SP 4 (1969): Metric Change in India [PGD 1: Basic Standards]

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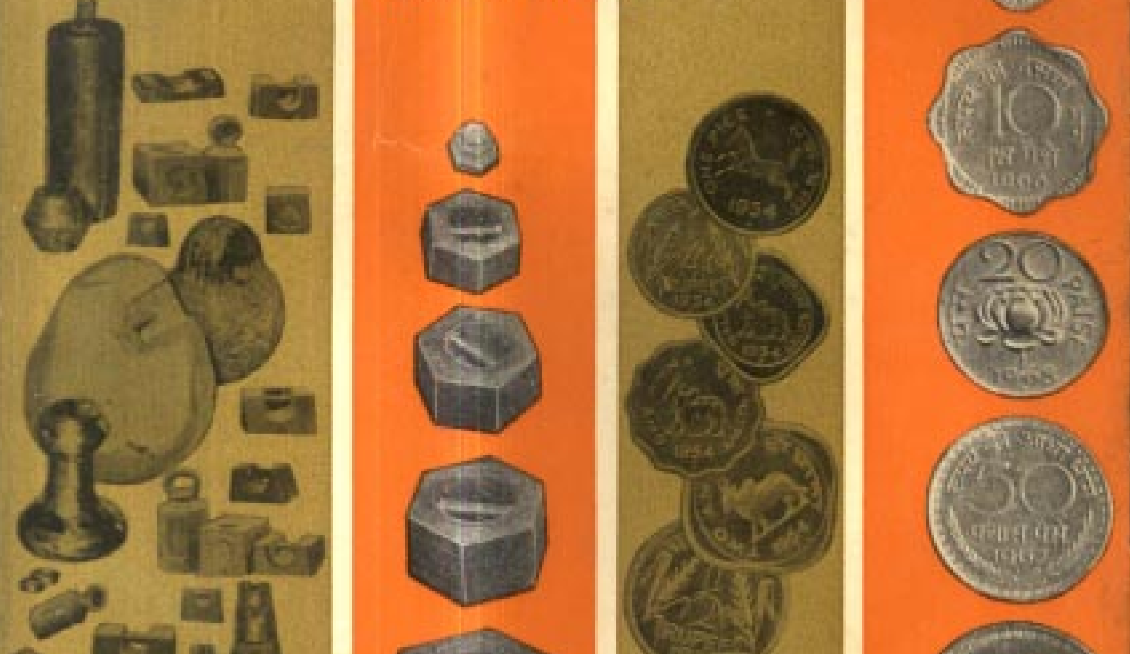
METRIC CHANGE IN INDIA

DR LAL C. VERMAN
JAINATH KAUL



INDIAN STANDARDS INSTITUTION, NEW DELHI 1

about the book....

Here's the first authoritative chronicle of events leading to the metric switch-over in India and the decade that followed. The scientists, engineers, administrators and educationists who tell this story of one of the great accomplishments of free India, are persons with intimate knowledge and wide practical experience of the programmes of metric change in their respective fields of specialization.

The problems and difficulties encountered in bringing about a basic change in the system of measurements of a complex economy will be very nearly the same everywhere. And to that extent the Indian experience would be of great value to other developing

(continued on flap 2)

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METRIC CHANGE IN INDIA

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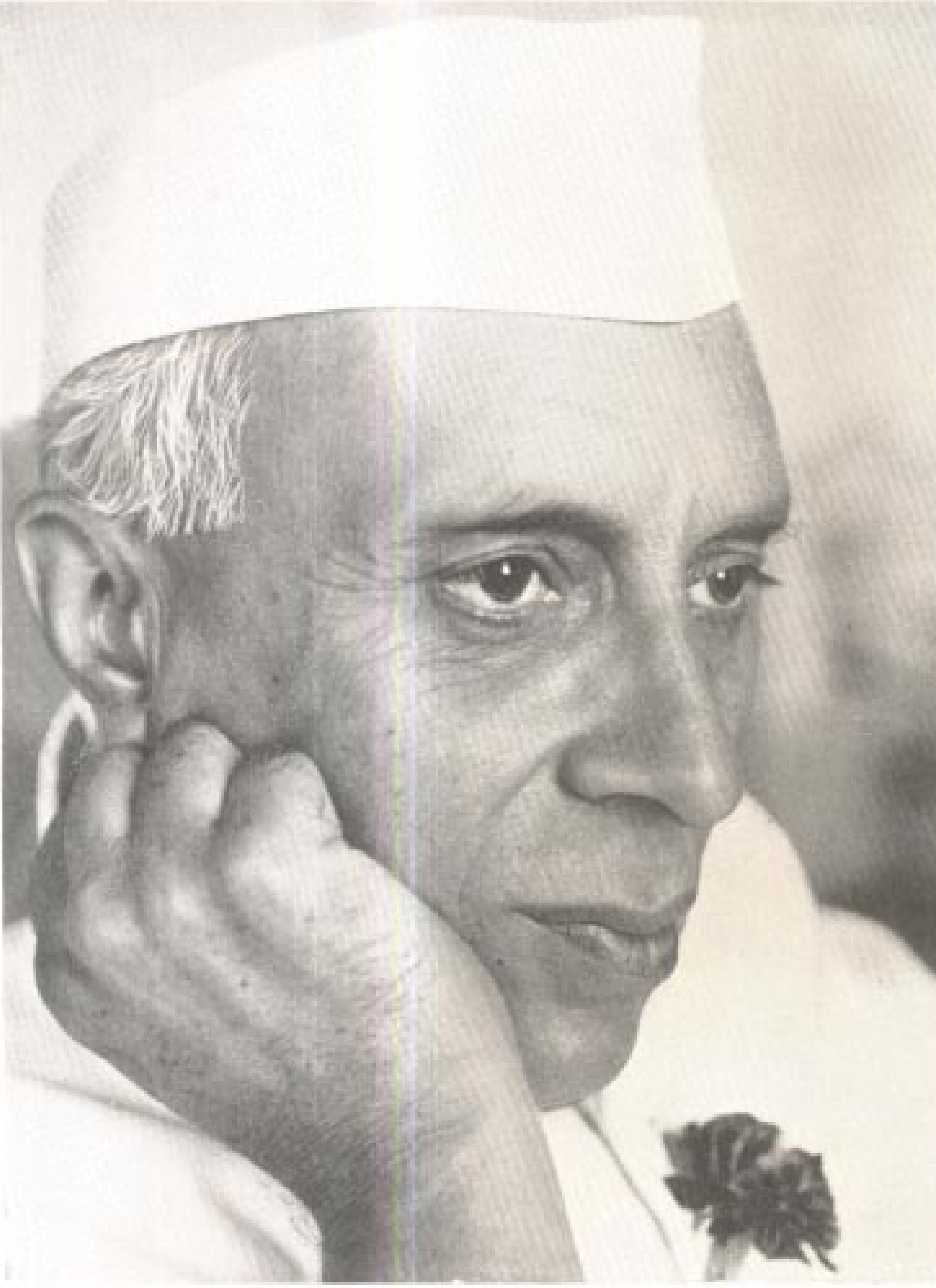

JAWAHARLAL NEHRU

METRIC CHANGE IN INDIA

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INDIAN STANDARDS INSTITUTION
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Dedicated

To the memory of
Jawaharlal Nehru,
Architect of modern India,
But for whose wisdom,
Foresight and drive, the
Motivation for writing this book
Might yet not have been.

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PRIME MINISTER

FOREWORD

The metric system makes for greater order and efficiency in economic management, whether in industrial production or in trade or even in running a household. It also facilitates technological progress. This is recognised by even those countries which follow other systems of measurement.

In India the adoption of the metric system also served as a powerful force for national unity. By doing away with a bewildering variety of provisional measurements, it has helped smoother flow of inter-regional trade.

The metric reform is undoubtedly one of the great accomplishments of free India, one which has attracted world-wide notice. We could take it up and complete it mainly because of the initiative and support of my father and also because of the pioneering zeal and hard work of the scientists and administrators who were entrusted with the promotion of the programme.

I am glad that the Indian Standards Institution is publishing a book documenting the story of this change. The book will be of historical value and of use to other countries as well.

Indira Gandhi

Manali,
30th May, 1969.

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Contents

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Preface

As in many other fields in which Jawaharlal Nehru's genius was responsible for leading human thought and action towards the advancement of man within and without the national boundaries, so it was, at his initiative, that the metric reform in India received decisive push. Thus, in December 1956, just nine years after Independence, the Parliament of India decided to adopt the metric system as the only system of weights and measures for use in the country, and directed the Government to have the change-over effected within a period of ten years. A short account of these ten years of effort has been attempted in this book.

This period was marked by a continuous struggle with the multifarious problems presented by the change-over and the process is not yet complete. It has involved, among other things, the replacement of literally millions of weights and measures and associated equipment, and the organization of the requisite administrative apparatus for enforcement on an extensive scale. But even more significant was the change required to be brought about in the mental attitude and process of thinking of hundreds of millions of people, some literate, but mostly illiterate. During this period, and since then, several enquiries were received from abroad*, both by

*These enquiries emanated from the Governments and institutions in Afghanistan, Argentina, Brazil, Burma, Canada, Ceylon, certain East African countries, Ethiopia, Nepal, Pakistan, Saudi Arabia, South Africa, Thailand, United Kingdom and others.

the Indian Standards Institution (ISI), the prime mover of the reform, as also by the Government of India, and perhaps other bodies as well, about the details of the Indian experience in dealing with different aspects of the programme. These enquiries were individually dealt with as best as they could be. But the repeated collection of all the requisite material for satisfactorily handling the enquiries posed serious problems. It was felt that the best way to deal with the situation would perhaps be to prepare a systematic account of the progress of change-over, constituting what may amount to a history of the process. That is the *raison d'être* of this book. It is hoped that the account presented will help satisfy the need for information outside as well as inside India.

It is now well-known that in May 1965 the Government of the United Kingdom made a clear-cut declaration that the metric system would gradually be introduced in that country. According to a report published in August 1968 in the United Kingdom, it would appear that:

> 'In 1965 the proportion of the world's population using the metric system was assessed at over 85 percent. The balance of world trade, however, was assessed as only being marginally in favour of metric — of the order of 55 percent. Since then, however, the picture has changed dramatically, 75 percent of world trade now being in metric, and the present trend towards metric suggests that by 1975 only the North American continent may still be using primarily a system other than the metric system.'

The plans that have been made in the United Kingdom, with the participation of the British Standards Institution (BSI), indicate that the British industry expects to change over to the new system by 1975.

As recently as in August 1968, the Congress of the United States had authorized the United States Bureau of Standards to make a comprehensive study of the question whether the US should switch over to the metric system of measurements. It would appear that considerable interest already exists in that country in favour of such a change-over. In fact it is known that certain sections of industry find it more convenient to work on metric basis. Quoting again from the United Kingdom report:

> 'Closely allied to America, both economically and geographically, is Canada, which, for some time now, has been following closely the progress

made in the UK. Virtually all of Britain's former recent colonies, dependencies and Commonwealth associates have already announced their intentions to change, which clearly must be a warning that their trade will tend towards countries manufacturing in metric. With South and East Africa already formulating their plans, soon the whole of the African continent will be metric. Australia and New Zealand too have been gathering information and considering a change-over. A decision from this part of the world is also likely in near future, following the recent recommendations of a select committee to the Australian senate, that metric should be introduced and become the only system in use in that country*.'

Thus, it would appear, that after well nigh two centuries of the origin of the metric system (1795), and after nearly a century of the signing by 18 nations of the Metre Convention (1875), the world as a whole may be said to be well on the way now to its universal adoption. When this does happen, the dream of its orginators will have been realized. India, in this process, appears to have made its own contribution by having decided boldly in favour of adopting the metric system at a critical period of history soon after its Independence. It was felt that, despite India's economic and historical links with the non-metric countries, the speed of its own development would largely depend on an orderly approach to a sound programme of standardization, geared to a scientifically conceived and universally used system of measurements.

It is noteworthy that every one of the countries which has signed the Metre Convention up-to-date has not legally adopted the metric system for exclusive use. Nor is it true that among the non-signatory nations it is neither legally recognized nor exclusively used; among some of them it is indeed legally obligatory and enforced. Recent position reported by the *Bureau International des Poids et Mesures* is that, of the 81 countries in which the system is mandatory, only 34 are signatories to the Metre Convention, and of the remaining, six signatories are to be counted among the 16 other countries where the use of the metric system is optional. Furthermore, the position with regard to the rigour of its enforcement varies considerably, even where it is required for universal use by law; this is particularly so in certain developing countries. Even in some developed countries, where the metric system is by and large universally used and enforced, there might exist pockets of economy in which one or

*Since then, both Australia and New Zealand have decided to go metric.

more traditional units may still prevail. The position indeed is too complex to be surveyed in a few paragraphs. However, in any new country, where it is decided to adopt the metric system, it must be recognized that, while scientific and metrological services in neighbouring countries could perhaps be called into service for help, the legal apparatus and administrative machinery for enforcement must be considered as absolutely essential to be organized locally.

Soon after the decision was taken in India for adopting the metric system, the Government decided not only to sign the Metre Convention but also to enrol itself as a member of the International Organization for Legal Metrology (OIML). In consequence, as an active member of the international community concerned with scientific and legal metrology, India has derived many benefits in its effort to bring about successfully the change-over of the country to the metric system, within the planned period. It is hoped that, as a result of the experience so gained, India will be able to make positive contribution to the further development of both scientific and legal metrology in the world.

While the material contained in this book may be found to be of some use to the conversion programmes currently being contemplated, formulated or executed in some of the advanced countries like Australia, the United Kingdom and the USA, it has been the editors' attempt to pay particular attention to the special interests of the numerous developing countries which have either adopted the metric system already but are anxious to make it more widely used and strictly enforced, or which are contemplating its adoption *ab initio*. Some of the problems, such as those of industrial standardization and the translation of standards into actual industrial practice, those concerned with the change in engineering education, design and construction, and others of similar character would naturally be much more complex in an advanced industrial society than they were in India. But the common problems of mass communication for changing the thinking habits of generations and millions of people, and the problems of everyday life of the housewife in the home and the man in the street are typical of all countries, and deserve very special handling in less advanced countries. The information on international background contained in certain chapters is included particularly in view of the peculiar need in the developing countries for both historical and technological information. Being itself, by and large, a developing country, India's experience as related in this book, it is hoped, would hold some useful hints and even some lessons, which may be helpful in saving time and effort in other developing countries where similar programmes may be undertaken.

Those interested in English etymology may be curious to know why in India the words 'metricize' and 'metricization' as used in this book were preferred, while in the United Kingdom the preference is for the words 'metricate' and 'metrication'. There is really no rational answer to this question, except to say that the case illustrates one of the many ways in which the English language has been enriched from time to time. It was indeed the editors of this book who were first faced with the problem of finding suitable new words for these concepts, when the numerous Indian Standards and other literature had to be compiled and issued in metric terms. It must be confessed that the use of the endings '–ize' and '–ization' came to them quite naturally, there being several precedents for such usage in similar situations in the English language. It has now come to their notice that when the United Kingdom decided to adopt the metric system, the question was referred to the Editor of the Concise Oxford Dictionary, who expressed the view that 'The modern tendency is to use –ize, –ization, in forming new words rather than –ate, –ation', adding that 'It seems to me that either metrication or metricization could be used.'

It was thus that the Government in the United Kingdom decided to popularize 'metricate' and 'metrication'. It appears quite likely that these words would continue to be preferred in other English-speaking and English-using countries. But in India the preference for 'the modern tendency' to use '–ize' and '–ization' has already taken such a root in the standards and legal, administrative and industrial literature, that it would be futile to contemplate any change at this stage. After all, two equally acceptable sets of words for the same concepts would only go to make a language richer, though standardization enthusiasts may be somewhat disappointed.

In preparing this presentation of India's experience in book form, it has been considered essential that generally the authorities and institutions that have been directly concerned with a given aspect of the change-over plan should present their account in their own words. As a result, the editors' job has been made both light as well as difficult — light, because they could depend on other better informed people to do most of the original writing; and difficult, because most of the authorities requested to write being in responsible positions could not always turn their attention to every demand made on their time. Thus, the work that was expected to take about a year has taken well over two years.

This method of approach has also led to a certain amount of repetition of material, which may be considered natural in a book like this written by several authors. Though an attempt has been made to reduce such repetition to the minimum, a certain amount of it has purposely been allowed to remain so that each chapter would give a complete picture of the particular subject it deals with. Reader's indulgence is also sought for any impression that may be created by some passages about the thoroughness of the metric change achieved during the ten-year plan period. Though a great deal may be claimed to have been accomplished, many tasks still lie ahead. In a final chapter, therefore, a broad review of the present situation has been attempted.

The editors are extremely gratified at the willing response they have received from the numerous contributors, and are grateful to every one of them for his co-operation. Specific mention in this connection deserves to be made of Shri S. K. Sen, Deputy Director General, ISI, presently UNIDO expert assigned to the Institute of Standards and Industrial Research of Iran in Tehran, for taking an active part in the original planning of the book; Shri V. B. Mainkar, Director, Weights and Measures, Government of India, for his constant co-operation and manifold assistance; Shri B. S. Krishnamachar, Deputy Director General, ISI, and the Publications staff of ISI, headed by Shri Ram D. Taneja, Director (Publications), for all the continued help and co-operation received during the production of the book.

One of the editors would also like to express his personal appreciation of the courtesy and understanding shown by the authorities of the United Nations Economic Commission for Asia and the Far East during the course of compilation of this book.

The editors would particularly like to express their deep indebtedness to Dr A. N. Ghosh, Director General, ISI, for his keen interest and for generously placing at their disposal all the necessary facilities and resources of ISI for this work.

It is hoped that the effort of all those who have helped write this book, and those who made its production a possibility, may prove useful in furthering the cause of universal adoption of the metric system in the world, which is bound to facilitate international intercourse in all fields of human endeavour, and help move mankind towards 'one world'.

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May 1969

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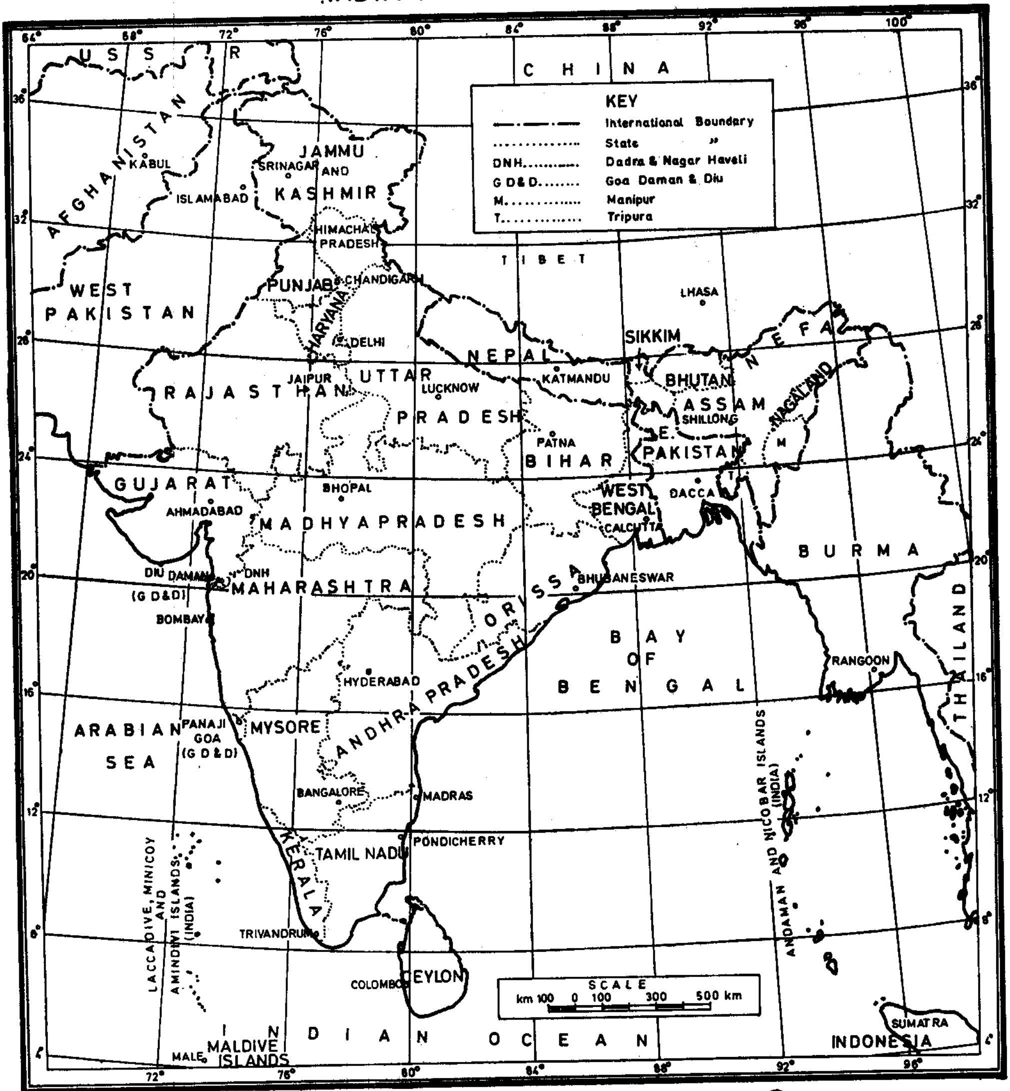
INDIA AND NEIGHBOURING COUNTRIES



BASED UPON SURVEY OF INDIA MAP WITH THE PERMISSION OF THE SURVEYOR GENERAL OF INDIA

SHOWING INDIAN STATES, THEIR CAPITALS AND UNION TERRITORIES

THE DEMARCATION OF THE GUJARAT-WEST PAKISTAN BOUNDARY IN ACCORDANCE WITH THE INDO-PAKISTAN WESTERN BOUNDARY CASE TRIBUNAL AWARD IS IN PROGRESS (1969)

Area and Population of India (Statewise)

State	*Area**	*Population†*
ANDHRA PRADESH	275	35 983
ASSAM	203	12 209
BIHAR	174	46 456
GUJARAT	187	20 633
HARYANA	44	7 591
JAMMU & KASHMIR	223	3 561
KERALA	39	16 904
MADHYA PRADESH	444	32 372
MAHARASHTRA	307	39 554
MYSORE	192	23 586
NAGALAND	17	369
ORISSA	156	17 549
PUNJAB	50	11 135
RAJASTHAN	342	20 156
TAMIL NADU	130	33 687
UTTAR PRADESH	294	73 746
WEST BENGAL	88	34 926
TOTAL	**3 165**	**430 417**
UNION TERRITORIES	103	8 656
GRAND TOTAL	**3 268**	**439 073**

*In 000 sq km.
†In 000 (1961 Census).

1

The Metric System — International Background

Lal C. Verman

The metric system was conceived and developed during the closing decade of the eighteenth century by a French team of scientists led by men like Delambre and Lavoisier. The chief motivation was to rationalize the then existing variety of measurement systems which prevailed in the European and American continents. There appeared no chance of any one of the prevalent systems being universally accepted, which could help promote freer intercourse between the various countries, and indeed between various regions of certain countries. So, the French scientists, encouraged by the revolution, addressed themselves to the task of devising a system, using nature as model and natural phenomena as guide, to which no national susceptibilities could possibly attach. It goes to Talleyrand's credit that the French Constituent Assembly took the initiative in 1790 to entrust to the French Academy of Sciences the task of establishing a measuring system which could be accepted by the whole world.

It was thus that, after as careful measurements as could be made at that time, one ten-millionth part of a quadrant of the earth's meridian was adopted as the unit of length — the metre. The unit of mass was derived from this unit of length by defining the kilogram as equal to the mass of water having a volume, under certain conditions of measurement, equal to a decimetre (one-tenth of a metre) cube. Based on these measurements two physical prototype standards, both in platinum, were constructed — one for the metre and one for the kilogram — and deposited in the Archives of the French Republic in 1799.

Another significant step, which was also taken at the same time, was quite novel in the realm of systems of units of measurement. All the multiples and sub-multiples of the basic units were to be integral powers of ten — thus linking up the units with the commonly used system of decimal counting. This innovation itself was a great step forward, for it simplified calculations and gave promise of saving millions of man-hours of time of the users at all levels of society. Incidentally, this step also brought the system close to the Indian tradition, where the zero and decimal system of place values had been originally invented.

According to Lavoisier: 'Never has man come out with anything greater and simpler, or anything more coherent in all its parts'.

METRE CONVENTION

In spite of the hopes of its originators for its unquestioned acceptance by all the advanced nations of the world, the metric system continued to remain dormant for several years, and indeed its universal acceptance even within France was not as spontaneous as might have been expected. Voices in favour of world-wide unification of measuring systems on the basis of the metric system continued to be raised from time to time by various learned societies in France as well as other European countries. There arose a general feeling that an international approach to collective action was called for. It was thus that the French Government, in 1870, invited the representatives of several countries to meet in Paris. Twenty-four countries responded to this invitation of whom only 15 could send their delegates because of the out-break of the Franco-Prussian War. These delegates constituted the *Commission Internationale du Mètre*, but could take no decisions. The work of this Commission could, however, be resumed in 1872 with the participation of delegates of 30 countries, 11 of whom were from the American Continent. About 40 resolutions were passed dealing with the preparation of new prototypes of kilogram and metre and related matters. The creation of an International Bureau of Weights and Measures was also recommended to the interested governments.

But the members of this international commission, who were all scientists, had no authority to commit their governments. Hence, some years later, in 1875, another conference, attended by representatives of the governments, was held again in Paris. It was called *Conférence Diplomatique du Mètre*. This time positive results were achieved. On 20 May, 1875, a *Convention du Mètre* was signed by 18 States. By this convention, the signatory States bound themselves to set up and maintain at common expense a permanent scientific body of weights and measures at Paris. It was given the name of *Bureau International des Poids et Mesures* (BIPM).

CONFERENCE GENERALE DES POIDS ET MESURES

The governing authority of the Bureau was the *Conférence Générale des Poids et Mesures* (CGPM), made up of delegates from all the member countries, which were signatories to the *Convention du Mètre* and those which might join the convention later. The duties of the General Conference of Weights and Measures were defined briefly as follows:

1) To discuss and adopt necessary measures for the propagation and improvement of the metric system;

2) To sanction the results of new fundamental metrological determinations and various scientific resolutions of international importance;

3) To take important decisions concerning the organization and the development of the International Bureau of Weights and Measures.

The CGPM, which meets every six years, being the supreme authority, takes all the major decisions in regard to the new and revised definition of metrological standards and all policy matters including finances and the programme for future developments. It also appoints members of the implementing body called the *Comité International des Poids et Mesures* (CIPM), consisting of a maximum of 18 specialists chosen from the signatory countries. The CIPM is expected to meet at least every 2 years or more frequently, if need be. It is charged with the functions of following up the decisions of the Conference and looking after the operation and management of the Bureau. The CIPM appoints its own specialist consultative committees, of which there are seven at present, one each dealing with definition of the metre, definition of the second, thermometry, electricity, photometry, ionizing radiation and the *Système International d'Unités* (SI).

Up to the end of 1968 altogether 40 States had signed the Metre Convention, which now constitute the membership of CGPM. The contribution of each member is based on the economic development of the country and its population, and is calculated according to the co-efficients adopted by the United Nations for this purpose. But the dues are otherwise limited for any member to a minimum of 0·5 and a maximum of 10·0 percent of the total for the organization. A list of member countries together with years of their entry and co-efficients and percentages of their contribution is given in Table 1. The present total contribution of 2 000 000 Gold Francs (US $ 654 000) for 1969 is expected to rise to 2 990 000 Gold Francs (approximately US $ 977 000) by 1972 in steps of nearly 14 percent each year (9 percent to be paid in convertible currency and 5 percent in national currency, if so desired). More recently, the organization has also received some grants from the Rockefeller Foundation.

TABLE 1 MEMBERS OF CGPM AS OF 1968 END

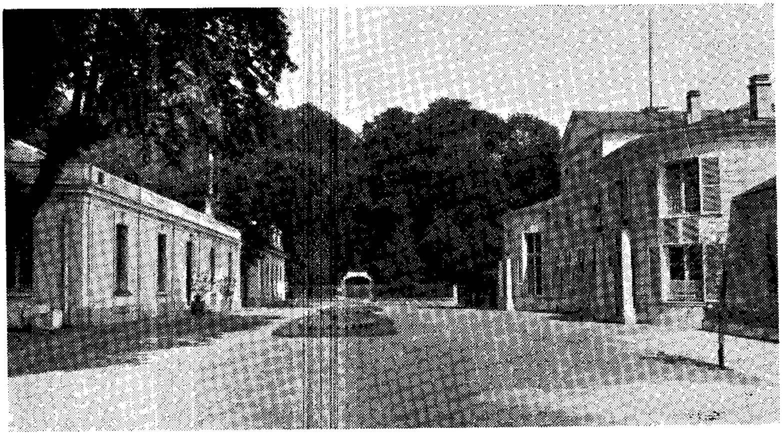
SL No.	NAME OF THE COUNTRY	YEAR OF ENTRY	UN CO-EFFICIENT	PER-CENTAGE
1.	Argentina	1875	0·93	1·49
2.	Australia	1947	1·52	2·43
3.	Austria	1875	0·57	0·91
4.	Belgium	1875	1·10	1·76
5.	Brazil	1954	0·89	1·42
6.	*Bulgaria	1911	0·18	0·50
7.	Canada	1907	3·02	4·83
8.	*Chile	1908	0·23	0·50
9.	Czechoslovakia	1922	0·92	1·47
10.	Denmark	1875	0·62	0·99
11.	*Dominican Republic	1954	0·04	0·50
12.	Finland	1921	0·49	0·78
13.	France	1875	6·00	9·59
14.	*Germany (East & West)	1875	—	10·00
15.	Hungary	1875	0·52	0·83
16.	India	1957	1·74	2·78
17.	Indonesia	1960	0·34	0·54
18.	*Ireland	1926	0·17	0·50
19.	Italy	1875	3·24	5·18
20.	Japan	1885	3·78	6·04
21.	Mexico	1890	0·87	1·39
22.	Netherlands	1929	1·16	1·85
23.	Norway	1875	0·43	0·69
24.	Poland	1925	1·47	2·35
25.	*Portugal	1875	0·16	0·50
26.	Rumania	1881	0·36	0·58
27.	South Africa	1964	0·52	0·83
28.	*South Korea	1959	0·12	0·50
29.	Spain	1875	0·92	1·47
30.	Sweden	1875	1·25	2·00
31.	Switzerland	1875	0·86	1·38
32.	*Thailand	1912	0·13	0·50
33.	Turkey	1933	0·35	0·56
34.	*UAR	1962	0·20	0·50
35.	*United Kingdom	1884	6·62	10·00
36.	*Uruguay	1908	0·09	0·50
37.	*USA	1875	31·57	10·00
38.	*USSR	1875	14·61	10·00
39.	Venezuela	1960	0·45	0·72
40.	Yugoslavia	1879	0·40	0·64

NOTE—Underlined countries of the present world are the original signatories of the Metre Convention.

*Of the 13 countries with an (*), 9 pay the *Min* and 4 the *Max* contribution.

BUREAU INTERNATIONAL DES POIDS ET MESURES

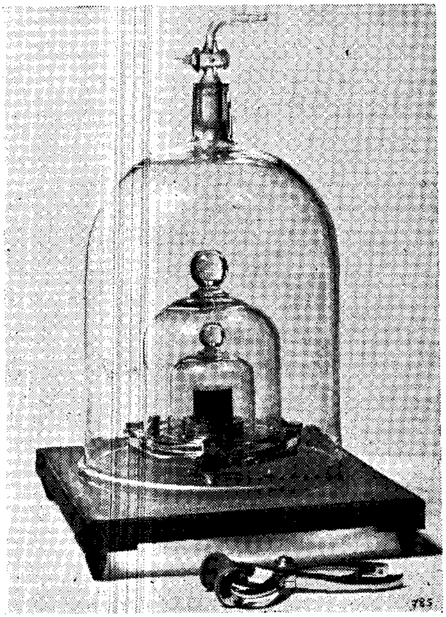
The *Bureau International des Poids et Mesures* (BIPM) is the laboratory wing of the organization headed by a Director appointed by CIPM by secret ballot. The laboratories of the organization



The manor of 'Pavillon de Breteuil', the centre of activity of the International Bureau of Weights and Measures

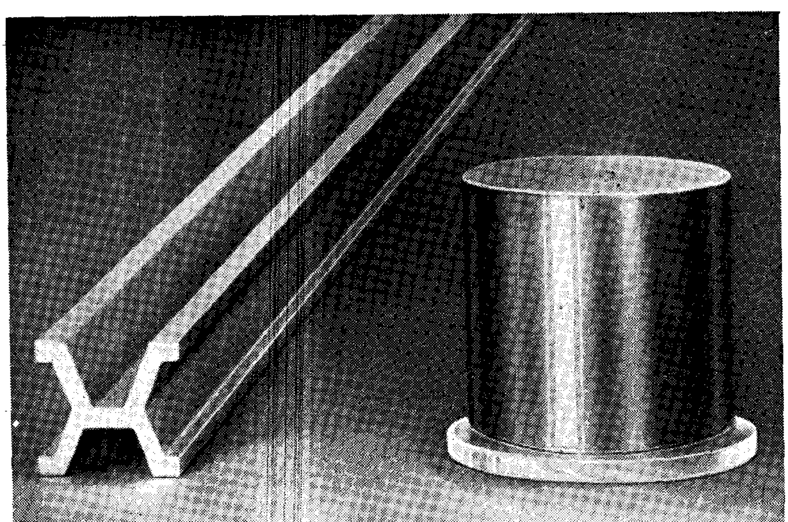
are housed in the manor of Pavillon de Breteuil and other more recent buildings, located in a spacious area of more than four hectares (11 acres) surrounded by the French national park — Parc de Saint-Cloud, in Sèvres near Paris. At this central laboratory, the standards of weights and measures of the world authority are maintained as also all other prototype standards of various physical quantities.

One of the very first tasks that the BIPM performed soon after its creation was to remove the difficulties which were involved in reproducing the length of a metre in terms of a fraction of the earth's meridian. After several years of intensive work by BIPM, the new definitions of the metre and kilogram were adopted in 1889. The metre was now to be the length between two engraved lines on the bar, specially designed for the purpose and made of platinum-iridium alloy measured at zero degree Centigrade (now called Celsius). The kilogram was to be the mass of a platinum-iridium



The ultimate standard international kilogram made of platinum-iridium alloy

Prototype standard metre and kilogram, both made of platinum-iridium alloy



cylinder. Both of these prototype standards were carefully prepared, approximating as closely as possible to the original definitions. They were deposited at the BIPM laboratories in specially constructed vaults, for periodic future use in comparing other copies which the Bureau has continued to make available to various member countries.

Besides the maintenance of these standards, functions of the BIPM include carrying out research on further refinement of standards and of methods of measurements of ever-improving

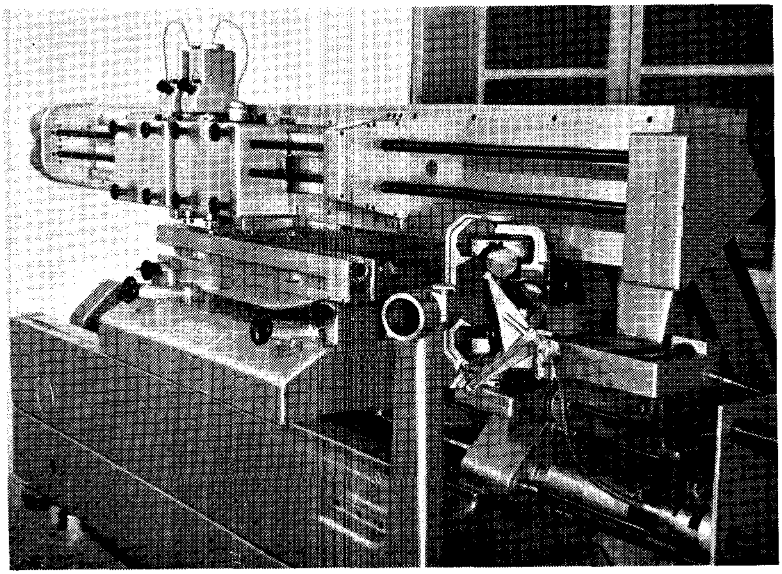


Photo-electric and optical interference comparator of the International Bureau of Weights and Measures for accurate length measurements

attainable accuracy. BIPM also serves the member countries as the central authority for all matters connected with scientific metrology, including such periodic verification of national standards in terms of the international prototypes as may be requested. These services are rendered free of charge to member nations; from other countries, requiring such services, an appropriate charge is made.

WORLD CO-OPERATION AND EXTENSION

The international work on physical metrology is not concentrated only in the BIPM but it spreads over all the important national laboratories dealing with standards of measurements, which today number about 10 and include:

National Standards Laboratory, CSIRO (Australia),
National Research Council (Canada),
Conservatoir National des Arts et Métiers (France),
Physikalisch-Technische Bundesanstalt (Germany),
Deutsches Amtfür Mass und Gewicht (Germany),
National Research Laboratory of Metrology (Japan),
National Physical Laboratory (United Kingdom),
National Bureau of Standards (USA), and
D. I. Mendèleev Institute of Metrology (USSR).

More recently, the National Physical Laboratory (India) has also joined this group and is equipping itself to carry on similar work in the various advanced fields of metrology.

With the central co-ordinating role of the BIPM and the co-operative effort of the national laboratories, considerable advances have been made in extending and refining the metric system so that it now goes far beyond the original standards of length and mass. In its eleventh session in 1960, the CGPM adopted the so-called International System of Units (SI), based on the six basic units, namely, the units of length, mass, time, temperature, electric current and light intensity, which have by now been as precisely defined as the present day science and technology would permit. Incidentally, it may be noted that the length standard is no longer the prototype metre; it is now defined in terms of a given number of wavelengths of certain light. Similarly, the standard of time, the second, depends no longer on movements of heavenly bodies which have been found to be somewhat variable. It is now represented by the time duration of a given number of cycles of vibrations of light of a particular spectrum line. For details, reference is invited to Chapter 9. Similarly, all other standards of measurements are constantly being defined and re-defined more and more accurately through the work of the BIPM and the associated national laboratories. New fields in which standards of measurement are now being developed include ionizing radiation and nuclear physics.

INTERNATIONAL ORGANIZATION FOR LEGAL METROLOGY

It has always been conceded that so far as scientific aspects of standards of measurements are concerned, the Metre Convention complex of the CGPM, CIPM and BIPM, together with the co-operating national laboratories are well organized, equipped and endowed to serve all the national and international needs of measurement. But metrological standards developed by science have ultimately to be applied to everyday economic activity of man related to his industrial and commercial requirements, namely, those arising from the exchange of goods and services. This requires the highly precise scientific standards to be translated into everyday standards of commerce and industry and the related machinery — legal, technological and administrative — to ensure the availability and utilization of the latter standards at all levels of human activity. This link is provided by what has now come to be known as legal metrology. Until recently, legal metrology problems were dealt with by individual countries according to their own genius and regardless of the practices obtaining in other countries. But more recently, with the unprecedented growth of world trade and travel, a need has been felt for international co-ordination in the formulation of rules and regulations governing the use of metrological standards. To meet this need, an inter-governmental organization for legal metrology was created in 1955 under the title *Organisation Internationale de Métrologie Légale* (OIML), the headquarters of which are also located in Paris.

The forty-three countries which have so far joined this organization in the two categories of membership include:

FULL MEMBERS

Australia	Cuba	France
Austria	Czechoslovakia	Germany
Belgium	Denmark	Guinea
Bulgaria	Dominican Republic	Hungary
Ceylon	Finland	India

Indonesia	Morocco	Switzerland
Iran	Netherlands	Tunisia
Israel	Norway	UAR
Italy	Poland	United Kingdom
Japan	Rumania	USSR
Lebanon	Spain	Venezuela
Monaco	Sweden	Yugoslavia

ASSOCIATED MEMBERS

Greece	Nepal	Pakistan
Jordan	New Zealand	Turkey
Luxemburg		

Membership subscription units at discrete levels of 1, 2, 4 or 8 are allotted to each member State depending on whether its population is less than 10, 40, 100 or over 100 million respectively, the present value of the unit being US $1 133. With a view to facilitating developing countries to join the Organization, an exception has been made for lowering the subscription to a suitable level, depending on the extent of usage of weights and measures and related instruments in the country, which, in turn, depends on its degree of economic development.

Dealing with the whole field of legal metrology at the international level, the OIML attempts to bring about a unification and co-ordination of the legal practices prevailing in member countries, through the issue of recommendations on methods and standards for instruments used in measurements, on model laws and regulations for the control of weights and measures, on the pattern of services required to be organized for exercising such controls and so on. An important aspect of its work is to set up a central documentation and translation service to collect and disseminate information on all legal metrological matters from different countries. Above all, by promoting closer relations between departments responsible for legal metrology in the various member countries, the OIML serves the cause of facilitating international exchange of goods and services.

The organization of OIML is patterned after that of the Metre Convention and comprises three similar units, namely, the International Conference, the International Committee and the

International Bureau of Legal Metrology, each of which has similar functions and status vis-a-vis one another, as among the Metre Convention units. The main difference is that International Bureau of Legal Metrology is not a laboratory organization but more of a central secretariat designed to serve the Conference and the Committee as also its Working Groups which constitute the deliberative organs of the OIML. The Bureau also looks after the documentation and information services.

At present there are some 70 active Working Groups, each charged with the task of preparing recommendations on specific topics. Membership of these Working Groups is open to all interested members and the secretariat is assigned to one of them who assumes the responsibility of progressing the work and servicing the meetings. The deliberations of the Working Groups seek to reconcile existing practices presently prevailing in different countries, keeping always in view the related work being carried out by other international organizations, with which OIML maintains close liaison, such as the CGPM, UNESCO, ISO, IEC and so on. The object always in view is to arrive at decisions which would represent good international practice and promote the economic well-being of all nations. This is at best a difficult and time-consuming task. Nevertheless, during the past 14 years of its existence, the OIML has been able to issue 18 recommendations on important subjects, with some 40 odd recommendations nearing completion and about hundred or so being in various stages of consideration.

Some of the recommendations already issued deal with such important subjects as the model law for legal metrology, model regulations for legal units of measure, basic equipment required for a model department controlling weights and measures in a national service of legal metrology and so on. The material incorporated in these recommendations represents the result of collective thinking of experienced people, which can be of great value, particularly to the developing countries, where local experience in such legal-cum-technical matters is often limited or even lacking, and where it is often necessary to establish new institutions and practices, which are considered essential for the intra-structure required for industrial and commercial development.

It was such consideration which, soon after launching its ten-year plan to adopt the metric system, led India to join the OIML in 1958. Though the organization at that stage was in the early stages of formation, yet the very contacts established with overseas departments of legal metrology proved highly valuable in helping to guide the policies and practices adopted during the ten-year plan period in India. Today India happens to be the only developing country among the members of OIML that is serving as a secretariat of one of its Working Groups which deals with standardization of equipment used in legal metrology work at various levels in a country. India also enjoys the honour of being a member of the Presidential Council of OIML.

The OIML policy towards developing countries of the world was emphasized in a recent General Conference Session when it was decided that developing countries should be encouraged to associate themselves more closely with its work at various levels and that OIML Working Groups should meet more often in such countries.

That part of OIML work, which concerns units of measurements, standards of weights and measures, their tolerances and instrumentation, is naturally related to the metric system of units, since that happens to be the most prevalent world-wide system at present. It also happens to be the system which is expected in not too distant a future to become universally adopted. Nevertheless, there is an important aspect of OIML work which is independent of any system of units and that is the part which deals with legal, administrative and organizational matters. Irrespective, therefore, of the system of measurement which may prevail in a country, the regulatory apparatus, if guided by internationally agreed practices, can be of significant advantage. Thus, it would be clear that whether a country has adopted or intends to adopt the metric system, it stands to benefit from OIML work on legal metrology in several different ways.

Same cannot, however, be said of the metric convention complex of organizations, for they represent a highly advanced stage of work of scientific character, from which many developing countries may not be in a position to derive direct benefit. Nevertheless, any country which wishes to regulate its weights and measures would need to establish its own national standards. But these standards need not be so extremely accurate as would require the services of the *Bureau International des Poids et Mesures.* Such standards and related services could readily be obtained from a neighbouring country which might have well developed institutions for the purpose.

Such matters will be found dealt with in more detail in some of the chapters of this book, particularly in Chapter 9. □

2

History of Metric Debate in India

Lal C. Verman
Jainath Kaul

The metric system of weights and measures was conceived and developed by leaders of scientific thought in France during the last decade of the eighteenth century. So manifest were its advantages that by 1900 the new system had been gradually adopted in principle by as many as 38 countries, including many on the European continent. The following fifty years saw this figure doubled. And yet, in India, where the concept of and the symbol for zero, and the decimal place-value notation for writing numbers had been invented, the merits of the metric system took a long time to be officially appreciated. In fact, it was not until 1955 that India formally decided to adopt it.

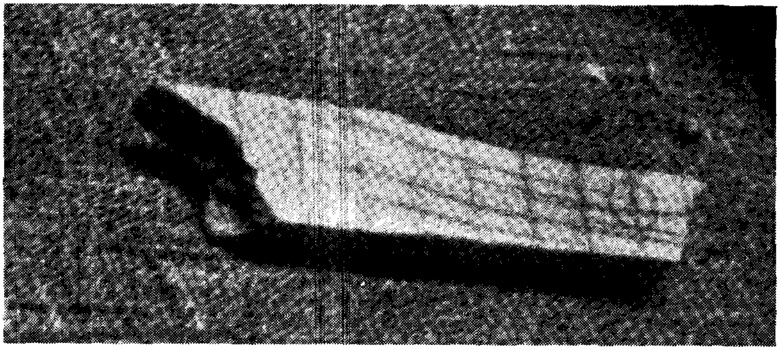
What was the reason for this inordinate delay? The country surely needed standardization and unification of weights and measures, because the bewildering variety and the resulting confusion and inconvenience that prevailed exposed the average citizen to unfair and continuous exploitation. Several attempts were indeed made to introduce uniformity in this field throughout the length and breadth of the sub-continent. Nevertheless, other considerations prevailed to foil these attempts.

Before India gained Independence in August 1947, the sub-continent had been ruled by the British. They had originally come to the country as traders during the seventeenth century, but in the wake of the disintegration of the Moghul Empire, following the death of Aurangzeb, the last of the six great Moghul Emperors, in 1707, the British began to participate actively in power politics, and with skilful manipulation, managed to emerge, in due course, as the paramount ruling power in the country. The East India Company, which originally started its life as a trading concern, actually became the ruler of the country, its rule lasting till 1857, when a revolutionary upheaval led to a major change. In 1858, after successful suppression of the upheaval, direct responsibility for the governance of India was assumed by the British Parliament and the Crown of England. The Company had exercised political power through a Governor General in India and a Board of Control in England. With the termination of the Company rule, the Governor General was replaced by the Viceroy of India, and the Board by the Secretary of State for India, assisted by a Council.

ATTEMPTS TO UNIFY WEIGHTS AND MEASURES (1801-67)

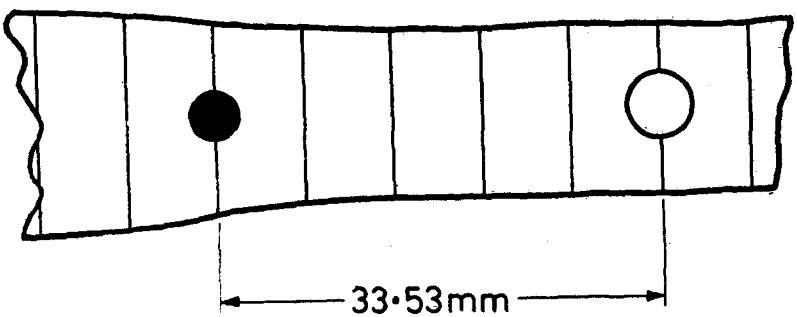
The British rule may be considered, in retrospect, to have become fairly well-established in India by the beginning of the nineteenth century, that is, just about the time when France had developed its epoch-making metric system.

In the centuries preceding the arrival of the British in India, since the beginning of the Christian era, several unsuccessful attempts had been made at standardization of weights and measures. Strong evidence exists that some five thousand years ago, during the Indus



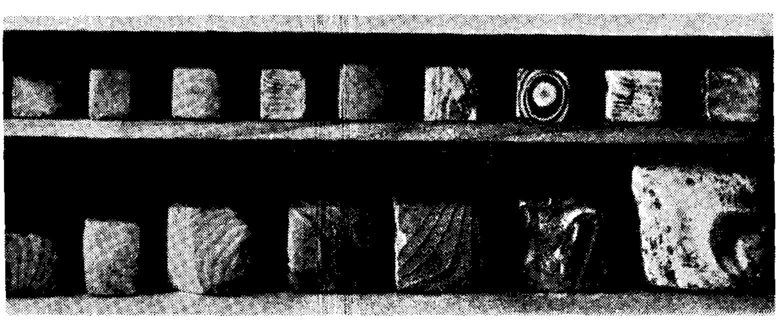
Courtecy: Archaeological Survey of India

The broken piece of a linear measure of Mohenjo-Daro (Indus Valley Civilization — 3000 to 1500 BC)



The line drawing shows the marking of each subgroup of five graduations with a dot on one side and circle on the other. Ten such graduations constituted a whole group

A set of chert weights of the Indus Valley Civilization



Courtesy: Archaeological Survey of India

Valley Civilization (3000-1500 BC), which spread over an area of some 1 500 km × 1 500 km, covering most of North-West India, an unbelievably uniform system of weights and measures existed[1]. How it was enforced is still to be discovered. Again, during the Maurya Period, in the third and second centuries before Christ, uniformity of weights and measures was well-established.

After the British seized political power in India, the first effort at standardization of weights and measures was made in 1801. A proclamation issued from Fort St George, Madras, on 23 March[2], after pointing to the great inconvenience caused by the lack of uniformity in weights and measures, promulgated 'that on and after the 12th day of July next, no weight or measure shall be used but those which are under-mentioned, known by the appellation of the Madras Standards'. The proclamation then specified for general information 'the proportions which the old but abrogated standards bear to that of Madras'. The attempt was not successful, because all the follow-up action required for enforcement had neither been planned beforehand nor taken after the proclamation was issued.

A very good resumé of the various actions taken during the British times towards securing uniformity in weights and measures is given in the Report[3] of the Weights and Measures Committee, 1913-14, of the Government of India, extracts from which are extensively reproduced in the following paragraphs. According to this Report, 'In the first quarter of the nineteenth century, a careful perusal of the proceedings of Madras, Bombay and Bengal will show that a few futile attempts were made to rectify the prevailing confusion of weights and measures, especially in land-locked areas'.

BETWEEN 1825 AND 1855

This period saw a successful attempt at standardization of the weight of the rupee coin of Madras, Bombay and North-West Provinces, and the specifying of values of the tola, seer and maund — the Indian units of weight — in terms of grains (British unit of weight).

'In 1833, James Princep, the Assay Master of Calcutta, addressed a letter to the Mint Committee proposing that the *Farruckabad* rupee for the

North-West Provinces should be 180 grains instead of 180·234, and he suggested the adoption of 180 grains as the standard for the tola weight and the making of seer weights of 80 of these tolas. He also pointed out the fact that the Madras and Bombay rupees were already 180 grains, and with a tola of 180 grains, the seer of 80 tolas would be exactly $2\frac{1}{2}$ lb troy and 40 seers, or a maund, 100 lb troy'... 'The Government of India, in May 1833, passed Regulation VII of 1833 which altered the weight of the *Farruckabad* rupee to that of the Bombay and Madras rupee (180 grains English weight)'. The Regulation declared in the Preamble 'that it is convenient to introduce the weight of the *Farruckabad* rupee (180 grains) as the unit of a general system of weights for Government transactions throughout India, under the native and well-known denomination of tola'...... 'This standard was adopted by the Customs authorities, and also by the merchants and traders of Calcutta in a meeting held in 1836, when it was resolved that the new maund should be $82\frac{2}{7}$ lb avoirdupois.' (1 maund = 40 seers = 3 200 tolas = 576 000 grains = 576 000/7 000 or 82 $\frac{2}{7}$ lb).

Government Proclamation of 1846 — In 1846, after two committees, one set up in 1839 and the other in September 1840 by the Madras Government had submitted their recommendations, the Government issued the following proclamation, fixing the local weights in terms of the standard tolas and measures in terms of cubic inches:

> 'The Governor in Council hereby notifies that on and after first January 1847, the weights and measures herein particularized shall alone be used in the revenue, Commissariat, and other Public Departments throughout the Presidency of Fort St George, Madras, and that all the public accounts shall be kept therein, duly authenticated standards having been furnished to the several Heads of Departments throughout the Presidency for that purpose.'

However, the proclamation had, in fact, only a limited application in Public Departments, and for all practical purposes, it was entirely a dead letter, presumably, again, because of inadequate previous preparation for systematic enforcement of the new weights and measures.

Bengal Maund Adopted on Railways — The Railways, which had begun to be developed by British entrepreneurs under capital return guaranties, had adopted the English standards of weight, pounds and hundred-weights, instead of the official standard of the Indian maund of $82\frac{2}{7}$ lb. This had resulted in considerable inconvenience, to which the attention of the Government was drawn by the Director General of Post Offices in India in October 1854. The following month, the Government decided that, in line with the practice of using Indian currency for railway payments, the railway standard weight should also be the Indian maund.

BAYLEY'S PROPOSALS

In 1857, a proposed reform of weights and measures by W. H. Bayley of the Madras Civil Service was forwarded to the Government of India for consideration. His scheme, in brief, was as under:

> 'Taking the Bengal seer as the most generally used of the existing Indian weights, he adopted it as the unit, and proposed that it should be fixed at 2 lb avoirdupois. The existing unit — the tola of 180 grains — being incompatible with the avoirdupois scale, he abandoned it.' However, since Indians use rupees to test weights and since 'rupees in use lose weight, which, on an average, may be set down at half a grain on each rupee, he considered that, as an approximation and a practical test for the people, 78 worn rupees would represent, with sufficient accuracy, the new 2 lb unit. For the unit of capacity, Mr Bayley recommended the imperial quart. Both the units of weight and capacity were to have decimal multiples and binary subdivisions. For linear and superficial measure, he recommended the adoption of the English scales, taking the yard and mile for length, and the acre, decimally divided, for area.'

Since no action was taken on Bayley's proposals, the Government of Tamil Nadu (Madras) drew the attention of the Government of India, in May 1863, to the need for taking steps

> 'to reform the various systems of weights and measures in use in British India. The Tamil Nadu (Madras) Government also suggested that a committee should be appointed consisting of properly qualified persons from each Presidency to report on a system which it would be desirable to adopt for all-India. In July of the same year, the Calcutta Trades Association also addressed the Government of India, and proposed that a mixed commission should be appointed to enquire into the existing system of weights and measures, and to suggest one uniform system which should be enforced by legislation'.

THE COMMITTEES OF 1864

The Government of India did not accept the suggestion of the Government of Tamil Nadu (Madras) for a single committee, or that of the Calcutta Trades Association for a mixed commission, but ordered in June 1864, that a separate committee for each province should be set up to meet and deliberate on the subject of weights and measures, and report the result to their respective

Governments for submission to the Government of India. This extraordinary and unpractical step was taken as it was felt that there was not at that time sufficient information available, 'and His Excellency (Viceroy) in Council, therefore, believed that, as a preliminary measure at any rate, local committees would be more useful besides being far less expensive'.

'His Excellency', said the resolution of the Government of India, 'observed that a uniform system of weights and measures for all-India would, doubtless, be a great advantage, but the difficulties in the way of attaining so useful an object were grave and numerous. There was much to be done before a practical scheme for general adoption could be discovered, and it was anticipated that, when discovered, it would be better introduced by indirect means than by penal legislation'. Local committees were, therefore, formed, and they met, deliberated and produced their separate reports.

The Madras Committee adopted Bayley's scheme, but with one modification; it wanted to 'lower the weight of the tola from 180 to 175 grains, in order that a seer of 80 tolas should exactly equal 2 lb'. 'The Bombay Committee recommended a decimal system of multiples and sub-multiples of the pound avoirdupois and gallon; for linear measure, the inch, foot, yard and mile; and for area, the acre, decimally divided.' The Committees of North West Provinces and the Punjab supported Bayley's proposals with slight modifications. But realistically enough:

> 'The Bengal Committee opposed Bayley's scheme. They considered it a fallacy to seek for approximation with English weights and measures when those were on the brink of a tremendous change. When the rest of the world had adopted, or is about to adopt, the metre as its unit of length, they considered that it would be a retrograde step to adopt the English foot.' The Committee opposed 'all previous propositions, as involving considerable change without simplifying calculations, as tending only to approximate Indian to the British scales, which are in an unsettled state, as being unscientific and possessing no clear connection between weights and measures. They, therefore, proposed the gradual, but finally complete, adoption of the French metric system, and that recommendation received the support of the Bengal Government'.

The metric system had, by then, been adopted by a number of countries, as the following extract from the Report of this Committee[4], which was submitted by the Government of Bengal to the Government of India in August 1866 shows:

> 'It (metric system) was made compulsory in France in 1840; and has since been adopted by Italy, Spain, Portugal, Belgium and Holland. It has been partially adopted in Austria and Switzerland; and the Zollverein have declared their assent to the principle. The Imperial Academy of Sciences in St Petersburgh have recommended its adoption in Russia, which is only waiting for England to take the lead. In 1862, forty percent of the total tonnage of Great Britain was carried to or from countries using the kilogram. Turning to America, Mexico, Chili, Peru, New Granada, Bolivia, Venezuela and French and Dutch Guiana have adopted the metric system, and the United States have (according to accounts which have reached us since the commencement of this Report) permitted its introduction into any State desiring it.'

The Report, therefore, stressed that:

> 'For purposes of international trade, the use of the metric system in India would be desirable on many grounds, even if it were not likely to be adopted in England.'

Towards the end, the Report recalled that:

> 'The decimal notation, which was, it is believed, invented in this country, is always used for expressing mere numbers; so that, in the most universal idea of all, the idea of abstract quantity, the people are familiarized with that notation. If a native has occasion to write Rs 3,425.8.3, he uses the decimal notation to express the number of rupees, though not to express the fractions of a rupee.'

Finally, it may be mentioned that among all these committees, it was only the Bengal Committee, which had not only recommended in 1866 the adoption of the metric system, but had also given in an appendix the draft of an 'Act to render permissive the use of the metric system of weights and measures'. No other committee had gone into such details. The draft, however, did not contain any clauses to cover the administrative aspect of the adoption of the metric system, although the last para of the main Report contained a series of practical propositions as follows:

> 'Offices of verification should be established in every district and large town, and supplied with standard weights and measures bearing the stamp of the permanent committee',
>
> 'Tables should be prepared and widely circulated, showing the metric expressions for the seer of 80 tolas and its multiples and subdivisions', and
>
> 'The metric system should be taught in all Government and aided schools, and a knowledge of it should be required at the entrance examinations in universities, and from all candidates for public employment.'

THE CENTRAL COMMITTEE OF 1867

When all the replies of the Local Governments had been received, it was, as might have been anticipated, found that the proposals submitted by them differed greatly. The Governor General in Council, therefore, decided in a Resolution of 25 January 1867 that a well selected Central Committee should be appointed to decide the best method of dealing with this question. The Committee, which was required to meet at Calcutta*, was to consist of the Master of the Calcutta Mint, the Comptroller General of Accounts, two members of the Bengal Chamber of Commerce, three Indian Members appointed by the Government of Bengal, two civilians representing Bengal, Bombay and Madras, and any Indian gentlemen recommended by the Governments of Madras and Bombay.

The terms of reference conveyed to the Committee reflect the peculiar thinking of the authorities. They read:

> 'It will be sufficient instruction to the Committee to accept generally the views of the Government of Madras. Although the Governor in Council does not wish entirely to preclude the Committee from examining what may be theoretically the best system of weights and measures, His Excellency desires that they may be guided in their selection of a system rather by considerations of its practical convenience for adoption in India generally and its capability of being placed in easy relation with that now existing in England. Nor does the Governor in Council consider it expedient that the Committee should narrow their inquiries by the arbitrary adoption of any particular standard unit from any existing system of measurement or weight.'

These delightfully worded terms of reference, amounting almost to directives, were further complicated when the Secretary of State for India, while approving the proposed resolution, conveyed that he 'did not believe it to be advisable to introduce the present English system, but that it would be more expedient to establish a system on the best theoretical model, although extreme caution should be used not to sacrifice practical convenience to theoretical symmetry'.

STRACHEY'S MEMORANDUM

Col Richard Strachey, a Royal Engineer and a Fellow of the Royal Society, who was a member of the Legislative Assembly, was appointed President of this Central Committee. He was a great advocate of the metric system, and gave a lead to the thinking on the subject, by issuing a detailed Memorandum on 1 October 1867, in which he supported the proposal of the Bengal Committee.

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*Capital of India at that time.

The Memorandum appeared under the title 'Proposals relating to the introduction of New Standards of Weights and Measures in British India[5]'.

In arguing against Bayley's proposal of adopting a seer of 2 lb, and in favour of the metric system, Col Strachey stated in his Memorandum that:

'The pound, though the nominal unit of English weight, is not practically the unit of wholesale dealings, with which alone commerce concerns itself in an important degree. The ton being 2 240 lb, and the hundred-weight 112 lb, the expediency of adopting as the new unit a weight of 2·24 lb avoirdupois, which is one-thousandth part of the ton, and one-fiftieth of the hundred-weight, readily suggests itself. For the purpose of practical retail dealings, this weight would be equal to $2\frac{1}{4}$ lb. It would, on the whole, more nearly approximate to an average Indian seer, I believe, than a weight of 2 lb, and so be more acceptable to the people of India. It would also be not greatly different from the French kilogram which is 2·205 lb avoirdupois, and for small quantities might be regarded as an equivalent. The difference between the kilogram and 2·24 lb being about $1\frac{1}{2}$ percent, larger quantities would require a correction.

'But the question arises, when we have got thus far, whether it is possible to regard the present English system of weights as likely to continue in force for such a length of time as to preclude the necessity for considering in what direction it is likely to be modified. If India is to be kept dependant on England in respect to its weights, and if we are now to come to a conclusion regarding the Indian system, it seems essential to look forward to the probabilities of the English system in the future. It would be most objectionable to enter upon so important an operation as fixing a standard for the weights of India, with the conviction that what is now done is not likely to be lasting.

'I ask, therefore, is it likely that the present English system of weights will last indefinitely? My reply is that I do not believe that it will so last. The conclusion seems unavoidable that before long the French weights and measures must be adopted in England.... On these grounds, I cannot avoid the conclusion that if any attempt be made to introduce uniformity of weights in India, we should at once adopt the French unit and take the kilogram as the basis of the new system — a proposal already put forward by the Bengal Committee, and accepted by the Lieutenant Governor of Bengal, Sir C. Beadon. As I have already observed, the kilogram which weighs 2·205 lb, is quite sufficiently near the existing seer weight of Northern India to be as acceptable as a 2 lb weight, and is probably more convenient so far as the people are concerned. The average seer is in excess of 2 lb, and a change which somewhat increases a weight is more popular than one which reduces it; the majority of the people being purchasers, and the sellers being comparatively few in number.'

Regarding the standard of length, Col Strachey recommended the metre, merely on the basis of his own clear conviction, which his vision about the shape of things to come in the future gave him. And, this he did, while accepting the validity of the reasoning in favour of British units of length. In his own words:

> 'It cannot be denied, then, that the adoption of the English Foot as a general standard of length, with a *gaz* of 3 feet would be much easier and more popular, both with the European* and native communities, than what I have advocated. Also, I admit that my proposal rests on what may, to some extent, be termed theoretical consideration of symmetry, as opposed to those which are practical. But I have so firm a conviction that the French unit of length will eventually be adopted generally, that I should not hesitate to fix it as the new standard for India, if it were determined to introduce one uniform standard, and if the decision rested entirely with myself as to what the new unit should be.'

Col Strachey's Memorandum was complete. A draft of a Bill to regulate the weights and measures was appended to and discussed in the Memorandum, after introducing the subject as follows:

> 'I have thought that it may be convenient to suggest in a definite form the provisions which might be made in a law for carrying out the reform of the weights and measures in India. In doing this, I have consulted the French Code and that of New York, which I have had an opportunity of seeing.'

The draft was in 4 parts, covering, in the first, all the permanent legislation on the subject. This included 'the preparation of standards to be deposited with each Government or Province to serve as types for future', and 'appointment and duties of Inspecting Officers of weights and measures'. Part II authorized 'certain provisional modifications of the new Standards named in Part I to facilitate the changes contemplated'. The next Part provided 'for introducing the changes contemplated, and for discontinuing the provisional systems, and for exempting special persons or things from the operation of the Act'. Finally, Part IV dealt with 'the obsolete denominations of weights and measures'. This Memorandum was studied by the members of the Committee but a majority of them did not agree with the views of Col Strachey. This might have been anticipated in view of the wording of the terms of reference of the Committee. Realizing that under the circumstances, he could hardly serve as an effective and impartial chairman,

*In British time, all Westerners in India, including Americans, were known as Europeans, though a large majority of them was English.

Col Strachey retired from the chairmanship of the Committee almost at the beginning of its labours.

THE COMMITTEE'S RECOMMENDATIONS

The Committee went on to submit its Report[6] in March 1868. It had studied the recommendations made by the various local Committees and felt that the first point it had to decide was, as stated in the Committee's Report, 'whether the new standards of a uniform system for British India should be English or French'. It, therefore, went into the question of the possibility of England adopting the metric system, and came to the conclusion that 'the abandonment by England of her own system of weights and measures in favour of the metric is a most remote, if it can be allowed to be at all a possible contingency'.

The next point the Committee considered was the proposal to adopt the metric system on its own merits. While admitting its superiority, the Committee rejected the proposal on purely political considerations. To quote again, from its Report:

> 'The Committee are fully sensible of the beauty and symmetry of the metric system. It is not perfect, but it is the best that has been yet adopted to any extent; and if India had no connection with any other country, much might be advanced for the introduction of that system in preference to any other. But India is dependant on England; her trade with England and with countries using English weights is ten times as great as her trade with countries using metric weights; and for the convenience of her foreign trade alone, it is clear that it is with the English system that her weights and measures should be assimilated. On the broader grounds of public policy, it is essential also that India should be linked as closely as possible with the ruling power; and the Committee think that it would be a grievous error, by adopting a foreign system of weights and measures, to dissever England from India, and to place a possible bar between the commerce of the two countries.'

The argument of adverse effect of adoption of the metric system in India on her trade with England was proved by Col Strachey as having little force in his minute of dissent, extracts from which are reproduced later on. Other points the Committee took into consideration were that the English weights and measures had already been introduced to some extent in India and the fact that:

> 'the successful carrying out of any reform of Indian weights and measures must depend on the hearty co-operation of the English officials on whom the task will devolve.... There are doubtless gentlemen who would devote themselves to the furtherance of the metric scheme, but such men are

exceptions, and one cannot but doubt the facile introduction of a foreign system which most of the teachers must themselves in the first instance learn.'

Quoting again from the Report:

> 'On all the above considerations the Committee determined that the reform of Indian weights and measures should be based on their assimilation with the English system; and it remained to determine what units should be selected. After most careful consideration, they have had no difficulty in accepting Mr Bayley's proposals, and have adopted almost in its entirety his practical and well-considered scheme.'

The hybrid set of standards recommended by the Committee was as follows:

For length — The yard, cubit, foot, *hath* ($\frac{1}{2}$ yard) and inch.

For area — The acre, but only in Government transactions, in addition to computations from the standards of length.

For weight — The seer of 2 lb, with binary divisions down to the 256th part and decimal multiples;
the maund of 50 seers;
the double maund, or *sotee* of 100 seers; and
the ton of 1 000 seers;
Decimal subdivision was also permitted. The tola of 180 grains was abandoned, and the new tola, equivalent to $\frac{1}{4}$ chittack or $\frac{1}{2}$ oz avoirdupois was proposed for the post office.

For capacity — The quart, containing, when struck, one seer weight of rice or mixed grains, with binary divisions down to sixteenth and decimal multiples.

Regarding the mode of introduction and the system of inspection, the Committee, in its words, 'availed themselves largely of the valuable suggestions contained in Col Strachey's Memorandum, modifying such of his proposals as appear to be too stringent for practical enforcement'. As stated in the summary of the recommendations at the end of the Report:

> 'A gradual introduction is recommended. It is hoped that the new system may be in use in all Government Departments within two years of the passing of the Act. In the third year it should be enforced in the Presidency Towns, and after that period be spread by degrees throughout India, commencing in the larger towns, and spreading thence to villages. It is not to be introduced into any town or village until arrangements are complete for supply of the new weights and measures on the spot.

> 'It is proposed that the use of none but stamped weights and measures be permitted, under pain of confiscation and fine; that Inspectors shall stamp all weights and measures in accordance with the standards, which shall not be liable to re-stamp, but shall be adjusted by Inspectors when called on, upon payment of half the fee for stamping; that Inspectors shall have the power of examining weights and measures in shops; and that those which are found to be light shall be liable to confiscation on the order of any Magistrate, while fraud shall be prosecuted under Penal Code. The shape of measures of capacity is fixed, and the practice of heaped measure is forbidden. It is not provided that balances should be stamped.
>
> 'The Committee have drawn out a Bill containing the proposed provisions, and have added a Section giving power to treat the case of bazar dealers shutting up their shops to prevent the introduction of the new system.'

The Report was not signed by two members who dissented from the views adopted in it. Two others added a note recommending the alteration of the weight of the present English hundred-weight and ton to 100 and 2 000 lb, as, in their words 'without this change, the new system of weights and measures for India would be of no use to her in her commercial relation with England'.

STRACHEY'S NOTE OF DISSENT

Col Strachey submitted a strong and comprehensive note of dissent[7], with which the two members who had not signed the Report, concurred. In dealing with the strongly held opinion of the Committee that England would not change its own system of weights and measures within foreseeable future, Col Strachey stated, with great practical wisdom and with a remarkable prophesy, that the true test of what is probable is to be found in the character of the change which it is proposed to make. 'If the change be one of certain utility', he wrote, 'it may, in my judgement, be considered as one certain to be made in due time; and it is because the adoption of the metric system of weights and measures seems to me of certain utility, that I regard its eventual accomplishment as also certain'. Continuing he wrote:

> 'I am no fanatical advocate of the metric system. I regard all standards of magnitude as being essentially arbitrary and as having very little in their ultimate character to make one preferable to another. But the metric system has the great practical advantage of being based on appropriate scientific principles; of being in operation, at least partially, over the most advanced part of Continental Europe. These advantages are such as to satisfy me that it will never have any real competitor when the day for change has come.

The true importance of international uniformity in these things is at last beginning to be properly estimated, and the movement which has commenced in its favour cannot cease until it has been successful.

'It is perhaps unlikely that England, like the German States, may commence its conformity with the metric system by the adoption in the first place of weights only. Possibly, such a plan might be the best; but that the system as a whole will eventually be forced upon England, seems to me, on the grounds I have stated, to be as certain as any future event can be. An opposition which rests on no other basis than confidence in the obstinate adherence of ignorant men to their old prejudices, and which to positive argument in favour of change can only reply *non possumus*, is already hopeless.'

He went on to prove that the system of weights recommended by the Committee could not be regarded as affording any real assimilation to the weights of English commerce. He argued:

'Every quantity, whether large or small, expressed in the proposed system would require to be reduced into the ordinary English weights for the purposes of English trade, or for comparison with English quantities, just as much as though it had been expressed on the metric system, or on the old Indian system.' He, then, offered an example to give incontrovertible proof of the truth of his remarks. 'I take at random', he wrote, 'any weight expressed according to the Indian system, and write it down according to the system proposed by the Committee, and for comparison also according to the metric system. The results are as follows:

	ton	*cwt*	*qr*	*lb*	
English system	53	17	3	17	
	Tons	*Sotees*	*Maund*	*Seer*	*Chittack*
Committee's system	60	3	1	12	8
Committee's system (in decimals)		60 362·5 seers			
Metric system		54 760·1 kg			

'I ask whether there is any one who, by any process short of a regular arithmetical computation, could, from the figures expressed according to the Committee's system, form any idea of the corresponding amount on the English system. There is no system conceivable which could give results more thoroughly out of union with the English system, or which, for the purposes of ordinary trade between England and India, could practically be less convenient. The two English mercantile members of the Committee have entirely assented to this view when they record their opinion that the proposed system would be unsuitable unless England adopts a ton of 2 000 lb and a hundred-weight of 100 lb. In short, the weights of India are first to be wholly subverted in order to assimilate them to those of England; those of England, are, then, to be fundamentally altered to bring them into harmony with the new system for India. Thus, in what I understand to be the chief merit claimed for the proposed system, it wholly fails.'

KILOGRAM AS NEW UNIT OF WEIGHT

The views of Col Strachey found powerful support from Hon'ble John Strachey, a member of the Governor General's Council. In a fairly lengthy minute dated 4 August 1868, he said:

> 'If we take the kilogram for our unit of weight, we may be satisfied that we are laying the foundation of a system which will be perfectly convenient for the internal wants of India; which will be in harmony with that of the greater part of the civilized world; which will probably be eventually adopted by England herself; and which in any case will be more convenient for the transactions between England and India than any other system can be, which is not commensurable with that in England. A very large and increasing part of English business is with nations using the metric system, and this system would be necessarily familiar to all English merchants. To extend it to the Indian trade would be attended with less annoyance than to introduce an altogether new system.'

