the) meter’. Kilometre is not one of these. It ends in ‘re’ and is not a measuring instrument.

Others think that kilometre belongs to the group of words like diameter, perimeter, pentameter and hexameter. But these are simply words ending in ‘er’ which have no other special relationship to each other and to which the usual rules of English pronunciation may reasonably be applied. Kilometre is not one of these.

Kilometre belongs to a special group of its own — the group of double words, consisting of a prefix and unit of measurement, which makes up the bulk of the metric system of words. The rules for metric word building are, therefore, the rules for metric word pronunciation also.

Metric words, other than the basic words themselves, are made up of the name of the particular unit of measurement, for example, metre, litre, gram, watt, etc., joined to a prefix which tells how many of these units there are. For example, ‘kilo’ means one thousand, ‘centi’ means one hundredth, ‘milli’ means one thousandth. Therefore, kilometre means ‘one thousand metres’ and millimetre means ‘one thousandth of a metre’.

Metric words are not permanent combinations but are intended to be broken up as required, for example, one kilometre is one thousand metres or one million millimetres. Separation is always between the prefix and the unit name.

Correct pronunciation of metric words is, therefore, obtained by dividing the word between the prefix and the unit and pronouncing each part with equal stress as if they were hyphenated words. For example:

kilometre = kilo-metre

The Americans pronounce the word ‘micrometer’ as micro-meter (which we spell ‘micrometre’) when they mean one millionth of a metre but also say microm-eter, as we do, when they are talking about a small measuring instrument (same spelling as ours).

Correct pronunciation is important only in so far as it is an indication that the user understands the system. Syllabication into kil/om/et/re with emphasis on the second syllable clearly indicates that they do not.

In hindsight, it might have been better if the decimetre (dm) had been retained in SI as an optional measurement unit. This unit is essential in developing the concept of the ‘litre’, which is the special name for the cubic decimetre (dm³) and which, therefore, is taught at schools. It is used in the timber milling industry for measuring and tallying the logs where the decimal point in a number is easily lost.

It is also used in the leather industry as the square decimetre (dm²) as the prime unit for area measurement, although pricing is per square metre.

SI is not a perfect system and further modification appears almost certain to occur. It is, however, an extremely sophisticated system, conceptually accurate for teaching purposes and is simpler in day-to-day use than previous systems of measurement.

With its obvious implications for greater internationality of measurement language, it appeared likely that the decimal comma would eventually replace the decimal point. Partly in preparation for this, and partly as a rationalised technique of writing numbers, the Board adopted and promoted the practice of using a space between triads of numbers as the thousands marker, and this practice was widely adopted by education authorities. Though it seemed unlikely that the decimal comma would be adopted uniformly throughout Australia it was recommended that the space be further promoted as the thousands separator. Where there was a risk in financial transactions that the space could be manipulated for the purposes of forgery, it was recommended that numbers be blocked up together or other devices used to prevent alteration of figures in documents.

A space between the number and the unit symbol had also been promoted and taught but the advent of computer typesetting largely precluded this item of style from being adopted by many printers.

8. COSTS OF CONVERSION

From the very outset, costs were considered by the Board not to have major relevance as to whether Australia should convert.

That is not to say that costs were likely to be negligible or unimportant. On the contrary, it would have been surprising if the cost was not very considerable.

The Senate Committee concluded that “although no meaningful estimate could be made of the costs or benefits which would result from the adoption of the metric system, the Committee is satisfied that the ultimate benefits would greatly exceed the costs of conversion. The actual conversion costs would be considerably reduced by careful planning.”

In his second reading speech on the Metric Conversion Bill 1970, the Hon. N H Bowen, QC, MP, Minister for Education and Science, within whose portfolio metrication was administered, said that conversion would provide a special opportunity to rationalise and modernise industrial practices and reduce diversification in manufactured goods.

He recommended that adoption of an overall conversion period of about 10 years would allow advantage to be taken in many sectors of natural obsolescence and depreciation to minimise costs. It was recommended that, in general, costs should lie where they fell and that no compensation should be offered.

In his subsequent delegation of powers and functions to the Metric Conversion Board, Mr Bowen also instructed the Board “to keep under review and report to the appropriate authorities any attempts to take unfair advantage of the public in course of conversion”.

The Board was, therefore, always conscious of its responsibilities for guiding industry towards the best ways of avoiding unnecessary costs or, more particularly, of turning the disruptions due to conversion to maximum economic advantage by redesign of products and product ranges. In this context, conversions were divided into “soft”, meaning easy, and “hard”, meaning not so easy, as described below:

Where a product was free-standing and its measurements had no need to match with, or coordinate dimensionally with the measurements of any other product, for example, a table, that product and the plant used to make it did not need to be changed except for the documentation used to describe it. In such cases, all that was required was to give that product a metric name in sensible metric numbers in which its measurement name appeared to be neither more nor less accurate than its original, for example, a 5 × 3 (ft) table became a 1500 × 900 table, though it actually remained 1524 × 914 (mm). This was called a “soft”, or easy, conversion.

Where a product was not free-standing, and its dimensions or measurements had to interlock or coordinate with those of other products which had been changed for the purposes of metrication, for example, door sets or window sets, changes in the dimensions of the product in question and the plant used in its manufacture were unavoidable. Because of the greater difficulty and effort involved in doing so, this operation was described as a “hard” conversion.

However, when “hard” conversion was unavoidable the Board urged manufacturers to take advantage of the necessary disruption to redesign products and product ranges to offset conversion costs, at least to some degree, by reducing inventories, improving manufacturing productivity or upgrading product design.

It was also forever vigilant for any attempt by manufacturers or retailers to obtain unwarranted price rises under the cloak of metric conversion. In fact the Board went so far as to recommend that, in a period of vigorous inflation, manufacturers and retailers refrain, as far as possible, from making price rises, due to any cause, less than three months before or after the conversion date for that product. Industry responded extremely well to this call and price ‘hikes’ due to metrication were almost non-existent. Although several cases of ‘hikes’ were reported, none were substantiated.

Although a limited survey was made in an attempt to determine the costs of conversion, it became obvious that any attempt by the Board to determine such costs could be interpreted by some industry as being the basis for compensation; some cost estimates collected were wildly inflated. For example, one organisation indicated the cost as total replacement of all its lathes which, in fact, could have been adapted to metric by replacement of lead screws at around ten per cent of the capital cost.

It was concluded by the Board, as the Senate Committee had already done, that it would be very difficult, if not impossible, to obtain an accurate estimate of the industrial cost of going metric. Nor would it be possible to assess the economic benefits of using a simpler system. Like the Senate Committee, the Board contented itself with the knowledge that once the trauma of the change itself had passed, the benefits of using a system like SI would become obvious to all and that the benefits would extend indefinitely into the future.

An analysis of the costs showed that they would be mostly overhead or indirect costs due to modifications of production equipment, new plant, retraining of staff and revised sales and advertising programs. The costs would be distributed over the life of the new plant and applied to many years of production. It was, therefore, very unlikely that these costs would result in a sudden and large change in commodity price.

On the other hand, there were potentially large costs due to stocking of metric and imperial products at the same time and to wastage or discounting of obsolete products or packaging. The premature destruction of pint milk bottles was claimed to be such a case but, in fact, there was no need for earlier than normal replacement. Careful planning and flexible programming allowed most companies to run down their stocks of products and materials well before Metrication-day for their company and costs should have been minimal.

The Board always recommended that staff training be limited to those metric units which the employee had to use in his or her job and that training programs be implemented not earlier than about three months before the change. Premature training tended to generate an enthusiasm which was dissipated before the conversion occurred, making re-stimulation more difficult.

With proper training and careful planning of production and re-equipment schedules, the amount of unproductive down-time was minimal, or nil, and no abnormal manufacturing cost was attributed to such down-time.

Many people have claimed that metric conversion costs were inflationary and in a period of high inflation, as it then was, it is natural for people to see any increase in costs as inflationary.

As has already been indicated, the majority of costs were of a capital nature, either for modification of existing plant or for the purchase of new plant. The cost of plant modification was accepted as maintenance of income-producing plant and was written off in the year in which it was incurred. Parts imported for conversion of existing plant were entered duty free.

Thus, while the government did not accept the principle of compensation for conversion costs, mainly because they were of a capital nature and could be expected to add little, if anything, to the unit product cost, considerable relief for costs of conversion was given in the form of deductions from taxation.

Since metrication costs rarely added to direct cost but were capital costs to be distributed over several years of production, the change in unit cost was, in most cases, negligible and certainly not inflationary by comparison with other costs operating at that time. Where new production equipment was purchased for the purposes of conversion, it goes, almost without saying, that the unit cost from the new equipment would have been equal to or less than that from the equipment it replaced, otherwise re-equipment would not have occurred.

A study of the changes in the price of building materials, six months after conversion of the building industry began in July 1974, showed that there had been no increases in prices and, in fact, where the product size was marginally reduced, as in the case of asbestos cement sheeting where metric sizes in multiples of 300 mm conversion replaced imperial sizes in multiples of one foot (305 mm), the price was reduced in the same proportion. For some items, such as doors, the production of imperial and metric sizes continued side by side at standard prices for six months, after which metric only became standard production and imperial was produced as a 'special', usually with a small surcharge applied.

During this period much was made of the problems of renovation and remodelling of existing houses. As with all renovation, even in purely imperial times, there were cost penalties that could not easily be avoided. Most of these problems were due to the disappearance from the market of the original materials and the lack of standardisation of materials used in older houses. The major area of complaint was in the replacement of broken sheets of asbestos cement. Although duplicate stock of metric and imperial were held for some time the imperial were eventually depleted and renovators found that they had to make do with metric. In the case of replacement of broken asbestos cement sheets ("fibro"), the imperial sheet 8×3 ft (2438×914 mm) on 18 in (457 mm) stud centres was replaced by 2400×900 mm for use on 450 mm stud centres. If a single metric sheet was used to replace an imperial there was a gap of 14 mm between sheets and the sheet was too close to the edge of the stud for easy nailing. There were several ways of overcoming this problem, from fixing to a "dummy" stud nailed to the original and covering the gap with a cover strip, or if no cover strip is used, by taking a larger 2400×1200 mm sheet and cutting to waste. However, as the number of sheets purchased for repair work is calculated to be less than 0.1 per cent of total production this wastage does not represent a major cost factor.

Where metric sheeting was used on building additions to imperial houses it was simply a matter of placing the new frame members at 450 mm centres and proceeding normally at no extra cost.

Corrugated iron roofing had the same form and width but was shorter in length by 38 mm in 8 ft (2400 instead of 2438 mm). This gave occasional problems in repair and replacement but the adverse cost penalty was minimal.

Nevertheless, this did not prevent one building company from attempting to recoup costs resulting from bad metrication planning as metrication extras. The case was reported to the Board and on investigation it was found that this builder had actually incurred large costs due to continued designing to and ordering of imperial sizes, instead of designing to and ordering the appropriate metric sizes, after production of imperial had virtually ceased. The result was that in order to obtain the correct imperial size, the next metric size up had to be used and cut to waste. The Board disallowed this claim against the company's clients and the full cost was borne by the builder.

By careful planning it was sometimes possible to submerge metrication costs totally in costs of redevelopment or changes in technology which would have occurred, regardless of metric conversion. The conversion of petrol pumps, while in itself relatively expensive at \$900 000, was a case in point. With inflation, the price of petrol in 1976 was already rising close to \$1.00/gal, at which point the price computing mechanism would have had to be replaced. A metric mechanism could be substituted at similar cost. In some areas the price on the pump was being halved, as also occurred in the USA, and the read-out doubled for payment by the customer. Weights and Measures Authorities were unhappy about this procedure and in the interest of the consumer favoured conversion to metric.

Although some firms were willing to divulge their metrication costs off the record, most were not. The largest single figure reported was \$2 000 000. Others of \$250 000 and \$550 000 were also reported. The quarter million figure related to refitting and making of metric dies and moulds which would, like imperial ones being replaced, have a very long service life. Rationalisation of stock lines permitted one company to recoup its \$550 000 costs in less than three years and as a result of these savings it had, through metrication, achieved a net gain.

Metrication itself was not seen as a source of profit and the possibility of cost benefit was not seen as a reason for conversion. Even so, the disruption that the change required and the need to rethink many industrial processes and redesign products into metric created a rare opportunity in modern industry to totally revise products and adopt newer and more effective procedures.

The best way of taking advantage of this opportunity was to standardise or re-standardise products and the rationalisation or variety reduction of product ranges to eliminate less popular or non-standard lines. Examples of such processes gainfully applied were: the standardisation of the location of screw holes on hinges, thus reducing the number of standard hinge sizes from 153 to 11 to suit the same applications as before; and by reducing the number of steel sections, to rationalise the sizes of oil drums from 55 to 11.

The change was used as the opportunity to reduce the number of fasteners in use, and in time a single ISO metric coarse thread series replaced the multitude of systems in use before metrication.

As a result of the change from the foot (305 mm) to the preferred metric multi-module (300 mm) room sizes were reduced in the ratio 305 to 300. The quantity and materials used for a particular purpose were reduced in the same ratio, without detectable difference in the quality of the accommodation.

Also associated with the change to metric, though not a direct result of it, was the publication of the Light Timber Framing Code, the Australian Model Uniform Building Code, on which metric building regulations in all States were modelled, and the Uniform Plumbing Code. Work had begun on these codes before metrication began but metrication served as an added incentive to convert them and bring them quickly to a conclusion. In Queensland, the opportunity was taken to replace 131 individual council building regulations with a single uniform State code.

From 1972 onwards, the Commonwealth Government allocated funds to the States to assist them with conversion of their operations. The total amount distributed for this purpose was \$10 000 000. The total sum of money expended by the Board in its 11 years of operations was \$5 955 000.

It is clear that while the actual costs of metrication were indeterminate, even ignoring the positive, but equally indeterminate, cost benefits, the costs of going metric did not appear to have been exceptionally high. Real costs were in addition to the company's capital stock and these were distributed over several years of production. Very few companies gave cost as a reason for not converting although many justified "soft" conversion on this basis.

Significantly, the Prices Justification Tribunal reported that metrication was not used to justify price increases.

Opponents of metrication sometimes claimed that its cost in Australia was \$2 500 000 000. This amount was first suggested in 1973 and had not been amended by 1982. It was clearly an estimate not based on facts, and in view of the difficulty the Board had in obtaining reliable figures, it seemed highly unlikely that a less well equipped organisation could have been more successful in this regard.

Even assuming, for a moment, this cost to be accurate, it represented \$179 per person or \$18 per person per year for ten years which was a small enough cost compared with the benefits which resulted from metric conversion.

9. CONVERSION IN PARTICULAR SECTORS

9.1 Engineering

When metrication began in 1971, the engineering industry, for reasons of manageability, was divided into 12 functional sector committees of reasonably related interest.

- Mining and Metallurgy
- Iron and Steel
- Non-Ferrous Metals
- Fabricated Metal Products

- Automotive Engineering
- Locomotive and Rolling Stock
- Electronics and Electrical Engineering
- Machine Tools
- Ship Building
- Aeronautical Engineering
- Heavy Machines
- Chemical Engineering

Panels and Working Parties

- Abrasives, Grinding Wheels, Power Tools
- Commercial and Industrial Refrigeration
- Small Boats
- Fastener Users
- Metric Fasteners
- Bicycle Description
- Engineering Industry Metrication Review
- Room Air Conditioners

These committees consisted of executives from major companies in that sector, government and the industry associations. Members of each committee participated, not as representatives responsible to their company or association, but as experts in that industry having sufficient status to make contributions and decisions which could reasonably be expected to be binding on the whole of that industry. Appointment to all Metric Conversion Board sector committees and panels was on the same basis.

By funding fares and expenses for each member to attend meetings of their committees, attendances were maintained in the high nineties per cent and decisions truly reflecting the consensus of that industry were generally achieved.

In addition, most appointees to the committees, being party to all metrication decisions affecting their industry and being, in fact, responsible for seeing that metrication decisions once made were carried out, appreciated the responsibility placed upon them and were enthusiastic for its success.

At no stage did the Board seek to force a decision of its own on an industry committee. Instead, each industry, within the requirements of the Metric Conversion Act, decided, by consensus, when and in what way it would be practicable to metricate its industry. To that extent, conversion to metric must be seen as one of the most democratically executed government projects in Australia's history.

By selecting top executive people to participate in metrication planning, the Board ensured that, to a large degree, the metrication program was popular with the management of that industry. As a result, management was more likely to adopt those policies and issue those instructions which would see that the task was properly carried out. As a further consequence, most larger companies appointed an appropriately senior

staff member as metrication coordinator. This did a great deal to see that a positive metrication message was carried to all departments of the organisation.

While many companies were enthusiastic in their approach to conversion, in many cases their enthusiasm was considerably greater than their know-how and planning. It was for this reason that the Board produced a leaflet called “A Metric Conversion Check List for Use Within Industry” which dissected a company into functional departments and tabulated areas in which metrication activity would be likely to be required. This check list proved highly popular and was reprinted widely both in Australia and in other metricating countries to which it had been sent.

On the basis of this check list, companies were able to set up and supervise broad bar-chart programs in conformity with the original industry program. In this regard, a slight variation from target dates was not considered of any importance and undetailed bar-charts were considered more appropriate than less flexible network and critical path plans. However, it was essential that all critical elements, such as standards and legislation, which took a long time to convert, were identified well in advance.

Once an industry program had been worked out by the Sector Committees it was given wide publicity through the industry associations and journals to ensure that such a schedule could reasonably be carried out by every member of the industry.

Although these programs were in no way mandatory, they were generally implemented voluntarily without opposition by the industry and the sector program became the official program for that industry.

To assist the engineering industry, a booklet, “Metric Conversion Information Brochure — Engineering Industry” was produced by the Metric Conversion Board. This booklet contained all bar-chart programs plus notes on changes in engineering materials and components, notes on the areas in each sector most likely to be affected and general metrication information. These booklets were distributed to individual companies via mailing lists and through their membership in industry associations.

A more detailed guide book to metrication in engineering, called “Metric Conversion Manual for Engineering Establishments”, was published by the Board in 1974. This 30 page booklet gave advice on the conversion of design, drawings, workshop practice, marketing, personnel, accounting, raw materials and standards.

In addition individual industry sectors produced their own handbooks. These included “Metric Conversion in the Shipbuilding Industry”, “Metric Conversion in the Aeronautical Engineering Industry” and “Metric Conversion Information Brochure — Mining and Metallurgy Industry”.

A large number of information leaflets, such as “Engineering Workshops”, which gave details of sheet and wire thickness, fastener sizes, tax concessions and relevant standards, or “Bright Steel Bars”, which catalogued bright bar sizes available, were

published. "Metric Change Information Sheets" gave up-to-the-minute information on changes in individual products.

The larger companies all produced their own excellent metrication manuals which, although mainly for internal use, were eagerly sought by people from other companies. Most companies continually revised their trade literature as metric changes occurred.

The MTIA (Metal Trades Industry Association of Australia) engaged a public relations specialist to promote metrication in the engineering industry. Under his guidance, a "Change to Metric Information Service" was provided to members over several years in continuous loose-leaf form. This CMIS, as it was called, consisted of three volumes — "A Metric Bulletin", "A Metric Learning Guide" and "A Metric Product Guide".

The Chambers of Manufactures in each State maintained an active interest in metrication with seminars and booklets on various aspects of the subject. In those States where the Board did not have an office, the Chambers of Manufactures maintained a metric information service which was partly funded by the Metric Conversion Board.

The Board's officers also participated widely in seminars and metrication discussions and visited individual companies throughout Australia on metrication problems.

Throughout the planning stage the Board maintained a very close liaison with the Standards Association of Australia which carried out "crash programs" to ensure that standards would be metricated in time for conversion in particular industries.

The net result of this planning was that a great deal of drive and enthusiasm was generated and most industries converted systematically without too much prompting by the Board.

Despite careful planning in this way, the Board did not become aware for some years that there were segments of industry which, with all the drive and enthusiasm in the world, could not undertake immediate, or even early, conversion.

These sectors were areas in which the industry was concerned with the operation, repair and maintenance of existing imperial plant and equipment which it was clearly impracticable or too costly to convert. This included industries manufacturing raw materials and components such as bright steel bar for shafting, bearings and fasteners which would be required for maintenance work for years to come. There were also manufacturers of appliances or farm machinery, which did not have to coordinate dimensionally with any other product, which would be converted only with the redesign and production of the next model. Some products which were unlikely to be modified in the near future were "soft" converted simply by being described in metric terms.

The identification of individual companies where metrication was inhibited by the need to operate and maintain existing imperial equipment, or where the product was totally or partially manufactured outside Australia, was made easier by the introduction of controls on the importation of certain non-metric measuring instruments.

This action, while not greatly inconveniencing people for whom it was entirely practical to work in metric, highlighted those areas where engineering activity was tied to imperial drawings and imperial components. As a consequence, ample use was made of the provisions of the Customs (Prohibited Imports) Regulations to ensure that all persons or organisations which could reasonably justify a continued need for imperial instruments would be able to obtain them.

In accordance with the need to maintain existing plant and equipment, a need also arose to “reverse train” some apprentices who had been trained in metric only. However, total retraining in imperial was generally not necessary and such retraining rarely consisted of more than learning to read in sixty-fourths of an inch or to use a micrometer measuring in thousands of an inch.

In hindsight, it is hard to see how this program might have been improved except in the area of employee training. Involving companies at top executive level and the age-old problem of failure to communicate effectively right to the factory floor apparently left a number of operatives in different industries improperly trained in their duties following metrication.

This problem was more noticeable in the small and very small companies, often operated by a skilled craftsman with one or two mates, in the servicing and repair industries. These people had neither the time, the know-how, nor the incentive to analyse and solve the problems of metrication in their industry. They were trained in imperial and all their formulae and rules of thumb were in imperial and it was outside their training to return to first principles to convert these to metric.

If a tradesman, such as in air conditioning or refrigeration, needed an output in metric he may have worked it out in imperial and applied a conversion factor at the end. The only way to solve this problem, in the short term, was for the Board, the technical colleges and/or the industry association to reproduce practical formulae, rules and rules of thumb in an uncluttered form in metric and distribute these to people working in particular fields. In 1982 action of this type was being continued by Departmental officers still engaged in metrication duties.

In general, the metrication of the engineering industry was very satisfactory as far as it could go but, inevitably, there would be evidence of imperial usage for many years to come.

9.2 Building And Construction

The building industry was the first major industry grouping in Australia to complete its change to metric. This was achieved by January 1976 for all new buildings other than those for which design had commenced well before metrication began.

In the pre-planning for conversion, the building industry was divided into four sector committees: Building Supply, Building, Civil Engineering and Architecture and Government Construction, under the supervision of the Building and Construction

Advisory Committee. Members of each committee were highly qualified specialists, all eminent and respected in their fields.

The terms of reference of each industry nominee on these committees were identical with those of the engineering industry and other industries. Each was required to act on his or her own initiative as an expert in the field and not simply on behalf of his company or organisation.

The first task of these committees was to establish a bracket of dates by which metric designs, building materials, standards and codes and building regulation could reasonably be expected to be ready for use. From these a series of flexible bar-chart schedules was established as the program for the industry.

This was the first industry program established. Because of its significance, the program was formally announced in March 1972 by the Minister for Education and Science who welcomed the industry's enthusiasm in setting itself such a program.

In the lead up to the establishment of this program, the first vital decision was the adoption of the 100 mm design module and its preferred multiples and submultiples. Even before this, it was decided to adopt the millimetre and the metre as the only length units to be used in the industry. In this the industry was grateful to the SAA for the early production of the Standard AS 1155-1974 "Metric Units for Use in the Construction Industry".