The Viceroy, Sir John Lawrence, came to the conclusion that, on the whole, the balance of argument was in favour of introducing the metric system with regard to weights, and that it should be finally enforced for general use without delay. The papers were forwarded to the Secretary of State for India in November 1868 with the recommendation that the contemplated reform should be confined to weights and that the new unit of weight should be a seer equal to the kilogram, or 2·205 lb avoirdupois. It was also suggested that the new system 'should not be enforced on any class of the community until such class is, to some extent, prepared to accept it'. In accordance with this policy, it was proposed that 'the best preparation for the general adoption of the new weights would undoubtedly be their introduction and authoritative use in the public departments of the Government'. In June 1869, the Secretary of State for India commended all the proposals of the Government of India. He approved, that to begin with, the reform should only be in respect of weights, and conveyed his decision that the kilogram be adopted as the new unit of weight.

ACT OF 1870 AND ONWARD

To give effect to the decision, *the Weights and Measures Act* (*Act XI of 1870*) was passed in March 1870. It was a comprehensive piece of legislation, but it went beyond what the Secretary of State had approved. It not only fixed the seer as equal in weight to the kilogram, as the new unit of weight, but also made the metre as the primary standard of length. For measure of capacity, the Act specified a measure containing one such seer of water at its maximum density and weighed in vacuum without giving it a name. Other provisions related to the use of the new units of weights and measures by Government departments, the verification, correction and inspection of the weights and measures, penalties for infringement, etc. The Act also provided for the operation of the law 'to be extended to the dealings and contracts of all persons engaged in business or trade'. Since the legislation went far beyond the proposals approved by the Secretary of State, he conveyed in his Dispatch No. 50[8] dated 22 December 1870, his inability to sanction the bill straightaway and called for a statement of reasons which had induced the Government of India to go so much further than what had been originally contemplated by it and agreed to by the Secretary of State. In March 1871, an explanation was offered in a detailed Memorandum[9] to the Secretary of State by Col Strachey, who as member of the Legislative Council, had been responsible for drafting and piloting the bill. He stated that when the bill was considered by the Legislative Council he had explained the circumstances under which the scope of the measure had been extended by him and the members were satisfied with his explanation. To quote from the Memorandum:

'The discussions that had taken place regarding the new unit of weight to be adopted in India, which ended in the selection of the kilogram in preference to the English pound, appeared to me practically to render it certain that it was a mere question of time when the metric unit of length would also be adopted. It seemed to me inconceivable that a bastard system, having the kilogram as the unit of weight, and the yard as the unit of length, could by any possibility be advocated with success, or be accepted under any circumstances; and the adoption of the kilogram as the new unit of weight in India, in any law, therefore, appeared to me as certainly to involve the future adoption of the metre as though a declaration to that effect were openly made in that law.

'It further became apparent to me that, for certain purposes and classes of business, the use of the kilogram as a unit of weight, in conjunction with any other unit of length than the metre, would be open to many disadvantages. Having come to this conclusion myself, I took measures for ascertaining the opinions of all the heads of engineering and other technical departments in India, including all the Railways, as to the relative convenience or inconvenience of adopting the metre simultaneously with the kilogram, or of retaining the yard or foot after the unit of weight was changed. Three-fourths of the persons consulted by me agreed that the change of the two units should be made together, and of the dissentients, several objected to all change. Under these circumstances, I had no difficulty in coming to the conclusion that, for engineering purposes and quasi-engineering purposes, the adoption of the metre was required as a matter of convenience by the persons engaged in those sorts of work whenever the kilogram was introduced, and the Government of India in the Public Works Department accepted this view in its own behalf, and was prepared to act upon it.

'As I have already stated, there was no law relating to weights or measures in force. It hence seemed to me that if the Government of India for any of its departments adopted the metre, it was proper for the protection of the public, and to prevent irregularities of practice that the metre should be defined at the same time that kilogram was defined, and with the approval of the Government of India, the Bill was drawn so as to do this, and to declare that the metre was the unit of length for India. As I shall further on point out, this in no way affected the general public excepting as an enabling measure, and as tending to their convenience.'

The Secretary of State was, however, not satisfied with this explanation, and a revision of the Act was ordered. Consequently, a new Act (*Act XXXI of 1871*) which complied with the original view of the Secretary of State was introduced in August 1871 and submitted to him in January the following year. Unfortunately, however, Lord Mayo (who had taken over as Viceroy of India from Lord Lawrence in 1869) was stabbed to death the same month (Jan 1872) by one of the convicts, when the Viceroy was on a visit to the convict settlement in the Andaman Islands under the jurisdiction of the Government of India. The Secretary of State, therefore, ordered, in March 1872, that all action in connection with the proposed reform be postponed until the arrival in India of the successor of Lord Mayo, the Earl of Northbrook, who had accepted the post in London on 21 February.

A Memoir[10] on Earl of Northbrook by Bernard Mallet gives the picture of the conditions in India when the new Viceroy took over. According to Mallet during the period since the transfer of the Government of India to the Crown (1858-72), the progress made through legislative reform and expenditure on 'reproductive' works had somewhat outstripped the requirements of the people, leading to a general and widespread discontent. Thus a period of comparative rest was required, which 'truth' was recognized by the new Viceroy.

To quote further from Mallet, 'Lord Northbrook had not been many weeks in India before he had convinced himself of the existence of what he described as an uneasy and dissatisfied feeling in the country'. 'Probably it has arisen', he wrote (in May 1872), 'from increase of taxation and certain improvements in the laws, etc, which have perhaps been pushed forward a little too fast'. In another personal letter dispatched a year later, which is also quoted in the Memoir, he wrote, 'My aim has been to take off taxes and stop unnecessary legislation, and I have so far succeeded tolerably well in reversing (for it comes to that) the policy of the last few years without the appearance of planning what has passed'.

No wonder, then, that Lord Northbrook was not at all enthusiastic about pushing the metric reform in weights, and recommended in September 1872, 'that the compulsory clauses of the Act be not put in force so far as concern the railway companies, but that the Directors should be consulted at Home*, and, if they agreed, the new seer should be adopted for all railways, but that otherwise the new Act must become a dead letter'. When the Boards of Directors of the various Indian Railways were consulted, it was found that some of the Railways were opposed to the move while others offered conditional acceptance. The Secretary of State was, therefore, informed in November 1873 that 'the Railways were unwilling for the most part to introduce the new weights on their lines, and it was inexpedient to introduce their use on State Railways and that, therefore, no steps would be taken to bring the Act into operation'.

It is quite interesting to note that, having come so near, the adoption of the metric system in India was destined to be postponed for nearly another century, through nothing more than an accident of history in the assassination of a Viceroy by a convict with probably a personal grievance against the regime, which was interpreted by the successor Viceroy as a sign of 'general and widespread' discontent arising out of progressive legislation and 'reproductive' works. The legislative lull in respect of weights and measures which

*Meaning 'in England'.

followed lasted seventeen years till the *Measures of Length Act* was passed in February 1889. Actually, the question of weights had been re-opened in 1875 because of 'the difficulty experienced in obtaining correct agricultural, railway and trade statistics, owing to the diversity of weights throughout India'. The problem was solved by the Government of India taking the decision that the Indian maund of 40 seers of 80 tolas (1 tola=180 grains) should be the standard in use on Indian Railways. It will be recalled that the Government had already resolved in 1854 that the railway weight should be the Indian maund, but that decision, it appears, had not been firmly implemented.

MEASURES OF LENGTH ACT 1889

The United Kingdom adopted the *Merchandise Marks Act* on 23 August 1887. The Act defined the different types of fraudulent marking of merchandise and made all such markings punishable. The British Parliament had, by its *Weights and Measures Act, 1878,* already defined the British Imperial Yard as 'the distance, at 62·00°F, between two fine lines engraved on gold studs, sunk in a specified bronze bar known as No. 1 standard yard'.

These two British Acts helped to create awareness in the official circle for the need for similar laws in India. Interest in this was further stimulated with the receipt of certain communications from the Bombay, Madras, Karachi and Bengal Chambers of Commerce, asking for declaration by law of the English standard yard as the standard measure of length for British India. The Bombay and Madras Chambers had urged the standardization of length measures on the ground that, 'under the existing law, the marking of false length on cloth goods is not punishable, and ought to be made so'. In the Karachi Chamber's representation, it was stated that 'in the working of the piece goods trade of this country, the standard of length is essentially necessary for the protection and convenience of the same'. The Bengal Chamber based its request for standardization on the ground that the absence of a standard for length caused 'difficulties in the working of the piece goods trade of the country'.

Two bills were, therefore, introduced in 1888 in the Council of the Governor General of India, one relating to length measures on

16 March and the other to amend the law relating to fraudulent marks on merchandise on 18 October. The two Acts were passed in the following year on 15 February and 1 March respectively.

The *Measures of Length Act* made the imperial standard yard for the United Kingdom the legal standard measure of length for use in British India. The Act, which contained seven clauses, defined the standard foot and the standard inch in terms of the standard yard. It laid down that a copy of the imperial standard for determining the length of the imperial standard for United Kingdom shall be kept in a place to be prescribed by the Governor General. Other provisions included the presumption in favour of accuracy of certified measures (measures made under the authority of the Governor General in Council or of a Local Government), when produced before any Court; a list of authorities which were required to keep certified measures; right of inspection at all reasonable times of such a measure by any person, free of charge and also of its comparison with any measure in his possession.

INITIATIVE FROM HIGH

According to the Report of the 1913-14 Committee:

> 'In 1901, the Secretary of State for India, forwarded to the Government of India, copies of a paper presented to the British Parliament, regarding the adoption of the metric system of weights and measures by European countries. He pointed out that in nearly all European countries, except Turkey, the metric system had been introduced without much opposition from or disturbance to the people, and that it had proved a great benefit to the countries which adopted it. No country which had adopted it, was willing to go back to the old system. The Secretary of State, in pointing out that most Governments intending to adopt the metric system did so in their own establishments for a few years before the general adoption was enacted by law, suggested that the first step in India would be to accustom the public to the new weights by adopting them on railways, at custom houses, and in post offices.'

This time it was the Government of India that declined to act on this suggestion from a higher authority, without, however, giving any solid reason against it, losing, thereby, another golden opportunity to go metric. In their reply, the Government stated:

> 'While recognizing the advantages of the decimal system as shown by the experience of other countries, we are of opinion that the difficulties in the way of its introduction into India would be very great. For the currency there might perhaps be no great difficulty in introducing the decimal subdivision of the rupee as in force in Ceylon; but in the case of weights

and linear, superficial and cubic measures, the obstacles would be very serious. On the whole, we are averse from taking any action in the matter at the present time, and we prefer to wait before proposing a change in the Indian practice, until the United Kingdom has decided to adopt the decimal system.'

THE COMMITTEE OF 1913-14

Nothing of any great significance seems to have taken place during the next decade, and it was only in 1913 that the Government of India decided to re-open the question of the feasibility of securing the use of uniform weights and measures in India. The reason for coming to this decision was recorded in a Resolution dated 10 October 1913 under which a Committee was appointed to go into the whole subject. The Resolution stated, *inter alia*:

'The Government of India are fully alive to the difficulties which beset attempts to impose a uniform system of weights and measures for adoption throughout British India. At the same time, they are satisfied that the existing lack of uniformity is seriously prejudicial to trade, and they have reason to believe that the development of railway communications and commerce in this country, the formation of Chambers of Commerce and the advance of municipal and trade organizations have gone far to remove objections formerly felt to the introduction of a single uniform system.'

The Committee appointed under this resolution met at Bombay on 10 November 1913 and issued two sets of questions, a longer one for the highly educated witnesses and a shorter one for others. It toured extensively throughout the length and breadth of the country for on-the-spot study of local opinion as to the desirability and feasibility of introducing some uniform system, and of the difficulty or opposition likely to be encountered as a result of various lines of action.

The Committee produced a Report containing a comprehensive history of the efforts so far made to standardize weights and measures and a fairly complete survey of the existing state of weights and measures in different parts of the country. Opinions regarding a uniform system were digested from the evidence received on these matters, province by province. After a detailed discussion covering the advantages and drawbacks of the metric system, the Committee made draft recommendations for the adoption of a standard system based on a combination of the Indian and English systems.

It recommended standardization of weights on the basis of a tola of 180 grains British weight, subdivided into four *tanks*, a *tank* of 3 *mashas*, a *masha* of 8 *rattis*, a *ratti* of 8 *chawals* and a *chawal* of 8 *khaskhas*. The multiples of a tola were fixed as a chittack of 5 tolas, a seer of 16 chittacks and a maund of 40 seers. For the unit of length, the Committee recommended the adoption of the British yard, a chain of 66 feet subdivided into one hundred links and the furlong and the mile of 220 and 1 760 yards respectively.

No units of capacity were named. The recommendations contained the following notes on this point:

> '*Measures of Capacity* (*Dry*) — The chief local measure of capacity to be standardized at the most suitable integral multiple of a measure made to hold $1\frac{1}{4}$ seers of water at a temperature of 86°F or 30°C, and such other local measures as may be deemed necessary in proportion thereto. The tin or basket to be equal to one British bushel of 8 Imperial gallons.'
>
> '*Measures of Capacity* (*Liquid*) — No separate measures, except in Madras, but liquids to be sold by any authorized measure of capacity (dry) or by weights, with permission to use measures made to contain definite weights of particular liquids for selling small quantities of those liquids.'

No draft of any legislation for the introduction of the new weights and measures was included in the Report. But the recommendations suggested the setting up of a standards department, the maintenance of an 'imperial set of standards of scientific accuracy for the correct maintenance of provincial standards' and, in addition to the latter, a set for each district at the district treasury; the employment of staff for enforcing regulations — executive staff for testing, correcting and stamping of weights and measures, and inspection staff. No proposals were offered to guide such staff in the performance of their new duties, but the attention of the Government was drawn to certain regulations of the British Board of Trade and those of the German Empire on the subject by a reference to them. The questions of publicity and education were discussed and certain suggestions made. Leniency was advocated in inflicting penalties in the beginning on defaulters.

MINORITY OPINION

One of the four members of the Committee, A. Y. G. Campbell, a member of the Indian Civil Service, who was then Acting President of the Corporation of Madras, however, submitted a note of dissent, recommending that it was eminently desirable that Government should take steps without further delay to constitute the metric system as the uniform system of weights and measures in India. Mr Campbell forcefully argued in favour of the metric system. He said that the metric system was very easy to learn and to remember. It simplified accounts and calculations very materially, and it would be possible to introduce the new system gradually by areas; that is, if the system was introduced in one particular town, it would create no further confusion in the meaning of the term seer, maund, etc, in the neighbouring area, and it would be possible to allow sufficient time before its use was extended to rural tracts. Being an international system, and designed as such, its adoption would prevent any feeling of jealousy, which might arise at the attempt to extend the use of a system of a particular province to other provinces. The metric system would be useful also in foreign trade, as it had, 'in recent years, been making steady headway in all parts of the civilized world'. The system would, he believed, 'facilitate the future industrial development of India more than the system proposed by the Committee'. 'Machinery made on metric measurements', he said, 'can be readily obtained, and scientific researches affecting industries are carried on in terms of metric units'.

In dealing with the suggestion of some witnesses that India should not adopt the metric system till the United Kingdom had adopted it, Mr Campbell made a remarkable forecast when he stated that the United Kingdom was likely to be the last country to adopt it. To quote him:

> 'Where weights and measures are in a comparatively primitive and inaccurate condition, it is easier to introduce a new system than in a country like England, where the weights and measures are stereotyped and accurate; greater advantages are immediately apparent in the former case than in the latter. Moreover, the United Kingdom can obtain all she wants in the way of machinery, etc, made to her own weights and measures, within her own borders, whereas other countries have to import machinery and manufactured articles, and they also desire to buy them in the cheapest market, and, consequently, may find it advantageous to obtain machinery, etc, made to metric measurements.'

The introduction of the metric system, he wrote,

> 'will put a final stop to variety in the weights and measures introduced or patronized by Governments, municipalities or officials; for, if it is once introduced throughout the country, no one will ever suggest any further change. If, however, some other system is adopted now, it is not unlikely

that a few years hence proposals may be put forward for the adoption of the metric system, and if such proposals are accepted, the trouble and expense involved in a change of weights and measures would have to be incurred a second time'.

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put forward for the adoption of the metric system in India, and, if such proposals were accepted, the trouble and expense involved in a change of weights and measures would have to be incurred a second time.

13. I would strongly advocate, therefore, that the metric system should be introduced now with the least practicable delay. Delay will, I believe, only increase the difficulty and expense of introducing it. In many parts of the country, weights and measures are still in a primitive condition, stones being used as weights and baskets, etc., as measures. In such places, the introduction of good material weights will probably be appreciated in itself; an example is afforded by the extensive use of the British avoirdupois weights in the Northern Circars of the Madras Presidency in spite of the fact that the British avoirdupois table of weights is not widely used and of the action of the Local Government in endeavouring to encourage the use of another system of weights based on the tola. As time goes on, however, a larger number of fairly good manufactured weights will be scattered abroad over the country and the trouble and cost of replacing them by accurate authorized weights will be materially increased. Further, it appears to me to be a fallacy to urge that the people are not sufficiently intelligent or sufficiently educated to understand the metric system; if they can understand the more complicated system proposed by the majority of the Committee, *a fortiori*, they can understand the metric system if it is properly explained to them. Education, however, is now spreading rapidly and the Government are doing all they can to extend its advantages to all classes. But so long as a uniform system is not adopted, one result of the spread of education will be that a larger proportion of the population will be taught local and other tables of weights and measures; but nearly every one who has learnt and used a particular system of weights and measures is naturally prejudiced in favour of it and that prejudice constitutes in each case an additional obstacle to be overcome.

14. For these reasons, it appears to me eminently desirable that the Government should take steps now without further delay to constitute the metric system the uniform system of weights and measures in India. When its use has become established throughout India, the action of Government in introducing it will, I am convinced, be appreciated by all.

SIMLA,
The 8th July 1914.

A. Y. G. CAMPBELL.

A page from Campbell's Minute of Dissent

BETWEEN TWO WORLD WARS

The Report of the 1913-14 Committee with Mr Campbell's minute of dissent was submitted to the Government of India on 10 July 1914. Twelve days before this, Archduke Francis Ferdinand of Austria-Hungary had been shot by Serb citizens of Austria, which led to a declaration of war on Serbia by the Austrian Emperor on 28 July — a war in which Britain entered on 4 August. Once more, historical events intervened and the consideration of the Committee's Report was held up while the war lasted. But, for reasons stated below, Government decision on the Report was delayed for several years, even after the war was over.

GOVERNMENT ORDERS ON COMMITTEE'S RECOMMENDATIONS

The Resolution[11] of the Governor General in Council on the Committee's Report was, at last, adopted on 3 January 1922. In the opening paragraph, it stated that:

> 'The Government of India refrained during the war from dealing with the question of standardization of weights and measures, as it was obvious that any radical change of system would entail, at any rate, a temporary dislocation of trade. A further factor which influenced this decision was the uncertainty whether the United Kingdom would adopt the metric system in its policy of post-war reconstruction; for, if it did, the arguments in the Minority Report in favour of the adoption of that system in India would have been strongly re-inforced. The Report of Lord Balfour of Burleigh's Committee* on commercial and industrial policy after the war makes it clear that any alteration to the standards of the United Kingdom is highly improbable, at any rate, for sometime to come. The Government of India, therefore, consider that they are now in a position to dispose of the recommendations made by the Weights and Measures Committee with a reasonable prospect of finality.'

Making a 'distinction between weights and measures from the point of view of standardization', the Resolution stated that since measures of capacity are used in retail trade, and since the replies of Local Governments and Administrations showed 'with singular unanimity that discrepancies in measures of capacity do not cause so much practical inconvenience or discrepancies as in weights, while their influence on inter-provincial and foreign trade is practically negligible', the Government of India decided to leave the question of attaining uniformity in measures 'at any rate for the

*This British Committee, which reported to the Parliament in London, issued three Interim Reports and one Final Report on commercial and industrial policy after World War I. They are bound in Volume 13 of the series of Parliamentary Papers for 1918 in the British Museum, London.

present, entirely to Local Governments who may take such action as they may think advisable to standardize dry and liquid measures of capacity within their provinces'. Similarly, it was decided not to adopt standards of length or area, as the Government considered 'the English measures of length and area the most prevalent and, therefore, the most suitable'.

As regards weights, the Government confirmed the majority finding of the Committee in favour of the Indian Railway standard, namely, a maund of 40 seers and a seer of 80 tolas, as 'it has a definite and convenient base in the tola of 180 grains, a weight which is universal throughout the country in the form of the rupees'. Local Governments, it was claimed, had been consulted and were found to be almost unanimous in their support for this decision.

On the question of enforcement, the Resolution stated that:

> 'In order to make the change effective, it would be necessary firstly to pronounce illegal from some future specified dates the possession and use of weights varying from the standard; secondly, to enforce this pronouncement by definite penalties; and thirdly, to ensure the substitution throughout India of standard weights for local varieties. The difficulties attending such legislation were recognized by the Committee. The Government of India fully appreciate them, and would be exceedingly loath to create, by statute, a new offence, specially an offence involving no moral obliquity in the minds of the people. The expense of prompt and general distribution of standard weights would also be very great.'

The Governor General in Council, therefore, contented himself with a mere declaration 'in favour of the ultimate adoption in India of a uniform system of weights based on the scale now in use on the Railways', without any attempt at enforcing it, in the following words:

> 'The Government of India are not prepared to allow the intrinsic merits of the Railway system to weigh against the strong general arguments against compulsion, and they have decided to limit their action first, to indicating a preference for the Railway system of weights, and second, to maintaining standard weights at the chief Presidency towns.'

Regarding the *Indian Weights and measures of Capacity Act (XXXI of 1871)*, the Resolution stated that:

> 'This Act has in practice no operative effect, because none of the notifications prescribed by the various sections of the Act have yet been issued. It is based on the continental metric system, the seer being defined as equal to the kilogram. The Government of India do not propose to repeal this Act nor to introduce at present any new measures prescribing the all-India

measures of weight or capacity. Their opinion is that Local Governments, in exercise of the power conferred upon them by the Devolution Rules, should take such executive action as they can, to educate public opinion in favour of the standard maund and seer, by publicity work, by adoption in school curricula, and by any other suitable measures. Municipal bodies might be encouraged to frame by-laws adopting this standard, and Local Governments might maintain standard weights at their respective capitals and at important trade centres. Where a Local Government considers that provincial standardization by law is feasible, the Government of India will have no *a priori* objection to such legislation, on the usual understanding that they will be consulted as to the actual form which such proposed provincial legislation is to take and thus such legislation will not be introduced without obtaining the previous sanction of the Governor General under Section 80-A(3)(f) of the Government of India Act. If, subsequently, opinion develops strongly in favour of imperial standardization of weights, the Government of India will be prepared to undertake such legislation, but at present they consider that any such step would be premature.'

In the context of the pressing need for standardization in weights and measures, the last para of the Resolution of 1922 quoted above should have encouraged Local Governments to introduce requisite provincial legislations without any appreciable delay. But the Resolution did not produce this effect and, by 1939, only two of the eleven Provincial Governments, namely, the Government of Central Provinces and Berar and the Government of Bombay had enacted the *Weights and Measures Act,* the former in 1928 and the latter in 1932.

URGENCY FOR CENTRAL LEGISLATION

While the Governments in the provinces continued to be lethargic in taking appropriate action to set matters right, several organizations and *ad hoc* bodies continued to draw, from time to time, the attention of the Government of India to the urgency of rectifying the lack of uniformity in weights and measures.

Thus, the Royal Commission on Agriculture, 1928, observed in its Report:

'From all parts of India, we received evidence of the disabilities under which the cultivator labours owing to the chaotic condition in which matters stand in respect of the weights and measures in general use in the country, and on the hampering effect that this has upon trade and commerce generally. Needless complications and unevenness in practice, as between market and market, tend to prejudice the interests of the cultivator.'

In 1936, the eighth Indian Industries Conference at Lucknow passed a resolution which called upon the Government to adopt a standard system of weights and measures. In the same year, a similar resolution was passed also at the meeting of the Associated Chamber of Commerce in Calcutta.

In 1937, the Report on the Marketing of Wheat in India contained the following observation:

> 'It seems hardly necessary to stress the desirability of standardizing weights and measures. It is generally accepted that the many different methods of weighing, and the systems of weights and measures in vogue, lend themselves to dishonest practices by the unscrupulous. This is, however, a relatively unimportant aspect of the problem. It is not as yet fully realized what a great handicap the present system imposes on the development of organized trading. Any merchant anxious to carry on business in different parts of the country finds himself hampered, and his ordinary day-to-day labour very much increased by having to calculate buying and selling rates on the basis of various units of weights and measures.'

Again, in the Report on the Marketing of Linseed in India, 1938, it was stated that:

> 'The chaotic condition of weights and measures in the country undoubtedly hampers the development of organized trading. The unscrupulous also take full advantage of the diversity in the existing system of weights and measures. There are so many types and kinds of weights in India that they differ not only from village to village, but even within the village itself.'

STANDARDS OF WEIGHTS ACT, 1939

As summarized in the Report of the Special Committee on Weights and Measures, 1949, of the Indian Standards Institution:

> 'By 1939, public opinion for a Central legislation was considered as having crystalized to the extent that the Central legislature could pass the *Standards of Weights Act* (*Act IX of 1939*) applicable to the whole of British India. The Act repealed the *Weights and Measures of Capacity Act* (*XXXI of 1871*) in so far as the establishment of standards of weights was concerned.'

The Act defined the standard grain in terms of the iridioplatinum cylinder in the custody of the Mint Master, Bombay, and laid down as standard a tola of 180 grains, a seer of 80 tolas, a maund of 40 seers, a pound of 7 000 grains, an ounce as one-sixteenth part of a pound, a hundred-weight of 112 pounds and a ton of 2 240 pounds.

The Act received the assent of the Governor General on 28 March 1939, and by Notification No. 33-C(6)37 A dated 13 June 1942, the Act was brought into force from 1 July 1942. The notification could not contain any provision for enforcement of the Act, as the *Government of India Act of 1935,* under which the Governments at the Centre and in the Provinces were then functioning, had placed the subject of *weights and measures* as a responsibility of the Provinces in the 'Provincial List' and 'standards of weight' as a central subject in the 'Central List'. The Act, therefore, defined two sets of reference standards — central and provincial — and laid down that the former shall be kept in the custody of the Mint Master at Bombay. As regards the others, one set was to be supplied free of charge to each provincial government. Further, the Mint Master was required to carry out verification of the Central reference standards in his custody once every three years. He was also to do similar verification of the provincial sets every four years, provided transportation charges to and from the Mint were paid by the Government sending the set for verification.

After the Act was passed, and as a result of a request from the Government of India, most of the provinces passed Acts, some of which standardized only weights, while others covered both weights and measures. However, these Acts differed widely not only in defining the powers of inspectors and other officials but also with regard to the definitions of the standard weights and measures themselves. For example, the *Madras Weights and Measures Act, 1948,* defined a seer of 24 tolas and a *viss* of 120 tolas. The *United Provinces Weights and Measures Act, 1947*, defined a seer of 80 tolas.

DEMAND FOR METRIC REFORM

This attempt at standardization could not, however, satisfy the progressive elements, which, with increasing political awareness in the country had started making themselves heard more and more. There had been a long spell of peace which had helped to spread education, and with English as the medium of instruction, increasing numbers of Indians came into contact with English literature replete with the struggles of the British and American peoples for wresting political power from the unwilling hands of autocratic rulers. While administrative unity promoted a sense of oneness among the people from different parts of the country, the sorry state of Indian industry and trade, the poverty-stricken masses in the villages and an atmosphere of hopeless dependence made the people realize that foreign rule was not an unmixed blessing. Several associations were formed to study political and economic questions, and in 1885, the Indian National Congress came into being. This organization became the principal medium through which the Indian people carried on their hard, bitter and long struggle for political freedom.

The growth in the strength and influence of the Congress brought increasing political awareness among the masses and development of informed public opinion on various national issues. So, while the question of unifying weights and measures on metric basis was being treated with the casualness natural for an alien rule, the public demand for such action in the interest of the country began to be voiced more and more strongly. In 1930, Shri Phanindra Nath Seth, who later became the founder Secretary of the Indian Decimal Society when it came into existence in 1944, and others, notably the late Dr Sisir Kumar Mitra FRS and the late Dr Hira Lal Roy raised this question through press and platform. Dr Mitra was an eminent professor of physics at the University of Calcutta, while Dr Roy was an outstanding leader in the field of chemical engineering education, who later became the founder President of the Indian Institute of Chemical Engineers. In November 1933, in a debate organized in the Calcutta Rotary Club, the need to adopt the metric system was stressed. Mr H. E. Watson, the Editor of a leading daily newspaper, the Statesman, 'emphasized that as industrialization in India was in its infancy, the change-over to the metric system should be made at once to avoid future hardship and other complications. He said that the metric system was sure to be the only one system all over the world in the near future'.

In 1934, the Indian Science Congress Association passed a Resolution at its Bombay Session urging the Government to standardize weights and measures on metric basis and make their use compulsory in all government and private transactions. The Association had also resolved to set up 'the Metric Committee of the Indian Science Congress', to devise ways and means to press upon the Government the urgency of the reform.

The Indian National Congress, which had naturally been looking forward to the time when the Indian people would be managing their own affairs, had set up a National Planning Committee under the chairmanship of Shri Jawaharlal Nehru, to formulate a national plan for the development of the country to be implemented when India became independent. In 1940, its Manufacturing Subcommittee recommended standardization of weights and measures on an all-India basis and to adopt the metric system for this purpose, if other conditions permitted. In this connection, the Subcommittee also suggested the establishment in India of an Institution similar to the British Standards Institution.

In 1944, the Indian Decimal Society was established and actively engaged itself in popularizing the cause of decimalization and the metric system[12]. Its strenuous efforts, and specially the scheme for decimalization of coinage, weights and measures of Shri P. N. Seth received public support through the Press, which led to the Government issuing a circular on 24 April 1945 setting forth the details of their scheme for decimal coinage and appealing for public support. This scheme, which contained proposals more or less similar to those of Shri Seth, met with encouraging response from the Press, Chambers of Commerce, Scientific and Industrial Institutions and others. This induced the Government of India to introduce a Bill in the Legislative Assembly in February 1946 to amend the *Indian Coinage Act, 1906,* and convert the currency to the decimal system of coinage. The Assembly decided to circulate the Bill for eliciting opinion. In the same year, the Indian Science Congress Association strongly supported the demand for this conversion and also for decimalization of weights and measures. Dr Verman, who had participated in these discussions, emphasized that simultaneous adoption of decimal currency and the metric system of weights and measures was essential if unnecessary inconvenience in calculations and translation was to be avoided. The Executive Committee of the Association considered the matter further at a meeting held on 8 March 1946 with Shri Jawaharlal Nehru in the chair and passed the following resolution unanimously:

> 'Resolved that the Science Congress notes with satisfaction that a Bill for the decimalization of Indian Currency has been introduced in the Legislative Assembly. The Science Congress is, however, of opinion that decimalization of currency alone is not enough, and considers the decimalization of weights and measures on the basis of the metric system to be equally urgent.'

In 1939, when World War II broke out, India being under British regime had automatically become a party to it as she had previously become in 1914. The Indian National Congress demanded from the ruling power a statement of war aims including complete independence for India, which Britain refused to concede. Japan entered the war in December 1941, and reached the Indian borders after over-running Indo-China, Malaysia and Burma. Britain then wanted moral support of India and made an offer of dominion status after the war. This was turned down by the Congress, and it launched, in August 1942, under the leadership of Mahatma Gandhi, the famous 'Quit India' movement. The movement was suppressed ruthlessly, and the suppression created widespread and deep discontent. In May 1945, the Conservative Government which had conducted the war was defeated, and Labour Party came into power. This party was more sympathetic towards the Indian viewpoint, and finding the people, and even the defence services, in a mood of open revolt, wisely agreed in 1946 to set up an Interim Government of the Indian people pending the conferment of independence a year later. The Indian National Congress decided to co-operate, and an Interim Government was sworn in on 2 September 1946 with Shri Jawaharlal Nehru as the leader.

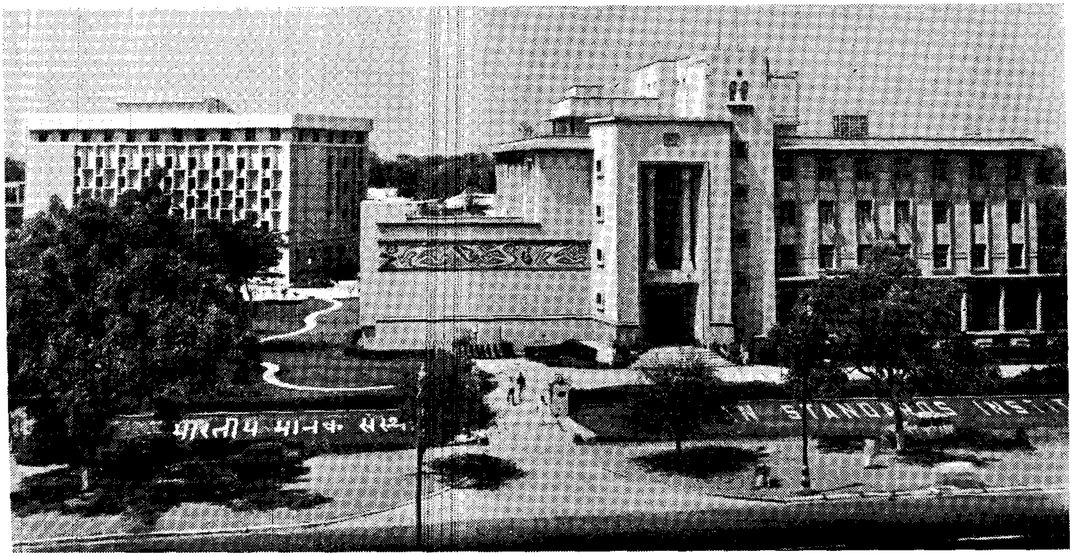
India became free in August 1947 but was divided in two parts, one part of the sub-continent forming a new independent State of Pakistan. The impending constitutional changes, the communal turmoil combined with problems of rehabilitation of displaced persons and other urgent issues associated with the partition of the country absorbed all the attention of the Government. The proposal for introducing decimalized currency, for which a Bill had been introduced in the Legislative Assembly in February 1946, was relegated to the background and no further action was taken on this until the Parliament of Independent India amended the *1906 Indian Coinage Act* in 1955, under which India switched over to the decimal system of coinage with effect from 1 April 1957.

All the same, the Interim Government of India, under the leadership of Shri Nehru, did take interest in the standardization of weights and measures, and initiated action towards metricization. In deference to the view expressed earlier by the Indian Science Congress, also under the chairmanship of Shri Nehru, the Interim Government decided in February 1947 that 'the provinces should be requested to take up urgently the question of the metric system of weights and measures'. As stated earlier, the subject of weights and measures was on the Provincial List and so the Government of India, which was then continuing to function under the 1935 Act was unable to proceed with a central legislation involving enforcement in the field of weights and measures. The post-partition problems were, however, overwhelming, and a major reform of change-over to the metric system on provincial basis, which would have been an uphill task even in normal times, could naturally not be accomplished. The new constitution of India, under which the country became a sovereign democratic republic with effect from 26 January 1950, placed *the establishment of standards of weight and measure* on the Union List of subjects, and *weights and measures except establishment of standards* on the States' (erstwhile provinces) List, thus removing some of the obstacles in the way of enacting the required central legislation by the Union Government.

INDIAN STANDARDS INSTITUTION (ISI)

On the day after the Interim Government took over, it passed its first Resolution No. 1-Std(4)45 dated 3 September 1946. As had been recommended by the Manufacturing Subcommittee of

Manakalaya (left) and Manak Bhavan, the headquarters of Indian Standards Institution in New Delhi



Indian National Congress, the Industries Conference of Lucknow, the Institution of Engineers (India), and others, this Resolution brought into being the Indian Standards Institution (ISI) as the national standards body for India, with the following, as one of its objects:

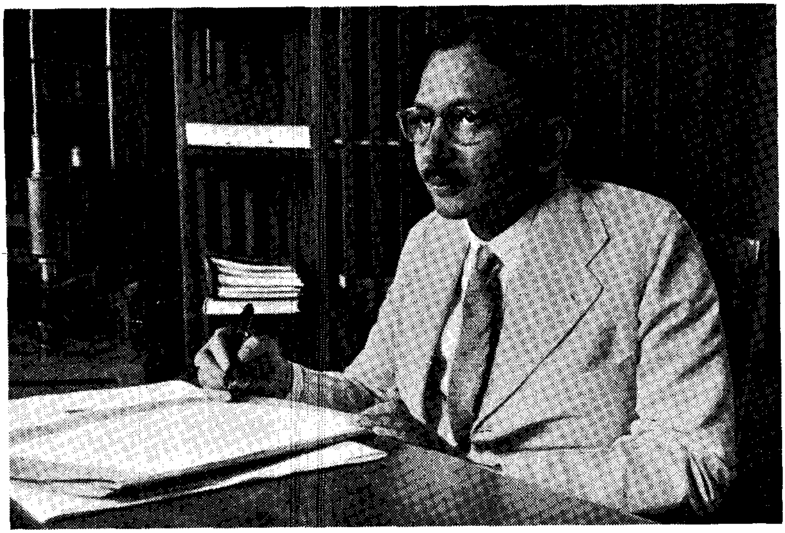
> 'To consider and recommend to Government of India, national standards for the measurement of length, weight, volume and energy.'

The Institution was inaugurated five months later in February 1947 and started its activities in June the same year. Dr Verman, as its first Director, immediately undertook a study of the position in regard to the object quoted above, and compiled a report on it, in which he suggested the adoption of the metric system with Indian nomenclature for basic units and an Indianized system of uniform nomenclature for fractions and multiples. By this time (August 1947) India had become an independent country.

The Report was subsequently published in the January 1949 issue of ISI Bulletin. Another Report by him dealt with the design of the system of decimalized coinage which was related, in respect of dimensions and weights, to the metric system.

These two Reports were considered by the Engineering Division Council (EDC) of ISI, which reviewed the prevalent state of standards of weights and measures in the country. The Council felt that it was high time for ISI to ascertain the general consensus of opinion in the country and recommend to the Government a definite plan for standardization in the field. The EDC, therefore, recommended the appointment of a Special Committee to consider and Report on the basic standards for weights and measures for adoption in India. In May 1948, the Institution appointed the Committee, with the concurrence of the Government of India.

The Committee had, as its Chairman, Dr J. C. Ghosh, an eminent scientist, who was then the Director General of Industries and Supplies of the Government of India, and included among its members representatives from Central Ministries, State Governments, Council of Scientific and Industrial Research, Chambers of Commerce and Industry, All-India Manufacturers' Organization, Institution of Engineers (India) and National Institute of Sciences of India. The Committee issued a questionnaire to all interests



The late Dr J. C. Ghosh, well-known Indian chemist and administrator, Chairman of ISI Special Committee of Weights and Measures

concerned to ascertain the consensus of opinion on the subject. To quote from the Report:

> 'After prolonged deliberations on the various points of view expressed by different authorities, the Committee concluded that the general consensus of opinion in India was in favour of the adoption of the metric system, but agreed that, in order to spread out the rather considerable expenditure involved, the change-over should be carried out in three stages, covering a period of 11 to 15 years.'

ISI RECOMMENDATIONS

It was, thus, for the first time that a comprehensive 'Action Report[13]' was made available, uncluttered by arguments unrelated to national economy (*see* Appendix 2). The Committee recommended a programme of action for the change-over, the creation of a central liaison agency, adoption of decimalized currency and initiation of central legislation, together with the adoption of a model legislation for the States (erstwhile provinces). Following is a summary of these recommendations.

1. PROGRAMME OF ACTION

The change-over to the metric system was to be carried out in 3 distinct stages as under:

a) *The Preparatory Stage* of 3 to 5 years, when no extensive change would be enforced but intensive education and dissemination of information on the metric system of weights and measures would be carried out, and, wherever practicable, gradual introduction of the metric system would be encouraged. During this period, decimalized currency could be introduced and intensive education and propaganda carried out. Among other things, the following actions could be taken:

i) Teaching in elementary and secondary schools and in technical and engineering institutions; schools to keep samples of all standard metric weights and measures;

ii) Press and radio publicity;

iii) Public speeches and press conferences by eminent people;

iv) Publicity films (using mobile cinemas, wherever possible);

v) Popular exhibitions;

vi) Publication of informative bulletins and pamphlets, including conversion tables;

vii) Free distribution of conversion tables through post offices;

viii) Public discussions and symposia;

ix) Publicity through village panchayats; and

x) Sale by Government to the public of standard metric weights and measures at the beginning; later, private parties to produce and sell these units.

Also, other steps could be taken as follows:

xi) All Central and Provincial units to initiate preliminary preparations and estimates of cost of equipment for conversion to the new system;

xii) Wherever regulated markets existed, the authorities controlling them might introduce the use of the metric system in their day-to-day operations;

xiii) All agencies to initiate designing their new schemes of development on the metric system with the ultimate object of going over entirely to that system at an appropriate stage;

xiv) All engineering designs and plans, which may be considered necessary to be executed on the basis of foot-pound-system to give metric equivalent;

xv) Centre to establish an official agency for the preparation, deposition and checking of primary, secondary and reference standards;

xvi) Planning of enforcement agencies by State units wherever they may be needed and augmentation of existing agencies for the new task; and

xvii) If any of the State Governments felt ready for the adoption of the model form of legislation to be suggested by the Centre, they could do so even during this period.

b) *The Change-over Stage* of 5 years in which the change-over was to be effected in the agencies under the control of Central and State administrations and in public life.

During this period, the undermentioned actions were suggested:

i) Adoption by all State Governments of the model legislation to be proposed by the Centre;

ii) Implementation of the plans suggested to be prepared under (xi) above;

iii) All central agencies to go over to the new system from a red letter day to be declared by each agency, retaining existing facilities only for replacement of parts of existing machinery;

iv) All engineering designs and plans to be based on the metric system, giving foot-pound equivalents where considered necessary;

v) In everyday public use and for trade purposes, the metric system to be gradually and progressively introduced; and

vi) Land records to be changed to the new system at the time of transactions, such as transfer, sale or any other registration of land.

c) *The Final Stage* of 3 to 5 years, when the country was to be brought over to the metric system entirely, and after which no other system was to be regarded as legal. This stage was to be in the nature of a period of grace during which the change-over to the metric system was to be finalized and the use of all other systems eliminated from the legitimate activities of all departments, Central or State, and from everyday public life. Old land records, were, however, to remain in the older system of measure until any transaction took place, when they were to be changed to the new system.

After the end of this period, the metric system was to be the only recognized system having legal sanction.

2. CENTRAL LIAISON AGENCY

This Agency was to be created to guide educational activity, carry on intensive propaganda to popularize the new system, co-ordinate the activities of Central and State Governments in respect of all the measures connected with the change-over and to act as a clearing house of all information connected with the subject.

3. DECIMALIZED CURRENCY

The introduction of the metric system was to be preceded by the adoption of decimalized currency, and the weights and dimensions of the new coins were to be related to the metric system of weights and measures, so as to facilitate propagation of general knowledge of the magnitude of the new units among the public.

4. CENTRAL LEGISLATION

The Centre was to initiate legislation on the subject of weights and measures which, among other things, was to provide for the following:

a) Standards of weights and measures (linear, square, cubic and capacity) based on the metric system.

b) Nomenclature based on the international basic units and fractions and multiples thereof:

i) Use of international nomenclature for basic units to be compulsory and universal; and

ii) Indian nomenclature for multiples and sub-multiples could be adopted, but in all these cases any name applying to a fraction or a multiple was to contain the name of the basic unit, for example, 'centimetre' could be termed 'satakmeter';

c) Schedule specifying commodities of everyday use which have to be sold on the basis of specific units of either weight, volume, linear measure, square measure or number. A schedule or schedules might be found necessary for specifying the use of more than one set of units for certain commodities;

d) A model form of legislation for adoption by States for the purpose of enforcement of standards. This model, among other things, was to include tolerances of weights and measures to be allowed for different purposes. The States were to be required to adopt this model legislation as such, but minor modifications could be permitted, if found absolutely necessary to suit local conditions;

e) Creation of a Central Agency for education, propaganda and co-ordination of activities of Central Departments and Provincial and State units in respect of all activities envisaged to be carried out during the three stages of development; and

f) Defining the three stages of change-over and provision for periodic review of the time limits allocated for each.

The Report of the Committee, after its adoption by the General Council of Indian Standards Institution in December 1949, was submitted for the consideration of the Government of India in the Ministry of Commerce and Industry.

CONCLUSION

With the submission of the Report of the Special Committee of ISI to the Government of India began the final consideration of the problem by the latter, resulting ultimately in the change-over to decimal currency in 1957, and to metric weights and measures during the decade ending December 1966.

Over a hundred years ago, the Weights and Measures Committee set up by the Bengal Government had been the first to recommend the adoption of the metric system. But this was not acted upon by the Government of India as similar committees set up in other regions of the country thought otherwise. On three occasions, thereafter, opportunities for going metric were missed, principally because the Government of the day was divided on the issue of what was of benefit for the people of the country it ruled. Public opinion in United Kingdom and sometimes in India also influenced the decision or the lack of it.

The first opportunity had presented itself in 1872. A new Act providing for the standardization of weights and measures on the basis of the kilogram had been passed by the Government of India. The Act was in accordance with the orders of the Secretary of State for India. And yet its postponement was ordered because the Viceroy who had approved the Act had been assassinated and the reform could not be introduced without the support of his successor who preferred to act over-cautiously. Political considerations, resulting perhaps from a natural state of nervousness prevailing at the time, weighed with the new Viceroy and the new legislation became, as recommended by him, a dead letter.

A second occasion arose when the Secretary of State for India himself suggested to the Government of India in 1901 that as the metric system had been introduced without much opposition in many European countries, it might also be adopted for standardization of weights and measures in India. The Secretary of State went as far as to point out that no country which had adopted it was willing to go back to its old system. But the Government of India went into reverse gear this time and saw 'great difficulties' in adopting the course suggested by the higher authority and refused to adopt the progressive measure without giving any solid reason against it.

And when the Government failed to act on the well-reasoned minute of dissent of A. Y. G. Campbell on the Report of the 1913-14 Committee of Weights and Measures, the British regime for the third and the last time failed to earn the credit for introducing the metric system in a dependent country.

At long last, however, India did go metric soon after it became free. The next chapter records an account of the seven years of further debate and endeavour which followed the submission of the Report of the Special Committee on Weights and Measures of ISI to the Government of India until the passing of the *Standards of Weights and Measures Act* in December 1956 which ushered the new era.

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3

The Final Decision

Jainath Kaul

The previous chapter covered the history of metric debate up to December 1949 when the Report of the Special Committee on Weights and Measures of Indian Standards Institution (ISI) was submitted for the consideration of the Government of India in the Ministry of Commerce and Industry. The paragraphs dealing with the Report in that chapter gave, in detail, the composition of the Special Committee and its recommendations, including the programme of action to bring about the change-over to the metric system. In brief, the Committee had recommended that the metric system of weights and measures should be adopted for all purposes in the country, the period of transition being roughly in three 5-year stages. The general public was to be educated and prepared for the change in the first stage with widespread publicity and propaganda, dissemination of essential information and modification of existing text-books. In the second stage, the metric system was to be adopted by Government organizations like the Railways and industrial units in the public sector. The general adoption of the new system was to start in the third stage.

In a preliminary examination of the Report in the Ministry of Commerce and Industry, it was conceded that theoretically the metric system offered the best basis for the standardization of weights and measures. However, its general adoption in practice was a question which, according to the Ministry, needed further examination, since it was felt that the emphasis in the Report had been on industrial production and manufacture. Detailed consideration, it was argued, needed to be given to some other aspects too, such as trade, imports and exports, road and railway mileages and freights. Besides, it was necessary to make an estimate of the overall expenditure that would be involved in the change-over. The view was taken that until some of these matters had been worked out, at least in rough details, the Government could not consider the matter further. This was perhaps a natural conclusion at the time, for, during those years, the Government was quite preoccupied with several other urgent problems, such as the resettlement of millions of refugees, creation of a republic under the new Constitution, national planning and so on.

INTER-MINISTERIAL COMMITTEES

For co-ordinating the necessary investigation and collecting the required data, an inter-ministerial committee was set up in February 1950 under the chairmanship of Dr J. C. Ghosh, Director General of Industries and Supplies, who had been the Chairman of the Special Committee of ISI. Its membership was to consist of Shri K. Sen, Joint Secretary, Ministry of Industry and Supply; Dr Lal C. Verman, Director, ISI; representatives of the Ministries of Agriculture, Commerce, Defence, Finance and Railways; and of the Central Public Works Department, Directorate General of Industries and Supplies and Directorate General of Posts and Telegraphs.

It was proposed that this co-ordinating Committee should meet representatives of each Ministry or Department and discuss with them problems with which they were concerned, and then leave it to the Ministry concerned to do its own investigation. The Committee could receive reports of the various Ministries in 3 to 6 months, discuss them with the Ministries concerned, consolidate the reports and prepare a comprehensive report for the consideration of the Government.

This Inter-Ministerial Committee at its very first meeting in April 1950 reached the conclusion that it would not be worthwhile for it and the various Ministries to undertake any detailed studies of the problems involved before the Government had taken a decision on principle that it was desirable to change-over to the metric system. The resolution on record reads:

> 'The Committee strongly feels that it would be extremely desirable to have the definite view of the Government of India as a whole on the question whether they accept the introduction of the metric system in principle as an ideal to be attained at least at some future date before the Committee could engage itself in the huge task of working out the necessary details for the introduction of the scheme as envisaged in the Report of the ISI Special Committee on Weights and Measures.'

SECOND INTER-MINISTERIAL COMMITTEE

The matter was thus allowed to rest until October 1952, when it was decided to appoint another inter-ministerial committee to examine the question. This new Committee, with the Joint Secretary (Commerce and Industry) as Chairman, and the Director of the Indian Standards Institution as Member-Secretary met just a year later. Its membership was even more comprehensive and included the representatives of the Ministries of Works, Housing and Supply; Production; Food and Agriculture; Health; Finance; Defence; Communications; Irrigation and Power; Natural Resources and Scientific Research; Education and Law; and of the Planning Commission.

The Memorandum issued for information of members on 5 December 1952 summarized the principal recommendations of ISI and outlined the task of the Committee as follows:

> 'Since these recommendations (of the ISI Special Committee) were made after extensive consultation with almost every interest concerned, no serious

> difference of opinion is expected as regards the principles of the recommendations, but the exact process of the introduction of the new system, the stages in which this should be undertaken, the legislative and administrative measures that will have to be taken and the extra expenditure involved are matters of utmost importance. Before legislation can be undertaken, or the matter even considered by the Cabinet, the process of introduction and the different stages including the expenditure involved and the impact of the measures on Governmental transactions in particular, should be carefully worked out in detail.'

The Committee met on 22 October 1953. In this meeting, the members of the Committee were requested to give their views on the question whether action should be initiated immediately in regard to the introduction of the metric system of weights and measures and decimalization of currency more or less on the lines envisaged in the Indian Standards Institution Committee's Report. In giving their views in a general way, most of the members referred to the many difficulties to be overcome, involving a considerable amount of work and expenditure. As the hands of the Ministries were already full with high priority problems, some members thought that the time opportune for the introduction of the metric system might be 15 or 20 years hence.

The representatives of the Ministries of Agriculture, and Natural Resources and Scientific Research favoured early adoption of the metric system. The representatives of the Ministry of Finance expressed the view that, in their opinion, the decimalization of coinage should follow and not precede decimalization of weights and measures, and that for various reasons, the present was not the opportune time for any reform in the currency.

It was also suggested at this meeting that if some rough estimate of the cost of the change-over could be made in one or two illustrative cases, it might be helpful in reaching a decision on the question of principle.

In pursuance of the views expressed at this meeting, the Ministry of Commerce and Industry requested all the other Ministries concerned to furnish estimates of the expenditure likely to be involved, and also asked them again, and the Planning Commission, to give their considered views on the general question of principle. They issued a fresh circular letter to organizations of trade, commerce, industry and others inviting them to express their opinion whether the change-over to the metric system was considered desirable or not.

This round of consultations had the merit of revealing that the cost of the change-over would probably not be so formidable as had previously been feared.

The Planning Commission at first desired to consider the question after replies of the Ministries to the Commerce and Industry Ministry's circular letters became known. Later, when the subject came up again before the Commission on 30 August 1954, it was decided that a comprehensive study should be undertaken by Shri Pitambar Pant (then Private Secretary to the Chairman, Planning Commission, and now Member, Planning Commission), in association with the Indian Standards Institution, to enable the Commission to determine its views on the question.

PANT'S MEMORANDUM

In pursuance of this decision, Shri Pitambar Pant undertook the challenging task with zeal and determination. He studied all aspects of the question in great detail and collected a vast amount of data to support the contention that standardization of weights and measures should be carried out on the basis of the metric system and that immediate action should be taken to achieve such standardization.

The results of Shri Pant's wide-ranging studies, which he completed in a remarkably short period of six months, were incorporated in a 'Memorandum on the Introduction of Metric System in India' which has now come to be known as 'Pant's Memorandum[1]'. The document greatly facilitated the final decision on this vexed question which had remained undecided despite several attempts during the past hundred years or so. It carried a foreword by Prime Minister Jawaharlal Nehru, which is reproduced overleaf in facsimile.

An outcome of great significance of Shri Pant's contribution was the fact that the adoption of the metric system could be linked with the economic development of India through planning. While the task of gathering the appropriate data on the subject and presenting them suitably in a forcefully reasoned dissertation had been superbly undertaken by him, the linking of the issue with planned economic

FOREWORD

This is rather a formidable volume and yet it is worthy of perusal by all those who are interested in the Metric System in India. It represents a great deal of labour and some research work by Pitambar Pant and he deserves congratulations for it.

Our Parliament has accepted the principle of introducing the Metric System in India and legislation has already been passed in regard to coinage. The rest will no doubt follow. It is important, however, that there should be full publicity about this system and the obvious advantages that it will bring to us. We are, on the whole, a conservative country and it is not very easy to change old-established customs. But I am sure that our decision to adopt the Metric System is the right one from every point of view. For the scientist, the technician and the statistician, it is the only system that can be used. But even to the people generally this will bring relief and many facilities. There will no doubt be slight inconvenience to begin with, but this will not last.

This book will make it clear that there is a long history behind this introduction of the Metric System in India. The decision has not been made in a hurry or without due consideration. Indeed, it is rather unfortunate that it has been delayed for so long. One of the first subjects that came up before the Interim Government in, I think, 1947 *was this introduction of the Metric System in India. The principle was accepted, but then all kinds of other developments took place in the country which delayed further consideration of this matter. I am glad that at last we have crossed the major hurdle and the future path now will be relatively easy. It is important, however, that full publicity should be given to the advantages of the Metric System and the people should understand how they will profit by it. This book gives both the past history and an indication of these advantages.*

New Delhi,
16*th September,* 1955.

Jawaharlal Nehru

The late Prime Minister Nehru's foreword to Pant's Memorandum

growth laid the foundation for the rapidity with which the general adoption of the metric system proceeded in the country.

The Memorandum discussed, *inter alia,* two basic issues, namely, the choice of the new system of weights and measures to be adopted, and the timing of the reform, and concluded with specific recommendations. The information itself, on which the discussion was based in the Memorandum, was classified and distilled in 44 appendices. The following paragraphs reproduced extensively from it, show how the discussion logically led to the conclusion that the standardization of weights and measures in the country had to be effected on the basis of the metric system and that this had to be done with the least possible delay.

WHY METRIC SYSTEM ?

The discussion began with a reference to:

'the proposal that standardization would be facilitated if it is made on the basis of the present standard tola, chittack, seer and maund for weights, and the foot, yard and mile for lengths, on the ground that this system is more widely known than any other in the country; and that while the decimal system was better and could be considered worthy as an ultimate objective, its introduction now would mean much inconvenience.'

This argument was countered by pointing out that if the country as a whole was considered, the diversity in weights and measures was so great

'that standardization even on the basis of the standards recommended would affect the majority of the people. And as the desirability of a change of system is universally admitted, it is obviously better, since a sweeping or modified change would be equally distasteful at first to the people, that the change should be a thorough and efficient one, not merely a tentative adoption of a system which in itself has no merit other than that of its being comparatively better known in some parts of the country — to be followed perhaps by further disturbing changes a few years later.'

After quoting a few paragraphs from Col Strachey's Minute of Dissent, 1868, extracts from which have been reproduced at some length in Chapter 2, the Memorandum referred to

'the fact of the adoption of the metric system by more than 50 countries, comprising three-fourths of the world's population and embracing people of various climes and cultures, races and religions, languages and customs, and being in stages of development ranging from the highly industrialized to the predominantly agricultural.'

It was pointed out that it was on the basis of the metric system that every country had attempted standardization in recent years, and that there had hardly been any exception. Further, it was a significant fact that no country of the world which had once adopted it, had ever wanted to change it for any other. Transcending all national boundaries, the metric system had practically fulfilled the dream of its founders that 'though conceived and created in France, it will belong to all nations'. It, therefore, seemed obvious that sooner or later India would also have to fall in line.

Commenting on the conditions in India and the UK in respect of the units of weights and measures, it was stated that

'Were it even possible to achieve countrywide standardization, after several years of concerted effort, in terms of standards laid down in the *Indian Standards of Weights Act, 1939* (*see* Chapter 2), we would still be in far worse position than say Britain today — far worse because Britain has at least a system, however cumbrous, which is related to technology, international commerce and scientific literature, besides serving the requirements of daily life. The system based on a seer and foot has no relevance, apart from its use in internal commerce. It is unrelated to technology, useless for scientific education and unsuited for international intercourse.'

After again quoting extensively from Col Strachey's observations and from an article by Shri C. Rajagopalachari, the well-known Indian veteran, published in the Statesman dated 23 Feb 1947, in support of the metric system, the discussion on this point concluded with the comment:

'By adopting the metric system, India would enter the long list of countries who have accepted one common international language of measures. This decision of India will be no less a symbol of her well-known sentiment of internationalism than of her resolve to rid herself of all fetters that have hampered her growth.'

TIMING OF THE REFORM

The Memorandum also examined the question of timing of the reform. The following considerations had been seriously urged at the meeting of the second Inter-Ministerial Committee:

'While the advantages of the metric system may be indisputable and its ultimate adoption may be desirable, the amount of energy, time and money involved in the change-over would not justify initiating action immediately; furthermore, since India is envisaging very large development plans and the hands of Ministries are full with high priority problems, the time opportune for this change-over might be 15 to 20 years hence. Patience is also enjoined on the ground that there are risks to India if it should get out of step with UK and USA, with whom it has close commercial contacts.'

That these contentions were untenable was proved on several grounds.

'Firstly, the reform of weights and measures of India has remained outstanding for too long a time, and it can no longer be regarded as one with the lowest priority in the scheme of things.... It is not difficult to imagine that a reform designed to save the poor cultivator from fraud, the honest trader from loss, and the common man from bewilderment and confusion would be welcome to these classes, and such a measure must receive a high place in a rational scheme of priorities.

'Secondly, it is absolutely beside the point, when we are considering the question of standardization of our weights and measures, whether Britain will be able to abandon its own system and make the use of the metric system obligatory in the country, its use being already permissive now. Britain has been enjoying for centuries the advantages of a unified system of weights and measures which is well regulated and standardized throughout the country. Not only is there complete standardization, but the system itself is one of the only two languages of measurement in international use .... What is significant in her case is, that notwithstanding these factors, the UK Board of Trade Committee on Weights and Measures, which reported in 1951, made the unequivocal recommendation that Britain should give up its own English system and adopt for sole use, the metric one because of the superiority of that system.

'In one respect, however, we are better placed than Britain because, if we do not permit drift, we should certainly turn our present low level of industrialization to good account by standardizing our weights and measures on the basis of the metric system which Britain is finding difficult to do because of the heavy expenditure involved in the change-over on account of her high industrial level.'

In this connection, Sir Edward Bullard, Director, National Physical Laboratory, UK, had expressed the following opinion in November 1954:

'If it is decided that India is to change to the metric system, this action would have to be taken very soon, before industrialization has progressed so far that it becomes infeasible to impose the change. In this country, the step could have been taken (and would have been, but for a few contrary votes in the House of Commons) during the latter half of the nineteenth century.'

It was argued that:

'Sir Edward's reply is incidentally the strongest reason why we cannot afford to take a leisurely view of this matter. We are now on the verge of rapid industrialization. The value of the entire plant and machinery in the sector of organized industry may be estimated, at the present moment, at about rupees five hundred crores. In the course of the next 10 years, if our plans materialize, we should be putting up new plant and machinery worth at least double the total value of the present stock. And this development may be expected to proceed perhaps even at a faster pace. Whatever, therefore, may be the cost of conversion occasioned by machinery and measuring instruments, being on the British system now, it is likely to be multiplied at least threefold if reform is delayed 10 years, and this factor of multiplication will go on increasing progressively and rather steeply as the years of indecision roll by.

'Indeed, no aspect of this problem is simplified, no problems are resolved merely by the magic of passing years. The cost of conversion, as we have seen, must increase; more engineers and more technicians will have been trained in the 'wrong' way, and the process of their adjustment will become more difficult; more vested interests will have been created giving rise to further difficulties and more obstructions. After some years we would become fully entrenched in the old system, get used to its inconvenience and would be less in a mood for a radical reform. The cost of conversion would then, moreover, assume frightening proportions, and if it does not become prohibitive, it will at least be very much more than now.'

Illustrating with examples the discussion on another aspect, partly related to what has been stated above and partly of an altogether different nature, the Memorandum recalled that:

'At present, a large number of our industries are operating on the foot-pound system but quite a few have found it more convenient to adopt the metric system. In recent years a number of factories in the public sector have been equipped with machinery and equipment operating on the metric system. The Machine Tool Prototype Factory (Ambarnath), the Machine Tool Factory (Jalahalli), the Bharat Electronics Factory (Bangalore), are examples. As there has been no clear indication of what direction we were following, there has been much room for confusion and controversy. It is not long ago that a decision of the French firm of technical consultants to the Bharat Electronics Ltd, to adopt the metric system for all engineering work, raised a storm of protest .... The fact that ultimately the decision for the adoption of the metric system in this factory was upheld serves to emphasize the point that quite an unnecessary and distracting controversy arose only because there had been no clear indication of the general attitude of the Government towards the ultimate adoption of the metric system.'

A letter dated 23 April 1951, from Shri P. A. Narielwala, Director, Tata Industries Ltd, Bombay, to Dr Lal C. Verman, Director, ISI, which is reproduced below, was cited as typical of the difficulty experienced in this respect:

'I hear that a Committee of the Indian Standards Institution have submitted a Report to the Government of India suggesting the adoption of the metric system in a period of 15 years. I should like to know if the Government have come to a decision on this Report. This is a question of such importance to the country that if the recommendations of the Committee are accepted by the Government, we shall have to undertake a drastic change in our weights and measures in use at our various factories. If the Government accept the recommendation, we should from now onwards take steps to make modifications in our drawing and designing office first of all, so that we gain experience in the use of this system, and secondly, whenever we have to import a new plant or equipment in future, we might start using both the metric as well as the present system. I shall be glad to be enlightened with your views.'

To avoid such difficulties and needless controversies, it was claimed that postponement of the decision to go metric would bring no benefit to the country. On the other hand:

'In the absence of any clear direction of future development, factories might be put up on considerations of mere temporary expedience, and unplanned multiplicity of systems may prevail, giving rise to problems of adjustment indicated earlier in connection with the controversy relating to the Bharat Electronics Ltd.'

Another argument against the adoption of the metric system, which had been advanced by some people, was that two-thirds of the country's trade was with non-metric countries like the UK and USA, and, therefore, it would be a serious disadvantage to go metric. Shri Pant found this argument to have no force, as the direction of international trade showed that:

'more than two-third of the total trade of the United States of America, a non-metric country, is with metric countries. The trade of United Kingdom is equally divided between the metric and non-metric countries. On the other hand, there are several countries which have adopted the metric system but carry out the bulk of their trade with non-metric countries. Philippines provides a striking example in so far as four-fifths of its trade is with non-metric countries. Thailand (67 percent), Japan (58 percent), Brazil (55 percent) are other examples. It is clear, therefore, that the fact that United Kingdom and United States of America have not decimalized should be no deterrent to India trying to conform with the usage current in the largest part of the world.'

There was still another important consideration, it was argued, which should weigh in favour of immediate adoption of the metric system. The States Re-organization Commission was expected to submit its Report shortly, and its recommendations could involve transfer of population to administrative units with different systems of weights and measures. If the metric system were introduced, there would be no inconvenience on this account.

A final consideration in undertaking immediately a reform of such fundamental nature touching the life of the masses of the people, the Memorandum underlined, was:

'the supreme advantage of having at the helm of affairs, Jawaharlal Nehru, whose overwhelming popularity and the esteem and affection in which he is held are crucial for ensuring the ready acceptance of a reform supported by him, by the people of India.'

IMPLICATIONS OF THE CHANGE-OVER

Commenting on the implications of the change-over, the Memorandum stated:

'It is not necessary to reproduce here the results of the several studies that have been made to study the implications of the introduction of the metric system. The whole of Appendix F is devoted to this question. The conclusion that may be drawn is that if a decision to adopt the metric system is taken, it will be generally welcomed, and that if the change is spread over 10 to 15 years, there would be no serious difficulties in adopting the metric system.

'Full consultations with the industry made recently by the Ministry of Commerce and Industry and the Indian Standards Institution indicate clearly that if the Government take a firm decision to introduce the metric system and decide to make its use compulsory and universal within a period of 10 to 15 years, the industry will not have too great a difficulty to accomplish the change. In such a gradual process, which will have to be properly phased and planned, cost of conversion will also be considerably reduced.'

CONSIDERATION OF COST

The Memorandum discussed this issue in detail in one of its appendices and reached the conclusion that:

'it seems reasonable now to accept Rs 1 crore (10 million) per year over a period of 10 years as the maximum likely cost to organized industry during the period of transition. This is of the order of about 0·1 percent of the net annual output from factory establishments and only 0·05 to 0·1 percent of the total net industrial investment which might be expected during the Second Five-Year Plan.

'It is thus clear that neither the cost of conversion is excessive nor are the difficulties of transition in any way insurmountable; nor have the industries generally shown any opposition to the move. This favourable situation, however, cannot be trusted to continue indefinitely. The time for decision is, therefore, now.'

The consideration of cost, the Memorandum urged, needed to be seen in proper perspective.

'The justification of adopting the metric system (with, of course, decimal coinage) is that it is a superior system of measurement which introduces simplicity and convenience in reckoning and makes life easier for most of us. This simplification and convenience must necessarily find a reflection in the increased efficiency and the saving of time and effort in the diverse spheres of national life.'

It was claimed that by the exclusive use of the metric system and drawing up of syllabuses of schools and colleges in consonance with that practice, some '20 percent of the average student's time in school, which is now wasted in learning conversions from one system to another, vulgar fractions and complex tables of multiplication, will become available for learning something more worthwhile'. The money equation, therefore, had two sides; one of cost and the other of savings and gain.

'The cost is a defined amount incurred within a comparatively short period. The savings and gain are continuing items extending all the way to an endless future. To look at one side of the equation and ignore the other is thus to get an altogether biased view of the transaction. It is for this reason that most of the countries who have adopted the metric system, did so without considering overmuch this question of cost of conversion, and it seems to have been generally taken for granted that a reform of such fundamental a character must, over a period of time, more than make up for any temporary difficulties or expenditure in the matter of its introduction.'

RECOMMENDATIONS

The Memorandum concluded with the proposal that the Government give its general approval to the Recommendations contained in the Report of the Special Committee of the Indian Standards Institution and take the following steps in pursuance of that decision, inaugurating the first phase of the reform:

'1) To make an authoritative statement at an early date that the Government of India had decided, after full deliberation:

(a) to introduce the metric system of weights and measures in the country as early as possible with a view to making its use obligatory after a period of 10 to 15 years in all spheres of the national life;

(b) to introduce a Bill in the Parliament during its ensuing session in order to amend the *Indian Coinage Act, 1906* so as to provide for the decimalization of the Indian coinage as a first step towards the adoption of the metric system.

2) To set up a strong Central Metric Committee, composed of representatives of the Ministries of Commerce and Industry, Finance, Defence, Agriculture, Railways, Posts and Telegraphs, Education, Natural Resources and Scientific Research, and the Planning Commission. The Director of the Indian Standards Institution should be an *ex-officio* Member. The Committee should have the right to co-opt and invite expert consultants representing scientific and technical institutions, public bodies and commercial and industrial organizations. The Member-Secretary should be a whole-time officer of sufficiently high status. This Committee should be charged with the responsibility of studying all the questions concerning the introduction and application of the metric system, so as to be in a position to advise on the manner and phasing of the change and the conciliation of diverse interests. The Committee should enjoy high prestige and have enough sanctions behind it so that it can function as the spearhead of this important reform.

3) To initiate as early as possible comprehensive legislation on the subject of weights and measures which should, *inter alia*, provide for the standards of weights and measures based on the metric system; nomenclatures to be adopted; defining of the stages of the change-over and for periodic review of the time limits allocated for each.

4) To direct all agencies to initiate designing their new schemes of development on the metric system with the ultimate object of going over to that

system entirely at an appropriate stage; and further, in respect of such engineering designs and plans which may be considered necessary to be executed on the foot-pound system, to direct that metric equivalents should be given.

5) To request the Ministry of Education to initiate action in regard to the inclusion of the metric system in the syllabuses of elementary and secondary schools and of technical, engineering and medical institutions.

6) To request all Central and State Units to initiate preliminary preparations for conversion to the metric system.

7) To ask the Central Statistical Organization and other Government Statistical Organizations to examine the feasibility of presenting the statistics in their future publications both in the present units and in the units of the metric system.

8) To initiate a programme of intensive education and propaganda for explaining the metric system to the masses through all available means of publicity. Mention may be specially made of the National Extension Service as a vehicle for reaching the new system to the remotest parts of India.

9) To take immediate steps to make India a member of the International Bureau of Weights and Measures, and to acquire prototype metre and kilogram to serve as reference standards in India.

10) To take effective steps to see that the large supply of new weights and measures that would be required, would be actually manufactured.'

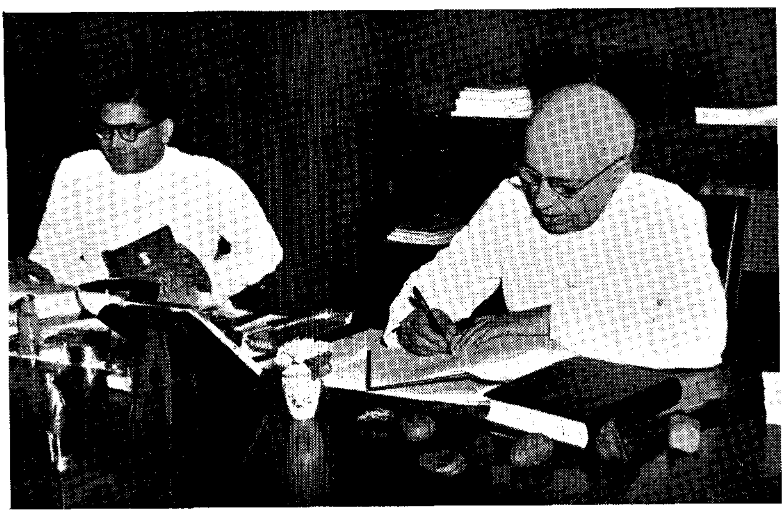
APPENDICES TO THE MEMORANDUM

The 44 appendices to the Memorandum mentioned earlier contained appropriate information necessary for enabling a final decision to be reached on this important and urgent subject. All the major aspects of the matter received attention and the various questions at issue were discussed in detail. The lack of any system in the existing weights and measures in vogue was brought out with reference to the latest information regarding the prevalent diversity; authoritative and informed opinions were cited to show what a great harm resulted from such a chaotic state of affairs and how imperative it was to bring about standardization in this field. Claims of rival systems were examined and objections against each were indicated. Lastly, the problems of change-over to the metric system, if that system were to be the basis of uniformity and standardization in India, were discussed in some detail in relation to several important sectors of national economy including industry, agriculture, railways, posts and telegraphs, civil aviation, health and defence, showing how the problems were likely to be aggravated if a decision on this matter were further delayed. Decimalization of the currency received separate and detailed attention. The experience of 58 countries in the matter of introduction of uniform system of weights and measures was analyzed. Opinions of Central Ministries and State Governments, views of various chambers of commerce, associations of manufacturers, scientific and technical organizations, and of individuals capable of affording useful suggestions and criticisms were put together.

NEHRU'S APPROVAL

All hurdles in the adoption of the metric system in India were virtually crossed on 9 March 1955 when Shri Pant's recommendations received approval of Prime Minister Jawaharlal Nehru, who was also Chairman of the Planning Commission. In commending the circulation of Pant's Memorandum and its Appendices to the members of the Planning Commission, Shri Nehru gave his categorical support to the proposal to adopt the metric system in the following words:

> 'For my part, I have been a convinced advocate of the metric system for India for many years past. I realize all the difficulties in changing over from



The late Prime Minister Nehru and his secretary Pitambar Pant at work together existing systems of coinage and weights and measures. But I am quite convinced that some time or other we shall have to do this. If so, the sooner we do it, the better. We are on the eve of large-scale industrialization. That will be helped or hindered by the system of coinage and of weights and measures that we employ.

'All scientific work is done today according to the metric system. Technical work will necessarily follow that and does to a large extent follow it even now. A technical civilization can hardly be based on anything but the metric system. Therefore, apart from other obvious advantages, it has become incumbent on us now, at this stage of our development, to face this problem and solve it.