In the adoption of the millimetre the Board leaned heavily on experience in the UK and the ISO, where this decision had already been taken.

The logic of using the millimetre in this context was that the metric system had been so designed that there would exist a multiple or submultiple for every use. Decimal fractions would not have to be used. Since the tolerances on building components and building practice would rarely be less than one millimetre, the millimetre became the sub-unit most appropriate to this industry.

It was regrettable that, from this decision, other industries gained the impression that the centimetre was being deprecated by the Board, in favour of the millimetre, for general use. This was not intended. It would have been impossible to educate school children in the logical construction of the metric system, as distinct from the imperial system it replaced, without progressing from centimetre through square centimetre to cubic centimetre to millilitre. However, the multiple "centi" has been limited to use with the metre in Australia.

The decision to adopt the 100 mm module as the replacement for 4 in was not taken arbitrarily.

Of all the dimensions in a building, the one which appeared to be prime was ceiling height and it was from the decision about conversion of that value that most other dimensions stemmed.

Under imperial building regulations in all States, the minimum permissible ceiling height was 8 ft or 2438 mm. The choice of 2400 mm as the minimum permissible height of ceilings in habitable buildings was made by the Interstate Standing Committee on the Uniform Building Regulations (ISCUBR) in the process of drafting the Australian Model Uniform Building Code (AMUBC). This was already in the final stages of development when metrication of the building industry began. The impact of the production of this Code on metrication was very considerable, as will be discussed later.

Had the corresponding ceiling height selected been 2500 mm, a building module of 100 mm could still have been adopted but the multi-modules which would have been modular with 2500 mm would have been 250 mm and its multiples. This would have required all building materials sizes to be slightly larger, for example, 2500 and 1250, making it more expensive to obtain sizes in the ratio of length to width of 2:1 to make materials modular with ceiling height. By selecting a ceiling height of 2400 mm, the minimum specification was not quite achieved but with modern crossflow ventilation the living condition was not worsened.

Having thus established that the minimum or standard ceiling height would be 2400 mm, it was clear that sheet sizes 2400×1200 would be modular and could be used vertically or horizontally to fill the space without the need to cut and fit.

Out of this grew the concept of preferred sizes of building materials based on dimensions which were multiples of the preferred multi-module 300 mm, that is, 300, 600, 900, 1200 etc. On this basis, SAA produced the Standard AS 1224-1972 "Preferred Sizes of Building Components" which standardised sizes of windows, door sets and other components.

The publication of this Standard allowed manufacturers of building materials and components to decide whether their products should be "soft" converted or "hard" converted. Nevertheless, before manufacturers would commence manufacture to these specifications it was necessary for the then Commonwealth Department of Works to announce its acceptance of the 300 mm multi-module and its multiples, and that it would give preference, in Government construction projects, to "hard" converted materials and components. Indeed, most architects and building designers were reluctant to design in metric until metric building regulations had been published. Designers and manufacturers considered that an official Government statement, in the form of mandatory regulations, was essential as an indication of the firmness of Government intent before they could reasonably be expected to make a massive commitment to change.

One of the big achievements of the period, although not directly attributable to metrication, was the concurrent publication of the draft Australian Model Uniform Building Code (AMUBC) which was produced in metric.

All States accepted the release of the Code as the opportunity, not only to metricate, but to revise their building regulations. All States and Territories produced regulations

in a form virtually identical with the model code or very closely related to it. In Queensland, the introduction was of particular significance in that a single State code replaced the 131 sets of council building by-laws which had previously existed.

The new building regulations based on AMUBC differed markedly from the ones they replaced in that, where the imperial regulations were very specific about sizes of materials, the new codes were performance codes in which the minimum standard of performance was specified. The manufacturer or builder could then decide whether or not a product conformed, allowing the maximum amount of innovation in the design of new building materials. To minimise difficulties builders might encounter in interpretation, companion manuals of practice were published.

The impact of the new building regulations was to remove ambiguity, eliminate dual usage almost instantaneously and to give the force of law to the change in building operations.

If there were to be any criticism of the change in regulations it would be about the time taken between the release of the final draft of the Model Code and its subsequent appearance as State building regulations. In the event, however, the irritations were due to impatience on the part of the metricationists as, by 1982, all States enjoyed fully metric codes.

Considering the diffuse and fragmented nature of the industry one of the major achievements was the training in preparation for the change. This was accomplished in a three-tiered fashion, with architects and engineers, building tradesmen and building labourers being treated separately.

The first conversion aid produced was the handbook, "Metric Conversion in Building and Construction", prepared by the Chairman of the Government Construction Sector Committee with editorial assistance from members of the Building and Construction Advisory Committee. This book of 96 pages was published and sold under the title, SAA MH1-1972 "Metric Conversion in Building and Construction", by the Standards Association of Australia. It contained background to the change, management for change, drawing practice, dimensional analysis and details of metric building materials. It became a highly popular compendium of metric building information. While essentially a conversion guide, this book continued to attract buyers long after conversion of the industry had been completed.

This handbook was most valuable to the building designers and the master builder but due to its early publication, was relatively incomplete. A second handbook of 140 pages, SAA MH2-1974 "Metric Information for Building Designers", was written by an MCB editorial panel and published for sale by the Standards Association of Australia. This book was less of a conversion aid than an architectural handbook in metric. It also was highly popular among architects and designers and seemed likely to continue in demand well after the completion of conversion.

Throughout the early stages of conversion the Board issued two pamphlets, “Design Notes — Metric Conversion for Building and Construction — September ’72” and “Design Notes — Metric Conversion for Building and Construction — June ’73”, which gave details of scales, spacings, regulations, titles, training etc. These were distributed widely through the Master Builders Associations. Another pamphlet, “Builders and General Hardware”, issued in 1974, gave details of tools, fasteners and a wide range of building materials and components. In addition, up-to-the-minute information on various products, some of it of an interim nature, was published in nearly every issue of the MCB Newsletter or issued as Metric Change Information Sheets.

The major building materials manufacturers excelled themselves in the production of metrication booklets and catalogues which gave quite detailed assistance to practical builders in making the change. Some of these commercial booklets did a great deal to enhance the public image of the companies which produced them.

The Master Builders Association and the Housing Industry Association organised for their members seminars and lectures in which guest speakers from the Board and the industry participated. The Board’s officers made frequent visits to individual companies to confer on metrication problems and to lecture to staff.

A commercially produced audio visual film strip, called “Built to Measure”, did a great deal to “sell” metrication to builders and building workers and was much used by the industry.

The Commonwealth Department of Works organised seminars and discussions on innovations and possibilities opened up by metrication. State departments of works and local government participated closely in these.

To assist the building tradesman on the job, a 58-page pocket book, “Metric Information for Building Tradesmen”, was adapted, with HMSO permission, from a British publication “Metrication in the Construction Industry”, and published by the Board. This booklet proved highly popular and was widely distributed to building supervisors and foremen by the Master Builders Association. Requests for general distribution to plumbers, painters and decorators were also received. Distribution was accomplished through the relevant trade unions.

Attention was also given to training of general staff on the building sites. A special pamphlet, “For Building and Construction Workers”, was published by the Board and issued extensively through both the companies and the trade unions.

As a consequence of receiving this widely distributed, graded information, people in the building industry were probably the best prepared and most highly trained for conversion of people in any industry. This, along with mandatory regulations, almost certainly accounts for the very considerable success achieved in converting this industry.

Throughout metric conversion, the public has been extremely sensitive to the risk of “being ripped-off” under the cloak of confusion caused by metrication. The Board, likewise, was ever conscious of the possibility of undue price rises and was particularly watchful for evidence of this.

To the credit of Australian industry, excessive price rises did not occur. As a result of the adoption of the 2400 mm minimum ceiling height, ceilings in new buildings were lowered by 38 mm rather than increased by 62 mm which would have happened if 2500 mm had been chosen. As a consequence, all building material dimensions were reduced by the fraction $\frac{38}{2438}$ to give a product which was cheaper than the original in a building which was, generally, indetectably smaller.

Only one builder attempted, unsuccessfully, to compensate himself for costs alleged to have been due to metrication and even this was occasioned, not by metric conversion, but by the inefficiency of a designer.

A survey of costs showed that the prices of building materials had not been significantly affected by metrication.

In the early stages there were some fears that existing contracts could be adversely affected by unavailability of specified products and the need to substitute metric equivalents. An attempt was made, through the Standards Association, to write draft contracts containing a metrication clause against such eventualities. In the event, however, such variations were covered by normal variation clauses and the problem did not appear to arise.

On the consumer side, the use of metric in building designs and applications was ensured by the publication by the lending authorities (banks and insurance offices) of booklets, “Acceptable Standards of Construction” and “Standard Building Specifications”, which served as *pro forma* building specifications for private use. Project home builders published brochures and advertisements in metric only although a small number continued to include dual figures.

During metrication, the industry promoted the concept of building material size rationalisation around standard preferred sizes. Dimensional coordination was recommended as a method of building with minimum on-site cutting and fitting.

The concept of dimensional coordination existed before metrication. Metrication, however, was seen by the proponents of dimensional coordination as a special opportunity to revitalise interests and to redesign building materials and components to conform to dimensionally coordinated designs.

Unfortunately, there seemed to have been no greater interest shown in this subject than existed before, except that most products and components were now produced in sizes based on the preferred multi-module 300 mm.

The slow acceptance of dimensional coordination principles appeared to be due to deficiencies in the development of a practical system based on them. For example,

unless wall thicknesses or floor thicknesses in multi-storeyed buildings are themselves multiples of 300 mm there is no possibility of both the inner dimensions and the outer dimensions being dimensionally coordinated at the same time. As a consequence, the proponents of dimensional coordination have had to invent the concept of a neutral zone to which dimensional coordination apparently does not apply.

It would appear that dimensional coordination may only become a practical building concept when all building materials used directly as components and subassemblies of materials are truly modular, rather than the building materials themselves. In this sense, lining materials may be considered to be raw materials if used in furniture etc. but as components when used as wall panelling. Likewise, the metric standard brick of $230 \times 110 \times 76$ mm is not a component, but a panel of $2\frac{1}{2}$ bricks long by 7 courses of bricks high, measuring 1600×600 mm, is a coordinating component. In this sense also a wall, a floor-ceiling or a roof system is a component but the individual materials used in the construction of these may not be.

In order to make dimensional coordination a more acceptable procedure, it would seem that it must be developed to the stage of full modular coordination in which a building can be surrounded by a standard wall system, topped by a standard roof system and so on.

Reviewing the subject as a whole, it can be said that metrication of the building industry was, from the Board's point of view, highly successful. This success was attributable to the support of legislation, the high degree of staff training at all levels, the literature produced by the building materials industry and the enthusiasm and support of all sections of the building industry.

9.3 Transport And Communication

This group consisted of industries involved in the transportation of passengers and freight by road, rail, sea and air, and includes the carriage of mail, and other forms of communication.

In detail, it is concerned with conversion of transportable equipment such as vehicle, trains, ship and aircraft, warehouses, depots and stores, fares and freight charges, railroads, highways, air and seaports, maps, tourist facilities and regulations.

Conversion was coordinated by the Transport and Communications Advisory Committee and the detailed planning was developed by the individual sector committees listed below:

- Road Transport Sector Committee
- Railway Transport Sector Committee
- Water Transport Sector Committee
- Air Transport Sector Committee
- Road Aids Sector Committee

- Storage Sector Committee
- Panel for Publicity on Road Travel
- Panel on Road Maps
- Panel on Freight Forwarding
- Panel on Tourism

Conversion of postage, telegrams and telephones was planned and implemented by the Post Master General's Department which was the government authority responsible for these services. Letter and parcel weight categories adopted for metrication were those already adopted internationally.

Freight Forwarding

Conversion of weights and volumes of goods for consignment were worked out by the four forms of transport but the date and cost of service was coordinated so that the units of measurement and freight charges would not have to change as goods were transferred from one mode of transport to another.

M-Day for freight forwarding was 1 July 1973, which took account of the fact that many industrial products would already be metric by that date.

Conversion involved production of new freight schedules based on kilograms, tonnes and kilometres, rewriting of road transport regulations relating to vehicle sizes and loadings in metric terms, conversions of weighbridges, scales, flowmeters, vehicle markings, changes in documentation and pricing calculations and, of course, training for the change.

Where goods and parcels were to be charged by mass, the rate was calculated in whole kilograms and whole kilometres.

Many goods are relatively more bulky than heavy and in these cases a charge has traditionally been calculated on the mass equivalent to a particular volume. In pre-metric days, several different kinds of "measurement ton" were used. The most common of these was the "shipping ton" of 40 cubic feet = 1 ton. Although it might have been expected that in metric the industry would have adopted one cubic metre (m^3) = 1000 kg (1 tonne), the more generous "soft" conversion $1 m^3 = 897$ kg was adopted.

For goods transported on pallets, the size of pallets for use within Australia remained at 1170×1170 mm, a "soft" conversion of the popular 46×46 inches. For international container use, the size adopted was 1100×1100 mm.

Transport Equipment

It was not regarded as necessary or practicable to convert instrumentation on existing trucks, trains, ships or aircraft) and these continued to be operated and maintained in imperial for the remainder of their working lives. From 1974, cars and trucks built in

Australia were fitted with metric instruments. Cars were increasingly designed in metric from that time.

Existing aircraft and ships continued to operate with imperial instruments and navigational equipment and metricated versions did not become available until conversion had occurred in their country of origin. For this reason, passenger aircraft cabin announcements tended to be given largely in miles, miles per hour and feet, despite efforts to get pilots to give them in metric.

Road Traffic Regulations

One of the most important and publicly visible of the metric changes was the change in road speed and distance signs and the accompanying change in road traffic regulations. M-Day for this change was 1 July 1974 and, by virtue of careful planning, practically every road sign in Australia was converted within one month. This involved installation of covered metric signs alongside the imperial sign prior to the change and then removal of the imperial sign and the cover from the metric during the month of conversion.

Except on bridge clearance and flood depth signs, dual marking was avoided. Despite suggestions by people opposed to metrication that ignorance of the meaning of metric speeds would lead to slaughter on the roads, such slaughter did not occur.

A Panel for Publicity on Road Travel, representing the various motoring organisations, regulatory authorities and the media, planned a campaign to publicise the change, believing that public education, not the confusion that would result from dual sign posts, would be the most effective way of ensuring public safety. The resulting publicity campaign cost \$200 000 and was paid for by the Australian Government Department of Transport.

In addition, the Board produced 2.5 million copies of a pamphlet, "Motoring Goes Metric", which was distributed through post offices, police stations and motor registry offices.

For about a year before the change, motor car manufacturers fitted dual speedometers to their vehicles and, after 1974 all new cars were fitted with metric-only speedometers. Several kinds of speedometer conversion kits were available

As a result of all these changes, conversion on the roads occurred without incident.

Coordinated with the road change, tour guides, road maps and street atlases were also produced in metric and, of course, traffic regulations in each State were amended to metric measurements.

The opportunity was also taken to change the design of road signs to conform to internationally recognised standards.

The change to metric on the roads quickly led to changes in the units used by motor car enthusiasts and engine power in kilowatts (kW) quickly replaced horsepower and newton metres (Nm) replaced foot pounds as the unit of torque. The kilometre, though

mispronounced kilom'etre more often than not, soon become the unit of distance and the 'k', as in "doing 100 k", became the jargon for kilometre.

After consideration of all aspects, the litre per hundred kilometres (L/100 km) was adopted as the preferred unit of fuel consumption. This was the system most frequently used in metric countries. The arithmetical process was neither harder nor easier than that of calculating miles per gallon or kilometres per litre and was more universally meaningful. As it is a compound unit, the public has found this a more difficult conversion to which to adjust than miles to kilometres or gallons to litres.

Claimed fuel consumption was stated in L/100 km by all Australian motor car manufacturers and its use as a unit was gradually established.

9.4 Industrial Materials

The materials and processes included under the description industrial materials consist of:

- Timber
- Forest products
- Hardboard, particle board, plywood
- Paper and pulp
- Printing and advertising
- Plastics
- Chemicals
- Agricultural and veterinary chemicals
- Sanitation and cleaning chemicals
- Paint
- Explosives
- Industrial gases
- Lubricants and greases
- Rubber
- Leather
- Ropes and twines
- Flat glass
- Refractory bricks

Industrial materials, as distinct from fabricated products, were predominantly the products of the process industries and related industries. The distinction from building materials was not clear cut and the decision to classify in this way was largely motivated by convenience and the secretariat resources available.

Most of the above materials were the products of sophisticated industrial processes and complex plant and the process of metrication, particularly of the plant concerned, tended to be more complex than for other industries.

Conversion of these materials was planned by the following committees:

- Industrial Materials Advisory Committee
- Timber Sector Committee
- Forestry Sector Committee
- Paper, Pulp and Printing Sector Committee
- Non-Metallic Industrial Materials Sector Committee
- Plastics, Chemicals and Petroleum Derivatives Sector Committee
- Rubber and Allied Products Sector Committee

To ensure that all aspects of conversion were fully considered, a “Metric Conversion Program Check List for Use Within Industry” was devised to identify the areas likely to be affected by conversion. This consisted of a listing of about 70 typical questions related to the various functional departments of a manufacturing organisation such as general management, technical department, engineering, manufacturing, marketing, accounting, and personnel.

Problem areas having been identified and priorities determined, a bar-chart program could be set up for each company. From this type of information a bar-chart program was prepared for each industry by the Sector Committee concerned.

The bar-chart programs established in this manner were designed to accommodate both the fastest and the slowest in completing each phase of the plan. Each bar, therefore, consisted of an intensive period of activity with provision for build-up and run-down period. The need to build in flexibility made more precise programming unnecessary.

Programs prepared in this way were made available for comment by the whole industry through publication in appropriate journals, in the MCB Newsletter, and by reference to Sector Committees considered likely to be affected, prior to official promulgation as the agreed industry program.

Each company within the industry was urged to communicate and liaise closely with raw material suppliers and end users, to ensure that industries on either side could take account of the intended changes in planning their own adjustments.

In planning for conversion, it was recognised that in many organisations conversion would be in two parts, that is, product conversion and conversion of processing plant.

By 1982, product conversion was complete and production and marketing of these materials was in metric terms.

Conversion of processing plant, as in other engineering areas, was a larger problem and in many cases was incomplete when the Board ceased to exist.

Since many industrial materials were bulk packaged or sold in loose bulk form, conversion of packaging, batching processes, quality control procedures, production recording, production scales (for non-trade use), sales and technical literature, sales and advertising were achieved relatively simply.

Forestry

Because the “point” is so easily obliterated and lost in the roughness of the log surface, log lengths were stamped on the log in decimetres and log volume tables were similarly in decimetres. Log diameter was measured directly in decimetres with appropriately designed girth tapes.

Log sales were by length in metres and increments of 0.1 m and by true volume in cubic metres. The old method of log volume approximation in Hoppus units was discontinued.

Stacked round wood was measured in cubic metres and the cord and the load were no longer used.

Timber

Conversion in the timber industry was seen as a special opportunity to attempt major rationalisation of a long-established and traditional industry.

For this purpose, the CSIRO Forest Products Laboratory, Division of Building Research was asked to undertake a preliminary investigation of the optimum series of structural sizes required in the building industry. This resulted in a proposal for a considerable reduction in the number of standard sizes based on a single standard size of 90 × 35 mm and multiples of this size.

Because this represented a very drastic departure from the traditional approach in a highly conservative industry and because the newly developed “Light Timber Framing Code (1971)” based on quite new principles had recently been published by the Standards Association of Australia, the CSIRO proposal was not acceptable to the timber industry in its then form.

Conversion in the hardwood (eucalypt) industry was, therefore, subsequently based on existing inch sizes converted on the basis 25 mm = 1 inch. The concept of nominal size green off-saw was maintained, in incremental lengths of 0.3 m.

For Radiata pine and other Australian produced softwoods, change from the standard inch based sizes was achieved by quoting metric sizes as kiln-dried and dressed to a stated minimum size with plus tolerances only. The same length increment of 0.3 m was adopted.

Where sales by volume continued, the cubic metre was adopted to replace the super foot, but a large number of timber producers adopted sales by length following conversion.

Some problems in Australia would continue as a result of continued importation of timber in imperial lengths and flitch sizes from non-metric sources. Oregon and Canada pine from the US West Coast were among these imports. Imported timbers in imperial sizes could not be cut exactly to Australian preferred sizes or lengths and some wastage resulted from supplying, say, 2.44 m (8 ft) where 2.4 m is required.

Stress grades formerly based on pounds-force per square inch were converted to an equivalent series in megapascals.

Plywood initially underwent “soft” conversion of existing sheet sizes but the industry subsequently adopted modular sheet sizes based on 1 ft = 300 mm.

Particle Board also initially adopted “soft” converted sizes but later “hard” converted to modular sheet sizes based on 1 ft = 300 mm and a new series of thicknesses derived from rounded metric equivalents of imperial thicknesses.

By 1982, all hardboard sizes were “soft” conversions of previous sheet sizes and thicknesses.

Paper And Pulp

Conversion of manufacturing operations did not encounter major problems. Within the Sector Committee concerned, conversion activities were centred around attempts to achieve a reduction in the number of commercial paper sizes and thicknesses, hopefully by the adoption of a suitable international standard. Unfortunately, in 1982 the ISO sizes did not appear to have a sufficient degree of acceptance as an international standard. Apart from the Australian Government Printer there were no major users of ISO sizes other than A4, which became Australia’s most popular stationery size.

The growth in demand for continuous stationery for computer software, based on existing generations of computers, was one of the major factors operating against the adoption of ISO paper sizes internationally.

Paper sizes adopted in Australia consisted of the then range of imperial sizes converted to the nearest 10 mm. It was expected that eventually these sizes would be known by their dimensional names and use of traditional names — crown, cap, royal, ream and quire — was declining.

Printing

Printing and advertising were grouped with the paper industry for the purpose of conversion.

Although a number of attempts were made to produce an internationally acceptable standard of typographic measurement, no such standard existed in 1982. Consequently, the existing system of composing, based on proportional measurement using ems, points and picas, continued to be used but such measurements were expressed in millimetres when required.

Advertising

So far as advertising was concerned, there were no technical problems involved other than the adoption of the column centimetre for classified advertising and the square centimetre for display advertising, as the appropriate units of sale.

Plastics And Chemicals

The conversion of plastic raw materials and industrial chemicals involved only the adoption of bulk packaging sizes in metric units, recalibration of equipment and the production of technical literature in metric units.

Conversion was achieved without difficulty.

Chemical engineering associated with these products was, however, dependent on the availability of a large number of specialised engineering supplies. Conversion of this aspect was much more difficult and long term.

Agricultural And Veterinary Chemicals

Agricultural and veterinary chemicals consisted of sprays, weedicides and animal medicines. The problem of conversion related chiefly to the selection of appropriate metric packaging quantities and the rewriting of directions for use in metric terms.

In rewriting directions for use the opportunity was accepted to standardise on the method of presentation of information on labels. A set of "Metric Conversion Guidelines for the Labelling and Use of Agricultural Chemicals" was prepared in conjunction with the Australian Government Department of Primary Industry.

These guidelines included tables of appropriately rounded metric equivalents of mixing and application rates for powders and liquids.

Industrial Gases

The gases oxygen, nitrogen, hydrogen, acetylene, chlorine, sulphur dioxide and carbon dioxide are included here.

In order to achieve sensible metric figures, the uncompressed volume of these gases was upgraded to a suitable rounded metric volume consistent with the capacity of the container. Ordering of these gas cylinders was changed to letter code instead of volume. Sale of compressed carbon dioxide was in standard mass ranges.

The unit of pressure, the bar, formerly used in some parts of the compressed gas industry in Australia was replaced by the kilopascal.

Paint

After much debate, the industry adopted a series of paint can sizes based on the “4 litre gallon” rather than the “5 litre gallon” to replace the imperial gallon of 4.55 litres.

The series of can sizes was:

100 mL, 250 mL, 500 mL, 1 L, 4 L, 10 L, 20 L.

The 2 L size was omitted from the range but as a result of some consumer pressure was offered by some manufacturers.

Rubber

Rubber products, such as hoses and conveyor belting, were “soft” converted without problems. Custom-made rubber products were unaffected by conversion.

The sizes of rubber tyres for cars, trucks and tractors were based on international standard rim sizes in inches and would not be altered. The inch size was to remain in existence as apart of the product code number. Tread widths on radial tyres were in millimetres.

Leather

The kilogram was adopted without difficulty for the sale of hides and leather by mass.

For light leathers sold by area, the square metre was adopted as the unit of sale even though the square foot was still recognised in many countries, including traditionally metric countries in Europe.

Rope And Twine

Metriation offered this industry the opportunity to rationalise some classes and sizes of rope from product ranges. It also allowed the industry to standardise on the measurement of diameter for the measurement of thickness instead of the circumferential method.

Flat Glass

Some rationalisation of glass thicknesses was achieved and the opportunity was taken to eliminate mass per unit area as a measure of glass thickness. Sales based on increments of 20 mm were adopted to replace sales by the inch.

Refractories

Refractory bricks were “soft” converted to conform to existing international standards for those products.

Polyethylene Piping For Agricultural Use

Conversion of this industry proved to be an insoluble problem as of 1982.

Because of the extreme conditions of competition in the market for polyethylene pipes for farm water supply, manufacturers and resellers showed a complete unwillingness to adopt metric terminology for fear of loss of market share.

The situation was exacerbated by the introduction of a “hard” converted standard for polyethylene pipe, AS 1159 which, in effect, prevented the accurate description of pipe by inch sizes and which gave the appearance of increasing the cost simply for the sake of metrication. Although in many cases the cost per metre for the new standard pipes was higher than the assumed inch equivalent the cost per litre of water delivered was usually comparable.

Despite repeated efforts to obtain industry agreement on a particular mode and date of conversion, in the absence of protective legislation, uniform conversion could not be achieved by 1982. Production continued to both the new and obsolete (AS K119) standards. This was seen to be an area of confusion for rural users for many years to come.

Plant Conversion

There were many manufacturing concerns in which product conversion was relatively simple, involving little more than the adaptation of batch sizes and filling equipment for the production of bulk powders in paper or plastic sacks, and liquids in drums or tank cars.

Many of these products were the result of very sophisticated chemical engineering processes. The conversion of the manufacturing plant was relatively complex and was expected to continue long after product conversion was complete.

Conversion of the plant at the same time as conversion of the product was usually impracticable and unnecessary.

Conversion of plant fell into two main categories. The first concerned conversion or replacement of pressure gauges, thermometers, recorders, tanks and vats, machine setting indicators, flow gauges and other items of equipment registering in imperial units. The second task related to the long term maintenance of major items of plant and involved conversion of the maintenance capability of the company including machine shop equipment, engineering spares and stores and the library of plant drawings.

In nearly every case, the plant in use was at various stages in its working life and was unlikely to be written off or worn out for many years. It was necessary, therefore, to determine a policy to be adopted in relation to this aspect of conversion.

For this purpose a comprehensive list needed to be made of every item of plant, equipment, control systems, recording and monitoring procedures or ancillary equipment which needed to be converted to achieve total conversion to metric operation.

Relative conversion priorities needed to be determined for each item and the work of conversion programmed into normal maintenance schedules according to the priorities given. It was quite clear that some equipment was more necessary to successful conversion than other. In fact, there was some equipment which did not require conversion. Instead, it was replaced with metric on renewal. The only objection to this approach was that within a few years the organisation would be operating in a totally metric environment, imperial spare parts would be harder to find and apprentices and younger employees would be unfamiliar with the old terms and units and might need special reverse training to cope. In many cases, operatives were unaware of the units on control gauges and merely operated between limits set by their supervisors. Such gauges would need to be changed eventually, but change would not be essential at a particular date.

The various items could be grouped as follows:

- Priority 1 essential for conversion.
- Priority 2 not essential for conversion, but needing early replacement for reasons of accuracy of control, safety etc.
- Priority 3 not essential for conversion but liable to early normal replacement.
- Priority 4 not due for early replacement, providing minimum inconvenience or hazard.

Conversion During Repairs And Maintenance

It was recommended that the engineering maintenance workshop be equipped to work in either metric or imperial units as required during the life of the plant. The workshop would thus retain the ability to refabricate spare parts from existing drawings whenever necessary without the need for arduous and mistake-prone conversions of existing plant drawings.

However, some design changes could be forced on imperial drawings by the substitution of metric material, such as plate or bar, when imperial supplies were no longer available. In this case, it was recommended that the drawing should not be converted but that the dimensions be altered to accept metric. Materials should be shown in imperial units. Dual dimensions should not be used on drawings.

Exact conversions from imperial to metric dimensions often resulted in unintentional apparent increases in precision, for example $\frac{5}{8}$ " on a drawing may imply $\frac{9}{16}$ " to $\frac{11}{16}$ ", a tolerance of $\frac{1}{8}$ " or approximately 3 mm. The exact conversion of $\frac{5}{8}$ " is 15.875 mm, and a tolerance of 0.001 mm might be assumed.

Attempts to round off the metric figure could result in errors which would alter the overall dimension of a component compared with its simple imperial size as designed originally.

Where spare parts were refabricated by direct reference to the dimensions of the part being replaced, the nearest equivalent metric material should be substituted and machining back to an imperial size avoided unless it was vital to do otherwise.

Before attempting to assess what stocks of imperial engineering supplies needed to be maintained after conversion, an analysis of plant for which imperial materials and spares would be critical needed to be made, and a policy on substitution on all other plant determined.

9.5 Primary Industry

For the purposes of metric conversion the rural sector was deemed to consist of the production, marketing and reprocessing of all animal and plant products, including seafoods, but not forestry. It, therefore, included animal raising, milk, butter, cheese, honey, wool and hides, grain, sugar, fruit, nuts, vegetables, tobacco, land descriptions, land-based statistics, farm machinery and farmer education as the products and processes to be converted.

Conversion of this group of industries was coordinated by the Primary Industry Advisory Committee and individual products and processes were converted by their particular Sector Committees as listed below:

- Grain and Seeds Sector Committee
- Wool Sector Committee
- Beef, Mutton and Lamb Sector Committee
- Pigs Sector Committee
- Poultry and Eggs Sector Committee
- Tropical Fruits Sector Committee
- Vegetables Sector Committee
- Tobacco Sector Committee
- Pome, Stone and Berry Fruits Sector Committee
- Cotton Sector Committee
- Sugar Sector Committee
- Fishing Sector Committee
- Agricultural Information Sector Committee
- Panel of Horticultural Authorities
- Tomato Panel
- Wholesalers Panel on Fruit, Vegetables and Hard Produce
- Fruit and Vegetable Packing Panel
- Farm Machinery and Construction Equipment Panel

Membership of these committees was, in the main, drawn from representative producer and marketing associations, relevant boards and Government departments. Where appropriate, committees were also made representative on a geographical basis.

Responsibilities of the Sector Committees generally covered practices inside the farm through to the first change of ownership of the produce, that is, at sale yard or the receiving dock of a processing plant. For a few sectors, such as poultry and eggs, produce was followed through to the retail pack.

Many sectors had direct interfaces with other sectors within and outside the primary group. Thus, pig production was concerned with grains and seeds used as stock feeds, and also with the meat products sector of the Consumer Goods and Service Industries Advisory Committee. The Dairy Products Sector Committee liaised with both the Primary Industry and Consumer Goods and Service Industries Advisory Committees.

Liaison between the Sector Committees and bodies responsible for the control of some aspect of the utilisation of their products was important in many cases. Thus, liaison with the Standing Committee on Packaging was necessary to the marketing and standardisation of packaged goods, such as milk, butter, sugar and dried fruits.

Many sectors were also concerned with the need to rationalise the wide and overlapping variety of packs and cases in use and panels were established for this purpose.

Conversion of primary industry, while covering a large variety of products, did not involve such extensive changes as occurred in many of the secondary industries. In most cases, conversion consisted of little more than a decision to use from a certain date, a metric unit of weight or volume instead of pounds, bushels, tons and gallons to describe farm output and yields. Conversion of most agricultural products was achieved by the end of 1973.

One of the first operations converted was the auctioning of wool at a price per kilogram. This occurred on 23 August 1971, following conversion of scales in the wool stores.

Metric egg gradings was another early change, commencing on 1 July 1972. It was followed by retail packs of sugar in kilograms the same year.

The complete conversion of agricultural and veterinary chemicals, particularly pesticides and animal medicines, did not occur until 1975, although most bulk fertilisers were packed in metric quantities some years earlier.

The Australian Bureau of Statistics called for farm production statistics to be submitted in metric from 1973 onwards. This required the farmer to be aware of the size of his farm in hectares and, while most continued, in 1982, to talk in acres, few were unaware of the meaning of land areas in metric.

Changes in farm machinery occurred much more slowly and principally with new equipment manufactured to designs created since conversion began. Existing equipment

and models which were still current at the time of most farm produce conversion continued to be sold and operated in imperial form. In most instances existing designs were, quite sensibly, “soft” converted to metric descriptions of size and performance.

By 1982, tractor power was stated mainly in kilowatts and drawbar pull in kilonewtons in advertisements although it is doubtful if, at that stage, the figures meant much to the older farmer. Application rates in kg/ha and L/ha were reasonably well understood by farmers as most agricultural chemicals and pesticides carried instructions for use in metric only and spraying pressures in kilopascals (kPa) were also used without difficulty. Despite the fact that directions for mixing and application were in metric only it was not necessary to convert or fit new instruments to existing spray machinery and tractors. Provided he worked out the area to be sprayed in hectares and the volume of his spray tank in litres before mixing, the farmer could continue to use his existing spray equipment at the same speeds, pressures and coverage rate as before.

Maintenance of farm machinery required the continued supply of most imperial spare parts and engineering supplies, although some substitution of shafts and bearings, plates and sections was possible. As with most long life industrial equipment it was not necessary or practicable to convert most existing farm machinery except perhaps to enable output quantities to be read in metric.

Farmer education in the techniques of using metric in usual farm operations was largely the responsibility of Agricultural Department regional offices and extensions services. As with other members of the public, general education in the use of metrics was obtained through the purchase of goods and services in metric quantities and especially from seeing farm implements and supplies described in metric in stores and at shows.

The dissemination of metric farming information to farmers, agricultural industries and organisations was organised by the Agricultural Information Sector Committee on which were represented State Agricultural Departments, the Australian Government Department of Primary Industry, the Agricultural and Veterinary Chemicals Association of Australia, Australian Fertiliser Manufacturers, the Australian Bureau of Statistics and the Australian Broadcasting Commission.

In 1973, the Board printed and distributed 300 000 booklets, “Metric Farming”, which explained the use of metric units in many farming applications. This booklet was distributed by rural supply companies and was reprinted in full in one of the major farmer newspapers. In retrospect, while this booklet was excellent for the purposes of explaining metrication and giving conversion factors it tended to be superficial and did not explain how to work in metric in specific tasks, such as irrigation, spreading fertilisers, spraying pesticides and fencing where more direct “how-to-do-it” information would have been more effective and useful.

In general, the units used by the primary industry sector were the same as those used by the community. However, there were a number of old units which were used

predominantly for rural applications. These included wool diameter in microns, rainfall in points of an inch, fences in chains, dams in millions of gallons or acre feet, grains and fruit in bushels, crop yields in bushels per acre and so on. These units were replaced by metric units.

The micron is an old metric unit, being one millionth of a metre. It is used to measure wool and cotton fibre diameter. This unit did not change but became known by its correct systematic name “micrometre” and symbol μm . The bushel was originally a volume measure of eight imperial gallons but has become a measure of weight where the number of pounds of a particular grain is known. Grain yield was recorded in bushels/acre, probably because, in the absence of weighing facilities in the field, it was easier to estimate the volume of grain recovered by counting the number of bags produced. Although the bushel is equal in volume to 36.4 L there is no equivalent volume unit in metric and the bushel is no longer used in regulations for grains or fruit. Bulk handling and yields were calculated directly in tonnes per hectare (t/ha) from the weighbridge ticket at the receiving centre. Grain quality is determined by chondrometer measuring in kilograms per hectolitre (kg/hL).

Excavations for dams were measured in cubic metres instead of cubic yards and the volume of storage was measured in megalitres (ML) instead of millions of gallons (1 million gal = 4.5 ML) or acre feet (1 acre foot = 1.23 ML).

One of the most useful changes in units used in agriculture was the simple change from points to millimetres of rain. This had particular significance in irrigation work. The simplification that this change brought the ordinary farmer allowed him to make his own irrigation calculations, something which was not usually possible in imperial units.

A millimetre of rainwater is exactly one litre per square metre

$$1 \text{ mm rain} = 1 \text{ L/m}^2$$

and when used in conjunction with the information that one hectare is exactly 10 000 m² the number of litres of water which must be applied per hectare to be equivalent to 1 mm rain is easily seen to be 10 000 L. The equivalent calculation in imperial units is

$$1 \text{ point of rain} = \frac{1}{100} \times \frac{1}{12} \times 6.23 \text{ gal/ft}^2$$

which is a moderately difficult calculation for many farmers to do, even on paper.

Likewise the power of a pump required to raise a quantity of water in litres per second a height in metres using a pump of known efficiency is given by the formula

$$\text{pump kW} = \frac{\text{metres head} \times \text{litres per second}}{\text{per cent efficiency}}$$

For a pump delivering g gals/min to a height of ft feet with a pump of E per cent efficiency the equivalent calculation is

$$\text{pump h.p.} = \frac{g \times ft}{E \times 33}$$

Since neither imperial calculation was one which could be done in the head such computations were usually beyond the scope of the average farmer.

In metric, both calculations were simple mental arithmetic. While this might have been of little relevance to the pre-metric generation of farmers, the change to metric would mean that future farmers would be able to do many of their own irrigation calculations and designs.

With regard to acceptance of metric by farmers, this industry was almost entirely experience trained, and voluntary changes without detailed instructions in working in metric did not occur unless the farmer was shown on the job or forced by the purchase of metric equipment to make the change. Consequently, old units predominated in most rural activities and, since much of the education of farm workers was by word of mouth, penetration of a knowledge of metric was expected to take a long time.

In many ways farm workers were similar to the small organisation tradesman in his inability to bring about his own conversion and it was clear that successful metrication in agriculture would depend on the effectiveness of the efforts of agricultural departments and suppliers' extension services.

9.6 Consumer Goods and Services

It was recognised from the outset that metrication of the retail trade and the purchase of foodstuffs, packaged goods, clothing and household goods would provide the maximum exposure of ordinary people to metric units and the greatest number of opportunities to gain experience in the use of metric units, and hence would have a major impact on public acceptance of metric measurements. Because of this, a number of early conversions directly involving the consumer were deliberately engineered to begin the establishment of a metric environment which would ultimately surround people, both in the supermarket and at home.

As a result, with each change to sole metric trading, people quickly learned how to obtain the quantities they required in metric just as easily as they used to do in imperial. No one in Australia seemed to have to do without because of his or her inability to understand the metric measurements used.

Planning for conversion of consumer goods embraced those industries concerned with the production, processing, packaging, wholesaling and retailing of articles and commodities offered for sale in shops and department stores; food processing, dairy

products, meat and meat products; and beverages. The range extended into textiles and manchester, clothing and footwear, household equipment and garden supplies.

Conversion of consumer goods and services was organised by the Consumer Goods and Services Industries Advisory Committee plus the sector committees, working parties and panels listed below:

- Consumer Goods and Service Industries Advisory Committee
- Dairy Products Sector Committee
- Packaging Materials Sector Committee
- Packaged Goods Sector Committee
- Bread and Pastry Sector Committee
- Beverages and Licensed Premises Sector Committee
- Textiles Sector Committee
- Clothing Sector Committee
- Meat Products Sector Committee
- Wholesaling and Retailing (Large Establishments and Chains) Sector Committee
- Wholesaling and Retailing (other than Large Establishments and Chains) Sector Committee
- Household Utensils and Equipment Sector Committee
- Financial and Commercial Activity Sector Committee
- Personal Services Sector Committee
- Working Party for Retail Scale Conversion in New South Wales
- Working Party for Retail Scale Conversion in Victoria
- Working Party for Retail Scale Conversion in Queensland
- Working Party for Retail Scale Conversion in South Australia
- Cream Packaging Panel
- Milk Packaging Panel
- State Carpet Retailing Panels
- Soap Industry Panel
- Smallgoods Panel

The main task of all consumer goods committees was to determine appropriate preferred metric sizes in an environment where there were a minimum of formal standards, then to plan for the necessary changes to take place progressively in a logical

pattern within the confines of legislative requirements, preservation of export markets and the requirements of the consumer.

The importance of liaison with other Advisory Committees was recognised, as was close cooperation with organisations and authorities external to the Board, including the Standards Association of Australia, the Standing Committee on Packaging, Chambers of Manufactures and Commerce, and Consumer Organisations. For example the introduction of preferred sizes of packaged goods was coordinated with the legislative requirements of the Uniform Packaging Code and excise regulations.

The early cooperation of the Standards Association of Australia in converting imperial units in existing consumer standards to metric units provided a comprehensible basis for commercial transaction. SAA was directly concerned in the standardisation of the packaging of consumer commodities by mass or volume, and in the physical properties of various items such as packets, cans, buoyancy vests, children's toys, bicycles and saucepans. A range of standards was developed to cover infants and children's wear, school wear and women's and men's wear in which size designation systems were related to body dimensions in centimetres. By thus specifying products in metric terms, market exchanges were facilitated to coordinate conditions of supply and demand for products and promote orderly marketing from the very first meeting of the Consumer Goods and Services Advisory Committee. The committee also accepted that it was its responsibility to ensure that no attempt was made to take unfair advantage of the consumers' lack of knowledge of metric quantities. While the Board and its committees had no powers to deal with malpractice, the public's own vigilance and the possible publicity attendant upon such malpractice served as deterrents. No cases were reported to the Board which proved to be other than genuine errors.

The Advisory Committee also recognised that concern for, and fear of, the impending change would result from one or more of the following:

- public ignorance of why the change was being made, how it would be implemented and how it would affect the consumer.
- lack of size appreciation of the units of measurement used in the purchase of consumer products.
- lack of appreciation of how little actual assistance would be needed by the consumer.
- difficulty in making quantity and price comparisons during the transitional period when both imperial and metric pricing were allowed.

It was felt that these fears could best be dispelled by departing as little as possible from established practice. For example, women's outerwear had, for a number of years, been labelled to a numerical code — each number related to imperial bust, waist and hip measurement as set down in an Australian Standard. Under conversion, the numerical

codes remained unaltered with the measurements related to that size expressed in centimetres.

The early appearance of true metric packs of familiar reference commodities like sugar, salt, soap powder and soft drinks was believed to have been advantageous when marked solely in metric units.

Retailers planning metrication based their programs upon two aspects of the MCB's charter:

- conversion would take place over a period of years.
- no compensation, as such, was to be paid by the Government to industry for the costs of conversion, although provision was made for taxation concessions for the cost of purchase or conversion of retail scales.

Many major retailers advocated early legislation to require sole mandatory use of metric trading units in order to make the transition period as short as possible. While this had to wait for the requisite amendment of Weights and Measures Regulations in the States and Territories, the Metric Conversion Board provided posters to retailers and leaflets for customers, assistance in training retail staff, and display materials in supermarkets and other suitable locations.

It was recognised, early in the changeover, that metrication would give the manufacturer and the retailer a golden opportunity to simplify the number of stock items the retailer carried by rationalising sizes and size ranges, and that many commercial transactions would be simplified by the ease of calculations in a decimally based system.

Packaged Goods

The major consideration of the Packaged Goods Sector Committee was directed towards formulating, in conjunction with the Standing Committee on Packaging, appropriate metric quantities for packaged goods. Their recommendations covered labelling and marking, preferred sizes for non-standardised commodities, prescribed sizes for standardised commodities and timing for the change.

Members of the Packaged Goods Sector Committee were nominees of the Standing Committee on Packaging, Grocery Manufacturers of Australia, National Packaging Association, the Pharmacy Guild of Australia, Cosmetic and Toiletry Manufacturers' Association of Australia, National Council of Chemical and Pharmaceutical Industries, National Standards Commission, Confectionery Manufacturers of Australia, Adhesive Manufacturers' Association of Australia, Australian Canners' Association, Chambers of Manufacturers, Federal Council of Flour Millowners of Australia and State Consumer Affairs Authorities.

The original timetable for the conversion of packaged goods was as follows:

- sole metric marking should be permitted from 1 January 1972.

- non-standardised commodities should undergo conversion by a three-stage approach beginning 1 January 1972 to reach, if possible, an ideal packaging pattern by 1 January 1976.
- sole imperial marking should not be permitted after 1 January 1974.
- standardised commodities should undergo conversion from 1 July 1972 progressively for completion no later than 1 January 1976. Individual completion dates for each commodity in this period should be recommended after full consultation with the industry involved.

The early development of firm guidelines for metric packaging was of great benefit in the planning and implementation of the conversion of packaged goods. These guidelines were explained in detail in a series of documents, entitled “Metric Conversion and the Quantity Marking and Standardisation of Packaged Goods”, Issues 1 to 5, known as the Statement of Principles, which were produced by the Standing Committee on Packaging (SCP), a joint Federal–State Authority for coordinating packaging legislation. It was found possible to omit “Metric Conversion” from the title of Issue 6, since the metrication of packaged goods was virtually complete.

The Statement of Principles enabled manufacturers to plan conversion of their packaged products with confidence, with desirable long-term goals and a clear understanding of the requirements of the relevant authorities

In consultation with SCP, the Board produced a pamphlet giving advice to package and label designers and printers on the correct use of metric units and symbols to encourage correct metric usage and uniformity of labelling of packaged goods.

The change to metric sizes provided opportunity to rationalise the large number of rigid containers (for example, cans and jars). By standardising these containers by volume it was possible to reduce the number of can sizes, for packing goods sold by mass, from approximately 90 to 30.

Another example in wholesale packaging concerned corrugated fibreboard cases for packing fruit. With the establishment of metric packing quantities the opportunity was taken to reduce the variety of shapes and sizes from many hundreds to about 50.

When non-recommended quantities were packed in acceptable rigid containers, an additional statement showing the container capacity in millilitres was required. The quantity marking was in multiples of five or, preferably, ten grams.

The specifications for the additional statement were use of the words “x mL container” within a circle (where “x” was the listed gross lidded capacity of the container) and certain conditions of size of print, placement etc.

In spite of the early decision to retain the 1170 × 1170 mm standard Australian pallet (incompatible with ISO Freight Containers), for use within Australia, the increasing use of International Freight Containers on Australian transport systems resulted in the development of a standard 1100 × 1100 mm unit load module (1120 × 1120 mm

maximum dimension pallet — AS 1899-1976) which was compatible with ISO Freight Containers and all internal systems.

While the 1170 × 1170 mm pallet was expected to remain for many years, the 1100 × 1100 mm was gradually phased in as packaging designers began using this size for their designs.