'I think the initial decision should be of accepting the principle fully of the adoption of the metric system in our coinage and for our weights and measures. That seems to me simple enough. The other question, which is more complicated, is the phasing of it and the other details connected with it. The change-over will inevitably have to be phased over a number of years so as not to upset existing conditions too much.

'I know the difficulty of convincing people in favour of a change when they are used to working along certain well-established lines. But that change becomes inevitable. Sometimes not to accept it is to impede progress. Therefore, the price of the change has to be paid.'

PLANNING COMMISSION'S SUPPORT

The matter came up before the Planning Commission at its meeting on 4 April 1955. The Prime Minister gave a lead to the discussion by pointing out that the immediate matter for consideration by the Planning Commission was whether the introduction of the metric system was acceptable to it in principle. Once the principle was accepted, the details could be worked out later. Regarding the decimalization of coinage, it was agreed that this could be undertaken without much difficulty either before or simultaneously with the introduction of the metric system of weights and measures.

It was appreciated that it might not be possible for the period of the change-over to be the same in all spheres. In some fields, like land records, it was not necessary to introduce metric units immediately. This could be done gradually, by effecting the change-over at the time of transfer of property. Again, the need for vigorous propaganda to educate the people on the benefits of the new system was also stressed. After some further discussion, the Commission formulated the following recommendations:

1) The Planning Commission accepts in principle the introduction of the metric (decimal) system in coinage, weights and measures,

The Planning Commission members at Prime Minister's office at the signing ceremony of the second five-year plan for national development launched in 1956, which included the metric programme. The late Prime Minister Nehru signing on the right, with late Dr J. C. Ghosh opposite (fourth from left) looking sideways

and recommends that steps may be taken to this end.

2) As a first step, a bill may be introduced in Parliament providing for the decimalization of Indian coinage. It may be made clear in the preamble to the bill that the objective of the Government is to introduce the metric system of weights and measures, and decimalization of coinage is a first step in that direction.

3) A Standing Committee with Shri Kanungo, Deputy Minister, Commerce and Industry, as Chairman, and with representatives of the Ministries of Finance, Law, Defence, Agriculture, Railways, Commerce and Industry, Education, Natural Resources and Scientific Research, and Communications (Posts and Telegraphs), and of the Planning Commission, and Director, ISI, as members, should be appointed to work out the details connected with the introduction of the metric system of weights and measures. Apart from advising on the framing of the Draft bill, the Committee would make recommendations regarding the appropriate measures to be undertaken for educating the public and for different stages of the change-over.

PARLIAMENT RESOLUTION

In the meantime, a non-official resolution on the introduction of uniform weights and measures, had been tabled in the Parliament by Shri K. T. Achutan. The resolution was worded as under:

> 'The House is of opinion that Government should take necessary steps to introduce uniform weights and measures throughout the country, and to make penal the use or possession of any other weight or measure.'

So, after the recommendations of the Planning Commission had been forwarded to the Cabinet and the Cabinet had duly considered the matter, the stage had been set for the next step, namely, the final and formal decision on the issue by the Parliament of the Republic of India.

The Achutan resolution was moved in the *Lok Sabha* (House of the People) on 9 April 1955[2], and was adopted with an amendment on 22 April 1955[3].

Four amendments to the resolution had been tabled. By the first, moved by Shri Thanu Pillai, the original resolution was sought to be substituted by the following:

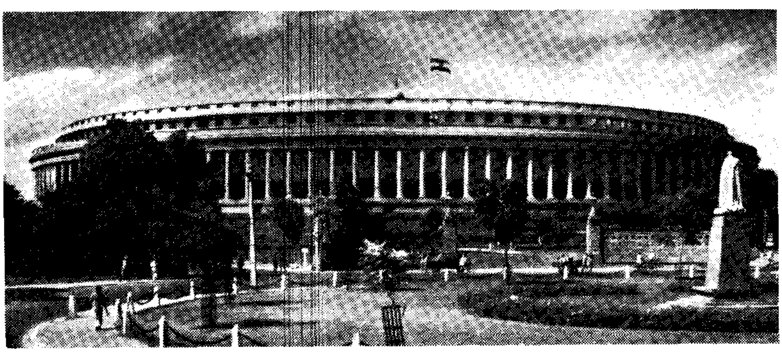
> 'This House is of opinion that Government should take necessary steps to introduce uniform weights and measures throughout the country based on the metric system.'

The next two amendments proposed by Shri N. B. Chowdhury were as under:

1) In the resolution, after 'to introduce' insert 'by a phased programme', and

2) In the resolution, omit 'or possession'.

The fourth amendment tabled by Shri K. C. Sodhia stated that 'No change in the weights and measures used in the country is



Parliament House, New Delhi

desirable till the percentage of literacy rises considerably'. This amendment was not discussed as the member who had tabled it was not present in the House when other amendments were being moved.

STATEMENT BY THE MINISTER OF COMMERCE AND INDUSTRY

After giving a brief history of the various stages through which this question had progressed up to the recommendation of the Planning Commission, Shri T. T. Krishnamachari, Union Minister of Commerce and Industry, said:

> 'It is the intention of the Government that my colleague, the Finance Minister should, at an early opportunity, introduce a Bill in this House for adopting the decimal system of coinage. In regard to legislation in respect of the metric system of weights and measures, the Kanungo Committee will consider not merely the phasing of it which has been suggested in one of the amendments but also the type of legislation that is necessary.'

Commenting on the view of Shri Sodhia, the Minister said that he had no desire to blame Shri Sodhia for his view, 'because there is quite a large section of people, representing the many departments of the Government of India who share the opinion of Shri Sodhia'. However, he said that:

> 'it was a question of examining the two types of opinions and ultimately coming to a conclusion that when we want progress, when we want a uniform nomenclature all over the country — we are attempting to have a uniform language, we have a Constitution which covers the entire country — when we want an economic system which will benefit the entire country, naturally, the weights and measures and the coinage should go along with it.'

Shri T. T. Krishnamachari stressed the fact that the measurements largely used all over the world for scientific and industrial purposes were the metric measurements. The metric system was also 'in tune with our own proclivity; and our own background, tradition and culture fit in more or less with the practice in the major parts of the world'.

The Minister concluded his statement by saying that Shri Sodhia's point of view, though a valid one, was not practicable 'because we cannot perpetuate the existing systems of weights and measures all over the country. Standardization in some form is inevitable. Once you accept standardization, let us have something rational and scientific'.

FIRST AMENDMENT ADOPTED

There were no effective arguments against the adoption of the metric system. Difficulties in going metric throughout the country were pointed out by those who opposed the resolution. But it was contended that, if there were difficulties, these had to be surmounted, and as one speaker put it, 'anything that concerns our country is a huge thing; the hugeness itself is a problem'.

The first amendment which had been moved by Shri Thanu Pillai when put to vote was accepted. Since this amendment replaced the original resolution, and since the Minister of Industry and Commerce had given the assurance that the change-over would take place according to a phased programme, there was no need for considering the other two amendments.

BILL FOR DECIMAL CURRENCY

A fortnight later, on 7 May 1955, Shri A. C. Guha, the Minister for Revenue and Defence Expenditure, introduced a Bill in the *Lok Sabha* to amend the *Indian Coinage Act, 1906*. The Bill was taken up for consideration on 28 July and passed on the following day. On 26 August, the *Rajya Sabha* (Council of States) also agreed, without any amendment, to the Indian Coinage (Amendment) Bill 1955 passed by the *Lok Sabha*, and within a month it received the assent of the President of India. The Bill provided for a switch over to the decimal system of coinage, dividing the rupee into one hundred units.

Opening the debate in the *Lok Sabha*[4] on the Bill, the Minister emphasized the need for an early change-over to the new system of coinage and weights and measures. He said, 'The greatest difficulty in other countries in introducing the decimal system is the mechanical accounting machines which have not yet come into vogue in India so much, but their number is increasing. The more we delay, the more it will be costly for the commercial public to introduce the decimal system — not in currency of course, but in weights and measures, and in mechanical counting. So it is the decision that both in coins and in weights and measures, the decimal system will be introduced, and this is the first Bill.'

The Bill received almost unanimous support, except for a couple of dissentient voices. The dissension was based on the contention that the Bill was going to affect mainly the rural population which had not been consulted. It was stated with emphasis that since the people at large were uneducated, the money changers or dealers would take the opportunity to harm the poor and innocent people, and there would be considerable confusion in rural areas. But another speaker, who supported the Bill, was equally emphatic in his opinion. He said that the people were not fools and that they would not be put to great trouble for a long period. However, the latter proposed that the new currency should not be a legal tender for two years, and in the meantime, lot of propaganda to educate the people should be carried out. There were also quite a few comments on the nomenclature for the new unit for one-hundredth of a rupee, some insisting on the term *paisa* and others disfavouring the proposal on the ground that since this word was being used for the existing coin which was one-sixtyfourth of a rupee, it would be confusing to apply the same term for the new coin.

PRIME MINISTER'S REMARKS

Intervening in the debate, Prime Minister Jawaharlal Nehru said, 'It seems to me that there is a grave misunderstanding, a misapprehension. This is not merely a question of a new nomenclature. It is a basic approach not only in regard to coinage, although this Bill deals with coinage, but with other matters too, with weights and measures'. Continuing, he said, 'The real thing is that this change has to come, if I may say so, in every country in the world today. It cannot escape it. The more you delay it, the more difficult it becomes. Because, if things are calculated in the other way, you have to change them, convert them and translate them at every step, and that means not only delay now, but confusion later'.

About consulting the country, the Prime Minister said, 'I must confess that in a matter of this kind, rather scientific, technical kind, one does not normally consult the country. One does not consult the country, let us say, about mathematical formulae, or about the Theory of Relativity. It is not fair to go about. We must take the responsibility for it entirely and explain it to the country. If we think it is right, then it is right'.

One member, who had heartily welcomed the Bill, suggested that 'the weight of the new coins to be introduced must have some integral relationship with metric units, so that the common man may use these coins by permutation and combination for weighing gold and similar articles from half a gram to 10 grams and more by the addition of a particular coin which would exactly weigh 10 grams'. He accused the Government for not doing publicity in favour of the metric system, and wanted the Government to make up for it. It must carry on, he insisted, 'a raging tearing compaign all over the country, especially in the countryside, explaining how the change-over is to take place'.

One of the members, who was in favour of the proposal to circulate the Bill for eliciting public opinion, remarked that, since the House had not accepted that proposal, 'the date on which the Bill shall come into force by notification by the Central Government may be some date in 1957, a year* of revolutionary significance for India'. He added, 'I also suggest that during the one and a half years before the Act comes into force, there should be an intensive publicity and education drive among the people so that they can understand the implications as well as the complications of this new measure'.

IN RAJYA SABHA

In the *Rajya Sabha*[5], some amendments were proposed which sought, for instance, to specify the metals of the new coins and their appearance, and to stipulate that 'they shall be related to metric measures of weight and length by simple multiples'. The motion to effect such changes in the Bill, was, however, negatived.

All the same, some members referred to certain problems, like re-fixing the cost of a postcard in the new currency. Since exact equivalents of the existing rates would introduce fractions of new coins, there would be need for re-adjustment. In reply, the Minister said that 'in re-valuing under the new system, Government may lose in some cases, while in some other cases, there would be a gain, but ultimately, Government's budget would be balanced'.

In regard to the nomenclature for the basic unit of one-hundredth

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*A revolutionary upheaval against British rule took place in 1857 (*see* Chapter 2).

of a rupee, the Minister said that it would be termed *naya* (new) *paisa* to avoid confusion with the current lowest coin of a *paisa*, which was one-sixtyfourth of a rupee.

STANDARDS OF WEIGHTS AND MEASURES BILL

The *Lok Sabha* passed the Bill decimalizing Indian coinage on 29 July 1955. A year later, a bill to establish standards of weights and measures based on the metric system was introduced in the *Lok Sabha* by Shri N. Kanungo, the Minister of Consumer Industries. On 25 August 1956, twelve days after the Bill was introduced, the Minister moved[6] that the Bill be referred to a Joint Committee of the two Houses consisting of 45 members, 30 from the *Lok Sabha* and 15 from the *Rajya Sabha*, and that the Committee be asked to submit its report latest by 20 November 1956.

Before this was agreed to, one of the members proposed that the Bill be circulated for the purpose of eliciting public opinion thereon by 1 January 1957. The object of doing this, according to him was 'to focus the attention of the Government on the extraordinary difficulties they have to face, both here and in the States, in implementing its provisions. Also, during the next 10 years, there are several other things probably much more important than this which we have to do'.

MINISTER'S REMARKS

The proposal was withdrawn after Shri Kanungo had explained that the Bill only laid down the standards, and the standards as such would be hardly understood by the people. 'The definitions and all that which you find in the Bill and hardly anything can be discussed by the public in general. It is only for the members of this honourable House to digest and to express their opinion on it. In regard to the other steps, which are more important and about which doubts have been expressed, as I said, where legislation is necessary, we shall come to the House for it. Regarding the programmes and the implementation of the programmes, we will have to consult not only the members of Parliament but also the representatives of the people in the State legislatures, because it is a programme which has got to be implemented all over the country, and God willing, I hope once the standards are laid down by law by Parliament, the programme can be implemented and implemented in a shorter period than anticipated.'

REPORT OF THE JOINT COMMITTEE

The proposal of the *Lok Sabha* to set up a Joint Committee of the two Houses to examine the provisions of the Standards of Weights and Measures Bill was agreed to by the *Rajya Sabha*. The Joint Committee submitted its report[7] by the due date. The Committee approved the Bill, subject to a few amendments. One of these recommended that 'the secondary units to be declared should be only in relation to the units of mass and measures'. Another important amendment which was of the nature of an additional provision, stated that:

> 'All rules made under this Act shall be laid for not less than 30 days before both Houses of Parliament, as soon as possible after they are made, and shall be subject to such modifications as Parliament may make during the session in which they are so laid, or the session immediately following.'

The Committee was categorical in its support for the provision in the Bill to introduce international terminology. It stated that:

> 'The Committee have considered the question whether international terms should be used for the various units of mass and measures proposed to be introduced by this Bill, or whether Indian names might be used in addition to, or in place of international terms. The Committee are of the view that the international terms, as proposed in the Bill, might be adopted.'

There were notes of dissent from some members of the Joint Committee, proposing that the period of change-over be reduced from ten years, that Hindi nomenclature be invented and adopted, and that designations of secondary units, which had been left to the rule making body, be included in the Bill.

DISCUSSION ON THE BILL

The Bill, as reported by the Joint Committee, was taken up for consideration by the *Lok Sabha*[8] on 8 December 1956. Although the Bill received general support, strong views were expressed on certain points. While one member, in particular, pressed very hard for reducing the period of change-over to 5 years, a couple of others wanted it to be increased to 20 years. There was demand that propaganda about the metric system should start immediately even before the Bill became an Act. There were suggestions for supplying conversion tables to schools, preparation of suitable text-books for students, making of helpful films for educating the public at large and preparing it for the great change. Comments were made on the co-ordination between the Centre and the States and the need for expeditious implementation by the latter.

Before the Bill was passed on that day, Shri Kanungo, winding up the debate, said, 'As put in by one of the speakers, there are no two opinions about the principles and purposes of the Bill. One thing that remains now is in regard to the organization which has to bring it into effect. We are very much conscious of the enormous efforts that have got to be made'. Continuing, he said, 'One honourable member had questioned the urgency and the necessity of this measure, while there are many other problems which could claim priority. I would merely remind him of my remarks in the earlier debate that we are changing over from a static agricultural and pastoral economy to an industrial age; and this is the time when we need this particular measure to hasten our progress in industrialization'.

About the speed of change-over, the Minister assured the House that the provision of 10 years in the Bill was the maximum considered by the Government, and that no efforts would be spared to have the conversion completed earlier, if possible. Although quickness of change was the essence of the thing, Shri Kanungo felt that 'taking all factors into consideration, the best was to stick to the time table'. He mentioned, for instance, the problem of conversion of maps and of manufacturing secondary and working standards. He said, 'Some relaxation was possible in the case of working standards, but for primary and secondary standards, a very high accuracy was required. Now the Mint and the ordnance factories were the only organizations which could ensure this accuracy. And though the ordnance factories are exploring the possibilities of utilizing their capacity to the fullest extent, even in these factories, certain new machines and equipment would have to be installed for the preparation of standards of length and measure'.

Regarding the implementation of the programme, Shri Kanungo informed the House that all the States had offered unstinted support. But he said that to implement the programme, trained personnel would be required. And this, he said, would be in 3 or 4 tiers: 'lower down, the inspectors, higher up, supervisory staff, and on top, highly trained technicians, who will give the basic guidance to this programme'. Besides this, he added, we would need a large body of administrators.

The Minister concluded by saying that the only statement he could make was: 'that there is a will for getting over these difficulties, and where there is a will, there is always a way, which can be found. As soon as the Bill is passed, we hope to convene a meeting of representatives of the States and work out the ways and means by which the programme can be implemented quickly and thoroughly'.

Six days later, the *Rajya Sabha*[9] passed the Bill with unanimous support of all sections of the House. And when, on 28 December 1956, the Bill became law, with the assent of the President of India, the world population which accepted the metric system as the basis of their weights and measures, suddenly rose by some four hundred million.

CONCLUSION

It was thus that the supreme Parliament took the final step to authorize the Government to adopt effective measures to go metric and stipulated 10 years as the period for the change-over in weights and measures. The first decision had been taken in April 1955 by adopting a resolution to introduce decimal currency and uniform weights and measures on the basis of the metric system. This was followed, a few months later, by an Act of Parliament amending the *Indian Coinage Act, 1906* to introduce decimal currency. And finally, a year later, at the end of 1956, the required legislation was passed to change-over to the metric system of weights and measures.

Thus, just nine years after Independence, the people of India, by placing these two enactments on the Statute Book, put an end to the controversy that had raged for almost a century in the country. And the credit for all that should go to one man and one man alone, Jawaharlal Nehru, who had it in him to be bold enough to say to his people what was good for them and their future, even though it would be full of difficulties. His part was not only confined to saying it, but also making it possible to accomplish that which some people had correctly felt was a 'huge thing' for a huge country.

The *Central Act of 1956* only enabled the Government to establish standards of weights and measures. The greater and more difficult job was the enforcement of the new standards. Both the content of the two legislations and the guidance provided by the Centre for adoption of consequential legislation by the States to enforce the new standards and other allied matters are discussed in the next chapter.

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Metric Legislation

R. C. S. Sarkar

India was put on the metric map of the world some thirteen years ago by the *Standards of Weights and Measures Act, 1956* and the *Indian Coinage (Amendment) Act, 1955*. Since then, though considerable progress has been made in the implementation of the scheme, the task is not yet complete. The problems which have to be faced in changing over completely to the metric system in all spheres of life, economic and scientific, are many and complex. The solution to these problems calls for imagination, administrative efficiency and the willing co-operation of the people. Various measures have already been undertaken to bring about this reform and some are yet to be taken. These measures cannot, however, be undertaken except under the authority of law, and legislation plays an important role in the process. Legislation is, after all, the formal and legal expression of a policy, and a survey of the history of legislation leading to the adoption of the metric system in India and of the laws, so far made in relation thereto, would be of great help. Such a survey is necessary for a proper appreciation of the policies pursued by the Government from time to time and of the difficulties involved in the implementation of the scheme. It would also be a guide in taking suitable steps for removing the difficulties inherent in any scheme of change-over and for a smooth transition to the new system.

India has been known from ancient times as the originator of the decimal and the place value systems. It is, however, surprising that the metric system, which was the logical extension of the decimal system to the practical field of weights and measures, was not adopted in India till 1956. The idea of making a fusion between the decimal system and the system of weights and measures first struck the people of France, and out of this fusion, the metric system was evolved. Though India has adopted this system only recently, the idea of introducing it has been under consideration for about a century.

HISTORICAL SURVEY

Although there was some uniformity in India in the standards of weights and measures in the remote past, there was, in recent times, a unique lack of uniformity in them and such lack of uniformity in a vast country like India led to the birth of considerable amount of malpractices in trade and commerce.

Although attempts at standardization of weights and measures were made from time to time during the past two thousand years, they did not succeed for a variety of reasons. When the British began to extend their control over India some two centuries back, they also keenly felt the need for achieving uniformity in the standards of weights and measures. However, they were very reluctant to disturb the existing social and economic practices. As far back as 1870, the *Weights and Measures Act* (*Act XI of 1870*) was passed for establishing the metric system of weights and length in British

India in preference to the British pound and yard. This Act was forwarded to the then Secretary of State for India for his sanction, but it was vetoed down by him because, in his opinion, the compulsory clauses of the Act were too severe and too extensive. A new bill was introduced in 1871 in conformity with the suggestions made by him, and in the same year, the *Indian Weights and Measures of Capacity Act, 1871* (*XXXI of 1871*) was passed. In March 1871, the Secretary of State, however, ordered that all the steps for enforcing the Act should be suspended till the matter was further examined. By 1875, the attitude of the Government of India underwent a complete change and the idea of introducing the metric system was given up and no notification was ever issued by the Government for bringing the Act of 1871 into force.

In 1889, the *Measures of Length Act* was passed which provided that the Imperial standard yard for the United Kingdom shall be the legal standard of measure of length for British India. This Act merely provided for a unit of length and no legislation was undertaken in regard to standards of weights till 1939. In 1939, the *Standards of Weights Act* was passed which established the standard grain as the primary unit of weight. It also recognized standard tola, standard seer, standard maund, standard pound, etc, as standard weights. This Act repealed the *Indian Weights and Measures of Capacity Act, 1871*, in so far as it related to the establishment of standards of weight. The Act of 1871, while it remained in the Statute Book till 1939, was a dead letter as no notification was ever issued under it and nothing whatsoever was done to carry out its purpose. No Act was, however, passed to specify standards of area, volume or capacity measures until 1956.

In 1946, the Indian Coinage (Amendment) Bill was introduced for the adoption of the decimal system of coinage. But this Bill was also allowed to lapse.

The legislative history of weights and measures in this country reveals a wavering and hesitant policy on the part of the Government till the achievement of Independence.

One of the important questions that came up before the Interim Government in 1947 was the introduction of the metric system in India and the principle was broadly accepted. Since then, the question had been under active consideration, but due to a number of reasons, the principal one being the partition of the country, it was not possible till April 1955 for the Government to take the decision to adopt the metric system*.

ADOPTION OF DECIMAL COINAGE

It was felt at the very initial stage that in order to make the metric system fully effective, it must be linked up with the decimal coinage. The first step towards the adoption of the metric system was, therefore, the introduction of the decimal system of coinage by the *Indian Coinage (Amendment) Act, 1955*. The *Indian Coinage Act, 1906*, which regulated the coinage in our country, recognized the rupee as the primary unit of currency, and coins were issued under authority of the Act in denominations of annas, pice and pies at the rate of 16 annas, 64 pice and 192 pies to the rupee. The Act of 1955 was a simple measure by which a new Section 14 was inserted in the Act of 1906 (*see* Appendix 6). Under this Section, the value of the rupee remained unaltered, but it was divided into 100 units, and the Central Government was empowered, by notification in the official gazette, to designate the new coin representing the new unit by such name as it thought fit. In exercise of this power, the new unit was designated by the Central Government as *naya paisa*[1], and subsequently, after the expiry of the period of transition in 1964, the world *naya* (new) was dropped from the name of the new unit and it was designated as *paisa*[2] (plural *paise*). That Section further provided that the rupee, half rupee and quarter rupee should be respectively equivalent to 100, 50 and 25 new coins and shall be legal tender in payment or on account accordingly. Section 13 of the Act which provides that the rupee coin shall be legal tender for any sum, the half-rupee coin shall be legal tender for a sum not exceeding 10 rupees and any other coin for any sum not exceeding one rupee was made applicable to new coins.

Since a sudden switch over to the decimal coinage was not possible, both from the practical as well as from the psychological point of view, old coins continued to be legal tender and remained in circulation during the transitional period till a notification was issued under Section 15A of the Act recalling the old coins, and

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*A detailed coverage of the historical background is given in Chapter 2.

they ceased to be legal tender. During the transitional period, when both the old and new coins circulated side by side, prices could be quoted in terms of either, and it was necessary to provide for the conversion of old coins in terms of new coins. In the nature of things, such conversion would involve fractions, and a provision had been made for the rounding off of fractions, when any new coins were tendered in any transaction. This rounding off did no doubt lead to certain difficulties, but they were inherent in any scheme of change-over from one system to another during the transitional period. Experience has shown that the transition from the old to the new system has been on the whole smooth and the new system is now working well and has been well received by the public.

ADOPTION OF METRIC SYSTEM

Decimalization of coinage was the precursor of the more complicated system of reform sought to be introduced. The underlying idea of adopting the new system was to have a uniform standard of weights and measures throughout the country based on the metric system. This system was introduced in India by the enactment of the *Standards of Weights and Measures Act, 1956,* on the 28 December of that year (*see* Appendix 3). This Act was amended twice, once in 1960 by Act 41 of 1960, and again in 1964 by Act 54 of 1964 and supplemented by *Standards of Weights and Measures (Extension to Kohima and Mokokchung Districts) Act, 1967.* The amendments related to certain changes in definitions in the light of international progress, recognition of more units, etc. The Act of 1956 is a short enactment consisting of 18 Sections and two Schedules only. The main purpose of the Act was to declare and establish metric units of mass and measures and to make those standards the sole standards of measurement in India. Other provisions of the Act are incidental in nature and are meant to remove the difficulties during the transitional period. Having regard to the distribution of the legislative powers between the Centre and the States, the enforcement of the Act is the responsibility of the State Government, and in view of the constitutional difficulty, it was not possible to incorporate in the Act provisions relating to its enforcement.

The Act was necessarily incomplete, but it could not be helped.

PRIMARY UNITS

Now, Sections 3 to 11 of the Act deal with the primary units. Sections 3 and 4 declare the metre and kilogram to be the primary units of length and mass. These units have been defined to mean the units of length and mass deposited in the International Bureau of Weights and Measures at Sèvres in France and kept there under certain specified conditions, and which were declared as the International Prototypes of the metre and kilogram by the First General Conference of Weights and Measures held at Paris in 1889. India adopted the international units of length and mass as primary units. This was the right thing to do, for, obviously, a country accepting the metric system should not adopt any derived or duplicate standards of its own, but should adopt the international standards. It was, however, recognized that there was need for maintaining a standard unit in our country with reference to which the various units of mass and measures in use may be verified. The Central Government was, therefore, empowered to get National Prototypes of the metre and kilogram prepared and have them certified in terms of the International Prototypes.

It is also pertinent to point out in this connection that the Act seeks to establish a unit of mass and not that of weight. As the weight of a substance may vary from place to place, it was not considered proper to establish a standard unit of a variable quantity. But as the expression 'weight' is generally used by the public, an attempt was made in Sub-section (4) of Section 4 to define weight also in terms of the primary unit of mass. Apart from the units of mass and length, the unit of capacity has been declared to be a litre under Section 11. Besides these, the Act defines ampere as the unit of electric current, Centigrade scale, otherwise known as Celsius, as the scale of temperature and candela as the unit of luminous intensity. The Act seeks even to define 'second' as the unit of time. By the Act of 1964, the definitions of metre and 'second' have undergone changes in accordance with the latest concepts of these terms. As the unit of length used in relation to navigation by sea or air is a nautical mile, it has been recognized as a unit of length for those purposes, though strictly speaking, it is not a metric unit.

In effect, the six units defined in the Central Act for length, mass, time, electric current, luminous intensity and temperature are the fundamental units of a system called the *Système International d'Unités* (SI), which was recommended by the *Conférence Générale des Poids et Mesures,* in 1960. The Central Act, when passed in 1956, was thus somewhat ahead of the advanced international thinking on the fundamental aspects of weights and measures. Opportunity was taken to give the latest definitions of some of these units whenever the Act was amended.

With the advance of science, greater precision in the definitions of fundamental and derived units becomes possible. However, in many cases, these definitions tend to be complex and lengthy, but this cannot be helped. In this Act, the units of weight and measure have been defined with scientific precision. The definitions cannot be simplified because the whole edifice of weights and measures is based on them, and science and technology cannot survive without precise weights and measures. The Act is scientifically oriented because it is intended not only to serve the needs of the man in the market place but also of scientists and technologists.

SECONDARY UNITS

The Act does not declare the secondary units. The choice of these units should be made keeping in view the interests of trade and commerce and the convenience of the public, and it may be necessary to choose them from time to time. In order to allow some amount of flexibility in their choice, it has been left to the Central Government to declare them by a notification under Section 12. It has, however, been provided that every such secondary unit shall be an integral power of 10 (positive or negative) of any one of the primary units. In pursuance of the powers conferred on the Central Government, it has specified the secondary units of length, area, volume, mass and capacity[3].

NOMENCLATURE

The Act of 1956, it may be observed, uses international names for all the units of mass and measure, while the Act of 1870 established seer as the primary unit of weight and gave it a value equivalent to that of a kilogram. There was a strong feeling among a section of the public that it would have been more appropriate, keeping in view the traditions of our country and the convenience of the general public, to use the existing Indian names like seer, and give them new values. Such a step would have merely created greater confusion because it would have added one more seer to the scores of seers that were in use in the country. Every country which has adopted the metric system has also adopted its nomenclature. Moreover, having regard to the fact that International Prototypes of the metre and kilogram have been declared to be our units of length and mass, the question of using any other terms for designating them hardly arises. In any case, the international terminology is very simple and easy to pronounce. These terms can also be absorbed in our language, and the introduction of these terms has not created any difficulty as they are easy to remember and easy to pronounce.

COMPULSORY USE OF METRIC STANDARDS: CONSTITUTIONAL ASPECT

The provisions of Sections 3 to 12 are merely declaratory in nature. These declaratory provisions, by themselves, are not very helpful. No doubt there are some countries where the metric system is merely permissive, but such permissive provisions would be of no avail here. No law was required to authorize the continuance of the existing confusion, nor the increase of it by adding one more category of weights and measures to the vast array that already exists. The law was needed to put an end to such confusion, and it was framed with that intention. Section 13 makes the use of metric units obligatory in this country and Section 18 seeks to repeal all the enactments in force relating to standards of weights and measures, whether they were enacted by the Central Government or State Governments. These two Sections read together would have the effect of making the metric standards the sole standards of measurements. Yet there are no provisions for the enforcement of the Act or for imposition of a penalty for any contravention of the provisions of the Act. The very essence of a law is in its sanction and in the absence of such sanction, the Act of 1956 is obviously incomplete.

Under entry 50 of the Union List, Parliament is competent only to establish standards of weights and measures, while under entry

29 of the State List, the actual implementation of these standards would be the responsibility of the State Governments. In view of the constitutional difficulties, it was not possible to incorporate in the Act provisions relating to its enforcement and it was necessarily incomplete. In order to get over these difficulties, it was proposed that entry 29 of the State List should be transferred to the Concurrent List. But no effect has yet been given to this proposal.

It was, therefore, the responsibility of every State Government to enforce the provisions of the Act, and to enact supplementary law for the purpose. The responsibility of the Central Government, in this respect, is rather limited. Under Section 15 of the Act, the Central Government has been entrusted with the duty of preparing reference standards and supplying them to State Governments. It is also their duty under Section 17, to make arrangements for their periodical verification and adjustment. With regard to commercial weights and measures, which cannot be expected to be as accurate as reference standards, the Central Government has been empowered under Section 17 to make rules for the limits of errors which might be tolerated in their manufacture or use. In pursuance of this power, the Standards of Weights and Measures Rules, 1958, were made by the Central Government[4] (*see* Appendix 4). Under these Rules, reference standards are prepared at the mints of the Central Government either at Calcutta or Bombay, and they are verified and certified in terms of the National Prototypes by the Director, National Physical Laboratory, New Delhi, before they are supplied to the State Governments. It is, however, the task of the State Government to enforce the proper use of commercial weights and measures and the success of this measure depends to a great extent on such enforcement.

TRANSITION PERIOD

The Act of 1956 which received the assent of the President on 28 December of that year did not come into force immediately. It was realized that the radical reform which was sought to be made could not be ushered in a vast country like India immediately. There were many difficulties. It was necessary to educate the people through publicity and propaganda and change the psychological climate so that they might willingly adopt the new system.

It was also necessary to allow time for the manufacture and production of standard weights and measures, and for making them available to the State Governments and to people engaged in trade and commerce. Again, it was essential for the State Governments to make laws for the enforcement of the Act before the new system could be effectively introduced. It was thus clear that the transition to the metric system should be gradual and according to a phased programme. While, in order to avoid any hardship, the transition should be gradual, a far too leisurely pace may defeat the very purpose of the reform. Section 1(3) of the Act empowered the Central Government to bring the Act into force by stages, but the maximum period of 10 years was provided for the complete adoption of the metric system. Having regard to the complexities involved in the process of change-over and the experience of other countries in this regard, it appears that a period of 10 years provided in Section 1(3) for the complete adoption of the metric system was neither too long nor too short. Experience during the last 10 years has justified this judgement.

Even when the metric units were introduced, it was permissible for the Central Government to allow the existing weights and measures to continue to be used for a period of three years. During the period of transition, when both the existing weights and measures as also the metric units were in use, it was necessary to provide for conversion of the values of the existing weights and measures in terms of metric units. Such conversion necessarily involved fractions, and this would, undoubtedly, have led to some difficulties. There was already some experience of the difficulties involved in converting old coins in terms of new coins. Here the problems were far greater. In order to avoid the difficulties in the matter of calculation, the Central Government was empowered under Section 17 to make rules in this behalf. The experience gained during the last 13 years shows that transition from the old system to the new system has been on the whole smooth and has also been well received by the public.

GRADUAL APPLICATION OF THE ACT

The transition to the metric system since its introduction in 1956 has been gradual and according to a phased programme. Initially, it was made applicable to transactions in well-developed markets and gradually it was extended to other transactions and to different classes of undertakings and goods and to different areas in the country.

It was brought into force in trade and industry for the first time on 1 July 1958 and was made applicable in relation to the purchase of raw jute and sale of jute products and in relation to the forward contracts in raw and manufactured jute[5], and on 1 October 1958, the Act was brought into force in selected areas, districts, cities and towns all over the country in relation to the goods specified in Notification No. SO 1250 dated 24 June 1958. Thereafter, different provisions of the Act were gradually brought into force and were made applicable to cotton textiles, iron and steel, engineering, chemicals, cement, salt, paper, coffee, non-ferrous metals, sugar, vanaspati, rubber, coir, paint, biscuits, soaps, drugs, fertilizers, tea, petroleum products, milk, tobacco and alchohol (*see* Chapter 11).

The various undertakings of the Government also gradually changed over to the metric system and for that purpose necessary legislation had also to be undertaken. The Railways changed over to the metric system on 1 April 1960[6] and for that purpose Standards of Weights and Measures (Conversion of Railway Mileage) Rules, 1959 were promulgated on 23 November 1959. The *Central Excise (Conversion to Metric Units) Act, 1960,* was passed on 20 September 1960 and the *Customs Duties and Cesses (Conversion to Metric Units) Act, 1960,* on 21 September 1960. Both the Acts were brought into force on 1 October 1960 when the Central Customs and Excise Departments changed over to the metric system[7].

With a view to enabling the Postal Department to change-over to the metric system, the *Indian Post Office Act, 1898* was amended in 1960. By that Amendment Act, the first schedule to the *Indian Post Office Act, 1898* was substituted by a new schedule in which the postal rates were specified in accordance with the decimal coinage and the metric units. Preliminary work in connection with the switch over to the metric system was completed after the passing of the Amendment Act of 1960 and the post offices switched over to the metric system on 1 February 1961 when the Amendment Act was brought into force.

The Act of 1956, as originally enacted, did not extend to the

State of Jammu and Kashmir nor to the Kohima and Mokokchung Districts of the State of Nagaland. It was extended to the State of Jammu and Kashmir by the *Standards of Weights and Measures (Amendment) Act, 1960,* and to Kohima and Mokokchung Districts by the *Standards of Weights and Measures (Extension to Kohima and Mokokchung Districts) Act, 1967.*

Today the Act extends to the whole of India. The metric system has not yet been made fully applicable to the State of Jammu and Kashmir or to Kohima and Mokokchung Districts of Nagaland. This would obviously take some time. But this new system has been made applicable to trade and commerce throughout the rest of India and also to major undertakings and the use of metric units has now been made compulsory by law. It is indeed a matter of gratification that the change-over to the metric system in the commercial world has been accomplished in a much shorter time than anticipated, and the change-over has, on the whole, been smooth and without much friction.

STATE LAWS: MODEL BILL

It has already been pointed out that the Central Act had a limited object only, namely, the establishment of standards of weights and measures, while it is the responsibility of the State Governments to enforce the provisions of the Act in accordance with the supplementary laws to be enacted by them. In the interest of trade and commerce, it is necessary that the State laws should generally be uniform, and with a view to achieving this uniformity, a model Bill was prepared by the Central Government and circulated to all the State Governments (*see* Appendix 5). The model Enforcement Bill seeks to enforce standard weights and measures in commercial transactions only. While the Central Act established standards for use in every field of human endeavour, including science, industry, technology, and in trade and commerce, the scope of the model Bill was restricted to the narrow field of transactions for trade and commerce only. This was the practical thing to do in the initial stages, as the common man is affected mostly by commercial transactions.

In order to avoid malpractices in commercial transactions, it is necessary to ensure that, in such transactions, correct weights and measures and weighing and measuring instruments are used. It has, therefore, been provided in the model Bill that no commercial weight or measure or weighing or measuring instrument shall be manufactured or repaired or sold except by a person who has obtained a licence for the purpose. These pieces of commercial equipment would then be verified and re-verified by an inspector in accordance with the rules, and they would also be properly stamped in the prescribed manner. The use of unstamped commercial weights and measures has been completely prohibited. These commercial weights and measures have to be verified with reference to working standards to be prepared by State Governments. The working standards have again to be verified against secondary standards which have also to be prepared by State Governments. The secondary standards, in their turn, have to be verified by comparing them with reference standards which will be supplied by the Central Government. A provision was, therefore, made in the model Bill for the preparation and custody of working standards and secondary standards and the custody of reference standards. Provision was also made for the prohibition of use of weights and measures other than the standard weights and measures. The model Bill also provides for penalties for contravention of the various provisions of the legislation. It also provides for appointment of various officers, Controller, Assistant Controllers, Inspectors, etc, for the administration of the Act and for checking malpractices. It also contains the usual incidental, supplementary and miscellaneous provisions.

The underlying idea of the Bill was to prohibit the use of any weight or measure other than standard metric weights and measures for which a specific provision was made. In order that no transaction may take place except under the metric system, a further provision was made that no person might quote prices or express any quantity otherwise than in terms of metric weights and measures. A difficulty of an entirely different character arises in the case of articles which are contained in a sealed package or container. In such a case, the consumer has no means of checking the accuracy of the contents as in the case of loose articles. Provision has, therefore, been made in the Bill that the package or container should bear on it the description of the net weight or measure of the article contained therein. It is not, however, possible to do so in many cases and the necessary exceptions have also been provided in the Bill.

When the Bill was circulated among State Governments, some of them raised objections. They were based partly on constitutional grounds and partly on practical and administrative considerations. The model Bill was discussed with the State Governments and all of them have now enacted legislation on the lines of the model Bill.

In the light of experience, the model Bill had to be amended from time to time to meet new situations or to cover lacunas discovered. While all such amendments were issued centrally after full discussion with the States, not all the States have incorporated them in their Acts. The result is that until the States do so, some provisions of the State Acts would not comply with the current model Bill. A few instances of such deviations arising from this fact are given below.

DEVIATIONS FROM THE MODEL BILL

A provision was made in the model Bill requiring every licensed manufacturer to submit a prototype of weights or measures or of weighing or measuring instruments to be manufactured by him for approval to the Government, and the Government had the right to reject the prototype or suggest suitable modifications therein. The intention underlying this provision was to achieve uniformity in commercial weights and measures not only throughout the State but also throughout India. No State Government could so far adopt this clause, mainly on the ground of practical difficulties, which are now being solved.

There was another amendment of the model Bill which prohibited any person from quoting any price or expressing any quantity of any article otherwise than in terms of metric weights or measures. This was a salutory provision to ensure complete change-over to the metric system. This clause has been adopted by only one or two States.

A provision had been made in the model Bill for special working standards to verify bullion weights and measures. It was, however, subsequently established that such standards were not indispensable. In view of the high cost of such standards and of the balances to be used with them, this provision was dropped from the model Bill. But this has not been done so far by the States of Assam, Andhra Pradesh, Bihar, Jammu and Kashmir, Kerala, Madhya Pradesh, Mysore, Orissa, Punjab, Rajasthan and Tamil Nadu.

The model Bill was intended to prohibit the use of any weight or measure other than standard metric weight or measure in any transaction for trade or commerce. Some of the States like Assam, Andhra Pradesh, Bihar, Jammu and Kashmir, Kerala, Madhya Pradesh, Mysore, Orissa, Punjab, Rajasthan, Tamil Nadu, Uttar Pradesh and West Bengal felt that the scope of the Bill should be widened to cover also any dealing and contract. This is a welcome improvement on the model Bill.

UNION TERRITORIES

India comprises not only States, but also Union Territories. They are administered by the President of India, acting to such extent as he thinks fit, through an Administrator who is appointed by him. Some of the Union Territories have legislatures of their own, but Parliament is competent to make laws for them. No Enforcement Law has, however, been enacted by Parliament in respect of any of the Union Territories. The object has been achieved by other means. In relation to the Union Territories of Delhi, Himachal Pradesh, Manipur and Tripura, the *Union Territories (Laws) Act, 1950* was applied in 1958. Under this Act, the Central Government is empowered to extend, by notification in the official gazette, to the Union Territories any enactment which is in force in a State on the date of the notification, with such restrictions and modifications as it thinks fit. In the case of Delhi, an Act — *Orissa Weights and Measures (Delhi Repeal) Act, 1958* — had to be passed by Parliament to repeal the *Orissa Weights and Measures Act, 1943,* which had been in force earlier. Manipur and Tripura have now passed Acts of their own.

The President has also powers to make regulations for the Union Territories of Andaman and Nicobar Islands, the Laccadive, Minicoy and Amindivi Islands, Dadra and Nagar Haveli, Goa, Daman and Diu, and Pondicherry, which have been exercised in the case of Andamans, Laccadives and Goa. For Pondicherry, the *Madras Weights and Measures (Enforcement) Act, 1958,* was made applicable, while the Bombay Act was extended to Dadra and Nagar Haveli. When, however, any legislature is created for Goa, Daman and Diu or Pondicherry, the President ceases to have power to make regulations for them. The Enforcement Law has been made applicable to Union Territories by various methods, either by a notification of the Central Government or by a regulation or by a local law of the legislature. All these laws are, however, based on the model Bill prepared by the Central Government.

The intention underlying the preparation and amendment of a model Bill was to have a uniform law throughout India. Though some changes have been made in the model Bill in its application to the States and Union Territories to suit local conditions, they do not alter the character of the Bill, and it cannot be disputed that the enforcement law applicable to all the States and Union Territories is, by and large, uniform.

STATE RULES

With a view to ensuring uniformity in the enforcement of the provisions of the State laws, the Central Government also prepared a model of the States Weights and Measures (Enforcement) Rules. These model Rules were generally adopted by all the State Governments and no difficulties were experienced in regard to this matter. These Rules deal with the preparation and custody of various standards and their verification from time to time, the licensing of manufacturers, verification and inspection of commercial weights and measures and various matters of detail. They also deal with specifications for numerous categories of commercial weights and measures and weighing and measuring instruments, as also other standards. More specifications are added as the work of preparing them progresses. Thus, while the model Rules contain the latest specifications which extend the Act to more and more weights and measures and instruments, the State Rules lag behind, if not amended quickly. It must be admitted that today very few State Rules contain the specifications given in the latest version of the model Rules, which sometimes leads to difficulties.

SURVEY OF WORKING OF LEGISLATION

All the State Governments have now enacted laws and made rules for the enforcement of the metric system. These laws naturally extend only to the territories of their respective States. Trade and commerce is not, however, confined to the boundaries of the State and we have to deal largely with inter-State trade and commerce. It is, therefore, of utmost importance that not only laws and rules made by the State Governments but also their enforcement practices should be uniform.

It has already been pointed out that under the Constitution, the sole responsibility for the enforcement of the metric system is that of the State Governments and the Centre has no legal powers in this behalf. In order, however, to achieve uniformity, the Central Government prepared a model Bill and also model Rules and the State Governments were persuaded to adopt them. In a dynamic society, and particularly in a developing country, law cannot remain static and the working of the State laws during the last few years has revealed certain difficulties and defects and they have to be removed. For this purpose, a legal Committee has been set up for a comprehensive study of Central and State laws and suggest suitable amendments. The State laws are now restricted to commercial transactions only and they have to be extended gradually to cover other important but very highly technical fields. What is more, both the Central and State laws have to be brought into line with the international practices recommended by the *Conférence Générale des Poids et Mesures* (CGPM) and the *Organisation Internationale de Métrologie Légale* (OIML). The recommendations of this Committee would not be binding on the State Governments and it would be necessary to persuade them again to accept the Committee's recommendations.

Uniform laws throughout the country are no doubt important, but uniformity in enforcement practices is also not less important. To achieve this object, a convention has been established by which the Centre co-ordinates the activities of the States in this field. The powers of the Centre in co-ordinating the activities of the States are, however, of an advisory nature.

There are a number of major problems of co-ordination for which no satisfactory solution has yet been found. One such problem relates to verification and stamping of weights and measures, when they are manufactured in one State and used in another State.

Under the present law, weights and measures and weighing and measuring instruments have to be verified and stamped by the authorities of the State in which they are used and not by the State in which they are manufactured. This has created a problem and after trying out various methods, it is now clear that the most satisfactory solution to this problem would be the recognition of the central verification and stamping of such weights and measures. This is not, however, possible because the Centre does not have the necessary legislative and executive authority to do so. In the absence of this power, a proposal has been made by the Centre that the State Governments should entrust this power to the Central Government under article 258A of the Constitution of India, which runs as under:

> 'Notwithstanding anything in this Constitution, the Governor of a State may, with the consent of the Government of India, entrust either conditionally or unconditionally to that Government or its officers, functions in relation to any matter to which the executive power of the State extends.'

Another such problem relates to the experimental determination of tolerances to be prescribed on the net contents of commodities sold in packages. A commodity, say, biscuits or baby food, may be packed in one State but would be sold all over India. The factories may be situated at different places in different States. The commodity would be packed during different seasons. The important point is, what is the quantity the consumer should get. Since the weight or measure of the packed commodity may be affected by the method of packing, method of transportation, shelf life, weather conditions, handling and various other factors, it is necessary to evaluate the influence of each such factor systematically and scientifically, and establish tolerances which would be permissible on the net weight or measure on each packed commodity. As such, a study cannot be undertaken by any State Government. It has been suggested that this work should also be undertaken by the Central Government, but it has no legal powers to do so. A proposal has, therefore, been made that the State Governments should empower the Central Government to undertake this work also under article 258A of the Constitution.

There are at present many such problems and more are likely to come up in future, which cannot be satisfactorily solved by the

Centre by mere persuasion or co-ordination of the activities of the States. What is required is that the Centre should have the necessary legal and executive authority to enforce the new system. This purpose can be achieved if entry 29 of the State List is transferred to the Concurrent List. This would enable the Centre to make uniform laws throughout India and also adopt uniform enforcement practices. At the same time, the States would also have power to undertake legislation to suit their local conditions. This would, however, require a suitable amendment of the Constitution and a proposal was made by the Centre to achieve this object but nothing has so far been done. It is not yet too late for the Centre to take up this question again and undertake suitable amendment of the Constitution to achieve uniformity not only in laws but also in enforcement practices.

ORGANISATION INTERNATIONALE DE METROLOGIE LEGALE (OIML)

It is not enough to have uniform laws and enforcement practices throughout India; it is also necessary to have a certain amount of uniformity in regard to these matters throughout the world. Without such uniformity, honest and reliable trade is not possible either in the national or in the international spheres. In order to achieve this object, an international organization (hereinafter referred to as OIML) was established under a Convention deposited for signature in Paris. India became member of this Convention on 4 October 1956 when the President of India signed the Instrument of Ratification. This agreement became effective on 28 May 1958. At present, there are 36 member countries, including India, besides 7 countries which are Associate Members (*see* Chapter 1). The Ministry of Commerce acts on behalf of India. The OIML is constituted of 3 bodies, namely, (1) The International Conference of Legal Metrology, which is the policy making body, and meets once in six years; (2) The International Committee of Legal Metrology (CIML); and (3) The International Bureau of Legal Metrology. The CIML is the executive body which meets once in two years. Its membership consists of one representative of each member country. The Bureau acts as the Secretariat of the OIML.

India is also a member of the Presidential Council which meets once a year and advises the President, OIML on matters to be discussed at the meetings of CIML and the International Committee.

The OIML studies the problems with regard to legal metrology from all angles and makes its recommendations thereon. The member countries of the organization are expected to give effect to the recommendations by undertaking suitable legislation in their respective countries. At the present moment, studies are in progress under the auspices of the OIML relating to various subjects, such as the preparation of specifications for various types of weights, measures and measuring instruments, the verification practices and the model international law on weights and measures. A special subject under study is the development of legal metrology in developing countries and the expeditious fulfilment of their requirement. India has to shoulder a major responsibility in this sphere, as it represents the developing countries in the Presidential Council. To pursue these obligations, India is participating in the work of 40 out of 70 Technical Committees set up by the OIML, and has taken up the Secretariat of one of the Committees relating to the standardization of equipment used in legal metrology offices. The work of the Secretariat is now gathering momentum.

The OIML has made several recommendations regarding standardization of weights and measures and maximum tolerances to be permitted in verification of weights and measures and weighing and measuring instruments; some of them were adopted provisionally by the Second International Conference of Legal Metrology held in October 1962. Experimental production of cast-iron and brass weights in conformity with the OIML recommendations is being carried out in the National Physical Laboratory of India. The specifications for permissible errors for various types of weighing instruments and specified in the OIML recommendations are being processed for incorporation in the enforcement laws.

Specifications for automatic weighing machines and totalizing machines, based on the work which is being carried on by the working groups of the OIML, have been provisionally adopted in India, while in the standardization of taximeters, considerable help has been derived from OIML specification which is now under preparation.

It is intended that in future, the specifications for various types of weights and measures and weighing and measuring instruments to be used in India would be modelled on the specifications which have been prepared by the various OIML Secretariats. Where such guidance may not be available, data will be collected from the member countries before any specifications are finalized. During the short period of its existence, the OIML has done valuable work in standardization of weights and measures.

Mention may be made here of the *Conférence Générale des Poids et Mesures* (CGPM) which India joined with effect from 1 January 1957 on the recommendation of the Standing Metric Committee. The necessity for the recommendation arose from the fact that it was necessary for India to acquire prototypes of the International metre and kilogram, as the metric standards proposed to be established by law were to be with reference to these prototypes and they are made available only to member countries. This international body was set up under the Metre Convention. The National Physical Laboratory in New Delhi represents India on this body (*see* Chapter 1).

CONCLUSION

A survey of legislation so far undertaken shows that though considerable progress has been made in the change-over to the metric system in commercial transactions, the task is not yet complete. It would be necessary to enforce the system gradually in other fields of industry and technology. Even in regard to commercial transactions, the problems which remain to be solved are enormous and complex. Lack of legal powers in the Central Government to enforce the new system has added to the difficulties. Inspite of the constitutional and legal difficulties, the Central Government is trying to achieve its object by persuasion and by offering its good offices in co-ordinating the activities of the States. India has achieved this object in a large measure; yet, much remains to be done. In order to ensure speedy and smooth transition to the complete adoption of the metric system, it is but right and proper that the Central Government should be vested with necessary legal powers by a suitable amendment of the Constitution. In the interest of economic and industrial development, India has to develop not only her internal markets but also her international market. In order that she might do so and occupy her rightful place in the metric world, it is also necessary that India should act in close co-operation with other countries of the world under the auspices of the *Conférence Générale des Poids et Mesures* and the *Organisation Internationale de Métrologie Légale.*

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5

Decimal Currency

M. K. Venkataraman

The history of Indian currency reform is replete with changes, but none of them is as revolutionary and epoch-making as the introduction of decimal currency. By simplifying the process of conversion, the change-over to new currency has facilitated accounting in the modern complicated system of trade and commerce. It has brought about a harmonization of money and non-money calculations, and, as a result, money calculations have become quicker, easier and less prone to error. The reform has led to substantial savings of time and effort in offices, banks, shops and schools. Though the benefits cannot be computed in money terms, they are undoubtedly large, spread over the entire economy, and of great practical significance.

HISTORICAL BACKGROUND

The reform had come none too soon. When the country was on the threshold of economic development and huge developmental expenditure was being envisaged in its Five-Year Plans, the time was opportune for launching a change in its currency system. Expert opinion in India had been advocating the introduction of decimal coinage for a long time. The first major step in this direction was taken as long ago as 1867. After extensive examination of the subject and a thorough consideration of the problem, the Government of India came to the conclusion that the decimal system should be adopted gradually in several stages. This decision led to the passing of the comprehensive *Metric Act of 1870*, which was subsequently modified by a new Act in 1871. For a variety of reasons, however, this Act remained inoperative, and it was repealed in 1939.

The break-through came in February 1946 when a bill was introduced in the Central Legislative Assembly with the object of introducing the decimal system of coinage by retaining the rupee as a standard unit and dividing it into 100 cents. However, owing to the impending political changes, the bill could not be pursued and it lapsed. As the interest in the reform was sustained, the Indian Standards Institution (ISI) appointed, in May 1948, a Special Committee to consider and report on basic standards for weights and measures for adoption in India. The Committee, after extensive consultation with practically all interests concerned, recommended that the decision of the Interim Government of India for the adoption of decimalized currency should be implemented as early as possible, as it would be an advantage if the adoption of decimal currency preceded the introduction of the metric system of weights and measures (*see* Chapter 2).

In April 1955, the Planning Commission made a similar recommendation that, as a first step towards the adoption of the metric system, a bill should be introduced in Parliament providing for the decimalization of coinage. The *Indian Coinage (Amendment) Act, 1955*, empowering the Government of India to introduce decimal coinage in the country was enacted as a sequel in September 1955. The provisions of the amended Act were brought into force with effect from 1 April 1957. The Government of India issued notifications indicating:

1) the date for introduction of decimal coins, namely, 1 April 1957;

2) the nomenclature of the new units;

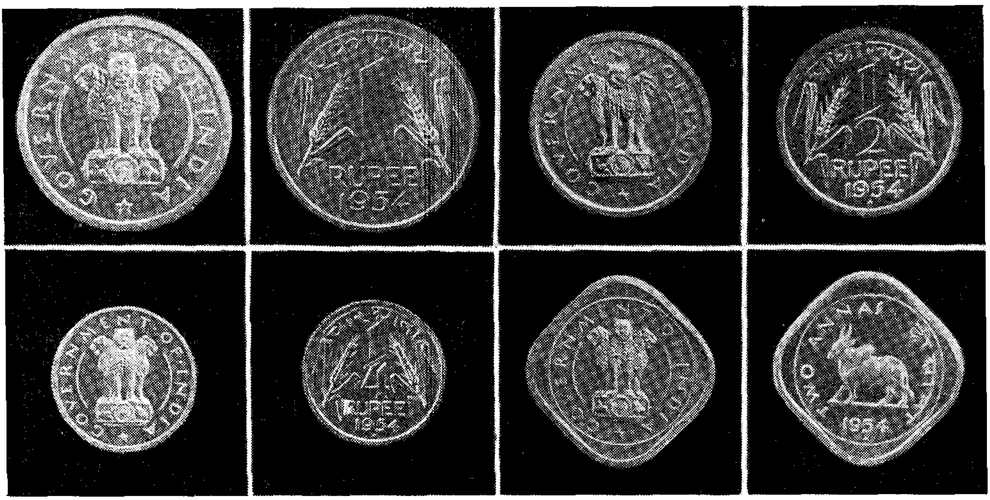
3) the denominations, designs, metal composition and dimensions of the new coins; and

4) the standard weights and remedies allowed in the making of the new coins.

COINS ISSUED

The rupee had hitherto been divided into 16 annas, and each anna into 4 pice (*paise*) or 12 pies. Under the new coinage, it was decided to divide the rupee into 100 units, and to name the new unit as *naya paisa* (plural *naye paise*), *naya* or *naye* meaning new, in order to avoid confusion during the transition period when the old *paisa* also remained in circulation. The most important and

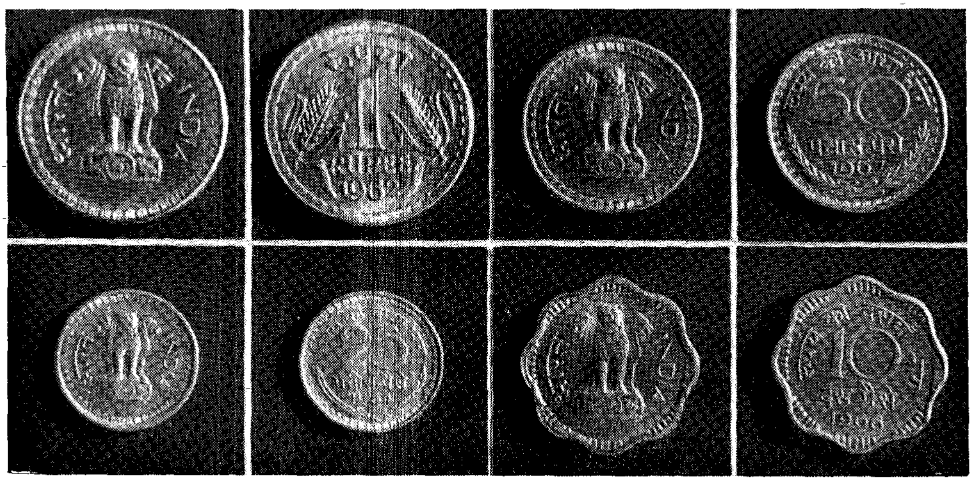
The two sides of the old coins of one rupee, half-rupee, quarter-rupee and two annas



The two sides of the old coins of one anna, half-anna and one pice

significant characteristic of the new system was that the rupee retained its original value. Between the rupee and *naye paise* there were to be five other coins of the value of 50, 25, 10, 5 and 2 *naye*

New coins of one rupee, 50 paise, 25 paise and 10 paise



paise to facilitate transactions in money and easy payment of sums less than a rupee, as the gaps in the decimal progression were inconveniently large. Now, the quarter and half-rupee coins in the old system had exact equivalents in value in the decimal system.

New coins of 5 paise, 3 paise, 2 paise and 1 paisa

Jawaharlal Nehru commemorative coins of one rupee and 50 paise

It was, therefore, decided that, to begin with, only coins of the denominations of 1, 2, 5 and 10 *naye paise* should be put into circulation, to be followed later by 25 *naye paise* and 50 *naye paise* and the decimal rupee (100 *naye paise*) coins. The latter three coins were issued on 1 December 1959, 1 November 1960 and 2 July 1962 respectively. To the series of decimal coins, a 3 *paise* coin (the prefix *naya* was dropped from 1 June 1964 after the old coins had ceased to be legal tender), was added from 1 October 1964.

The 3 *paise* coin does not fit into the decimal system. In a perfect system, the various units are arranged in multiples or sub-multiples of ten with reference to a standard unit, and there are no breaks or interpolations. But a rigid system is seldom observed and the countries that have adopted decimal coinage have departed from this rigid rule. In India, the issue of a 3 *paise* coin was decided upon to minimize the use of 1 *naya paisa* coins, the demand for which was so large that it was taking up nearly 42 percent of the productive capacity of the Mints. As the 1 *naya paisa* coin had very little purchasing power by itself, it was (and is still) being used mainly for providing the balancing change in transactions involving both decimal and anna-pie coins and also for transactions involving odd multiples of the 1 *naya paisa*, for which other suitable coins were not available. It was felt that the minting of 3 *paise* coins would reduce very appreciably the demand for 1 *naya paisa* coins for these purposes. As a few other countries, which had adopted the decimal system, like Cyprus and El Salvador, had also introduced odd denominations of this kind, it was considered that it might not be inappropriate on the whole to introduce a new 3 *paise* coin, notwithstanding the fact that it did not divide the rupee integrally.

DESIGN OF COINS

On the designs of the new coins, suggestions were invited from the public, but the response was not encouraging. The Coinage Design Committee, therefore, approved the designs prepared by the Bombay Mint. The design on all denominations consisted of the Lion Capital of the Asoka Pillar with the words 'Bharat' in Hindi and 'India' in English inscribed on the obverse face of the coins. The reverse side bore the year of coinage and the value of the coins in international numerals. In addition to the value, the number of such coins required to make up one rupee was also indicated on the coins. This practice has since been discontinued on the aluminium-magnesium 2 *paise* and 1 *paisa* coins now being minted. On the higher denomination coins, that is, the rupee, 50 *naye paise* and 25 *naye paise* coins, the Ears of Corn design also appeared on this face.

The three higher denomination coins had the same shape as the old rupee, half-rupee and $\frac{1}{4}$-rupee coins. All of them were round with serrated edges. The rupee coin was also security-edged. The shapes of the three next lower denominations, namely, 10, 5 and 2 *paise* coins were chosen keeping in view the Ceylon coinage, the 10 and 2 *paise* coins 8-scalloped and the 5 *paise* coin square, all with rounded corners. The 1 *paisa* coin was chosen to be of a round shape.

Particulars of weights, metal composition and dimensions of the various decimal coins in circulation at the beginning of July 1968 are given in Table 1.

FIRST STEP — ITS IMPLICATIONS

The change-over to decimal coinage implied the continuance of the existing system for a certain period until the old coins were completely replaced by the new ones. To facilitate the process of adjustment to the new coins, two decisions were taken at the time of their introduction. The first was that a sufficiently long period of transition during which both old and new coinage would be legal tender should be provided for, and the second, that by general rule of construction, for which provision was made in the *Indian Coinage Act,* as amended, all references to annas, pice and pies should be construed as references to the decimal equivalents in the new series rounded to the nearest decimal unit.

Any reform of such a revolutionary character should have wide acceptance in the country before it could be introduced. The country had, therefore, to be prepared for the reform. Even though public opinion in favour of the change had been crystallizing for some time past, the people had to be educated and the change brought about gradually without any inconvenience to the public. This was all the more necessary in a country like India where the people with a comparatively low level of literacy were accustomed through generations to the anna-pie system. The reform had, therefore, to be preceded by publicity and propaganda on a very extensive scale. All available media were utilized. A number of leaflets and brochures was printed and circulated widely. Propaganda through newspaper articles and advertisements, films and radio talks had also been undertaken months in advance, and continued even after the introduction of the reform to educate the people in what it meant to them and how it would affect the transactions in their daily life. It had been stated time and again that there would be petty annoyances to members of the public for a short while but this had to be viewed against the large and permanent gains which the country would derive from the reform.

Arrangements were also made to ensure that copies of the conversion tables showing the equivalents in new and old currencies were available all over the country for free distribution. In public transport vehicles, copies of such tables were displayed at prominent places so that no member of the public should find any difficulty in referring to it.

The educational system was also geared up to the new reform. The authorities had arranged for the incorporation in text-books of lessons in the new coinage to suit the different grades of pupils in schools. A handbook on decimal coinage was compiled for distribution among teachers. Innumerable sets of new coins mounted on cardboards were distributed to the State Governments, Community Development Blocks, etc, for purposes of demonstration. Such concerted efforts helped greatly in ensuring a smooth transition from the old to the new system.

DIFFICULTIES IN THE TRANSITION PERIOD

The change-over was, nevertheless, beset with many difficulties. They arose mainly on two counts, namely, double circulation and 'associability' of the two types of coins. As it would have been virtually impossible to demonetize all the existing coins, and to issue decimal coins in their place simultaneously, it was decided to permit the circulation of both types of coins for three years. This was found to cause some difficulties initially, particularly as there was no associability at the lower denomination stages.

TABLE 1 DESCRIPTION OF DECIMAL COINS IN CIRCULATION AT THE BEGINNING OF JULY 1968

COIN DENOMINATION	GROSS WEIGHT (g)	COMPOSITION (PROPORTION OF METALS)	DIAMETER (mm)	EDGE	SHAPE
(1)	(2)	(3)	(4)	(5)	(6)
Rupee Coin					
Pure Nickel	10·00	Nickel 100 percent	28	Milled and security edged	Round coin
Pure Nickel Jawaharlal Nehru Commemorative	10·00	do	28	Milled with a serrated or upright milling, the serrations numbering two hundred	do
50 Paise/Naye Paise					
Pure Nickel	5·00	Nickel 100 percent	24	Milled	Round coin
Pure Nickel Jawaharlal Nehru Commemorative	5·00	do	24	Milled with serrations numbering hundred and fifty	do
25 Paise/Naye Paise					
Pure Nickel	2·50	Nickel 100 percent	19	Milled	Round coin
10 Paise/Naye Paise					
Cupro-Nickel	5·00	Copper 75 percent and nickel 25 percent	23 (Outer)	Plain	Scalloped coin
5 Paise/Naye Paise					
Cupro-Nickel*	4·00	Copper 75 percent and nickel 25 percent	22 (Across corners) 19 (Across flats)	Square with rounded corners and unmilled rim	Square coin with rounded corners

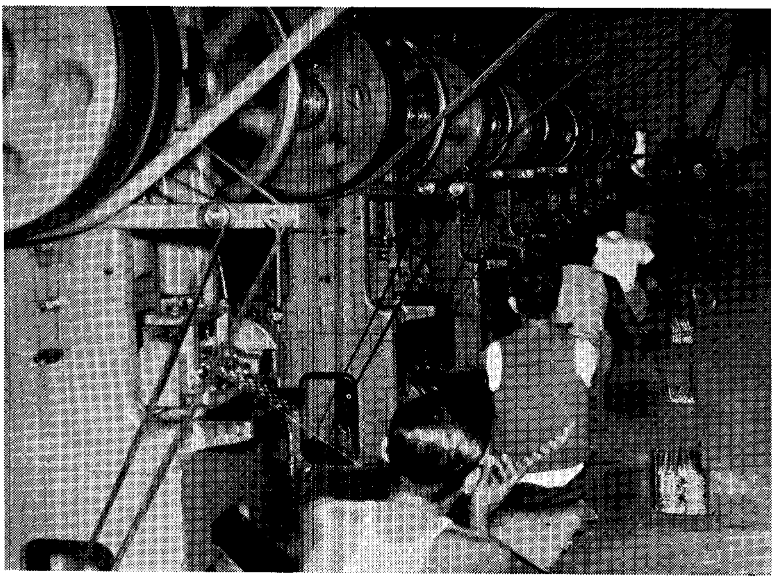
Aluminium	1·50	Aluminium with 3·5 to 4 percent magnesium	do	do	do
3 Paise					
Aluminium	1·25	Aluminium with 3·5 to 4 percent magnesium	19·50 (Across flats) 21·00 (Across corners)	Plain	Hexagonal shape with rounded corners
2 Paise/Naye Paise					
Cupro-Nickel*	3·00	Copper 75 percent and nickel 25 percent	18	Plain	Scalloped coin
Aluminium	1·00	Aluminium with 3·5 to 4 percent magnesium	20·00 (Outer)	Plain	do
1 Paisa/Naya Paisa					
Bronze	1·50	Copper 97 percent, zinc $2\frac{1}{2}$ percent and tin $\frac{1}{2}$ percent	16	Plain	Round coin
Nickel-Brass	1·50	Copper 78 to 83 percent, zinc 17 to 20 percent and nickel 0·9 to 1·4 percent	16	Plain	do
Aluminium	0·75	Aluminium with 3·5 to 4 percent magnesium	17·00 (Across corners) 14·70 (Across flats)	Plain	Square coin with rounded corners

*The issue of these coins has been discontinued.

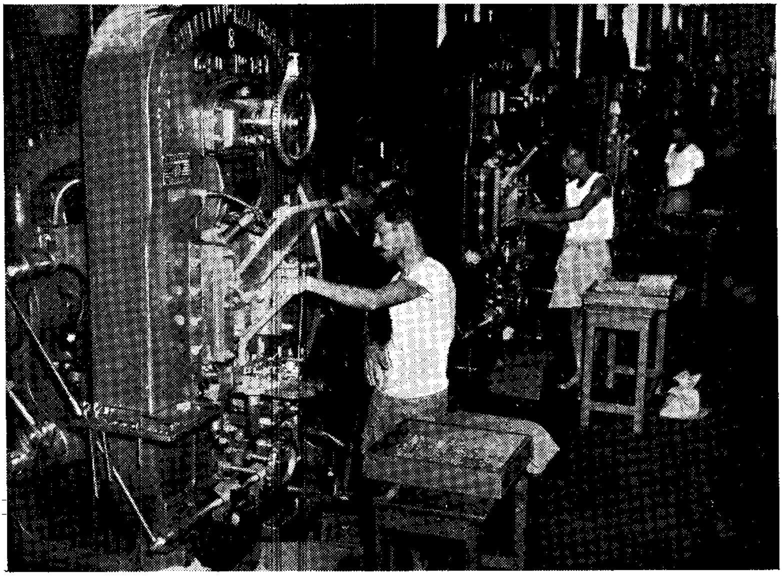
Thus, below 4 annas, and except in multiples of 4 annas, it was difficult to arrive at the exact equivalent of the anna-pie coins in decimal coins. This difficulty, however, disappeared, when the new decimal coins up to the denomination of ten *naye paise* (on the production of which the Mints were concentrating in the early years of the reform) began to replace the corresponding coins up to the denomination of two annas in the anna-pie series.

MINTING AND SUPPLY PROBLEMS

Due to the changes in the shape, design and weight of the coins, the Mints faced a tooling-up problem. But having foreseen the changes that were envisaged in the coinage, the tooling-up had begun in the Mints nearly two years ahead. The Bombay Mint, which supplied matrices, working punches, drifts and master cams to other Mints, was ready with the basic material that was required for the minting of the new coins. As the new coins were to be produced from the same metal, which was used for the production



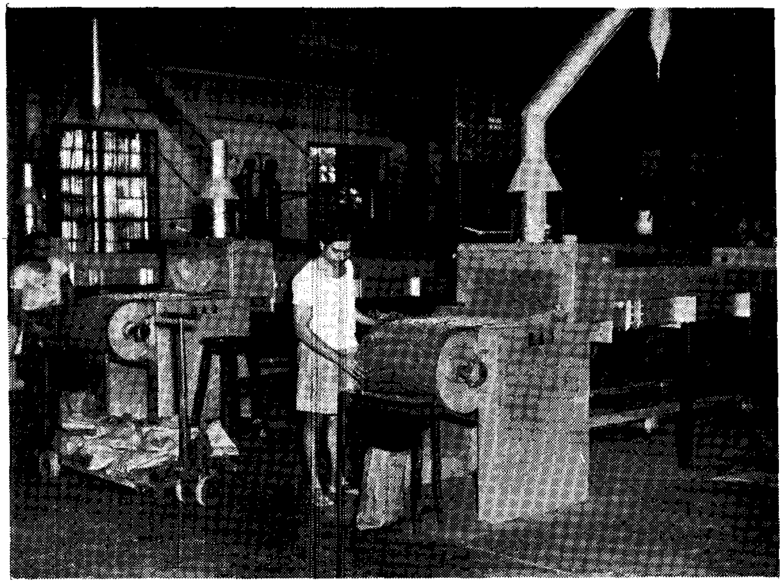
A row of machines punching coin blanks



Stamping presses in action

of their predecessors, there was no problem as far as the melting technique was concerned. The former machines (on which dies and collars are cut to shape) in the Die Department had to be fitted with new cams for shaped coins. These cams had to be duplicated from the master cam and new drifts had to be prepared to obtain 100, 150 and 200 serrations on the collars for 25 *paise,* 50 *paise* and 1 rupee coins respectively. New security edging dies had also to be made for the rupee coin. All the operations of rolling and blanking had to be done in conformity with metric weights and instruments, and by labour which was not familiar with the metric system. The feed fingers and the tubes of the coining presses had to be changed to suit the new shapes.

During the first decade of decimal currency in the country the Mints had also to face certain production problems. The main metals used for the minting of coins were nickel and copper, both of which were being imported. In order to conserve foreign exchange, it was decided that the 3 *paise* coin, introduced in 1964,



Washing and polishing of coins in progress

would be minted in a new alloy of aluminium and magnesium. Subsequently, this alloy has been used for the minting of other lower denomination coins also, namely, 5 *paise,* 2 *paise* and 1 *paisa* coins. The change in the metal composition of the coins necessitated changes in the melting techniques to which the Mints were accustomed. They met the challenge successfully without hampering production in any way.

The problem of supply of the new coins to the issuing authorities was no less important. Since the issue of the new coins had to be commenced simultaneously on the appointed day at all offices of the Reserve Bank, treasuries, sub-treasuries and branches of the agency banks of the Reserve Bank, which numbered in all about two thousand, an adequate stock of coins had to be made ready sufficiently before the appointed day and despatched to the various banks, treasuries, etc, in time, The requirements of Government departments which were asked to indent for sufficient quantity of decimal coins so as to start dealing in them on 1 April 1957, were also to be met.

The new and old series of coins continued to be legal tender till 1964 by which time the old coins were gradually being withdrawn from circulation. The withdrawal of old coins and the growth in the economy of the country led to an increasing demand for the new coins. To cope with this demand the three Mints at Alipore (Calcutta), Bombay and Hyderabad were put on overtime work and required to mint the new decimal coins only.

As the influx of withdrawn coins into the Mints was very large, their Un-current Coin Departments had to be geared up to receive the bulk of withdrawn coins. Due to paucity of vault space, the stocking of those coins posed a problem in the initial stages.