Goods Weighed Or Measured In The Presence Of The Customer

The metric conversion of goods weighed or measured in the presence of the customer, which affected practically every form of wholesaling and retailing of goods and services, was unique in two ways. The first was that existing State legislation covered all transactions where the price paid was for a measured quantity. This meant that new legislation was not necessary, as amendment to the existing legislation would, in general, be adequate. The second was that for the first time, people would find themselves asking for goods in metric units. Previously, the predominance of self-service in packaged goods outlets had meant that buying a 500 g or a 250 g packet of cornflakes involved the customer only in taking one of them from the shelf after deciding between the 'large' and 'small' packet. The purchase of sausages, carrots, bacon, turf, sand, rope, fabric etc., would involve customers in deciding what metric amount they needed and actually asking for a metric quantity.

In 1973, the Board, the two Wholesaling and Retailing Sector Committees, and the Weights and Measures Authorities of the States and Territories recognised that before Australia's conversion would be completed it would be necessary to require that all trading be conducted in appropriate metric units and that, accordingly, all instruments in use for trade, for example, weighing instruments, would have to be graduated in such units. The Board took the view that, initially, retailers should not be compelled to convert their imperial scales at a particular time. The desire to leave with retailers the choice of when to implement their conversion was in keeping with the principle of voluntary metric conversion to which the Board operated from the outset. This policy was adhered to despite representations to the contrary by leading trade associations.

Accordingly the MCB offered to act as coordinator in the selection of specific geographic zones where the conversion on a voluntary basis could be commenced. As a first step, in January 1974, panels were set up in Victoria and New South Wales to commence the planning of the conversion program. These panels comprised nominees of the various trade associations involved, the Scale Makers Association of Australasia (SMAA), the Weights and Measures Authority and the MCB. The panels each established a working party to help organise the zonal conversion in their States.

The decision to use a zonal program of scale conversion was adopted for the following reasons:

- it was thought that a whole area 'going metric' at the same time would allay the fears of some retailers that they might lose business to competitors who did not convert at that time.
- scale manufacturers and adjusters could provide more efficient and more economic service by concentrating their staff in areas zoned.
- more effective support for facilitating the change could be organised by the Metric Conversion Board.

The Australian Meat Board and the MCB published a kit for butcher shops which was distributed by the Meat and Allied Trades Federation. Other posters published included one for fruit and vegetable retailers and a combined one for delicatessens, health food stores and fish shops. Another poster, 'Metric Shopping', was an aid to help shoppers to order in metric units. A 'Metric Shopping Guide' which gave price and mass comparisons was made available to shoppers to reassure them that they were not being price disadvantaged by the metric change.

As part of the MCB role in the exercise, a small number of assistants were recruited for the Sydney and Melbourne areas involved. Their job was to visit all retail shops employing weighing instruments, inform retailers of conversion plans, distribute posters and other relevant literature and give other assistance toward consumer education and reassurance as appropriate.

A handbill, in Greek, Italian and English, was printed and distributed to retailers for guidance. It listed the concessions relevant to scale conversion which were:

- Section 536 of the Income Tax Assessment Act (No. 51 of 1973) permitting essential conversion costs as an allowable deduction.
- Item No. 149 of the First Schedule to the Sales Tax (Exemptions and Classifications) Act (No. 17 of 1973) which exempts conversion kits from Sales Tax.
- duty free entry of conversion kits (Item 20 of the Consolidated By-Law references).

The first zones for conversion were the Sutherland Shire in New South Wales and the Mornington Peninsula in Victoria. The conversion programs in these zones commenced on 1 July 1974.

As expected, from 1974 onwards the retail scale conversion program emerged as the predominant program requiring attention and facilitation. To this end, the major proportion of MCB resources and expenditure were allocated to this continuing task. The activity was all-pervasive, affecting every consumer in Australia and it was recognised that the change must be spread over a number of years because of the magnitude of the task of changing to metric instruments in relation to the specialised

workforce available. It was of direct concern to weights and measures authorities that during the transition from the use of imperial to metric weights and measures, the units, instruments and practices used in trading were under proper control. It was also of concern to the consumer protection authorities because of possible confusion, both to consumers and traders, during the period of change and the risk that some would be disadvantaged in these circumstances in the absence of appropriate controls.

In accordance with its charter to report to appropriate authorities any attempts to take unfair advantage of the public, inquiries were instituted by the Board in respect of all alleged cases of unjust pricing reported or detected.

Liaison and cooperation were maintained with statutory consumer protection authorities with mutual benefit.

At the suggestion of the Minister, private and statutory consumer organisations were invited to meetings held in Sydney in August 1974 and Melbourne in October 1974.

The purpose of the meetings, to which the press and the Australian Anti-Metric Association were invited, was to provide a forum for discussion and the exchange of information relating to metric conversion in retailing and its effects on consumers.

By the end of 1975 it had become clear that purely voluntary conversion would result in a protracted period of confusion resulting from:

- imperial trading using metric weighing machines.
- non-uniform pricing practices which result in the consumer being unable to make simple price comparisons.

Fear that going metric would put the retailer at a disadvantage relative to his competitors proved more significant and intractable than was expected. For this reason some traders who had converted their scales continued to trade and advertise in imperial units or to adopt non-uniform metric pricing techniques.

In South Australia, controls aimed at overcoming most of the problems associated with zonal (and non-zonal) conversions were introduced through regulations gazetted on 31 July 1975 under the Trade Measurements Act.

These regulations were intended to ensure that, in a conversion zone:

- the consumer could easily make comparisons of prices because it was required that unit prices (e.g. price per kilogram, price per metre) be shown in terms of prescribed metric units, irrespective of whether the measuring instrument is graduated in imperial or metric units.
- the quantities in terms of which lot sales may be advertised (e.g. “200 g for 45 cents”) must be related to the pricing unit, that is, price per kilogram in the above example in a simple manner.

For some commodities, the conversion of which was completed, the regulations already required metric pricing throughout the State.

The above requirements did not at that time preclude the additional presentation of unit prices in terms of imperial units provided the imperial information was not more prominent than the metric.

These regulations, which in South Australia were welcomed by retailers including many who had previously refused to have their scales converted, helped to alleviate customer and retailer confusion and retailers' fear of being disadvantaged by competition from other retailers who had not changed.

The Metric Conversion Board strongly supported action taken in South Australia and sought similar action in the other States and Territories. To this end, in December 1975 the Board sponsored a meeting of State officials to discuss the question. The meeting, held in Adelaide, endorsed the principle of enacting controls along lines similar to those in force in South Australia. State Working Parties (comprising nominees of retailing groups, the scale industry and State Weights and Measures Authorities) expressed unanimous support for the introduction of such government controls in their respective States.

Attempts to change the sale by length and area of goods such as carpets and hardware items, without the necessary legislation, were also largely unsuccessful with the exception of fabrics and piecegoods. MCB and the Retail Trading Association set a nationwide 'M-Day' for the change to selling these items by the metre, and with a few exceptions, mostly in discount fabric shops, the changeover held good.

By mid-1978, legislation had been amended to require metric trading and metric advertising in South Australia and Tasmania. Western Australia and Victoria were making the change by zones. New South Wales and Queensland were both studying the feasibility of making the change operative for the whole State at the same time. Since the scale population in those States was already predominantly metric, such a change would present no logistics problems.

The Formal Conference of Weights and Measures was able to expedite the introduction of metric weighing instruments by formulating cut-off dates. The date applied to new instruments was 1 March 1975, and the cut-off date for all others to be graduated in metric units was 1 January 1978 (1 March 1977 in New South Wales). This meant that as all instruments had to be changed before the date for reverification fell due, the scale industry was able to accommodate the rate of change.

This was followed by a decision by all States and Territories to require the use of metrically graduated measuring devices for all trade measurements and (except in Tasmania) to require the unit price per kilogram, metre, litre or cubic metre, as appropriate. Some States still permitted a multiplicity of pricing units, which tended to detract from simple price comparisons.

The recommendation for the price per kilogram only to be shown for goods to be weighed in the presence of the customer applied throughout New South Wales, the Northern Territory and Victoria. In the Australian Capital Territory, Queensland, South

Australia and Western Australia, the display of the price per kilogram was compulsory but, additionally, price in a multiplicity of other metric units was allowed for a period. In the Australian Capital Territory, Queensland and Western Australia imperial pricing was also permitted. The legislation in Tasmania allowed only metric statements, although the price to be shown was not necessarily the price per kilogram.

With the predominant use of digital scales which showed the mass of goods, the price per kilogram and the total cost, pricing in imperial units became superfluous and kilogram pricing was widely accepted.

Goods sold by length (such as timber, carpets and fabrics), goods sold by area (such as sheet glass and plywood) and goods sold by volume (such as petrol and gravel) were also covered in all States by legislation similar to that for weighed goods. Even where there was still provision for the additional use of imperial units, most retailers recognised the confusion resulting from dual marking and traded only with metric prices.

At the last meeting of the Metric Conversion Board, on 16 June 1981, the Chairman of the Consumer Goods and Services Committee was able to report the following position with respect to weights and measures legislation in Australia:

- the recommended practice of allowing only a price per kilogram or tonne for goods weighed in the presence of the customer, applied throughout New South Wales, the Northern Territory, Western Australia and Victoria.
- in the Australian Capital Territory, the imperial price was allowed but could not be shown more prominently than the price per kilogram.
- imperial pricing was not allowed in the remaining States, but in South Australia and Tasmania, retailers were allowed to price goods in metric units other than per kilogram.
- in Queensland, weights and measures regulations had been amended to require that the kilogram price be shown in addition to the price for any other multiple or fraction of a kilogram.

The uniform requirement that the price per kilogram be shown removed the difficulty faced by shoppers in trying to assess the relative value between three shops selling the same goods, for example, one greengrocer selling mushrooms at \$2.29 a pound, another at \$1.29 per 250 g and a third at \$4.49 per kilogram.

The value to the customer of this type of legislative assistance was not always understood, but it was urged by many retailers and Retail Traders' Association for a considerable time prior to its introduction. The conversion of retail scales, begun in 1973, had been completed throughout Australia by 1982. Many retailers took advantage of the changeover to introduce new digital scales which computed prices more accurately and reduced the time spent on each weighing operation.

In hindsight, the decision to press for “per kilogram” only pricing was unfortunate. While pricing on a common unit basis facilitated price comparisons, it gave no guidance to the public on sub-kilogram quantity selection. As a consequence, consumers reverted automatically to the halving and quartering process which was so much a feature of the 16 ounce–pound system. Although Australia’s decimal currency system is a true decimal system based on a unit and multiples of a tenth of a unit, no encouragement was given to people to make use of the decimal nature of the metric system, and Weights and Measures Authorities continued to have difficulty in eradicating per 250 g and per 500 g pricing.

In Canada and Singapore, fractional pricing based on halves and quarters of the kilogram was forbidden but prices per kg or per 100 g were permitted. This simple device ensured that in those countries sub-unit quantities were obtained as multiples of one tenth of a kilogram and successive halving was avoided.

For the same reason, packaging regulations in Australia permitted 125 g, 250 g, 750 g and the much criticised 375 g size.

For Australia to gain the fullest benefit of conversion to a decimal system of weights and measures, it was inevitable that authorities permitted and encouraged “per 100 g” pricing in addition to “per kg” pricing.

Goods Described By Measurement

As there was no legislation, either State or Federal, which specified the units of measurement to be used in the sale of goods described by measurement, the descriptions of such goods were more difficult to convert than the descriptions of quantities in packaged goods.

Except where goods were sold at a price per unit of measurement, such descriptions did not come within the purview of traditional weights and measures authorities. In September 1977, a special Retailing Industry Metrication Review Committee was convened to review progress, to identify remaining problems and to consider action necessary to complete the conversion of goods described by measurement. Organisations that participated were:

- Australian Confederation of Apparel Manufacturers
- Australian Council of Furniture Manufacturers
- Australian Federation of Consumer Organisations
- Australian Retailers’ Association
- New South Wales Department of Consumer Affairs
- Standards Association of Australia
- Textile Council of Australia

- Retailers: David Jones, Barry and Roberts, John Martins, Nock and Kirby, Woolworths, Waltons and Myer Group
- Metric Conversion Board

Full support was expressed, with minor reservations, for the application of legislation to progressively and systematically finalise the conversion exercise in an orderly manner and to attain a solely metric market place.

In order to minimise confusion until such legislation was available, the Metric Conversion Board pursued a policy of seeking individual industry cooperation in conversion. Advertisers were encouraged to increase their use of SI units, and a pamphlet was prepared to assist them with correct usage and realistic conversion.

During 1977, increased effort was directed to consultative processes, and to the formulation, drafting and implementation of the proposed initiatives.

During 1978, there was a dramatic increase in the extent to which metric dimensions were used in the description of such goods, often to the exclusion of imperial dimensions. This was ascribed to the general increase in metric usage and understanding in the community, particularly in regard to packaged goods and goods measured in the presence of the customer.

However, it was generally recognised by manufacturers, retailers, consumer protection authorities, consumer organisations and authorities concerned with the control of trading practices, that mandatory control of advertising of goods described by measurement would be essential if a confused, lengthy and disadvantageous transition to the use of metric units was to be avoided. This view was expressed at a widely representative meeting of key organisations which met in September 1977, to review progress with metric conversion and to consider desirable action to complete the orderly change to the sole use of metric units for such goods. It was confirmed at a conference of Ministers in October 1977, and was reconfirmed in very positive terms at a further meeting held in March 1979. Participating organisations at this latter meeting included:

- Australian Confederation of Apparel Manufacturers
- Australian Council of Furniture Manufacturers
- Australian Federation of Consumer Organisations
- Australian Toolmakers Association
- Confederation of Australian Industry
- Metal Trades Industry Association of Australia
- Plastics Institute of Australia
- Real Estate Institute of Australia
- Retail Traders' Association
- Small Business Advisory Council of New South Wales

- Timber and Building Material Merchants Association of New South Wales
- Timber Merchants Association (Victoria)
- Victorian Chamber of Manufactures
- Metric Conversion Board

In late 1979 and early 1980, the MCB convened meetings of major retailers in New South Wales, Victoria and South Australia to consider what practices might be adopted in respect of goods described by measure, at least on an interim basis pending the introduction of mandatory controls.

In all three meetings, immediate agreement was reached that the companies participating would, from then on, use sole metric measures in their merchandising. This policy was closely followed.

It was obvious that the rapid elimination of confusion in the marketplace, without consumer complaint and with the approval of retailers, that resulted from the amendment of weights and measures legislation, could reasonably have been expected if the requisite legislation were provided for goods described by measure.

In the absence of supporting legislation, the Metric Conversion Board continued to pursue its policy of approaching individual industries for voluntary conversion. The wide variety of individual consumer items, the manufacturers of which agreed to a voluntary change, was a clear indication that most industries were pleased to be relieved of the need to use both systems. The manner in which the change of some consumer items was effected is outlined in the following sections covering specific products.

Clothing And Textiles

Acceptance by industry of the Australian Standards Association's recommendations on size coding for clothing, assisted the adoption of metric sizes in the market place.

Initially, attention was given by the Textile and Clothing Sector Committees to the revision of relevant standards and to the selection of preferred units of measurement for adoption.

It was recognised that metric conversion would provide the opportunity to seek uniformity where divergence of practice and sizing was evident, and to encourage rationalisation where appropriate and beneficial to the consumer. A program was envisaged as follows:

- delivery of metric yarn to commence about January 1973.
- delivery of metric fabrics to commence about July 1973.
- delivery of metric-sized clothing to commence in the first half of 1974

With respect to the revision and updating of existing standards and the formulation of appropriate new ones, the SAA was a major participant in this sector. Sector Committee members were, in many cases, also members of the SAA committees, thus ensuring

close cooperation. The industry saw metric conversion as an opportunity to establish uniform size codings for garments, such as men's trousers, suits and shirts, for which there were no standards.

In women's clothing sizes, the Australian Standard L9-1970, which provided a series of numerical sizes related to body measurements in inches, was revised so that the existing numerical sizes were retained. Only the specific body measurements pertaining to the numerical size were converted to centimetres. This meant that a woman taking a size 12 garment continued to take size 12 after conversion.

In order to retain quantities similar to those used under the imperial system, it was agreed that piece goods would be sold by the metre and tenths of a metre, which closely approximated the practice of buying by yards and eighths of a yard. The centimetre was chosen as the common consumer unit of measurement for description of clothing sizes, manchester sizes, etc., with millimetres being used for hem descriptions. In general, rounding down was adopted to prevent overstatement of sizes. The MCB sought the advice of the Department of Customs and Excise to ensure that importers adopting the rounded down descriptions would not contravene tariff requirements.

The SAA commenced publishing metric standards for size coding schemes with AS 1182-1972, Size Code Scheme for Infants' and Children's Clothing (Underwear and Outerwear), which replaced L 50-1971.

These were followed by AS 1601-1973, Size Coding Scheme for School and College Wear for Boys and Girls, AS 1334-1975, Size Coding Scheme for Women's Clothing (Women's Underwear, Outerwear and Foundation Garments), and AS 1954-1976 Size Designation Scheme for Men's Clothing (including multiple fitting Outerwear and Industrial Wear). The standard for women's wear was revised in 1981. Foundation garments and brassieres were removed from the main standard, as a new measuring system demanded the establishment of a separate code for those garments.

There was some initial difficulty with the new metric sizing of business shirts, due to dual labelling, with some manufacturers labelling as follows,

15" / 38 cm	(15" = 38.1 cm)
15½" / 39 cm	(15½" = 39.4 cm)
16" / 41 cm	(16" = 40.6 cm)

so that customers continuing to ask for imperial sizes were not offered a 40 cm size. As a consequence, retailers saw little "demand" for the 40 cm size and did not add it to their stock.

By omitting the range between 39 cm and 41 cm, retailers provided minimum size variation at the point of greatest demand, with the result that a customer finding a 39 cm collar a little tight, had no option but to take a shirt of 0.788 inches greater interval instead of the previous 0.5 inch interval.

This difficulty was largely resolved as manufacturers and retailers discontinue the use of dual markings.

In 1977, a Bill was passed amending the Trade Practices Act to permit the calling up of standards produced by authoritative organisations, for example, SAA, for the purpose of Sections 61 and 62 of that Act. However, the Department of Business and Consumer Affairs appeared to consider standardisation of clothing sizes to be an infringement of a manufacturer's right to make other sizes and so opposed rationalisation by standardisation.

In response to a request by the Australian Retailers' Association, because of concern at the failure of manufacturers and retailers to adopt the SAA clothing standards voluntarily, the MCB convened a meeting to discuss these matters (March 1979).

The following organisations participated in this meeting:

- Australian Confederation of Apparel Manufacturers
- Australian Federation of Consumer Organisations
- Australian Knitting Industries Council
- Department of Business and Consumer Affairs
- New South Wales Department of Consumer Affairs
- Retail Traders' Association
- Standards Association of Australia
- Metric Conversion Board

In spite of the strong representations which were made to the Department of Business and Consumer Affairs by all the consumer and trade organisations represented at the meeting, that the benefits of rationalisation of sizes and uniformity of their description should actively be sought by the calling up of standards, the Department continued to oppose these initiatives.

Footwear

The metrication of footwear could not accurately be termed a conversion since the many previous shoe sizing codes did not use imperial measurements. Apart from rubber thongs, previously marked in inches and later marked in centimetres, the footwear industry used a number of different sizing systems including those known as the British, the American Fractional Fitting and the Continental systems.

The Australian shoe market was supplied from many sources, and even within Australia there was a great deal of variance in manufacturers' interpretation of sizes. As a result, consumers had long found themselves unable to say what size their shoe actually was.

ISO and SAA had, for many years, urged the adoption of the Mondopoint system which was taken from the length and girth of the foot in millimetres. Some countries

had adopted the length measure for shoe sizing, but adoption of true Mondopoint sizing had not occurred widely.

Dairy Products

The important aspects of the metrication of the dairy industry to the consumer were the decision to use 200 mL, 300 mL, 600 mL, 1 L and integral multiples of 1 litre for milk, and 125 g, 250 g, 375 g and 500 g for butter.

The 600 mL bottle developed as an Australian Standard by SAA, was introduced first in New South Wales in November 1973, and progressively replaced the pint bottle as these were lost, destroyed or became unusable. By March 1974, all remaining imperial bottles were removed. Despite objections that 500 mL should have been adopted in preference to 600 mL, 600 mL and 300 mL were more truly metric sizes, being multiples of 100 mL, than 250 and 500 mL, which were obtained by successive halving of 1000 mL.

The smooth transition to sole metric bottles in New South Wales and the existence of a standard shape recommended similar activity in other States and Territories. The conversion of all packaged dairy products — milk, cream, butter, cheese and milk powders — was completed early in 1976.

Meat

The Meat Products Sector Committee, which was drawn principally from nominations provided by the Meat and Allied Trades Federation, drew up a conversion program in which attention was given to conversion of weighing instruments in all retail butcher shops, and also to the effect of conversion activities upon the meat export trade.

The program covered extensive conversion in the abattoir and wholesale sectors prior to March 1973. At each establishment, the committee recommended that the exercise be commenced with conversion of livestock weighing, followed by conversion of the abattoir, wholesaling and boning sections.

Appropriate metric sizes for smallgoods were recommended by the National Smallgoods Council of the Meat and Allied Trades Federation, supported by the Board and accepted by the Standing Committee on Packaging. The conversion of smallgoods was completed by the end of 1975.

After some initial problems with the conversion of the Export (Meat) Regulations, the Regulations were promulgated at the end of 1978.

Bread

The Bread and Pastry Sector Committee membership was drawn from nominations provided by the Standing Committee on Packaging, the Associated Bread Manufacturers of Australia and New Zealand, the Master Pastrycooks' Association, the National Council of Women and the Bread Research Institute of Australia.

The committee adopted an approach which envisaged utilisation of existing baking tins and bakery equipment.

State legislation and regulations required significant revision once final recommended sizes were formulated.

The specific recommendations were:

- that bread loaf sizes of 225 g, 340 g, 450 g, 680 g, 900 g and 1800 g be adopted to replace the existing sizes of 8 oz, 12 oz, 1 lb, 24 oz, 2 lb and 4 lb respectively.
- that the prescribed masses of bread rolls be the equivalent of the existing imperial masses rounded to the nearest 10 g.
- that, if possible, legislation be amended to enable bread to be sold in metric terms from 1 January 1973.
- that a period of grace be allowed for the continued use of embossed bread tins and printed wrappers with imperial mass markings (five years and 18 months respectively) with provisions for extension.

While ideal rounded metric sizes such as 500 g might have been preferable, “soft” conversion of bread sizes meant that new baking tins or ovens would not be required.

The recommended sizes, adopted in 1972, proved to be acceptable to the industry. The period of grace allowed for the attrition of imperially embossed bread tins was found to be more than adequate and bread products were substantially metric by 1974.

Beverages

The Beverages and Licensed Premises Sector Committee was drawn from national associations of brewers, winemakers, spirit merchants, soft drink manufacturers, hoteliers and licensed clubs, and the bottle manufacturers. A matter of concern were the difficulties presented by returnable bottles, the determination of preferred bottle volumes and the complex implications of excise requirements.

The legislation controlling excise on beer was amended so that from 1 July 1972 it was levied in cents per litre.

Sole metric marking of bottled beer commenced in South Australia and Western Australia in 1971. In the Eastern States, sole metric marking commenced during the latter half of 1972 and was completed by the end of 1972.

In spite of a prediction that the conversion of proprietary bottles might present problems and require a longer time for conversion than standard or stock bottles for wine, spirits and soft drinks, which were converted by December 1973, most bottles in this category were converted by 1975.

In Issue 6 of “Quantity Marking and Standardisation of Packaged Goods”, the 370 mL and 749 mL beer containers were no longer allowed, and a number of soft drink, wine, spirits and spirits packs were withdrawn by January 1983.

Because of wastage of beer glasses through breakage, the change to metric sizes was completed by 1979.

By the end of 1980, some States spirit measures were still either metric (30 mL) or imperial (1 fl oz = 28.4 mL). The cooperation of State regulatory bodies for the discontinuance of the permissive use of imperial measures was sought as South Australia, the Northern Territory and Victoria had completed the change to sole metric measures for spirits.

Precious Metals

Prior to 1982 there had been a significant amount of trade in the precious metals gold and silver, in the form of miniature ornamental ingots and pendants, as well as in commercial sized ingots, described and advertised in terms of mass — sometimes in grams but also in “ounces” which were, in fact, troy ounces. This resulted in some confusion due to the lack of awareness of the difference between the troy ounce and the avoirdupois ounce. Because of this, and because of the degree of sole metric trading evident in South Australia, Western Australia, Tasmania and Victoria and increasingly in Queensland and New South Wales, legislative action was considered necessary by the Board to require retail transactions in gold, silver and other precious metals be conducted to in metric units only. South Australia already had such a requirement and consideration of the recommendation require was sought from New South Wales, Tasmania, Western Australia, Queensland and Victoria.

By 1982, retail sales were in grams but ingots were still sold on the bullion market in kilogram or troy ounce bars.

Personal Weighing Machines

Personal weighing machines on chemists’ premises, in post offices, etc., were, by 1982, predominantly metric.

Domestic Utensils And Equipment

The responsibilities of the Household Utensils and Equipment Sector Committee covered many products.

The two main areas were cooking and dressmaking. In the ease of pots and pans and other kitchen equipment, the change to metric sizes was steadily undertaken by manufacturers and retailers as imperially marked stock was replaced by metrically marked stock. Domestic cookery scales were exempted from the prohibition of imperially marked measuring instruments, but the decision by the cookery sector

committee to recommend the use of cup and spoon measures meant that most writers of recipes adopted this system, thus obviating much of the need for metric cooking scales.

Metric cooking jugs, cups and spoons were in increasing demand to match the growing availability of Australian cookbooks which used metric recipes.

Domestic gas and electric ranges were marked in Celsius temperatures from the beginning of 1975.

All new domestic tape measures and similar measuring devices were graduated solely in metric units. The application of import restrictions on non-metric measuring devices resulted in a major importer of cutting boards having them designed and printed in Australia. However, with the withdrawal of the import regulations these items again became available in dual.

Early in the change from imperial to metric measures, a number of patterns gave 5 cm increments, which caused dissatisfaction among fabric buyers who found they were unable to purchase fabric in less than 10 cm increments, the increment adopted by the retail trade to correspond to the imperial practice of selling $\frac{1}{8}$ yard increments. Representations by the MCB resulted in paper pattern manufacturers using increments of 10 cm for fabric requirement. All catalogues of the four major paper pattern manufacturers were printed in metric terms and three of these manufacturers, commanding some 80 to 90 per cent of the market, printed all new patterns in sole metric terms. The remaining manufacturer, importing from the USA, was expected to adopt sole metric usage shortly.

In Australia, size codes for knitting pins and crochet hooks were traditionally those of the Imperial Standard Wire Gauge of the material from which they were manufactured. The largest sizes were designated 0, 00, 000 etc., a not very satisfactory system requiring a gauge or code to identify actual sizes. Crochet hooks of the same stock size were designated differently.

The same position existed in the UK, where, with metrication, a change to labelling by diameter in millimetres was adopted. Unfortunately the nominal sizes allocated were not always close to the actual sizes and use was made of such vulgar fractions as $2\frac{1}{4}$ mm, and $2\frac{3}{4}$ mm.

A survey of practices in the western world revealed that there were at least seven ways of describing one size of knitting pin and that there were anomalies even between Australia and New Zealand. In the hope of improving this situation a panel of suppliers was established by the MCB and a simple code was developed for designating diameter by a number equal to the diameter of the pin or hook expressed in tenths of a millimetre (e.g. size 22 for a 2.2 mm diameter pin). A draft SAA Standard embodying this was prepared.

The furniture industry converted slowly to metric descriptions without legislation to require metric descriptions. By 1982, venetian blinds, curtain rods and awnings were

quoted solely in centimetres. Paint brushes and other home handyman items were described metrically as were all retail items for the home gardener.

Babies' masses and lengths were recorded in metric units in hospitals and baby health centres. All tins of baby milk formula gave preparation details in metric units only and, in order to avoid mistakes in making up baby milk formulae, babies' feeding bottles graduated in other than metric units were prohibited under import regulations. These regulations were subsequently withdrawn.

9.7 Land, Fuel, Power and Public Services

Land

The conversion for land included the surveying and mapping of land areas, ownership and titles, real estate development and sales.

The committees which were responsible for these conversions were:

- Land and Surveying Sector Committee
- Real Estate Panel (New South Wales)
- Real Estate Panel (Victoria)
- Real Estate Panel (South Australia)
- Real Estate Panel (Western Australia)
- Real Estate Panel (Queensland)
- Real Estate Panel (Tasmania)
- Panel on Surveying Tapes

The land titles offices in each State, which were represented on these committees, greatly assisted the change by requiring all new plans and surveys to be in metric only from 1973. As a result, these operations were converted without difficulty and were some of the first conversions to be completed.

Despite the success of the conversion of new survey work, it was sometimes found necessary to continue to work in imperial when using old plans which could not easily be converted. This was particularly the case with old mine workings in which the original surveys had been done in feet and decimals of a foot.

Immediate conversion of existing plans and deeds was not considered essential and, in accordance with the low priority given to this task, small teams were created to work systematically through all plans and update them to metric by typing in the margin the appropriate conversion of every imperial reference contained on it. Because of the large number of plans involved this work was expected to take many years to complete.

Because of the inevitable delays in completing the conversion of certificates of title, it was widely recommended that contracts for the sale or purchase of land should be written in metric, notwithstanding that the title deed to which it related might remain in

imperial for many years. As a general rule, certificates of title were only converted when, as a result of new subdivision, a new certificate of title had to be created or where further endorsement of the existing certificate was no longer possible and a new certificate had to be drawn.

Real Estate

Despite the successful conversion of surveying and mapping and the registration of land titles, conversion of the sale of real estate was considerably less successful and was a classical case of the need for conversion to be supported by legislation and of responsibility for action being useless without proper authority to carry out that action.

The first attempt to convert the real estate industry consisted of a recommendation from the Land and Surveying Sector Committee, on which the real estate industry was represented, that the several industry associations should advise their members that from 1 July 1974 only metric units should be used. At first many agents attempted to follow these recommendations but as resistance and competition increased there was a widespread return to imperial units.

As the public was believed to have had significant exposure to metric already, it was wrongly assumed that people would have little difficulty in making the change from feet, square feet, squares and acres to metres, square metres and hectares, and few problems were anticipated in the attempt at real estate conversion.

With the failure of this attempt, it soon became obvious that the difficulties of the change for the industry and the public had been considerably underestimated and that much more detailed planning would be required before a new attempt could be made. Separate real estate industry panels were, therefore, set up in each State and a new program was developed for conversion throughout Australia from 1 January 1976.

Although a great deal of time was devoted to industry training it was recognised that the greatest difficulty would be in effectively communicating in metric with the public. While it was reasonable to assume that most people would, by 1976, know that the metre was the unit of length and that it was slightly more than 3 ft, very few would have an appreciation of typical house and land sizes in metric numbers. In fact, throughout metrication it became obvious that it is not the learning of the names and sizes of the ten common units, but the learning and remembering of typical numerical values of a variety of things in metric units, which was difficult. To the extent that this factor was not recognised early enough, a great deal of time was wasted teaching two-way conversion factors when direct thinking in metric by comparison with average metric sizes was what was actually required. In addition, unlike experience gained rapidly in the daily purchase of foodstuffs in metric, the infrequency of real estate transactions precluded any possibility of the public being able to learn real estate metric values by experience in the time programmed for conversion.

Several companies which had strongly supported the industry's conversion program found that the number of responses to sole metric advertising was so low as to render them economically unable to continue to support sole metric advertising. Some even reverted to sole imperial. Most agents agreed that while the difficulties of advertising in sole metric related to a lack of size appreciation in metric numbers, this difficulty disappeared as soon as the client saw the land, house or office advertised. The real difficulty was to convey sufficient information in the advertisement or on the telephone to bring the client into the office or to inspect the property.

Conscious of the difficulties of gaining public acceptance of metric units, the industry repeatedly urged the Board to assist, through a program of national advertising, to bring public appreciation of metric sizes to a level at which the loss of sales would not be intolerable.

The Board considered that it did not have sufficient funds to engage in expensive advertising programs such as this might require and, were it to do so, it would be obliged to assist other industries similarly. With a policy of no compensation for costs incurred for conversion, the Board considered also that consumer or market education should be a matter for the industry itself.

However, in accordance with its policy of providing aids and literature for use in the conversion the Board produced and published a poster, "Metric Real Estate", and a pamphlet, "Buying Real Estate the Metric Way", which were distributed very widely to agents and the public.

In the absence of mandatory legislation or a public education program directed at buyers of real estate, and with the risk that reversion to imperial units could give rise to unfair competition between agents, the industry asked the Board to obtain the assistance of the media, particularly the newspapers, in implementing a cut-off for the acceptance of non-metric advertisements.

While all newspapers responded favourably to this request, they considered it to be the responsibility of the industry associations, not the media, to ensure that their members adhered to the metrication program. The associations, on the other hand, clearly had no powers to discipline members and could not ensure success of the conversion program.

Despite efforts by the newspapers to urge the industry and private users of its columns to use metric only, much copy and artwork, over which the newspapers had no control, was submitted to them in imperial units and many valued clients and private users were unwilling to voluntarily limit their advertisements to metric. Competition between newspapers also rendered the achievement of a uniform conversion by this method largely unworkable.

Again, in an effort to introduce some form of legislative support for a uniform conversion, the Board approached the Trade Practices Commission for assistance in prohibiting unfair competition between traders in process of conversion, which could

result from reversion to imperial units. Unfortunately, in the absence of legislation which would specifically prohibit the use of imperial units by an industry in process of conversion, the Trade Practices Commission could find no basis on which it could legally insist on metric measurements only. The only assistance that this organisation could give was the publication of guidelines, under the title “Consumer Protection, Advertising and Metric Conversion”, which urged agents to take account of progress in conversion and to use metric units only.

While initially high levels of metric usage were achieved in each State, the effects of competition and public unfamiliarity with dimensions given in metric units forced a significant return to imperial units, particularly in the advertising of rural land.

It was evident that without mandatory legislation to regulate the change, such as the State weights and measures Regulations for retail trading, uniform packaging regulations for packaged goods, building regulations for building design and materials, and highway speed signs and traffic regulations, conversion of the real estate industry on a wholly voluntary basis would be almost impossible to achieve.

At one stage, consideration was given to amending the (Federal) Weights and Measures (National Standards) Regulations to withdraw the acre and the perch as Commonwealth legal units. These units had no applications outside their use in real estate description and could therefore have been removed as obsolescent without hardship to the public. The effect of withdrawing units from the lists of Commonwealth legal units was to make contracts using them, after the date of the withdrawal, void and unenforceable. No penal clause existed in these regulations and while no judicial action had ever been taken to void a contract because of its failure to use Commonwealth legal units, deletion of the acre and the perch could have provided a sufficient deterrent to the continued use of these units to have allowed real estate conversion to proceed.

It was subsequently shown that removal of the acre and the perch was capable of being used by unscrupulous people to deliberately invalidate a properly drawn-up contract which, by oversight or design, might have included withdrawn imperial units, thus allowing the agent to resell the property at a higher price to another bidder. Under these circumstances, the Board did not consider it wise to explore further the possibility of this kind of amendment at this stage of conversion.

A less hazardous method of securing mandatory conversion of real estate was seen to be the creation of a regulation under the Metric Conversion Act to permit the selective withdrawal of non-metric units from use by particular industries where imperial units were approaching obsolescence. However, by the time this action was proposed, public reaction to enforced metrication had worsened considerably, largely as a result of the unpopularity of the prohibitions on the importation of non-metric measuring devices, and the government indicated that it would be unwilling to consider additional metrication legislation at this stage.

With the passage of time and the effects of trouble-free conversions in the retail sale of foodstuffs and other consumer goods sold by weight or measure in New South Wales since 1979, and with the imminent demise of the Board in June 1981, another attempt was made to secure a more effective cut off for non-metric real estate advertisements through newspapers in New South Wales.

Again, reluctantly, the newspapers accepted that, while they may have the power to do so, they still considered it the responsibility of the real estate industry to obtain the total compliance of its members. The new newspaper cut off date was set at 1 April 1981 but as with previous attempts at control by this method the agreement broke down and many agents reverted to dual or sole imperial usage.

Finally, an attempt was made to secure the legislative support of the only State, New South Wales, which had an Act which might have been amended to require the use of metric units in real estate advertisements in that State. Understandably, this State was unwilling to take action unilaterally without an indication that similar action would be taken in the other States.

In review, it seems almost axiomatic that any far-reaching national change, not only metrication, which is initiated by government can only be achieved by voluntary acceptance if it is made a democratic obligation on all by legislation.

In the absence of supportive legislation, a public education program to popularise and simplify the change would have done much to secure a successful conversion.

Most of all, insistence on sole metric advertising of real estate was a mistake because, while many agents were unhappy about advertisements which they knew would produce a diminished response in sole metric, most would have agreed to a requirement that allowed them to use both metric and imperial in their advertisement. In due course agents would decide for themselves that their clients could understand metric sufficiently for them to forgo the tedium and expense of having to work in two systems.

As things remained in 1982, it was difficult to see elimination of the acre, the perch and the square from real estate advertisements until generations of children still at school became a significant proportion of the real estate market.

Coal, Gas, Oil And Electricity

Metriation of industries concerned with the production and marketing of energy in the form of coal, coal gas, coke, natural gas, LPG, oil and petroleum products and electricity was organised as part of the Land, Fuel, Power and Public Services Advisory Committee. The particular sector committees concerned were:

- Electricity Generation and Distribution Sector Committee
- Gas Production Sector Committee
- Petroleum Products Sector Committee

The processes of mining coal and drilling for oil and gas were, however, metricated as engineering operations under the direction of the Mining and Metallurgy Sector Committee of the Engineering Industry Advisory Committee.

The sale of petrol primarily involved a change in the unit of measure by which the product was sold. This required the conversion of pumps to dispense in litres instead of gallons. This conversion was planned separately by the Petrol Pumps Sector Committee of the Science and Technology Advisory Committee.

In common with most other major industrial operations, conversion of existing plant and equipment was neither practicable nor necessary and in most instances it continued to be operated and maintained in imperial for the remainder of its working life.

Conversion of solid, liquid and gaseous fuels and electrical energy, therefore, consisted of conversion of the methods of describing and measuring these products.

Coal and coke was sold by the tonne and its energy content or calorific value was given in MJ/kg. Coal reserves were expressed in thousands of tonnes or in energy terms in petajoules ($PJ = 10^{15} J$).

Coal gas and natural gas were metered on a volume basis in cubic metres but charged on a net energy basis on MJ/m^3 at standard temperature and pressure. Metric Standard Conditions (MSC) is $15\text{ }^{\circ}C$ and 101.325 kPa . Reserves of natural gas are expressed in petajoules (PJ).

Liquefied Petroleum Gas (LPG) was sold by the kilogram and its energy content was in MJ/kg. Conversion of domestic gas meters was on an as-required basis with metric meters being installed on all new installations and imperial meters being replaced with metric as they wore out or were taken out for maintenance. The conversion of gas meters, therefore, took several years to complete and for this reason gas accounts indicated the legal conversion factors between imperial and metric units.

Gas burning appliances were rated in terms of their maximum combustion rate in MJ/h. In strict metric terms these should be rated in kilowatts where a kilowatt is a rate of energy use of 1000 joules per second or 3 600 000 joules per hour (3.6 MJ/h). The gas industry argued that, unlike an electrical appliance rated in kilowatts, the capacity of a gas appliance could vary well below its rated maximum capacity by limiting the volume of gas fed into it and that the analogy with electricity could be misleading. It, therefore, agreed to use the unit MJ/h instead.

The units of measurement used in electricity generation and distribution had always been metric units, there being no electrical units in the imperial system. Conversion did not cause any significant changes in this industry.

Electrical appliances had always been rated in watts and kilowatts and electrical energy had been sold in kilowatt hours. Again, in strict metric, electrical energy should be sold in megajoules (MJ) where $1\text{ kW.h} = 3.6\text{ MJ}$ but as a one kW appliance used for one hour uses 1 kW.h of energy this was a very convenient unit for selling electrical

energy to the public, and one which could be difficult to replace. The kilowatt hour has, therefore, been retained indefinitely as the unit for selling electrical energy. It was recommended that on design calculations, where the coherency of SI is important, some multiple of the joule should be used.

It was disappointing that the opportunity provided by metric conversion to adopt a single energy unit to replace Btu, calories, therms, gas units, cubic feet of gas, kW.h did not result in the adoption of the joule as the sole unit of energy. However, the use of MJ and kW.h seems a reasonably satisfactory compromise.

Water And Sewerage

The conversion of water supply and sewerage and drainage authorities was, essentially, a “soft” conversion of existing operations. It was planned by the Water and Sewerage Sector Committee. Catchments and storage were simply redesignated in metric terms and the kilolitre was used as the basis for accounting.

Water volumes and flow rates were recorded in multiples of the litre, that is kilolitre, megalitre, gegalitre and teralitre, and as a general rule the cubic metre is not used for this purpose.

All new pipe work was recorded in metric and all metal, concrete and stoneware pipes for underground use were “soft” conversions of inch sizes. No attempt was made to convert reticulation plans which were in existence at the date of conversion.

Domestic pipework continued to use “soft” converted inch sizes of galvanised iron and copper but “hard” converted polyethylene pipe, which was relatively new to domestic plumbing, was being used increasingly for cold water supply. Plastic rainwater down piping for houses was mainly in “hard” converted metric sizes.

As with gas meters, imperial water meters were replaced over a long period as and when required.

9.8 Health And Recreation

Health Services

The Australian pharmaceutical industry began its conversion to metric in 1965 with the adoption of metric units in the national formulary for Commonwealth Pharmaceutical Benefits.

In accordance with metrication in Great Britain, which commenced in 1965, the British Pharmacopoeia published since that date were metric, though not SI. This fact was relevant to conversion in Australia as the British Pharmacopoeia was accepted in Commonwealth legislation as the primary source of Australian standards on pharmaceutical and therapeutic goods.

The combined effect of these two changes was to bring about a rapid change to metric in the pharmaceutical industry. The adoption of standardised packaging sizes for patent medicines, and cosmetic materials effectively concluded this conversion.

Conversion of health services was planned by the Health and Recreation Advisory Committee, the Medical Sector Committee, the Pharmaceutical Sector Committee, the Energy Value (Diabetic) Panel, the Panel for Units on Ionising Radiation and the Panel on the Measurement of Pressures in Body Fluids.

The major impact of metrication on the medical profession, in addition to the need to prescribe medicines in metric quantities, was the reporting of pathological test results in metric units.

Although there were some general inquiries about the significance of cholesterol determinations in metric, most of these changes were of little consequence to the public and, for this reason, conversion of the medical profession passed almost unnoticed.

The change to metric bulk weights in Baby Health Centres was slightly more traumatic and for a considerable time hospitals volunteered both metric and imperial information. Conversion of infant feeding formulae, however, created very few difficulties.

Although SI units were adopted for pathological analysis and these results were more properly regularly reported in millimoles per litre instead of non-SI mass units, the change to SI units for chemical solutions used intravenously, though planned, had not occurred by 1982.

One area in which significant changes were made, but once again without impact on the public, was in the units used in X-rays and ionising radiation due to radioactive chemicals. However, although these units were adopted by radiologists, Health Departments and the Atomic Energy Commission, International Air Transport Regulations, which were based on old metric units, required radioactive goods transported both locally and internationally to be designated in old units.

Conversion of units used in the measurement of blood pressure from millimetres of mercury, in which pressure was measured in length units, to SI, in which blood pressure was measured in true pressure units, namely kilopascals, occurred more slowly than expected because of the slowness of overseas countries to change to this unit. By 1982, manufacturers of non-SI clinical pressure gauges continued to export these to Australia although the World Health Assembly of May 1977 recommended that the transition to SI units be not unduly prolonged.

The adoption of the kilojoule by dieticians as the unit for the energy contained in foodstuffs occurred professionally but the change from calories to kilojoules was more slowly accepted by the public. Once again it was reaction to change itself, rather than the particular unit, which caused the delay, because diet-conscious people rarely had a concept of the meaning of calorie or energy. This was another example of how the

public needed to be relocated, in kilojoules, on a scale of small, medium and large for a normal diet. Likewise the slowness of the public, and sometimes the health studios, to adopt body weights in kilograms was largely due to the same cause.

Associated with the gradual adoption of the kilojoule in diets was the need to redesignate low calorie dietary foods by a more suitable expression. Low kilojoule or low joule were not acceptable translations of low calorie or low-cal and while the term “low-energy” was more appropriate and had a satisfactory sound, the idea of foods being deficient in one of the essential properties of food was not acceptable to manufacturers.

The teaching of doctors and nurses was generally metric and a number of courses in the application of metric to medicine were held by teaching hospitals for the benefit of former nurses returning to work after several years. Conversion of these professions was, however, likely to remain incompletely converted until English language medical textbooks were readily available in SI.

Sport And Recreation

The conversion of sport and recreation was planned by the Health and Recreation Advisory Committee with individual members reporting on progress in recreational activities such as shows, clubs, galleries and studios, professional sport, amateur sport, youth activities and safety.

Because of its expected impact on the ordinary citizen, conversion of sporting activities was seen as an important factor in the subconscious education of the public in metric units. For this reason horse racing, a highly traditional sport, was converted, with the support and cooperation of media commentators, in August 1972.

Greyhound racing converted in January 1973 and trotting converted in August 1973. All football codes were converted by 1974. Conversion consisted largely of “soft” conversion of distances in rules and dimensions of playing fields and all commentaries were provided in metric.

In most cases the dimensions of cricket pitches and tennis courts could not be varied and were sensible conversions of previous measurements.

All swimming and athletic events, including Olympic Games and Commonwealth Games, had been metric for years although, strangely, this did little to condition the public for metrication in other sports.

Where the sport’s controlling body was in the United States of America and conversion had not yet been considered, the rules remained essentially imperial. These sports included ten pin bowling, baseball, drag racing and quarter horse racing.

In certain sports in which a measurement was part of the title, such as the 16 footer and 18 footer sailing clubs, the rules were metricated but the names were retained.

However, where practicable, motor races like the “Bathurst 500” (miles) have been varied to become the “Bathurst 1000” (km).

On occasions when international sporting events were held, the commentaries were recorded in old measurements for the benefit of the visitor countries.

By 1982, the various city and provincial Agricultural Shows had almost completed their metrication programs with the notable exception of the height of horses. Horse categories in hands and quarters of a hand (a hand is exactly four inches) had been used in British countries for many years and the practice was deeply entrenched. Most show societies required the height to be stated in centimetres in addition to hands but it was expected to be a long time before this “unit” disappeared. Height categories in centimetres were used in Europe but the hand was retained for commercial transactions with Britain.

In sports fishing, line breaking strain in newtons replaced the pound or pound force measurement. Conversion to the kilogram mass was not appropriate as the breaking strain specified for a certain kind of fish was not related to its mass. Kilogram force was no longer a legal unit of force and breaking strain in newtons was required under Standardised Packaging Regulations.