INITIATIVE BY GOVERNMENT

Having launched on a reform of such a magnitude, it was but natural for the Government to take the first step in switching over to decimal currency for all its transactions. Instructions were issued to all the Ministries and Departments of the Government of India, State Governments, Union Territory administrations and public sector undertakings to change-over to decimal currency on the appointed day, that is, 1 April 1957. Payments by treasuries, Government departments, etc, were to be made only in new currency, except when they ran short of it. Non-postal stamps of over 300 varieties and denominations, such as revenue stamps, entertainment tax stamps, copying fee stamps, issued by the Central and State Governments had to be re-issued in terms of decimal values in consultation with the State Governments concerned.

The adding, accounting, calculating and other business machines in use in the various Government departments, banks and business establishments had to be converted to the decimal system. Discussions were held in the beginning of 1956 with the concerned Ministries and suppliers of the machines, and the various problems involved in the change-over were examined. An inventory of the machines in use in the country was made and facilities were afforded to the suppliers to import spare parts necessary to convert the existing machines, to re-export unsold surplus machines and to import new machines suited to the decimal system, when the older machines could not be converted and had to be replaced. All these and allied problems had to be tackled with patience and precision, in consultation with the various authorities and suppliers concerned. As there was general enthusiasm for the reform, all these matters were satisfactorily settled, though not always in time. The administrative arrangements were completed well in time and there had hardly been any bottlenecks in the smooth progress of the reform from the date of its introduction.

The Government had to take further steps to complete the reform, the issue of new coins being only the first step in it. It had originally been envisaged that the transition period would be only three years, during which the coins in the anna-pie series would be withdrawn from circulation in a phased programme of demonetization. However, it took nearly seven years after the introduction of the decimal coinage to complete the process of demonetizing the old coins which started on 1 January 1959, when the nickel-brass 2-anna, the half-pice and the pie coins ceased to be legal tender. This was followed by the demonetization of the nickel-brass one anna and half-anna coins from 1 January 1960, and of the cupro-nickel 2-anna and half-anna coins from 1 October 1960. No more steps were taken for the next about three years, as there was a phenomenal increase in the demand for small coins due to the development of the economy of the country, and the Mints were hard put to meet this rising demand. The process of withdrawal of the old coins which did not have exact equivalents in the decimal series came to an end on 1 January 1964, from which date the cupro-nickel one anna and the copper and bronze coins were demonetized. The old anna-pie coins are, however, still exchangeable at the offices of the Reserve Bank of India, but they have for all practical purposes ceased to be in circulation otherwise.

To quicken the pace of withdrawal during the transition period, the Reserve Bank requested banks, treasuries and sub-treasuries not to resort to issue of anna-pie coins as far as possible.

The process of conversion to the decimal system was officially declared to be complete, when the *Indian Coinage Act, 1906*, was further amended with effect from 1 June 1964, so as to drop the words *naya* and *naye*. Decimal coinage had then been in existence for a little over seven years. In actual practice, it had come to be quite well-established in about three years as originally envisaged.

IMPACT ON BANKING AND FINANCIAL INSTITUTIONS

The banking system in the country had also to attune itself to the new reform. Because of the general rule of construction by which all references to rupees, annas and pies were construed as references to the new decimal coins, all accounts in the banks and financial institutions were to be maintained in the new currency with effect from 1 April 1957. As the banks had a very large number of individual accounts the balances of which had to be converted into decimal currency from that date, it was found necessary to declare 30 March and 1 April 1957 as public holidays (31 March being a Sunday) to enable the banks to attend to the task of conversion. The registers, forms, etc, till then in use, had to be adapted to the new system. It was, however, decided that the existing forms could be used, wherever possible, with suitable modifications so as to minimize wastage and loss.

The banking institutions in the country were among the first champions of decimal system, because it simplified accounting and brought about enormous saving of clerical labour in calculations. Nevertheless, in the transition period, the banks and other financial institutions did encounter difficulties mainly because of double circulation and the absence of associability, except when coins were tendered in multiples of 4 annas. In the initial phase, when both coins circulated, there was some additional work for the employees at the cash counters, but with the demonetization of anna-pie coins this workload was considerably reduced.

LOSS OR GAIN ON ACCOUNT OF CONVERSION

Owing to the absence of complete interchangeability, the conversion into the new currency units of the old ledger balances or other amounts due to or payable by various Government authorities, which were expressed in annas and pies, involved a net loss or gain on account of the rounding off in accordance with the provision of the *Indian Coinage Act, 1906,* as amended. Likewise, any receipt or payment in the new units against balances or amounts expressed in the old units or *vice versa* involved a loss or gain. For example, there could be losses when the cashier received two pieces of 3 pies in settlement of two dues involving 2 *naye paise* each, because when taken together the two quarter-anna bits accounted for only 3 *naye* *paise* and not 4 *naye paise* as recorded in the books. Similarly, if two 2-anna bits were tendered in satisfaction of two dues of 12 *naye paise* each, the receiving cashier would have in fact received 4 annas or 25 *naye paise* as against a recorded receipt of only 24 *naye paise*. The treatment of such losses or gains in Government accounts was simple. Under the instructions issued by the Comptroller and Auditor General in November 1956, the differences were brought to account under 'Loss or Gain on Conversion to Decimal Coinage in Section T — Deposits and Advances Part IV — Suspense'. As regards non-government institutions, particularly banks, it was provided that the receiving cashiers should maintain a subsidiary register indicating the amount of old coins received by them in each transaction so that at the end of the day, the net loss or gain could be known and suitable adjustment made. The loss or gain was to be treated as loss or gain of the institution. By and large, the loss and gain cancelled each other in the long run.

LEADERSHIP OF COMMERCIAL DEPARTMENTS

The commercial departments of Government led the way in implementing the reform without any let or hindrance, and their contribution to the smooth transition is praiseworthy. In the Postal Department, it became necessary to determine all the postal rates and charges in terms of *naye paise* consequent to the introduction of decimal currency from 1 April 1957. Otherwise, the rates would have stood converted into the decimal coinage to the exact equivalents with all fractions involved by the general rule of construction embodied in the *Indian Coinage Act*. Such rates with fractions would have created administrative problems and confusion all round. Hence it was decided to determine the rates and charges in decimal coinage. The tariff was fixed keeping in view the principle that there should be an approximate equivalence between the new rates and the old rates. Slight deviation had to be made in certain cases for the purpose of making the calculations easy and for ensuring that there was no loss to the Department as a result of this measure. Thus there was a slight increase in the rates of postage in some cases, and slight decrease in other cases, as it was not possible to regulate the rate on the basis of the conversion table, which would have meant a reduction in the revenues of the

Department. To give effect to the revised tariff, the first schedule to the *Indian Post Office Act, 1898*, was amended.

As a result of the fixation of the new tariff in decimal coinage, a new series of postage stamps and stationery bearing values in terms of *naye paise* had to be introduced from 1 April 1957. Steps were taken well in advance to stop the further printing of stamps in anna-pie series. The stamps and stationery lying in treasuries and sub-treasuries had been collected with a view to regulating fresh supplies, re-distribution of stocks and effecting sales through post offices in such a manner as to ensure that stocks were reduced to the barest minimum possible. However, the stocks left over on 31 March 1957 could not be withdrawn from about 500 treasuries and 60 000 post offices spread all over the country and destroyed or over-printed without creating administrative, financial and organizational difficulties. Neither could the old stamps and stationery be issued as such, as their values stood converted to their equivalents in decimal currency with all the fractions involved, and the principle of rounding off under Section 14(2) of the *Indian Coinage Act* could not be applied to them. The withdrawal and demonetization of the old stamps was considered, but it was found impracticable administratively as it would have required the setting up of an elaborate organization at a considerable cost, and enormous practical difficulties would have had to be faced. The value of the stocks to be withdrawn or destroyed also ran into several hundred thousands.

In order to solve this problem, the Indian Post Office Rules, 1933, were modified under the powers bestowed in the *Indian Post Office Act, 1898*, and a notification was issued whereby it was stipulated that the old stationery would be priced on the basis of the new postage rates and that each denomination of stamps should correspond to the new denominations of stamps under the decimal series. For instance, the rates for the letters being 13 *naye paise* (13 nP), the 2-anna embossed envelope was priced at 13 nP. These orders led to some difficulties and complaints from the public in a few cases, as some people refused to pay 13 nP for a 2-anna embossed envelope, since they felt that it should have been sold at 12 nP on the basis of the conversion table. This apparent anomaly was inherent in the change-over. However, it was finally decided on

10 April 1957, to stop the sale of postage stamps and stationery in the anna-pie series. The stocks of those stamps except of 4 annas, 8 annas, 12 annas and Re 1 denominations were subsequently ordered to be utilized as service stamps at the denoted values.

The new rates of postal tariff were fixed in terms of weight units in tolas. They were redetermined later in terms of the weights in the metric system (grams and kilograms), and the new rate structure was introduced with effect from 1 February 1961, after amending the first schedule to the *Indian Post Office Act, 1898* again.

The Postal Department continued the prevailing rates on the telephone side temporarily in view of certain special difficulties involved. Great inconvenience was felt in the Telephone Revenue Accounting Offices in the matter of preparing Trunk Call Bills, which were prepared on Remington Accounting Machines fitted with RA or Z type totalizers capable of working rupees and annas, or rupees, annas and pies respectively. As these totalizers had sufficient capacity of taking the totals of bills even if columns for recording annas and pies were ignored, it was decided that all the existing accounting machines and National Cash Register Machines should be used according to their capacity by not operating the keyboard relating to annas and pies, in which case the decimal was to be written in manuscript after the first two right hand digits. The old headings containing columns for rupees and annas were changed by a rubber stamp affixed to bring out the correct position. This practice continued till either the totalizers of the existing machines were replaced or some new machines were purchased.

The process of conversion of the rates to decimal currency according to the conversion tables retarded the speed of operation in the Revenue Accounting Offices and resulted in accumulation of arrears. Besides, it led to large disparities between the actual and converted charges. For example, by fixing the trunk telephone charge for unit call at Rs 1·19 which was the equivalent of one rupee three annas, the half rate charge had to be Re 0·59, instead of Re 0·62, which was the decimal equivalent of the old rate of 10 annas. The losses were greater in the case of calls of longer duration. The charges for trunk calls were, therefore, refixed in decimal coinage at their exact equivalents with certain changes so as to bring about simplicity in collection, while ensuring that they were not appreciably higher than the previous charges. The revised charges were brought into effect from 1 October 1959.

The decimal coinage was introduced over the Indian Railways in stages. The passenger fares were notified in decimal currency from 15 September 1957. The fares in force prior to that date were converted according to the conversion table. The rates for other coaching traffic were notified in decimal coinage from 1 October 1958. The goods rates were also decimalized from that date. In the new freight structure introduced from 1 October 1958, the freight rates for goods traffic were expressed in decimal coinage. The railway authorities had to undertake a heavy programme of preparatory work in refixing the rates and fares in terms of the new coinage and reprint their calculation tables for distribution throughout the country. All this, however, did not present any difficulty and the change-over was smooth.

COMMON MAN'S PROBLEMS

There has never been any nation-wide reform in any country without inconvenience or annoyance to some section or other of the community. The introduction of decimal currency also caused mild irritation and some inconveniences to the common man but they were never such as to dislocate business to any noticeable extent in any part of the country. The problems arose on three counts. Firstly, in the early stages, the average illiterate man or woman was not sure of the rate of conversion and was easily duped by the trader. Secondly, as the two sets of coins were in circulation, it always turned out that there was some loss in respect of payments as well as receipts. Thus, if one did not have sufficient decimal coins, one had to pay in anna-pie coins resulting in some marginal gains to the shrewd trader. So also, when one received the balance from the trader, who invariably had sufficient stock of decimal coins, there was some manipulation at the cost of the recipient. In many cases, the prices of the articles had no exact equivalents in decimal currency and they came to be fixed a little higher than the exact equivalents in the conversion table. Thirdly, owing to the switch over, there were also initial delays at the counters and long queues were found at postal windows, bank counters and other public places.

Another complaint heard initially was that the new coins were far weightier than the old ones. This complaint had been met to some extent by the substitution of aluminium for cupro-nickel coins in the lower denominations. It had died down with the disappearance of anna-pie coins.

ADVANTAGES OF DECIMAL CURRENCY

Nevertheless, the reform has been well received. It has now come to stay as a permanent measure on the Statute Book and in the minds of the public at large. Its strength lies in its inherent advantages. They flow from the ease with which the relationship of the various coins can be computed and the convenience of arithmetic manipulation of stating sums of money as multiples, tenths and hundredths of the unit of account. These advantages have led to a simpler and more expeditious accounting and an appreciable economy in time and effort in educational, banking and financial institutions. There is no easy way of expressing the savings in money terms, but it can be said without any hesitation that they have more than offset the cost of the change-over. The cost has not been prohibitive in India as it took to decimal currency before economic development had reached an advanced stage, involving the mechanization of accounting. Whatever the cost, the reform is so beneficial that the present generation will ever be remembered for the bold step it took in breaking the age-old tradition and ushering in a change of such magnitude and importance.

EPILOGUE

This reform is well suited to the genius of India. As is well-known, the decimal system of notation was born in this country. By the beginning of the Christian era, Indian philosophers had begun to use a special system of their own for indicating numbers. They gave a symbol to each of the numbers one to nine and also to zero, instead of using a symbol to represent a particular number, as the Romans did. Each symbol received a value of position as well as an absolute value. As Laplace (1749-1827), the brilliant mathematical astronomer, would have it, this ingenious method is 'a profound and important idea which appears so simple to us that we ignore its merits, but its very simplicity, the great ease which it has lent to all computations, puts our arithmetic in the first rank of useful inventions'. Having progressed thus far, it is unfortunate that India did not carry the 'decimal system' to its full practical use. It is good that she has adopted this system in toto at least now. 'Better late than never' is a useful motto. □

6

Strategy for the Change-Over

K. V. Venkatachalam

Since Independence twenty-two years ago, India has been attempting to carry out reforms in many fields — social, political, educational, agrarian, industrial and so on. One of the reforms which has been given effect to rather unobtrusively is the adoption of the decimal currency and the metric system of weights and measures. Yet, it has been a reform of basic importance with the widest incidence touching on every aspect of day-to-day activity in the country. Considering the magnitude of the task involved, the implementation of this reform can be said to be quite a significant achievement.

The decision taken by the Government of India in 1955 to decimalize the coinage and to adopt the metric system of weights and measures was a bold and imaginative one, a decision which required — beyond a study of facts — clear vision, deep insight and intuitive wisdom. The facts and the figures, and the arguments for and against, were all there in the numerous reports, notes and memoranda compiled over many years (*see* Chapters 2 and 3). But what was needed was a clear and firm decision to make the change by an authority which had popular backing and an intellectual commitment to follow up the decision and see the change-over through. This was provided when, under the inspiring guidance of the Late Prime Minister Shri Jawaharlal Nehru, the Government of India and later, Parliament accepted the view that notwithstanding all the difficulties and complexities, the balance of advantage lay in adopting the metric system, and that too without delay. In taking this decision, India has been luckier than many other countries which are still in the process of cataloguing the problems and difficulties of transition and computing the probable costs. One circumstance which favoured India was that the country was just on the threshold of industrialization. The adoption of a new system of measurement would obviously be far more arduous and expensive to a highly industrialized country than for one on a lower rung in the ladder of development. India undoubtedly saved millions of rupees by taking the decision to change-over to the metric system in 1955, instead of a decade later.

That it was by no means an easy or a facile decision, would be clear when one realizes the magnitude of the task of the change-over. India is a vast country and in the use of weights and measures, there was immense diversity — a diversity, one could almost say, bordering on chaos. A sample survey revealed that there were about 150 different systems of weights in use in different parts of the country. Even when the same nomenclature was used, the actual weights differed. For instance, more than 100 kinds of maunds (weight unit) were in use ranging from 280 tolas* to 8 320 tolas in weight as compared to the standard maund of 3 200 tolas. Many of the practices were tradition-bound. There were powerful entrenched

*1 tola = 11·664 grams.

interests who were exploiting these traditional practices to their own advantage. For example, in certain areas and in certain kinds of transactions, the unit of weight, say, the seer or the maund, had one value when the trader purchased the commodity from the producer and another value when he sold it to the consumer. In both the transactions, it was the trader who benefited; and these practices had been halœd by long years of use. Over and above these, there were different levels of literacy and sophistication, from the wholly illiterate to the highly educated. The problem was, to make these people with varying reactions to the new reform, to accept it on the basis of a reasoned explanation of its benefits, to the individual, in the first instance, then to the group and finally to the country as a whole.

It was realized that the implementation of the reform would be an extremely complex undertaking. It was clear that for the task to be tackled in a systematic way, it was essential to mobilize the assistance of all the interests concerned and to associate with the implementation of the change-over, the several Central Government departments, State Governments, scientific and technical bodies, such as the Indian Standards Institution (ISI) and the National Physical Laboratory, representatives of trade and industry and those of the ordinary consuming public. A Central Metric Committee under the chairmanship of the Union Minister for Commerce and Industry* was established to lay down policies in consultation with the various sectors mentioned above. A small working cell was constituted to service this Committee. This working cell was really the executive body entrusted with the overall responsibility for carrying through the programme. When the Metric Committee commenced working, it found there were few guidelines to help it in its huge task. Except for three or four States like Bombay, Bihar, Punjab and Hyderabad, there was no systematic regulation or control of weights and measures in the country. In the States other than these three or four, there was no organization for checking weights and measures used by the trade. In other words, in

*The Ministry of Commerce and Industry was later split into two separate Ministries, one of Commerce and the other of Industry. The latter is now called the Ministry of Industrial Development, Internal Trade and Company Affairs.

greater part of the country, there was no awareness or consciousness of either the need for a unified system of weights and measures, or the fact that a healthy working of the country's economy called for a proper regulation of weights and measures. In order to understand the various aspects of the problem and to draw up a broad and tentative working programme (which could thereafter be the subject of detailed examination and further discussion), the first step that was taken was to have a series of discussions with the various Central Government departments, State Governments and representative bodies of trade and industry. The Central Government departments, the State Governments and trade and industry associations were, in their turn, requested to set up similar committees for examining the problems involved, with small executive cells to service them.

Two important decisions of principles were taken at a very early stage of the programme. The first was the decision that the ten-year period for the change-over to the metric system would be taken to apply to commerce and trade and to the normal day-to-day activities of the public, and not to the field of industrial activity and techniques and processes of production in factories. It was realized that the complete change-over to the new system in industrial production would be highly complex, involving extensive re-designing. To force the pace of change in this field would involve scrapping of costly machinery, resulting in prohibitive expense and might even retard the tempo of India's growth and development in the short-term. It was, therefore, agreed that each industrial plant in the country would draw up a programme for the change-over depending upon its complexity and having regard to the optimum benefit from the point of view of cost, and adhere to it, even though the period involved was more than ten years.

The second decision related to the nomenclature of the new weights and measures. There was a strong lobby which desired that the country should have Indian names for the various metric units, namely, tola, seer, maund, etc, with the prefix *naya* (new), in place of the corresponding metric weight, capacity and length measures. Here again, the decision to adhere to the international nomenclature was a courageous one, and judging from the result, proved to be the correct one.

Any change which involves a large effort is bound to meet with resistance, particularly from those who have to make the effort. The reform of weights and measures was no exception. In this case, as mentioned above, the metric system sought to change people's attitudes encrusted over by the traditions of long centuries and it was not a surprise that the first general reaction of the public was intense scepticism that the reform was unpractical and could not be put into effect. There was a large body of opinion that the many and different systems of weights and measures to which people in this vast country had been accustomed for many hundreds of years could not be superseded. Past experience supported them in this view. Enactments to standardize and regulate weights and measures which had been placed on the Statute Book from time to time in earlier years were instances in point; they failed to strike roots. This attitude of scepticism pervaded not only the general public and the people engaged in trade and industry but also administrators, whose responsibility it was to implement the change-over. Thus, the first formidable task was essentially a psychological one — to change the minds of men.

I recall that when I made my first round of visits to meet the officials of the State Governments, the reception to the idea was uniformly indifferent. Some of the experienced administrators even chose to treat the idea of the change-over as a joke and tried to laugh it off. They said that the law was there no doubt, but not all laws were enforced. A few months later, when the author made the second round of visits to the States, some of the officials seemed satisfied that the Central Government seemed to be serious about the matter, but thought that the task was too complex and formidable, and public apathy would kill the reform. Real encouragement came to me when in the course of my third round of visits, I found that indifference and scepticism had given place to anger on the part of some of the State Government's representatives — a sure sign that the measures that the Central Metric Cell was taking were beginning to bite. This, in fact, was the starting point for the establishment of proper rapport with the State Governments to work the scheme successfully. From then on, I am very happy to say, I had the fullest co-operation and support from the State Government representatives.

If past experience in the realm of weights and measures had made anything clear, it was the fact that success in the implementation of the measure depended on the laying of a firm legal base and building up of an efficient enforcement organization. Under the Constitution, while the Union Government could lay down the standards, regulation and enforcement of weights and measures fell within the jurisdiction of the individual State Governments. This meant a very considerable amount of central planning by the Union Government and persuading the State Governments to act in a co-ordinated way.

In order to ensure a measure of uniformity in regulation and enforcement, a draft Model Weights and Measures Enforcement Bill was drawn up by the Government of India. This was circulated to the States and later formed the subject of detailed discussion with individual State Governments and at conferences of the States' Controllers of Weights and Measures. On the basis of these discussions, the model Bill assumed final shape and was adopted by all the State Governments for being placed on their respective Statute Books. In the field of rules framed under the various provisions of the State Enforcement Acts, uniformity was similarly secured by discussions at the State Controllers' conferences.

The next step was to create weights and measures organizations in all the States. As mentioned earlier, except for three or four States, none of the other States had any departments worth the name for the regulation of weights and measures. It was realized that neither the Police Department nor Departments like Revenue or Industries or Agricultural Marketing could regulate or enforce weights and measures effectively. The task needed special skills. Besides commercial weights and measures, various types of weighing machines and devices of a complex nature had to be tested and certified. As the country moved forward with industrial development, newer and more intricate methods of weighing and measuring would come into use and the checking of these would require men specially trained for the purpose. Apart from this, in the initial stages, the major task of preparing the people for the change-over to the metric system and carrying out the reform on the basis of a chronologically worked out programme with an overall dead-line required undivided and sustained attention by a team of officers. The need was, therefore, accepted for a separate agency in each State to be in charge of the programme of the change-over in the initial stages and for the continued control and regulation of an ever-increasing variety of weights and measures and weighing and measuring instruments. It was realized that as the work of preparations decreased with time, the work of regulation and control would increase.

As stated earlier, the psychological aspect of the problem had to be particularly taken care of. This was sought to be done by the appointment, to the posts of heads of weights and measures organizations in the States, of mature officers who were prepared to involve themselves emotionally in the programme. In the building up of the organization too, care was taken to see that each individual member of the staff, from top to bottom, was made to have a sense of participation, that he was making a significant contribution to the nation's development and taking part in an exciting adventure. By this, each member of the staff felt, overcoming the earlier reactions of scepticism, that he was engaged in a nation-building undertaking. When in the course of two or three years he could see visible results of the implementation of the programme, he felt a great sense of satisfaction which spurred him on to greater enthusiasm and intenser activity.

Once these State organizations came into being, they became the nuclei for implementing the change-over in the different States, in discussion with the various other authorities in their respective governments. There was a bi-annual Conference of State Controllers of Weights and Measures presided over by the author as Joint Secretary in charge of the subject in the Union Ministry of Industry, at which every aspect of the programme was discussed and agreed decisions were taken. The sessions of this Conference contributed enormously to the smooth implementation of the programme. While it secured co-ordinated action on the part of the various State Governments, it enabled pooling of effort and drawing valuable lessons from actual experience. The conferences have now become a regular feature, and are held annually.

The staffing pattern of the States' weights and measures organizations was one of the subjects of detailed discussion at the conferences of the States' Weights and Measures Controllers. Roughly, on the basis of one inspector for every 2 000 commercial establishments, a cadre of 1 000-1 200 inspectors for the country as a whole was considered necessary. These were to be supplemented by appropriate supervisory staff at the district levels and at the State capitals. To enable the State Governments to move forward with the implementation of the programme without being inhibited by paucity of funds, it was decided that the Central Government would provide financial assistance to the State Governments on the basis that 50 percent of the total net expenditure of each State on the implementation of the reform would be given to them by the Centre as grant and the other 50 percent as loan, repayable in 20 years. One essential feature of the weights and measures reform was that a small fee was to be charged from the traders and commercial and industrial establishments for the stamping by Government inspectors of their weights and measures and weighing and measuring instruments, as part of their regulatory function. While the revenue from this fee was not expected to be large during the initial years, it was hoped that once the reform got into its full stride, the State Governments would be able to maintain their weights and measures establishments from the revenue earned from the stamping fees. Actually, many of the State Governments have become self-sufficient in this regard.

The staff who were recruited to man the weights and measures organizations of the States were given training at the laboratories in Bombay and Patna, which had weights and measures organizations in existence for quite some years. The organization in Patna was specially strengthened to meet this responsibility for training of personnel from other States.

The States' weights and measures organizations had to be provided with specialized equipment to enable them to discharge their functions. Arrangements were made with the Government of India Mints at Bombay and Calcutta for the production and supply to the State Government organizations of Working Standards, Secondary Standards and Reference Standards of weights and measures and balances. Recourse had also to be had to certain private establishments for the production of precision balances of high accuracy. In order to meet the sudden large demand for these balances, the manufacturing firms were assisted to increase their capacity.

It was obvious that the ordinary man in the street as well as the sophisticated individuals in charge of trade, industry and administration should be made to understand the essentials of the new system and the benefits which it was expected to confer on them. Keeping in mind India's vastness, the varying stages of development of its people and the different levels of literacy and sophistication, this was a major task of mass communication. In the main, people had to be told in the language they could understand what the reform was, its objectives, its benefits, and what part they were to play in the implementation of the reform. A sustained and systematic publicity campaign was, therefore, conducted using all available media, the press, the radio, films, posters and exhibitions. The metric system of units was publicized through conversion tables and demonstrations of specimen weights and measures. Full advantage was taken of local fairs and regulated markets wherever they existed.

THE STRATEGY

It was accepted in principle from the very start that the reform would be carried through by persuasion and not by imposition. On the one side, efforts were made to make the people understand the essentials of the new system and the need for it to be adopted within the ten-year period provided in the *Standards of Weights and Measures Act, 1956*. On the other, specific programmes for the change-over to the new system were left to be drawn up by the different interests concerned, official or non-official, having regard to their special circumstances.

As mentioned earlier, the first step was to lay the legal base for the new metric regime. This was done by the States' *Weights and Measures Enforcement Acts* being placed on the States' Statute Books and the issue of rules under them. The next step was to build up weights and measures organizations in all the States with the whole-time responsibility of carrying through the metric reform. It was ensured that adequate finances were made available to the weights and measures departments; the specialized equipment needed was provided.

While the head of the weights and measures organization in each

State was the focus of action for implementing the programme in the State, every other department of the State Government was involved in the programme by being included in the State Metric Committee. At the meetings of this Committee, the heads of the various departments brought up their individual programmes for the adoption of the metric system in their respective departments and the public activities which came within their charge. At these committee meetings, the various programmes were examined, and since they were, to a large extent, inter-dependent in nature, agreed common programmes were drawn up with target dates for implementation. Representatives of the Central Metric Cell sat with these State committees according to a predetermined schedule. These discussions inevitably meant a two-way traffic — while the Central Metric Cell officials brought to the notice of the State committees the broad approach to the problem and the main policy aspects formulated by the Central Government and the progress of implementation of the programme in other parts of the country, they learnt from each State committee what had been done in that particular State, what were the special problems they were facing, in what way some of their difficulties were tackled and solved, etc. In subsequent meetings of these State Government committees, the action programmes were reviewed from the point of view of the progress that they had made. At these meetings, the difficulties and the problems which had cropped up as a result of the programme being implemented in the field were brought out. Once these problems were identified, efforts were made to find suitable solutions. Actually, it was found that there was not much difficulty in finding solutions, as there was a significant pooling of experience. Thus, the implementation went forward in a co-ordinated manner and faster than what one could have expected at the start.

It is important to note that the detailed programmes of implementation were drawn up by the various departments themselves, having regard to their special circumstances. The discussions with the other departments of the State Government and the representatives of the Central Metric Cell were intended to assist them in finding solutions to their difficulties and to secure overall co-ordination.

In making public bodies and trade and industry accept and implement the programme, the same strategy was followed. The main feature was that at every step, close co-operation was sought by discussion with individuals but mostly with established associations of trade and industry in drawing up specific programmes for the change-over. In every case, the action programmes with detailed target dates were drawn up by the trade bodies themselves. There was no imposition from the Government. They were encouraged to set up their own action committees and nucleus cells. The same system of periodic meetings with these bodies to review the progress made and to find solutions to the problems that cropped up in the implementation of the programmes was followed and proved eminently effective. The response from the trade bodies was most co-operative. Special mention should be made of the help and advice Government received from representative associations of industry and commerce like the Petroleum Oil Industry Metric Committee, Indian Jute Mills Association, Cotton Mills Federation, Development Councils for various industries and many others. Particular mention may be made of the dynamic part played by the Petroleum Oil Industry Metric Committee. It gave advice and assistance not only in framing the programme for the industry but also for implementing it stage by stage and in devising solutions to the numerous technical and administrative problems which arose from time to time.

A similar procedure was followed in drawing up action programmes for giving effect to the metric reform in the various Central Government departments and the public sector projects. Standing Committees were established in each department and public sector project with one co-ordinating officer specifically earmarked for implementing the reform. The Posts and Telegraphs Department, the Railways, Customs and Central Excise establishments, the Defence organizations, etc, had all country-wide and far flung establishments, and the enforcement of the new system in their activities involved very detailed and meticulous planning and quite extensive organizational modifications. Even though the overall general policy of change-over to the metric system had been accepted, many points of major principle had still to be settled at the highest levels in these organizations before specific action programmes could be drawn up. The respective departments handled this matter with great vigour and earnestness. With appropriate Expert Committees at various levels to review the progress of implementation on the one side and to identify the problems and find solutions to them on the other, the work progressed quite smoothly.

The success of the programme of change-over and the smoothness with which it was carried out could be attributed mainly to the system of joint consultations, discussions and mutually agreed target dates, which at every step were kept flexible, in order to accommodate difficulties and problems which arose in the course of implementation.

The initial rough overall review of the problem of the change-over to the metric system brought us one clear conclusion. A reform of this magnitude can be implemented only in stages, according to a systematic well-defined programme. The course adopted, therefore, was to start introducing the new weights and measures in specified areas and fields of activity; and after understanding the problems which arose, and solving those problems, the area of implementation was gradually extended to other areas and fields on the basis of experience.

There was a suggestion at the start that the new system should be introduced throughout the country with effect from a specified date. This suggestion was largely based on the precedent of the introduction of the decimal currency on a specified date throughout India. But the comparison was not at all on all fours. There were basic differences between the preparatory steps to be taken in respect of the two changes. In the case of currency, there was an established standard system with no diversity of units and the problem was only of change-over to the new decimal system. In the field of weights and measures, there was no standard system in force in the country; on the other hand, there was an immense diversity of units and practices. Further, the production and distribution apparatus of coins was solely in the hands of the Government and it was possible to be ready with the new denominations of the coins well before the prescribed date. On the other hand, the complete adoption of the metric system throughout the country from a specified date would have meant the production and distribution of tens of millions of new weights, capacity measures and length measures, and re-calibration of thousands of weighing and measuring instruments before that date. This was clearly beyond the capacity of the manufacturers and distributors. Any attempt at bringing in the use of the new weights and measures on a given date and driving out of the old ones would have broken down the Government administrative apparatus. Above all, there was the psychological factor, that without a transition period, during which the public would have an opportunity of becoming familiar with the new units and their values in comparison with the old, introduction on a specified date throughout India would either have created chaos or proved ineffective or both. Against this, phased introduction in stages area-wise and time-wise had several overwhelming advantages. It would take note of the fact that certain areas and certain fields of activities were more receptive to the new system than others. It would be clearly an advantage to gain strength by trying out the new system in these fields and areas to start with and draw lessons from experience. Actually, having regard to all these aspects, the *Standards of Weights and Measures Act, 1956* gave the Government of India discretion to introduce the new weights and measures in convenient stages [*see* Section 1(3) of the Act in Appendix 3].

Thus, it was decided that a beginning of the reform should be made by the introduction of metric weights in Government departments and undertakings, organized industries and selected urban areas like Bombay, Calcutta and Madras. It was notified that from 1 October 1958, metric commercial weights would be legal in these areas and fields of activity. In April 1961, metric capacity measures were introduced. Gradually, extensions were made to other areas, undertakings and fields of activity. When new weights or measures were introduced in an area or a class of undertaking or a field of activity, the older weights and measures were allowed to be used for a period not exceeding three years. This transitional period was intended to serve two purposes:

1) to facilitate the completion of the preparatory steps by all concerned so that the change-over to the new system would be smooth and without hardship; and

2) by having the two systems in force side-by-side, the traders, industrialists and the public would gradually become familiar with

the new units and be able to understand their values in comparison with the old.

The organized industries in which the metric system was then introduced included, among others, jute, cotton, textiles, iron and steel, heavy engineering, chemicals, cement, rubber, coir, sugar, vanaspati, paint, biscuits, soap, drugs, fertilizers, tea, coffee and petroleum.

The preparatory steps involved the making of arrangements for the progressive production of tens of millions of new weights and large numbers of capacity and length measures. Precise specifications had to be drawn up for these in consultation with the various interests concerned and keeping in mind the interests of the consumer. The production of working standards and secondary standard weights, balances and capacity and length measures had also to be organized. In all this work, very valuable assistance was rendered by the Masters of the Government of India Mints, the Indian Standards Institution and the National Physical Laboratory.

The phased programme of enforcement was indeed a manifestation of the flexibility of the approach to the implementation of the metric reform. The policy was throughout to allow the widest latitude. A specified date was not so important as the genuineness of the decision or the intention to adopt the reform and take necessary steps for it. In other words, the spirit of the reform was given precedence over the latter of the law. Thus, for instance, in the case of the jute industry which was, to a substantial extent, concerned with exports to UK and USA which are non-metric areas, the packing continued to be in bales of 1 000 and 2 000 yards; only an indication of the length in terms of metres was also to be given within brackets. Facilities like these were extended to other industries where found necessary.

A concomitant feature of the reform was the rounding off of units and the rates of tariff during the process of conversion. Railway passenger fares, for example, had been shown in terms of annas and pies per mile in the pre-metric period. Under the new regime, they had to be converted to *naye paise* per kilometre, two new units being involved in the process of rounding off. Generally speaking, all public undertakings, industrial organizations and the trading and commercial public were cautioned against rounding off in the upward direction, because it was important to avoid the criticism that the metric reform was being utilized to earn more revenue or indulge in a little profiteering. In order to help the consumer in the day-to-day transactions in the market, conversion tables were published in the various languages and distributed very widely.

It is necessary to emphasize again the close co-ordination and contact maintained between the Ministry of Commerce and Industry in the Government of India which had the overall responsibility for taking measures to effect the change-over and the other different Ministries in the Central Government, the State Governments, the public sector undertakings and organizations of industry and trade. In regard to State Governments, the machinery of co-ordination and contact was particularly important. It was necessary to ensure uniform policies and practices throughout the country. As stated earlier, the *Weights and Measures Enforcement Acts* of the various States were based on a model Bill which had been examined, discussed and adopted by the Conference of State Weights and Measures Controllers, of which the Officer-in-Charge in the Ministry of Commerce was the President and the other officers in the Metric Cell in the Ministry of Commerce and Industry were members. In addition, the various details in the application of the law, the procedures to be followed by the inspectors, the specifications to be observed, the tolerances that may be permitted and the various new technical problems arising from the industrial growth of the country had to be examined on an overall basis to ensure a large measure of uniformity. For this purpose, as stated earlier, the Conference of the Controllers of Weights and Measures was held in the initial period twice a year. These meetings also made it possible to transmit the general policy of the Government of India and the approach to the implementation of the reform to the enforcement staff. To cite one instance — it was emphasized as a general policy that prosecution which was provided in the law for infringement of any of its provisions should be resorted to with the greatest caution in the initial years when the reform was being gradually introduced. It was clear that any excessive zeal in enforcement and any rash resort to the use of penal provisions would generate resistance, lying dormant amongst the public, apart from causing genuine hardship to the persons concerned who in the initial stages might have found it difficult to adhere to the provisions of the law to the fullest extent. This would have resulted in creating difficulties in the progressive adoption of the reform in that particular region.

METRIC SYSTEM IN EDUCATION

It was in the fitness of things that education should occupy a very important place in the scheme of the change-over. It was realized at the outset that the ultimate success of the metric reform would depend upon the young ones at school. The generation at school would have the experience of the metric system from a very early age and would have had no need to use the old units like the seer or the pound. It was accordingly important that they should be taught the metric system not just as a world system which every educated person should know about, but as India's national system which they would be using everyday of their lives. Systematic steps were, therefore, taken to revise the text-books and introduce new curricula for the teaching of mathematics and science in all classes in the schools from bottom to top.

The adoption of the metric system in the field of higher technical education, particularly engineering education, however, presented difficulties. The fps system was almost exclusively in use in the engineering colleges and technological institutes in the country. The change involved the replacement or re-calibration of the measuring tools and instruments to conform to the new system. The curricula followed and the very large majority of the text-books in use were based on the fps system. The revision of the text-books was not easy and would have had to be undertaken by persons specifically selected for the purpose. Considering these difficulties, a phased programme covering a period of five years was drawn up for the adoption of the metric system in the engineering colleges and institutes of technology. Today, the majority of the colleges and the institutes have switched over to the metric system in the teaching of engineering subjects. Indian authors are being encouraged to write text-books in original in the metric system for being used in this teaching or to translate standard text-books from French, German, Russian and other European languages which follow the metric system. The response has been encouraging.

CONCLUSION

The *Standards of Weights and Measures Act, 1956*, had stipulated a period of ten years for the change-over to the new system. The bulk of the work was completed well ahead of schedule. By 1964, the position was that for the first time in the history of India, there was uniformity in the matter of weights and measures everywhere. The metric system in India now rests on a firm foundation. All the units prescribed by the 1956 Act have been established by law and there is a wide network of enforcement organizations throughout the country. A silent revolution in a vital field has been brought about through a policy of persuasion and understanding. Force in the shape of legal action was seldom resorted to. The very few cases where penal action was taken arose from repeated flouting of authority despite several warnings.

It must, however, be emphasized that to derive the full benefits of the metric system, it is necessary that in the area of industrial production also, the system is adopted in almost complete supersession of the fps and other systems which are still in vogue. As mentioned earlier, this is bound to take time. The movement for the change-over in this field also is gathering momentum. Before long, we could expect that the productive potential of the country will be greatly benefited by the advantages flowing from the full adoption of the new system.

As one who was fortunate to be closely associated with the reform for the bulk of the period, I am happy to recall that it was an exhilarating experience, the like of which rarely comes by the way of a civil servant. □

7

Publicity

L. R. Nair
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The introduction of the metric system of weights and measures in India affected millions of people in their day-to-day activities, and without their willing co-operation and active participation, a reform of such a nature and magnitude could not possibly have succeeded. Effective publicity campaign was, therefore, an essential prerequisite for success. In his foreword to Pant's Memorandum on the Metric System in India (*see* Chapter 3), the late Prime Minister Jawaharlal Nehru wrote:

'Our Parliament has accepted the principle of introducing the metric system in India and legislation has already been passed in regard to coinage. The rest will no doubt follow. It is important, however, that there should be full publicity about this system and the obvious advantages that it will bring to us....and the people should understand how they will profit by it.'

To produce the desired result, the publicity campaign was launched with a three-fold objective: to convince the people of the need for and benefits of the reform, to enable them to understand and to learn the use of new weights and measures, and finally, to keep them informed of when and how the new units of weights and measures would be introduced and used exclusively in the various fields.

The campaign was conducted through the different media units of the Ministry of Information and Broadcasting. This was supplemented by the efforts made by the weights and measures organizations in the States and the Central Directorate of Weights and Measures. It is significant that the entire programme was so administered as to produce maximum impact through a co-ordinated multi-media campaign, which laid emphasis on the widest possible dissemination of educative material on the metric system throughout the country. Anticipating an amount of criticism and hesitancy, appropriate safeguards had to be provided at the early stages of planning the campaign.

The crux of the problem was not merely to familiarize the people with the new weights and measures but also to assist them in re-adjusting their shopping habits in terms of round metric units. So, when the Bill to adopt the metric system had just been introduced in the Indian Parliament in 1956, and this was several months before the Act was passed, the Press Information Bureau of the Ministry of Information and Broadcasting nominated an officer exclusively to look after the publicity for the programme. This helped close understanding of the reform in all its aspects, the magnitude of the task and the sensitive areas of public reaction. The publicity campaign that followed may be broadly divided into three stages:

First Stage — Preparatory

Second Stage — Actual use of the new system, with its attendant problems

Third Stage — Exclusive use of the metric system

FIRST STAGE

The Parliament passed the *Weights and Measures Act* in December 1956, and the Act armed the Government of India with the requisite legal powers to introduce the metric system in the country. For the successful introduction of the new system, however, it was necessary that the people should understand clearly that the Government was in earnest — an ingredient that was missing in the earlier efforts at standardization in this field. That is why it was decided that the administrative programme and the publicity campaign should operate simultaneously.

A series of feature articles, released by the Press Information Bureau, marked the beginning of the educational campaign. The series traced the origin and history of the metric system, explained the simplicity of the proposed system of weights and measures in contrast to the welter that prevailed in different parts of the country and illustrated the simplicity of the system and the benefits of uniformity in weights and measures throughout the country. The invention of the symbol zero and the place value system in ancient India 2 000 years ago was the central point in the early articles and releases. The publicity material laid stress on the link between the universal system of counting and the metric system of weights and measures, the latter being presented as merely a logical extension of the former. This went a long way in establishing in the minds of the people the simplicity of the metric system, avoiding at the same time, an impression that it was something foreign. 'Towards simplicity and uniformity' became, in fact, the theme of publicity. There was also an article canvassing the need for immediate adoption of the system, in order that India might not be faced, like the UK and the USA, with the problem of mounting costs in introducing the inevitable reform at a later date, when India would have become more industrialized.

The series was widely published in all the newspapers and led to interesting discussions in the readers' letters columns. Some people had doubts whether this was the appropriate time; others said, 'if Britain can do with the foot-pound system, why not India'? Some others imagined that the cost of change-over would be colossal, running into tens of millions of rupees. A few 'nationalists' even quarrelled with the nomenclature for the new weights and measures, and suggested that India might adopt a *naya* seer (new seer*) like the *naya paisa* (new *paisa**). All this was analyzed and answered through articles, statements in Parliament and speeches. The Hon'ble John Strachey's memorable note of 1868 (*see* Chapter 2), recommending the adoption of the metric system in India, the views of eminent scientists and industrialists and the recommendations of commercial organizations in India and of the Special Committee of ISI, were all pressed into service in preparing material for publicity.

To the ordinary man, however, the important thing was to understand what this new system was, its structure and its correlation to known weights and measures and why it was at all necessary to disturb the existing order of things. Even the terms 'metre', 'litre' and 'kilogram' had to be taught and learnt. In retrospect, however, it must be said that most of the fears expressed on behalf of the people at large proved ill-founded. Properly explained and given reasonable time, the common man, it was found, could adopt the new system as readily as anyone else. Ironically, the educated intelligentsia, perhaps because of their education, had more difficulty in changing over their mental processes of thinking from the old system to the metric system than the villagers.

SECOND STAGE

At the second stage, publicity centered on two main themes:

1) familiarizing the people with the new units, their multiples and sub-multiples; and

2) helping the public to correlate the new units with the ones that were already in use in the various regions.

To help easy understanding and identification, model weights and measures were manufactured and distributed widely for display through weights and measures organizations in the States as well as the publicity agencies of the Central and State Governments. These were of great help, and often the public was invited to handle the new weights and measures.

Correlating them with the old became important, particularly because, by legal provision, the new system was in use *side-by-side*

*Seer and *paisa*, the Indian units of weight and money, were replaced by kilogram and *naya paisa*.

with the old for a transitional period covering about three years. The consumer had to reckon with both the systems during this period. It often happened that the shopkeeper had changed over to the new system while the consumer kept thinking in terms of the old. Besides, in certain areas some of the shops dealt in the new system in respect of some of the commodities only. All this made correlation very important.

CONVERSION TABLES

Conversion tables were, therefore, printed in huge quantities (several hundred thousand) and distributed freely to shops, trading establishments, schools and the like. There were even pocket-size cards on which conversion tables were printed for ready reference, while for more durable purposes, these tables were printed on metallic tablets which could be nailed on the wall in the shop.

What began as a facility soon proved two things. Firstly, that the consumer found it much easier to deal with the new system as it was, rather than to go through the process of conversion every time, and secondly, that in the name of conversion, the trader very often tended to over charge the consumer. This significant aspect soon caused concern to the Weights and Measures Directorate in the Ministry of Commerce. Any malpractice that prevailed was bound to cause a setback in the readiness with which the reform would be accepted by the people. Therefore, a further step was taken to prepare price-conversion tables so as to show the price per kilogram of a commodity which would cost, say, a rupee per seer, or the price per metre of cloth which would cost a rupee per yard and so on. These conversion tables were supported by press advertisements which gave publicity to the exact conversion ratio in terms of price between the old unit and the new.

While the conversion tables were printed in large size in the shape of hanging cards, it was found by experience that these cards were not always readily available in the shops. Therefore, the Government of India persuaded the State Governments to amend the rules so as to make it obligatory on the part of the shopkeepers to display these conversion tables at the premises. It must be recorded that this was an extraordinary move in the realm of information strategy. While the Controllers of Weights and Measures did not find it necessary, except in a few cases, to invoke the law, the mere fact that they were empowered to compel the shopkeepers to display the conversion tables had a salutory effect upon the traders as well as the public. The public was convinced that while Government was keen to introduce the reform, which was obviously

CONVERSION TABLE FOR PRICES

RUPEES PER SEER TO RUPEES PER KILOGRAM

Rs/Sr	Rs/kg	Rs/Sr	Rs/kg	Rs/Sr	Rs/kg	Rs/Sr	Rs/kg	Rs/Sr	Rs/kg
1	1.07	11	11.79	21	22.51	31	33.22	41	43.94
2	2.14	12	12.86	22	23.58	32	34.29	42	45.01
3	3.22	13	13.93	23	24.65	33	35.37	43	46.08
4	4.29	14	15.00	24	25.72	34	36.44	44	47.15
5	5.36	15	16.08	25	26.79	35	37.51	45	48.23
6	6.43	16	17.15	26	27.86	36	38.58	46	49.30
7	7.50	17	18.22	27	28.94	37	39.65	47	50.37
8	8.57	18	19.29	28	30.01	38	40.72	48	51.44
9	9.65	19	20.36	29	31.08	39	41.80	49	52.51
10	10.72	20	21.43	30	32.15	40	42.87	50	53.58

1 SEER = 80 TOLAS : 1 KILOGRAM = 1,000 GRAMS

ISSUED BY GOVERNMENT OF INDIA

NAYE PAISE PER SEER TO NAYE PAISE PER KILOGRAM

nP/Sr	nP/kg	nP/Sr	nP/kg	nP/Sr	nP/kg	nP/Sr	nP/kg	nP/Sr	nP/kg
1	1	21	23	41	44	61	65	81	87
2	2	22	24	42	45	62	66	82	88
3	3	23	25	43	46	63	68	83	89
4	4	24	26	44	47	64	69	84	90
5	5	25	27	45	48	65	70	85	91
6	6	26	28	46	49	66	71	86	92
7	8	27	29	47	50	67	72	87	93
8	9	28	30	48	51	68	73	88	94
9	10	29	31	49	53	69	74	89	95
10	11	30	32	50	54	70	75	90	96
11	12	31	33	51	55	71	76	91	98
12	13	32	34	52	56	72	77	92	99
13	14	33	35	53	57	73	78	93	100
14	15	34	36	54	58	74	79	94	101
15	16	35	38	55	59	75	80	95	102
16	17	36	39	56	60	76	81	96	103
17	18	37	40	57	61	77	83	97	104
18	19	38	41	58	62	78	84	98	105
19	20	39	42	59	63	79	85	99	106
20	21	40	43	60	64	80	86	100	107

Conversion tables on pocket-size cards — the two sides easy and simple, there was also the readiness on its part to appreciate the consumer's difficulty and to protect his interests against the profiteer. This legal provision was maintained in the rules until the end of 1966; thereafter, it was not considered necessary.

The manner in which the metric system of weights and measures was introduced, itself reflected the depth of knowledge of communication. The new system was brought into force step-by-step;

METRIC LENGTHS-CONVERSION TABLE

LENGTHS

	Feet	Centimetres (cm) (to nearest cm)	Yards	Metres (m)	Centimetres (cm) (to nearest cm)	Yards	Metres (m)	Centimetres (cm) (to nearest 5 cm)	Yards	Metres (m)	Centimetres (cm) (to nearest 10 cm)
The equivalents given here are nearest to the appropriate unit. But use them merely to form an idea of the new lengths in relation to old ones. When you buy, please ask for cloth etc. in metric units; it saves time and avoids confusion.	1	30	1	0	91	6	5	50	60	54	90
	2	61	2	1	83	7	6	40	70	64	0
			3	2	74	8	7	30	80	73	20
			4	3	66	9	8	25	90	82	30
			5	4	57	10	9	15	100	91	40
						20	18	30			
						30	27	45			
						40	36	60			
						50	45	70			

PRICES (YARD TO METRE)

	nP/Yard	nP/m	nP/Yard	nP/m	nP/Yard	nP/m	nP/Yard	nP/m	nP/Yard	nP/m
NAYE PAISE PER YARD TO NAYE PAISE PER METRE	1	1	21	23	41	45	61	67	81	89
	2	2	22	24	42	46	62	68	82	90
	3	3	23	25	43	47	63	69	83	91
	4	4	24	26	44	48	64	70	84	92
	5	5	25	27	45	49	65	71	85	93
	6	7	26	28	46	50	66	72	86	94
	7	8	27	30	47	51	67	73	87	95
	8	9	28	31	48	52	68	74	88	96
	9	10	29	32	49	54	69	75	89	97
	10	11	30	33	50	55	70	77	90	98
	11	12	31	34	51	56	71	78	91	100
	12	13	32	35	52	57	72	79	92	101
	13	14	33	36	53	58	73	80	93	102
	14	15	34	37	54	59	74	81	94	103
	15	16	35	38	55	60	75	82	95	104
	16	17	36	39	56	61	76	83	96	105
	17	19	37	40	57	62	77	84	97	106
	18	20	38	42	58	63	78	85	98	107
	19	21	39	43	59	65	79	86	99	108
	20	22	40	44	60	66	80	87	100	109

	Rs/Yard	Rs/m	Rs/Yard	Rs/m	Rs/Yard	Rs/m	Rs/Yard	Rs/m	Rs/Yard	Rs/m
RUPEES PER YARD TO RUPEES PER METRE	1	1.09	11	12.03	21	22.97	31	33.90	41	44.84
	2	2.19	12	13.12	22	24.06	32	35.00	42	45.93
	3	3.28	13	14.22	23	25.15	33	36.09	43	47.03
	4	4.37	14	15.31	24	26.25	34	37.18	44	48.12
	5	5.47	15	16.40	25	27.34	35	38.28	45	49.21
	6	6.56	16	17.50	26	28.43	36	39.37	46	50.31
	7	7.66	17	18.59	27	29.53	37	40.46	47	51.40
	8	8.75	18	19.68	28	30.62	38	41.56	48	52.49
	9	9.84	19	20.78	29	31.71	39	42.65	49	53.59
	10	10.94	20	21.87	30	32.81	40	43.74	50	54.68

An example of a conversion table in English, millions of which were issued in all Indian languages to schools, retail shops and so on the weights were first introduced, followed by volumetric measures and linear measures. To begin with, the system was made applicable to selected commodities in selected regions, and extended gradually, district by district in each State, so that there was time for assimilation and learning from experience. This approach also made it possible to spread the programme with the minimum enforcement machinery. But in all cases, the system began with the Government first so that there was proof of Government's readiness to set an example themselves to abide by the new system (*see* Chapter 11).

THIRD STAGE

Despite all this, when the new weights and measures became compulsory by law throughout the country, the old habit of reckoning in terms of the old system persisted, at least in the minds of the older generation. At this stage, it was no longer necessary to publicize the merits of the metric system and the advantages of adopting it, as the law was there and the public had already become aware of its merits. It was all the same necessary to induce the traders and the public to use only the metric units and no other in expressing quantities and prices in transactions. A concerted campaign was, therefore, launched with the theme 'DON'T COMPARE' and 'BUY IN ROUND METRIC UNITS'. The people were exhorted not to compare the kilo with a seer or a pound, but take it as it was; nor to ask for quantities in non-preferred metric units equivalent to a seer or a pound. The campaign proved very popular and had considerable impact. A design, which was used as an advertisement, was also adopted for a poster, bus boards and hoardings, with great effect.

In the concluding part of this stage, it was felt that there was no need to publish conversion tables of weights, length and capacity measures but to lay emphasis on intensive publicity in other directions — temperatures, areas, volumes, etc, where metric units were going to be adopted. This was sought to be conducted through printed literature, cinema slides and newspaper advertisements.

In all these stages, publicity was conducted by the Directorate of Advertising and Visual Publicity (DAVP), through the State Controllers and Directors of Publicity. The DAVP supplied to the States all publicity material in English and all Indian languages produced by it in consultation with the Central Directorate of Weights and Measures. The Field Publicity Organization of the Ministry of Information and Broadcasting also assisted the DAVP in distributing the publicity material.

CONFERENCES ON WEIGHTS AND MEASURES

Conferences on Weights and Measures were periodically held between 1959 and 1967, under the chairmanship of the Joint Secretary concerned in the Ministry of Industry, Government of India. State Controllers of Weights and Measures; representatives of the Union Ministries of Commerce and Industry, Finance, Information and Broadcasting, and Law; and those of the Indian Standards Institution (ISI) and the National Physical Laboratory participated in these conferences. These conferences discussed the progress made in the change-over to the metric system, and, *inter alia*, reviewed the publicity campaign conducted by the Central and State Governments, and laid down the publicity programme for the future. The publicity campaign, described below, conducted by the Central and State Governments through the various media at their disposal was, thus, according to a programme agreed upon by the participating agencies.

FILMS

During the earlier stages of the reform, two documentary films with commentaries in English and regional languages were produced by the Films Division of the Union Ministry of Information and Broadcasting, and copies were distributed to the State Publicity Departments. These films displayed the metric weights and measures, verified and stamped by the enforcement authorities. They highlighted the advantages of the metric system of weights and measures in contrast to the irksome calculations, the delay involved and scope for malpractice in the purchase of goods when non-standardized old weights were used. It was pointed out that metric units and decimal coins had made all calculations easier, and the metric system of weights and measures had become the only legal system.

These films were shown in information centres, particularly in community development and national extension service blocks.

They were also exhibited in commercial cinema houses throughout the country.

Besides the above, other films were also produced by some State Governments in their regional languages for local use, which, after dubbing, were also shown in several other States.

SLIDES

Cinema slides on the metric system of weights, capacity and length measures were prepared by the Central and State Governments and were exhibited in cinema houses over a long period to publicize the metric system and its advantages.

ALL INDIA RADIO

The All India Radio (AIR) played an important part in explaining the advantages of the metric system to the people, through its network of radio and television stations.

Talks by weights and measures officers, both at the Centre and in the States, in English and regional languages, were broadcast by AIR from its various stations throughout the country, in its national programmes as well as in its daily and weekly programmes for workers, women, children and villagers. The AIR also carried slogans, such as 'DON'T COMPARE' and 'BUY IN METRIC UNITS'. A symposium on the metric system was arranged by a regional station of AIR on the occasion of the Tenth Conference on Weights and Measures in 1965.

Discussions, special talks, etc, were arranged on television to inform the public of the change-over. The television unit, which broadcast to schools during school hours, was also utilized in propagating the metric system, its advantages and the fact that it was the only legal system in the country.

The broadcast receiver licences which, in India, are required to be held by all radio receiver owners, carried advertisements on the metric system.

The publicity campaign through AIR later entered a new phase with the pressing into service of the commercial broadcasting facilities available on the *Vividh Bharati* station. This is used to explain to the public the correct weighing and measuring practices and the role played by the weights and measures organizations in protecting the interests of the consumer.

EXHIBITIONS

Stalls were reserved in the various exhibitions organized centrally and by the States for publicizing the metric system. The advantages and proper use of the metric system were explained to the visitors. Sets of the metric weights and measures were exhibited and pamphlets on the metric system as well as handy conversion tables were distributed. Films and cinema slides on the metric system were shown during these exhibitions, and illumination boards with legends relating to the metric system were displayed. Illustrations of fraudulent weighing and measuring practices were displayed.

During fairs and festivals, the State Governments organized special publicity campaigns and exhibitions to popularize the use of metric weights and measures. Field Publicity Officers of the States explained to the people the advantages of the metric system and brought to the notice of the traders that the use of obsolete weights was punishable under law.

JOURNALS

The Directorate of Weights and Measures at the Centre itself conducted publicity of a continuous nature through its journals 'Metric Measures' in English and 'Metric *Map Tol*' in Hindi. Articles were contributed by persons concerned with the change-over to the metric system in various fields in the country as also by persons from abroad having expertise of the subject. The inspectors of weights and measures, who were in direct contact with the public and the trade, were also encouraged to contribute articles for these journals. These journals provided information on various aspects of the reform, particularly on the phased programme of introduction in the various spheres and activities in the country, and became popular, not only in the country but even abroad.

Selected material from 'Metric Measures' was adapted, translated in regional languages and published in the official journals of the State Publicity Departments. Some of the more important articles dealing with education and other subjects were reprinted and distributed to concerned readership in thousands. Besides the articles on the metric system, the journals also carried conversion tables from the old systems to the new systems of weights and measures. These journals were distributed to Inspectors of Weights and Measures to help them in their day-to-day work of publicity and enforcement.

A fortnightly newsletter in Hindi *Map Tol Samachar* was circulated to the block development officers in Hindi-speaking areas for the use of the village level workers.

Some of the State Governments produced and published their own journals in their regional languages. These journals went a long way in publicizing the metric system, as those published by the Central Government could reach only a minority of people. Articles on DOs and DON'Ts of the metric system were also published in these journals.

PERSONAL CONTACTS

Publicity on the change-over to the metric system was also conducted through personal contacts by the officers of the weights and measures departments both at the Centre and in the States. Officers of the Central Directorate of Weights and Measures and the State Controllers convened meetings of various sectors of trade and consumers wherein the difficulties in the change-over to the metric system were discussed and agreed solutions found. Inspectors of weights and measures in the States toured their areas intensively, meeting individual traders as well as representatives of trade associations, explaining, in close co-operation with the State Publicity Departments, the advantages of the metric system to both the traders and the public. To save the villagers from being exploited by unscrupulous traders, the inspectors, while on their routine verification or inspection tours, called meetings of villagers and explained to them the relationship of old units to the new metric units and the ratio of the principal metric unit like the kilogram to the local unit like seer.

The village level workers, who were in direct contact with the people in the villages, also helped in publicizing the metric system and its advantages in the rural areas. They were supplied with talking points as well as a demonstration set of weights and measures to enable them to acquaint the people with the metric system. The village level workers in Hindi-speaking areas also made use of the fortnightly newsletter *Map Tol Samachar* supplied to them through the block development officers.

WRITE-UPS AND SLOGANS

Write-ups on the introduction of the metric system in the country were included in diaries produced by the Government of India for distribution to Government officers and private firms. The Times of India Year Book, 'INDIA — A Reference Annual', published by the Government of India and the *Panchangs* (Indian almanacs), also contained write-ups on the change-over to the metric system. Slogans on the metric system were published in the diaries and calendars produced by the Government, and also broadcast on the radio.

BOOKLETS, FOLDERS, ETC

An informative booklet on the work done by the weights and measures departments, its usefulness to the public and how it ensured a fair deal for the consumer was published by the Government of India. This gave guidance to the general public on how best they could utilize the services of the weights and measures organizations, and also instructions about the correct weighing and measuring practices they should observe in the trade and how to calculate money equivalents of quantities purchased in new weights and measures.

Pamphlets and folders on the use and advantages of metric weights, capacity, linear and area measures were prepared by the Directorate of Advertising and Visual Publicity and widely distributed through State Publicity Departments. Besides, the States also produced their own pamphlets having local appeal. A folder giving an abbreviated list of standard piece lengths in metres of cloth required for tailoring purposes, such as suits, shirts and saris, was produced by the Central and State Governments and widely distributed. Folders on the progress of the reform were published by the Central Government from time to time. Folders on the metric reform were also brought out on important national and international occasions, for example, when the ECAFE Conference was held in India in 1966.

Show Cards with the theme 'DON'T COMPARE' and 'BUY

ONLY IN METRIC UNITS' were printed by the Government of India and distributed throughout the country through the State Controllers of Weights and Measures. These show cards were displayed at shop windows and counters.

Cards indicating the various units of the *Système International d'Unités* (SI) and their abbreviations were produced and distributed to all high schools and technical and science colleges. A card which could guide the housewives in their daily work was also produced and widely distributed.

HOARDINGS

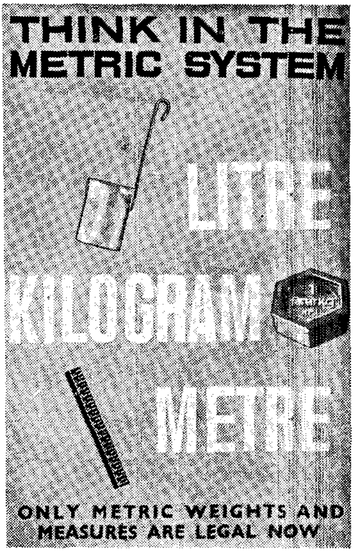
Large-sized hoardings on the introduction of the metric system, exhorting people to use only metric weights and measures, were put up at prominent places, along public squares and thoroughfares in all major towns and cities at railway stations throughout the country, and during fairs, festivals and exhibitions. Public transport vehicles carried bus boards with suitable catchy slogans.

POSTERS

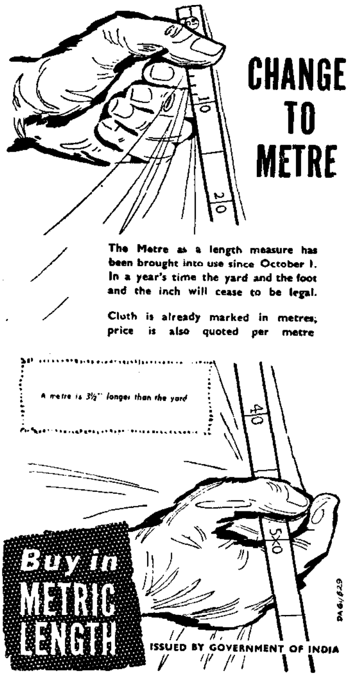
Posters informing the people of the change-over and appealing to them to think only in terms of the new units, namely, kilogram, litre and metre, were displayed prominently at all important places, such as post offices, railway platforms, municipal markets, etc, throughout the country. The aid of the local bodies was sought in this connection.

ADVERTISEMENTS

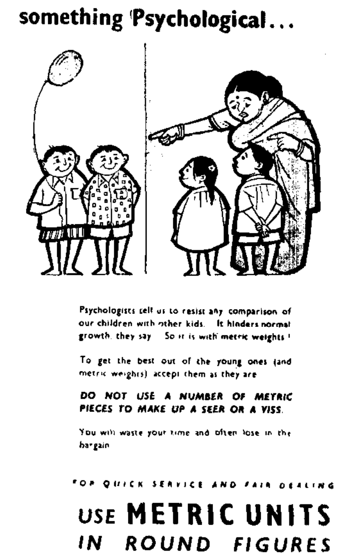
Advertisements in the newspapers, journals, souvenirs, etc, formed an important and effective medium of the publicity campaign since its inception. Series of advertisements in English and Indian languages with catchy and appealing captions were periodically released in newspapers and journals throughout the country. The contents of the advertisements differed, depending upon the stage of the reform. While the theme of the advertisements at the earlier stages was the introduction of the metric system and its advantages, the advertisements released later enjoined on the trade and the public the necessity of transacting business only in round metric units. Some of the advertisements publicized conversion tables for

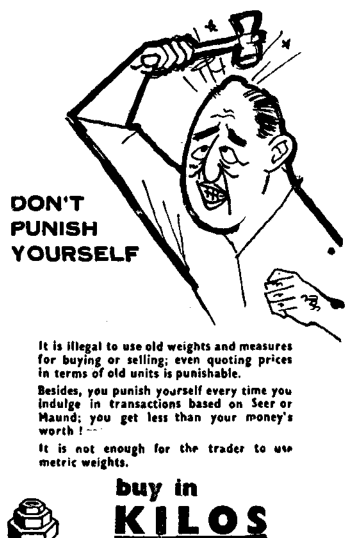


A poster appealing to people to think only in terms of the new units



Advertisements published widely in newspapers and journals





weights and measures of capacity, length, area and temperature, while others gave equivalents in metric units for textile lengths of common use, such as suits, shirts and saris. After the compulsory introduction of metric weights and measures throughout the country, the advertisements warned the traders against the use of weights and measures other than metric.

MATCH BOX LABELS

Another medium of publicity which reached every home in the country was the match box labels. Match box labels on the metric system were printed in English and regional languages by the Government of India and distributed to the match factories for putting on the match boxes.

DEMONSTRATION SETS OF WEIGHTS AND MEASURES

In order that people may familiarize themselves with the new units, specimen weights and measures were demonstrated at information centres in community development and national extension service blocks, exhibitions, etc. Besides, the village level workers usually took these weights with them on their rounds to the villages.

PUBLICITY VANS

Vans fitted with loudspeakers were used for announcing to the people the introduction of the metric system and its advantages, at market places, weekly bazars and villages.

PUBLICITY WEEKS

The Eleventh Conference on Weights and Measures recommended that a weights and measures week might be held. Accordingly, a publicity week was organized in all the States in December 1966 under the guidance of the Central Directorate of Weights and Measures, to educate the people on the work of weights and measures organizations and the important role it played in the life of the community. After seeing the encouraging response from the public to this publicity week, the Twelfth Conference on Weights and Measures recommended that a publicity week should be organized between 28 December and 3 January every year, with a uniform programme for the whole country, which might be drafted by the

Centre in consultation with the States. The date 28 December was significant because it was on this day in 1956 that the *Standards of Weights and Measures Act* had been placed on the Statute Book.

PUBLICITY BY INDIAN STANDARDS INSTITUTION

Publicity of another type aimed at the specialized and technical personnel was carried out by the Indian Standards Institution during the entire period of the change-over. At every Annual Convention from the beginning, a Session used to be devoted to the discussion of various aspects of the technical change-over. This publicity in a sense continues even today through hundreds of technical committees of ISI which are constantly hammering out standards in metric terms.

The Metric Conversion Session of the 1958 Standards Convention being inaugurated in New Delhi. (r to l) Dr Lal C. Verman, Shri K. V. Venkatachalam and Shri T. Purnanandam, contributing authors of Chapters 1, 6 and 15

STATES' EFFORTS

The publicity campaign in the States was conducted by the State Directors of Publicity and Controllers of Weights and Measures, with close collaboration between them. In some States, publicity subcommittees were set up, where representatives of the departments of publicity and weights and measures participated, to co-ordinate their publicity programmes. These departments have been conducting their publicity programmes largely with the aid of material supplied by the Central Government. They had to supplement this material with that produced by themselves for local use. Copies of such material were exchanged with Controllers and Directors of Publicity in other States for translation in other languages and adoption, if suitable, as well as with the Central Government.

The State Governments produced cinema slides, pamphlets, conversion tables, etc, for local use. Some State Governments produced their own documentaries on the metric system. They took active part in all the exhibitions, fairs and festivals with a view to giving effective publicity to the change-over. Weights and measures authorities in the States arranged publicity weeks, symposia, seminars, etc, on the metric system and gave talks over the radio.

CONCLUSION

The publicity campaign conducted by the various agencies, both at the Centre and in the States, with as perfect co-ordination as humanly possible, has largely been responsible for the successful change-over to the metric system. The people have now become fully conversant with it and think and deal only in terms of metric units. However, it is felt that it will be necessary to continue, in future, a sustained publicity campaign so as to ensure that the gains achieved by the reform are not allowed to be dissipated. Annual Publicity Weeks, which have become a permanent feature, will aid in the process of educating the consumer not necessarily about the metric system, but about the regulation of weights and measures in general.

Moreover, the field of weights and measures has a close bearing on consumer protection and the process of holding the price line. Therefore, the need to keep the people informed of their rights, and how to safeguard them through a knowledge of good and bad weighing and measuring practices is continuous. This needs to be reflected in the future programmes. □

8

Enforcement of New Weights and Measures

V. B. Mainkar

The first organized and systematic effort at enforcement of uniform weights and measures in the world was perhaps made in India during the days of the Indus Valley Civilization which flourished from about 3000 BC to about 1500 BC (*see* Chapter 2). Again, after a break of several centuries, uniform weights and measures were established when the Maurya dynasty held sway in the third and second centuries before Christ. And, though several efforts were made during the past two thousand years to set matters right which had worsened since the decline of the Mauryan Empire, none of them succeeded in achieving uniformity in this field throughout the entire country[1].

It was only after India had gained Independence in 1947 that it became possible to give serious thought to the question of unification of weights and measures on country-wide basis.

CENTRAL RESPONSIBILITY

The first and the most important lesson that could be drawn from the history of weights and measures in India is that unless there is central planning, guidance and direction, the administration of weights and measures suffers seriously, with consequent deleterious effects on trade, commerce, science and industry. This lesson was taken into account when preparations were made for the setting up of the machinery for the standardization and enforcement of the new system of weights and measures.

Early in 1957, a conference attended by the representatives of the States and the Central Ministries recommended that for effective enforcement, it was necessary to change the existing constitutional provision which permits the Centre to 'establish standards of weights and measures' and leaves to the States the responsibility for 'weights and measures, except the establishment of standards'. The Conference thought it necessary that enforcement in the States should be carried out uniformly and the Centre should have overall planning, direction and guidance in its hands. To achieve this objective, a proposal was made to amend the Constitution, transfer entry 29 of the State List on weights and measures to the Concurrent List and to delete it from the State List. All the States agreed to this proposal.

Amendment of the Constitution is, however, not an easy matter. It takes a long time. It was, therefore, decided that the States should accept central planning, guidance and direction in enforcement of weights and measures and set up adequate institutions for enforcement on an approved pattern until the amendment could be made.

ENFORCEMENT THROUGH CO-ORDINATION

With these considerations in view, the Standing Metric Committee of the Government of India which was converted into a permanent

Directorate of Weights and Measures in 1962, was entrusted with the task of co-ordinating, guiding and directing the State activities on a uniform basis. This was achieved without waiting for the amendment of the Constitution, by supplying models of *Weights and Measures (Enforcement) Act* (*see* Appendix 5) and the Rules under it, which contained the technical specifications of the various types of weights and measures and weighing and measuring instruments, to the States for uniform adoption. The States duly adopted them. These model Acts and Rules are amended from time to time in consultation with the States to incorporate new specifications or to extend the scope of the Act or Rules.

Besides the Directorate of Weights and Measures, there are three other central bodies which also carry out important functions in the field of weights and measures. These are the Indian Standards Institution (ISI), the National Physical Laboratory of India (NPL) and the Government of India Mints, particularly the one at Bombay. A short description of each of these organizations is given below.

DIRECTORATE OF WEIGHTS AND MEASURES

The Directorate of Weights and Measures was made responsible not only for supplying the States with the model laws but also for surveying continuously the extent to which the metric system and the new weights and measures were being adopted in various spheres. It was essential to keep a constant watch on every aspect of the change-over, if quick results were to be achieved. For this purpose, four liaison organizations have been set up by the Central Directorate of Weights and Measures at Delhi, Bombay, Calcutta and Madras. These liaison organizations are the eyes and ears of the Central Government and carry out detailed surveys of the extent of the change-over in every field of national economic activity.

Speaking organizationally, the Central Directorate of Weights and Measures is responsible for the implementation of *Standards of Weights and Measures Act, 1956* (*see* Appendix 3), duties arising out of the Act and the co-ordination of all activities in relation to weights and measures. The principal units defined in the Act are the six basic units of the internationally recognized *Système International d'Unités* (SI), namely, the units of length, mass, time, intensity of electric current, thermodynamic temperature and luminous intensity. The various secondary units prescribed under the Act along with the fundamental units constitute the standards of mass and measure which have to be enforced in all spheres.

The Central Act is applicable to all undertakings and all classes of goods, and so covers an extremely wide field. It is in implementation of this Act that the metric change-over is being effected. The Central Directorate is thus the principal agency through which the entire change-over to the metric system is effected in a co-ordinated manner in every sector of economic activity, and also the agency which co-ordinates the work of standardization of weights and measures and their enforcement. It is assisted in its work of co-ordination by the ISI, NPL and the Mints.

INDIAN STANDARDS INSTITUTION

In most of the advanced countries of the world, the agency for preparing standards for weights and measures is different from that which prepares specifications for goods. For example, in the United Kingdom, the Board of Trade looks after weights and measures while the British Standards Institution looks after industrial goods; so too in France, Germany, USA, Italy and other countries.