Despite the interest in sport in Australia and the very high degree of support given by the media and sporting commentators, conversion of sports did not appear to have been significant as an educational aid for the public, although its significance in creating wide public awareness and acceptance of metrication could hardly be questioned.

9.9 Education And Industrial Training

The conversion of educational activities of all kinds was planned by the Education and Industrial Training Advisory Committee, the Adult Education Sector Committee, Cookery Sector Committee, Industrial Training Sector Committee, Primary Education Sector Committee, Secondary Education Sector Committee, Technical Education Sector Committee, Tertiary Education (Non-Universities) Sector Committee, and Tertiary Education (Universities) Sector Committee.

The objective of these committees was to ensure that curricula, teaching procedures, teaching aids and equipment and examinations were reproduced in metric as quickly as possible and that teaching in imperial units was discontinued as early as practicable.

Education in primary schools was fully metricated by the end of 1973 and in most secondary schools by the end of 1974. From that time onwards, except in some subjects such as geography, in which old maps with imperial scales were sometimes used, imperial measurements were no longer taught as a system and all measurement training and use of measurements was in metric. That meant that all children who commenced school year 3 on or after 1973 were educated in metric measurements only. On the basis of an average of 200 000 children in year 3 throughout Australia, the total for the ten years to 1982 was 2 000 000 children educated only in metric.

At the same time, children in other school years, while grounded in imperial measurements, had their education completed predominantly in metric measurements. This added a possible further 1 000 000 school graduates to the number of Australians formally educated in metric. Already many parents were commenting on the increasing difficulty of communicating with their children except in metric measurements.

Needless to say, it was through formal education, both scholastic and vocational, that the impact of metrication would be most effective and most apparent and this has certainly been the case.

It was in education, also, that the differences between the metric system, with its logical structure, and the arbitrary relationship of the imperial system became most apparent and the many shortcomings of the imperial so-called system became obvious.

The imperial system is a non-decimal system. That is, smaller quantities than the unit are obtained by repeated halving and quartering so that all quantities less than the unit are vulgar fractions, the smallest of which is $\frac{1}{16}$.

While a system based on fractions is well adapted to the buying and selling of goods by weight or measure, it becomes hopelessly inadequate in commercial and technological applications, from the simplest carpentry calculations to complex engineering. For example, to find the cost of a piece of furniture veneer measuring 3 ft by 7 ft 10 in at \$10.00 per sq ft or to divide 1 gal 2 qt 1 pint 13 fl oz by three is moderately difficult for the majority of people. Unfortunately, nearly all imperial measurements occur in this polyfractional form and must be converted to a single fraction and thence to decimal before they can be used in calculations, even using electronic calculators. Metric measurements on the other hand are already in decimal form, ready for immediate calculation.

Because the teacher no longer had to teach addition, multiplication and division by polyfractional numbers, considerable time may be saved in teaching measurement and measurement calculation. British educationists have estimated this time saving as high as one year of one subject time as a result of not having to teach the imperial system.

In a decimal system of such as the metric system, quantities smaller than the unit are obtained as tenths and multiples of tenths of the unit by a simple process of moving a decimal point. Numbers occur automatically in decimal form ready for immediate calculation. The Board urged that teachers teach metric usage in decimal form and avoid the halving and quartering process so essential to the now obsolete imperial system.

Unfortunately, many teachers mistakenly believed that the Board had advised that vulgar fractions should not be taught.

However, apart from the fact the Board would not have had the authority to have made such a recommendation, the teaching of vulgar fractions was clearly an essential prerequisite to the teaching of decimal fractions and therefore must be retained.

Because the Australian Standard AS 1000 “The International System of Units (SI) and Its Application” and the Board stressed that for reasons of economy of words, prefix multiples which rose or fell in steps of 10^3 should be preferred, teachers sometimes concluded that teaching of the centimetre and decimetre was forbidden. However, for unstable dimensions such as body sizes, fabrics or similar uses where an implied accuracy of ± 0.5 mm was not justified, the centimetre was a more appropriate unit than the millimetre and should have been used. While the decimetre offered no advantage over the metre, centimetre or millimetre as a unit of length measurement, and was not used for this purpose, it was essential that it be taught and understood in order that the litre may be properly defined, the litre being one cubic decimetre ($L = \text{dm}^3$).

Some problems of interpretation arose because the Board assumed that the educational authorities, consisting of large organisations of professionals, would include appropriate instructions into class curricula. Unfortunately this did not happen, as most State Authorities had already departed from centralised instruction to teachers. As a result, teachers were left to select and arrange their own teaching material and, in many cases, the instruction in metrics was more old CGS metric than SI.

It was apparent that education authorities were not about to publish details of the metric system or how to teach it.

In 1974, the Board produced its own definitive statement on the metric system, called “Australia’s Metric System”, in the form of a booklet as comprehensive as the Australian Standard AS 1000. This booklet was issued widely to Education Departments with the recommendation that it be issued to science and mathematics teachers. Apart from the fact that the distribution was not always efficiently carried out, the booklet was, in general, far too technical and comprehensive for use as a teaching resource and many teachers who, received it did not read it.

In 1976, a pamphlet, called “SI — The Students Guide To The Metric System”, was produced and 1 500 000 were distributed to schools throughout Australia for issue to all teachers and all students in years 10, 11 and 12. This pamphlet was produced in the form of a direct teaching aid with basic tables and rules. It was requested repeatedly and copied by schools, colleges and the public.

In addition to the teaching of the metric system as a simpler and more sophisticated method of measurement, many teachers recognised in the unique design of SI, the possibility of applying it to significantly improve the teaching of physics and AS 1000 was widely purchased as a teaching aid for this purpose. Unlike previous systems of measurement, all physical quantity concepts were linked through a single coherent system of units of measurement and the symbols for these quantities were logically derived from each other.

SI unit symbols were thus easily adapted to demonstrate the meaning, definitions, derivations, and interrelationships of all physical quantities and what, in many cases, was previously a feat of memory in the learning of physics could now be reduced to a

limited number of logical theorems in algebraic symbols. In 1982, this system had not had world wide acceptance but it seemed inevitable that as world usage of SI increased, its enormous potential in physics teaching would be recognised.

At university level, the adoption of SI and the recognition of its special value in teaching was slower than expected and much teaching material and textbooks which were already metric, although not SI, continued to be used. There was, however, considerable scope for the rewriting of physics and chemistry textbooks in SI as distinct from the simple insertion of SI units into existing texts.

Similarly, the inclusion of SI in trade courses tended to proceed by substitution rather than by recognition of the true potential of SI as a teaching medium. Many of the old fashioned rules-of-thumb were designed around imperial units and these became considerably simpler when adapted to SI.

In regard to informal training within industry, the Board recommended that this be confined to that required to enable people to continue to work effectively in metric as they used to do in imperial. This ensured that training was kept as simple as possible and intensely practical. It was also recommended that training within industry be given no more than two or three months before conversion was planned to take place. The purpose of this recommendation was to take advantage of the enthusiasm which could be built up in a lead up to conversion but which could be lost if unduly protracted. It would then be much more difficult to recommence.

With regard to adult education, while many people claimed they would need special classes to learn metric, courses put on by technical colleges and other institutions were rarely well attended. The Board produced a teaching aid, called "Metrikit", which consisted of teaching notes and a collection of plastic strips, sheets and jugs for establishment of notions of size for different units, but this was not highly sought or used.

Two strip films, "Made To Measure", introducing metric measurements in practical applications and "Built To Measure", showing how metric measurements apply in the building industry, were produced independently of the Board but made available on loan through it. Both were well used with captive audiences in industry but were not greatly used for voluntary adult education.

The lack of interest in adult education confirmed the Board's belief that such courses were unnecessary and that people would learn from experiencing metric units in practical day to day situations as and when each individual required.

It also confirmed that people did not perceive metric in systematic form, but learned each unit and its application as an independent and unrelated piece of information. As a consequence, the highly logical nature of the metric system or the unsystematic nature of the imperial system had very little meaning or relevance for the ordinary citizen. Re-education of ordinary people, therefore, needed to concentrate on providing a new set of

metric bench marks and to avoid irrelevant references to the elegance of the metric system.

Two disadvantaged groups of people to which the Board gave particular consideration were the blind and the people of the outback. A Braille leaflet on basic metric units was issued through the Australian National Council for the Blind. Throughout Australia, radio talkback sessions on metric, through the Education Departments' Schools of the Air in conjunction with the Royal Flying Doctor Service, were conducted in 1975.

Because of its relationship with Domestic Science Education, conversion of cooking and recipe writing was included under the Education and Industrial Training Advisory Committee.

Members of the Cookery Sector Committee were drawn from the Home Economics Association of Australia, the National Council of Women of Australia, the Country Women's Associations, the Electricity Supply Association of Australia, the Australian Gas Association, the Australian Dairy Produce Board, the Australian Newspapers Council and the Standards Association of Australia.

The first decisions of this committee were in regard to the sizes of Australian standard measuring cups and spoons which were already under consideration by SAA. Spoon measures were unchanged, the existing standard having defined the tablespoon as 20 mL and the teaspoon as five mL, but a metric cup of 250 mL was adopted to replace the existing eight fluid ounce measure which was equal to 227 mL.

In the conversion of existing recipes, 30 g was adopted as the equivalent of one oz and 30 mL as the equivalent of one fl oz.

However, as far as possible the opportunity was taken to write recipes in volume measure in terms of cups and spoons and to avoid measurement by mass. The measurement of quantity on kitchen scales was not accurate and very difficult where small quantities are required. Measurement by bulk or volume was, however, relatively simple and even in the absence of standard measuring implements, the proportions of ingredients remained the same, provided the same non-standard cup and spoon are used throughout the recipe.

During the period of operation of regulations against the importation of certain non-metric measuring devices, importation of dual marked kitchen scales and measuring jugs was not restricted. It was considered important to ensure that people could continue to use tried and tested recipes collected in pre-metric days as well as experimenting with metric recipes and for this reason cookery measures should have dual capability.

To assist non-professional and professional cookery writers in adopting a common and logical approach to conversion, a booklet, "Cookery and Metric Conversion", was published and a leaflet, "Metric Conversion of Domestic Recipes", was produced, to

encourage direct conversion from ounces and fluid ounces to metric cup and spoon measures.

A pamphlet, “Kitchen Metrics”, was produced for use in the home and was distributed widely.

Except for some imported cookbooks written in both metric and imperial, all recipes published in books, magazines and newspapers in Australia were, by 1982, in metric cup and spoon measures.

9.10 Science And Technology

Under the heading of Science and Technology, decisions were made about the totality of units which would constitute Australia’s metric system, which units could legally be used in trade and commerce, the circumstances under which particular units were required to be used and the conversion of instruments to measure in these units.

The committees which met to analyse the problems and plan conversion in these areas were:

- Science and Technology Advisory Committee
- Instruments Sector Committee
- Liquid Measurement Sector Committee
- Meteorological Services Sector Committee
- Photography Sector Committee
- Research and Technology Sector Committee
- Units Sector Committee
- Weights and Measures Sector Committee
- Medical X-ray Panel
- Parliamentary Counsel Panel
- Panel on Units for Ionising Radiation
- Panel on Petrol Pumps Conversion
- Panel on Typewriter Keyboards

Units For Use In Trade

Under the Commonwealth Constitution, the Australian Government was empowered to make laws with respect to weights and measures.

The Commonwealth first exercised these powers in 1948 with the creation of the National Standards Commission to advise the Minister on matters relating to weights and measures.

In accordance with powers given by the Weights and Measures (National Standards) Act 1960, regulations were gazetted which listed the units of measurement of a wide

range of physical quantities which could be used in commercial transactions within Australia. The units so listed were known as Commonwealth legal units and only those units could be used in contracts or trade.

The regulations contained both metric and imperial units but all imperial units were defined in terms of metric units. Thus metric units had been legal for use in trade in Australia since 1960.

The Weights and Measures (National Standards) Regulations were administered by the National Standards Commission which was required to establish and maintain uniform standards and uniform units of measurement and, among other things, to advise the Minister on additions or deletions of units from the regulations. Although, for the purposes of metrication planning, responsibility for bringing about a change in the units used by industry etc. was delegated to the Metric Conversion Board, the National Standards Commission had the continuing task of reviewing and amending the lists of Commonwealth legal units.

The regulations were, therefore, amended during the process of metrication to incorporate SI units not already included and at a later stage to remove units which had become obsolete or fallen into disuse and were unlikely to be used again. It was expected that other imperial units would be withdrawn in due course but this was not likely to occur for many years. The withdrawal of Commonwealth legal units in this way was intended to reflect progress in metrication, however, and not to enforce it.

In regulating the sale of goods by weight or measure, and following the established British tradition, the States agreed in pre-metric times to permit imperial units only to be used. Accordingly, all instruments verified by them for use in trade were imperially graduated and pricing and advertising in imperial quantities only was permitted.

In the early stages of conversion to metric, the States permitted both imperial or metric instruments to be used, accompanied by dual pricing and advertising.

Initial attempts to bring about a general conversion to metric weighing instruments was on a voluntary basis. Many traders, anticipating the change, purchased metric scales but continued to price in imperial only.

To assist voluntary conversion, the Board suggested conversion on a zonal or regional basis where all scales and all pricing should be converted in a particular market zone at the same date. This was intended to minimise the risk of any trader in the area losing sales to competitors who had not converted and at the same time to minimise costs to scale convertors. Unfortunately, some traders took deliberate advantage of the situation to do just what the plan was designed to avoid. As a consequence, voluntary conversion on a zonal basis became unworkable.

Subsequently, the State Weights and Measures Authorities gazetted regulations to declare areas of their State compulsory scale conversion zones in a sequence of dates until the whole State was converted. With the support of legislation, the problem of

unfair competition was totally removed and purchasers quickly adapted to the procurement of foodstuffs in metric quantities. As the population of metric scales increased and retail trade became predominantly metric, the State Weights and Measures Authorities amended their regulations to permit metric pricings only, thereby achieving total conversion in their States.

During the transitional period some States permitted fractional pricing, that is per 250 g, per 500 g as well as per kg, although the Board had recommended against this. Many traders saw the retention of the 500 g unit and 250 g unit as close to the old pound and half pound and they considered that the change in price would be less traumatic than with full kilogram pricing.

While the Board and the Weights and Measures Authorities considered that pricing “per kilogram” only allowed the consumer to make simple price comparisons on the same quantity basis, this procedure did nothing to encourage the consumer to take advantage of the decimal nature of the new system. Consequently, halving and quartering of the kilogram continued, as in imperial days, to be used as the basis for the selection of smaller quantities and many shops continued to defy the regulations and price per 250 g or per 500 g. Housewives were faced with having to do unnecessary mental arithmetic to determine the cost of their purchases.

Had pricing per kg and per 100 g been permitted, as occurred in Canada and Singapore, selection of smaller quantities than one kg would have been in multiples of 100 g and the price comparisons and cost calculations would have been much simpler.

It was hoped that authorities responsible for the control of commercial weights and measures would recognise the disadvantage to the public of fractional pricing and would encourage price per 100 g and per kg so that people would gain the full benefit of the change to a decimal system of measurement.

Although many consumer items were priced and sold per unit of measurement and therefore were under the control of weights and measures regulations, there were many items which were described, but not sold per unit of measurement, for which there are no regulations which could have been amended to reflect the change to metric. Such items included furniture, tools, real estate, sporting equipment, small boats and so on.

As with the retail scale conversion, a short trouble-free conversion of goods described by measurement on a purely voluntary basis, without the support and protection of legislation, was not possible and an investigation into other means of mandating the change was made.

In the case of real estate, the Board examined the possibility of withdrawing the acre and perch from the lists of Commonwealth legal units. Unfortunately, this action could have led to deliberate voiding of legitimate contracts by virtue of it being accidentally or deliberately written in imperial units, in order to secure a higher price from another buyer. For this reason, the Board agreed not to pursue this approach any further,

although no precedent existed for any contract having been voided by reason of it using non-legal units.

Since mischievous voiding of contracts could have resulted from the withdrawal of units under the Weights and Measures (National Standards) Regulations, the possibility of creating regulations under the Metric Conversion Act to selectively withdraw units for use by particular industries was also examined. The main difference from the above approach would be that pecuniary penalties would apply for use of proscribed units but contracts would remain valid. At the time that this action was proposed, Government policy was opposed to the introduction of new legislation specifically designed to enforce metrication and the matter was not pursued.

With most units other than those used in real estate advertising, voluntary agreements between major retailing companies to accept, for stock, goods described in metric only, achieved almost total conversion of most consumer products.

In addition to the sale or description of consumer products by unit of measurement, conversion required that the instruments used in the processes of use or manufacture of these products be converted also.

As with retail scale conversion, real estate advertising, building and construction in which conversion could not have occurred without the support and protection of legislation, conversion of instrumentation or measuring equipment in areas where this was feasible seemed unlikely to occur on a purely voluntary basis.

The Board sought the cooperation of the Department of Business and Consumer Affairs in obtaining an amendment of the Customs (Prohibited Imports) Regulations to prohibit the importation of certain types of non-metric measuring devices, except where it could be shown that such devices were essential to the continued operation and maintenance of existing plant and equipment, or equipment newly purchased from non-metric sources.

While ample facilities appeared to exist under this regulation for exemption to be granted wherever imperial measuring devices were shown to be necessary for use with existing plant, and a great number were issued, the regulations tended to favour the larger organisations and reacted unfairly against the smaller companies or private individuals. Indeed, while industry appeared to cope very well under such controls it was the resentment of the many private home handyman type of user which eventually gave rise to political pressure from Members of Parliament to have the regulation repealed.

The import prohibitions operated for 2½ years and from industrial users, at least, most complaints had, by then, very nearly ceased. Those for whom non-metric instruments were essential got the instruments they required, while those for whom imperial instruments were a matter of preference but not essential learned quickly to work with metric instruments. From this point of view, which by now had obtained the support of both importers and local manufacturers, it was disappointing that the

Government did not see fit to allow the regulations to continue for another year, by which time the purpose for which they were designed would, almost certainly, have been achieved.

Unfortunately, the import prohibitions and local agreements were seen as an affront to the great many private individuals who, for reasons of habit and tradition, would probably continue to think and work in feet and inches for the rest of their lives. For those people, metrication was not a technological change but a major cultural change to which they were not actually opposed but about which they just didn't wish to be bothered.

In hindsight, the introduction of the import prohibitions, and the concurrent agreement among local tape measure manufacturers, was a mistake and did much to detract from an otherwise, if not popular, successful and trouble free conversion and it was better that it was withdrawn earlier rather than later.

Conversion Of Instruments Used For Trade

Apart from weighing machines and counter rules which were converted as described above, the other major conversions were farm milk tanks for the bulk purchase of milk by processing companies and the conversion of petrol pumps for retail use.

The conversion of petrol pumps did not suffer the same competitive problem that retail scales did, although as a product sold at a price per unit of measurement it was included in the amendment to State Weights and Measures Regulations and metric only pricing became mandatory. Conversion was coordinated by the pump manufacturers and the oil companies and conversion was accomplished on a zonal basis in a little over 12 months.

Although the cost of converting every petrol pump in Australia was considerable, the rapid rises in the price of petrol had placed the price computing mechanism of the pump close to the limit of its capacity and even without metrication identical modifications would have had to have been made. Thus metrication costs in this instance could not easily be differentiated from the costs of normal technological change.

The conversion of farm milk tanks was taken as the opportunity to measure volumes in litres instead of pounds based on assumed standard density in pounds per gallon.

In the case of process control, instruments used to measure temperature, pressure, flow rate and so on in industrial plant, the Board recommended that, unless it is critical to do so, these instruments should not be changed until they were worn out or broken and then they should, as far as possible, be replaced with metric instruments.

The Board always recognised that there would be many items of plant and equipment which would need to be operated and maintained in imperial for the rest of its working life and that no attempt should be made to mandate such a change before that time.

The Impact Of Metrication On Typewriters And Computers

The change to SI metric was accompanied with an unprecedented standardisation of symbols for units of measurement in which there was only one internationally recognised symbol for any unit or unit multiples. This led to the adoption of several symbolic forms not normally found on imperially designed typewriters. These included ...^o, ...², ...³, ...⁶, Ω, μ.

Initially, a script or italic “l” for litre was also included. In order to accommodate the new symbols it was suggested that some of the obsolete vulgar fraction symbols be replaced with metric and the Board, in conjunction with the Standards Association of Australia, called together a panel of typewriter manufacturers to try to design a standard keyboard for metric use. This resulted in an Australian Standard AS 2287 “Layout For Typebar Typewriter Keyboards”.

Because of the limited number of keys available, particularly on smaller typewriters, where the lower case “l” (letter) and the number “1” were the same key, it was not possible to fit a script or italic “l” and the Board opted to follow the American lead and recommended that the symbol for litre be L. This became the preferred legal symbol in Australia. In the case of computer printouts, all letters were capitals. For this reason, a standard AS 1340, “Symbols For SI Units For Systems With Limited Character Sets”, was produced to take account of this problem.

In designing letter and line spacings for both typing and continuous stationery these machines were based on subdivisions of an inch which were not varied on existing equipment and might not need to be varied with new equipment. For layout work with typewriters and computers, measurement in inches and tenths of an inch would continue to be used almost indefinitely.

Units

It was the responsibility of the Units Sector Committee to determine which SI units should be used in Australia and which, if any, of the imperial or older metric units should be retained, permanently or temporarily, for use with Australia’s metric system.

In the imperial system, and in earlier metric systems, the problem had existed that several different units had been used for the same quantity and some of these had been used as special units for particular industries, for example, foot, fathom, nautical mile, micron, point (of rain), Angstrom unit and light year were all length units for particular purposes. This meant that the various units were rarely related to each other by simple factors and were rarely coherent with the system from which they were derived.

A second problem was that many units of the older systems were not in accordance with the definitions of the quantities they were intended to measure. For example mass and force, which were distinctly different physical quantities, were both measured in pounds or kilograms. The unit names “kilogram force” and “pound force” were adopted to try to avoid this problem. Pressure was defined as the ratio of force to the area over

which it was applied, but older units such as lb/in² or psi and kg/cm² were in mass units per area, and inches and millimetres of and mercury and torr were in length units.

Thus, both the imperial and the older metric systems contained conceptual inaccuracies and the conversion factors within the system were rarely simple numbers.

It was this multiplicity of similar units, their unnecessarily complex mathematical relationships and the units conceptual inaccuracies of older units, which SI was designed to eliminate, and it was to ensure that the system adopted in Australia was the simplest and most practical obtainable that the Units Sector Committee was dedicated.

In determining which units should be adopted in creating a simpler and, ultimately, international system of measurement, the source material used was the Australian Standard AS 1000, "The International System Of Units (SI) And Its Application", which was modelled very closely on the International Standard ISO 1000, "SI Units And Recommendations For The Use Of Their Multiples And Of Certain Other Units". It also adhered closely to the Resolutions and Recommendations of the General Conference of Weights and Measures (CGPM) as contained in the English translation of *Le Systeme Internationale d'Unités*, published by the International Bureau of Weights and Measures (BIPM).

In determining whether a unit should be retained for use in Australia, consideration was given to the need for that unit by a particular industry and whether or not an SI unit existed which was equally satisfactory for the purpose.

In accordance with international recommendations, several non-SI units have been retained but units such as the bar, which have not previously been widely used in Australia, have been rejected.