In India, however, there were too many tasks to be handled directly by the Government in the beginning in 1956, and the Indian Standards Institution had already established the necessary network to prepare specifications required by different industries. As an interim measure, therefore, it was considered convenient and economical to entrust the work of preparing standards for various types of weights and measures to ISI. To avoid conflict between the *Certification Marks Act* of ISI and the weights and measures laws, it was specifically ensured that the *Certification Marks Act* would not apply to the items covered by the weights and measures laws progressively. The simple principle followed was that the work of the *Organisation Internationale de Métrologie Légale* (OIML), briefly described later in this chapter (*see also* Chapter 1), represented the scope of weights and measures laws. ISI prepares the specifications for various types of weights and measures and weighing and measuring instruments to be covered under the weights and measures laws. The Central Directorate and a few Controllers of Weights and Measures from the States participate actively at all stages in the preparation of the standard specifications. When these specifications are ready, they are adapted by the Central Directorate to the requirements of enforcement laws and sent to all the States and Union Territories for uniform incorporation in their Weights and Measures (Enforcement) Rules. ISI is thus acting as a technical body for advising on the problems of preparing specifications for weights and measures.

NATIONAL PHYSICAL LABORATORY

The second organization which plays an important role in the field of weights and measures is the National Physical Laboratory (NPL), in New Delhi (*see* Chapter 9). The National Physical Laboratory is the custodian of the prototypes of the kilogram and the metre. It also maintains the standards required for realizing in practice the other four units besides mass and length. The NPL undertakes periodical verification of the reference standards of weights and measures supplied by the Centre to the States. In order to encourage the manufacture of accurate balances, the NPL gives the industry technical advice with constructive suggestions to improve their products. It is a matter of satisfaction that the Indian industry has used the advice to advantage and developed from indigenous resources, high quality standard equipment for which there is now a demand from many other countries.

Model Approval — It is intended to take up in the near future what is called 'model approval' of weights, measures and weighing and measuring instruments. Under this scheme, every manufacturer would have to submit, before regular production is allowed, one or more models of his product to the prescribed authorities for approval tests. The approval tests would be thorough. They would establish whether the weight, equipment, etc, proposed to be produced, would retain the required accuracy over long periods of time and whether its performance would be according to the requirements of the law. This would ensure that weights, measures, etc, produced later could be relied upon for accuracy and performance during the periods between verifications. Such schemes are already being successfully operated in many developed countries and have proved very helpful. The *Organisation Internationale de Métrologie Légale* (OIML) has also recommended this scheme for adoption to all countries. It should be obvious that if this scheme is operated in India, besides the industry benefiting by improving the quality of its products, the consumer would also be a beneficiary, as his interest would be protected with complete assurance about the dependability of the product. The NPL will have to play an important role in implementing the scheme for model approval.

Advanced Training — A third basic activity which the NPL is already preparing itself to undertake, is imparting advanced training to weights and measures officials. Curriculum drawn up for this advanced training has created world-wide interest, particularly in the developing countries.

The training is to be in addition to the training the officials may receive at the All-India Training Institute of Weights and Measures at Patna (Bihar). It would cover the verification of more complicated instruments like taximeters and the principles involved in the verification of the more sophisticated standards like reference and secondary standards, or even instruments like automatic packaging machines, totalizers, automatic weighing machines, water-meters, electric meters and the like. The course of advanced training at the NPL would deal with these subjects in detail.

The NPL is also responsible for undertaking research and development activity in connection with the work being done at the international level by the *Bureau International des Poids et Mesures* (*see* Chapter 1).

THE MINTS

The Mint at Bombay, and to a certain extent the Mint at Calcutta, are also carrying out some basic activity which is important to the State weights and measures organizations. The reference, secondary and working standard weights and measures required by the States have been manufactured by the Mints, particularly at Bombay. A creditable feature of the work of the Mint is that this has been achieved with little or no expenditure of foreign exchange, except in the initial stages, for procuring some of the necessary equipment. The know-how has been developed by the Mint at Bombay and it now has a capacity to produce accurate standards of various types which can be utilized by the industry in this country, thus saving foreign exchange required for importing standards and gauges. As stated earlier, many countries have imported the standard weights and measures produced by the Mint in competition with what is offered by developed countries.

OIML — The *Organisation Internationale de Métrologie Légale* (OIML), referred to above, is an inter-governmental organization set up under a convention to evolve international laws and practices in the standardization and enforcement of weights and measures. India has been its member since 4 October 1956 when the President of India signed the Instrument of Ratification. The OIML consists of 3 main bodies, namely, the International Conference of Legal Metrology, the International Committee of Legal Metrology (CIML) and the International Bureau of Legal Metrology.

The first is the policy-making body which meets every six years. India is represented on it by the Central Ministry currently dealing with weights and measures. The second is the executive body the membership of which consists of one representative of each member country. This Committee meets every two years. India is represented on it by the Director of Weights and Measures. The Bureau acts as the Secretariat of the OIML.

To advise the President of the OIML on matters to be discussed at the meetings of CIML and the International Conference, there is a Presidential Council consisting of eight members. It meets once a year. India is a member of the Presidential Council, and is represented by the Director of Weights and Measures.

The OIML lays down recommendations on weights and measures laws, the organization for enforcing them and training, and prepares specifications for the various types of weights and measures which are to be used in industry, trade and other fields. The Convention prescribes that these international standards should be uniformly adopted by the participating countries, thus facilitating world-wide trade and industry, besides unifying weights and measures practices in the country concerned. The OIML works through a number of Working Groups which undertake, in collaboration with the interested member countries, the development of specifications of various items. India is at present participating in the work of about 40 Working Groups out of 70 which have been set up so far; it holds the Secretariat of the Working Group set up to standardize the equipment used in Legal Metrology Offices. The

Working Group has already started functioning, and five to six specifications for standard weights and measures are now under consideration. The first meeting of the Working Group was held in New Delhi in December 1968.

TRAINING OF INSPECTORS

There are numerous inter-State activities which require co-ordination. One such activity is the training of inspectors. Over 1 200 inspectors of weights and measures are working in the States and the Union Territories. These inspectors have to be trained uniformly so that the verification practices do not differ from region to region and State to State. The inspectors are imparted preliminary training which consists of a 3-month course at the All-India Training Institute of Weights and Measures at Patna, according to a curriculum laid down by the Centre in consultation with the States. All the States and Union Territories are expected to send their inspectors for this preliminary training. Advanced training, as stated earlier, which follows the course at the Institute at Patna, is given at NPL.

Even after being trained, the weights and measures officials require handbooks and manuals for ready reference in the course of their work. A comprehensive *Manual for Inspectors of Weights and Measures* is being compiled by the Central Directorate of Weights and Measures, which would describe, in detail, the various operations of verification, inspection and other work which they have to undertake as a part of their technical and other duties under the *Weights and Measures (Enforcement) Acts* and the Rules.

At the All-India Training Institute of Weights and Measures in Patna
A class receiving theoretical instruction in progress

Besides compiling the Manual, certain text-books on technical aspects of weights and measures, such as the principles and practices

Inspector trainees carrying out practical work in the laboratory

A demonstration of the working of the comparator for testing length measures arranged for inspector trainees

of construction of weighing and measuring instruments and the application of the various principles of physics to them have also to be compiled. The text-books and *Manuals* of other countries do not always suit Indian needs because they cannot be expected to cater for the Indian requirements and cover the local conditions.

There are certain other inter-State problems which have cropped up during the last ten years to which attention is now being given. These are discussed later in this chapter.

STATE ENFORCEMENT ORGANIZATIONS

The development of organizations of weights and measures in most States took place during the last decade. Only in the States of Bombay and Hyderabad was an organization functioning from pre-Independence days. After Independence (1947), organizations were set up in some States like Bihar, Punjab or the Union Territory of Delhi. In most other States, although weights and measures acts had been passed before the decision was taken to introduce the metric system, the facilities for verification and inspection were of the most rudimentary character. In some States, the police were expected to carry out verification and inspections of weights and measures in addition to their normal duties. In others, ordinary tin-smiths had been empowered to adjust and correct weights and measures. The picture was one of utter and general neglect in a sphere of vital importance to the people.

The first task, therefore, was to clear away the cobwebs of these crude and primitive practices and concepts, and then to undertake the setting up and equipping of viable and modern organizations of weights and measures in the States. In order to do so quickly, it was decided that the Central Government should render financial assistance to the States for setting up their organizations. Fifty percent of the expenditure on them was treated as grant-in-aid, while the remaining 50 percent was given in the form of loans. It was expected that with the extension of the work of the weights and measures organizations, the income collected by them through fees, would make them self-sufficient within a few years. With further extension of their activities, the income was likely to exceed expenditure. A guiding principle was, however, kept in view. The weights and measures organizations should not be considered as merely revenue-earning machinery. The fees charged for verification were really meant to cover the expenditure incurred by the Government in undertaking a service — a social and economic service — which is essential for protection from fraud of millions of people as consumers, and for ensuring a healthy growth of the industry and trade of the country. The earning of revenue was of secondary importance to the basic service being rendered to society.

The early effort had to be on a modest scale, in view of lack of experience in the country. Small nucleus organizations were set up in the States. They were then expanded as the law was extended to cover more categories of weights and measures. It was expected that with the passage of time and the progress of trade and industry in the country envisaged in the Five-Year Plans, the State organizations of weights and measures would also expand to meet the growing volume of work. The experience of the Bombay Weights and Measures Organization which had been functioning for about 25 years, though in a limited sphere, was utilized for formulating the basic pattern of the weights and measures organizations in other States.

PATTERN OF ORGANIZATION

The general pattern envisaged that an independent organization of weights and measures should be set up in every State with a controller of weights and measures at the head so that he could seek orders directly from the Government. Under him would be a number of deputy controllers, assistant controllers, inspectors of weights and measures and other staff who would supervise and carry out the day-to-day work.

The inspector of weights and measures was taken as the basic unit of the organization. He was to be assisted by what may be called, an inspectorial unit. This unit should consist of an inspector of weights and measures, a manual assistant who should help the inspector with routine stamping and a peon who should have the charge of heavy equipment and other arrangements which are necessary for the office or camp office of the inspector. A clerk should also be attached to this unit where the correspondence work justified it. An inspector was expected to undertake the verification and inspection work of weights and measures used in one *tehsil* or 2 revenue subdivisions in rural areas and 2 000 to 3 000 shops and establishments, though not industries, in urban areas. Generally speaking, the inspector was responsible for the verification of weights and measures of about 2 000 to 3 000 establishments in rural as well as urban areas, the number varying with the size of the area he had to cover, its terrain and facilities of communications. For example, in highly developed States like Maharashtra or Gujarat, where the inspector could travel by railway, bus or Government transport, and where road communication was good and establishments were situated in a concentrated area, the inspector could handle comparatively more work than an inspector in the hilly or tribal areas of Assam or Orissa, where communications are poor, and in Himachal Pradesh or Kashmir, where he may have to carry the equipment on mule back.

In order to provide adequate supervision and to open adequate avenues of promotion to inspectors, it was recommended that for every 8 inspectors of weights and measures, there should be one assistant controller who should be a gazetted officer. Further, for every two assistant controllers, that is, for every 16 inspectors, there should be a deputy controller. Thus, the deputy controller would have under him two assistant controllers and 16 inspectors. The headquarters would also have one deputy controller to assist the controller with his work and an assistant or deputy controller who could take charge of the reference standard laboratory and other technical and administrative work as may be necessary.

Although this pattern was laid down for general acceptance, certain difficulties had to be faced in actual implementation. For example, in some States, the weights and measures organization was working as a part of, say, the Industries Department. The inspectors often had to carry out the work of not only weights and measures but also that of industries. Such an arrangement caused neglect of both. The norms of work indicated above were applicable to a full-time inspector, and it was not reasonable to expect him to undertake other tasks without detriment to his principal work. A review of the organizational pattern is now under study in the light of past experience and future requirements.

NEW TRENDS

The staffing pattern was based on the workload generated by the verification of weights, measures and weighing and measuring instruments every two years except those used by factories and railways which were verified every year.

With experience, and in the light of practices in other countries and the needs of trade and industry in India, it was necessary to change the periods of verification in a number of cases. As a result, all measuring instruments generally, all weights and weighing and measuring instruments used in the bullion, precious stones and petroleum trade, and those used by a factory, as also platform machines and weigh-bridges, are now to be verified every year. These changes created more work for the inspectors because a number of items which earlier required verification every two years were now expected to be verified every year. Consequently, old criteria for estimating the workload of inspectors became largely outmoded. The 25-year old system based on shops and establishments had not proved useful when applied to the conditions of a fast-developing new India. Another set of criteria based on a more realistic approach, for example, on the basis of the time required for the various activities of an inspector is now being evolved in consultation with the States. This work would also involve preparation of model recruitment rules for the Weights and Measures Organization, making the inspectors more mobile by giving them vehicles, reduction in paper work they have to do and study of several other connected matters.

RESPONSIBILITIES OF INSPECTORS

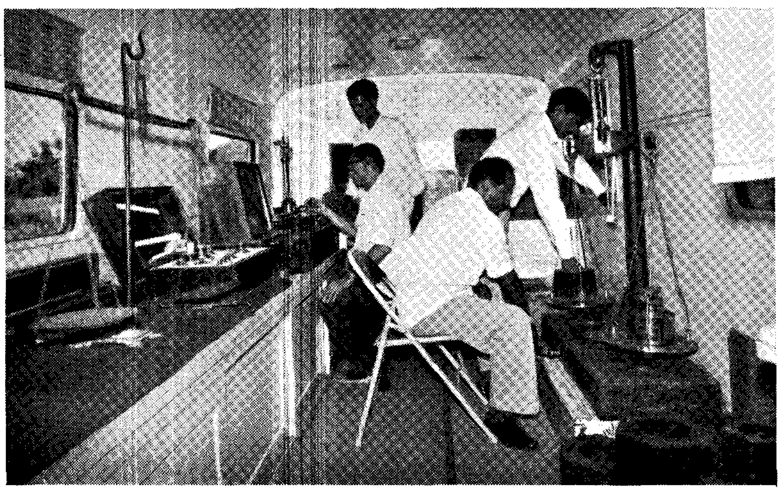
In order to ensure that the accuracy of weights and measures used in the country in trade and industry was related to the international prototype, it was prescribed by law that the Centre should supply to each State reference standards of weights and measures certified in terms of the international prototype by NPL (*see* Chapter 9). There is one such set of reference standards for each of the States and Union Territories. Sets of secondary standards of weights and measures are installed in selected regions by the States. These secondary standards are compared with the reference standards periodically. The secondary standards, in turn, are used for the calibration and verification of working standards of weights and measures used by the inspectors for verification of commercial and industrial weights and measures. Thus, a co-ordinated link between the weights and measures used in industry and trade and the international prototype of the metre and the kilogram was established.

In the beginning, the inspectors had also to undertake publicity work to propagate the introduction of the new system. They used to organize meetings of traders to inform them about the correct use of metric units. The inspectors used to solve the traders' difficulties on the spot. If a study was required, this was carried out by higher authorities. They also participated in exhibitions, seminars and other educational work.

As the introduction of new weights and measures progressed according to the phased programme, the old weights went into disuse gradually. People began to understand the importance of and facility offered by the new weights and measures through everyday use. The inspector, therefore, could devote more and more time to the increasing work of verification and inspection. In earlier stages, he carried out verification of the ordinary weights and measures used in provision stores, vegetable markets, cloth shops, etc. As the reform gathered momentum, the inspector had to attend to the verification of the more complicated instruments and learn new techniques. This necessitated that a regular training programme should be undertaken as indicated earlier at the Institute set up at Patna. The inspector's duties are onerous. He represents the Government to the general public whose interests he protects. He should, therefore, be well-qualified and adequately paid. He not only verifies weights and measures periodically but also inspects them frequently and seizes the false ones. He has to process cases against offenders in courts of law. He has progressed from the verification of ordinary cast-iron weights to the verification of complicated instruments like taximeters, water-meters and electronic weighing machines. With the revision of laws, his responsibilities will increase considerably.

It is necessary to give the inspector mobility, if he is to render his duties effectively and to serve the public properly. Mobile laboratories have been made available in which the inspector can keep his instruments and take them directly to the markets for verifying traders' weights and measures. These laboratories have proved a boon to the inspectors and the people.

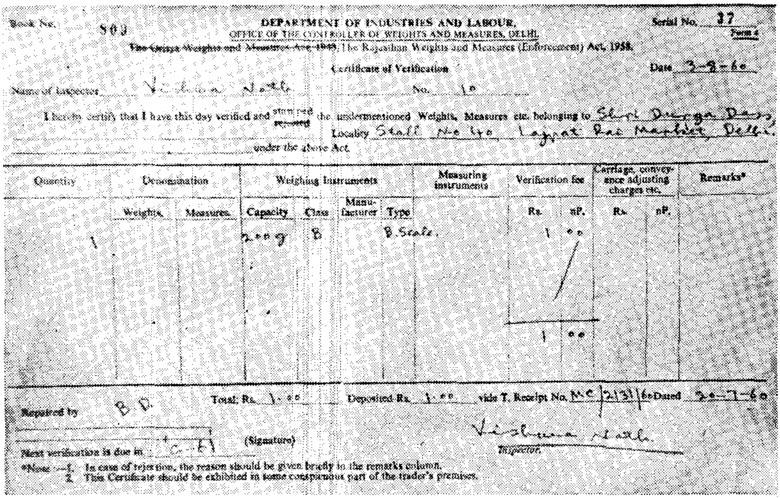
One or two other aspects of verification work may be touched upon. The inspector usually camps at a place, and traders within the vicinity are expected to submit their weights and measures for verification to him. In order that their normal trade should not be disrupted, licensed repairers are allowed to collect traders' weights and measures, clean them, repair and paint them, as may be necessary, and get them verified by the inspectors. The repairers give on loan sets of weights and measures for the use of traders.



Inside of a mobile van which carries verification service to outlying rural areas

As soon as their own weights and measures are verified and stamped, the repairers return them to the traders along with the certificates of verification which the traders are expected to display prominently in their shops.

Special arrangements are made for verification of instruments like weigh-bridges, petrol pumps and the like which cannot be moved from their sites. Verification of weights and measures is carried out at manufacturers' premises also if the workload justifies it.


Book No. 503 DEPARTMENT OF INDUSTRIES AND LABOUR, Serial No. 37
OFFICE OF THE CONTROLLER OF WEIGHTS AND MEASURES, DELHI. Form 4
~~The Punjab Weights and Measures Act, 1949~~, The Rajasthan Weights and Measures (Enforcement) Act, 1958.
Certificate of Verification Date 3-8-60
Name of Inspector ______ No. 10
I hereby certify that I have this day verified and stamped ~~rejected~~ the undermentioned Weights, Measures etc. belonging to ______ Locality ______ under the above Act.

Quantity	Denomination		Weighing Instruments				Measuring instruments	Verification fee		Carriage, conveyance adjusting charges etc.		Remarks*
	Weights	Measures	Capacity	Class	Manufacturer	Type		Rs.	nP.	Rs.	nP.	
1			2.00 g	B		B. Scale		1	00			
								1	00			

Repaired by B.D. Total: Rs. 1.00 Deposited Rs. 1.00 vide T. Receipt No. MC 2131 Dated 30-7-60
(Signature)
Next verification is due in ______ Inspector.
*Note :—1. In case of rejection, the reason should be given briefly in the remarks column.
2. This Certificate should be exhibited in some conspicuous part of the trader's premises.

Specimen certificate of verification issued by inspectors of weights and measures to traders

INTER-STATE PROBLEMS

With the implementation of the weights and measures reform, a number of problems of inter-State character have been thrown up which have to be resolved. These problems arise out of the fact that the enforcement laws apply only within the boundaries of the States, while the Central law has no provisions for enforcement even for inter-State purposes. One of the inter-State problems discussed earlier, relates to the training of inspectors.

A second problem is connected with the indication of the contents on pre-packed commodities particularly when such commodities are introduced in inter-State trade. The third problem of inter-State character relates to the sale of weights, measures and weighing and measuring instruments manufactured in one State, for use in another State. A fourth problem relates to model approval. Under present conditions, every manufacturer of weights and measures would have to submit models to every State and Union Territory separately for approval. The confusion and the unnecessary multiplication of work that could emerge out of this procedure can well be imagined, when we note that there are

17 States and 10 Union Territories in India today. With the continuous expansion of trade and industry, inter-State problems are bound to increase. It is necessary to devise solutions quickly. This is being done through a full revision of Central and State laws on weights and measures and, if necessary, also the Constitution.

EXPANSION OF ACTIVITIES

In the olden times and up to about 100 years ago, the field of weights and measures was considered to be restricted to the weights and measures used by ordinary traders in their day-to-day transactions, that is, it was confined to purchase and sale of commodities. With industrial development, it was realized in European countries that weights and measures were equally or even more important for industrial production. In recent times, the interchangeability of parts and components has become a basic industrial requirement. Since assembly plants receive parts and components produced in different firms, the need for guaranteed accuracy of gauges and measuring instruments has become pressing. Most European countries now offer the services of weights and measures departments for periodic calibration in terms of the national prototypes of measures and measuring instruments used in production in industry. In the UK, where the *Weights and Measures Act* had been applicable only to commercial activities, a Central Calibration Service which could undertake this work for the industry, has recently been set up under Government auspices. In the USA, a National Conference of Standards Laboratories has been established under the National Bureau of Standards to undertake such calibration work. Thus, the calibration and verification of weights and measures, whether they are used for commercial purposes or for industrial production or other such purposes, is now considered essential and is, in most countries, an activity of the weights and measures organizations.

India is now embarking on a vast programme of industrialization. It is essential that the services of the Central Directorate, NPL and States Weights and Measures Oganizations should also be made available in the field of calibration facilities to all industries — large, medium, small and cottage. Such well-organized periodic calibration facilities in terms of the national prototypes are not available at the moment even to large-scale industries. Small and medium scale industries are being set up at a fast rate. None of them can have its equipment calibrated and tested in terms of national prototypes, as in the case of commercial weights and measures. It is the duty of the State to provide such facilities. As the Constitution does not restrict the field of weights and measures to commercial activities, it should not be difficult to extend the facilities of the Weights and Measures Departments to such calibration in the near future.

Another new activity would be the periodical verification of measures and measuring instruments which are used for ensuring health and safety. The OIML is standardizing instruments like clinical thermometers, blood-pressure instruments, noise and illumination measuring instruments, radiation measuring instruments, etc. It is essential to cover the calibration of such instruments in the near future through appropriately equipped and staffed weights and measures organizations.

With a view to making it possible to undertake these new activities, solving inter-State problems and streamlining the operations of the Central Directorate and States Weights and Measures Organizations in accordance with the weights and measures laws, a Committee has recently been set up to examine and revise the entire range of the Central and State laws on weights and measures.

CONCLUSION

Starting from modest beginnings in the year 1956, the Central, State and Union Territory Governments have now set up weights and measures organizations, which are doing useful work. The total income earned by these departments in India exceeds ten million rupees*. It is likely that in the near future with the increase of fees, this income would be doubled. In several States, the expenditure on weights and measures organizations is less than the income earned. Thus, with the increase in fees from January 1968, in most of the States, the organizations have now either become self-sufficient or are approaching self-sufficiency. The work of

*Approximately US $ 1 330 000.

these organizations is co-ordinated by the Central Directorate of Weights and Measures. It is because of the co-operation of the States in enforcing uniform laws that India has been able to unify the entire country in relation to the use of a single system of weights and measures. The fears expressed earlier that it may take India 50 or 100 years to achieve the task have been belied by experience. The people themselves have realized the need for unification of practice in this vital field of human activity, and India is now speaking one common language of weights and measures.

The work of standardization and enforcement of weights and measures in India is also related to the recommendations which are now being considered by the OIML. Some of the recommendations produced by the OIML are already being incorporated in the weights and measures laws. It will be our endeavour to catch up with the developed countries in as short a time as possible in this and other basic fields of human endeavour.

REFERENCE

1. MAINKAR (V B). A Decade of Metric Reform in India. *ISI Bull.* 19, 4; 1967, 172-77.

9

Basic Reference Standards

A. R. Verma
Satya Vir Gupta
P. C. Jain

Measuring any quantity means comparing it with an accepted, arbitrarily chosen unit for that quantity, and finding out a number which indicates how many times that unit is contained in that quantity. The length of an object, for example, is measured by finding how many times it is longer than a certain measuring unit of length.

The unit does not become effective in practical measurements until it has been physically realized, that is to say, embodied in the concrete form of a standard, based either on some natural phenomenon or chosen arbitrarily. In the metric system, the unit of length, the metre, which was originally defined as a ten-millionth part of a quadrant of the earth (a natural phenomenon), was later defined as the distance between the two fiducial lines engraved on a certain bar of platinum-iridium (a material standard), but now it refers to a certain number of wavelength of a particular radiation of light (an atomic manifestation of nature). The modern trend is to establish standards in terms of atomic phenomenon, since such standards are indestructible and superior in precision, stability, reproducibility and accessibility as compared with the material and terrestrial standards.

Under the metric system as at present defined, six basic units have been internationally recognized for measurement purposes. The basic international standards of these units are being maintained at the International Bureau of Weights and Measures (BIPM) at Sèvres, near Paris, under the authority of the General Conference on Weights and Measures (CGPM) (*see* Chapter 1). The maintenance of the corresponding national standards is the responsibility of the national laboratories, such as the National Physical Laboratory (NPL) in India. The legal enforcement of standards of weights and measures has been assigned in India to the State Governments under the overall supervision of the Weights and Measures Directorate of the Government of India. The work of co-ordination of legal metrology practices at the international level is being carried out by the International Organization of Legal Metrology (OIML) (*see* Chapter 1) with its central office at Paris.

NATIONAL PHYSICAL LABORATORY OF INDIA — ESTABLISHMENT AND FUNCTIONS

With the attainment of freedom the need for rapid development of science and technology in the country as a primary prerequisite for industrial progress was widely recognized. Towards achieving this objective, the Indian Council of Scientific and Industrial Research decided to establish a chain of national laboratories in the country. The National Physical Laboratory was one of the earliest under this programme. The foundation stone was laid by the Prime Minister, the late Shri Jawaharlal Nehru on 4 January 1947, and the main building was completed and formally opened by the late Deputy Prime Minister, Sardar Vallabhbhai Patel on 21 January 1950. The laboratory was fortunate in having the late Dr K. S. Krishnan, a Fellow of the Royal Society of UK, as its first Director. Under his able guidance, the laboratory grew into one of the important research and standards centres in the country. Incidentally, it was he who argued the case for India and other developing countries at the Eleventh General Conference of Weights and Measures (CGPM) in 1960, the first to be held after India had signed the Metric Convention in 1957. Until then, the membership dues to the CGPM were determined simply on population basis, which constituted quite a handicap for the well-populated developing countries to take advantage of the services of the International Bureau of Weights and Measures. As a result of Dr Krishnan's intervention, the new basis described in Chapter 1 was adopted.

FUNCTIONS OF THE LABORATORY

The main objectives of the laboratory are:

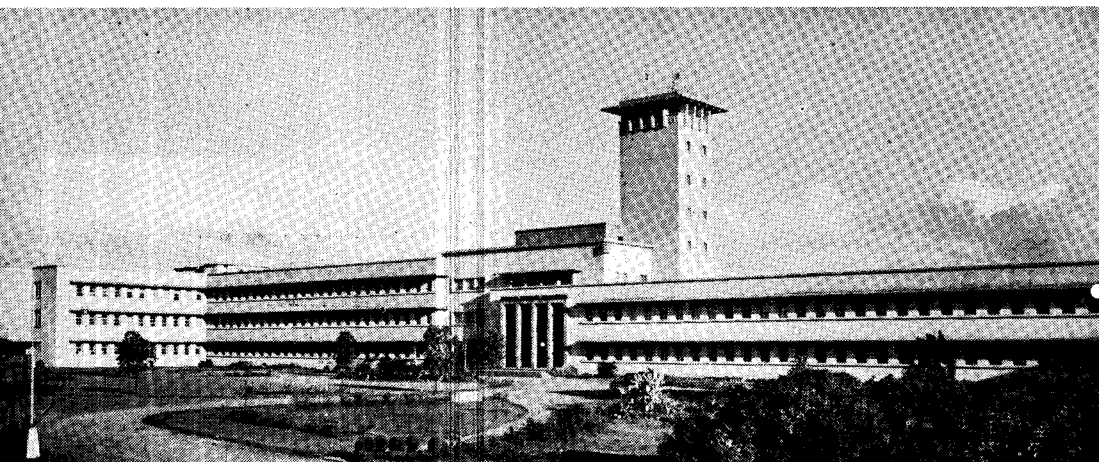
1) to maintain and to do research on fundamental and derived standards and industrial testing,

2) to do research on applied physics with a view to helping industries,

3) to carry out fundamental scientific research arising out of its work under (1) and (2) above, and

4) framing of and advice on specifications.

A view of the National Physical Laboratory, New Delhi



The laboratory has been applying itself, ever since its inception, to the implementation of the above objectives. The scientific work of the laboratory is being carried out in the following Divisions: Weights and Measures, Electricity, Optics, Heat, Mechanics, Acoustics, Basic Physics (including Theoretical Physics and Low Temperature Physics), Electronics, Materials, Material Analysis (Chemical Analysis and Physical Analysis), Solid State Physics and Radio Science.

BASIC UNITS AND STANDARDS AND THEIR MAINTENANCE AT NPL

The Eleventh General Conference of Weights and Measures in 1960 adopted the following six units to serve as basis for the establishment of a practical system of measurement for international purposes:

Metre	for length
Kilogram	for mass
Second	for time
Ampere	for intensity of electric current
Degree Kelvin	for thermodynamic temperature
Candela	for luminous intensity

The system based on the above six basic units is designated by the name *Système International d'Unités,* having the abbreviation 'SI' in all languages.

Metre — The fundamental unit of length is the metre, which is defined as equal to 1 650 763·73 vacuum wavelengths of the orange line emitted by the Krypton atom of mass 86 and corresponding to the transition between the atomic energy levels denoted by the spectral terms $2p_{10}$ and $5d_5$, the atom being at rest with respect to the observer.

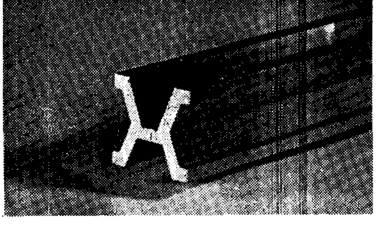
The metre was formerly defined as the distance between two graduation lines on the platinum-iridium (90 percent Pt, 10 percent Ir) International Prototype Metre which, with various copies, is preserved at the International Bureau of Weights and Measures, Sèvres, near Paris.

The new definition of the metre relates it to a constant of nature, the wavelength of light, which is immutable and can be reproduced with great accuracy (within 1 part in 100 million) in any well-equipped laboratory, and is at least 10 times more precise than readings taken on the international prototype metre or any other material standard used as a means of defining the unit of length. It is now no longer necessary to return the national standards of length to Paris for periodic re-checking. However, the metre bars which have served as standards of length throughout the world for over 70 years will not be discarded because of this decision. They will remain important because of the ease with which they can be used for certain types of measurements and for comparison measurements between national laboratories. They will also always remain useful for measurements at second highest level of accuracy, which would be high enough for most metrological purposes.

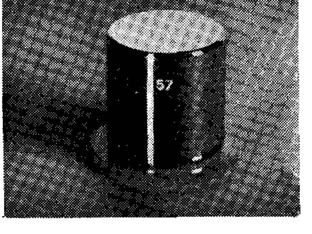
Of the various national platinum-iridium copies of this International Prototype Metre, the Indian copy No. 4, is in the custody of the National Physical Laboratory, New Delhi.

Kilogram — The fundamental unit of mass is the kilogram, defined by a material standard known as the International Prototype Kilogram. This standard is in the form of a simple cylinder of platinum-iridium alloy (90 percent Pt, 10 percent Ir), of height equal to its diameter. By definition, the mass of this prototype represents the kilogram unit of mass.

The International Prototype Kilogram and its principal copies (temoins) are preserved at the International Bureau of Weights and Measures. The Indian copy of the kilogram, No. 57, is in the custody of the National Physical Laboratory, New Delhi. Though there is no fixed routine for re-verification of the National



Indian National prototype metre No. 4, preserved at the National Physical Laboratory, New Delhi



Indian national prototype kilogram No. 57, preserved at the National Physical Laboratory, New Delhi

Prototypes, it can be re-verified, whenever desired, at the International Bureau of Weights and Measures in terms of the International Prototype.

Second — The fundamental unit of time-interval is the second, which has been defined by the Thirteenth General Conference of Weights and Measures in 1967 as follows:

> 'The second is the duration of 9 192 631 770 periods of the radiation corresponding to the transition between the two hyperfine levels of the fundamental state of the atom of cesium 133.'

Formerly, the Eleventh General Conference of Weights and Measures in 1960 had defined the second as the fraction 1/31 556 925·974 7 of the tropical year for 1900 January 0 at 12 h ephemeris time.

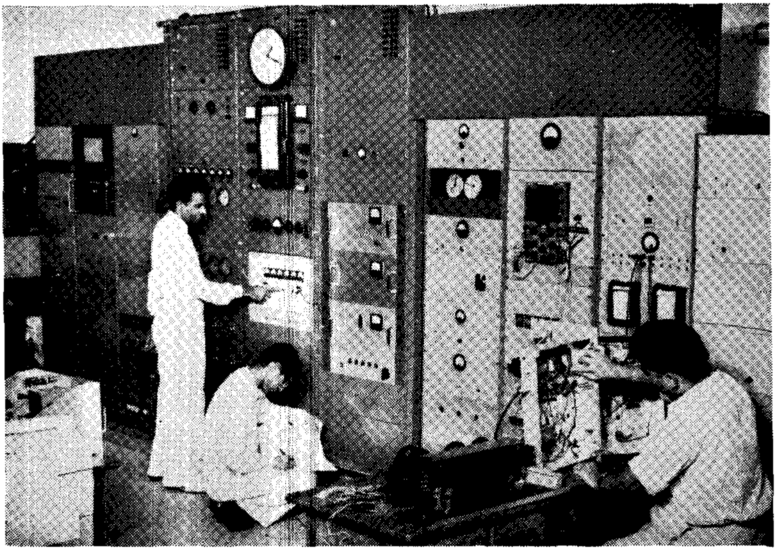
NPL daily broadcasts at 10 Mc/s (30 metres) the standard time and frequency signals from its transmission station ATA at Kalkaji (New Delhi) from 11 hours to 15 hours Indian Standard Time [0530 to 0930 UT (GMT)]. The time signals are correct to a millisecond per day and the frequency is constant to 1 part in 100 million over a nominal value.

This high precision is maintained by the continuous comparison of the standards among themselves and by the check up of time signals against those received from similar stations established in other countries, such as JJY in Japan and WWV in the USA. These time signals can be heard over the whole of South Asia.

Ampere — The fundamental unit of intensity of electric current is the ampere, which is defined as the intensity of a constant current which, if maintained in two parallel, rectilinear conductors of infinite length, of negligible circular cross-section and placed at a distance of one metre from one to the other in vacuum, will produce between the conductors a force equal to 2×10^{-7} newtons per metre length, the newton being defined as a unit of force required to give one kilogram mass an acceleration of one metre per second per second.

The definitions of other electrical quantities, such as volt, ohm, coulomb, farad, henry and weber all depend on that of the ampere (*see* Appendix 1).

The National Physical Laboratory maintains, under carefully controlled conditions, the units of absolute ohm and absolute volt



Monitoring station at NPL, New Delhi, for ATA transmission of time signals

in the form of banks of stable manganin coils and Weston cadmium cells. These are regularly inter-compared among themselves and cross-checked against the British and German standards from time to time to ensure that at any time their values are accurate to better than one part in a million.

Kelvin — The fundamental unit of thermodynamic temperature is the Kelvin, which was defined by CGPM in 1967 as follows:

> 'The Kelvin, unit of thermodynamic temperature, is the fraction of 1/273·16 of the thermodynamic temperature of the triple point of water.'

The thermodynamic Kelvin scale is recognized as the fundamental scale to which all temperature measurements should ultimately be referred. But experimental difficulties in utilizing the methods of thermodynamic measurements have led to the adoption of a practical scale called the International Practical Scale of Temperature. It is realized with the help of specified platinum-resistance thermometers, rhodium-platinum versus platinum thermocouples and optical pyrometers (using Planck's law of radiation), calibrated at certain 'defining fixed points'.

These defining fixed points available at NPL are as follows:

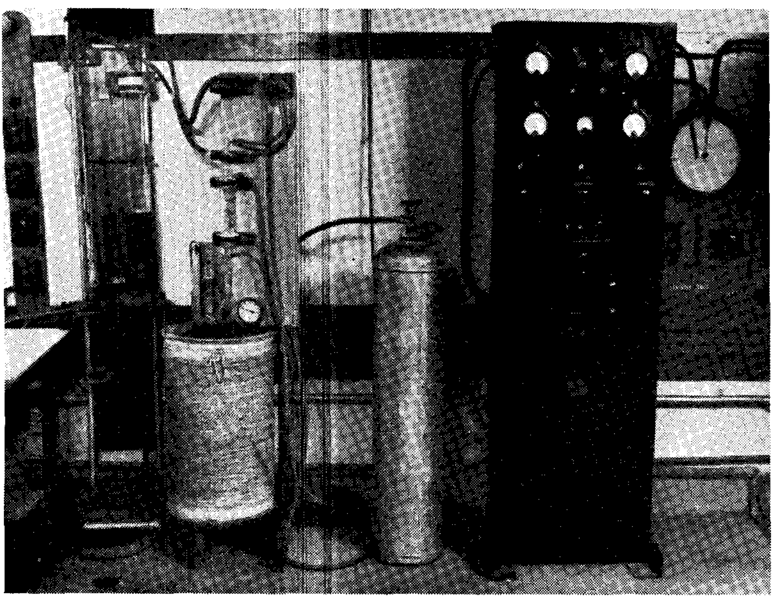
1) Boiling point of oxygen (at 1 atmosphere)	$-90{\cdot}19°K$
2) Triple point of water	$0{\cdot}10°C(273{\cdot}16°K)$ exact
3) Freezing point of tin	$231{\cdot}97°C$
4) Zinc point	$419{\cdot}58°C$
5) Silver point	$961{\cdot}93°C$
6) Gold point	$1\ 064{\cdot}43°C$

Below the oxygen point, the vapour pressure scales as well as the platinum-resistance thermometer scale are at present used in NPL.

The National Physical Laboratory maintains the temperature unit from 90°K upwards, with the accuracy: 0·2 deg near 90°K, 0·001 deg near 0°C, 0·002 deg near 100°C and 2 deg at 1 800°C.

Candela — The primary standard of light is a full radiator (black body) at the temperature of solidification of platinum (2 042°K approx). The fundamental unit used in photometry is the unit of luminous intensity or candela which is defined as one-sixtieth of

Steam point apparatus for calibration of platinum-resistance thermometers at NPL, New Delhi



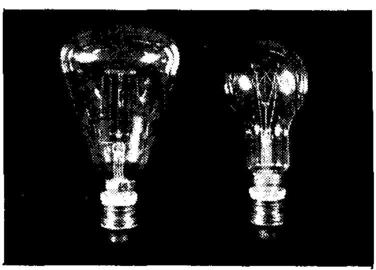
the luminous intensity per square centimetre of the full standard radiator.

In 1967, the Thirteenth General Conference of Weights and Measures re-stated the definition of candela in the following manner:

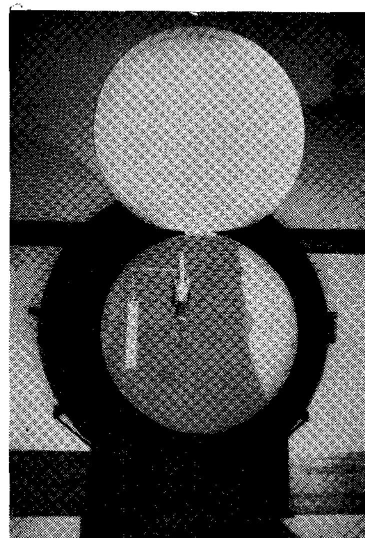
> 'The candela is the luminous intensity, in the perpendicular direction, of a surface of 1/600 000 square metre of a black body at the temperature of solidification of platinum under the pressure of 101 325 newtons per square metre.'

NPL maintains the secondary standards of light, which have been derived from the primary standard at the International Bureau of Weights and Measures. They are specially made incandescent lamps and comprise those of (1) Luminous intensity, (2) Luminous flux, and (3) Colour temperature.

Besides the basic reference standards, there are other derived standards which are needed to be established in the interest of industrial development of the country. NPL is conscious of this and is working constantly towards meeting this need. For example, with large production of proving rings in the country, the need for maintaining the standard of force arose and a 3 000 kgf dead weight machine designed and fabricated from indigenous resources



Standard lamps at NPL, New Delhi, for luminous flux measurements



Spherical integrator at NPL, New Delhi (opened up to give inner view), used to measure light output of lamps has been recently commissioned in the NPL. The design and manufacture of machines of larger capacities are in progress.

Similarly, with the increasing use of VHF, UHF and microwaves in India for radars, communication systems, navigation, research and education, the importance of standard methods for accurate measurement of radio frequency power has been realized, and the NPL has established facilities for accurate measurement of rf power in the range of 0·1 milliwatt to 10 watts for frequencies up to 10 kilomega-cycles per second, with an accuracy of about 2 percent. These facilities would be useful for calibration of rf power meters generally used for direct measurement of power in experimental work and in instruments like signal generators.

NPL'S ROLE IN THE IMPLEMENTATION OF THE METRIC SYSTEM

The Council of Scientific and Industrial Research (CSIR) in general and the NPL in particular played a very important role in the introduction and subsequent implementation of the metric system in the country. Dr S. S. Bhatnagar, FRS, Director, Scientific and Industrial Research, represented CSIR on the Special Committee on Weights and Measures constituted by the Indian Standards Institution (ISI) in 1948. The Committee submitted its report to the Government of India in December 1949 recommending a phased programme of change-over to the metric system over a period of 11-15 years (*see* Chapter 2). In 1955, the Government of India finally decided to change over to the metric system, in pursuance of which the *Standards of Weights and Measures Act* was passed by the Indian Parliament in December 1956.

The National Physical Laboratory was associated with this legislation right from the drafting stage of the Act and was actively concerned with the work of the Standing Metric Committee (SMC), a co-ordinating body set up at the Central Government in 1956 representing ISI, Planning Commission, NPL and various Ministries of the Government of India. Apart from maintaining the national prototypes and other derived standards, which is its statutory responsibility, the NPL has rendered valuable assistance on many technical and scientific matters related to the implementation and enforcement of the metric system.

Commercial Weights and Measures — The assistance given to the Standing Metric Committee by NPL started with the drafting of the technical content of the *Standards of Weights and Measures Act, 1956*. A close liaison was maintained with it thereafter. The Laboratory was later requested by ISI and the SMC to undertake investigation on permissible errors prescribed in different countries on various grades of standard and commercial grade weights, linear measures and capacity measures, and to suggest suitable limits of errors to be prescribed in this country. Coherent series of permissible errors on all types of weights and measures, from the most accurate standards to the coarsest commercial grade types were worked out. These were later adopted in all Indian Standards and in Weights and Measures Enforcement Rules of the States.

With a view to assisting the relevant ISI Committee in drafting Indian Standards, a large number of experimental sets of commercial grade weights of different shapes and designs were prepared. From among these, the following four grades of commercial weights were considered most suitable, and their dimensions and other characteristics were adopted:

1) Cast-iron weights (50 kg to 50 g);

2) Ordinary brass weights 1 kg to 1 g nesting type and 500 mg to 1 mg sheet metal weights;

3) Bullion weights of two types, namely:

a) 20 kg to 1 g cylindrical weights and 500 mg to 1 mg sheet metal weights, and

b) 1 kg to 1 g nesting type weight and 500 mg to 1 mg sheet metal weights; and

4) Carat weights:

a) 500 carat to 5 carat knob weights, and

b) 2 carat to 0·005 carat sheet metal weights.

This involved several months of work for calculations, fabrication and verification. Similar work was also carried out to arrive at a suitable design for conical commercial capacity measures and other linear metric measures.

Popularization of Metric Weights — The Laboratory also supplied complete demonstration sets of various commercial grade weights to all the States and Union Territories before the initiation of the metric system in the country with a view to enabling the authorities and the public to familiarize themselves with the new weights. This proved very helpful in popularizing the metric weights.

Manufacture of Metric Weights — The metric commercial weights were introduced in 1958 in certain areas in the country. These weights were to be manufactured in accordance with IS : 1056-1957 'Specification for commercial metric weights'. The manufacturers of commercial weights were unable to manufacture the new weights as they neither possessed any standard metric weights for checking the mass of weights produced by them nor could the weights and measures enforcement departments in different States take up the job of adjustment for them. These weights, therefore, could not be made available in the market for a considerable length of time. Great difficulty was thus experienced in effectively introducing the new weights. The Laboratory then offered to adjust and certify all grades of commercial weights, including cast-iron weights for the use of the manufacturers as their reference standard weights. The manufacturers were asked to make 'over-weight' weights and send them to NPL for necessary adjustment. These weights were adjusted to a nominal value plus half the positive tolerances allowed on this grade of weights. The Laboratory also offered to give necessary training to the manufacturers of cast-iron weights and to provide them with necessary details regarding patterns. Prospective manufacturers of metric weights all over the country were informed by the Standing Metric Committee about the availability of these services at the NPL and a large number of them took advantage of this facility.

Similar assistance was also given to several manufacturers of capacity measures by providing them with sets of adjusted capacity measures for use as their standards. The assistance rendered by NPL in these respects has proved to have been indispensable in ensuring an adequate supply of the metric weights and measures for the successful implementation of the metric system in India.

Standard Weights and Measures — Designs of reference, secondary and working standard weights and measures for the use of the enforcement departments were also worked out in collaboration with the India Government Mint, Bombay, which initially prepared twenty sets of reference standard weights, slightly 'over-weight' for ultimate supply to the various States. On receipt at the NPL, these weights were adjusted and suitably aged with a view to stabilizing their masses as far as possible. After ageing, the final adjustment of the masses was made again to bring them within the prescribed limits of adjustment tolerances before issuing the certificates. A very large number of secondary standard weights have been similarly certified. Many sets of secondary standard capacity measures in heavy admiralty bronze casting were also adjusted for their capacities and certified. This work took considerable time and effort as the adjustment of weights greater than 100 g denominations and of capacity measures generally is a laborious and time-consuming process.

Besides certifying standards of weights and measures for various States in India, NPL has certified the standards of weights, capacity measures and length measures supplied to other developing countries like Nepal and Ethiopia. This service continues to be available to other countries.

In addition to the duty of supplying reference and secondary standard weights, the re-verification of the reference standard weights and some of the secondary standard and working standard weights and capacity measures has also been carried out. This service will continue to be performed by NPL until such time as the enforcement departments of the States are fully equipped to re-verify themselves their own sets of secondary and working standard weights and capacity measures.

Balances for Weights and Measures Departments — For the enforcement of the metric system, the weights and measures departments required testing equipment including a number of balances with capacities ranging from 2 g to 50 kg. Providing suitable balances to them was a major problem as the question of importing these balances was more or less ruled out in view of the shortage of foreign exchange. The total requirements of the States departments came to about one thousand sets of balances costing about ten million rupees or 1·3 million US dollars. The Standing Metric Committee wanted the Laboratory to explore the possibility of meeting the entire requirement of inspector's balances as well as those of higher precision from local resources.

Working Standard Balances — Specifications for the required type of balances were drawn up and manufacturers of balances all over the country were contacted. A meeting of all those manufacturers was convened who were willing to take up the manufacture of the desired type of balances. They were asked to prepare sample balances and send them to the Laboratory for critical examination. Half a dozen manufacturers sent balances of the required capacities. These were given a very thorough and critical examination. Defects in design and faults in fabrication were pointed out and suggestions of a technical nature were made to the manufacturers concerned, thereby enabling them to improve upon the quality of their product. The manufacturers then re-submitted improved balances for further tests and the process continued until they were able to make balances of the desired quality. A number of manufacturers are now producing a complete range of the required type of working standard balances.

Secondary Standard Balances — The question of drawing up specifications for higher precision balances required by the enforcement departments for the verification of their working standard weights against the secondary standards held by them was then taken up and as a first step, suitable specifications were drawn up. Selected manufacturers were asked to make these precision balances and send them to NPL for critical examination. Two manufacturers submitted complete sets of secondary standard balances with capacities ranging from 2 g to 20 kg. These balances have now been approved after the suggestions offered by the Laboratory were incorporated. Every individual secondary standard balance to be used by a State is now required to be checked for its performance by the Laboratory.

Work on this project has constituted an important contribution from NPL, since it has not only helped the country in making a large saving in foreign exchange but has also resulted in the establishment of a flourishing new industry making high precision balances having important export capability.

Training Facilities — NPL has been taking active interest, right from the beginning, in imparting technical training to the representatives of the different industrial undertakings and of various scientific and technical institutions. As stated earlier, a large number of manufacturers of commercial metric weights, particularly those of cast-iron weights, took training in manufacturing techniques for the purpose.

At the request of the Ministry of Commerce and Industry, NPL arranged a one-week advanced training course in the testing of balances, weights, capacity measures and length measures for the senior personnel of the weights and measures enforcement departments of the States. This training included both theoretical and practical aspects of testing the above mentioned items as well as

Testing at NPL, New Delhi, of secondary standard balances for use by weights and measures enforcement departments adjustment and care of balance knife-edges. The training was given in small batches consisting of 6 to 8 officers, with a view to enabling each participant to carry out the testing of weights, balances and capacity measures individually. About 400 officers including most of the Controllers, Deputy Controllers, Assistant Controllers and Senior Inspectors from all the States and Union Territories participated in this training. This training has greatly helped the officers of the weights and measures enforcement departments in maintaining and checking their standards.

ROLE OF INDIA GOVERNMENT MINT

In the pre-metric days, India Government Mint was responsible for maintaining the standards of weights and measures, and for fabricating and supplying the authenticated copies of reference standards of weights and measures to different Provincial Governments and the Governments of Indian States and foreign settlements then situated in India. The Mint also used to train the weights and measures staff of Provincial Governments in the manipulation and testing of various standards.

During the course of the introduction of the metric system, the Mint again played an important role and maintained close liaison with NPL in working out the designs of various standards of metric weights and measures and the system of related tolerances.

Since the Mint already had full facilities and necessary equipment to fabricate certain categories of standards of weights and measures, it continued to fabricate these, which greatly assisted in the implementation of the metric system in the country. In particular, the Mint assumed the responsibility for fabricating and supplying the following categories of standards:

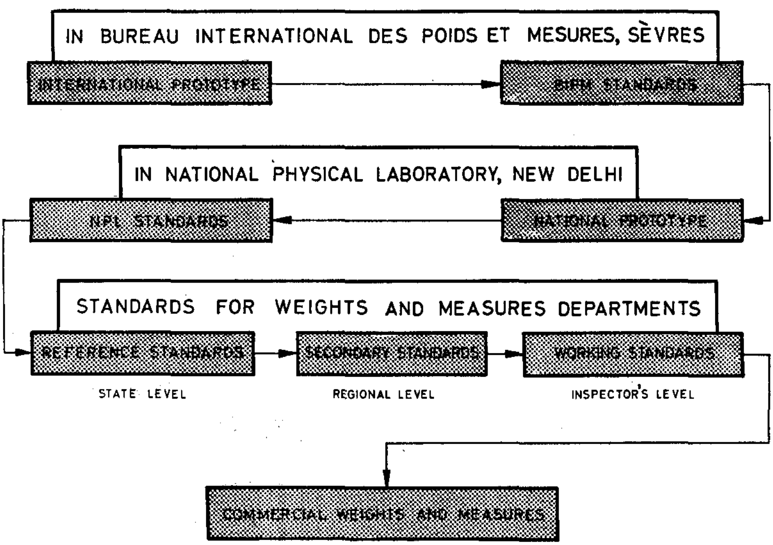
1) Reference standard weights,
2) Secondary standard weights,
3) Working standard weights,
4) Secondary standard metre bars,
5) Working standard metre bars,
6) Secondary standard capacity measures,
7) Working standard capacity measures, and
8) Copies of the comparator designed by NPL for the comparison of working standard metres against the secondary standard metres.

Besides fabricating the above mentioned items, which of course is a very laborious job requiring technical know-how and great skill, the Mint, with the help of NPL certified sets of reference and secondary standard weights, continues to supply direct to various weights and measures enforcement departments the sets of working standard weights. Similarly, with the help of certified copies of secondary standard capacity and length measures it supplies duly tested sets of working standard capacity and length measures to all the States of the country. The Mint is also undertaking the job of designing and fabricating the reference standard metre bars in co-operation with the NPL.

ECHELON OF STANDARDS

Practically in all the countries, there exist in general several intermediate standards between the commercial weights and measures and the relevant international prototypes.

The figure below gives the echelon of weights and measures standards in India in order of decreasing accuracies.



Echelon of weights and measures standards

In the following paragraphs a brief account is given to show how a common man's kilogram, the coarsest type of weight, is derived from the ultimate standard of mass, namely, the international prototype kilogram. All the other commercial measures are derived from the international prototypes more or less in the same manner.

INTERNATIONAL PROTOTYPE KILOGRAM

This weight of 90 percent platinum and 10 percent iridium alloy, cylindrical in shape and having diameter equal to its height, is kept under the custody of BIPM. This prototype kilogram is regarded as being the only weight, which possesses a mass of exactly one kilogram. All other standard masses are referred to it. With a view to conserving its mass and thereby its accuracy, reference to this standard is not made more than once in 50 years.

BIPM STANDARDS

A number of subsidiary platinum-iridium standards, which are copies of the international prototype, are maintained in BIPM for the purpose of verifying the national standards. These BIPM standards are also used sparingly, say, once in 5 or 10 years, the values of the mass of these standards are known within 0·001 mg, that is, to one part in 1 000 million.

NATIONAL PROTOTYPE KILOGRAM

The Indian national prototype kilogram No. 57 is in the custody of NPL. The mass of this prototype is 999·999 946 grams with an accuracy of ±0·010 mg.

NPL STANDARDS

The Laboratory maintains several grades of standards, the values of the mass of which are accurately known in terms of the national prototype kilogram. A standard kilogram of NPL may have an error less than 0·1 mg.

REFERENCE STANDARDS (STATE LEVEL)

Each of the 27 States and Union Territories in the country possesses one of reference standards set, comprising 28 masses from 5 kg to 1 mg denominations, which is maintained at weights and measures headquarter's laboratory in each State capital. The values of the mass of individual reference standard weights greater than 5 g are known to an accuracy of better than 1 part in a million (10^6), and for weights of smaller denominations including 1 mg weight, the precision is 0·010 mg. Tolerances of adjustment of weight in case of 1 kg weight of this set are +5 mg and −2·5 mg.

SECONDARY STANDARDS (REGIONAL LEVEL)

Each regional laboratory of the State possesses one set of secondary standard weights from 10 kg to 1 mg denominations, which is re-verified normally after every 5 years against the reference standard weights at the weights and measures headquarter's laboratory of the State. Tolerances of adjustment of weight in case of 1 kg weight of this set are +10 mg and −5·0 mg.

WORKING STANDARDS (INSPECTOR'S LEVEL)

Each Inspector of the States' Weights and Measures Departments is provided with one set of working standard weights with nominal values from 20 kg to 1 mg, which is periodically verified against the secondary standard weights, normally once a year. The error in 1 kg weight of this set does not exceed +20 mg or −10 mg. These are the weights which are constantly used for checking commercial weights of all grades.

COMMERCIAL GRADE WEIGHTS

There are four classes of commercial weights with different accuracies for use in different trades.

Carat Weights (500 Carats to 0·005 Carats) — These are small denomination weights with 500 carats (100 g) as the head weight. The weights are used for weighing pearls, diamonds and other precious stones. The permissible errors in these weights are half of those of bullion weights.

Bullion Weights (20 kg to 1 mg) — These weights are chiefly used in weighing gold, silver and other precious materials. The permissible error in 1 kg weight of this class is +50 mg or − 25 mg.

Other than Bullion Weights (1 kg to 1 mg) — These weights are less accurate than bullion weights and are used for weighing costly commodities and, if necessary, for supplementing the cast-iron weights. The permissible error in 1 kg weight of this class is +250 mg or −125 mg.

Cast-Iron Weights (50 kg to 50 g) — These are the coarsest of the commercial weights and are used for weighing ordinary commodities. The permissible error in 1 kg weight of this class is +1 000 mg or −500 mg.

All these commercial grade weights are normally re-verified once a year. For details of allowed tolerances, materials of construction, shapes, sizes, denominations and other characteristics of commercial grade weights, reference is invited to relevant Indian Standards listed in Appendix 7.

CONCLUSION

It will thus be seen that the introduction of the metric system in any large and developing country like India would require manifold and varied task to be undertaken on the scientific, technological and industrial fronts. In the performance of these tasks, a national laboratory like the NPL (India), could prove very useful. Though a standards laboratory is a necessity for every country, the maintenance of basic reference standards is very expensive and time-consuming. Hence the smaller developing countries may not be able to justify the high cost involved in setting up a full-fledged metrological standards laboratory for maintaining the highly precise basic reference standards of the type that NPL of India has in its custody. In such cases, either a collaboration may be worked out with the countries in the neighbourhood having such laboratories, or a liaison may be established with the International Bureau of Weights and Measures.

Ever since its inception, the National Physical Laboratory, India, has kept in view its objectives and contributed in a significant manner towards developing science, technology and above all, the industry in the country.

It is making a steadily increasing contribution towards the achievement of these objectives in India and is prepared to co-operate with the developing countries in the domain of metrological standardization. □

10

Equipment Required for Trade and Commerce

M. V. Patankar

The Standing Metric Committee of the Government of India, which had been set up following the decision to introduce the metric system of weights and measures, recognized from the very beginning that, if the metric system were to be made to prevail universally in the sub-continent of India within the ten-year plan period, it was essential that national standard specifications be prescribed and enforced for the various categories of weights and measures and weighing and measuring instruments. Thus, soon after its formation, the Committee addressed itself to resolve, *inter alia*, two problems on an urgent basis. One was how to prepare the standard specifications, and the other, how to create the necessary facilities for the production of weighing and measuring equipment in the country.

The question of preparing standard specifications was entrusted to the Indian Standards Institution (ISI) for study and action on priority basis. The problem of estimating the quantities of weights and measures which would be required to replace the old weights and measures and organizing their manufacture, however, presented some difficulties.

CHANGE-OVER TO NEW WEIGHTS, MEASURES AND INSTRUMENTS

ESTIMATE OF DEMAND

As described in detail in Chapter 11, the result of a special survey showed that arrangements would have to be made for the manufacture and supply of some 50 million pieces of standard metric weights.

In regard to weighing and measuring instruments, no estimate had been prepared. However, a rough estimate was made on the basis that the weighing and measuring machines in use should be twice the number of factories and railway stations in the country that existed on that date.

PROBLEM OF REPLACEMENT

The problem of replacement of weights and measures and weighing and measuring instruments had to be considered under two broad heads. Some weights, measures and instruments required complete replacement, while others could be used after suitable modifications and re-calibrations. Cast-iron and brass weights, yard measures, gallon and seer capacity measures and the like belonged to the first category, and had to be replaced, because there was no possibility of re-calibrating them to suit the requirements of the metric system. In the case of instruments like beam scales, counter machines, etc, it was possible to continue to use them with an indication of capacity in terms of the metric system. In case of other instruments like platform machines and weighbridges, suitable re-calibration had to be carried out.

The estimate of the number of metric weights and ordinary measures like metre bars and litre measures, which were required for replacement, brought out the magnitude of the problem. The production and distribution of millions of weights and measures was found to be possible only if a phased programme were adopted. But even this demanded that new production units should be created. Adequate facilities for this purpose were given to the producers of weights and measures as indicated later.

RE-CALIBRATION AND RE-ADJUSTMENT

In so far as re-calibration and re-adjustment of existing weighing and measuring equipment was concerned, the weigh-bridges, scales, meters, etc, used in the country, at the time of introduction of the metric system, were mostly either in fps system or in maunds and seers. The Railways, the largest users of weigh-bridges and platform machines, were following the maund-seer system. The industry, on the other hand, was by and large using the fps system. An expert group of the Standing Metric Committee studied this problem and came to the conclusion that it would be uneconomical and also time-consuming if all the existing weigh-bridges, platform machines and other weighing instruments were scrapped and new ones procured. Instead, the possibility of re-calibrating the existing machines to read in metric units was examined.

In the case of weighing instruments, the indication of weight is either by means of a pointer moving on a dial or by manually adjusting the slide poise on the steel yard. The latter type of equipment is of two kinds — with loose weights and with no-loose-weights. In the latter case, the sliding poise bears a definite ratio to the weight arm. In the case of dial machines, it is only necessary to re-calibrate the dial, keeping the rest of the machine intact, and in the case of no-loose-weight machine, while keeping the same slide poise the steel yard bar has to be replaced by a newly graduated bar. In the case of loose-weight machines, it would be necessary not only to re-calibrate the steel yard bar but also to change the size and denominations of the loose weights.

While on this question, the possibility of having double graduations as an interim measure was also examined. In certain cases where doubly graduated machines were already in existence, they were allowed to be continued till such time as they could be replaced through obsolescence or otherwise. However, it was made clear both to the users of the machine as well as the inspecting authorities that all weighments would be made and records maintained only in the metric system, and that the accuracy of the machine should be judged on the basis of the metric graduation only. For the purpose of conversion and re-calibration, an assessment of the repairing capacity available in the country was made, and guidance and assistance rendered through the Central Government and State Government agencies not only to the then existing manufacturers but also to new firms, which were encouraged to take up this service. This re-calibration programme was phased out in such a way that both the industry as well as the consumer were least disturbed. Although it was possible to re-calibrate a large number of pieces and varieties of equipment, there were certain types for which such a simple method was not possible. In those cases, as in the beam scales, the machines were allowed to be converted into the metric system to the nearest converted capacity and allowed to be used.

In the case of the petroleum industry, a committee was set up, within the framework of the industry, to study the entire question of changing over the existing measuring equipment used in the industry into the metric system. One of the specific problems studied by this Committee was with regard to dispensing pumps. Originally, it was estimated that such a change-over for all such pumps would entail a foreign exchange of approximately Rs 20 million. After a very detailed study and experiments carried out by this Committee, it was possible to accomplish the conversion by altering dials and rack and pinion assemblies, at a total expenditure of only Rs 0·2 million*. In addition to converting petrol pumps, the Committee also made recommendations for changing the existing bulk meters, tank lorry charts, tank storage charts, automatic fillers, dip measures, etc, used by the industry. It was a result of this Committee's efforts that the petroleum industry was able to make the change-over very smoothly, quickly and with the least dislocation.

**See* Chapter 18 Sec 6 Roads and Road Transport for illustrations.

FORMULATION OF STANDARD SPECIFICATIONS

Before the introduction of the metric system, the then existing *Weights and Measures Acts* were very loosely implemented both by the Centre and the States, although weights and measures and, to some extent, weighing and measuring instruments were being produced. The production of weights and measures was on cottage industry and small-scale industry basis, and the manufacturers had no access to know-how, nor did there exist any specifications which could guide the small manufacturer. Many types of weighing and measuring instruments were being imported and there was hardly any worthwhile production in the country. Beam scales were manufactured in one or two isolated areas, but the quality left much to be desired. With the advent of metric reform, a considerable demand developed for various types of weights and measures and equipment and, as such, systematic development of this industry became necessary. Prior to introduction of metric reform, because of the lack of specifications, the weights differed in shape and size. Even the provision of loading hole was non-existant.

As regards the material used in the manufacture of weights and measures, no guidance was available to the manufacturers and, as such, depending upon the ingenuity of the manufacturers and the availability of the material, weights and measures were produced, the quality of which was far from satisfactory.

In short, the weights and measures industry was in a very backward condition, especially in regard to the choice of material for the manufacture of weights and measures, their specifications, accuracy, etc.

That is why the Standing Metric Committee of the Government of India had directed, as stated earlier, that ISI should prepare, on priority basis, standard specifications for weights and measures and weighing and measuring instruments, which would be later incorporated in the statutory requirements of the Weights and Measures Law. The task was primarily entrusted to the Mechanical Engineering Division Council (EDC) of the Institution. In accordance with the normal procedure of ISI, the Council set up a Sectional Committee for Commercial Weights and Measures, EDC 41, to handle this work, and the late Shri V. V. Apte, who had played an important role in setting up and running the enforcement organization of the Weights and Measures Department in the then Bombay State, was appointed its first Chairman. The membership of the Committee was drawn from the weights and measures organizations in the States as well as at the Centre, important users, such as Railways, Directorate General of Supplies and Disposals, the petroleum industry and large manufacturers of weighing and measuring equipment and other interests concerned.

Commercial Weights and Measures Sectional Committee of ISI meeting for the second time in Bombay in August 1956. The Chairman, the late Shri V. V. Apte, is on the extreme left

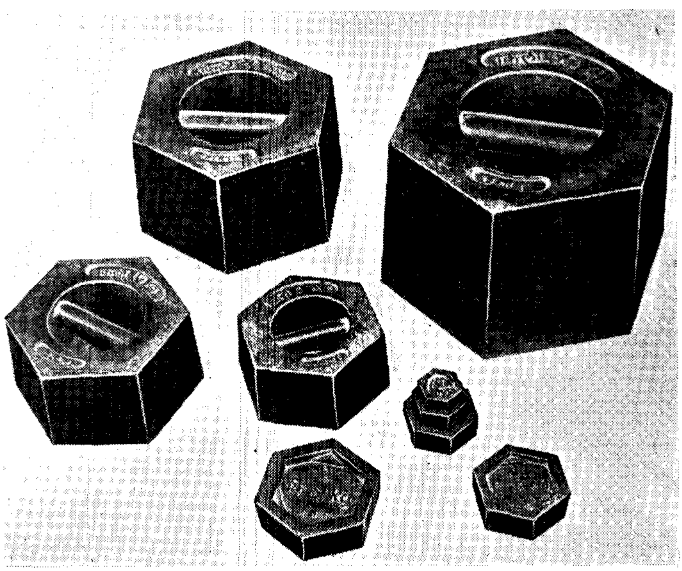
The first task of this Committee was to go into the question of preparing Indian Standard Specifications for the commonly used commercial metric weights and measures, such as cast-iron weights, bullion and non-bullion brass weights, carat weights, conical and cylindrical measures, rigid length measures, flexible tapes and the like. Other items, for which it decided to lay down national standards were such instruments as beam scales, counter machines, etc.

DESIGN OF NEW WEIGHTS AND MEASURES

In the formulation of standards by this Committee, certain well-defined principles were adopted and certain ingenious devices introduced to distinguish clearly new weights and measures from the old ones. This was extremely important and necessary, as the old weights and measures of varied shapes, designs and denominations were to continue to be used by the trade side-by-side with the new metric weights for the interim period of a number of years all over the country. In designing the new weights, it had to be remembered that there was the possibility of the new weights being confused with the old ones, thereby giving rise to malpractices by unscrupulous traders.

In considering the shape and the design of the weights, the economic production and raw material aspects were also gone into in great detail. The main consideration was that the weights should be easily produced from readily available materials without too costly equipment and in such a manner that they were not liable to lend themselves to fraudulent practices without harm to the weights themselves. This was necessary because the industry producing the weights was in a very backward stage.

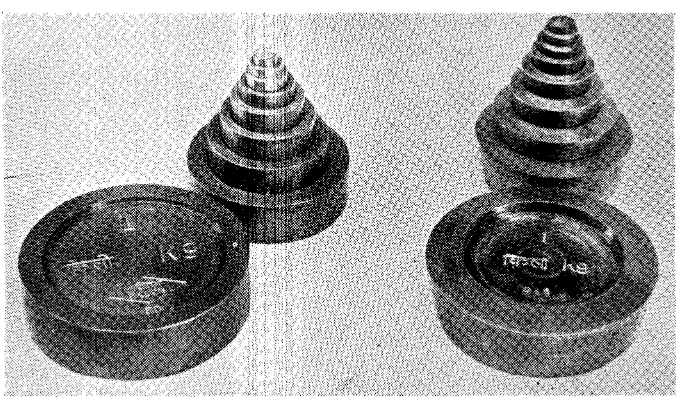
While considering the various types of weights to be standardized, it was realized that normally weights made out of cast iron, brass or bronze (cast or machined) were used extensively, while smaller weights were made out of sheet metal. Then came the question of how to distinguish between the old and the new weights. There was no standardization of shapes in the country for the old weights. Just as there were round weights, there were also square and other



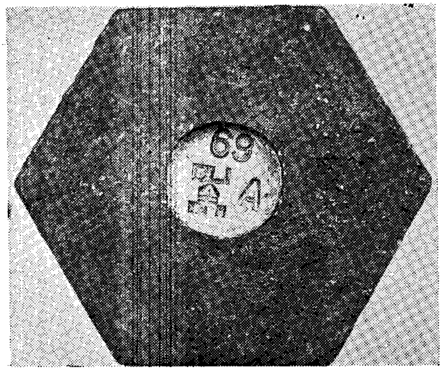
Cast-iron commercial weights for general use shapes. Even triangular shapes were in use in some areas in the country. Hexagonal shape was rarely used for cast-iron weights. It was, therefore, decided that for the purpose of standardization, hexagonal shape should be adopted for all the cast-iron weights. This had the further advantage that in many of the countries using the metric system also, hexagonal cast-iron weights were in use.

As for brass weights, two series were recognized for commercial purposes — non-bullion and bullion weights. In order to distinguish the bullion weights from the non-bullion ones, the bullion weights were assigned a uniformly cylindrical shape, whereas non-bullion weights had a distinct taper. The height and diameter ratio was so chosen that the two series were easily distinguishable from the existing non-metric weights. In addition to having a distinction of shape between bullion and non-bullion weights, it was also made mandatory that all bullion weights should have a diamond mark on the top surface to distinguish them from the commercial weights. The designs of these cast-iron and brass weights were very carefully worked out by the National Physical Laboratory to facilitate their use by the manufacturers.

An innovation which made provision for a loading hole at the bottom of the new weights deserves special mention. Such a provision had never been made in the weights in use in India. The purpose of the hole was to provide suitable space which could be



Bullion and non-bullion brass weights for general use



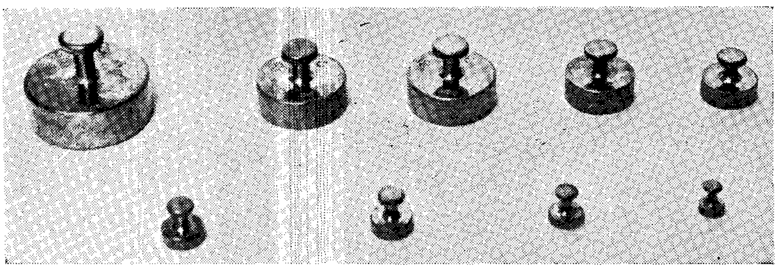
A cast-iron commercial weight with the stamp of the weights and measures authorities. DLI stands for Delhi, A for the first quarter of 1969 and 8 for the inspector's circle

filled with the required quantity of lead to adjust the weight within the tolerance limits, and also to take the stamp of the inspecting authority. The loading hole had the advantage that unlike the earlier weight which was adjusted by machining, it was not open to malpractice. Further, there was also the advantage that weights which had fallen below the limits of error prescribed due to wear and tear could be brought up to the required accuracy by re-filling the lead and having it stamped by the weights and measures authorities. Thus, the life of the weight could be increased and this was a dire necessity, especially in the case of brass and bronze weights as these non-ferrous metals were a scarce commodity in the country.

As stated earlier, the manufacture of weights being in the hands of small manufacturers, who did not have all the know-how, it was necessary to specify in the standards the type of cast iron, brass and bronze, to be used in the manufacture of weights. Considerable dimensional details were also included in the standards, which enabled the small manufacturers to produce weights with the appropriate raw material without much difficulty.

In view of the fondness of Indian women for ornaments, the weighing of gold and silver articles is very common even in the remotest villages in the country. The flat series of bullion weights was recognized to enable the goldsmith to carry his weights around.

For the purpose of weighing precious stones, pearls, etc, involving a higher degree of accuracy than that of the bullion weights prescribed for precious metals, a series of carat weights has been recognized. The shape of these weights is entirely different from that of other weights in commercial use, and the accuracy is also closely controlled.



Carat weights for weighing precious metals

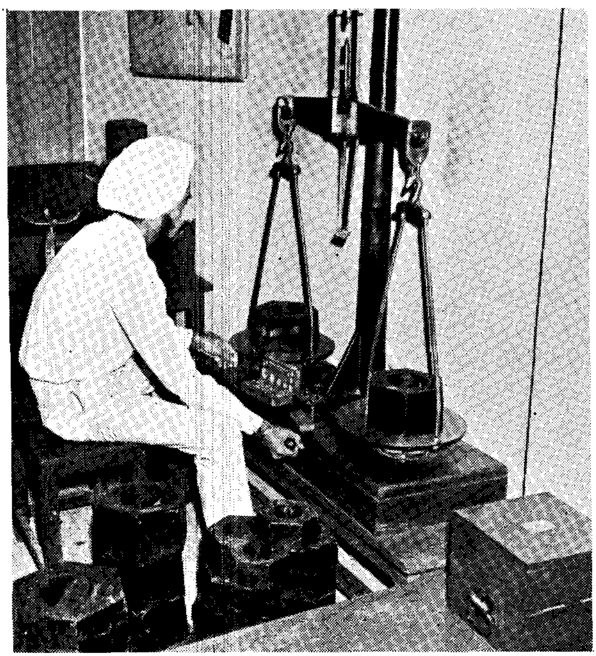
In the case of liquid capacity measures, conical type, the neck of the gallon measures had usually a slope of 3° to 4° to the horizontal. In order to distinguish the new litre measures, this slope was increased to 30°. This distinctive character was all the more necessary as the retailers of kerosene and other household materials were likely to misuse the measures and take undue advantage of ignorance of the general public. In the case of cylindrical measures, a beak was included in the metric measures which was distinct from the normally used measures. Also the ratio between diameter and height was kept at 1:1·5.

PROCEDURE FOLLOWED

The following procedure, which ISI normally uses in formulating all Indian Standards, was used in laying down standard specifications in the field of weights and measures. A proposed draft is prepared by a subcommittee or a panel. After it is approved by the sectional committee concerned, it is put into wide circulation for a period of not less than 3 months for eliciting comments. On expiry of this period, the document is re-examined in the light of the comments received, modifications made, and the finalized version, after approval of the appropriate division council, is published as an Indian Standard. Despite the delay involved, this procedure was strictly followed by the Commercial Weights and Measures Sectional Committee, since it was considered necessary that the proposed standards on weights and measures should receive as much public examination as possible. At no stage did the Committee decide to use its special powers to curtail extensive consultations.

COMMERCIAL METRIC WEIGHTS

While considering the series of denominations, the Committee laid down the principle that they should be fixed in such a way that it should be possible to build up any weight with the denominations prescribed, in steps of 10. Thus, three possible series of denominations became available, namely, 1, 2, 2, 5; 1, 2, 3, 5 and 1, 1, 3, 5.



Verification of a commercial weight with a test weight. The test weight is a cast-iron commercial weight calibrated with a standard working weight

It was also noticed that the usage in other metric countries gave preference to the series 1, 2, 2, 5. This was all the more considered desirable as the figure 10 was divisible into integral numbers by 1, 2 and 5. This series of denomination was, therefore, adopted for all Indian Standards.

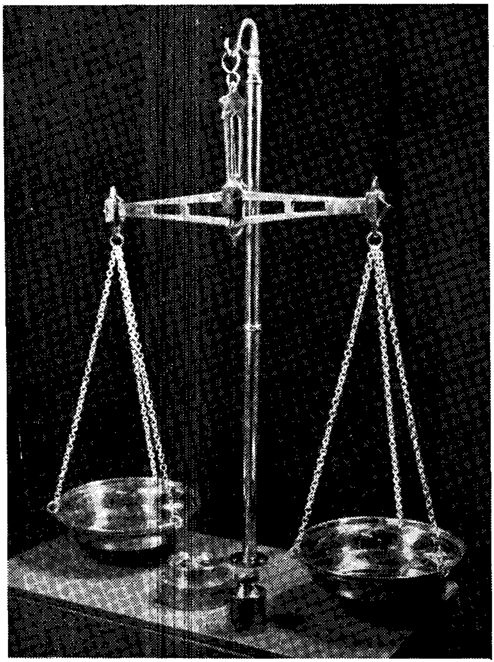
Cast-iron weights which ranged from 50 kg down to 100 g were standardized for normal commercial use. The series was later augmented by the addition of a 50 g weight in view of the scarcity of brass. The popularity of silver and gold articles in the country demanded that two types of bullion weights should be prescribed. One series of these weights ranged from 20 kg down to 1 g as cylindrical weights, with a handle for 20 kg and 10 kg weights and a knob for the rest of the denominations. Another series comprised weights from 1 kg down to 1 g as flat cylindrical weights.

In the formulation of these specifications, the errors on the weights in relation to working standards with inspectors were worked out. Table 1 shows the guiding principles involved.

BEAM SCALES

The equal arm beam scale has been the most popular weighing instrument in India for thousands of years. Even today it is the most popular and accurate instrument available. A further advantage in its use is, that in its portable forms, it can be carried easily to the weekly bazars in villages. The number of beam scales far out-numbered other weighing instruments in use in India. Such scales were used for all types of weighings, from the finest, like the weighment of diamonds and rare chemicals, to the most rough and ready weighings required for commodities like charcoal, firewood, etc. In order to cater to the wide range of uses to which the beam scales were put, it was considered desirable to arrange them under four classes, namely,

Class	*Use*
A	Assay and precision weighments
B	Weighment of precious stones and metals, jewels, pearls, bullion, saffron and similar expensive commodities, chemicals and drugs, perfumery, etc



Class B beam scale for weighing bullion, gems, etc

Class	*Use*
C	Weighment of base metals and commodities relatively costlier than those of Class D, such as cotton, cereals, tea, coffee, tobacco, jute, dry fruits, spices, oil-seeds, etc
D	Weighment of relatively cheaper commodities, such as scrap iron, fuel, wood, charcoal, vegetables, etc

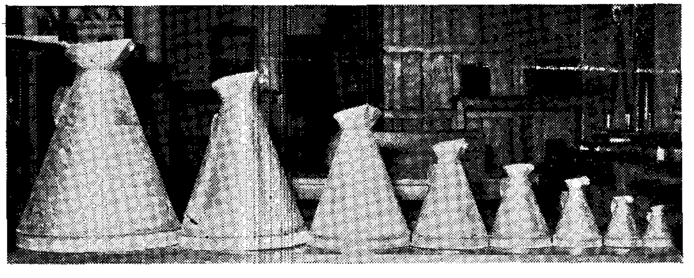
To distinguish beam scales of Class C from those of Class D, it has been specified that beam scales of Class D will have two circular holes on the beams. The Committee recommended that the use of the round type of wooden or iron beam known as *DUNDI* should be prohibited, as such a beam was easily manipulated to give false weighments.

The case of beam scales may also be considered to indicate how the process of preparation of specifications has been utilized to meet the requirements of the trade and industry. In the specification which was originally laid down, only the sensitivities and the maximum permissible errors had been prescribed, but not all the leading dimensions for all the capacities of the beam scales. It was, however, represented by the industry that manufacture being mostly in the small-scale sector, it would be desirable to give more details through the specifications to enable better and more consistent production. The specifications were, therefore, revised to include all the leading dimensions which were normally being used in the industry, and to incorporate a more realistic set of permissible errors.

CAPACITY MEASURES

In certain States, primarily in South India, there is, in vogue, the system of buying and selling dry produce by dry measures of capacity. After considerable deliberation, the Committee felt that dry measures of capacity were very much susceptible to variable errors arising out of modes of packing and particle size, and its distribution. It was also susceptible to malpractice and, therefore, should not be recommended for use. However, State Governments responsible for the control of weights and measures were given the option to introduce these measures in case they deemed it extremely necessary. Only two or three States introduced such dry capacity measures on a temporary basis, but are now discouraging their use in line with all-India practice.

A number of standards on liquid measures — conical type, dipping type and pouring type — have been formulated. For



Liquid measures of capacity, conical type

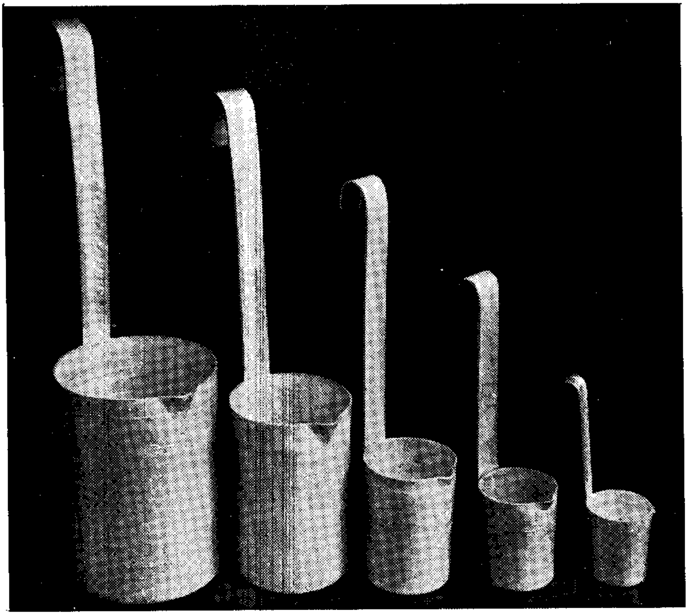
TABLE 1 PROPOSED MAXIMUM PERMISSIBLE ERRORS IN DIFFERENT GRADES OF COMMERCIAL AND STANDARD WEIGHTS

DENOMINATION OF WEIGHTS	MAXIMUM PERMISSIBLE ERRORS												ADJUSTMENT TOLERANCES (REFERENCE STANDARDS AT STATE HEADQUARTERS)	
	Commercial Weights for General Use								Working Standards for Inspectors		Secondary Standards for Regional Centres			
	Cast Iron		*Non-bullion Brass*		*Bullion Brass*		*Carat*							
	Excess mg	*Deficit* mg	*Excess* mg	*Deficit* mg	*Excess* mg	*Deficit* mg	*Excess* mg	*Deficit* mg	*Excess* mg	*Deficit* mg	*Excess* mg	*Deficit* mg	*Excess* mg	*Deficit* mg
Kilograms														
50	20 000	10 000	—	—	—	—	—	—	—	—	—	—	—	—
20	10 000	5 000	—	—	500	250	—	—	200	100	—	—	—	—
10	5 000	2 500	—	—	250	125	—	—	100	50	50	25	—	—
5	3 000	1 500	—	—	150	75	—	—	50	25	25	12·5	25	12·5
2	1 600	800	—	—	80	40	—	—	30	15	15	7·5	10	5
1	1 000	500	250	125	50	25	—	—	20	10	10	5	5	2·5
Grams														
500	600	300	150	75	30	15	—	—	10	5	5	2·5	2·5	1·25
200	400	200	100	50	20	10	—	—	8	4	4	2	1	0·5
100(500)	320	160	80	40	16	8	8·0	4·0	6	3	3	1·5	0·5	0·25

50(200)	240	120	60	30	12	6	6·0	3·0	4	2	2	1	0·25	0·12
20(100)	—	—	50	25	10	5	5·0	2·5	3	1·5	1·5	0·75	0·1	0·05
10(50)	—	—	40	20	8	4	4·0	2·0	2	1	1	0·5	0·04	0·02
5(20)	—	—	30	15	6	3	3·0	1·5	1·6	0·8	0·8	0·4	0·04	0·02
2(10)	—	—	20	10	4	2	2·0	1·0	1·2	0·6	0·6	0·3	0·04	0·02
1(5)	—	—	10	5	2	1	1·0	0·5	0·8	0·4	0·4	0·2	0·04	0·02
Milligrams														
500(2)	—	—	8·0	4·0	1·6	0·8	0·8	0·4	0·8	0·4	0·4	0·2	0·04	0·02
200(1)	—	—	6·0	3·0	1·2	0·6	0·6	0·3	0·4	0·2	0·2	0·1	0·04	0·02
100(50/100)	—	—	4·0	2·0	0·8	0·4	0·4	0·2	0·4	0·2	0·2	0·1	0·04	0·02
50(20/100)	—	—	2·0	1·0	0·4	0·2	0·2	0·1	0·2	0·1	0·1	0·05	0·02	0·02
20(10/100)	—	—	2·0	1·0	0·4	0·2	0·2	0·1	0·2	0·1	0·1	0·05	0·02	0·02
10(5/100)	—	—	1·0	0·5	0·2	0·1	0·1	0·05	0·1	0·05	0·05	0·02	0·02	0·02
5(2/100)	—	—	0·4	0·2	0·2	0·1	0·1	0·05	0·1	0·05	0·05	0·02	0·02	0·02
2(1/100)	—	—	0·2	0·1	0·2	0·1	0·1	0·05	0·1	0·05	0·05	0·02	0·02	0·02
1(0·5/100)	—	—	0·1	0·05	0·1	0·05	0·1	0·05	0·05	0·05	0·02	0·02	0·02	0·02

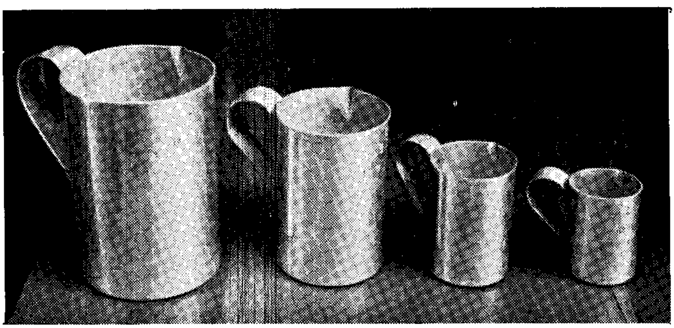
NOTE — Denominations within brackets refer to carat weights.

measures meant for dispensing foodstuffs like milk, precaution has been taken to prescribe for tinning the standard measures for hygienic reasons.



Liquid measures of capacity, dipping type

Liquid measures of capacity, pouring type



Standards on length measures have been formulated for both rigid and flexible types.

WEIGHING AND OTHER INSTRUMENTS

Standard specifications have been laid down for weigh-bridges, platform machines, counter scales, spring balances, etc. In the formulation of these specifications, an effort has been made to maintain 1, 2 and 5 series referred to earlier. At the same time, to meet the reasonable needs of trade and industry, some of the capacities which are now in existence, for example, 150 kg and 250 kg platform machines, have been shown as non-preferred, and they are expected to be discontinued as and when manufacture of this equipment is re-designed.

Other types of instruments for which specifications have been formulated are taximeters, auto-rickshaw meters, dispensing pumps, volumetric container filling machines, bulk meters, water-meters, etc. Among the land measuring and linear measuring instruments, mention may be made of the rigid half-metre, one-metre measures for retail cloth trade and the woven metallic and steel tape measures, as also surveying chains and levelling staff.

STIMULATING PRODUCTION OF EQUIPMENT

In order to meet the large demand for weights and measures and measuring equipment, it was considered very necessary that efforts should be made to assist the manufacturers. A number of steps were taken for this purpose, as given below.

PREPARATION AND APPROVAL OF PROTOTYPES

In the Weights and Measures Department of the National Physical Laboratory (NPL), a number of prototype samples were prepared and they were exhibited to prospective manufacturers. Further, the prototypes of manufacturers were examined and tested by NPL, and guidance was given to the manufacturers for improving the quality. The Indian Standards specify requirements and dimensions as well as details of the material to be used in the manufacture. More emphasis in this regard was laid on weights rather than on weighing and measuring equipment. In the case of cast-iron and brass weights, a number of alternative designs were produced, and after examining these alternative designs, the Committee decided on the most economical designs which have since been specified in the Indian Standards.

TECHNICAL GUIDANCE

The then Ministry of Commerce and Industry appointed a specialist officer, a Development Officer, under the Directorate General of Technical Development, to assist the industry in the manufacture of weights and measures and weighing and measuring equipment. The officer went round the country, discussed with the various manufacturers their problems, and assisted them by obtaining release of the required quantities of foundry coke, pig iron, brass, bronze and other materials. Special freight concessions were given to manufacturers. He also assisted the manufacturers in importing machinery and components needed both for re-calibration of existing machines and also for manufacture of new machines. Further, a liberal licensing policy was adopted for import of machinery and equipment which were not being manufactured in the country. The State Governments as well as the Central Ministry of Commerce and Industry demonstrated, through various publicity media including Exhibitions, new weights and measures, and also forecast the demand for such measures so that *entrepreneurs* could take advantage of the situation to build up the industry. By all these methods it was possible to stagger production and distribution of weights and measures in different States on the basis of the demand for them. It was very rare that, after the introduction of metric weights and measures, there was, at any stage, any lack of available weights and measures.

TESTING AND CERTIFICATION

In the production of weights and measures and weighing and measuring equipment, there are a member of phases in which testing and certifying is necessary. The first phase is the design and prototype stage. The second is the testing and approval for use by the weights and measures authorities in each State, and periodical checking by them. After approval of a prototype by a central authority, further approval of designs by the States authorities was considered unnecessary as the specifications laid down by ISI were detailed enough. As it stands today, the law is not very clear whether it is necessary for the manufacturer to have the prototype approval by each State certifying authority. However, this gap is being filled by amending the law, making it compulsory for all new equipment that prototype should be approved after due testing at one or more approved laboratories, for Indian Standards do not specify all the design characteristics, but only deal in general terms with the essential requirements, in particular the accuracies of the equipment. Wherever machines are imported, it is also possible to submit a prototype for approval before they are allowed to be imported regularly into the country.

The weights and measures authorities in various States have, by their licensing policies, regulated the manufacture and distribution of weights and measures and weighing and measuring instruments, and they have the machinery to check them according to rules and regulations laid down by them. However, they do not have the machinery to check prototypes.

The weights and measures industry in the country has expanded from a small beginning in 1956 into a large industry which is now exporting its products to other countries in Asia and Africa, and even to some of the western countries. India has supplied weights and measures and weighing and measuring instruments in ever-increasing numbers to Nepal, Saudi Arabia, Afghanistan, the East African countries and also to UK. The production of more and more sophisticated weighing instruments is also being taken up in the country. In order to meet the requirements of this ever-expanding industry, ISI has prepared a number of specifications, which have been incorporated in the Weights and Measures laws of the Centre and the States, and are being implemented statutorily. All such standards are included in the list given in Appendix 7. A number of standards on other subjects in this field are in various stages of preparation.

ALIGNMENT WITH INTERNATIONAL WORK

Both the Government of India and ISI are keeping in close touch with the work being done by the International Organization of Legal Metrology (OIML) (*see* Chapter 1) with a view to keeping all Indian Standards in line with the latest international thinking on the subject. In fact, ISI has based some of its specifications, like those for automatic weighers and totalizers on the preliminary draft recommendations which have been under consideration of OIML. When OIML reaches the final stage, Indian Standard Specifications would be revised to incorporate the international recommendations. As India is participating in over 40 technical committees of OIML out of 70, ISI has to consider the various draft recommendations to assess their suitability to Indian conditions and to make suitable comments in consultation with the concerned interests to shape them to Indian needs and requirements. There is thus a constant flow of technical data between the weights and measures authorities in India and ISI on the one hand and OIML on the other. □

11

Trade and Industry

P. N. Nayar

A major aim of the metric reform was to ensure better regulation of trade through standardization of means of measurements. The objective was not the supersession of one system of weights and measures by a better one, but the replacement of many systems by a single system, in all parts of the country, in all trades and in all other fields of economic activity.

There was quite a chaos in India's weights and measures before the change-over took place. Not only a hundred different seer weights and more were in use in trade, but often, a variety of weights was employed in the same market, different weights being used for different commodities. Sometimes, one kind of weight was used by the middleman in buying produce from the farmer, and another for selling it to the retailer or the consumer. Any kind of regulation of weights and measures to ensure their accuracy was, in these circumstances, quite impractical. Instances were not uncommon of a trader offering goods at prices well below the cost and yet making profit, the profit being concealed in his duplicate set of weights or measures. The honest trader and the consuming public suffered.

A Central law was made in 1939 to standardize weights; it authorized a dual system comprising the British system of weights and a set of Indian weights. But enforcement of the relevant law was left to the States, whose practices and methods remained weak, vacillating and irresolute. The attempt to eliminate unauthorized weights was a complete fiasco. The use of standard weights was confined to Government departments, public undertakings like the Railways and Post Offices and the organized industry. There were prophets of doom who predicted a similar fate for the metric reform. Their gloomy forecasts have been belied, and the use of the metric system has spread over the whole country, to the exclusion of all other weights and measures, during the relatively short span of a decade.

METHOD OF APPROACH

Experience had shown that a major reform of this kind could not be brought about by law alone. To introduce a new system of measurement without creating the conditions for its easy dissemination and acceptance by the trade and the public would be to court failure. The prerequisites for success considered essential included:

1) acceptance and understanding of the system by the trade and the public;

2) availability, at reasonable prices, of the new weights and measures;

3) facilities for conversion of weighing machines used in trade and industry;

4) an initially persuasive but ultimately an efficient enforcement agency; and

5) a workable and acceptable programme of introduction of the new system.

METRIC SYSTEM AND THE TRADE

The most essential condition for success was, without doubt, a climate of opinion in favour of the reform. State action would surely have failed in the face of public hostility. A programme of publicity to enlist the co-operation of the public and the trade was given high priority. The publicity had three main aims; to get people to know that a change was in the offing, to convince them of the need for the change, and to disseminate factual information on the new weights and measures. The first of these objectives was attained fully and the second and third partially. A full account of the publicity campaign is given in Chapter 7. Like other State publicity campaigns, it was conducted through the usual media — advertisements, posters, broad-sheets, exhibitions and radio broadcasts. If it did not achieve more than it did, that was largely due to the limited budget and the usual limitations of official red tape.

It must be said to the credit of the campaign that no one was taken by surprise when the new weights were introduced in 1958. Most people knew that a change had been planned. Everyone did not accept it as a *fait accompli.* Many expected that the new system, after making some noise, would fizzle out. There was, therefore, much hesitation in buying the new weights and using them in trade. Sophisticated arguments about the superiority of the metric system left people unimpressed. Few were prepared to accept the inevitability of change. The attempt to educate the trade and public on the new weights and measures in advance of their use in trade, did not meet with conspicuous success. Effective education began with the actual introduction of the weights and measures in trade. Language fanatics wanted Indian names to be coined for the new units. They argued that the trade and the public would accept them more readily if they were called by Indian names. Luckily, the authorities stood firm and did not take the bait. Trade itself has not shown any allergy to international terminology, and the kilogram, gram, metre and litre have become part of the vocabulary of Indian languages.

SUPPLY OF METRIC WEIGHTS AND MEASURES

When the introduction of metric weights and measures in trade was being planned, there was genuine anxiety regarding the ability of manufacturers and distributors to meet the anticipated demand for commercial weights and measures. There were apprehensions of shortage giving opportunities for malpractice to producers as well as distributors. Steps were taken to ensure that this did not happen.

The first step was to estimate the expected demand. Prior to 1956, *Weights and Measures Acts* were operative, either fully or partially, in Bombay, Bihar, Punjab, Delhi and Hyderabad. But even in these States, the Act applied only to commercial transactions, and not to Government Departments, such as Posts and Telegraphs, Railways, Defence, etc, which were to be covered under the *Standards of Weights and Measures Act, 1956.* The statistics of weights and measures in use in these States could not, therefore, be used to obtain an accurate picture of the requirements of the country. Estimates had to be made on some other basis to assess the magnitude

An assortment of old weights used in the former State of Hyderabad, now a part of Andhra Pradesh of the problem. A special survey was, therefore, conducted in 1957, through the field organization of the National Sample Survey, to make an accurate estimate. Field investigators visited every house and business establishment in the selected sample of a few thousand villages and urban areas and made inventories of all weights and measures. They also canvassed a sample of a few thousand industrial establishments. According to the results of the survey, the number of iron, steel and brass weights in use was found to be about 42 million in the country. These were, predominantly, seer and maund series of weights of various denominations not all conforming to any recognized standards. The use of the standard seer and the pound was limited to the organized industry, public undertakings and Government departments. The use of pieces of stone, bricks and other odd objects as weights was also found to be common, particularly in the sale of fruits, vegetables, coal and firewood. The major task, therefore, was the manufacture and supply of 45 to 50 million pieces of standard metric weights. The bulk of the demand was expected to be for weights from 50 grams to 2 kilograms. Larger weights were used only in wholesale trade, and weights below 50 grams, in the sale of comparatively expensive commodities like precious spices and metals.

There was enough industrial capacity available for the production of weights in the country. Over 900 engineering establishments were found to be equipped for manufacturing an assortment of hardware including weights and measures. Many of these had produced weights and measures on specific orders or when prices had been highly lucrative. These establishments at the time were not working to full capacity, due to shortage of raw materials and fuel. Pig iron, brass, lead, aluminium, coal and coke, the essential materials for producing weights and measures, were in short supply. Facilities for transport of iron, coal and coke were also limited. Special allocations of pig iron, brass, coal, coke and railway wagons for their transport were, therefore, made specially available to promising manufacturers. Only a few, however, took advantage of these facilities. Others were apprehensive that metric weights and measures would not sell, and that the law against the use of other weights and measures would be evaded or even openly defied, as in the past. Their scepticism and diffidence seemed justified, because when in 1958 metric weights were made permissive in trade, only a few traders replaced their old weights. The manufacturers who had invested in metric weights found themselves with large stocks of unsaleable weights, which they had to hold for nearly 2 years.

In 1960, after due notice, the use of metric weights was made compulsory in many industries and in trade generally over a large area of the country. Inspectors went round the markets seizing unauthorized weights. There was a scramble for metric weights, and manufacturers and traders who had stocked them, were able to sell them off at a handsome profit. Now there were charges of profiteering but the blame should be placed squarely on the users of weights for their failure to buy new weights in 1958 and 1959 when they were optional, cheap and abundant. The shortage, however, did not last long; new manufacturers and traders entered the business to profit by the opportunity. The parochial attitude of the weights and measures authorities in some States did not help to relieve the scarcity. Needless obstacles were placed in the way of the free movement of weights and measures from traditional centres of production in other States to States where production capacity was being sought to be developed. Barring this, however, several other measures taken by the State Controllers of Weights and Measures were specifically designed to keep prices down. Prices were kept under continuous review and supplies regulated to secure continuity of flow.

CONVERSION OF WEIGHING MACHINES

While the ordinary small trader in India uses mostly a pair of scales with weights, weighing machines are used by the bigger retailers, wholesalers, industrial establishments, post offices, and in the transportation of goods by road, rail, inland waterways and sea. These machines were graduated in pounds or standard seers and maunds. Since their replacement was very expensive and also avoidable, most of them were suitably converted to the metric system.

As described in detail in Chapter 10 (Equipment Required for Trade and Commerce), the weighing instruments were of three types. There were the dial machines, in which it was necessary only to re-calibrate the dial, and the two kinds of steel yards — with loose weights and with no-loose-weights. While it was possible to use the latter by having a newly graduated bar, a change in the size and denominations of the loose weights had to be carried out in the case of the former. Further, the re-calibration programme had also to be phased out to ensure a smooth change-over with least inconvenience to both the industry and the consumer.

AGENCY FOR ENFORCEMENT

One of the chief causes of the failure of earlier attempts to standardize weights and measures was the lack of an effective enforcement agency. Though laws had been made not only to prescribe standards but also for their enforcement, the latter had been left to the general law enforcement agencies of the States, mainly the police, who proved unequal to the task. The States were, no doubt, aware of the need for special agencies manned by specially trained and equipped personnel required for the administration of economic controls, labour welfare and social legislation. And, there were special agencies to administer laws regulating working conditions in factories, shops and other commercial establishments; the use and maintenance of boilers; and the quality and distribution of foodstuffs. But the enforcement of laws relating to weights and measures had not received the same attention. Separate departments for such enforcement had been set up only in Bombay and one or two other provinces. But, except in Bombay, departments of weights and measures received stepmotherly treatment; they were neither adequately staffed nor equipped to fulfil their responsibilities, with the result that enforcement was only a partial success.

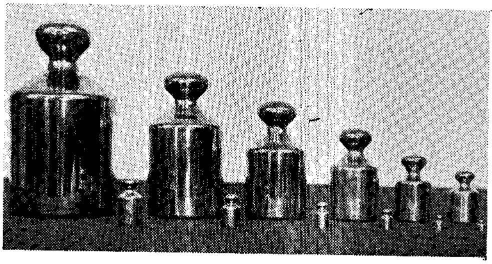
TRAINING OF INSPECTORS

This mistake was, however, not allowed to be repeated in 1956, when the metric legislation was adopted. Even before the law was enacted, plans were made to build up enforcement agencies in all the States, to recruit and train personnel and to procure the necessary equipment. This was a big task, the estimated number of inspectors for enforcing the law throughout the country being about 1 000. It was not easy, with the facilities available, to train such a large number of persons in the law, procedure and techniques of weights and measures enforcement. Qualified instructors available were few in number. However, in the State of Bombay, enforcement had been pursued rather diligently under the *Bombay Weights and Measures Act, 1932.* To train their inspectors, the State had set up a small training centre. The facilities available at this training centre were utilized to train teachers and inspectors from other States. In fact, the centre rendered invaluable service in many ways to introduce the reform of weights and measures in the country. Later, a separate all-India Institute for training of inspectors was set up at Patna in the State of Bihar. This is now the only institute for imparting training to inspectors from all over India, as also indeed from many neighbouring countries.

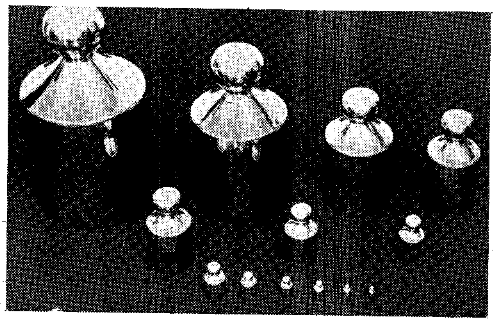
Production of Standard Equipment — The supply of essential equipment to the Weights and Measures Departments of States was another challenging task, since facilities had to be created for their production in the country in a very short time. Every inspector of weights and measures needs a set of portable sensitive balances, a set of standard weights of defined precision for verifying traders' weights, a set of standard capacity measures for verifying commercial capacity measures and a standard length measure for verifying commercial metre and half-metre rods, tapes and other length measures. The inspector's standard weights and measures are themselves verified every six months at regional centres. Every such regional centre had to be provided with what are called secondary standard weights and measures and a set of secondary standard balances; secondary standards had to be even more accurate than the inspector's standards and the secondary balances more sensitive than inspector's balances. The secondary standards are verified once every five years against reference standards at State headquarters, where a set of reference standard weights and measures and a set of reference standard balances had to be provided. The reference standard weights are verified and certified by the National Physical Laboratory against the National prototypes of the kilogram and the metre. The quantity of equipment required for the whole country was as follows:

For Inspectors (1 000 sets of each equipment)

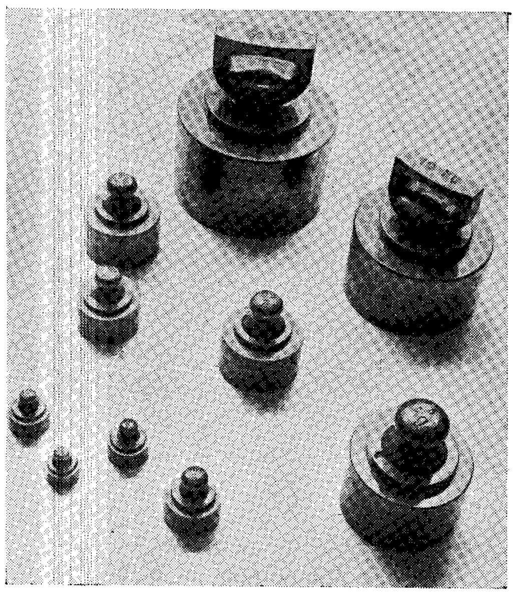
Inspector standard balances



Reference standard weights, 5 kg to 1 g



Secondary standard weights, 10 kg to 1 g



Working (Inspector) standard weights, 20 kg to 100 g

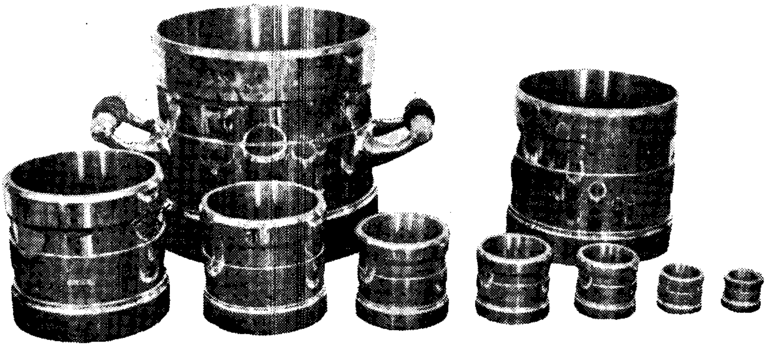
Inspector standard weights
Inspector standard capacity measures
Inspector standard length measures

For Regional Centres (250 sets of each equipment)

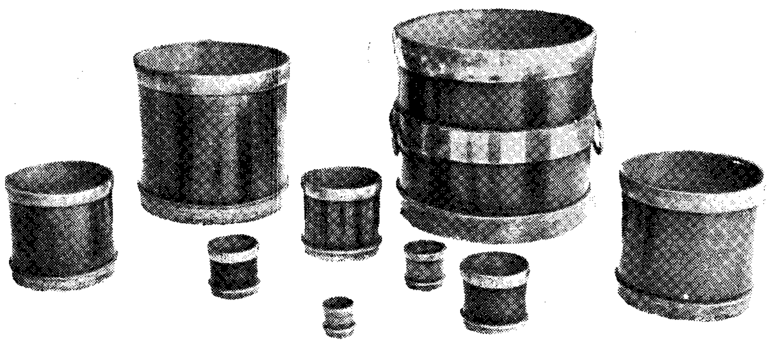
Secondary standard balances
Secondary standard weights
Secondary standard capacity measures
Secondary standard length measures

For State Headquarters (16 sets of each equipment)

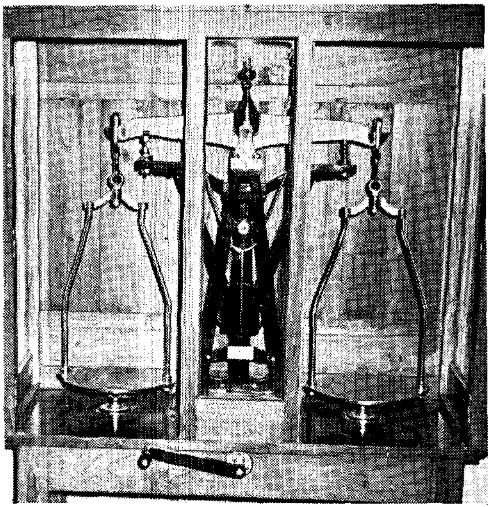
Reference standard balances
Reference standard weights
Reference standard capacity measures
Reference standard length measures



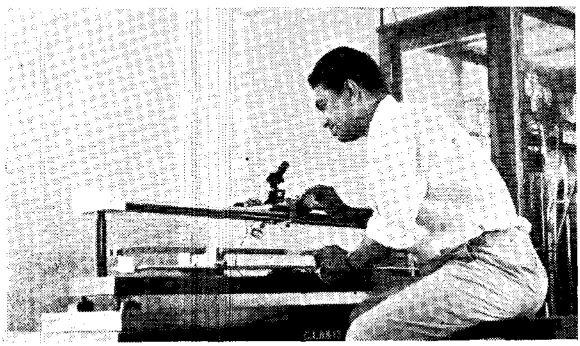
A set of secondary standard capacity measures, 5 l to 10 ml



A set of working (Inspector) standard capacity measures, 10 l to 20 ml



A secondary standard balance of capacity 50 kg



A working standard metric length measure being re-verified in the laboratory against a secondary standard length measure

The equipment had to be designed, manufactured, tested and supplied to the Weights and Measures Department within two years. There being no commercial manufacturer able and willing to produce standard weights and measures of the graded precision, the task had to be assigned to the Government Mints at Bombay and Calcutta. The Mints acted with remarkable speed. To meet

Verifying the accuracy of a spring balance

Conical type capacity measures being verified in the inspector's laboratory against a corresponding working standard

the complete demand within two years was impossible, but the Mints supplied a sufficient number of these standards to enable Government to introduce metric weights in trade, on a permissive basis in October 1958. There was only one small manufacturer, who could produce inspector's balances of the sensitivity required. He had an assured market for all the balances he could produce for years to come. He was also offered other incentives to raise his output. He could, however, meet only a fraction of the minimum requirements for the introduction of metric weights in 1958 and about 160 sets of balances had to be imported. By October 1960, when the use of metric weights in trade became compulsory over large areas, the Mints had met their commitments to the Weights and Measures Departments of the States in full and the production of inspector's balances within the country had gathered speed.

CHANGE-OVER IN TRADE

The metric legislation, passed in 1956, had allowed 10 years for the complete adoption of the new system, in supersession of others, everywhere in the country and in all fields of activity. Within this overall requirement, the Government had the discretion to choose the timing and the manner of introduction of the metric system in individual trades, areas, industries and other spheres. Programmes and plans for conversion were prepared in close consultation with the interests concerned, so that no one might feel that a new system was being imposed entirely from above. Suggestions were invited from all recognized chambers of commerce and industry and various associations representing individual trades and industries. Numerous meetings were held in which representatives of trade and industry participated. They were told that, subject to the overall requirements of the law, any programme to which they agreed would be acceptable to the Government.

There was agreement on the broad features of a programme for trade. Opinion was almost unanimous that introduction of metric weights, measures of capacity and length measures on the same day throughout the country would not be feasible. Since trading is predominantly by weight, metric weights might be introduced, to begin with in selected areas. The areas selected were the big metropolitan cities and other important urban areas, and certain comparatively well-developed rural areas. Further, with the introduction of the new weights other weights should not be prohibited immediately; a reasonable period of tolerance should be given for their continued use. Table 1 gives the detailed programme which was notified by the Government in 1958.

METRIC WEIGHTS

As may be seen from Table 1, for two years following the introduction of metric weights, the use of other weights was also permitted. This was to meet the near unanimous demand of trading interests. They expected two benefits from such an arrangement. The transitional period of two years would give an opportunity to trade to get familiar with the new weights, before their use became compulsory. Further, it would reduce the cost of replacement of traders' weights. It was hoped that any trader wanting a new set of weights during the transitional period would buy metric weights. By and large, the hope was unfortunately belied. The transitional period was wasted. Very few traders either bought metric weights or took the trouble to learn the new system and get familiar with it; there still lingered scepticism about the authorities' earnestness and ability to enforce the new system.

When the transitional period ended, trade was ill prepared to adopt the new weights. It would have been neither tactful nor feasible, at that time, to enforce the law with rigour, by suppressing the use of other weights and taking action against offenders. Apart from making the reform unpopular, it might have brought trade to a standstill. While trade was warned that the use of non-standard weights was a breach of the law, which could not be condoned indefinitely, no penal action was taken for nearly a year. During this period most traders bought metric weights, sometimes at a very high cost on account of shortage, and began using them. Traders found using non-standard weights even after this period, were relieved of their weights, which were broken up and auctioned, bringing substantial revenue to Government. Traders who persisted in using old weights, after repeated warnings, were prosecuted. Prosecutions were, however, few, and the penalties imposed generally rather mild.

Another illusion, which experience shattered, was that the change would be easy in areas which were better developed socially and economically, and among the better educated and more sophisticated classes of the people. The reverse, in fact, turned out to be true. Some so-called backward areas in the hills of Himachal Pradesh and Assam accepted the change without question. Traders in these areas adopted the new weights and measures quietly and efficiently. Rural areas generally accepted the change without fuss. Resistance came mostly from certain highly vocal sections in the large cities.

CHANGE-OVER IN INDUSTRY

In introducing the new system of measurement in industry, a clear distinction had to be made between activities related to manufacturing technology and purely commercial activities, like marketing products, or buying raw materials and fuels.

COMMERCIAL ACTIVITY

The transition in the commercial activity of industry had to be synchronized with the transition in trade. Table 2 gives the programme adopted.

MANUFACTURING PROCESSES

Changing the system of measurement in the different stages of production was far more difficult and complicated. It involved drawing up new standards and specifications, and re-designing numerous items of equipment used in industry as well as its products. It was wisely decided not to fix a time limit for this task. The law for adoption of the metric system fixed a time limit, only in regard to commercial transactions. A manufacturer could, therefore, well continue to use other systems in production processes and techniques, almost indefinitely, without breaking the law, although this would be against its spirit. All that he would have to do to comply with the law was, to use the new system for expressing prices, quantities and quality specifications, in tenders, contracts, and other documents relating to commercial transactions in materials, fuels, stores, products and by-products. Quality specifications might be converted to metric units without any change in the dimensions.

TABLE 1 PROGRAMME OF INTRODUCTION OF METRIC SYSTEM IN TRADE

1. WEIGHTS AND CAPACITY MEASURES

STATES AND UNION TERRITORIES	AREAS	DATE OF INTRODUCTION		DATES ON WHICH OTHER WEIGHTS AND MEASURES BECAME ILLEGAL	
		Metric Weights	Metric Capacity Measures	Weights	Capacity Measures
1	2	3	4	5	6
States					
Andhra Pradesh	Districts of Visakhapatnam, Krishna, Guntur, Kurnool, Hyderabad, Warrangal and Nizamabad and all regulated market areas	1-10-58	1-4-61	1-10-60	1-4-62
	Rest of the State	1-10-60	1-4-62	1-10-62	1-4-63
Assam	Municipal areas of Gauhati and District of Nowgong	1-10-58	1-4-61	1-10-60	1-4-62
	Rest of the State	1-10-60	1-4-62	1-10-62	1-4-63
Bihar	Divisions of Bhagalpur and Ranchi, the Municipal areas in Patna and Tirhut Divisions and the area under the Patna Municipal Corporation	1-10-58	1-4-61	1-10-60	1-4-62
	Rest of the State	1-10-60	1-4-62	1-10-62	1-4-63

Bombay	Municipal areas of Bombay, Poona, Ahmedabad, Rajkot, Baroda, Nagpur, Aurangabad, Sholapur, Kolhapur, Akola, Amravati, Wardha and Yeotmal and regulated market areas	1-10-58	1-4-61	1-10-60	1-4-62
	The remaining 29 major towns	1-10-59	1-4-62	1-10-61	1-4-63
	Rest of the State	1-10-60	1-4-62	1-10-62	1-4-63
Kerala	Districts of Kozhikode, Ernakulam and Quilon	1-10-58	1-4-61	1-10-60	1-4-62
	Rest of the State	1-10-59	1-4-62	1-10-61	1-4-63
Madhya Pradesh	Districts of Sehore, Indore, Gwalior and Jabalpur and regulated market areas	1-10-58	1-5-61	1-10-60	1-5-62
	Rest of the State	1-10-60	1-4-62	1-10-62	1-4-63
Madras	Districts of Madras, Chingleput, South Arcot and North Arcot and regulated market areas	1-10-58	1-4-61	1-10-60	1-4-62
	Rest of the State	1-10-60	1-4-62	1-10-62	1-4-63
Mysore	Districts of Bangalore, Raichur and Dharwar and regulated market areas	1-10-58	1-4-61	1-10-60	1-4-62
	Rest of the State	1-10-60	1-4-62	1-10-62	1-4-63
Orissa	Municipal areas of Berhampur, Cuttack and Sambalpur	1-10-58	1-4-61	1-10-60	1-4-62
	Rest of the State	1-10-60	1-4-62	1-10-62	1-4-63
Punjab	Districts of Amritsar, Jullundur, Ludhiana, Ambala, Patiala and Gurgaon and regulated market areas	1-10-58	1-4-61	1-10-60	1-4-62
	Rest of the State	1-10-60	1-4-62	1-10-62	1-4-63

TABLE 1 PROGRAMME OF INTRODUCTION OF METRIC SYSTEM IN TRADE — *Contd*

STATES AND UNION TERRITORIES	AREAS	DATE OF INTRODUCTION		DATES ON WHICH OTHER WEIGHTS AND MEASURES BECAME ILLEGAL	
		Metric Weights	Metric Capacity Measures	Weights	Capacity Measures
1	2	3	4	5	6
Rajasthan	Districts of Ajmer, Bikaner, Jodhpur, Jaipur, Kotah and Udaipur	1-10-58	1-4-61	1-10-60	1-4-62
	Rest of the State	1-10-60	1-4-62	1-10-62	1-4-63
Uttar Pradesh	Municipal areas of Meerut, Agra, Lucknow, Bareilly, Moradabad, Varanasi, Kanpur, Jhansi, Allahabad and Gorakhpur	1-10-58	1-4-61	1-10-60	1-4-62
	Rest of the State	1-10-60	1-4-62	1-10-62	1-4-63
West Bengal	Municipal areas of Calcutta and Howrah	1-10-58	1-4-61	1-10-60	1-4-62
	Rest of the State	1-10-60	1-4-62	1-10-62	1-4-63
Union Territories					
Delhi	The whole of Delhi	1-10-58	1-4-60	1-10-60	1-4-61

Himachal Pradesh	Districts of Mandi and Sirmur	1-10-58	1-4-61	1-10-60	1-4-62
	Rest of the Union Territory	1-10-60	1-4-62	1-10-62	1-4-63
Manipur	Municipal area of Imphal	1-10-58	1-4-61	1-10-60	1-4-62
	Rest of the Union Territory	1-10-60	1-4-62	1-10-62	1-4-63
Tripura	Municipal area of Agartala	1-10-58	1-4-61	1-10-60	1-4-62
	Rest of the Union Territory	1-10-60	1-4-62	1-10-62	1-4-63
Andaman and Nicobar Islands	Port Blair	1-10-58	1-4-61	1-10-60	1-4-62
	Rest of the Union Territory	1-10-60	1-4-62	1-10-62	1-4-63

2. LENGTH MEASURES

STATE	DATE ON WHICH METRIC LENGTH MEASURES WERE INTRODUCED	DATE ON WHICH OTHER LENGTH MEASURES BECAME ILLEGAL
All States and Union Territories	1-10-61	1-10-62

TABLE 2 PROGRAMME FOR CHANGE-OVER ADOPTED FOR COMMERCIAL TRANSACTIONS IN VARIOUS INDUSTRIES

INDUSTRIES	PURPOSES FOR WHICH THE METRIC SYSTEM WAS TO BE USED	DATES FROM WHICH THE METRIC SYSTEM WAS MADE	
		PERMISSIVE	COMPULSORY
1	2	3	4
Alcohol	Sale of alcohol and levy of excise duties	1-6-1961	1-6-1962
Biscuit	Sale of biscuits	1-4-1960	1-4-1962
Cement	Sale of cement	1-10-1958	1-10-1960
Coffee	Sale of coffee by the Coffee Board from the surplus pool	1-10-1958	1-10-1960
Coir	Purchase or sale of coir; yarn and other coir products	1-10-1959	1-10-1961
Copper, aluminium, lead antimony and tin	Sale of copper, aluminium, lead antimony and tin including alloys and products of these metals	1-10-1958	1-10-1960
Cotton textiles	Purchase of cotton	1-10-1958	1-10-1960
	Sale of cloth	1-10-1958	1-4-1961
	Sale of yarn and textile products other than cloth	1-4-1959	1-4-1961
Drugs	Purchase of materials or sale of drugs	1-4-1960	1-4-1961
Engineering	Sale of products	1-10-1958	1-10-1960
Fertilizers	Sale and purchase of fertilizers	1-4-1960	1-4-1961
Heavy chemicals	Purchase of raw materials and sale of products	1-10-1958	1-10-1960
Iron and steel	Purchase of raw materials and sale of iron and steel products	1-10-1958	1-10-1960
Jute	Purchase of raw jute and sale of jute products	1-7-1958	1-7-1960
Paint	Sale of paints	1-4-1960	1-4-1961

TABLE 2 PROGRAMME FOR CHANGE-OVER ADOPTED FOR COMMERCIAL TRANSACTIONS IN VARIOUS INDUSTRIES — *Contd*

Industries	Purposes for Which the Metric System was to be Used	Dates from Which the Metric System was Made	
		Permissive	Compulsory
1	2	3	4
Paper, pulp and paper board	Sale of paper, pulp and paper board	1-10-1958	1-10-1960
Petroleum	Production and sale of petroleum and petroleum products	1-3-1960	1-3-1961
Refractories	Sale of refractories	1-10-1958	1-10-1960
Rubber	Sale of raw rubber	1-10-1958	1-10-1960
Salt	Sale of salt	1-10-1958	1-10-1960
Soap	Purchase of raw materials and sale of soap	1-4-1960	1-10-1960
Sugar	Purchase of sugarcane and sale of sugar	1-11-1959	1-11-1961
Tea	Sale of tea and payment for plucking tea leaves	1-3-1960	1-3-1961
Tobacco	Purchase and sale of tobacco leaf and manufactured tobacco	1-1-1961	1-1-1961
Vanaspati	Sale of vanaspati	1-4-1960	1-10-1960
Woollen	Purchase of raw wool and sale of woollen products	1-10-1960	1-10-1960

Manufacturers had, in the beginning, to resort to this device to keep within the law, but they have since been gradually revising specifications and re-designing products and equipment. The process will be slow, and it is not easy to predict how long it will take for industries to re-align their production processes and techniques completely to the metric system.

The industrial equipment in the country has mainly been designed on the basis of fps system and cannot be readily discarded or modified for a long time to come. The continued supply of spares and components in that system will be needed for maintenance and repair. Nevertheless, a considerable amount of work has been done to facilitate the conversion of industrial technology to the metric system. The Indian Standards Institution (ISI) has redrafted virtually all the basic standards in terms of the metric system (*see* Chapter 12). Indian manufacturers have offered their customers supplies of many categories of measuring tools and instruments graduated in the metric system. Screw threads, bolts and nuts conforming to the revised Indian Standards are being produced by Indian manufacturers (*see* Chapter 15). The metric system has been made the dominant system of measurement in instruction in engineering schools and colleges as well as in craft schools for artisans (*see* Chapter 18 Sec 1).

The adoption of the metric system posed special problems to major industries like cotton and jute textiles, iron and steel and oil and the manufacture of metal containers.

JUTE TEXTILES

The jute industry exports 90 percent of its products mainly to UK, USA and other countries in which the fps system of weights and measures is in vogue. Care was taken to safeguard the export trade on which the industry's existence depended. No changes were made in the specifications of bags and cloth for export or even for sale within the country. It would have been uneconomic to manufacture cloth and bags according to different specifications for export and for the home market, since the latter absorbed not more than 10 percent of the output. Jute cloth, therefore, continues to be packed in packages of 1 000 yards (914 metres) and 2 000 yards (1 829 metres), both for the home market and for export. All dimensions, quantities and quality specifications are expressed in metric units, in documents relating to transactions within the country, to conform to the law.

It has further been found unnecessary to change the sizes of jute bags for packing major commodities in rational metric quantities for sale and distribution within the country. Sugar was previously being packed in bags holding $2\frac{3}{4}$ maunds (102·6 kg). The same size of bag continues now to be used to hold 100 kg. The original cement bag which earlier held 100 cwt (50·8 kg) gross, now holds

50 kg net. Wheat is packed in bags holding 93 kg and other grains in bags of 95 kg. The possibility of enlarging the bags to hold 100 kg of grains was explored. Experiments showed that unless the bags were made of stronger material, they would not safely be able to hold 100 kg of grains, and still withstand the rough handling they normally received in transport and storage, without giving way. The use of stronger material would increase the overall unit cost of packing, the burden of which would ultimately fall on the consuming public.

The raw jute bale is being gradually standardized at 180 kg. Smaller bales of 150 kg, 130 kg, 60 kg and 40 kg might be used for special purposes.

COTTON TEXTILES

There were sharp differences of opinion on the system of measurement of fineness of cotton yarn. The system in vogue was the British count system, the count representing the number of hanks of 840 yards in a pound of yarn. The International Organization for Standardization (ISO) had recommended the adoption of the tex as the unit of measurement of fineness, the tex being the mass in grams of 1 000 metres of yarn. India, along with a number of other member countries, had accepted the tex, in principle. Opinion in the industry was, however, against the adoption of the tex in the foreseeable future, although it accepted it as a remote goal. Adoption of the tex, they argued, would be a complete reversal of the basic concept of measurement of yarn quality. Since the industry and the trade had been accustomed to the British system, they were ill-prepared for the change. Tex was directly proportionate to linear density, while the British count was inversely proportionate to it; a higher count number represented finer yarn and a higher tex coarser yarn.

The industry, therefore, wanted the British count system to be replaced by another indirect system of count, defined with reference to the gram and the metre. The choice lay between the French count, or the number of hanks of 1 000 metres in 500 grams of yarn, and the metric count, the number of hanks in 1 000 grams. The French count was preferred, because its enumeration was nearer the British count numbers, being equal to 0·85 British count. The

French count, while it was based on the metric system, would retain all the advantages of the British system. Ten hanks would form a knot and the number of knots in a bundle of 5 kg would be equal to the French count.

But later on, the industry represented to the Government of India that as the English count system continued to be prevalent in almost all the textile industries of the world, and in particular those countries to which Indian textiles were being exported, it would be advantageous for the industry to revert to the English count system in regard to the manufacture of textiles for local requirements as well. After discussing the matter with the interests concerned, the Government of India decided to revert to the English count system in toto as from 1 February 1966, and the mills were advised to take action towards this end.

The reversion to the English count system extends, in addition to spinning of yarn, to the reeling of yarn with 109·7 metres (120 yards) lea and 768 metres (840 yards) hank, and also to the bundling of yarn in 4·54 kg (10 lb) and 2·27 kg (5 lb) bundles, as the case might be. The weights of the bundles continue to be shown on them in metric unit and also in pounds in brackets. The weight of standard metric bale for raw cotton is fixed at 180 kg net. As for the baling of cloth and yarn, the standard bales consist of 1 500 metres of cloth and 180 kg of yarn.

IRON AND STEEL

The supply of steel sections in metric sizes was an essential requirement for the adoption of the metric system in the engineering industry. By meeting this demand promptly, the primary producers of iron and steel facilitated the conversion of the engineering industry to the metric system. In 1957, the Indian Standards Institution announced standard millimetre sizes for steel sections, the whole series of which had been re-designed to achieve maximum economy. This was the result of prodigious effort spread over three years and based on the experience of manufacturers and designers the world over. Since iron and steel manufacturers had been associated with the work of the Institution from its very beginning, it was not difficult to convince them of the merit of the new sections. It was recognized that they were a distinct improvement on the inch sections which they were to supersede, and that their adoption would bring about definite economies in the manufacture, design, use, erection and maintenance of steel and steel structures. All the primary producers of iron and steel decided to produce the new metric sections.

The three new mills owned by the Government produced these sections exclusively, from their very inception. The two older mills owned by public limited companies gave notice to their customers that they would also discontinue producing inch sections after a certain date; till then they would manufacture and supply inch sections to the extent they could with the existing rolls. There was little resistance from customers who realized that they could select an effective substitute from the metric sections for every inch section they were using in the past.

METAL CONTAINERS

Metal containers of a variety of sizes and shapes are used in packing not only consumer goods, such as foodstuffs, but also commodities like paints, varnishes, kerosene and other oils. When the metric system was introduced in trade in these commodities, the net weights or measures of the contents of the packs were marked in metric units on the labels. The sizes of the containers and the quantities packed remained the same as they used to be until packers had exhausted their stocks of old containers and manufacturers were able to supply new containers in metric sizes.

However, the substitution of the four-gallon kerosene tin by a convenient metric size container presented difficulties. This tin container is probably the one most widely used in the country. Although used mainly as a container for kerosene oil, it is also used for packing a variety of other commodities, such as vegetable oils, hydrogenated oils, etc. The possibility of replacing it by a 20-litre container was examined, but found wanting. A change in the dimensions of the base of the tin to raise its capacity from 4 gallons (18·2 litres) to 20 litres would entail the replacement of dies and other manufacturing equipment, leading to a rise in the cost of packing and hence to the retail price of kerosene oil. This had to be avoided, kerosene being the main source of light and fuel to the less affluent classes of the people. It would be easy to make the tin bigger by raising its height, but such a tin would not be sturdy enough, unless thicker tinplate was used. This would again make the container more costly. Experiments were conducted to test the adequacy of a 20-litre tin of the same base dimensions but slightly taller, and fabricated from the same guage of tinplate as the 4-gallon tin. A consignment of kerosene oil packed in these tins was transported by rail from Bombay to Pathankot, a distance of 2 159 km, and by road from Pathankot to Srinagar another 402 km. It suffered heavier leakages in transit than could be tolerated. It was, therefore, decided to retain the 4-gallon tin as an 18-litre container for kerosene oil.

PETROLEUM PRODUCTS

With the adoption of the metric system, the litre and kilolitre became the units of sale of petrol, diesel, kerosene and other petroleum products. The change from the gallon to litre involved problems of complexity relating to re-calibration of oil tanks, tank wagons and tank trucks, and the conversion of dispensing pumps and bulk meters. Oil products brought in tankers and landed at ports are stored in very large terminal tanks. Oil refined in the country is stored in similar tanks at the refineries. From the ports and refineries they are transported in tank wagons to storage depots at points of supply in the main consuming centres. From the storage tanks they are carried in tank trucks to retailers' premises for sale to consumers through dispensing pumps.

Port terminal tanks, storage tanks at refineries, tank wagons, depot tanks and tank trucks previously calibrated in gallons had to be re-calibrated in litres and kilolitres. The accurate re-calibration of the large tanks at ports and refineries and tank trucks was of special importance. Customs and excise duties are levied on oil removed from the tanks at ports and refineries, while the tank trucks are required to deliver specified quantities of oil to the retailers. The quantity of oil in the terminal tank is estimated from the depth of the oil measured by a steel tape. A chart relating depth to volume of oil, is computed using what is called strapping data, which consists of measurements of the circumferences of the tank at various heights. The strapping data, where it was available, was converted from inches to centimetres, and charts relating depth in centimetres to volumes in litres were prepared. In many cases, however, the strapping data was not available, the measurement having been taken decades ago and the records lost. Taking measurements of the large number of these enormous tanks would have entailed much labour and expense. Calibration charts in centimetres and kilolitres were, therefore, computed by direct conversion and interpolation from the inch-gallon charts. The calibration of tank trucks was simpler. The capacity of each compartment of the truck was measured by filling it with measured quantities of water, using standard litre measures.

The conversion of over 12 000 dispensing pumps was another difficult and costly task. Representatives of the industry at first suggested the replacement of all old and obsolete pumps, the conversion of which might be difficult or uneconomic, and the replacement of the entire metering equipment in others. They wanted all the components necessary for such conversion to be ordered from foreign manufacturers of the pumps. This would have entailed importing components worth Rs 20 million (£ 1·5 million sterling). It was, however, not difficult to convince the industry that the foreign exchange to foot such a heavy import bill would not be available. A search was made for sources of supply within the country. It was ultimately found possible to fabricate indigenously over 90 percent of the components, thereby slashing drastically the value of components imported to only 1·5 million rupees (£ 112 000 sterling), or say, 7·5 percent of the original estimate.

Along with the adoption of the metric system, a standard temperature of 15°C was adopted for the measurement of petroleum products. The rates of customs and excise duties are fixed with reference to this temperature.

A smooth transition to the metric system by the oil industry owes much to the labours of the Oil Industry Metric Committee, a body set up by the industry in which all major oil companies were represented. The Committee was able to suggest workable solutions of the numerous problems raised during the transition. Since it was the voice of the industry, its unanimous recommendations were, without exception, accepted by the authorities.

PAPER AND PRINTING

The sale of paper by metric tonne and quintal instead of long ton and hundred-weight did not present any difficulty. The manufacture of paper in standard metric sizes and its use in the production of stationery and printed material like forms and books, raised problems for the paper mills as well as printers.

Standard sizes of paper were drawn up by a Committee of the Indian Standards Institution on which paper mills and printers were represented, the Chairman being the Controller of Printing and Stationery of the Government of India, the largest single organized user of paper in India. It was hoped, therefore, that manufacturers and users would not resist the introduction of the new sizes. Experience, however, proved otherwise. Manufacturers were, in the beginning, reluctant to produce the new sizes of paper, since it entailed some re-adjustment of manufacturing equipment. Paper production was short of demand, and a seller's market prevailed at the time. The users had, therefore, to accept willy-nilly the sizes offered by the producers. Supplies to Government departments were, however, regulated by a contract, and it was possible to induce manufacturers to supply a certain proportion of Government requirements in metric sizes. This proportion has steadily increased with every new contract.

The basic metric size adopted by ISI in India and based on ISO Recommendations is denoted by A_0 and has an area of 1 sq metre, the sides of which bear the ratio of $1:\sqrt{2}$ (*see* Chapter 18 Sec 9). Other sizes, A_1, A_2, etc, are derived from A_0 by successively folding it in half across the longer side. Every one of these sizes has, therefore, the sides in the ratio $1:\sqrt{2}$, which makes for convenience in use and handling. The use of these sizes involved re-designing the formats of books, journals, posters, forms, etc. The task was arduous because of the number and variety of formats to be revised. To give an instance, the railways use about 16 000 different forms.

The use of paper of A-series also involved adjustments in printing machinery. Certain old presses could not use these sizes of paper; others could use them with chassis replaced. Users who could not use A-sizes immediately were advised to use certain other standard sizes, B_3, B_2 and B_1 of B-series* corresponding to crown, double crown and quad crown, and C_3, C_2 and C_1 of C-series* corresponding to foolscap, double foolscap and quad foolscap. These sizes would be replaced by A-sizes as soon as the users were able to do so.

UNITS OF PRICING

The price of a commodity, whether wholesale or retail, may be expressed in any standard unit, which means any unit of the metric system. The choice is only limited by the law which insists on certain commodities being sold by weight and others by volume; foodgrains, for instance, may be sold only by weight in most parts of the country, while liquid paints may be sold only by volume. Government has, however, in consultation with the interests concerned, recommended the following units for use in trade in major commodities:

WHOLESALE

Commodities	*Unit*
Gold	10 grams
Confectionery: Biscuits and sweetmeats	1 kg
Grocery: Cardamoms; dry mangoes; jams and pickles	1 kg
Hides, Skins and Leather: Raw hides and leather (sides and skins)	1 kg
Metals: Silver; aluminium sheets, strips and circles; copper and brass wires and utensils	1 kg
Paints and Chemicals: Paints (if sold by weight) indigo and liquid chlorine	1 kg
Textile and Textile Fibres: Cotton yarn; damaged and seconds cloth (fents rags, chindies, etc) raw silk; rayon; silk yarn; raw wool and wool manufactures (when sold by weight)	1 kg
Miscellaneous: Tea; meat; camphor tablets; senna leaves and mica	1 kg

*For details of these sizes, reference is invited to Indian Standard specification for paper sizes (*revised*) (IS : 1064-1961).

Commodities	*Unit*
Forest Products: Lac and lac products; gum benjamin and gum arabic; myrobalans; galnuts; soapnuts; avaram bark and kennam bark Chemicals: Caustic soda; bleaching powder; glycerine; soaps; paper and salt Grains and Pulses: Rice; wheat; *bajra*; *jowar*; *arhar*; *moong*; *masur* and gram	1 quintal (q) (100 kilograms)
Non-ferrous Metals: Aluminium ingots, bars, blocks, slabs and billets; Lead ingots, sheets and strips; Copper ingots, blooms, slabs, cakes, tiles, bricks, billets, blisterbars and wirebars, rods, sections and pipes, plates, sheets and strips and circles; Brass ingots, sheets and strips; and Tin blocks Oils, Oilseeds and Oilcakes: Vegetable oils like groundnut, linseed, castor, gingelly, mustard, coconut, etc; oilseeds like groundnut, gingelly, rapeseed, copra, etc; groundnut cake; castor cake; sesamum cake and coconut cake Plantation Products: Coffee; rubber; cashewnuts; cashew kernals and tobacco (raw and manufactured) Spices: Black pepper; mustard; chillies; cloves; *dhania*; *dalchini*; *malethi*; turmeric; betelnuts and dry ginger Textile and Textile Fibres: Raw cotton; raw jute, raw hemp; coir yarn and jute twine Miscellaneous: Sugarcane; sugar; *gur*; vegetables; tamarind; garlic; fish; ice; etc	1 quintal (q) (100 kilograms)
Minerals: Iron ore; manganese ore; bauxite and coal	1 tonne (t) (1 000 kilograms)

Commodities	*Unit*
Iron and Steel: Pig iron and iron and steel manufactures and semis (billets for re-rolling)	1 tonne (t) (1 000 kilograms)
Cotton cloth (mill and handloom), silk and rayon manufactures and woollen cloth	1 metre (m)
Jute cloth	100 metres
Jute carpets; coir mats and mattings; sheet glass; etc	1 sq metre (m)
Timber	1 cubic metre (m)
Paints and spirits	1 litre (1)
RETAIL	
Foodgrains; cereals; pulses; spices; ghee; vegetables; meat; fish; sweetmeats; tea; coffee; sugar; salt and bread	1 kg
Fruits	1 kg or number, depending upon prevalent practice
Oil for cooking	1 kg or litre depending upon prevalent practice
Milk	1 litre
Cloth and related materials	1 metre

These units are not enforced by law. Their use, however, has been recommended to public authorities and recognized associations of trade and industry.

COST

The adoption of the metric system in trade and in other commercial transactions of all kinds was complete by the end of 1963. It was, therefore, possible to make a rough estimate of the cost incurred by trade, industry, transport, Government departments and the public. The main items of cost may be classified under the following broad heads:

1) Replacement of weights and measures by the public, trade, industry and other users.

2) Conversion of weighing machines.

3) Other miscellaneous costs to industry, transport and trade. These include conversion of various types of measuring instruments, training of staff, replacement of containers, labels, registers, forms, account, etc.

4) Cost to the Central and State Governments, on enforcement, publicity, replacement or conversion of weighing and measuring instruments, and other equipment in public undertakings like the railways and post offices.

The replacement of weights and measures took place during a period of about 3 years from the middle of 1960 to the middle of 1963. Every commercial weight or measure had to pass through the hands of a Weights and Measures Inspector, since no weight or measure might be used in trade or commerce before it was verified and stamped by the inspector. It was, therefore, possible to make an estimate of the value of new weights and measures, which entered trade, from the inspector's records; this estimate was Rs 72 million. A part of this, however, represented normal replacement, which would have taken place in any case. The average life of a weight or measure being about 5 years, about 20 percent of the weights and measures in use are estimated to be replaced every year. About 60 percent of the new weights and measures bought by users during the 3 years, therefore, represented normal replacement and the remaining 40 percent accelerated replacement due to introduction of the metric system. The additional cost of replacement was thus estimated to be Rs 28·8 million.

According to statistics furnished by recognized manufacturers of weighing machines, the value of conversions carried out by them was Rs 6·2 million. This inevitably included an element of repair and maintenance, since a machine which was not in good shape would first be repaired and serviced before conversion, but it was impossible to estimate the value of this element.

According to the Oil Industry Metric Committee, the oil industry spent Rs 2·5 million on the conversion of dispensing pumps and other measuring equipment, publicity, training of staff, etc. The cost to other major industries was estimated by a rough sample survey.

The State Governments spent about Rs 47 million on the enforcement of weights and measures, publicity and training of staff. Since the reform was sponsored by the Central Government, the latter gave liberal financial assistance to the State Governments. Besides monetary grants, it also supplied the bulk of the publicity material to the States. Public undertakings like the railways, post offices and manufacturing establishments in the public sector, as well as departments of the Central Government, incurred large expenditure. The railways converted their weighing machines in their own workshops without using any imported equipment — all the components used being fabricated in the railway workshops.

The approximate cost to the nation was as follows:

			Cost (*in millions*) Rs
1.	Replacement of weights and measures		28·8
2.	Conversion of weighing machines (except those used in the railways and in major industries)		2·5
3.	Industry and transport:		
	Cotton textiles	2·0	
	Jute	0·8	
	Sugar	3·6	
	Cement	0·3	
	Iron and Steel	0·5	
	Oil (Mineral)	2·5	
	Tea	2·4	
	Miscellaneous, including small-scale industry	7·0	
	Total		19·1
4.	Governments:		
	a) State Governments		47·0
	b) Central Government:		
	Railways	10·2	
	Posts and Telegraphs	3·0	
	Publicity	6·9	
	Other Departments and Undertakings	4·5	
	Total		24·6
	Total cost to the nation		122·0

Although this estimate relates mainly to expenditure on the transition in commercial transactions, it includes expenditure on technical education and in the conversion or revision of drawings, specifications and designs in industry, railways, transport, etc, during the 5 years 1958-63. The work is still in progress and it is difficult to predict what the ultimate total cost will be. The expenditure will be spread over a number of years and should not prove an insupportable burden to the country. □

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Problems of Industrial Standardization

S. K. Sen

In planning for the change to the metric system of measurement, it was evident that the change in trade and commerce and that in industry needed different approach not only for the basic difference in the transitional problems in the two fields but also for the fact that the separation of industry from commerce could present other practical advantages. If the common man was taken as the central beneficiary of the change, what concerned him most immediately was the distribution and consumption of goods and services. What happened within the four walls of the factory during production was of little interest to him. With the adoption of the metric system in education and commerce, the change was almost nearly complete for the common man.

The use of the metric system in everyday life produced the necessary psychological atmosphere for the industry to feel the compulsion of an early transition, but it was still free to regulate the pace to suit the economic resources of the country. Admittedly, the change in industry is not only vastly more complicated in comparison with the trade but also has a much greater financial implication. The cost could be very high for a quick transition for the majority of the industries. The freedom to plan a comparatively longer period of transition than the trade proved to be of much practical value.

In retrospect, it now appears that the decision not to tie industry and trade together to adopt the metric system simultaneously was a wise one. It was not easy in the beginning to assess the various implications of the change in all its technological and economic aspects. By-and-by they became clearer and the manifold apprehensions which loomed large for some time got sorted out into the real and the imaginary, and assumed proper perspective.

No other country had carried out a change of this magnitude in the recent past. Attempts to secure information from Japan and Turkey which were reported to have adopted the metric system before World War II did not meet with much success. There was, therefore, little to guide the Indian industry and they were left to themselves to devise their own measures. Under the circumstances, it was natural that various ideas, some of which were evidently unpractical, were thrown up in the debates which took place throughout the country to determine the best ways and means of carrying out the change in industry.

EXTREMES AND COMPROMISE

First of all there was a widespread view that the industry should start from a clean slate. This is not as utopian as may sound at first. The inherent merit of the metric system lies in its simplicity and rationality. If, therefore, some of the rationality is lost in trying to retain non-metric practices, the most potent reason for introducing the change will be impaired. It would appear logical that as a general approach, industry should look for rational metric practice and not hesitate to break away from the past.

There was also another compelling reason. From the point of international relations, uniformity of industrial standards between India and other metric countries was of obvious importance. India could not break away from its existing practices and still remain alien from other metric countries.

There are obvious and strong arguments against the above approach which were voiced from many quarters, particularly from financial considerations. It was pointed out that the change in industry meant a series of changes starting from the design table and ending with the finished product. Apart from the vast cost of changing designs, measuring instruments, jigs, fixtures and tools, India could hardly produce the manpower required to carry out the necessary change.

Some also argued that after all the metric system is merely a system of measurement. A given article can be expressed and produced as easily in the metric system as in the inch system. There is hardly any reason why a change in the system of measurement should mean a change in the article itself. If such a view is accepted, there should be little for industry to do except converting the values where the system of measurement comes in.

Clearly, a compromise between the two extreme propositions had to be sought. The approach which finally led to some definite conclusion lay in clarifying the two fundamental issues implied in the two opposing viewpoints. The first was what constituted rationality in adopting the metric system and the second was the extent to which a system of measurement determined the quantity or other parameters of an object.

When a housewife bought a pound of meat before, would she buy 454 g now? It is physically possible to measure the same quantity of meat in both the systems. However, the unit of price must necessarily be different to permit simple calculations in buying and selling. Since the pound as the unit for fixing price must be converted to kilogram, the housewife would find it extremely inconvenient to calculate the price of 454 g which is unnecessary anyhow. She could just as readily buy 400, 450 or even 500 grams.

There is nothing much rational or irrational in the various quantities involved, for it may be normally expected that a difference of 50 g on either side is immaterial as far as the housewife's need is concerned. Yet she will be forced to make a change for the practical convenience of carrying out the transaction.

Simplicity and convenience, therefore, are associated with the idea of rationality and may lead to a change of existing practices with the change of the system of measurement. What has not been considered in the above illustration is the other side of the balance sheet, that is, the cost of making the change. For the housewife, it is not likely to be of any serious consideration but when we direct attention to industrial problems, the cost could easily become a very important factor to reckon with.

Further, in measurements connected with industrial production, practical convenience may not be as clear cut as in commercial transactions. A rounded value of, say, 20 is normally considered more rational than, say, 19. But if 20 relates to a parametric dimension of a manufactured article, for example, the diameter of a wire, it will be associated with a tolerance, and the limiting dimensions may be 19·9 and 20·1. If the same tolerance was allowed on 19, the limiting dimensions would have been 18·9 to 19·1. *Prima facie*, there is little to choose between the two sets of limiting values. Besides, in modern manufacturing practices, measurement is very often done by gauging, in which case whether the nominal value was 19 or 20 would make no difference at all so far as manufacturing and gauging are concerned.

CRITERIA OF RATIONALITY

The burden of the above argument is that one has to look for other criteria of rationality as far as industry is concerned. Search for further ideas led to the realization that rationality could not be considered in isolation. In other words, something becomes rational or irrational inasmuch as it fits or does not fit in a broader spectrum of which it is a part. This naturally brings up the interrelationship between one object and another of the same series or of inter-related and inter-dependent subjects between practices in India and in other metric countries. The conclusions were codified in the following terms:

A rationalized value shall satisfy one or more of the conditions which determine its rationality, such as

1) whether the value is one of the preferred numbers or preferred dimensions for the item;

2) whether it conforms to the international usage in the matter; and

3) whether it is dimensionally correlated with its components, raw materials, other sizes of the series to which it may belong and items with which it should fit or be interchangeably used.

METRIC VALUES IN INDIAN STANDARDS

With the above clarification, a proper perspective grew for taking meaningful steps which could lead to a complete change-over in a co-ordinated manner. This was the approach of the Indian Standards Institution (ISI) in preparing new standards in the metric system and in revising those already in use at the time.

INDIAN STANDARD GUIDE

In order that the principles were understood and followed by all Standards Committees responsible for preparing Indian Standards, a 'Guide for specifying metric values in standards' (IS:1722-1960) was published which recognized three main steps of conversion, as

1) interchangeable conversion from non-metric to metric values,

2) rounding off values converted from non-metric to metric, and

3) adoption of rationalized metric values,

each step being permitted on the merit of a case, though the last was always preferred. The Guide stipulated the following as the considerations that would decide which step was more appropriate in a given situation:

> 'Where the adoption of rationalized metric values involves a significant change from the existing practice, the implications of the change shall be examined to strike a balance between the advantages to be gained by and the initial difficulties to be encountered in introducing the change. Factors to be examined may include:
>
> 1) the question of interchangeability with existing products and of fit in case of assembly components, for example, lampholders, lamp caps and pipe fittings;
>
> 2) possible effects on production, if re-designing, re-tooling, etc, should be called for; and

3) the need of correlation between inter-dependent and inter-related industries as in the case of electrical copper wire which is a raw material for many electrical industries, or cast-iron and asbestos pipes which have inter-related sizes.