Millimetres And Centimetres

The metric system was designed so that there was a unit multiple suitable in size for any purpose such that decimal numbers could be avoided. This was particularly important with spoken language where inclusion of a decimal point tended to unnecessarily interrupt the flow of words, for example, twelve millimetres (12 mm) was easier to say than one-point-two centimetres (1.2 cm) and four-twenty-three-litres (423 L) was preferable to nought-point-four-two-three cubic metre (0.423 m³).

The unit chosen should have been be the largest multiple which would permit the user to describe dimensions in whole numbers or with the minimum of decimal numbers. The building industry, for instance, elected to use the millimetre as the unit multiple which would allow dimensions of components or on drawings to be expressed in whole numbers while maintaining implied tolerances at plus or minus half a millimetre.

The clothing industry, on the other hand, had no need for tolerances closer than plus or minus half a centimetre and clothing and body dimensions, textiles etc. are always stated in whole centimetres.

The Decimetre

Though it was little required as a practical unit of measurement, the decimetre (dm) was an important application of the prefix “deci” (d) meaning $\frac{1}{10}$ and was essential in teaching the concept of the litre which was defined as one cubic decimetre ($L = \text{dm}^3$). However, as a unit multiple which permits decimal points to be avoided, the decimetre found special application in the timber industry for stamping log lengths in the forest. Logs were measured to the nearest 0.1 m but the decimal point was lost in the roughness of the surface on which it was stamped. For this reason logs were marked in decimetres, but tallied for sale in metres.

The decimetre was also used in the form of the square decimetre (dm^2) in the measurement of leather but tallies and prices were recorded in square metres (m^2).

Ladder manufacturers described their product by length in metres to one decimal place e.g. 1.8, 2.4, 3.6, 6.0 m. However, as tradesmen asked for ladders by these lengths, and as it was easier to ask for a size eighteen, twenty-four, thirty-six, or sixty ladder than a size one-point-eight, two-point-four, three-point-six or six-point-nought ladder, the decimetre could have been a better unit for this purpose.

The Litre (L)

The litre had always been accepted in Australia as the most suitable unit for volumes below one cubic metre, as the submultiple of the cubic metre which permitted the use of whole numbers and avoided the use of decimal fractions of the cubic metre, for example, 20 L rather than 0.020 m^3 . In fact while the cubic meter was the logical and coherent base unit of volume in SI, it was incapable of being prefixed to create multiples or submultiples.

Thus the progression in volume units based on m^3 was:

- cubic millimetre (mm^3) = 10^{-9} m^3
- cubic centimetre (cm^3) = 10^{-6} m^3
- cubic metre (m^3) = 1 m^3
- cubic kilometre (km^3) = 10^9 m^3

The litre, on the other hand adapted totally to the normal rules for using SI and the progression of multiples was as follows:

- millilitre (mL) = $10^{-3} \text{ L} = 10^{-6} \text{ m}^3$
- litre (L) = $1 \text{ L} = 10^{-3} \text{ m}^3$
- kilolitre (kL) = $10^3 \text{ L} = 1 \text{ m}^3$
- megalitre (ML) = $10^6 \text{ L} = 10^3 \text{ m}^3$
- gigalitre (GL) = $10^9 \text{ L} = 10^6 \text{ m}^3$
- teralitre (TL) = $10^{12} \text{ L} = 10^9 \text{ m}^3 = 1 \text{ km}^3$

Because of the more logical volume progression in litres, water authorities opted to use this volume unit exclusively.

In the early stages of metrication it was commonly believed that the litre was an inexact unit and should not be used in formal measurement. This was a view which had developed in the UK, where conversion had commenced in 1965, and was based on the pre-1964 definition of the litre as 1.000 028 dm³. Since 1964, the litre has been defined as the special name for the cubic decimetre (L = dm³ exactly) and all inaccuracies have disappeared. Despite this, in Britain the name litre is rarely used and all reference is to the dm³.

When metrication began there was a degree of confusion regarding the symbol for litre which was normally lower case ell (l). On many typewriters the small ell and the number one were the same key and the quantity “one litre”, when written in symbols, could be read as 11 (eleven). The Board at first recommended the adoption of a script or italic ell but typewriter manufacturers were unable to fit it as a standard key and general use of this symbol did not occur.

Following a lead set by the Americans, the Board recommended a change to upper case or capital L as the symbol for litre and this symbol became the preferred legal symbol for the unit in Australia.

The symbols L and l were both recognised by CGPM but it was expected that when world preferences became clear the non-preferred symbol would be withdrawn.

The Troy Ounce

This unit, which was equal to 31.103 g, was still in use for bullion sales of gold in the international market although gold assays were in grams per tonne (g/t) and retail sales of gold in Australia were priced in grams.

The Perth Mint produced gold bars in both ounce and kilogram sizes and planned to continue doing so until the major trading countries had converted.

The Micron (μ)

Micron was the old name for the micrometre (μm) which had been used for a long time for wool diameter and small particles. It was consistent with SI but its symbol represented the use of an adjectival prefix and symbol, micro (μ), on its own without the noun to which it should apply. The unit and symbol, micrometre (μm), were no more difficult to use than micron (μ) and this spelling and symbol was promoted by the Wool Secretariat for formal use. However, as it was listed in the Regulations under the Weights and Measures (National Standards) Act, no contract could be invalidated because it specified wool diameter in microns.

The Bar And The Millibar

The bar was a unit of pressure in the old CGS system and was defined as 10^6 dynes per square centimetre. It was not part of SI but was decimally related to it as the special name for 100 kilopascals (1 bar = 100 kPa exactly).

The bar had been used in underwater diving, compressed air and hydraulics for some time because of its close approximation to one atmosphere, 101.325 kPa. It had not been greatly used in Australia as a general pressure unit and as all calculations could be carried out just as easily in kPa as in bar there was no advantage to be gained by retaining it as an additional unit. Indeed, there were risks of incorrect calculations if both kPa and bar were retained.

As a consequence, the bar was deleted from the lists of Commonwealth legal units in the 1979 amendments of the Weights and Measures (National Standards) Regulations.

An attempt to limit its further unnecessary growth in Australia was made through the import control of non-metric measuring devices, which would have restricted it to use in the continued operation and maintenance of existing equipment. This regulation was subsequently repealed and it was thought its further growth in use would be difficult to control.

The millibar, however, as the unit for the measurement of atmospheric pressure in which 1000 mb = 100.0 kPa was almost universally recognised internationally in meteorological services and was retained for this purpose for the time being. The major impact of a change from mb to kPa would be felt in the aeronautical industry where differences in atmospheric pressure were read as differences in height or vertical separation between aircraft in the same vicinity. As atmospheric pressure varied continually with weather, aircraft instruments had to be readjusted for the height and pressure at the destination or departure airport.

The accuracy or interpretation of height readings would not be affected by a change in pressure units from zero at 1000 mb to zero at 100.0 kPa and, with proper training, both types of instruments could be operated concurrently without impairment of safety standards.

The Nautical Mile And The Knot

Because of the large numbers of ships and aircraft in service and the universal use of the nautical mile and the knot as units for navigation, it seemed unlikely that an easy change to metric equivalents would or should occur. It would have been clearly beyond Australia's competence to have attempted a change of this sort unilaterally.

In fact, the nautical mile and the knot are not linear measurements at all but angular measurements essential to global navigation. That these units had been accorded pseudo linear equivalence could be seen simply as a means of relating them to units used in navigation on land. Unlike measurements on land, which could measure directly the

distance travelled over a solid surface, no such measurement could be produced at sea or in the air and distances had, therefore, to be deduced from angular displacement.

Had the nautical mile been defined as a second of arc and the knot as a second of arc per hour, it would have been obvious that both were angular units and that conversion to linear equivalents would not be appropriate. As there was no indication that navigation and navigational instruments would depart from the process of measuring angular distances between angular coordinates on the earth's surface there would appear to be no benefit from conversion to mathematically more difficult calculation of linear distances over curved surfaces. Likewise, the location of sea boundaries could only be determined with accuracy by angular navigational techniques and the expression of territorial limits in terms of the nautical mile as the special name for a second of arc was entirely appropriate and should not be changed.

The Barrel

In the days of rapidly rising oil prices, repeated references were made to production statistics in thousands of barrels per day. All oil was stored and transported in bulk and barrels were never actually used for the purpose. Because of the dominance of the USA in the oil market the barrel seemed destined to continue in international parlance for some time although it was hoped it would eventually be replaced by volumes in cubic metres (m³) or preferably kilolitres (kL) and megalitres (ML). The barrel was a volume equal to 158.987 3 L. It was withdrawn as a Commonwealth legal unit in 1979.

Units For Ionising Radiation

The change to SI units included a change from old metric units of radioactivity such as curies, rems, rads and roentgens to the SI units becquerel (Bq), gray (Gy) and sievert (Sv) which were fully coherent with the other SI units.

Although SI units for radioactive chemicals had been adopted by health authorities in Australia, there was a need to indicate values in old units for goods transported by air, for which most regulations were derived from International Air Transport Association (IATA) recommendations. Further change would depend on changes in IATA regulations.

Mass And Weight

In the imperial and older metric systems the terms "mass" and "weight" were usually regarded as synonymous terms for the quantity mass though, in strict terms, they should mean mass and the force due to gravity acting on that mass. In the old systems, the unit of mass (lb, kg) and the unit of gravitational force or weight (lb, kg) was the same and had the same numerical value. This duplication of concepts caused considerable confusion (to students and technologists and the only practical method to distinguish between them was to refer to mass in pounds (lb) and kilograms (kg), and weight and

other forces in pounds force (lbf) and kilograms force (kgf). Unfortunately this left each quantity with the same numerical value and the actual size of the force still unspecified.

In SI, mass was measured, as before, in kilograms, and a new and absolute unit of force, the newton (N), named after Sir Isaac Newton (1642–1727), was used for forces including the force called weight. As the SI units of mass and force had different names and the mass and weight of an object had different numerical values, the mass–weight problem no longer exists. In South Africa, moves were made during metrication to expunge the words weight, weighing and kindred words from the language.

The Board did not share this view, and simply recommended that each word be given its proper meaning and be used accordingly, particularly in formal documents. The mass of objects was thus determined by comparing weights in circumstances where the accelerations due to gravity cancelled out and the process was known as weighing. Some teachers found this confusing but it was thought probable that the confusion was due to the mixture of new and old concepts in the teacher’s mind, rather than in that of the student.

The Decimal Point And The Decimal Comma

In the early days of metrication, it seemed likely that the European practice of using the comma as the decimal marker would be adopted in Australia. While the Board did not promote the decimal comma at that stage, it believed, also in accordance with European practice, that a space between digits should be encouraged to make way for the decimal comma if it were ever adopted. Thus, the practice of using the comma as the thousands marker was abandoned by education authorities in favour of the space between groups of three digits either side of the decimal point, with the point on the line retained as the decimal marker. In these circumstances, while the space represented a more modern writing style it was not fundamental to the change and either comma or space could be used for the purpose.

Vulgar Fractions

In the imperial system, the creation of quantities smaller than the unit was usually achieved by successive halving and fractions such as $\frac{1}{2}$, $\frac{1}{4}$, $\frac{1}{8}$, $\frac{1}{16}$, and multiples of these were common.

In the metric system, on the other hand, the decimal relationship between unit multiples favoured the use of multiples of decimal fractions $\frac{1}{10}$, $\frac{1}{100}$, $\frac{1}{1000}$, as the source of intermediate quantities.

For this reason, most metricating countries encouraged people to obtain smaller quantities by selecting multiples of tenths of a unit rather than the process of reducing larger quantities to fractions by halving and quartering. Decimal fractions could be entered directly into electronic calculators which vulgar fractions could not and this, also, was an important reason for avoiding them.

In promoting the use of decimal fractions in measurement applications and, at the same time, discouraging the use of vulgar fractions, it was not intended that vulgar fractions should not be used in other applications. On the contrary, without the recognition that vulgar fractions were incomplete divisions and precursors to decimal fraction the concept of a decimal fraction could not be developed and hence vulgar fractions were essential to mathematical education.

Dietary Foods

In the past, manufacturers of dietary foods coined names and phrases such as low in calories, low calorie, low cal to describe foods low in energy content.

The equivalent word in metric was low in joules or low joule but the purists were quick to point out that when we previously talked calories we were actually talking about kilocalories and, therefore, the equivalent metric expression should be low in kilojoules or low kilojoule.

However, the term low kilojoule was both clumsy and pedantic and, like low calorie, obscured the fact that, to be effective, dietary foods should be low energy foods.

Unfortunately, some manufacturers opposed adoption of the term low energy foods because of the risk that such statements could be misconstrued to the public as meaning low grade or non-nutritious foods.

9.11 Public Relations — Winning The Support Of The Public

By 1982, evidence existed that in certain sectors of the community metrication was just as unpopular as it had been at the outset 11 years previously.

Should this be interpreted to mean that the Board's public relations program had not been entirely successful?

Below is an analysis of action taken by the Board to obtain industry and public support for its program of progressively converting Australia to the sole use of the metric system.

From the outset the Board saw metrication as predominantly, though not exclusively, a technical exercise. That is, changes necessary to convert Australian industry and commerce, technology and engineering, legislation, industrial awards, education and industrial training were seen as being changes principally to the material infrastructure of the nation, having a relatively incidental impact on people away from their places of employment.

Only in the area of retail trade for goods and services would the public be significantly involved with metric units and these would be limited to the millimetre, centimetre, metre, square metre, hectare, millilitre, litre, gram and kilogram plus degrees Celsius, people's heights in cm and fuel consumption in L/100 km.

Compared with the complexities of conversion of plant and equipment, products and packages, technical literature, education, science and technology etc., the complexities of layman conversion would appear to be almost negligible. Indeed, as workers in the production of various goods and services, a very large number of people would gain familiarity with metric units in their daily tasks.

It would only be a small step further from their work environment for most people to meet and master the more commonly used metric units outside their profession or trade. Metric units were not fundamentally difficult and one or two personal experiences were about all that was required for most people to adapt to the change.

It was the Board's policy that people would find themselves surrounded by a rising tide of metric measurements used in daily life and each would learn from it, by experience, in his own good time. It would, therefore, not be necessary to dwell too heavily on the problems of public education and effort could be concentrated on the areas where it really counted, namely, in industry, engineering and education.

In regard to measurement language, idiomatic expressions, hobbies and crafts, estimates in conversation, yarns and anecdotes, these were largely of a cultural nature and inaccessible to retroactive education or conversion. Metrication, in this sense, was a major cultural change and it was hardly more likely that Australians would suddenly forget about feet and inches or convert personal reminiscences and anecdotes than people from other lands would forget the language and customs of the land of their birth. This was not an area which the Board considered profitable or practicable to try to convert.

Yet it was in this very area of pre-metrication knowledge that the media frequently concentrated its efforts in attempting to assess the progress of metrication instead of checking how well people were coping with metrication changes in their material environment. Some reporters appeared to find it amusing that people had not culled out all imperial references from their personal memory bank or reskilled themselves at estimating sizes in metric for use in casual conversation.

In the process of metrication, the Board recognised four areas of measurement usage which would require conversion. These were products and services and their means of production and distribution, the public as members of particular industries, the public as consumers of goods and services, and the public as members of an imperial measurement culture. The first three it considered practicable to convert but the area of ingrained culture it considered neither practicable nor profitable to pursue.

In regard to the conversion of particular industries, of major primary significance was the co-opting of well-known and well-respected experts from the industries to serve on the Board's industry committees and plan their own conversion. It seemed most committee members were honoured to contribute to their industry's conversion program and their status within their organisation or company was obviously recognised.

Indeed, in this regard, the Board recognised that whether conversion would be undertaken enthusiastically or begrudgingly within each company would depend very much on the expressed attitude of the Chief Executive. If he approved, action would proceed right down the line, but if he was negative in attitude his disaffection would also be reflected downwards. It was for this reason that the Board's Chairman wrote a personal letter to the managers of 100 major companies throughout Australia seeking their public commitment to the support of metrication as "front-runners" for Australian industry. The response to these letters was unanimous and positive and without a doubt contributed enormously to the success of metrication in their own companies and their industry.

The same courtesy was extended to these company leaders and other active participants at the conclusion of conversion to thank them for their support and to impress upon them the need to maintain the positive attitude within their companies following the disbanding of the Board. Once again the response was warm and generous.

Part of the success of the conversion within industry and commerce was due to the reputation the Board gained, through its Secretariat, as an organisation which was prompt and efficient in obtaining and delivering answers to metrication problems in industry. Staff appointed to the Secretariat were predominantly professionally trained executive personnel and from very early in the program the Secretariat established a reputation for accurate and practical answers to problems. Where an immediate answer was not available, the inquirer was advised, usually the same day, by phone to anywhere in Australia. An atmosphere of efficiency and reliability and close communication with industry was created which augured well for the success of the project.

The location of the Board's offices in the major industrial cities of Sydney and Melbourne, plus its contact with industry through the Chambers of Manufactures in other States, gave the Board and its executives a high degree of accessibility which minimised the possibility of bureaucratic entanglement.

Having established the organisational structure through which metric conversion of industry would be effected, the Board produced a number of booklets, pamphlets and advice sheets to assist industry in its task. These included a booklet, "Industrial Training In Metric Conversion In Australia" (1972), "Metric Practice" (1973), and a leaflet, "A Metric Conversion Program Check List For Use Within Industry" (1972). The latter analysed an organisation into its functional departments and listed all possible areas in which conversion activity might occur. From this list each company could design its own time-table of necessary changes and this proved very effective in giving direction to individual companies.

A wide variety of industry specific pamphlets and booklets were also produced and distributed to the industries concerned. These include:

Building: Pamphlet "Design Notes September 72"

	Pamphlet “Design Notes June 73”
	Pamphlet “For Building and Construction Workers”
	Booklet “For Building Tradesmen”
	Pamphlet “Builders and General Hardware”
	Book “MH1 — Metric Conversion in Building and Construction”
	Book “MH2 — Metric Information for Building Designers”
	Series — “Metric Change Information Sheets”
Engineering:	Booklet “Information Brochure — Engineering Industry”
	Booklet “Manual for Engineering Establishments”
	Pamphlet “Engineering Workshops”
	Pamphlet “Bright Steel Bar”
	Booklet “Aeronautical Engineering”
	Booklet “Ship Building”
Freight Forwarding:	Pamphlet “Freight Forwarding”
	Booklet “Road Transport”
	Booklet “Water Transport”
Mining:	Booklet “Mining and Metallurgy”
Farming:	Booklet “Metric Fanning”
Packaging:	Pamphlet “Guidelines to Label and Package Printers”
	Pamphlet “Quantity Markings and Standardisation of Packaged Goods”
Timber and Forestry:	Pamphlet “Timber and Forestry”
Paper and Printing:	Pamphlet “Paper and Printing”
	Leaflet “Guide to Typesetting”
	Booklet “Metric Reporting”
	Pamphlet “Advertising in Metric”
	Pamphlet “For Typists and Stenographers”
Real Estate:	Pamphlet “For Real Estate Agents and Developers”
	Pamphlet “Buying Real Estate the Metric Way”

Maximum use was made of the trade press and trade literature to publicise these changes. Some companies produced excellent metrication guides, catalogues and technical literature for in-house and public use which were eagerly sought by users of their products and by other companies.

The Board’s officers travelled widely and spoke with groups within individual companies and industry associations to address them on the change. There would be few industries and groups which had not had personal contact with the Board in this

way. The Board's officers also wrote extensively for the trade press and assisted with the design of trade literature on request.

People working in converted industries soon became familiar with units and measurements used in their own industries. By about 1975 there would have been few people in the work force who had not had some daily exposure to metric measures.

The Board, however, depended most heavily on the educational effect of retail buying in metric units. The philosophy was that a person who had had an initial experience of buying a metric quantity to suit his needs, followed by one or two repetitions, usually gained complete confidence in his ability to cope with metric measurements in that particular task. For this reason, despite the many earlier industrial changes, most Australians regarded M-Day for them as being the day from which goods weighed out in the presence of the customer were required to be in metric units only. This date varied from State to State, the first being South Australia (1975), Victoria (1976), Tasmania (1976), New South Wales (1978), Western Australia (1976), Queensland (1978). This was the date from which the shopper was obliged to nominate the quantity she or he required in metric. Not surprisingly, as the regulations related to daily purchases of foodstuffs, sufficient experience was gained very quickly and complaints were almost non-existent.

In hindsight, the early conversion of quantity statements on packaged goods and changes in package sizes had an insignificant impact on public education due largely to the universal existence of the supermarket method of marketing, in which packages were selected by the customer by visual size rather than by quantity name in either imperial or metric.

The process of consumer education was assisted by the diligence of the Board's Women's Adviser who operated a metric information stand in various shopping centres and supermarkets throughout Australia to advise women on simple techniques for metric shopping. Talks were also given to women's groups and on radio and television throughout the nation.

In the domestic shopping area, the major retailing companies did an excellent job in promoting metric usage in their stores. Of particular significance was the voluntary agreement among leading retailers in New South Wales, Victoria and South Australia that from a certain date all goods sold by them, including goods described by measurement, would be ticketed and advertised in metric units only.

Throughout metrication the Board enjoyed a very high degree of support from the media. This was largely due to the effort by the Board to ensure that, regardless of whatever editorial comment the media chose to make about the metric conversion process, it should avoid making criticism of the Government's decision to go metric. The media, for its part, reported news, sport and weather predominantly in metric from an early date and encouraged advertisers to do the same.

As with packaged goods, it was probable that metric reporting in the media had minimal effect in assisting or bringing about a public usage of metrics in ordinary conversation. It did, however, have the effect of demonstrating support for metrication by an influential section of the establishment, thereby helping to popularise conversion to metric.

In this regard, the Board relied heavily on the news worthiness of metrication changes and stories on metrication were the major method of popularising metrication in Australia.

To the extent that the good PR established through the media was partly neutralised by the activities of the Anti-Metric Association, it was also strengthened by their activity by creating additional opportunities for comment and explanation about metrication changes as conversion became less newsworthy and stories about metrication became a little “old hat” for the media. On balance, the sometimes exaggerated claims of the Anti-Metric Association would appear to have aided, rather than hindered, public understanding of what metrication was about and eventual acceptance of the system.

Letters to the newspaper concerning various aspects of metrication also proved to be a useful forum for correcting erroneous views and for disseminating factual information. The Board’s policy in this regard was that every person was entitled to his point of view, correct or false, but where such an opinion tended to seriously misinform or mislead the public, deliberately or otherwise, about the nature and process of metrication, the Board had an obligation to answer it.

By and large letters to newspaper editors could not be regarded as a significant means of public education as they were usually directed at the more serious newspapers and read by an intellectual elite from whom might be expected a minimum of uninformed opposition. As such, Letters-to-the-Editor tended to be more exercises in erudite hairsplitting than a vehicle for grass roots public education.

The Board’s own newsletter was, however, much more successful in disseminating factual statements and comment on various aspects of metrication as it was widely re-reported in the media, particularly in the trade journals. Here again, however, factual metric information was largely being served up to the converted in particular industries and had a minimal effect on the general public.

The Board produced a number of publications for general issue or household use. These included “Metric Conversion And You (1972)”, “Kitchen Metrics (1973)”, “Metric Me (1974)”, “Fabrics And Clothing (1974)”, “Metric Shopping (1974)” and “All You Need to Know About Metrics (1978)”.

Unfortunately, from the public education point of view, except for “Metric Conversion And You”, 4 300 000 of which were delivered to every letterbox in Australia, the other pamphlets, while issued in large quantities, were not publicised and were not distributed on a scale which would have ensured that every family received

one. These pamphlets were mainly sought by large companies and issued widely to employees, but once again this effort was largely wasted on industrial areas which were already well serviced.