'While it is important to give due consideration to the factors enumerated above, it will be pertinent to remember that:

1) the engineering and commercial problems of change-over are of transitory character;

2) manufacturing tools, dies, etc, are normally required to be changed at the end of their useful life, and certain machines, equipment and practices become obsolete and have to be replaced in course of time;

3) it is generally possible to provide for a period of adjustment during which the industry may plan to switch over to the new values; and

4) the benefits of simplification and rationalization are of lasting character and permeate not only the engineering but also the administrative functions of an organization.'

ALIGNMENT WITH INTERNATIONAL PRACTICES

Let it not be understood that a free ticket was given for metric translation of non-metric practices. Far from it, over-riding importance was attached to aligning with international metric usage. Wherever available, the Recommendations of the International Organization for Standardization (ISO) and the Publications of the International Electrotechnical Commission (IEC) were adopted as a rule. In preparing new standards for basic engineering products, tools, measuring instruments, gauges and raw materials, such as plates, sheets, wires, tubes, sections, bolts, nuts, screw threads, etc, only a rational approach was permitted.

MATHEMATICS OF CONVERSION

But having accepted the necessity of continuing present practices in certain situations, the mathematics of conversion had to be clearly stipulated. For, there was ample scope for different persons to arrive at slightly varying values for the same physical quantity. These small differences appearing in technical literature and documents throughout the country could easily create a lot of confusion. What was more, they could lead to serious manufacturing problems where close tolerances were involved.

Rounding Off — The mathematics of conversion itself is quite simple, but when one had to decide to what extent one could round off a converted value, there was little guidance available. This was the crucial issue, for here differences could arise out of personal judgement.

To illustrate, take the case of a linear dimension, say, 4·5 in. The straight forward converted dimension is 114·30 mm. Should it be rounded to 114·3 or 114 mm? The answer of course is that the extent of rounding should be such that the precision of the converted value remains the same as that of the original value. But what is the precision either of 4·5 in or of 114·30 mm?

The problem, therefore, reduces to establishing mathematical criteria to estimate the precision values. The sense here is not that of the statistical precision of a set of observed data. Rather, it is an enquiry into the region of uncertainty or doubt associated with a given value. When a value is stated as 4·5, it is certain that it is greater than 4·4 and less than 4·6. But there exists a region of doubt from 4·46 to 4·54, both of which could be rounded to 4·5. This region of doubt is the measure of precision. Stated as a rule, the precision of a value is $\pm\frac{1}{2}$ of the unit in the last significant place, in which the value is expressed. The precision of 4·5 in then becomes $\pm 0{\cdot}05$ in (1·27 mm) and that of 114·30 mm, 0·005 mm, which is much too fine. The value when rounded to 114 mm acquires the precision of 0·5 mm which, being of the same order of magnitude, is better comparable with that of 4·5 in.

This half-unit rule is more in the nature of a convention than a mathematical conclusion, but this does not in any way diminish its practical importance. There is little doubt that such a convention could be extremely useful both for specifying values and for their interpretation. Much too often values are expressed even in technical literature in superfluous numbers of decimal places which have no significance in terms of the precision required or intended.

However, the rule merely established a convention to state a value appropriately when the precision was known. It did not give any clue as to how precision should be determined in the first place. Also, it has severe limitation in dealing with vulgar fractions. If the dimension 4·5 in was expressed $4\frac{1}{2}$ in, it certainly was not expected to become as coarse as $\pm\frac{1}{8}$ in, as the half-unit rule would indicate. Therefore, other criteria had to be looked for to connect precision with a measurable quantity and were found in the inter-relationship between the precision of a value, the accuracy of its measurement and the tolerances associated with it.

An illustration will bring out this issue. Let us assume the linear dimension we have been considering, namely, 4·5 in is measured by two methods of differing accuracies as below:

	Method 1	*Method 2*
	in	in
Mean value	4·5	4·5
Accuracy of measurement	0·01	0·001
True value lies within (region of doubt)	4·49 - 4·51	4·499 - 4·501

Now let us compare the above regions of doubt with the following precisions of statement according to the half-unit rule:

Stated Value	*Precision*	*Region of Doubt*
in	in	in
4·5	0·05	4·45 - 4·55
4·50	0·005	4·495 - 4·505
4·500	0·000 5	4·499 5 - 4·500 5

Clearly, the first statement (that is, 4·5 in) is more compatible with the first method of measurement, the second with the second method and the third is too precise for both the methods of measurement.

The conclusion is derived that the accuracy of measurement and the precision of a value should be of the same order of magnitude.

It will be observed that the explanation of precision as a region of doubt associated with the value makes it similar to tolerance. While tolerance is the permitted deviation from the nominal, precision is an additional inherent deviation arising from the statement of the value. To illustrate, if the value 4·5 in is permitted a tolerance of ±0·01, then the limiting values are 4·49 and 4·51. The precision implies that the limits are extended to 4·485 and 4·515 because of the uncertainty of ±0·005 associated with each of the limits.

Procedure for Conversion to Metric Units — The scheme of steps in the mathematical procedure for conversion should be obvious by now. The precision of a given value is first estimated, either from its statement (by the half-unit rule) or from the method of its measurement or the permitted tolerance. The converted value is then successively rounded until it has the same order of magnitude of precision as that of the original. To go back to the illustration, if 4·5 in is measured to an accuracy of ±0·01 in (±0·254 mm), the converted value cannot be more precise than 114 mm, as otherwise the precision will be finer than the accuracy of measurement. If the accuracy of measurement was ± 0·001 in (±0·025 mm), the converted value could be stated as 114·3 mm.

The details of the procedure of conversion thus developed were incorporated in Indian Standards IS : 787-1956 'Guide for inter-conversion of values from one system of units to another' and IS : 1105-1957 'Method for precise conversion of inch and metric dimensions to ensure interchangeability' which also contained a number of practical examples.

EQUIVALENT METRIC UNITS

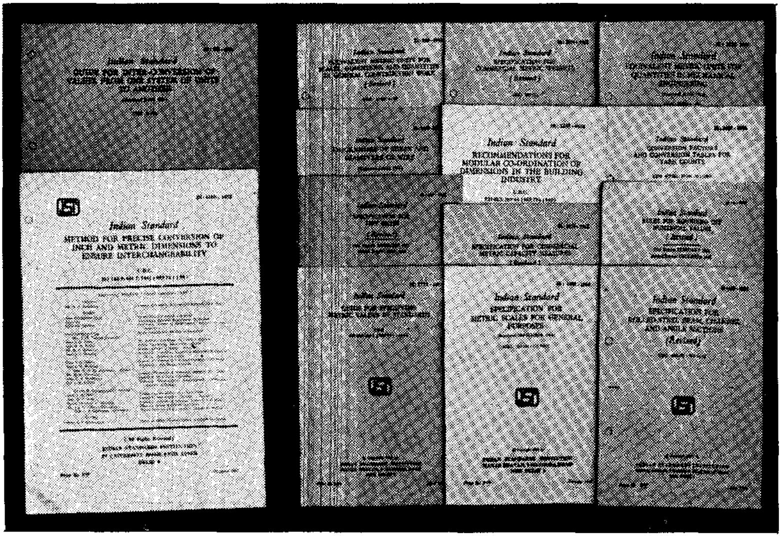
There was another basic issue which had to be clarified before the new units of the metric system could be used in standards. This was the question of equivalent units. When a dimension is expressed in inches, should it now be expressed in mm or cm? A clear guidance had to be given from the beginning so that the use of a number of multiple and sub-multiple units did not create a confusing situation. Here again the preference was to adopt those practices which had gained wide usage in metric countries. Otherwise, the multiple or sub-multiple metric unit having the order of magnitude of the original unit was chosen.

The choice of equivalent metric units could lead to some practical complications, if the *Système International d'Unités* (SI) was implemented without any deviation. They were avoided by accepting the metric technical units of force (kgf) and pressure (kgf/mm^2) and the thermal unit, kilo-calorie. Newton, as the unit of force, though recognized in the *Standards of Weights and Measures Act, 1956*, was so unfamiliar that its adoption was considered impracticable for the time being. An international agreement for its introduction in industry was considered essential before India could think of taking this step. The non-availability of the large number of tables, charts and diagrams used by the heating and refrigerating industry in terms of Joule, which is the proper thermal unit for heat energy in the SI system, ruled out its use.

It is unlikely that these SI units will find practical application in India without concurrent action in other countries. Here is an issue which needs international agreement and an international programme of implementation. It is hoped that the International Organization for Standardization (ISO) will soon be ready to give a lead in the matter, since its technical committee is actively considering the subject. Any undue delay may seriously hamper the progress of adoption of the SI units in the world.

METRICIZATION OF INDIAN STANDARDS

After the principles had been laid down as described above, preparation of new metric standards and revision of existing ones started in right earnest. About 1500 Indian Standards had been



A few of the many Indian Standards issued to assist in changing over to the metric system

published by that time (1959). Added to it was the task of preparing the guides and specifications required to establish rational metric series of dimensions and sizes of basic products and raw materials. This was a formidable programme to be completed within a period of five years, which was the target ISI had set for itself so that industry could know as early as possible what they had to produce and plan for the change accordingly.

METRIC CELL IN ISI

A 'Metric Cell' was set up in ISI in 1959 to ensure that metric guides and standards were made available in time. The functions of this cell were:

1) To formulate and adopt policies for guiding the introduction of the metric system in Indian Standards;

2) To co-ordinate the efforts of all departments of ISI in implementing these policies;

3) To assist technical committees in resolving specific problems of metricization; and

4) To keep in review the progress of preparation of metric standards, and to initiate actions to remove any deficiency observed in the implementation of the programme.

The Metric Cell maintained liaison with industry, trade and Government departments directly concerned with planning and executing the metric change. It answered queries of technical nature and generally kept itself available for consultation on the various aspects of the introduction of the metric system in industry.

Directives for Metricization — Some of the directives given to the ISI committees as practical steps to carry out the programme of metricization may be of interest to the reader. The more important of them were as follows:

1) All Indian Standards prepared since the passing of the *Standards of Weights and Measures Act* in December 1956 were to make reference to the decision to adopt the metric system indicating the extent to which it was reflected in the standard and the possible future date by which a complete change-over was expected to be carried out.

2) Standards finalized but not yet published at the time were to remain unaltered for the time being, unless it was possible to introduce metric units as a matter of editorial change without altering the substance.

3) All published standards in force were to be revised for incorporating metric units at the earliest opportunity.

4) In all standards under preparation, attempt was to be made to introduce the metric system of measurement provided the interests concerned were prepared to accept the change-over immediately.

5) If an industry were not immediately prepared for the adoption of rational metric values, it was to be urged to adopt the interim measure of expressing values in one or the other forms of converted metric equivalents and work out a programme of attaining the final stage of rationality as quickly as possible.

6) In the international sphere, all Indian delegations were to be briefed to press for the adoption of the metric system of measurement in preference to other systems, whenever occasions arose.

A further practical step was taken to classify all Indian Standards into a few classes in the order of priority to be allocated in the programme of metricization:

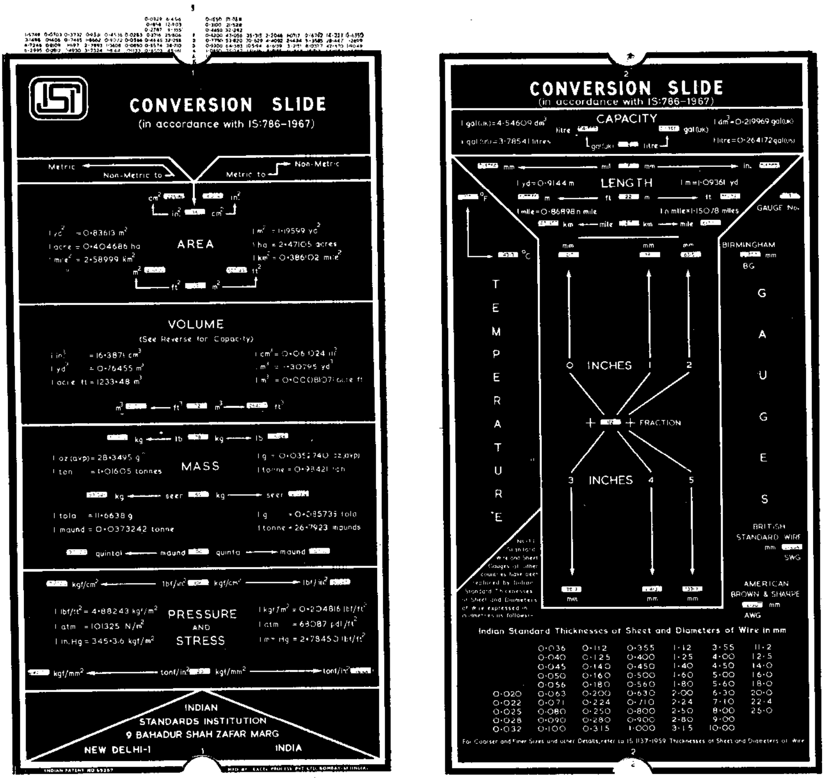
1) General guides,
2) Basic engineering standards,
3) Material specifications,
4) Test methods,
5) Codes of practice, and
6) Others.

The Metric Cell prepared exhaustive lists for each class of standards, and handed over a statement of the status of metricization of each standard and what remained to be done, to the operating divisions of ISI, which formed the basis of detailed programming.

Training in Metric Conversion — Another responsibility of the Metric Cell was the training of personnel in metric conversion, particularly the younger personnel. New recruits of the officer cadre in ISI normally undergo a two-year training. It was easy to extend this training to include the general principles of inter-conversion of values from one system of measurement to another, and also to give some practical guidance. But the training of industry personnel proved a baffling task. Some of the bigger industrial units organized their own training courses, but a large number of medium and small industrial units remained outside the scope of organized training. To help them, a small booklet entitled 'Guide to Metric System for Engineers', was published by the Ministry of Commerce and Industry, Government of India, in co-operation with ISI and was distributed in tens of thousands.

ISI PUBLICATIONS ON INTER-CONVERSION

Among other publications which proved extremely useful to both



The two faces of the Conversion Slide

industry and trade and also to the general public was the Indian Standard on conversion factors and tables (IS : 786-1956*). It was the most authoritative source of reference for conversion factors and contained tables of conversion not only for all common measurements but also for many rare measures which certain industries or trades used for very specialized purposes. ISI also prepared a metallic conversion slide which, by its extremely simple design, enabled one to read off directly the converted value for a wide range of quantities including mass, length, area, volume, capacity, pressure, temperature and wire gauges.

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*Since revised in 1967. The revised edition is bilingual (English and Hindi).

Dr Verman, former Director General ISI, explaining the working of ISI Conversion Slide to Prime Minister Nehru. Equally interested is Lal Bahadur Shastri, then President ISI, later Prime Minister of India (extreme right)

Well before the date line of five years, ISI completed its task of revising existing standards from non-metric to metric, and also prepared the basic standards and guides required to lay the foundation for the growth of rational metric practices (*see* Appendix 7). In the meantime, attention was being directed to the problems industry had had to face in implementing the new metric standards.

CO-ORDINATION IN CHANGE-OVER

The big question at this stage was whether the primary producers should change first or the industrial consumers. The former were apprehensive of marketing a new line before they were sure of the demand. The latter found it futile to ask for something which was not being actually produced.

Here was a classic vicious circle that had to be broken at some points. It was soon appreciated that neither party could be ready for metric production without a good deal of initial preparations. If each unit undertook to do this and kept its suppliers and customers informed of the progress, co-ordination between the supply and demand could become a practical possibility. Industries were, therefore, advised to take the following steps as early as possible:

1) To prepare or adapt designs to conform to the metric system;

2) To assess the need of metric sized raw materials, measuring instruments, tools, gauges, fixtures, etc, so that suppliers could be given an idea of the possible demand and the time when the demand could arise;

3) To enlist all work of alteration or adjustment to be carried out on existing machines and equipment, particularly where thread cutting was involved; and

4) To make, as far as possible, purchases in metric terms so that suppliers, of necessity, had to adopt metric standards.

Following this lead, the major producers of primary products, such as the iron and steel industry set out their programmes for metric production, which were widely publicized. Simultaneously, organized consumers like the Railways prepared their own schedules of change as far as practicable and informed the supplier industries. Within the framework of these programmes, other industries and consumers began to adjust their needs and services.

These adjustments are still progressing, for complete change-over to metric designs and production can only be a long-term proposition. Apart from the very high cost of conversion involved if production equipment and tools were to be replaced before they ran out their useful life, the dependence on import, for which the available foreign exchange was never plentiful, itself imposed a severe limitation on the pace of change. A further complicating factor was the excessive variety of standards which has been inherited from foreign collaborators all over the world. While such collaboration may be desirable or even necessary to obtain the technical know-how, a developing country like India needs in the initial stages of industrial development, it is hardly realized that indiscriminate collaboration may lead to such a confusing diversity of standards in the industrial base as to threaten further progress after a certain stage. Even more damaging perhaps is the influence that collaboration has by way of limiting the growth of indigenous experience and facilities for executing original designs of industrial products.

CONCLUSION

The introduction of the metric system has brought a unique opportunity to sort out and rationalize the operations of industries individually and collectively. A sound beginning has been made with the Indian Standards Institution acting as the spearhead of the movement. There is still some way to go but that is of less importance than the fact that the industries are moving in the right direction. □

13

Railways

S. L. Kumar

The Indian Railways are the nation's largest undertaking in the public sector with an investment in 1966 of Rs 32 555 million. They had a fleet of about 11 700 locomotives, 32 800 coaching vehicles and 370 000 goods wagons. About 10 000 trains ran daily to serve nearly 7 000 stations and carried about 5·7 million passengers, that is, more than one percent of the entire Indian population. More than 33 000 wagons were loaded daily. The gross earnings per day amounted to about Rs 20 million.

The Indian Railways operate on three gauges — the broad gauge (BG) of 1·676 m, the metre gauge (MG) of 1 m and narrow gauges

(NG) of 0·762 m and 0·610 m. On 31 March 1966, the railways had a 'route' kilometrage of 28 571 km of BG, 25 523 km of MG and 4 305 km of NG.

The Indian Railways' network is owned by the Central Government and is managed by a board called the Railway Board. The entire network in 1956 was divided into eight zonal railways (now nine), the Central, the Eastern, the South-Eastern, the North-Eastern, the Northern, the Western, the North-East Frontier and the Southern railways. The Research, Design and Standards Organization, now with headquarters at Lucknow, are the technical consultants of the Railway Board.

Apart from 32 major rolling stock repair workshops (mechanical), the Indian Railways own at present three manufacturing units, the Chittaranjan Locomotive Works (started production in November 1950 at Chittaranjan in West Bengal), the Integral Coach Factory (started production in October 1955) at Perambur (Madras) and the Diesel Locomotive Works (started production in January 1964) at Varanasi in Uttar Pradesh.

PLANNING FOR THE CHANGE-OVER

It was in August 1955, more than a year before the metric legislation was adopted, that an *ad hoc* committee, subsequently called the Railway Metric Committee, was set up to plan for a smooth introduction of the metric system of weights and measures on the Indian Railways. The Committee had representatives of almost all branches of the railway, civil, mechanical, electrical, signal and telecommunication engineering, stores, Designs and Standards Organization and manufacturing units.

The author was originally sceptic about the immediate necessity of metricization and suggested to the Chairman, Railway Board, to use his good offices with the Government of India to persuade it to postpone the scheme as it would seriously hamper the rehabilitation programme of the railway systems overdue after the intensive usage during World War II, and slow down the pace of construction of new lines. Further, he pointed out that all the Indian Railways were already using a single uniform system of weights for booking of luggage, parcels and freights, namely, a seer equal to 0·933 kg and a maund equal to 40 seers. It would be far simpler, it was argued, if others using different weights and measures could be made to use the weights and measures in use on the railways. The author's request was summarily rejected, as a firm decision in favour of the change-over had already been taken. And, thereafter, the Railway Metric Committee (RMC) started functioning and held its first meeting on 15 September 1955.

A detailed questionnaire for eliciting information in regard to the quantum of work which the change-over would involve and also for inviting suggestions for facilitating it was issued in November 1955 to the General Managers of all the zonal railways and the manufacturing workshops.

A part of the questionnaire dealing with the Mechanical Engineering Branch is reproduced as a sample in an annex to this chapter.

The Parliament passed the *Standards of Weights and Measures Act* in December 1956 and allowed a period of 10 years for effecting the change-over to the metric system. The report of the RMC was submitted to the Railway Board in March 1957. Orders were immediately given by the Board to all concerned for the implementation of the recommendations made in the report.

SUMMARY OF REPORT OF RMC

The following is a summary of the important recommendations made in its report by RMC:

1) A Metric Cell should be set up immediately under the Additional Member, Mechanical Engineering, of the Railway Board to plan and direct the change-over to the metric system on the zonal railways. The Cell should consist of a Joint Director from the Mechanical Engineering Branch and a Deputy Director each from the Civil Engineering, Stores and Traffic (Transportation and Commercial) Branches.

The main functions of this Cell would be:

a) to maintain a close liaison with the Standing Metric Committee of the Government of India, the Indian Standards Institution (ISI) and the State Governments in planning the change-over;

b) to plan the introduction of the reform so as to ensure complete co-ordination of the actions in all branches of railways;

c) to arrange revision of the Railway Board's codes and publications, particularly the Schedules of Dimensions, Indian Railway Standard Limits and Fits, Way and Works Manual and the State Railway Engineering Code;

d) to review the organizational set-up from time to time on the zonal railways for effecting the change-over;

e) to arrange for a progressive and phased introduction of the metric units in all railway statistics; and

f) to deal with other allied matters.

2) All recruiting agencies for railway staff should include an elementary test of the knowledge of the metric system in their syllabi.

3) The expeditious implementation of the change-over will depend on the availability of an adequate number of experienced draftsmen. In order to attract and retain suitable men, the number of additional posts in the higher grades in major drawing offices should be considerably increased during the period of the change-over. And, the outstanding among them should be promoted to fill additional gazetted posts to supervise this work.

4) In order to adopt the metric system, mere endorsement of the exact equivalent of inch dimensions on drawings of standard engineering equipment will ordinarily be of little practical utility. Re-designing of the normally replaceable assemblies in the standard equipment, including rolling stock, would, in most cases, be inescapable. There should be simultaneous development of designs for the new standard equipment based entirely on the metric system.

5) It would be futile to undertake any revision of designs and drawings of non-standard equipment, including non-standard rolling stock, which will not remain in service after 1970. Re-examination should, therefore, be confined mainly to the existing standard designs and drawings of equipment likely to remain in use beyond 1970. Such re-examination for the adoption of the new system should also be carried out as to reduce the element of re-designing to the minimum, and the leading dimensions of the standard engineering equipment should, as far as possible, remain unaltered.

6) Development of new designs of equipment should aim not only at the complete adoption of the newly developed metric standards but also result in such leading dimensions as would be convenient to the trade and the industry from the point of facility

of manufacture and to the railways in its subsequent maintenance.

7) The Central Standards Office (now RDSO*) should take immediate action in the matter of revision of standard designs and drawings, particularly those of standard locomotives to be manufactured in the immediate future. Early availability of new designs for the existing standard equipment would reduce the transitional difficulties in respect of the new equipment and may also reduce the period of the complete change-over.

As a corollary to the above recommendations, it is the responsibility of a zonal railway, either by itself or in collaboration with another zonal railway having similar non-standard rolling stock which would be in use beyond 1970, to metricize the drawings and designs thereof. The locomotives, coaches and wagons which would be scrapped by 1970 may have their components and assemblies manufactured to the existing designs in the fps system.

8) The RDSO should immediately select suitable metric scales for use in the engineering drawing offices and issue a directive to all railways on the subject.

It is obvious that the RDSO could not take this decision by itself but only in consultation with the Indian Standards Institution so as to secure a uniformity of practice all over the country.

9) In order to eliminate duplication of tracing work at various centres, adequate arrangements should be made by the RDSO for the preparation and distribution to railways of sets of tracings and ferros of revised designs of mechanical equipment.

10) Necessary additional office accommodation for the RDSO should be arranged on a priority basis.

11) Metric cells should be set up in each branch at the headquarters of each zonal railway for planning and effecting the change-over.

12) Railways should initiate early action for modification of weighing machines and weigh-bridges to indicate metric weights in addition to the present ones.

13) Railways should be advised immediately to commence marking of tare weights, carrying capacities, floor areas in metric

*Originally known as Central Standards Office, it was re-designated after reorganization in the late fifties, as Research, Design and Standards Organization.

units on the existing goods stock during their periodical overhaul.

14) Establishment of planning cells in the major mechanical engineering workshops and production units would be necessary for assisting the local management.

15) Provision of roving instructors or assistant instructors would be necessary on all zonal railways for training the unskilled employees and the artisan staff spread all along the line.

16) Engineering works which are likely to commence after 1960-61 should be planned entirely on the metric system. Designs of works in hand at present should show the leading dimensions in the metric system also.

17) The Civil Engineering Branch on railways should work out the station-to-station distances in kilometres from the longitudinal sections in advance of the actual fixation of the kilometre posts and supply these particulars to the Commercial Branch not later than the end of 1957 for timely revision of the fare and rate tables.

18) The revision of bases for rates, fares and other charges in the Commercial Branch of railways may be carried out simultaneously for both decimal coinage and metric weights and measures, and brought into effect from 1 April 1960.

19) Electrification projects likely to be taken in hand after 1960 should be planned on the metric basis.

20) Two junior scale officers would be necessary for a period of 3 to 5 years, primarily for the revision of the nomenclature lists in the Stores Branch of each zonal railway.

21) Existing organizations for the preparation of nomenclature lists should be suitably strengthened immediately so as to expedite their revision.

22) Chittaranjan Locomotive Works should consider commencing of production of each metric assembly as and when its metricized drawings are received from the RDSO.

23) Production of the integral design coaches to the metric standards at the Integral Coach Factory, Perambur (Madras), should commence with the 10th and 11th batches, sometime in 1961-62.

24) All production units, such as the Furnishing Unit at Perambur, Metre Gauge Integral Coach Factory, etc, to be set up in the future, should be planned on the metric basis, so as to manufacture from the commencement of production on the metric system only.

The RMC also made in its report some important observations and suggestions, which, *inter alia*, were:

1) A smooth introduction of the metric system would necessitate a planned change-over from the existing system in a phased manner and with proper co-ordination at all levels between the various branches of a zonal railway, and between it and the RDSO. This was essential if the efficient standards of railway operation were not to be jeopardized and production and maintenance norms in the workshops and sheds were not to be adversely affected.

2) The work involved in the change-over, could, with advantage, be spread over two phases, the preparatory and the transitional. In the Engineering Branches and in the RDSO, the preparatory phase would last for a period of about 5 years. The change-over, including the preparatory phase in the Commercial and Transportation Branches, would be completed in about 3 years.

Both in the engineering and manufacturing workshops, top priority was to be given in the preparatory phase to intensive training of the supervisory staff and the operatives so as to acquaint them with the metric system, procurement of small tools and measuring instruments and the adaptation of equipment and machinery to the metric system.

The transitional phase which might overlap the preparatory phase, mainly required the gradual elimination of the fps system by procuring the equipment and machinery in the metric system, by manufacturing components, parts, sub-assemblies and assemblies of standard equipment to metric designs, and by making progressively increasing use of the metric system in production workshops and in maintenance depots.

3) Although the *Standards of Weights and Measures Act, 1956* allowed a total period of 10 years for the complete change-over to the metric system and although the change-over could be brought about in most of the branches of zonal railways within the stipulated period, yet in the Mechanical Engineering Branch of a railway, a minimum change-over period of 12 to 13 years would be necessary. This is due to the fact that this branch has the maximum amount of equipment and machinery in its production workshops and in the maintenance sections of the workshops and sheds.

4) At a very rough estimate, the total cost of the change-over

would be Rs 65·8 million*. The bulk of this cost would be debitable to the revenue heads of accounts.

5) It would be difficult to visualize the full implications of the change-over in the various fields of railway working and unforeseen problems were bound to arise during the transitional period. They would require close examination in order to determine the most effective, economical and expeditious solution in each case.

6) It may not be possible to avoid completely minor setbacks in production, maintenance and operation during the transitional period, but with careful planning and with the co-operation of the trade and the industry, the suggestions and recommendations made in the Report would go a long way in minimizing the difficulties inherent in the adoption of the new system of weights and measures.

ACHIEVEMENTS OF RDSO

The RDSO, being a technical wing of the Railway Board, is responsible for:

1) preparing the standard designs of locomotives, coaches, wagons, bridges, structures, track layouts and fittings and signalling equipment, both mechnical and electrical;

2) laying down specifications for the supply of standardized equipment and stores;

3) drawing up codes of practice for their usage;

4) bringing out publications incorporating rules and regulations for the operation of railways and for the maintenance of their assets; and

5) providing technical guidance to zonal railways.

It was clear from the outset that there would be a considerable element of re-design of the standard equipment because of:

1) the introduction of new rolled steel sections to metric standards by ISI;

2) the substitution of the existing standard small tools, such as drills, reamers, cutters, etc, to the new standard sizes; and

3) the adoption of a completely new system of screw threads.

It would have been perhaps easier and more expeditious to

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*Actual cost about Rs 26 million. *See* page 298.

have inch-based screw threads, but ISI avoided the path of least resistance and went the whole hog for standard threads to metric standards recommended by the International Organization for Standardization (ISO).

The metricization of drawings could not be started by RDSO unless a few basic steps had been taken by ISI. The latter had to issue ISO Recommendations for bolts, nuts and threaded fasteners as also detailed data for the newly designed metric rolled steel sections, and had to specify limits of fits and tolerances. It had also to lay down scales which could be adopted in the engineering drawing offices for structural design work.

It has already been mentioned that in order to reduce the workload of RDSO involved in the metricization of drawings, it was recommended by RMC that RDSO should be made responsible for carrying out the modifications (involving a varying degree of re-design element) to standard designs for equipment, and the zonal railways to undertake similar work for non-standard equipment which was likely to remain in use beyond 1970.

Even with this division of work, RMC had estimated that as many as 35 000 to 40 000 drawings would have to be metricized by RDSO. As is shown by the tabular statement below, this has proved to be an underestimate.

In the beginning, the progress of metricization of drawings was quite slow; what with the delays in the setting up of the metric cells in the various wings of RDSO, in the issue of the ISO Recommendations for the screw threads and in the manufacture of the newly designed rolled steel sections to the metric units, it could not be otherwise.

There was a great shortage of draftsmen and tracers in the country. They had to be recruited and given on-job training for months before they could function effectively. The senior design staff needed an orientation course to enable them to get conversant with the use of the metric system and the task was rendered all the more difficult as the entire technical literature in the English language dealt only with the fps system. Consequently, technical reference books, data sheets, tables of constants, conversion tables, all types of specifications in the metric system had to be collected from various sources and supplied to the design staff. The workload which RDSO had to carry was colossal indeed!

However, the work gathered momentum, and by the end of 1966, the results achieved made a good showing as is indicated by the figures given in Table 1.

TABLE 1 PROGRESS OF METRICIZATION OF DRAWINGS IN RDSO

SL. No.	DIRECTORATE OF RDSO	TYPE OF DRAWINGS	NUMBER OF DRAWINGS			WORK STARTED IN
			Requiring Conversion	Converted	Balance	
1.	Loco	Set drgs	5 500	1 300	4 200	Apl 1963
		Part drgs	21 511	21 511	Nil	Jan 1959
		Other drgs	700	159	541	Oct 1962
2.	Carriage and Wagons	Set drgs	1 425	515	910	Sep 1960
		Part drgs	3 376	3 376	Nil	
		Other drgs	1 983	186	1 797	Sep 1960
3.	Bridge and Structures		471	343	128	1961
4.	Track		940	821	119	1961
5.	Signal and Telecommunication		4 910	1 438	3 472	
			40 816	29 649	11 167	

In regard to the revision of codes and other publications, the progress was even more satisfactory. All the civil engineering codes of practice had been revised to suit the metric system and reprinted; similarly, the Schedules of Standard Dimensions for the broad, metre and narrow gauges. The Indian Railways Way and Works Manual was revised to metric standards. Almost the entire metricization work involved in the Engineering Code was completed and correction slips issued to the code which needed extensive revision for other reasons.

The work of conversion of railway standard specifications generally progressed satisfactorily. All the 18 track standard specifications, most of the specifications of the Signal Branch and those dealing with bridges and structures were revised to metric standards and reprinted. On the whole, only about 3 specifications out of a total of 187, currently in use, remained to be metricized.

METRICIZATION ON ZONAL RAILWAYS

MECHANICAL ENGINEERING BRANCH

As was expected the greatest impact of the change-over was felt in this branch. On most railways the metric cells started functioning in 1958 while on some others by the end of the first half of 1959. Some of the important functions of metric cells in the branch were:

1) formulation of detailed instructions based on the policy directives received from the Railway Board;

2) training of the staff in the branch;

3) modification of designs and drawings of such non-standard equipment which would be retained in service after 1970;

4) revision of technical standing orders, maintenance orders, manuals, etc;

5) planning for adaptation of machinery and plant in railway workshops to the extent considered necessary;

6) formulation of the policy regarding phased substitution of existing replaceable spare parts and assemblies by metric designs;

7) estimation of the requirements of metric small tools, measuring instruments and gauges, and their procurement on a phased basis;

8) preparation of suitable instructions for maintenance depots (running sheds and sick lines) in regard to the stocking and use of spares on a dual system;

9) co-ordination with other cells at the headquarters, particularly that of the Stores Branch so as to ensure a uniform and smooth change-over in all branches of railway working; and

10) close liaison with the Mechanical Branch cells of other railways.

From the outset, it was the unanimous view of the experienced mechanical engineers that the important details of the various phases of the transition period in the Mechanical Branch would need to be planned and evolved in the field. Though the metric cell at the headquarters of a railway would formulate the broad outlines of the policy in regard to phased substitution by metric designed components of the existing replaceable duplicates in locomotives, wagons and coaches, yet the detailed implications of such substitutions would need a careful study at the workshop level. For this purpose a planning cell was established at each major workshop under an assistant officer who, in turn, received guidance from the production engineer of the workshop.

During the preparatory phase (1957-62) the following items of work were given priority more or less in the order mentioned below:

1) Recruitment of draftsmen and tracers, and training them for metricization of drawings of non-standard equipment.

2) Marking of tare weights, floor areas and carrying capacities of wagons and coaches in metric units.

3) Marking of loco-tenders to show coal and water loads in metric measures.

4) Re-calibration of weighing machines and weigh-bridges to indicate weights in kilograms and tonnes.

5) Re-calibration of pressure gauges, vacuum gauges and speedometers to enable readings being taken in metric units.

6) Procurement of measuring instruments, gauges, small tools and hardware to metric designs.

7) Ordering fresh supplies of equipment and machinery capable of operating on both the fps and metric units.

8) Gradual revision of raw materials schedules, planning cards, procedure orders and publications.

9) Modification of jigs and fixtures.

10) Adaptation of machinery and equipment to enable operation in metric units.

11) Gradual manufacture of some of the re-designed components in railway repair shops.

12) Use of the metric units in accounting coal.

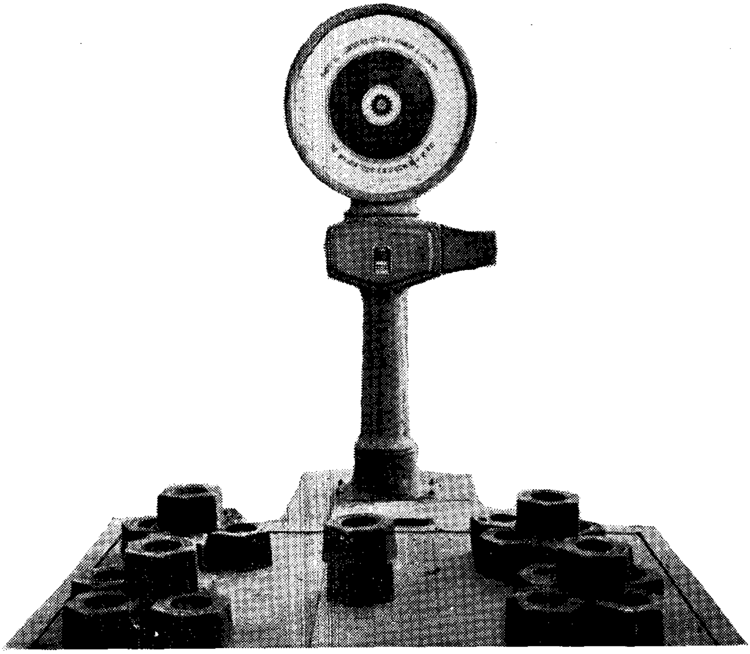
13) Revision of nomenclature lists and price lists books to metric units.

In the transitional phase extending over about eight years (1962-70), the following chief items of work are being attended to:

1) Completion of those items of work detailed above which had been taken in hand in the preparatory phase but had remained unfinished.

2) Procurement of new rolling stock, machine tools, plant and other equipment only to metric designs and standards.

3) Gradual elimination of the manufacture of components on the fps system.



A dial type platform weighing machine re-calibrated in metric units at Railway Workshops at Ambala, being re-checked after installation at a railway station

In the preparatory phase, the recruitment of draftsmen and tracers for the metricization of drawings was given topmost priority. There was such a great demand for these categories of staff that the existing training schools in the country were unable to cope with it. Each individual railway had, therefore, to set up special schools of its own to impart training to suit its own peculiar needs. A couple of years after the starting of such schools, the position improved considerably.

Re-calibration of the weighing machines and weigh-bridges to show weighments in kilograms and tonnes in addition to the existing calibration in maunds and seers or tons, hundred-weights and pounds on the whole railway system was generally carried out by the Mechanical Engineering Branch of the Railway at its own workshops. A few new weighing machines and weigh-bridges with metric markings were purchased to replace the existing ones which were sent piecemeal to the workshops for dual re-calibration. In some cases, the assistance of the manufacturers of such machines or of the industry was also obtained.

This work was completed on all Railways by the target date, except that on one railway which alone had over 1 100 of weigh-bridges, the re-calibration work could not be completed by 31 December 1966. In cases where dual calibrations have not been provided, conversion tables are in use.

The marking of the tare weights, floor areas and carrying capacities of wagons in metric units was done at the time of their periodical overhaul. Similarly, the calibration of tenders of locomotives was easy. By and large the re-calibration work of pressure gauges, vacuum gauges and speedometers has already been completed.

The training of the supervisory staff in workshops and sheds did not present any great difficulty. After receiving specially designed orientation courses, they were not only able to carry out their day-to-day work in the new system but they also trained their skilled staff and operatives on the shop floor. It was not considered necessary to make any special arrangements for the training of the unskilled staff. In the course of their normal duties they got gradually conversant with the new units of weights and measures. For the staff in the outlying sheds and maintenance depots, a few roving inspectors were sent to impart training so as to make the staff conversant with the metric system. Happily this work was completed with only minor setbacks in the maintenance standards or in the production norms.

Procurement of measuring instruments, including gauges of all types and small tools was a difficult problem. Among the measuring instruments may be listed steel rules, carpenter's rules, draftsman's scales, tapes of sorts, micrometers outside and inside, vernier calipers, dial test indicators, capacity measures, spring balances, etc. There are over a score of types of gauges in use on Railways. Among them the most important are the feeler gauges, vernier micrometer depth and height gauges, plug and ring gauges of plain and screwed types and radius gauges. The small tools comprise hand dies, hand taps, Coventry die sets, Landis chasers, drill and reamers of sizes, master crushing rollers, milling cutters, etc.

Difficulties in getting supplies of small tools in the metric system arose as a result of inadequate capacity for manufacture of metric tools in the country. The present position is that most of the manufacturing firms have gone into production of metric tools. Similarly, the supply position for measuring instruments has considerably improved during the last few years. Screwed, plug and ring gauges to ISO profiles were not being manufactured in the country. However, a number of firms are now manufacturing them. In addition, demands are also being met from imported stocks.

When the introduction of the metric system was ordered by the Railway Board, instructions were issued to all concerned that all outstanding orders for the supplies of machinery and equipment should be modified, where it was not too late, so that the equipment and machinery would be capable of operating on both the metric and the fps systems. For the supplies yet to be ordered, it was imperative that the order should specify the supply to be made to metric standards, unless, of course, it could be made to operate on both the systems, with or without the payment of a small premium.

Modification of jigs and fixtures, which are required when parts are to be manufactured on a mass production scale, was carried out on a planned basis. During the transition phase the production of parts in both the fps and the metric systems was inescapable. Consequently, in some cases, new jigs and fixtures were needed for the manufacture of metric designed components. In the case of drilling jigs, it was, however, possible to use the same jig after provision of a separate set of bushes.

At first sight, even a mechanical engineer might be inclined to think that the change-over to the metric system might require scrapping of a large majority of the existing equipment but a careful and detailed examination would convince him that the position is not half as bad as that. In fact, most of the equipment can be used for production in both these systems without any modification whatsoever.

A screw cutting lathe can generally be adapted to cut screw threads both in the British and the metric standards by change of a train of gears; normally, a replacement of the lead screw is not necessary. In fact, some indigenously manufactured lathes installed in some railway workshops have a quick-change gear-box which permits of screw cutting in either of the two systems by positioning of certain operating levers.

The drilling and drill slotting machines require replacement only of the existing drills, reamers and taper sleeves by those to the metric sizes. The planing, shaping, slotting, grinding and milling machines need changing only the scale or dial calibration, milling cutters and form grinding wheels to millimetre sizes; the screwing and tapping machines, only taps, dies, die holders, etc, to metric size and the boring and broaching machines, broaches when necessary.

The boiler shop and the paint shop are unaffected by the change-over. In the wheel shop, the changes are minor. Scales have to be calibrated, and in the quartering machines, crank pin screw cutting attachments have to be changed to suit metric threads.

The change-over to the new system involves a change in the gear tooth dimensions, since British pitches differ from the module pitches. Fortunately, however, in the rolling stock, the use of gear drives is limited and the multipurpose gear cutting machines produced in the country have further solved the problem.

The equipment in the foundries, forge-blacksmith, heat treatment and welding shops are unaffected by the change-over, except that the various gauges and recording devices need re-calibration. The same remarks apply to the circular and band saw mills, morticers, tennoners, moulders, planers and saw and cutter grinders.

It would, thus, be seen that the problems in the adaptation of machinery and plant were not difficult to tackle, as, in the bulk of the manufacturing processes in repair workshops, the control of dimensions is externally applied and, therefore, the machine tool itself, whether made to foot-pound or the metric system is not affected by the change in the system of measurements.

As already stated, the conversion and revision of drawings of non-standard rolling stock — locomotives, coaches and wagons remaining in use after 1970 had to be tackled by a zonal railway either by itself or in collaboration with another zonal railway having similar stock. This work was started after the draftsmen and tracers who had been trained in railway schools became available.

The magnitude of the work can be gauged from the fact that one railway alone had to metricize over 35 000 drawings.

None of the drawings pertaining to rolling stock which were to be scrapped by 1970 was converted to the metric standards as they could have their components and assemblies manufactured in the fps system.

In order to expedite manufacture of components of standard equipment to metric designs, railways were asked to prepare the lists of components of both BG and MG locomotives, metricized drawings of which they wanted in priority from the RDSO. A list of rationalized rolled steel sections to metric designs, which the steel mills were regularly producing, was also circulated to all concerned, so that, while metricizing drawings, the rationalized sections were only used.

With regard to the manufacture of components in metric sizes for new builds of wagons, the position is very satisfactory. The RDSO have made available almost all metric drawing sets for the types of new builds. With the exception of a type of wagon where some components are still being made in inch sizes, all our new builds are having their components built to metric design. Even when a complete wagon could not be manufactured in metric size, at least those parts that require frequent renewals (such as rivets, bolts and hardware items) were made to metric sizes.

In regard to the purchase of components from the trade, the response has not been entirely satisfactory. In some cases, the quotations received were far too high to be accepted. This was as would be expected in a sellers' market which prevails. In any case, the railways persevered in placing their orders in metric sizes or to metric designs so that the trade would be made conscious of the requirements of the railways and would ultimately respond to it.

Specifications of all permanent way materials like rails, sleepers and fittings have been altered to the metric system, and these are now being procured to the metric dimensions.

Table 2 shows the percentage progress made on the zonal railways in some items of work in the Mechanical Branch by the end of 1966. It may be pointed out that the figures are approximate.

TABLE 2 ITEMWISE PROGRESS IN MECHANICAL BRANCH

SL No.	NAME OF ITEM	PERCENTAGE OF PROGRESS ON ZONAL RAILWAYS							
		Central	Eastern	Northern	NE	NEF	Southern	SE	Western
1.	Procurement of small tools	49	32	54	75	25	70	68	85
2.	Procurement of measuring instruments	75	76	53	99	90	80	75	96
3.	Procurement of hardware items	All indents prepared in the metric system. Response from trade is erratic.							
4.	Adaptation of equipment and machinery:								
	(a) Screw cutting	60	22	79	72	60	100	75	89
	(b) Other		59		49		100		
5.	Modification of jigs and fixtures	69	54	75	77	NA*	100	77	84
6.	Revision of non-IRS drgs:								
	(a) Part drgs	98	89	83	100	50	100	100	97
	(b) Set drgs		Nil		Nil			19	58
7.	Manufacture of metric duplicates	62	74	69	52	76	70	68	80
8.	Revision of planning cards	88	66	91	78	96	100	90	88
9.	Revision of standing and procedure orders	66	NA*	90	100	NA*	100	100	50
10.	Revision of nomenclature lists and PL books	25	Nil	36	80	80	40	NA*	84

*NA — Figure not available.

CIVIL ENGINEERING BRANCH

In the Civil Engineering Branches of zonal railways the change-over to the metric system involved a considerable amount of planning and hard work both by the metric cell of the branch and the field staff. Some of the important functions of the metric cell in the branch were:

1) formulation of detailed instructions based on the policy directives received from the Railway Board;

2) training of staff;

3) revision of local manuals, schedule of rates, specifications for execution of works, etc;

4) re-design of type plans of bridges, buildings, structures and track layouts and fittings;

5) procurement of metric measuring equipment to replace the existing one;

6) metricization of the basic records relating to both Way and Works;

7) introduction of markings in metric units of distances and of particulars on curve boards and description boards of bridges, tunnels, tanks, etc; and

8) co-ordination with cells of other branches at the headquarters office of the railway.

In the Civil Engineering Branch, the implication of the change-over may be considered in two main aspects, namely,

1) Maintenance, and 2) New works.

On the maintenance side, topmost priority was given to figuring out distances in kilometres correct to 2 decimal places between different railway stations on the system, from the basic records, such as the longitudinal sections or the track diagrams. This information was supplied to the Commercial Branch of the railway to enable it to start booking of passengers and goods on the metric system by the target date of 1 April 1960 and also to the Operating Branch for the revision of the station working rules.

Simultaneously, the recruitment and training of draftsmen and tracers in special railway schools and training of field works staff, such as work supervisors, work mistries and mates was started. Roving inspectors, one for each division, went about from place to place training the categories of staff in the field so that they familiarized themselves with the metric system, particularly in the use of the measuring equipment in metric units, such as chains, levelling staves, tapes, box wood folding rules, sets of weights and thermometers.

To begin with, there were considerable difficulties in obtaining any measuring equipment, as there was no manufacturing capacity in the country. To facilitate the training, particularly of the senior supervisory staff, short courses were given at schools where such equipment was made available. On some railways, booklets containing detailed information about the metric system and instructions for its use were printed and freely distributed among the staff along with conversion tables and lists of rationalized steel sections with their properties.

Subsequently, the substitution in the field of the existing markings on telegraph poles, bridges, tunnels, etc, by those in the metric units went on simultaneously in the office with the metricization of the basic records relating to the structures and the track.

In the field, the mileposts were replaced by the kilometre posts; the location of the latter was determined in each case by utilizing the nearest milepost for measurement so as to avoid any cumulative errors which might have arisen, if the existing mileposts had not been correctly located originally. The markings on the telegraph posts or on the plates fixed thereto along the track, were changed to show kilometrage. Similarly, hundreds of description boards along the track, such as those on curves, tunnels, bridges and storage tanks, were modified to give all the particulars in metric units.

In the office, the metricization of the basic records, such as index plans; longitudinal sections; track diagrams; gang charts; yard plans; land plans; lists of bridges, of infringements of standard dimensions, of level crossings; bridge registers and completion and record plans was started. Generally, yard plans were not metricized nor completion plans of structures and buildings, unless some modifications were proposed thereto.

In the preparatory phase, most of the items of work mentioned above were completed except that in the case of land plans, not much progress has been made. Before their conversion to the metric system they had to be verified in the field with the Revenue authorities under the State Governments. It has not been possible to get adequate assistance from them. Some of them have suggested that this work should be undertaken at the time of their next periodic settlement operations.

In the transitional phase, the following items of work were taken in hand:

1) Adaptation of machinery and plant in the structural and bridge workshops on the zonal railways.

2) Revision of local manuals, schedule of rates, based on revised analyses of rates, works specifications, etc.

3) Revision or re-design of type plans of staff quarters, station buildings, ash-pits, etc.

The change-over in regard to machinery and equipment followed the same pattern as that adopted in the Mechanical Engineering Branch for similar equipment.

The revision of local manuals had to await the metricization of the three important publications of the Railway Board — Schedules of Dimensions, Way and Works Manuals and the State Railway Engineering Code. Metricization of the Schedules of Dimensions and the Way and Works Manuals has since been completed.

The revision of the type plans of buildings had also to await the issue of a building code by ISI giving the new building modules.

It has not yet been possible to procure abundant supplies of building bricks to the modular dimensions of 19 cm $\times$ 9 cm $\times$ 9 cm in place of the bricks to the size of $8\frac{7}{8}$ in $\times$ $4\frac{3}{8}$ in $\times$ $2\frac{3}{4}$ in in popular use at present. The demand for the latter on the existing kilns has outstripped the supply so that the kiln owners are in no mood to take any risk, from public unacceptability, with burning of the metric sized bricks. Owing to this, the building plans still use the fps system though the dimensions are shown in the metric units along with those in feet and inches. Recently, construction of a few residential quarters has been started at a number of places on an experimental scale with the metric sized bricks.

By the end of 1966, most of the railways had completed the revision of their manuals and issued the new schedule of rates based on metric units and revised the works specifications.

The planning and the execution of new works based on metric units has started though the metricization process has not made satisfactory progress on some railways for one reason or the other.

THE STORES BRANCH

The change-over to the metric system imposed a considerable additional workload on this branch, for the success of the metricization depended on the adequacy of the liaison which the branch maintained with the trade and the industry on the one hand and the railway consumers on the other, as also on the initiative and resourcefulness shown in the procurement of supplies, particularly of small tools, measuring equipment, raw materials and semi-processed (for example, rolled steel sections) and finished materials (for example, bolts, nuts, rivets and screws).

The metric cell was started in the branch at the headquarters of each railway. By the end of 1966 the metricization work had made good progress. On most of the zonal railways, the training of staff, the calibration of weighing equipment, planning and provision, where necessary, of the additional accommodation required for the stocking of spares in both the systems and the introduction of the metric system in the accounting of stores had been completed.

There are three main items of work which have not yet been completed. They relate to:

1) the revision of forms used for indenting and accounting of stores;

2) the preparation of nomenclature lists of various items of stores; and

3) the procurement of spares, small tools and hardware items to metric designs or sizes.

The revision work of forms was divided between the offices of the Railway Board and the zonal railways. The former was required to metricize about 575 forms commonly used on all railway systems, while each railway was required to undertake revision of forms used locally only. The latter varied in number between 1 500 to 2 250 from one railway system to another. The printing of the revised forms has been delayed because the printers could not get the metric sized paper from the paper mills as also by the recent decision of the Railway Board that the forms should be bilingual, that is, in both the Hindi and the English languages.

The nomenclature lists of various items of stores, till recently known as price lists books, are the fundamental books of reference, covering, on some railways, a total of some 40 000 to 70 000 items of stores. Their metricization, a colossal task, could not be undertaken till the details of the newly introduced rolled steel sections to metric sizes became available to the branch and till the designs of measuring equipment, small tools, hardware items and spares for the rolling stock to metric designs were finalized.

The printing of the revised nomenclature lists has been held up on account of a recent proposal under the consideration of the Railway Board which requires the recasting of the entire work so as to conform to the international decimal system of classification of stores.

The causes of delays of procurement of small tools, measuring equipment, spares, etc, have already been dealt with.

THE SIGNAL AND THE TELECOMMUNICATION ENGINEERING BRANCH

The metricization work in this branch could not commence till the basic data, such as the 'adequate distance', distances between signals, location of signals in relation to the facing points, etc, as given in the General Rules for the operation of trains and the Schedules of Standard Dimensions relevant to the branch had been revised in metric units. For this reason, and also for the fact that the branch was not required to undertake extensive re-design work, the metric cell in the branch on each railway started functioning later than those in the Mechanical and the Civil Engineering Branches.

In spite of this the metricization of drawings of signals assemblies, layouts and of fittings both for mechanical and electrical operations has made significant progress, an overall figure of about 75 percent. The problems of adaptation of the mechinery and equipment in the signal workshops of railways were similar to those in the Mechanical Branch and were tackled in the same way.

THE ELECTRICAL ENGINEERING BRANCH

The main functions of this branch on the railways are generation, transmission and distribution of power, train-lighting, electric traction, etc. Since the metric system units were largely in use already in this branch, the workload involved in the change-over to the metric system was much smaller than in the other engineering branches.

The work of the metric cell in the branch mainly related to the arrangements for the training of the staff, modifications to designs, drawings and manuals, replacement of tools and measuring instruments by those in the metric system and revision of specifications for electrical stores, machinery and plant. By and large, the metricization work in the branch on most of the zonal railways was completed by 31 December 1966.

Difficulties were, however, experienced in obtaining supplies of spares of train lighting equipment. Most of it had all along been supplied by a single firm. It took some time to persuade it to switch over to the manufacture of components to metric designs.

THE TRANSPORTATION AND THE COMMERCIAL BRANCHES

The change-over to the metric system required the Transportation Branch of a zonal railway to metricize the station working rules of each railway station on the new system.

In the Commercial Branch, the change-over involved the revision of the three tariffs — general, coaching and goods — printing of tickets to show the distances between stations in kilometres and the fares in decimal coinage. As already mentioned, the information regarding distances between stations was supplied by the Civil Engineering Branch and the re-calibration of weighing machines and weigh-bridges to metric units was mainly carried out by the Mechanical Engineering Branch in its workshops.

According to the schedule recommended by RMC, the booking of passengers, parcels and freight in the metric system was to start by 1 April 1960. Happily, all this was accomplished by the deadline.

Other branches of a railway not dealt with in detail above, such as the Medical Branch, were not much affected by the change-over and the metricization work involved was completed by the end of 1966.

PROGRESS OF METRICIZATION IN PRODUCTION UNITS

As already stated, there are three chief manufacturing workshops belonging to the Indian Railways. The Chittaranjan Locomotive Works (CLW) in West Bengal produces steam, diesel and electric locomotives, the Diesel Locomotive Works (DLW) at Varanasi in Uttar Pradesh is engaged in the manufacture mainly of diesel locomotives and the Integral Coach Factory at Perambur (Madras) is producing complete units of coaches.

CHITTARANJAN LOCOMOTIVE WORKS

The steam engines of WP_1 and WL_1 types (broad gauge passenger and light traffic engines) continued to be manufactured till mid 1966 in the fps system as the original construction drawings had not been fully metricized by the RDSO by that time. When a fresh order is placed for these engines, they would be to metric design. Manufacture of steam engines of other types is now being undertaken to metric designs.

In the case of ac electric locomotives, there was no difficulty in manufacturing to the metric system as the French collaborators had, from the beginning, supplied complete metric drawings.

The manufacture of the diesel shunting engines recently taken in hand is to the metric system.

DIESEL LOCOMOTIVE WORKSHOP

The workshop still continues to manufacture diesel locomotives to the fps system because the construction drawings received from the collaborators had used this system. Metricized drawings are now being prepared in India. When ready, the manufacture would be entirely to the metric designs.

INTEGRAL COACH FACTORY

The change-over to the metric system did not present any difficulty at all, as the equipment at this factory, set up in collaboration with the Swiss firm which normally works in the metric system, was easily re-calibrated to this system.

FINANCIAL IMPLICATIONS OF CHANGE-OVER

No account of the change-over to the metric system on the Indian Railways can be regarded as complete without a reference to the expenditure incurred in bringing it about. When the Railway Metric Committee discussed this question with the individual zonal railways in 1956, it found a wide disparity in the estimates of the expenditure for bringing about the change on the railways. This was understandable in the absence of any factual assessment of the workload involved. Consequently, each administration tended to inflate its estimate. Maybe, this was done so that no explanation would have to be given in the event of an excess and hence a wide margin of safety was provided in the estimated figures. The Railway Metric Committee tried to rationalize the cost estimates as best as it could, and in its report, it stated that the change-over would mean an additional expenditure to the railway exchequer of Rs 65·8 million.

Table 3 gives details of the expenditure incurred up to 31 December 1966 on Indian Railways for the adoption of the metric system. This totals to a figure of Rs 21·5 million. Since the change-over has not yet been completed, it may safely be assumed that the total expenditure for the change-over would not exceed Rs 26 million. Thus, the actual cost would be about 40 percent of the figure estimated by the Railway Metric Committee.

It is interesting to note that the change-over would cost the Indian Railways roughly a day's gross income or hardly one-thousandth part of the total outlay of Rs 27 000 million which they spent on their development plans during the period of the change-over.

A close analysis of the figures in Table 3 would show that in booking the expenditure incurred in doing a particular job, Railways have not followed a uniform practice. Thus, it would be difficult to believe that for 'conversion of production units', it did not cost anything to the Southern Railway, whereas the South-Eastern Railway and the Western Railway spent as much as rupees 0·41 and 0·38 million respectively.

CONCLUSION

It would be clear from the above review that the metric system has been successfully introduced on the Indian Railways. In fact, the Railways were the pioneers in its introduction, as by starting booking of passengers and freight in the metric system on 1 April 1960, they assisted in popularizing it among the masses and stimulated the change-over in the industry.

During the change-over, the Railways had to face numerous problems and difficulties, the main impact of some of which has been felt by the engineering industry of the country, which, by and large, has responded to the call well. It is conceded that there

TABLE 3 EXPENDITURE INCURRED FOR THE CHANGE-OVER UP TO 31-12-1966

(Figures in millions of rupees)

Railway Unit	Replacement of Weights and Measures	Conversion of Weights and Measures	Conversion of Production Units	Conversion of Drgs and Specifications	Training of Staff	Additional Staff	Misc Expenditure	Total
Railway Board	Nil	Nil	Nil	Nil	Nil	0·18	Nil	0·18
RDSO	Nil	Nil	Nil	0·55	Nil	2·20	Nil	2·75
Central Rly	0·22	0·36	0·03	0·12	0·37	1·01	0·12	2·23
Eastern Rly	0·23	0·24	0·06	0·05	0·14	1·47	0·22	2·41
Northern Rly	0·13	0·16	0·19	0·61	0·04	1·41	0·99	3·53
North-Eastern Rly	0·10	0·29	0·03	0·38	0·14	1·38	0·11	2·43
N. E. Frontier Rly	0·06	0·04	0·01	0·14	0·07	0·44	0·05	0·81
Southern Rly	0·15	0·31	Nil	0·06	0·01	0·99	0·15	1·67
South-Eastern Rly	0·23	0·12	0·41	0·26	0·05	0·23	0·02	1·32
Western Rly	0·19	0·23	0·38	0·31	0·08	2·13	0·16	3·48
C. L. Works	0·01	0·11	0·01	Nil	Nil	0·30	0·03	0·46
Diesel Loco Works	0·02	Nil	Nil	Nil	Nil	Nil	0·02	0·04
Integral Coach Factory	Nil	Nil	Nil	Nil	Nil	0·01	0·16	0·17
							Total	21·48

have been temporary minor setbacks in out-turn and in production norms in spite of the most careful pre-planning and phasing of the change-over. After all is said and done, nothing worthwhile has ever been achieved without teething troubles and travail.

ANNEX

EXTRACT FROM THE REPORT OF THE RAILWAY METRIC COMMITTEE GIVING A SAMPLE OF THE QUESTIONNAIRE ISSUED TO ZONAL RAILWAYS

Mechanical Engineering Branch

N.B. While answering questions, please indicate in detail the financial implications of the proposals made and the additional staff requirement, category-wise.

1. Assuming that the change-over from the existing system of weights and measures to the metric system will be gradual, will any special machinery be needed to implement the change-over?

2. In which sphere of the activity of your branch will it be necessary for the two systems to co-exist, and in which sphere or operation will a sudden change-over be desirable? Please give details of the change-over with reasons therefor.

3. Indicate the nature and extent of training to be given to different categories of staff affected by the change-over, and estimate the cost of such training. What arrangements do you propose for giving this training?

4. Indicate the amount of work involved in the change-over in modifying, retracing and/or re-dimensioning the existing drawings which may be divided under the following main heads:

(a) Locomotives — Gaugewise.

Assembly, sub-assembly and part drawings for:

- (i) pre-BESA locomotives,
- (ii) BESA locomotives,
- (iii) IRS type locomotives,
- (iv) IR type locomotives,
- (v) American type locomotives, and
- (vi) Electric locomotives.

(b) Coaches — Gaugewise.

All layouts, building sets and part drawings, separately for standard and non-standard stock, in respect of:

- (i) passenger stock,
- (ii) non-passenger stock, and
- (iii) EMU stock*.

*Non-standard here means pre-1951.

(c) Wagons — Gaugewise.

(i) Non-standard stock,

(ii) IRDA stock, and

(iii) IRS stock.

(d) Ferry stock

(e) All miscellaneous drawings, such as those for jigs, fixtures, tools, templates, etc.

5. How far the equipment and machines in Shops and Sheds

(a) will have to be completely scrapped in going over to the metric system?

(b) can be allowed to work to the existing system till their useful life is finished?

(c) can be adopted with minor changes to work on both the systems?

N.B. The answers should be divided under the following categories:

(i) Machines;

(ii) Machine tools;

(iii) Small tools, appliances and measuring instruments; and

(iv) Jigs and fixtures.

6. Will it be possible to modify indents for equipment, machines and tools already placed so as to obtain them designed and/or calibrated to the metric system? How far will the possible resulting delay in their supply affect your work? If it is not proposed to make any change in the indents, please give your reasons.

7. Give your appreciation of the nature and extent of additional work involved in the drawing and production sections in the use of existing designs entailed by the change-over in regard to:

(a) unprocessed materials, such as foundry pig, blooms and billets;

(b) semi-processed materials, such as new rolled structural sections, plates, joists, angles and channels; and

(c) finished materials, such as bolts, nuts, studs and screws.

N.B. Full appreciation of this work, however, will be possible only after the Indian Standards Institution publishes the details of the metric sections to be adopted in India as also lay down standards of fits and tolerances for various categories of work.

8. Indicate the extent of work involved in the revision of manuals, codes, specifications and Instruction and Rule Books so as to adapt them to the metric units. What arrangements do you propose, and how long will it take to complete this work? □

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Posts, Telegraphs and Telephone Services

N. Chidambaram

The *Standards of Weights and Measures Act, 1956*, stipulated that the metric system of weights and measures should be introduced in every field of activity within a period of ten years from the date of passing the Act, namely, by December 1966. It so happens that the posts, telegraphs and telephone services in India have for long years been run as a Government enterprise under a department of the Ministry of Communications. The services being daily in close touch with public at all levels, it was only proper that the change-over to the new system, which was to embrace all trade transactions within the country was sought to be introduced in the Posts and Telegraphs (P and T) Department ahead of all other Government departments. It was strongly felt that such a measure would provide adequate publicity to the new system of weights and measures among the general public. The fact that during the year 1957, the P and T Department handled about 3 400 million postal articles, 35 million telegrams and 21 million trunk (long distance telephone) calls besides local calls, would give an indication of the extent to which the ordinary citizen had contact with that Department in one capacity or another.

The Department's organization had, in the year 1957, within its fold over 62 000 post offices, 10 000 telegraph offices and 6 200 telephone exchanges spread over every nook and corner of India. Obviously, the introduction of the new system represented a tremendous undertaking and called for much foresight, elaborate planning and effectively co-ordinated execution of programmes of action. Realizing the significance of the task before it, the Department set up a special cell in the P and T Directorate for the introduction of the new system.

In keeping with the extent, volume and nature of operations of the posts, telegraphs and telephone services, and its close links with the daily life of the ordinary citizen, a careful planning for a smooth change-over was found inevitable. Many factors needed close attention of the Department. The implications of the change-over in the engineering branch, the replacement of the existing weights by metric weights, the re-calibration of the scales and measuring instruments, the redetermination of the new tariffs in terms of the metric system and the disposal of the resulting obsolete equipment, were the more important issues which needed immediate attention.

PUBLICITY

The question of giving wide publicity to the concepts of the new system received special priority by the Department. The operational efficiency of the Department depended to a great extent on the public co-operation and the measure of public confidence commanded by the Department, particularly the post offices. Hundreds of millions of unregistered articles in various weights, sizes and shapes which were posted by the public were not always weighed at the counter because members of the public knew what stamps would be required to cover the postage by virtue of the long-established familiarity with the existing system of weights and measures.

Any new system, therefore, required fair amount of understanding of the new concepts on the part of the public. This important aspect of public relationship rendered imperative that the change-over to the metric system in the post offices be preceded by adequate publicity of the implications of the change-over for the ordinary citizen.

REPLACEMENT OF OLD WEIGHTS

It became soon apparent that the metric system in the post offices could not be introduced piecemeal or region-wise as might have been possible in some other organizations and departments. A uniform system was required to be operated throughout the country at all times. Neither was it possible to adopt a theoretical change-over by adoption of converted equivalents of the existing rates, as that would involve the use of inconvenient fractions and lead to virtual confusion. Post offices had, therefore, to be supplied with complete sets of metric weights in replacement of the existing weights and introduce a new tariff based on the metric system in terms of convenient round numbers. In the matter of fixation of the new tariff in the metric system, the possible repercussions on the overall revenue of the Department, and on the public, had to be kept in view. Necessary legislation had also to be passed by Parliament well in advance of the date to be fixed for the change-over.

ENGINEERING BRANCH

The change-over to the metric system had several implications for the Engineering Branch of the Department. The problems involved were more varied and complex than those in the post offices. Standards for raw and semi-finished materials, parts, components and other engineering stores were to be established so that they could provide the basis for the designing and manufacturing telecommunication equipment of various types in the P and T Workshops. Specifications for components and parts were to be altered.

Machine tools in the P and T Workshops were required to be modified wherever necessary and possible. Small tools in the metric system were to be purchased or got manufactured by the industry. New machinery and instruments to work on the metric system were to be obtained wherever needed. The replacement of the existing capital equipment in the Department, like telegraph and telephone alignments and the various machinery and equipment, which were in the fps system, could not be thought of, because, firstly, it was unnecessary, and secondly, they could conveniently continue to remain in service for a long time alongside the new equipment and machinery. It was, therefore, essential that an amount of inventory and spare parts be maintained in the old system for a considerable period. However, in the design and installation of new equipment in the metric system the interchangeability between the metric and the fps systems was to be kept in view.

Thousands of drawings and maps in the fps system were to be re-drawn for the design and installation of the equipment in the new system. The change-over in the engineering branch to the metric system had to keep pace with the change-over taking place in the private sector of industry and other Government undertakings, as the Department depended, to a great extent, on supplies from private enterprise and sister Government undertakings for parts and components. Thus, the programme of change-over to the metric system in the engineering branch had to take into account the need for co-ordination at various levels both within and without the Department.

PLAN FRAME

In the light of above considerations, it was decided that:

1) an immediate change-over in the P and T Department would be impracticable, and that it should be effected only over a period of several years;

2) techniques should be developed to tackle each aspect of the change-over; and

3) these techniques should be carefully applied, ensuring a smooth completion of the process according to a phased programme in an efficient and economical but speedy manner.

Under this framework, the detailed programme for change-over was drawn up covering different aspects of the changes as given below.

It was planned to arrange with the Directorate of Visual Publicity to display at all the P and T Offices, posters, notices, broad-sheets, etc. This programme was to be supplemented by exhaustive instructions to the staff in the Department through circulars, notices and orders and by hand-bills. Documentary films on the metric system were to be shown to the staff of the engineering branches and workshops. The engineering staff connected with the production of diverse types of equipment, parts and components had to be trained in the use of the metric system in their operations.

REPLACEMENT OF OLD WEIGHTS

The requirements of the weights for the post offices amounted to nearly 1·6 million pieces, ranging from one gram to 20 kilograms. They were to be acquired and distributed to reach the post offices well in advance of the date fixed for the change-over. Simultaneously, conversion to the metric system of thousands of self-indicating and mechanical weighing scales of different makes and capacities currently in use in the post offices scattered throughout the country formed part of the programme. It was estimated that the preparatory steps for the supply of new sets of weights would take about two years and the re-calibration of the weighing scales about a year.

ENGINEERING BRANCH

To effect the change smoothly the following action was outlined:

1) Maintenance of close liaison with the Indian Standards Institution (ISI) for obtaining Indian Standards in the metric system for sections, fasteners, tools and other common parts, components and materials required for use in the Department;

2) Maintenance of engineering stores in the metric system;

3) Revision of drawings, specifications and maps from fps system to the metric system in a phased programme;

4) Modifications and alterations to such of the machine tools in the P and T workshops as were feasible;

5) Procurement of small tools and new measuring instruments to work in the metric system; and

6) Revision of specifications, designs and maps in such a way as to ensure interchangeability of parts in the metric and fps systems as far as possible.

EXECUTION

Publicity was arranged in co-operation with the Department of Advertising and Visual Publicity. The use of slogan dies in stamp obliterators and stamping machines, the display advertisements on the notice-boards and mobile post offices and the distribution of hand-bills by the postal delivery staff all helped in the propagation of knowledge about the new system. Instructions were issued through Departmental circulars, notices and orders. Conversion tables and ready-reckoners were distributed to them. Staff members were educated in all aspects of the new system. Demonstration sets of weights were made available to familiarize the staff with the metric weights. Brochures in all languages were issued.

Indents for the metric weights were placed on the Directorate General of Supplies and Disposals as early as October 1958. It took sometime to meet the large-scale demand for weights, as the metric system was in the process of being introduced simultaneously in various other spheres of the Indian economic life. Supplies against the initial indents were made by August 1960. The rates for the postal articles fixed in terms of tolas* and pounds were redetermined in the metric system and necessary legislation was passed in the winter session of Parliament in 1960.

The conversion and re-calibration of the existing self-indicating scales presented their own problems, since commercial transactions in certain trades were already in the metric system, and the existing facilities available in the country for conversion and re-calibration of scales were being used fully for the work from these trades. Firms engaged in the production of metric weights and measures were pressed to increase their output. In addition, the increasing traffic in postal articles had made it necessary that more and more self-indicating machines would have to be supplied to post offices so that the work may be carried out quickly and efficiently. Two hundred additional weighing machines in the metric system

*1 tola = 11·664 grams.

were ordered to be so supplied. Necessary foreign exchange for import of the parts and components required for these was also arranged. All this was completed by the end of 1960 and the metric system was introduced in the post offices with effect from 1 February 1961. Such prompt action could only be made possible by virtue of the earlier planning and preparation.

In the Engineering Branch, a beginning was made by introducing the stores accounting procedures in the metric system with effect from 1 April 1959 itself. The change-over in the P and T Workshops was undertaken in the following phases:

1) Expression of weights and measures in layout sheets, master estimates, drawings and specifications of various types in metric units;

2) Expression of prices and quantities in indents in metric units and conversion of stock balance figures; and

3) Conversion of equipment, procurement of tools and purchase of components in the metric system.

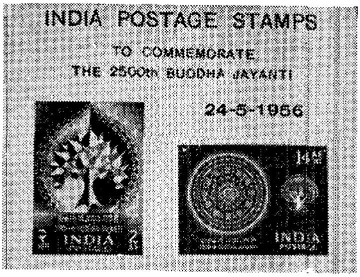
The Engineering Branch has adopted the new system progressively in line with the adoption of the system by other engineering industries and organizations both in Government and outside Government in a phased manner.