It was not until May 1978 that the Board mounted a limited radio campaign offering information to the public, first in New South Wales and subsequently in Victoria, for which “All You Need To Know About Metrics” was printed. This pamphlet was a combination of information from earlier pamphlets and was well received by the public. While they produced a significant response indicating a far from saturated public need for general information, these programs were small and in the nature of pilots for a planned nationwide program which was subsequently abandoned through lack of funds.

From 1972 to 1978 all phone directories carried a page of conversion factors called “Metric Units For Everyday Use” but it was never publicised and very few people were ever aware of its existence.

In 1979, Telecom accepted a new two-page format based on the pamphlet “All You Need To Know about Metrics” for use in the Sydney directory, and from 1981 in the Melbourne directory, but again, due to the absence of publicity by either Telecom or the Board, its existence remained hidden from the majority of people.

Throughout metrication, public education suffered greatly, not so much from a lack of suitable material but from the failure of the Board to publicise its existence and availability. Regrettably, when the Board recognised the need to do something to rectify this situation, its efforts to obtain the necessary campaign funds were unsuccessful due to stringent financial controls on expenditures on initiatives which had become Government policy.

To assist with the dissemination of metric information on a more localised geographical basis, the Board made arrangements, in 1972, with the Queensland Confederation of Industry, the Hobart Chamber of Commerce, the South Australian Chamber of Commerce and Industry, and the Confederation of Western Australian Industry, to act as agencies for the Board and as clearing houses for the more difficult questions which could be sent to the Secretariat for answering. While highly successful from both the Board’s point of view and from a public relations point of view for the agencies themselves, they again tended to provide information principally to member companies which were already well-equipped and well-serviced from their own source, so that the agencies would have had minimal effect within the general community.

The Board consistently opposed the use of dual measurement statements and dual tape measures and other measuring instruments. Ample evidence existed to show that dual units inhibited attempts by the public to try their hand at metric measurements and significantly delayed the process of learning metric by continually postponing the opportunity to learn by experience. Yet clear evidence also existed that, faced with a situation of inevitability, metric units in everyday use were far from difficult and people learned quickly from an extraordinarily small number of experience repetitions.

Arising out of this policy towards dual measurement, the Board sought and obtained an amendment to the Customs (Prohibited Imports) Regulations to prohibit the importation of non-essential, non-precision measuring instruments for ordinary use, except where it could be demonstrated that they were essential for the continued operation and maintenance of existing imperial plant which it would be unduly costly or impracticable to convert. At the same time, an agreement between local manufacturers of measuring instruments was obtained, if somewhat reluctantly, to manufacture dual or imperial instruments for the Australian market, only under conditions which would have applied if those instruments were to have been imported.

The purpose of these regulations and agreements was to limit the growth in the number of non-essential measuring devices which would become obsolete or obsolescent as Australia progressed towards total metrication. It was felt that many of the dual tape measures being purchased by the public were not essential as all building and handyman materials were sold in metric and the public had been sufficiently exposed to metric processes to be only minutely inconvenienced by being obliged to work in metric.

From the continuing complaints about the unavailability of dual tape measures and the resurgence of buying that followed announcement of the withdrawal of the regulation, it had to be assumed that, while the logic of the process was probably correct, the psychology of it apparently was not.

In continuing to obtain imperial instruments, people were not necessarily talking about a logical situation but about the fears, rational or otherwise, they had of being caught in a situation in which they would be unable to understand the measurements being used.

In the case of measuring tapes they seemed to wish to obtain dual, not so much because they needed them to measure with, nor because they wished to practice converting back and forth from metric to imperial to educate themselves, but as a safeguard against being caught in a situation in which they could not understand the measurements being used. Until people had experienced metrics in as many different situations as it required, and they adjudged themselves competent to understand metric in all such situations, they would not declare that they had "got used to metrics".

It seemed that to change public attitudes from inefficient involuntary learning with dependence on dual measurement for as long as it took to get used to metric by usage and involuntary experience, to a more efficient but more painstaking voluntary education might have required the Board to popularise metrication to overcome public disinterest, if not dislike, of metrication. Lethargy and disinterest appeared to be the main problems and it would have required some definite incentive for the public to depart from a learning process which, on the surface, appeared to require no personal effort, in favour of voluntary self-education in metrics which did. Such a process would

have required the Board to attempt to popularise metric measurements and metrication which, by its nature, would have been no easy task.

Unfortunately, the Board chose not to pursue a change in public attitudes through usual public relations processes but chose instead to bring about a change in measurement usage through a change in the Customs (Prohibited Imports) Regulations. These regulations were not primarily intended to regulate the units of measurement used in a particular field but were for a different purpose altogether. Regrettably, in hindsight, this action by the Board was inappropriate and bureaucratic and a departure from the policy of conversion by consensus which had worked so well before.

Although metrication was primarily a technical exercise it was also a social and cultural change. There was a large number of people from all walks of life whose daily work activities did not give them experience in metric measurement but whose hobbies and interests were measurement related. Although this group included many well-educated people, it also included people of lesser educational attainments who might have found difficulty in seeing the advantages of rapid self re-education, and, therefore, shown little inclination to depart from dual measurements.

Many less well educated people, when faced with, say, the conversion from mpg to L/100 km found this relatively simple change in concept absolutely mystifying. Their reluctance to change was because they did not know how to calculate a L/100 km figure from the litres used and the distance covered and were not able to compare such figures with fuel consumption figures with which they were already familiar.

From the type of questions answered by the Secretariat, making the change from well-known calculations in feet and inches (such as the area of a room or garden, the area of a wall for painting, the volume of ready mixed concrete for a path, the volume of a quantity of timber, cubing a parcel for freighting, the volume of a tank) to their equivalent in metric was beyond the capacity of many people and yet the switch from using a sole imperial tape measure to using a sole metric tape in mm or cm was simple if people only understood the change in the mathematical process. The failure of some tape manufacturers to recognise this consumer difficulty and to mount a positive marketing program aimed at assisting the customer to make the change undoubtedly led to the continued high demand for dual tapes and the reluctance of many to buying sole metric tape measures.

The failure of the Board to neutralise resistance in this section of the community resulted from its overestimation of the ability of that sector to cope with the change without assistance of the type indicated. It was not so much that the Board did not have a public education program as that what little was done was pitched too high to be of value to a large number of ordinary people. Even in 1982 there were moguls of the media who publicly proclaimed that they could not understand or see any benefits in metrics.

At grass roots level, the degree of sophistication in matters of this sort was not sufficient for people to be able, unaided, to transcribe simple imperial measurement calculations into metric. To have dealt effectively with conversion education in this sector would have required the public distribution of a variety of simple, practical pamphlets on basic measurement tasks and the associated arithmetic.

Regrettably, the Board always believed that to change public attitudes regarding measurement usage would be a near impossibility and that the costs of attempting to do so would be immense. Unfortunately the matter was never analysed or costed and it was therefore impossible to confirm or deny.

However, to the extent that the advertising industry continued, profitably, to be able to sell its services to cost conscious manufacturers it could hardly be denied that those who made their living by influencing public attitudes had the ability to do so. To the extent that the Government's instructions to the Board made no mention of metrication at minimum cost, there was no case for not having budgeted for this purpose.

If the job were to be done all over again, the task of popularising the change, and of distributing man-in-the-street kind measurement information to assist people to make judgements of value about the differences between metric and imperial, would need to be considered very carefully before a decision was made to do without a public education program.

In an attempt to resolve this issue, and to test the hypothesis that people would learn sufficiently from experience without the need for more deliberate persuasion, a survey was made of shoppers in Marion, South Australia, where sole metric retailing had been mandatory for some 12 months. This 1976 survey was commissioned by the Board and was carried out by the firm of McNair Anderson. The survey took the form of interviews and group discussions, not specifically or directly related to metric, to determine the various items which most caused concern to shoppers.

It was found that few people had acquired significant understanding of metrics although they coped with their shopping without trauma. Metric conversion was seen as a source of annoyance by only about two per cent of the people. The Board drew the conclusion that, although few people had gained an understanding of metrics from their metric shopping experience, virtually everyone was able to obtain all their shopping needs successfully. As metrication was not a particular form of annoyance to them, the original prognostication, that organised public education was not necessary, was considered confirmed.

The continued ground swell of resistance, small though it was assumed to be, seemed to indicate that the Marion survey was, at best, an unreliable indication of general community attitudes when extended to cover items such as tape measures.

While it may be said that a similar number of people would have given equally vague and erroneous answers to questions about the imperial system, indicating that

they had no greater knowledge of that system, the results tended to indicate public apathy rather than adequate metric knowledge.

While a lot of males were interviewed, it was predominantly the female sector which did the retail shopping for foodstuffs sold by mass. Even if learning by retail experience were effective in teaching metrics, the male sector had considerably less experience in this area than the female sector.

While for some people learning to cope with metrics may have been triggered, in some cases, by the example of knowledge acquired by the other partner, the continuing high demand for dual advertising in real estate and for dual measuring tapes for the home handyman seemed to indicate that, generally, it did not.

Likewise, the presumed educational impact on parents of helping children with their homework did not occur. On the contrary, there was considerable evidence of children, educated only in metric, learning about feet and inches and miles per gallon etc. from their parents.

Throughout metrication, the problem was not so much one of public opposition as of apathy and disinterest. To many people it was an academic exercise, related to mathematics and higher learning, and of no direct interest and importance to them.

The Board's attitude was that metric conversion, as a matter of Government policy, was its responsibility to implement, rather than debate or promote. Consequently, as a general principle, public debate on the desirability or worth of metric conversion was avoided and efforts to "sell" metrication were avoided as likely to lead to public debate and to harden or polarise public views on the subject. From this arose the concept of keeping a low-profile, low-key, avoid-argument approach.

There were significant differences between the two systems and significant benefits in using metric in day-to-day measurement and calculations, as well as in technology and higher learning, which could have been conveyed to the public in various forms to demonstrate how to cope with metrics and to dispel fears that it would be difficult. Unfortunately, this was only attempted in an ad hoc manner by leaflets, distributed on request only, or by public lectures by the MCB staff. The Board's total expenditure on public relations for the 11 years was \$1 199 000 or 8.56 cents per person.

Significantly, the system itself was never publicly explained to the community, even in its most limited form, before the issue of "SI — The Students Guide" in 1977. In 1973, a highly detailed and definitive booklet called "Australia's Metric System" was issued widely to school authorities for use by teachers. This booklet was in no way suitable for the general public and even the Students Guide was intended for senior secondary students and beyond. Industry depended heavily on AS 1000 "The International System of Units (SI) And Its Application", and several excellent monographs, as its guide to the metric system. Not until 1978, when the Board published "All You Need To Know About Metrics", did it publish the basic metric tables

equivalents to the old imperial tables learned at school. Again, this was only issued on request, although some 150 000 were produced.

The pity of it all was that having created such a vital and enthusiastic atmosphere within industry, commerce, government, education and the public, the Board did not follow through and capitalise on the excellent public relations it was enjoying through the media to generate an attitude that metrication was nationally desirable, beneficial and easy and that detailed help was readily available.

Though the policy of a low-key public image was, in many ways, desirable, it is doubtful if such an all pervading exercise could have been accomplished almost unnoticed, particularly when so many people were to be soon jolted out of their apathy by import prohibitions, building regulations, weights and measures regulations, regulations relating to units in contracts, newspaper cut offs and the like.

It might not have been disastrous that the public was not taken more into the Board's confidence but, unquestionably, the stubbornness of some sections of the community to change, the failure to maintain the import prohibitions, or to find a legislative method of ensuring uniform conversion in real estate, made one wonder why some deliberate effort was not made to smooth the path ahead and, hopefully, avoid the problems, which arose from these sources. After all, when it came to making people follow a particular course of action, in metrication or in any other field, there were only two options available: persuasion or force. In the absence of laws and regulations to mandate the change, the only alternative was persuasion and no matter what arguments could be used against this method there was no alternative other than to leave part of the problem unsolved and hope that time would do it all in the end.

9.12 Conversion Of Government Operations

The conversion of Government departments and their operations was planned and executed by the departments themselves, through their own metrication committees. The complexity of these operations varied from department to department.

Each State had its own interdepartmental coordinating committee to coordinate decision making and planning between individual departments and the Australian Government had its own Inter-Departmental Coordinating Committee for Metric Conversion (IDCC). The chairman of the IDCC was a Board Member.

The conversion of local government was achieved through the relevant department of each State.

Coordination of timing and approach between States and with the Commonwealth was achieved through the States' Committee for Metric Conversion. The chairman of this committee was also a Board Member.

As a result, Government departments appeared to have little difficulty in achieving successful conversion although the slow conversion of purchasing records for the calling of tenders delayed an otherwise trouble-free operation.

The Defence Services, which depended heavily on material from the USA or the UK, where conversion was not complete, found it impossible to make an immediate conversion in all areas. Much existing equipment would clearly have to be operated and maintained in imperial for the remainder of its useful life.

The cost of conversion of State government departments was, in part, paid for out of Commonwealth special grants for this purpose.

9.13 Conversion Of Industrial Awards

The conversion of Industrial Awards, in which working conditions and rates of pay were specified, was a highly sensitive area for conversion. In this regard the Board was fortunate in always having, as one of its members, a representative of the Australian Council of Trade Unions. As a result, virtually no problems arose in the conversion of those awards.

The basic principle for the conversion of Awards which were legal documents was that nothing should be done in varying an award for the purposes of metrication, which could have the effect of diminishing payment or conditions already granted in that award. As a consequence, any benefits gained by rounding to produce sensible metric numbers had to go to the employee and correction of any significant anomalies occurred at the next renegotiation of the award.

Although it was possible to progress in a single step from an award in sensible imperial numbers to a similar award in sensible metric numbers, this did not always happen. Because of the sometimes delicate relationship between unions and employees it was more usual to adopt a two stage process in which exact conversions or non-rounded metric numbers were first inserted for the sake of metrication, and the whole award renegotiated in sensible metric numbers at a later date.

Even this approach was sometimes fraught with difficulties resulting in arguments about the accuracy of figures and the number of figures to be quoted after the decimal point. The Board urged that the converted measurement should not be quoted to more significant figures or greater accuracy than the weighing machine or measuring device was capable of measuring. Thus, all "soft" converted figures given in stage one of the metrication of an award were accurate to the limit of reading of the machine and rounded in the direction which could not worsen the conditions already granted in the award.

On the matter of responsibility for cost of tools of trade resulting from metrication it was agreed that employers should abide by the award. Where tools of trade were the responsibility of the firm, then the firm should supply, but where, under the award, the tradesman was required to supply his own tools, then that should continue to apply.

However, many firms provided metric tools, even though they were not compelled to do so, and some exchanged the employee's imperial set for a metric set, to be returned to each other at the termination of employment of the tradesman. As a result, no difficulties were ever experienced due to metrication of industrial awards and no disagreement was ever reported over the tools of trade issue. In fact, the liaison with the trade union movement which existed through union membership on the Board also made it possible to distribute metric literature and arrange industry meetings on metrication for the benefit of employees.

10. CONCLUSIONS

This report has detailed the way in which the decision to convert to metric in Australia was reached and the means by which this decision was put into effect.

At this stage there can be little doubt that the decision was a wise one and that the efforts of the Government and of so many people in bringing it about were very successful.

So successful has the metrication program been that Australia is held in very high regard in many countries of the world, including the UK, Canada, the USA, Hong Kong, Singapore and Malaysia where metrication has occurred or is still in progress.

In fact, because of the lucidity of the legislation enacted to bring metrication about, and the practical charter delegated to the Board, Australia has been envied by the UK and the USA, particularly where Government intentions were less clearly defined and Government support for the project was less generously given.

Because of this, metricationists from these countries and others have visited Australia to see how our methods and policies might be adapted to conversion in their own countries.

By 1982, conversion of the material environment in which people lived, worked and played was, if not complete, very highly metricated and people were continuing to obtain in metric all the goods and services they needed with no greater difficulty than they did in imperial measures. Of course, this did not mean that people had a comprehensive knowledge of the metric system. As with pounds, pints, feet and inches they managed very well without any real knowledge of the system.

Many examples of non-conversion or incomplete conversion continued to exist, particularly in the engineering industry. Indeed, when the whole world is eventually metric there will remain many items of imperial manufacture which will function equally well in either system and which will remain unmistakably imperial even though they may have metric names. Such items will include motor car wheels in inch sizes or typewriters and computers in which line widths and spacings are based on inches and tenths of an inch.

Wherever the opportunity existed to profitably redesign a product or product range, or the need existed to redesign a product to conform with metrication changes in other products and uses, the Board encouraged manufacturers to “hard” convert and take advantage of the temporary disruption to production to increase their cost effectiveness. Where a product was not required to coordinate dimensionally with any other, and where there could be no economic advantage in a change in product design, the Board did not promote “hard” conversion, other than to give that product a sensible size name in metric numbers.

Measurements used by people in their private lives, in conversation or in estimation of sizes had not noticeably changed nor was such a change even attempted or thought necessary. Most people would continue to be bilingual in measurements for the rest of their lives. People would become metric in their thinking by progressively adding metric words and ideas to their existing stock of knowledge rather than by immediate substitution of metric for imperial.

The object of the Board’s public relations program was to show people how to live with metrics and use metrics in ordinary activities at work or as consumers of goods and services. No attempt was made to eradicate evidence of earlier knowledge.

People would, in the main, learn metric by experience. The Board rejected any suggestion that people should go “back to school” to learn metric or be required to carry conversion tables or pocket calculators. Its message was to think metric — that is to live within the metric system as far as possible and to avoid moving back and forth between metric and imperial. Provided people made an effort to relate to new metric benchmarks, instead of converting back to imperial to relate to imperial benchmarks, then metric really was easy.

Unfortunately, despite the excellence of this advice in showing people “how” to go metric, the public relations program fell down in not giving the necessary information by telling them “why” they should go metric. The consequence was that many people chose, as far as possible, to ignore the change.

The attitude of indifference became perceptibly hostile after 1978, when regulations were introduced to limit the importation of certain types of non-metric measuring devices, particularly those required by ordinary people away from their places of employment.

Faced with a slow rate of conversion to the use of metric instruments in situations in which they could be used just as easily as imperial, and with the possibility that dual metric–imperial usage and dual stocking of goods and instruments would continue almost indefinitely, the not-too-harsh prohibitions against the importation of tapes etc. in feet and inches seemed to be the lesser of two evils.

These regulations were largely successful in ensuring that industries which had not already changed, but which could just as easily work in metric did so, while at the same

time allowing companies for whom imperial instruments were essential in the operation and maintenance of their business, to get them.

Unfortunately, in the absence of deliberate moves to encourage people to make the change to metric in their private lives, or to show them why they should, these regulations were seen by many ordinary people as unnecessarily repressive and, with the support of some Members of Parliament, the regulations were withdrawn. By the time that the Board began to recognise a need for public motivation, it had already established a tradition of not spending money for this purpose. With the curtailment of Government spending on new projects it was unable to fund what, by then, was essentially a new undertaking.

The absence of a public motivation program to attempt to popularise metrication had a further unfortunate consequence. Faced with competition between sellers of real estate and a low level of public familiarity with metric units used in this industry, voluntary conversion was only partly effective and difficult to maintain. The real estate industry repeatedly asked for legislation to ensure uniformity in conversion and to avoid unfair competition between agents who converted voluntarily and those who did not. Only New South Wales had legislation which might have been amended to require metric units to be used in real estate advertising and sales and this State did not wish to do so unilaterally.

On the other hand, the possibility of amending the Australian Government's Weights and Measures (National Standards) Regulations to withdraw the acre, rood and perch as Commonwealth legal units or to produce a regulation under the Metric Conversion Act to selectively withdraw the use of the acre, rood and perch from use by the real estate industry, existed. Although the likelihood of hardship arising from either piece of legislation was extremely small, the amount of public resistance to the import prohibitions had grown so much that any legislative pressure aimed at enforcing metrication was politically unpopular and could not, therefore, be obtained.

Had public opinion been properly prepared, it seems highly likely that either of these quite normal legislative changes could have been made and real estate advertising converted as successfully as the building industry, retail sales of consumer goods, traffic rules and other activities controlled by State and Federal regulations.

One of the important lessons of metrication, as it could relate to other projects, was that voluntary adherence to an ethical code, in this case voluntary metrication, where there was the possibility of a profit for non-compliance, could not be achieved without legislation. It seemed likely that, eventually, legislation might have to be introduced to standardise the units of measurement used in real estate advertising for the protection of the public.

It was too late, in 1982, to implement a public education program of the kind envisaged. It was, however, a pity that to achieve such a worthwhile change the public

had to be subjected to so much unnecessary trauma and that aspects of the change had to be left incomplete.

The decision to establish an ongoing Metric Section of the Department of Science and Technology to service inquiries from industry and the public after the closure of the Board was a wise one. Letters, phone calls and requests for assistance continued to be received daily and as at least half of these were simple-to-complex technical questions, the service appeared to be worthwhile. The section continued to be called upon to provide material, articles and interviews for the media and, therefore, provided for the continued growth in usage of metric by industry and private individuals.

The future of this section, which consisted of four former MCB staff, was that within about two years it would decline by resignations and retirements. It was expected residual staff would be transferred or absorbed in other sections of the Department of Science and Technology.

Long after the process of conversion is complete, when people are generally working in metric, there will be a need for metric units used in trade to be regulated, just as imperial units were before. The responsibility for this activity will remain with the National Standards Commission, the object of which, in accordance with the Weights and Measures (National Standards) Act 1966 is to establish and maintain uniform units and uniform standards of measurement for which purpose the Weights and Measures (National Standards) Regulations will be from time to time amended.

GLOSSARY (PDF EDITION)

A few acronyms and other terms not explicitly defined in the text may be unfamiliar to non-Australians and non-scientists:

CGPM — General Conference on Weights and Measures (French: *Conférence Générale des Poids et Mesures*) — International conference established after the 1875 Treaty of the Metre.

CSIRO — Commonwealth Scientific and Industrial Research Organisation — A research body of the Australian Federal Government.

F Inst P, FAIP — Curiously inconsistent but accepted stylings for Fellow of the Institute of Physics, and Fellow of the Australian Institute of Physics.

HMSO — Her Majesty's Stationery Office — Publication service of the British Government.

Industrial Awards — Pay and conditions awarded by negotiation between government, business, and unions in an industrial court.

Manchester — Sheets and bedding, linens and towels — The boundaries of the term seem to be somewhat vague, and the usage today may be largely confined to commercial contexts, e.g. the manchester department of a large store.

MBE — Member of the Most Excellent Order of the British Empire. See OBE.

MCB — Metrication Conversion Board — Also referenced simply as the Board. (The acronym and the full name do not seem to be explicitly linked in the text.)

OBE — Officer of the Most Excellent Order of the British Empire. See MBE.

MP — Member of Parliament.

Point — Obsolete rainfall measure: 1/100th of an inch.

Primary Industry — Agriculture (usually) — Agriculture, fishing, forestry, and mining are often referred to as primary industries; processing and manufacturing are secondary industries; services are sometimes called tertiary industries.

QC — Queen's Counsel — An elite rank of barrister (usually). Barrister, in turn, denotes a senior class of attorney. QCs wear silk gowns in court, and are therefore known informally as *silks*.

SAA — Standards Association of Australia.

Shire — One of several designations for Local Government Areas (LGAs), which also include Cities, Councils, Municipalities and Regions. Shires are the most rural areas, generally, but precise definitions of all such terms may be specific to the State or Territory.

Smallgoods — Spiced or processed meats: sausage, bacon, salami, etc.

Square — Deprecated area measure for selling houses: 100 square feet.