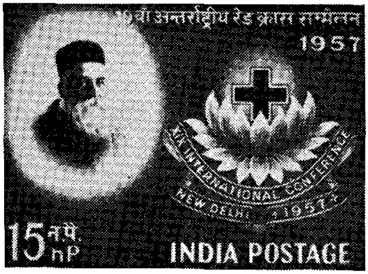
CONCLUSION

An account of the change-over to the metric system in the P and T Department, in retrospect, cannot adequately convey the amount of effort put in by officials and non-officials involved in the process — the various problems faced and methods adopted for solving them — considering the vastness of the country and the close contact that the Department has with millions of people in all walks of life. The country still continues to be predominantly rural, and the vast majority living in rural areas was used to dealings not only in the fps system but also in the indigenous systems of weights and measures then prevalent in different regions. It has not been easy to propagate the new ideas among the people spread over the length and breadth of such a big country as India, or even to train nearly two hundred thousand P and T employees in the new concepts, and ensure a comparatively smooth change-over, without encountering practical difficulties, criticisms and sometimes even opposition,

A section of a crowd at a post office purchasing new stamps priced in decimal coinage on 1 April 1957, the first day of their introduction

Getting the purchased new stamps cancelled





Before and after
Note the price in old currency in one and decimal currency in the other

That this has been accomplished without giving any room for serious complaints, is in itself a tribute to the painstaking preparatory measures taken by the Government and the adaptability of the people to the new system. It may be interesting to mention one incident when the decimalization of the coinage took place in the country. The rates of postage for postal articles, which had been prescribed in old coinage, were temporarily refixed by legislation enacted by the Parliament to enable old stocks of stamps to be used up, which had to be sold against new coins. In this process a marginal increase in the rates in certain cases was unavoidable. It created some stir when a prominent member of the public threatened to go on fast as a protest against the marginal increase, and, in fact, did so. It was with great difficulty that he was persuaded to give up his fast. Fortunately, no such serious incident occurred in the process of the change-over to the metric system of weights and measures. An idea of the complexity of the task can be had from the fact that the process of converting the permanent records to the metric system is still going on in the Department and will be completed only when all the old assets and equipment in the fps system are completely replaced after having served their useful life. □

15

Mechanical Engineering Industries

T. Purnanandam

In their Report submitted to the Government of India in December 1949, the ISI Special Committee on Weights and Measures had recommended the adoption of the metric system of weights and measures for the country. While the Report was still under active consideration of the Government it was felt essential to gain some knowledge of the implications of what was involved in the proposed change-over, and especially to assess difficulties that may arise in the course of adoption of the new system. Such a study was expected not only to help to put certain controversies at rest but also to assist in resolving serious problems that were bound to come up.

QUESTIONNAIRE AND ITS RESULTS

With this object in view, studies were initiated during 1951 and 1955 through the issue of questionnaires to important units of engineering industries of which the mechanical engineering and machine building industries formed an important component. This questionnaire, prepared by the Development Wing of the Ministry of Commerce and Industry, was intended to collect views and information on what the change-over would cost, how long a period of time would be required for a smooth transition and what particular difficulties, if any, would have to be overcome, and how.

The industries covered related to machine tools and small tools, industrial machinery, pumps and engine and several other light engineering industries. A summary of the views and comments received in response to the questionnaire mentioned above is given below.

In most of the cases, it was observed that the introduction of the metric system would not entail large-scale investments by way of purchase of new equipment. Only certain auxiliary equipment like jigs, fixtures and other devices and small tools like twist drills, reamers, taps and dies would have to be renewed under the new system. Luckily, most of these tools have short normal life and new purchases could simultaneously be made while the metric system was being adopted. Thus, the financial strain in a gradual change-over was envisaged to be not too serious.

Moreover, the prevailing and the new systems would have to be worked concurrently for a period of 10 to 15 years, as the supply of spare parts would have to be continued by manufacturers to their clients using the old machines made under the inch system. Further, this would also give adequate time for the industry to prepare drawings, formulate specifications under the metric system and tool up their production methods under the new system. It would also serve to educate workers to become familiarized with it. In some cases, where the factories were already working partially under the metric system, the time interval for the complete change-over could be very much shorter than in a factory, which had been working only on the inch system. It was also emphasized that the Indian Standards Institution (ISI) should start simultaneously the work of formulating standard specifications for many of the engineering items on the basis of the metric system. Government departments were to be persuaded to call for tenders based on the metric system which would give a lead to others and help avoid the difficulty of the firms changing over to the new system in the matter of conforming to indentors' specifications.

Purchase of machine parts and spares from abroad for the maintenance of existing machinery was found to pose no problem as the foreign suppliers were catering both to the metric and the inch system countries. The average investment was likely to be of the order of 5 to 10 percent of the total investment made on machinery and machine tools. In almost all the engineering industries, weighing machines would have to be re-calibrated in kilograms.

Engineering industries being generally equipped with different combinations of one or more of the following machine tools, the effects on the inch-based machines as a result of the change-over to the metric system was studied in detail and is summarily given below.

MACHINE TOOLS

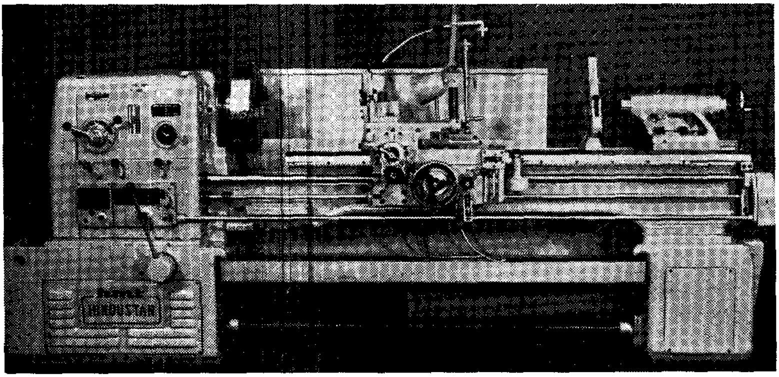
Lathes — Existing stocks of all types of lathes could be easily converted to do threading jobs in millimetre dimensions provided change gears could be suitably altered. This would necessitate changing of certain number of change gears, name plates, cutting speed tables, etc, for each machine.

Drilling Machines — The machines as such did not require any change for they could readily handle jobs in mm sizes. However, the taper shanks and the twist drills used with the machines had to be changed over to the metric system.

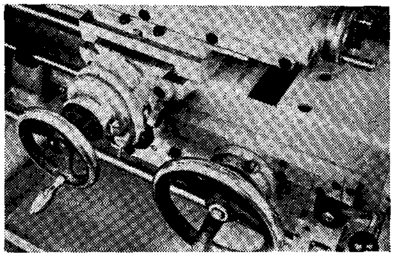
Milling, Grinding and Hobbing Machines — These machines required only the converted movement charts. For hobbing machines, change of hobs to module pitch was also necessary.

Other Machine Tools — In the shaping, slotting, planing, welding, sawing machines, presses and power hammers, etc, no changes were envisaged.

Heat treatment furnaces could be utilized without any alteration whatsoever except that recording, indicating and temperature control instruments would have to be re-calibrated to Centigrade scale.



HMT LB Lathe



Metric dials used on the Lathe

Threading Machines — The die holders, dies, etc, would have to be altered according to the requirements of the job, but the machines in the inch system could be utilized with only minor alterations.

Radial drilling, wood working, sheet metal machines and foundry equipment and machines in the inch system were utilizable as such.

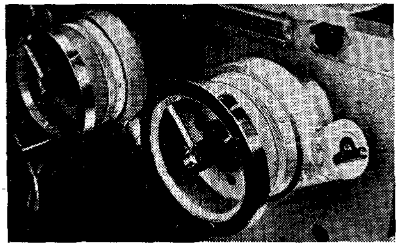
The above set of machines covered a broad cross-section of the usual types in a factory and the study proved that no major changes were required to be effected in the capital equipment.

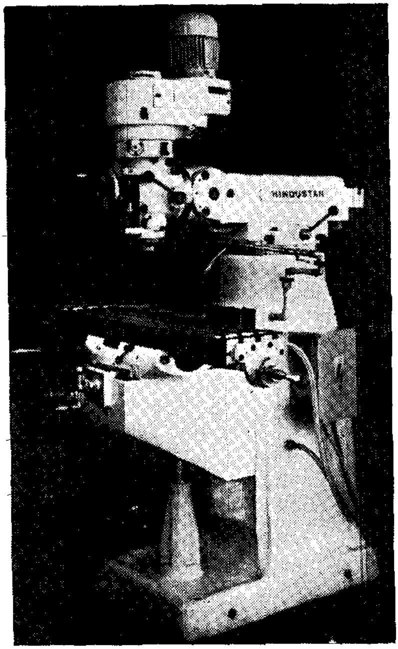
SMALL TOOLS

The change would have somewhat greater repercussions in the domain of small tools, as indicated below:

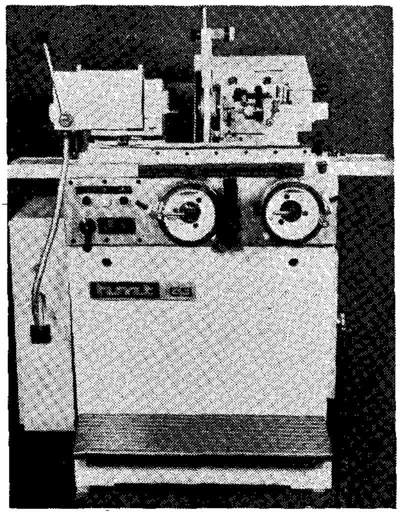
Drills — The inch stocks of drills would have to be replaced by mm drills. However, it was felt that if the change was gradual, the existing inch drills would have worn out with use and replacements could be effected in metric sizes without any extra cost.

Metric dials used on the Grinding Machine





HMT Ram Type Milling Machine



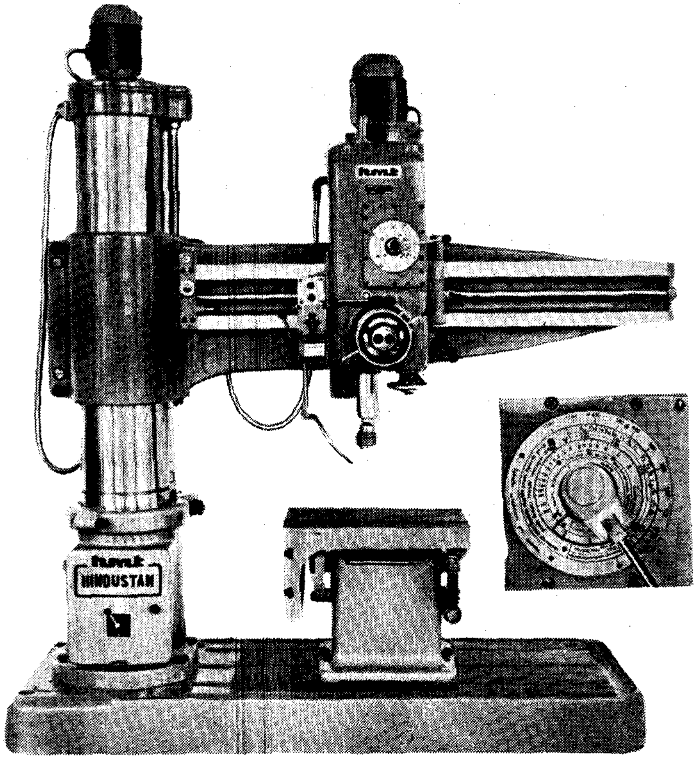
HMT G 9 Grinding Machine

Machine Reamers — Inch stocks would have to be replaced in their entirety by mm reamers. If change-over was gradual, inch stocks would slowly get worn out and their life time could be economically utilized. Adjustable reamers needed no change.

Taps and Dies — Existing stocks were to be replaced completely by the metric counterparts. However, if the change was gradual, economies in change-over could be maximized.

Lathe Tools — No change would be necessary in respect of lathe tools to do mm jobs.

Milling Cutters and Counter Sinks — While most milling cutters



HMT Radial Drilling Machine. Inset shows the metric dials used on it

could be utilized, counter sinks would have to be altered and inch tools replaced by metric counterparts.

Screw Drivers, Spanners, etc — These could be used after minor modifications in certain cases and the existing stocks need not be scrapped.

Files, Chisels, Punches, Hacksaw Blades, etc — Existing stocks could be used with some alterations in nomenclature.

Hammers, Anvils, Calipers, Dividers, etc — No change was envisaged excepting a change in nomenclature.

Bench Vices and Machine Vices — These could be utilized with different nomenclature.

MACHINE ELEMENTS

The effect on manufacture of elements like bolts, screws, nuts, rivets and pins was to be rather drastic, and these would have to be planned for a gradual change-over to metric series. The initial cost for the change-over of dies, screw cutting tools, etc, would form the most expensive part of this operation. As far as the consumers of these elements were concerned, the change would cause considerable initial inconvenience and extra expense, and the position would have to be reconciled.

GAUGES AND MEASURING INSTRUMENTS

All snap and plug gauges existing in the inch system could be modified by re-grinding to the nearest higher and lower mm sizes respectively. Thread gauges were to be used out to their full lifetime and finally replaced. Micrometers and vernier calipers were to be scrapped or used to their full lifetime.

Dial Indicators — These would have to be altered appropriately by the manufacturers.

Jigs and Fixtures — These would have to be designed anew for work on the product in metric sizes, and thus not entail any extra cost.

RAW MATERIALS

As regards semi-finished products covering profiles and sections which were to be used as raw materials for further conversion in the mechanical engineering industries, the rolling mills which produced ferrous and non-ferrous sections were to be required to modify their sets of rolls to roll metric sections and thicknesses. This was necessarily to involve some initial expenditure and inconvenience.

PLANNED CHANGE-OVER

Consequent to the decision to change over to the metric system taken by the Government, a Standing Committee under the Ministry of Commerce and Industry was formed in 1956. Experts from important Government departments concerned were represented on this Committee. The Committee was assigned the main task of planning the change-over in a co-ordinated manner. Details of the developments on working of this Committee are dealt with elsewhere in this book (*see* Chapters 6, 8 and 11).

To handle the problems of engineering industries, an Engineering Subcommittee of the Standing Metric Committee was formed. Various measures were devised by this Subcommittee to achieve the objective of a smooth change-over. The difficulties faced in this connection were also outlined. Extensive deliberations in the meetings of the Subcommittee and in conference of industries held under its auspices as well as the discussions at the Indian Standards Conventions had resulted in formulating a series of measures that were to be taken for metricization of the engineering industries in general.

Having elicited the views of industry and delineated possible difficulties, a co-ordinated change-over was contemplated to be brought about by solving the problems more or less simultaneously from different angles, namely, by:

1) early issue of metric standards,
2) making available metric based materials,
3) initial preparation by individual manufacturers, and
4) training of personnel in the use of the metric system and associated tools.

STANDARDS

The Indian Standards Institution had almost completed by the end of 1961 the task of furnishing the engineering industry with all the necessary metric standards in accordance with its planned programme. These Indian Standards comprised the basic standards relating to metric screw threads and fasteners, limits and fits as also machine tools and small tools. As regards raw materials, the basic and auxiliary dimensional standards had been laid down covering sizes of steel plates, sheets and various other rolled steel sections. Standards had also been prepared for building materials, components and accessories supplied by the mechanical engineering industries, such as builders' hardware, doors and windows, pipes and tubes and all types of service equipment to facilitate the change-over (*see* Chapter 16).

A number of codes of practice relating to general engineering drawings, architectural and building drawings, measurement of building works, plain and reinforced concrete, etc, have been worked out and completed. All this work was expedited because in the very early stages basic standards had been published to ensure a rational and co-ordinated approach to the inter-conversion of values and dimensions encountered in engineering drawings and other production documents. These included IS : 787-1956 'Guide for inter-conversion of values from one system of units to another' and IS : 1105-1957 'Method for precise conversion of inch and metric dimensions to ensure interchangeability' (*see* Appendix 7).

MATERIALS

As regards the raw materials to be provided to the engineering industry which are required for further fabrication and conversion, the existing steel mills and re-rollers had gradually geared their production to rolling metric sections to Indian Standards with the result that metric raw materials have long been freely available to the engineering industry. Initially, however, the problem was one of a vicious circle. Steel rollers were prepared to manufacture metric sections provided they received orders for these sections. The engineering manufacturers were prepared to work on metric raw materials provided these were freely available. With an amount of co-ordination and development of understanding through mutual discussions between consumers and producers, these difficulties were resolved in good time.

INITIAL PREPARATIONS

With the availability of standards and raw materials, initial preparations had to be made by each manufacturer to utilize the materials. With these preparations, the production was also planned hand in hand. These preparations included adoption of metric specifications in existing designs and preparations of new designs, wherever necessary. A careful assessment of several requirements was made along with the preparation of new designs. These requirements included:

1) Enlisting items to be purchased,
2) Alterations and adjustment work on machines, and
3) Indication of quantities and time by which the new equipment would be required.

Another aspect of these preparations covered replacements and re-calibrations of measuring and inspecting equipment, such as scales, micrometers and slip or plug gauges. Some of the machines needed adjustment, particularly where thread cutting was involved and some of the existing fixtures and adopters had to be changed. All these facets of preparation needed a considerable amount of pre-planning on the part of each unit.

TRAINING

This task included training of workers, foremen and engineers in the metric system to inculcate the concept of metric units. In-plant training of skilled and semi-skilled workers and persons engaged in drawing offices and tool room was considered of prime importance. For design engineers, a greater effort was necessary for the reasons that, firstly, in the initial stage both the fps system and the metric system had to exist side-by-side until the entire production was carried out in metric units; and secondly, all the original designs had to be converted eventually with a basic metric concept.

These steps were taken by the producer and consumer industries as well as personnel at Government level simultaneously, so that a major reform of the type could be introduced on all fronts. Even though some of the raw materials, tools, etc, became available earlier than others, appropriate adjustment of designs and production had to be made from time to time.

In spite of the best effort, the initial difficulties could hardly be entirely avoided, but they were certainly minimized by mutual understanding of one another's programme as between producer and consumer industries.

While taking stock of the overall progress made in the introduction of the metric system sometime in the first quarter of 1962, it was observed that the progress of adoption of the system in industrial production was not particularly rapid in the engineering industries chiefly because of its complexity, but the change-over was almost complete in Government departments and public sector undertakings. As for Government departments, special mention may be made of the Railways (except for the re-designing of rolling stock and structures), Posts and Telegraphs, Customs, Central Excise and the Meteorological Departments. These departments had to refix rates in terms of metric units, buy and distribute metric weights to the local depots and branch offices, spread out all over the country.

With respect to public sector undertakings, quite a few had come into existence since 1954, as a result of the rapid industrialization of the country. These included the three steel mills at Bhilai, Rourkela and Durgapur as well as major factories like Bharat Electronics, Hindustan Aircraft, Heavy Electricals, Heavy Engineering, etc. These plants were designed and their products based entirely on the metric system. Secondly, in view of their total capacity and output far exceeding that of the previously existing ones, introduction of the metric system was accelerated to a considerable extent.

It was recognized early that efforts had also to be specially reinforced to make engineers develop thinking in terms of the metric system and use metric products. In the following paragraphs are indicated some of the problems of change-over encountered in some important fields as well as some of the tasks remaining to be carried out.

SPECIAL PROBLEMS OF CHANGE-OVER

A STANDARD GUIDE FOR SPECIFYING METRIC VALUES

Specification of non-metric values and dimensions in metric terms, encountered in various fields of work ranging from simple trade practices to complicated engineering designs and drawings, bristles with a number of problems. Any non-uniform and unco-ordinated approach is bound to lead to considerable but avoidable national loss. It was, therefore, a necessary and a major task for ISI to provide a rational basis which could ensure a reasonable degree of standardization of values when converted from the non-metric systems to the metric system. IS : 1722-1960 'Guide for specifying metric values in standards' was published as a supplement to IS : 787-1956 and IS : 1105-1957 mentioned earlier, which latter provided merely the mathematical methodology of conversion. This guide was prepared with a view to delineating procedures which could lead to complete change-over in a co-ordinated manner in preparing new standards in the metric system and in revising those already in use, at the time. This guide was so designed as to ensure that the principles were well understood and followed by all standards committees responsible for preparing metric standards (*see* Chapter 12). Three main steps of conversion were recognized, namely:

1) Interchangeable conversion from non-metric to metric values;

2) Rounding off values converted from non-metric to metric; and

3) Adoption of rationalized metric values;

each step being permitted on the merits of each case, though the last one was always to be preferred.

Thus, the ultimate goal recommended in this guide was to reach the ideal stage to specify rationalized metric values for all given quantities. The guide specially recommends that metric value so specified should be able to reap the full benefit of the inherent decimal character of the new system for bringing about simplification and rationalization of features or dimensions under consideration. Preferred numbers in accordance with IS : 1076-1957 provided the internationally accepted basis for rationalization, which should be followed whenever opportunity arises.

SCREW THREADS

Any account of Indian experience enumerating the problems of metric conversion in mechanical engineering industries would be incomplete without the mention of screw threads which was one of the fundamental problems tackled by ISI.

The engineering industry in India had been using for many years thread series of British Standard Whitworth (BSW), British Standard Fine (BSF), British Standard Whitworth Special (BSWS) and British Association (BA). In addition to these, the use of unified coarse and fine (UNC and UNF) and continental metric thread were also being insisted upon by some manufacturing units collaborating with certain well-known American and continental firms. The need for, and the consequential advantage of, unification became quite apparent.

During World War II, active consultations had been initiated among the ABC group of countries (America, Britain and Canada) which culminated in an agreement on the unified screw thread system in 1948. As a result, B.S. 1580:1949 'Unified screw threads', was published. This British Standard was revised in 1953 with certain modifications. The continental practice, on the other hand, had followed the metric screw threads.

In 1947, the International Organization for Standardization (ISO) had come into being and it set up a technical committee (ISO/TC 1 Screw Threads), in which, besides the ABC countries, a number of other countries, among them India, decided to take active interest. In 1949, the ISO/TC 1 in its first meeting, brought into review the results of ABC negotiations and the Committee adopted the unified screw thread profile, as the ISO Basic Profile. In its second meeting in 1952, the Committee agreed on a number of other points, including pitch-diameter series.

International trends had thus begun to take shape when ISI decided to appoint its Screw Threads Sectional Committee under the Engineering Division Council in 1950 to take up the consideration of screw thread standards for India. This Committee took due note of the facts that (i) Whitworth and BA thread series had been in wide use for quite a number of years in India; (ii) the import of American equipment had necessitated the use also of American standard thread series; (iii) a variety of metric threads was not unknown in the country in relation to the equipment originating from the continental countries; and (iv) a very large proportion of mechanical and other equipment requiring use of screw threads was still being imported from abroad, and when this condition altered, there would develop the need for export. For these reasons, it was considered essential to recognize an internationally accepted screw thread system.

In 1953, largely on account of the fact that the inch system of threads was the popular one in India, and a decision for going metric had not yet been taken, it was decided to adopt the unified screw thread system of the ABC countries. Consequently IS : 448-1953, which was an adoption of B.S. 1580:1949, was brought out.

With the decision of the Government of India to change over to the metric system in 1956, the Screw Threads Sectional Committee re-examined its earlier decisions and after prolonged debate came to the conclusion that the final change-over to the metric system would be facilitated if a decision was taken to go over directly to the metric threads. Consequently, IS : 448-1954 (*revised*) was withdrawn and the ISO Recommendation covering metric threads below 6 mm was adopted as Indian Standard. Accordingly, IS : 886-1957 'Dimensions for screw threads (below 6 mm)' was published.

Further, at the level of ISO, finding that no agreement was possible for a unitary world standard for screw threads, it had been decided to recognize two separate ISO series, based on the inch and the metric system of measurement, but with a common basic profile for the threads. Insofar as tolerances were concerned, ISO/TC 1 resolved in June 1958 that pending preparation of ISO Recommendation on the subject, the tolerances for metric screw threads should provisionally be based on the German practice. Reflecting these decisions, IS : 1362-1959 'Dimensions for screw threads for general purposes (diameter range 0·25 to 39 mm)' was published to supersede IS : 886-1957.

Based on the International proposals on the tolerances for ISO metric screw threads, the Screw Threads Sectional Committee of ISI revised IS : 1362-1959 in 1962. Further, the ISI Committee on Screw Threads prepared, on the basis of ISO metric practices, a number of basic standards on screw thread profile, tooling and gauging as well as auxiliary standards on threaded fasteners, such as bolts, screws and nuts, which constitute the predominant field of application of screw threads. Some of the basic standards include:

IS : 1330-1958 General plan for metric screw threads with ISO profile (diameter range 0·25 to 300 mm)

IS : 1362-1962 Dimensions for screw threads for general purposes (diameter range 1·6 to 39 mm) (*revised*)

IS : 1859-1961 Thread-cutting dies

IS : 1988-1962 Screwing taps

IS : 2306-1963 Dimensions for gauge limits for ISO metric screw threads (1·6 to 39 mm)

For the manufacture and application of threaded fasteners, a number of other standards have also been published.

With the standardization of screw threads and fasteners on metric basis fairly well complete, users and producers did their best to work within the framework of metric standards, even though the industry could foresee the temporary swelling of their inventories and increase of locked up capital in the initial change-over period. Even at present the position is such that, though metric fasteners are freely available, others are still in demand, and this demand is expected to taper off only in a few years, when all old machinery would have worn out and designs renewed.

AUTOMOBILE COMPONENTS AND METRIC FASTENERS

One of the special problems of automobile industry, in which a deeper and more detailed study was made, relates to the use of metric fasteners. The Indian automobile industry has collaboration arrangements with several foreign firms leading to the employment of all types of screw threads prevalent during pre-metric days, as enumerated earlier. Further, the material and dimensional specifications for fasteners that are prescribed are based on the corresponding standards of various authorities in overseas countries, such as those published by the Society of Automotive Engineers (SAE), USA; Deutscher Normenausschuss (DNA), Germany; British Standards Institution (BSI), UK; *Ente Nazionale Italiano di Unificazione* (UNI), Italy and the Japanese Industrial Standards Committee (JISC), Japan. The need for unification is self-apparent, as otherwise it is highly uneconomical for the Indian manufacturers to cater to the varying demands.

The question of drawing up a phased programme of change-over and the assistance to be provided to manufacturers for overcoming the difficulties likely to be encountered during the process were considered at a conference of all automotive, accessories and fastener manufacturers. A thorough investigation was set in motion with a view to assessing the future requirements of industry and categorizing them into groups according to the difficulties of change-over. Information regarding the types, sizes and quantities of various fasteners employed, such as bolts, nuts, screws, studs, rivets, special male and female fasteners and locking devices was elicited from the automobile industry to help draw up a concrete plan.

Indian Standards for all the above items had already been made available. As far as possible, the manufacturers were requested to make the study bearing in mind the preferred sizes and keeping the selection of non-preferred sizes to a minimum. The plan also kept in view the overall consideration of avoiding disruption of production. This plan included changing over, in the first stage, of items like rivets, cotter pins and lock washers, as these involved minimum change in tooling. In the second stage, bolts, nuts and studs would be changed. For implementing the change in production departments, a group-wise list of fasteners for axle, transmission, propeller-shaft, etc, was prepared. This list included quantities required for each group, for the information of fastener manufacturers, so that their production capacities could be properly planned.

Even so, the plan has not made the headway it was originally expected to make. One may surmise that perhaps some 50 percent progress has been made. The major task of changing the design of components to the metric sizes still remains to be done. This was considered to be more time-consuming, as it involved preparation of new designs and drawings.

MACHINE TOOLS AND TESTING MACHINES

From a summary of effects of change-over on machine tools mentioned earlier, it was evident that, broadly stated, no major changes need be made on the existing equipment and that it could be safely utilized till the end of its life after which it may be replaced by the metric equipment. Further studies in this industry brought to light the following facts.

In the case of conversion of milling machines and grinding machines, it was considered sufficient to re-divide the dial, as these gradations were required for small displacements merely to regulate the depth of cut. Regarding testing equipment, conversion tables published by ISI were used, rather than to undertake the conversion of the machines, in the same manner as in the case of universal testing machines. On the other hand, it was found inconvenient to work with conversion tables on jig boring machines and measuring machines.

GEARS

The Technical Committee of the International Organization for Standardization on gears recognized both the world standards on gears, that is, the diametral pitch and the module. USSR and France have rigorously followed the module system only, but the other metric countries have adopted both the systems. In the inch countries, however, the diametral pitch system prevails. In India both the systems have equally taken roots. The use of both standards means duplication of tools and machinery, extra burden on reserve stock, delay in maintenance and the resulting loss in productivity. Consequent to the decision of the Government to go metric, a gradual change-over to module system was envisaged in India. For this purpose, the gear data had to be changed from diametral pitch to module pitch. The exact equivalent metric module was not generally available for diametral pitch expressed in metric units. When the nearest module was chosen, it was observed that it resulted in a complete design change. For instance, from the experience of the Indian Telephone Industries, it may be stated that the gear ratchet in the telephone dial was expressed formerly in the diametral pitch system. The exact equivalent of metric module was not available. If the nearest metric module were to be adopted, the entire dial had to be re-designed, which meant a basic change. In the case of automobile gears, a similar problem was encountered. In addition, it was found that the tooth proportion and its full depth, addendum and dedendum of gears were also different. Thus, a basic change in the design was necessary. As all these problems require a major change in the industry, the problem of metricization of gears continues to be pursued with caution.

REMAINING TASKS AND TYPICAL PROBLEMS

From the foregoing, it will be observed that metricization of values in trade and commerce and dimensions of raw materials, tools and equipment for production being relatively an easier task has been practically completed. However, the task of conversion of the original designs and drawings of various products into the metric system requires some more effort, and still remains to be done to some extent. Secondly, certain amount of co-ordination is yet to be achieved in putting the production of all Indian engineering industries totally on metric base.

For instance, the automobile manufacturers are gathering experience in the manufacture of components specially suitable for

Indian roads and climatic conditions. It would be much easier to design new components in the metric system than to convert the existing inch-based components. These problems are made particularly difficult wherever the manufacturer works in collaboration with overseas interests, bacause it is not always possible to act without the latter's consent. There is also the further complication that some imported components and sub-assemblies have to be used in conjunction with indigenous components and assemblies.

Another instance which illustrated the necessity of a change in design related to the experience of the Indian Telephone Industries, with their uni-selector rack framework manufactured by the company as part of their automatic exchange equipment. This framework consists of wrought steel sections, such as angle-iron and tees. The individual dimensions of these sections as well as the overall width of the frame were all important and functional. In order to maintain sufficient stability, particularly millimetre sections corresponding to the inch ones had to be selected. Employment of the chosen metric sections resulted in wide deviation of the overall width of the framework, which has, in turn, resulted in difficulties in assembling, as other mating components, directly converted will not allow proper assembling. This necessitated a basic change in the overall design of the rack.

It was often observed that while converting inch screw threads to metric threads, shank dimensions of the screws varied under the two systems. A change in the design of the matching component was necessitated, since the wall thickness on either side was sometimes too inadequate.

The aspect of co-ordination may be divided into two broad categories, namely, co-ordination within a particular unit (intra-unit co-ordination) and among several producer- and consumer-industries (inter-unit co-ordination). The type of problems encountered in intra-unit co-ordination were outlined earlier under the heading 'Initial Preparations' within the production unit.

The second category covers problems exemplified by the case of a steel mill which had decided to roll only in metric sizes after a particular period, say, one year. Their customers were thus forced to fix corresponding target date for switch over of their product manufacture to the metric system. This target date in its turn was linked up with the availability of other required materials which might cover semi-finished products (ferrous and non-ferrous), tools, measuring and inspection gauges, hardware, etc. But the target dates of suppliers of these latter products would generally differ. All these dates had thus to be so geared that the required materials arrived neither too early nor too late for production. The extent of perfection of gearing these activities would actually determine the state of completion of the change-over, which could only be achieved through inter-unit co-ordination among several varied types of consumers and producer industries.

The problem of making available raw materials at the right time could be tackled only by co-operative effort through improving understanding among producers and consumers on a common platform arranged, by holding periodic metricization conferences and mutual discussion through study groups.

Publicity material and catalogues indicating the programme of production and detailing the range of sizes and types of metric products, produced and to be produced would also serve the purpose, by keeping others informed and aware of what was going on.

The task of changing of designs is closely linked with the training and availability of factory engineers who have been taught and 'conditioned' to think in terms of metric units. Efforts in this direction are dealt with in detail in Chapter 18 Sec 1 'Education'. Organization of such education could also perhaps be augmented within the industry by setting up company standards departments or cells, which are becoming increasingly popular as a result of an organized effort for training and other forms of assistance. Even though it has been the practice in other countries for company standards departments to serve mainly as instruments for standardization within the company, the task of metricization could be, and has indeed been assigned to such departments and cells in view of the special needs in India.

CONCLUSION

Even at the beginning of introduction of the metric system, it was realized that complete change-over in industrial production would be highly complex as it involved extensive re-designing. It was, therefore, decided at a very early stage of the programme that the ten-year period for the change-over to the metric system would be taken to apply to commerce and trade and to the day-to-day activities of the public, and not to the field of industrial activity, techniques and processes of industrial production. The question of fixing a time limit for re-designing of equipment used in industry or its products, therefore, did not arise.

Even before the scheduled date, the metric system had gained a firm ground in all commercial transactions in the country. With a view to assessing the position of change-over with regard to engineering industries, a comprehensive survey was conducted by the Directorate of Weights and Measures in June-July 1966 with the co-operation of the two leading Associations, namely, the Indian Engineering Association and the Engineering Association of India. A questionnaire was issued and quite a number of returns were received. These returns included replies from all over the country and covered steel work fabricators, machinery and plant manufacturers. Even though difficulties were experienced, including the availability of additional hands for smoothening the change-over process, it could be concluded from the replies that the progress had generally been satisfactory in the field of change-over of technical drawings and design of products. A number of manufacturers who had sent in their returns, had indicated complete adoption of the metric system in the above two fields. Quite a good number had planned for complete switch over, with varying periods of 'saying good-bye' to the fps units, the farthest one going beyond December 1968. However, from a follow-up survey conducted in this connection, it has become evident that nearly half of the firms which had responded to the questionnaire of the first survey have achieved complete change-over, and others are following suit. Almost all the parties, having foreign collaborators, had stated that foreign collaboration posed no problem so far as the change-over was concerned. With the availability of trained additional hands and increase of inter-unit co-ordination, it is expected that the change-over in mechanical engineering industry will be achieved during the next few years. □

16

Construction Industries

H. C. Visvesvaraya
J. K. Varshneya

The *Standards of Weights and Measures Act, 1956*, envisaged a period of 10 years for complete change-over to the metric system in all spheres of national activity. This plan threw a great burden on all enterprises, but particularly on the building industry, which is still largely based on traditions passed down from generation to generation. Sizes of a very large number of building materials had to be changed to the metric system; new codes for design, construction and testing of structures had to be evolved; specifications, schedules and design handbooks of various Public Works

Departments and other construction agencies had to be revised; the standard measurement books and type drawings had to be converted, and, more than anything else, the very process of thinking of the construction personnel had to be re-oriented to develop a feel for the new system.

However, the change-over proved a blessing in disguise. For the first time in India, an opportunity arose to make a concerted effort to unify and co-ordinate the various construction practices and sizes of building materials. The result was the evolution of a National Building Code which could be used in all parts of the country, with minor modifications to suit local conditions.

The main burden of gearing the country for the metric change-over fell on the Indian Standards Institution (ISI), which is the national body for the formulation of various standards and codes though naturally, the planning, design and construction agencies had to bear the responsibility for implementing the various recommendations. The Ministry of Works, Housing and Supply of the Government of India and the National Buildings Organization also took an active part in the detailed work required to effect the change-over in the building industry.

In September 1959, the Ministry of Works, Housing and Supply convened a conference for the adoption of the metric system in architecture, town planning and building. This Conference recommended the setting up of 'Metric Cells' in every Public Works Department at the Centre and in the States of the Union to convert schedules, specifications, type designs, drawings, etc, to the metric system; requested the Indian Standards Institution to expedite formulation of metric codes and standards for building materials and entrusted to the National Buildings Organization the compilation of a comprehensive 'Handbook for Building Engineers in Metric System'. This publication was to serve as a standard reference book for metric change-over in the building industry.

ARCHITECTURE

Before the Architects could switch over to the metric system, it was essential to fix scales of reduction. The 12 scales, which ISI fixed for architectural purposes, were 1/1, 1/2, 1/2·5, 1/5, 1/10, 1/20, 1/50, 1/100, 1/200, 1/500, 1/1000 and 1/2000. Their manufacture was regulated by IS : 1491-1959 'Metric scales for architectural purposes'. The scales for drafting machines were manufactured according to IS : 1482-1960 'Metric scales for use with drafting machines'.

The Indian Standards Institution also prepared a code of practice for architectural and building drawings (IS : 962-1960). This code, which was revised in 1967, lays down detailed procedure for the preparation of drawings in metric units.

SURVEY PLANS

For the preparation of survey plans in metric units, it was essential to lay down scales for various purposes. After due process of consultation with the Survey Department authorities, the following scales were recommended by ISI (*see* Chapter 17):

FOR TOPOGRAPHICAL MAPS

1:250 000; 1:100 000 and 1:50 000

FOR TOWN SURVEYS

1:50 000; 1:25 000; 1:10 000 and 1:5 000

FOR SMALL-SCALE SURVEYS AND LAYOUTS

1:2 000; 1:1 000 and 1:500

EQUIVALENT METRIC UNITS AND MEASUREMENT OF BUILDING WORKS

Metric change-over in building industry required fixation of equivalent metric units, the units of measurement and the degree of fineness of measurements for each item of building work. The following Indian Standards were published by ISI for this purpose:

IS : 965-1958 Equivalent metric units for scales, dimensions and quantities in general construction work (This was revised in 1963)

IS : 1200-1958 Method of measurement of building works (This was revised in 1964)

These are now being widely adopted by surveyors, planners, designers, architects and builders alike.

MODULAR CO-ORDINATION

A further application of standardization in building industry is the modular co-ordination of dimensions. The modular co-ordination is achieved by the establishment of a common denominator or 'module' for the sizing of components. This reduces production costs of materials by variety reduction of building components and lessens the building costs by the elimination of unnecessary onsite modifications. By simplification and rationalization of dimensioning and detailing, the drawing office costs are also reduced. The concept of modular co-ordination is being fully exploited in some European and other countries for cutting down building costs and increasing productivity. ISI has adopted a 10-cm basic module for the architectural planning of buildings and sizing of building components.

ISI, being alive to this question, has formulated almost all of its specifications for basic building components on the principle of modular co-ordination. In addition, the following Indian Standards have been published to guide building engineers in the application of modular co-ordination:

IS : 1233-1958 Recommendations for modular co-ordination of dimensions in the building industry

IS : 2375-1963 Recommendation for modular co-ordination applied to RCC framed structures

IS : 2718-1964 Recommendation for preferred dimensions for storey-heights

BUILDING BY-LAWS AND BUILDING PLANS

Private building construction in towns and cities constitutes a substantial portion of the building activity in the country. This construction is to be carried out in conformity with the local by-laws which, in most cases, are out-dated and do not take into account the latest advances in the field of building materials and structural design techniques; and thus result in uneconomical construction and waste of certain national resources. To evolve a uniform pattern of building by-laws, ISI has published a code of building by-laws, first issued in 1958 and revised in 1967, which the local authorities can adopt with minor variations to suit local conditions. This code (IS : 1256-1967) is also published in metric units.

The Ministry of Works, Housing and Supply has directed all municipal corporations and municipalities in the country to accept building plans only in terms of metric units. This practice, wherever adopted, has forced the private architects to switch over to metric units.

BUILDING MATERIALS

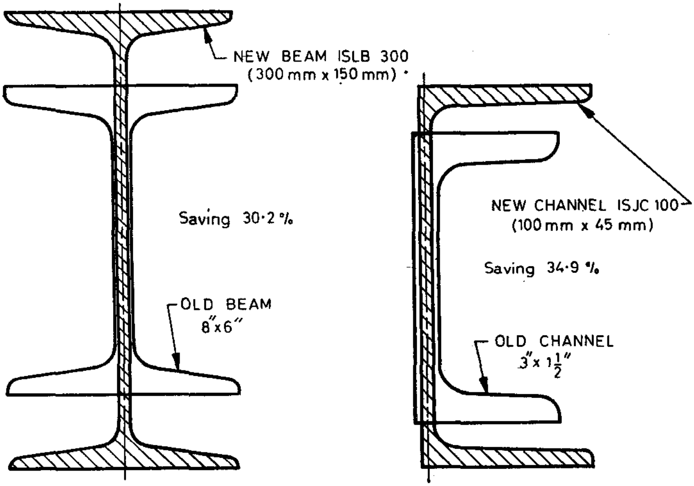
The construction industry uses a large number of building materials, the principal among which are cement, steel, bricks, stone, aggregates and timber. The existing Indian Standards for building materials were progressively converted to the metric system. The conversion was based on three principles, namely, arithmetical conversion, rationalization and standardization in the light of international practices. In revising these standards, the view of the various interests involved, specially those of the manufacturers, were also taken into account.

CEMENT

In the case of cement, apart from converting standard specification values to the new units, the size of packing was also rationalized. In terms of metric units, cement was now to be packed in 50 kg bags net in place of 112 lb bags gross.

STRUCTURAL STEEL SECTIONS

The task of changing the structural steel sections to metric units was quite arduous, as all the sections had to be completely redesigned. But this conversion proved very fruitful. While formulating metric standards for structural steel sections, full advantage was taken of the latest developments in the science of shape engineering, with the result that the new metric sections became 5 to 15 percent lighter than the fps sections for equivalent load-carrying capacities. The three new steel mills in the public sector were designed to produce only metric structural steel sections, while the existing mills prepared a phased programme for gradual change-over to the metric system. Well before the ten-year period of metricization was over, the entire production had been switched over to the metric standard sections and sizes.

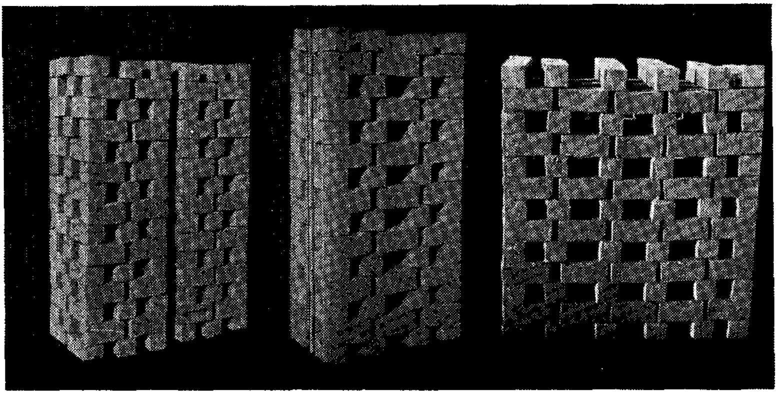


Typical examples of weight savings in beams and channels of equal strength, resulting from re-design and re-standardization of old inch sections on metric basis

BRICKS

Having agreed, on the basis of international and national deliberations, that promotion of modular co-ordination, as a basic approach to dimensional standardization in construction activity, is an essential prerequisite for the rapid progress of the construction industry, the Indian Standards Institution had taken up, as early as 1952, the question of standardization of 'brick' — the basic and primary component in building construction — and published the first standard specification in rationalized metric units in 1957. This specification (IS : 1077-1957), revised in 1966, laid down the basic size of common burnt clay brick as 19 cm × 19 cm × 9 cm, thus giving an overall unit modular size of 20 cm × 20 cm × 10 cm. Half-size bricks were also provided for in 19 cm × 9 cm × 4 cm size.

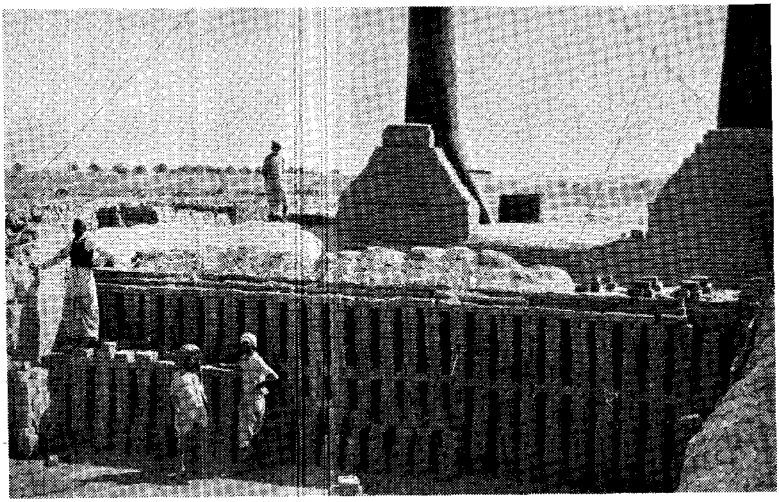
An attempt was thus made to unify the variety of sizes — numbering 26 or so — prevalent in different parts of the country, the most common one being 9 in × 4½ in × 3 in, and to provide a really dimensionally healthy basic building unit. Whilst these modular bricks were by and large welcome, certain fears were expressed by the construction industry and a great deal of resistance



Patterns for drying modular bricks: 6 on 6, 9 on 8 and 15 on 12

was put up by the manufacturing industry. The problems raised by the construction industry related to brick bonds, decreased thickness of wall leading to poorer structural stability and lower insulation resistance, architectural drawback because of having a square section and inconvenience in handling a larger section resulting in lower productivity of the mason. However, with experimental production of modular bricks and their initial experimental trials in use, not only did these fears vanish but their advantages in increasing productivity, lowering mortar consumption, reduction of wastage in breakages, etc, came to be appreciated. The Central Public Works Department first demonstrated the use of modular bricks in constructing 16 double-storey quarters. Later on, a number of construction departments in States and projects put up experimental buildings to demonstrate the use of modular bricks. At Bharat Heavy Electricals at Hardwar, modular bricks were extensively used in the construction of houses and factories[1].

On the manufacturing side, however, it was not easy to get over the resistance. The basic difficulty was that the brick industry, being of traditional type, passed on for generations from father to son as it were, possessed a natural resistance to any change and innovation. Many issues were raised, the first among these was the presumed increase in fuel consumption. To overcome this difficulty, the frog depth was increased from 10 mm to 20 mm, and



Cross-section of brick kiln illustrating the method of its loading with modular bricks

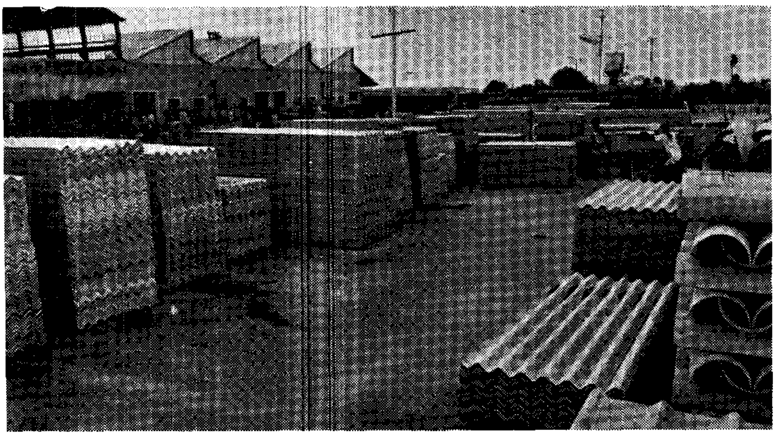
it was experimentally demonstrated that fuel cost in burning modular bricks was no higher than that in burning traditional thinner bricks. Difficulties in moulding, drying, stocking, arranging them in the kilns, were all brought forward and these were also effectively answered. Certain manufacturers, specially in the State of Tamil Nadu (Madras), claimed that due to lower plasticity of the soil there, ground moulding of metric modular bricks presented difficulties and pleaded for reducing the height to two-third the modular size as they had successfully tried this size[2]. To help meet these and other similar objections, the basic technology of manufacture of bricks itself has been taken up for study with a view to bringing out codes of practice relating to manufacture. On the whole, it is not yet possible to say that the metric size modular brick has been widely accepted in practice in the country, but with continued and concerted efforts, the industry is expected to change over to these bricks in not too distant a future.

TIMBER

Timber is another important material of construction, and here again metricization was started on basic principles. Examples may be cited of standards on coniferous sawn timber (IS : 190-1960), non-coniferous sawn timber (IS : 1326-1958), for further conversion, and components, such as flush door shutters (IS : 2191-1966 and IS : 2202-1966). To help transactions in timber trade, standards dealing with volume calculations in metric units, such as IS : 2184-1962 for round timber and IS : 2377-1963 for cut sizes were prepared and published. The latter was revised in 1967.

ROOF SHEETING

Corrugated roof sheetings are all now in metric dimensions. The relevant Indian Standard specifications are IS : 277-1962 for galvanized steel (plain and corrugated), IS : 459-1962 for asbestos cement, unreinforced and IS : 1254-1965 for aluminium. A point worthy of mention here is the fact that metricization has been carried out essentially from the functional point of view. In the process of metricization, the pleasure of seeing round figures or conversion for the sake of conversion have been scrupulously avoided. For example, take the case of IS : 459-1962 'Specification for unreinforced corrugated asbestos cement sheets (*revised*)'. Since, on the one hand, the revision of the dimensions of the corrugations was of no consequence, from the functional point of view of the user, and on the other, any revision in the dimensions of the



Corrugated asbestos cement sheets in metric sizes at the manufacturer's works corrugations would have meant a considerable amount of expenditure to the industry, the original inch dimensions of the corrugations and pitch have been maintained by directly converting them to equivalent metric values with marginal adjustments. On the other hand, the overall dimensions of the sheet, which is very important from the users' point of view, have been rationalized. Even here, interchangeability with existing sheets has also been kept in view, since occasional replacements in existing structures would be required.

OTHER MATERIALS AND COMPONENTS

Metric standards for other materials, such as stones and aggregates have also been laid down. Standards in metric dimensions for almost all building components, such as doors, windows and water supply, sanitary and electrical fittings are now available.

DESIGN AND CONSTRUCTION CODES

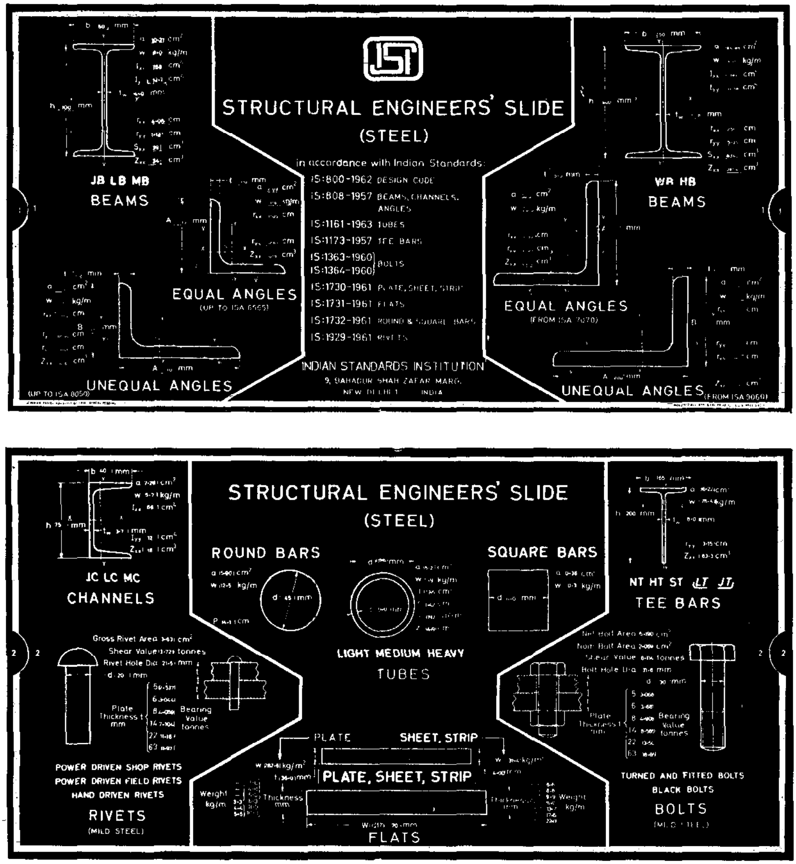
With the switch over to metric units, designers were faced with a number of problems. It was essential for them to know the rationalized values of permissible stresses for various mixes of concrete and various grades of steel. The following basic codes made available by ISI in metric units provided the required information and guidance:

IS : 456-1964 Code of practice for plain and reinforced concrete (*second revision*)
IS : 800-1962 Code of practice for use of structural steel in general building construction (*revised*)
IS : 875-1964 Code of practice for structural safety of buildings: Loading standards (*revised*)
IS : 883-1966 Code of practice for design of structural timber in building (*second revision*)
IS : 1172-1963 Code of basic requirements for water supply, drainage and sanitation (*revised*)
IS : 1343-1960 Code of practice for prestressed concrete
IS : 1911-1961 Schedule of unit weights of building materials (This was revised in 1967)
IS : 2065-1963 Code of practice for water supply in buildings
IS : 2212-1962 Code of practice for brickwork

In addition to the above basic codes, a large number of other codes on design and construction of buildings were brought out. To illustrate the use of metric units in actual design work, ISI has published handbooks for structural engineers on the following items:

1) Structural steel sections (*revised*),
2) Steel beams and plate girders, and
3) Columns and struts.

Besides the handbook on structural steel sections, ISI has also produced a structural engineers' slide. The slide provides,



ISI Structural Engineers' Slide — its two faces in a handy form, essential structural design data for hot rolled structural shapes, bolts, rivets, etc, in accordance with Indian Standards.

ISI has also encouraged and assisted in the compilation and publication of similar handbooks by other organizations, such as the National Buildings Organization and the Timber Merchants Association of Gujarat.

As in the case of materials, the change-over of the codes of practice to the metric system brought in its trail opportunities to rationalize code recommendations. For example, in IS : 456-1964, instead of specifying a concrete mix by its nominal proportions, it was specified by strength, which had a great impact on the technology of concrete and concrete construction in the country. IS : 875-1964 revised the basis of accounting for wind pressures.

NBO'S HANDBOOK FOR BUILDING ENGINEERS

In pursuance of the decision of the Conference for the adoption of the metric system in architecture, town planning and building industry, the National Buildings Organization prepared a comprehensive 'Handbook for Building Engineers in Metric System'. The entire body of information in it is in metric units in conformity with Indian Standards. The publication is intended to serve as a standard reference book for engineers all over India for ensuring a smooth change-over to the metric system. The handbook has been divided into the following 24 chapters covering various aspects of building engineering:

1) Quantities, units and conversion factors
2) Materials and construction
3) Structural sections and allied data
4) Loads on buildings
5) Structural analysis — formulae and tables
6) Masonry structures
7) Timber structures
8) Soil mechanics and foundations
9) Plain and reinforced concrete
10) Prestressed concrete
11) Concrete shell structures
12) Steel structures

13) Earthquake engineering
14) Multi-storeyed office buildings
15) Building construction — miscellaneous items
16) Water supply engineering
17) Sanitary engineering
18) Surveying
19) Ventilation and air-conditioning
20) Electrical installations in buildings
21) Measurement of building works
22) Building construction equipment
23) Miscellaneous information for the building engineer
24) Mathematical formulae and tables

HIGHWAYS

For a number of purposes, and specially in order to frame road estimates in metric units, it was essential to replace the existing mile-furlong stones with kilometre stones on highways, which aggregated to some 92 000 km in the country, of which the national highways themselves constituted about 26 000 km. This was an expensive and time-consuming work. After detailed deliberations in the Indian Roads Congress (IRC), the design of kilometre stones and 200-metre stones has been evolved and plan for their installation finalized. Though the work was started in 1956, the installations on national highways are nearing completion, while State highways are quite a way behind.

Road widths and IRC bridge loadings in metric units have been finalized by the Indian Roads Congress and are being generally adopted.

CENTRAL METRIC CELL

In April 1965, the National Buildings Organization convened another Conference on 'Metric Change-Over in Building Industry' to assess the progress made and to formulate future programme of action. As a result of one of the recommendations of this Conference, a Central Metric Cell was set up in the National Buildings Organization. The functions of the Cell were:

1) to prepare nomenclature for schedules of rates in accordance with Indian Standards laid down by ISI, the nomenclature to be

adopted by State Governments with minor adjustments to suit local conditions;

2) to scrutinize the specifications, schedules, etc, prepared by the State cells so that they are converted into the metric system in rationalized metric units according to Indian Standards; and

3) to collect, collate and disseminate information on metric change-over in building industry to various State cells.

Besides scrutinizing the schedules and specifications, the Central Metric Cell issued a set of 20 Metric Bulletins, giving information on metric change-over. It also issued Model Metric specifications for various items of building work, and prepared a special pamphlet entitled 'Notes on Metric Change-Over in PWD'. It prepared a Directory of manufacturers producing various building products and equipment according to the relevant Indian Standards and a Directory of books and codes available in metric units. The Cell also requested the editors of various technical journals to ensure that technical articles were published exclusively in metric units.

TRAINING OF PERSONNEL

The present generation of serving engineers, who had been trained in the fps system, was faced with a number of problems during the transition period. For instance, it is easy for an engineer to comprehend the bearing capacity of soil as 2 ton/sq ft, but when the bearing capacity is mentioned as 20 tonnes/sq m, the engineer first converts it to the fps units to get a feel of the magnitude of the bearing capacity, and similarly, when a stress is specified as 55 kg/cm^2 instead of 750 psi. Therefore, equivalent metric units for various items of building construction were circulated to the field engineers.

The field engineers who were conversant with the fps system, found it particularly difficult to get the feel of building elements in metric units. So, while conversion tables, giving conversions from fps to metric units and *vice versa,* were prepared and made available to engineers, it was suggested by the National Buildings Organization that small show rooms exhibiting various metric building products, survey and drawing equipment should be set up at the headquarters of every Superintending Engineer. This gave the engineers a chance to see these products and form a mental picture of them.

In order to acquaint the Section Officers and Junior Engineers in organizations of Public Works Departments with the new system and new survey and drawing equipment, it was decided to hold short-term refresher courses for them. The Railways and the Public Works Department of Madras held such courses regularly. The Central Metric Cell of the National Buildings Organization formulated a scheme for such a refresher course of one month duration. In this course, apart from the practical use of metric levelling staff, survey chains, etc, lectures were given on the following subjects:

1) History of the metric system
2) Basic metric units
3) Abbreviations for metric engineering units
4) Equivalent metric units and conversion factors
5) Metric structural products
6) Metric building products
7) Live loads on buildings
8) Metric surveying instruments
9) Metric scales for survey plans
10) Metric scales for architectural and building drawings
11) Allowable stresses in masonry, timber reinforced concrete and steel in metric units
12) Allowable bearing pressures on soils in metric units
13) Characteristics (in metric units) of building construction equipment
14) Measurement of building work in the metric system

The trainees were also given copies of model estimates for building work, road work, bridge work and sanitary work and sample calculation sheets for their guidance.

METRIC CHANGE-OVER IN TECHNICAL EDUCATION

As metric units became compulsory, it became desirable that the future building engineers should be trained in the metric system from the very beginning. The Association of Principals of Technical Institutes (India) formulated a phased programme of change-over to the metric system. According to this programme, complete change-over to the metric system was to be effected by 1966-67. The Union Public Service Commission will use both fps units and metric units for its examinations up to 1970 and only metric units thereafter.

TRAINING OF SKILLED LABOUR

In the countryside, small towns and to some extent in cities, building construction is carried out by masons and mistries who do not have any theoretical background, but who have learnt fundamentals of reasonably safe construction through apprenticeship and practical experience over the years. A mason knows that for door lintel of a particular span, 4 reinforcement steel bars of 5/8 in diameter are safe enough. When only metric bars will be available in the market, he should know which bar will be equivalent to a 5/8 in bar. For ready reference of such persons, tables of approximate equivalents on the lines of Table 1 were published in all regional languages for free distribution through the agency of steel and hardware merchants in cities and towns and Block Development Officers in villages.

In order to overcome difficulties in recognizing visually bars of various diameters in the field, when only metric steel bars will be

TABLE 1 APPROXIMATE EQUIVALENTS OF BAR DIAMETERS

Diameter of Bar (in)	Diameter of Bar (mm)
3/16	5
1/4	6
5/16	8
3/8	10
1/2	12
5/8	16
3/4	20
7/8	22
1	25
1-1/8	28
1-1/4	32
1-1/2	40

available, convenient gauge plates were issued with punched and labelled holes of the following diameters:

5, 6, 8, 10, 12, 20, 22, 25, 28, 32 and 40 mm.

CONCLUSION

While the change-over to the metric system in the building industry as a whole has been rapid and encouraging, it cannot be said that the process of change-over is complete. The basic ground and instruments necessary for a change-over have been prepared, and outstanding problems, such as those highlighted in this chapter are being tackled. It is hoped that with the gradual change-over in basic thinking, the construction industry will soon be completely metricized.

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17

Survey and Land Records

K. L. Khosla

The adoption of the metric system in survey, mapping and land records was a colossal task. All Indian maps had been drawn, before the metric system was adopted, on the mile-foot-inch scale. During the past hundred years or more, innumerable maps, from the small maps showing the borders of a field, village or town, to the maps depicting large territories had accumulated and had to be adapted for use on metric basis. The switch over to the metric system in survey and land records thus affected all organizations concerned with surveying and mapping, the premier of them in the country being the Survey of India. Other bodies principally involved in this work were the State cadastral survey organizations, the educational institutions, the instrument manufacturers, the Indian Standards Institution (ISI) and the Central Directorate of Weights and Measures in the Ministry of Commerce. This chapter deals mainly with the manner in which the problem has been dealt with, and how the phased programme of change-over in the field of survey and land records has been and is being implemented by all these organizations.

PROGRAMME OF CHANGE-OVER OF MAPS

TOPOGRAPHICAL MAPS

In the year 1905, the Survey of India had laid down the policy for standardizing maps on the fps system, and standard scales were adopted for executing a planned and systematic map coverage of the whole country. The standard scales prescribed for topographical maps were 1 inch = 1 mile, 1 inch = 2 miles and 1 inch = 4 miles, also known as one-inch, half-inch and quarter-inch scales, with 50, 100 and 250 feet contour intervals respectively. The layout of these series of maps was based on latitudes and longitudes. For example, each one-inch map covered an area of 15 minutes of latitude × 15 minutes of longitude, each half-inch map covered 30 minutes of latitude × 30 minutes of longitude and each quarter-inch map covered one degree of latitude × one degree of longitude. Since 1905 about 3 400 map sheets of the country had been surveyed and mapped on these scales, thus covering more than four-fifths of the entire area of the country. The remaining area was covered by the pre-1905 surveys. Now the change-over to the new system involved the stupendous task of re-survey, re-drawing and re-publication of about 6 000 different types of maps, maintained by the Survey of India. It was estimated that it would take many years to effect the change-over completely, and in the transition period, the public and Government departments would have to deal with maps on both the existing and the new systems. In course of time, use of old maps would not be necessary, as new maps to replace them would be ready.

The metric scales and contour intervals for the topographical maps now adopted are:

1) 1:25 000 with contour interval of 10 metres,

2) 1:50 000 with contour interval of 20 metres to replace the existing scale of 1 inch = 1 mile with contour interval of 50 feet,

3) 1:100 000 with contour interval of 50 metres to replace the existing scale of 1 inch = 2 miles with contour interval of 100 feet, and

4) 1:250 000 with contour interval of 100 metres to replace the existing scale of 1 inch = 4 miles with contour interval of 250 feet.

NOTE — The series 1:100 000 with contour interval of 50 metres is at present in abeyance, as its maintenance is not absolutely necessary, while the time and labour involved would be more gainfully applied to the production of other smaller scale series.

The layouts of the series on these scales remain the same as that on the fps system — the 1:25 000 series of maps cover an area of 5 minutes of latitude × 7½ minutes of longitude, six 1:25 000 sheets forming one 1:50 000 sheet. The metric scales for mapping now adopted are proportionately larger than the corresponding scales on the fps system. The existing maps cannot be converted to metric scale by direct photographic enlargements because it would be difficult to interpolate contours in flat and undulating ground while the accuracy of the map detail would also suffer. Also, the change-over involved complete re-survey throughout the country of distance stones along all roads and highways after the existing furlong and milestones had been replaced by kilometre stones by the Central and States' Public Works Departments. Besides, the maps require a fresh drawing suited to the larger scales for the simple reason that standards and significances of lines and symbols in their varying thicknesses and shades do not lend themselves to enlargement from aesthetic, conventional and educative points of view. It was, therefore, inescapable that the existing topographical maps be revised and mapped afresh on metric scales.

Simultaneously, with the adoption of our long range policy of complete conversion of maps to metric scale by re-surveying or re-mapping, an interim policy was very necessary, so that the existing maps on the fps system could be utilized to best advantage through the addition of suitable conversion scales and tables in the margins of the sheets. In pursuance of these long and short-term policies all new departmental original or revision surveys are carried out on metric scales and all these new metric scale sheets are being fair-drawn to metric specifications with effect from 1 April 1958. The existing maps are, when required, being reprinted with the addition of conversion scale of yard-metre in the west margin, height conversion table in the east margin, together with scales in kilometres/metres and miles/furlongs in the south margin until fresh surveys in metric terms are completed. The accessory work to this end, that is, engraving of conversion scales/tables has been completed.

Specifications for fair-drawing of topographical maps of 1:25 000, 1:50 000, 1:100 000 and 1:250 000 series on the metric system have been finalized.

The re-issue policy in regard to one-inch and primary half-inch scale maps in areas where original or revision surveys in the metric system are not contemplated in the near future is as follows. In such cases, the one-inch and primary half-inch sheets may be re-issued on the fps system, incorporating verification surveys of specified items of detail by correction of the existing fair-drawn originals. The following general changes are also incorporated: corrections to administrative boundaries and names, corrections to railway and other names, corrections to marginal items, addition of yard-metre scale and height conversion tables, etc, and introduction of grid in metres or yards as required by the map users. For such revision, if colour separated negatives are not available, colour separation is not normally undertaken and sheets are published in basic colours (black, brown, green and greenish blue for glaciers, etc) with the addition of auxiliary colours, for example, purple for grid, solid blue for double line streams, canals and tanks and appropriate colours for boundary ribands.

Re-issues on metric specifications have been done with the existing original outline on the 1½-inch scale after correcting and modifying the original. The contour original is required to be re-drawn on blue print of the outline with only surveyed metric contours.

Detailed policies have also been formulated with regard to reprint of the one-inch and primary half-inch maps and with regard to re-issue and re-print of other types of maps maintained by the Survey of India.

GUIDE MAPS

The existing guide maps were on varying scales and contour intervals. With the adoption of the metric system, the new scale and contour intervals are 1:20 000 in plains with no contours and 1:10 000 in hills with contours at 5-metre intervals.

GEOGRAPHICAL MAPS

The distinction between a geographical map and a topographical map may be expressed thus:

A geographical map is one that is on such a small scale that the features shown on the map are suitably generalized and the map is intended to give a picture of the country as a whole and not a strict representation of its individual features.

The Survey of India classes all maps on scales smaller than 1:250 000 (1 inch to 4 miles) as geographical maps. A topographical map, on the other hand, is one on a sufficiently large scale to enable the individual features shown on the map to be identified on the ground by their shape and position.

The problem of changing geographical and other miscellaneous small-scale maps to the metric system is different from that of changing topographical maps. All the maps are compiled from 1:1 000 000 (1:1 million or 1:M) maps and are on various scales ranging from 1:M to 1 inch to 250 miles (which is 1:15·84 M). The 1:M maps are compiled from the topographical maps. The following is the list of large-scale geographical maps which are published by the Survey of India.

Series of Large-Scale Geographical Maps Covering India

1) 1:1 000 000 *Carte Internationale du Monde* (CIM) or the International Map of the World (IMW);

2) 1:1 000 000 World Aeronautical Charts, International Civil Aviation Organization (ICAO); and

3) 1:1 000 000 State Maps.

Of the above three, the first two series, as their names suggest, are international commitments, and they are planned on international specifications, both in metric terms.

Then, there are single smaller scale geographical maps covering the whole of India as under:

	Scale in fps	*Description of Map*	*Equivalent Metric Adopted Scale*
4)	1 inch = 40 miles	Map of India and Adjacent Countries	1:2 500 000
5)	1 inch = 40 miles	Road Map of India	1:2 500 000
6)	1 inch = 67 miles	Railway Map of India	1:3 500 000
7)	1 inch = 70 miles	Political Map of India	1:4 000 000*
8)	1 inch = 70 miles	Physical Map of India	1:4 000 000*
9)	1 inch = 128 miles	Map of India and Adjacent Countries	1:8 000 000
10)	1 inch = 192 miles	Map of India and Adjacent Countries (Political-desk-maps)	1:12 000 000
11)	1 inch = 250 miles	Map of India and Adjacent Countries (Skeleton background map for special purposes)	1:16 000 000

Finally, there is the following category of maps covering a particular area only:

12) 1:2 500 000 Map of the Great Himalayas and Surrounding Regions.

No problem arises as regards 1:M series as these are already on metric scale. The rest are all being re-compiled and re-drawn on the equivalent metric scales now officially adopted for which the specifications have been drawn up. Many of these have already been printed, and it is hoped that the rest will also be printed on metric scales in the near future.

DEVELOPMENT PROJECT MAPS

There are a large number of special maps which the Survey of India prepares for other departments of the Central and State Governments in connection with various flood control, hydro-electric, irrigation and engineering projects, forest developments,

*The first edition has, however, been prepared on 1 : 4 500 000 scale.

geological investigations and other projects. For these maps, the scales used in the fps system were 64 inches to a mile, 16 inches to a mile, 8 inches to a mile, 6 inches to a mile, 4 inches to a mile, 3 inches to a mile and 2 inches to a mile. The new scales adopted to replace these are 1:1 000, 1:2 000, 1:5 000, 1:10 000, 1:15 000 and 1:25 000. Contour intervals may be 0·5, 1, 2·5, 5 or 10 metres depending upon the nature of the country and scale adopted or purpose of the project. In certain cases, where the maps on larger scales are required, in which the engineers are interested in larger paper space, photographic enlargements of specified areas could be provided from the nearest smaller scale surveys.

CANTONMENT MAPS

It has been agreed that future cantonment surveys will be carried out on scales 1:1 000 and 1:5 000 instead of the present 64-inch and 16-inch scales. The contour interval is dependent on the nature of terrain and will be decided in each case separately.

FOREST MAPS

These maps in the fps system are generally on 4 inches to 1 mile scale. The metric scale for these maps has been 1:25 000, to be with contours at 10 metres vertical interval. In rare cases, where this scale would not serve the purpose of planning or development, photographic enlargements of specified areas could be prepared.

For the existing maps, suitable scales and conversion tables have to be drawn on maps by the forest departments to enable the expression of fps equivalents in metric terms.

A standard symbol table for use on all forest maps prepared for different States and Union Territories in India has been brought out.

CADASTRAL MAPS

The metric system also affects the revenue and cadastral maps in the country. The number of such maps in each State is enormous. A conference of representatives from the State Governments and Central Government departments that met on 9 March 1957, had come to the conclusion that the conversion of existing maps to metric terms within a few years was most uneconomical and impracticable. Since these maps are meant for limited use only, it was agreed that the maps on the fps system, or any other systems, prevailing in the States, may be retained until the areas concerned come up for re-survey. Generally, cadastral maps were revised in a cycle of 30 to 40 years. As in the case of topographical maps, suitable conversion tables would be drawn up on the borders of existing cadastral and revenue maps to express area and linear measurements in the metric system. This would also help to educate the public and the custodians of revenue records in the metric system during the transition period.

The existing scales in the fps system in the different States range as follows:

1)	105·6 in to a mile, that is,		1: 600	
2)	64	do	1: 990	
3)	40	do	1: 1 584	
4)	32	do	1: 1 980	
5)	24	do	1: 2 640	Most generally used
6)	16	do	1: 3 960	
7)	8	do	1: 7 920	These scales are commonly used on index maps only
8)	4	do	1: 15 840	
9)	2	do	1: 31 680	
10)	1	do	1: 63 360	

It was agreed upon at the Conference that for correctly surveying the more valuable lands, the small-size holdings and the density of detail within such holdings, it would be necessary to have revenue maps on more than one scale. Future scales for cadastral maps, it was decided, should, as far as possible, be limited to 1: 1 000, 1: 2 000, 1: 5 000 and 1: 10 000, and these scales may be supplemented where absolutely necessary by scales 1: 500, 1: 3 000 and 1: 4 000. For index maps, the largest scale should be 1: 25 000. Existing maps are allowed to stand till such time as the areas come up for re-survey, when these are surveyed on the metric system. In the meantime, suitable scales and conversion tables are drawn on existing maps by the States concerned to enable expression of linear and area measurements in metric terms.

Existing land records are converted to the metric system as and when they are revised, either for converting assessment values to the new currency units or during transfer of possession or resettlement.

Units of Areas — The existing units of areas in the fps system in the different States range as follows:

Lessas	144 sq ft
Marla	1/160 acre
Cents of an acre	0·01 acre
Guntha	1/40 acre
Bighas	900, 1 600, 1 936, 2 093·625, 2 450·25, 2 526·25, 2 730·625, 2 756·25 and 3 136 sq yd
Bisis	4 800 sq yd
Nalis	240 sq yd
Muthis	15 sq yd
Square *Karam*	66 in × 66 in = 30·25 sq ft

For the sake of uniformity the areas in the metric system have been decided to be expressed in Ares (*see also 'Area measurements'* on P 368).

Lengths of Chains — It is also interesting to note that the following different lengths of chains are being used in cadastral surveys:

1 chain = 33 ft, 50 ft, 66 ft, $73\frac{1}{3}$ ft, 74 ft, 75 ft, $76\frac{1}{4}$ ft, $82\frac{1}{2}$ ft and 100 ft.

CADASTRAL SURVEYS AND CHANGE-OVER

An All-India Cadastral Survey Conference was called at Mussoorie in 1964 to collect details of the cadastral surveys done in various States and to bring them on uniform footing. This was attended by the Directors of Survey and Land Records Departments of the States. In this connection, Resolution No. 23 regarding cadastral surveys passed at the Second United Nations Regional Cartographic Conference for Asia and the Far East, held in Tokyo (Japan) from 20 October to 1 November 1958, is reproduced below:

'23. Cadastral Survey

The Conference,

Recognizing the importance of establishing new registers or improving existing land registers, *Noting* the following points:

a) Cadastral survey should in all cases be based on a sound geodetic control and connected with an existing national geodetic net,

b) Cadastral work should be planned on a broad scope and on a long-range basis so that it can keep pace with all requirements of future economic development as well as with changes in juridical or social systems,

c) The precision of a cadastral survey should depend on the land value and not be higher than necessary for the fulfilment of practical requirements. The cadastral survey should be prepared in different accuracies as required, the first of which could be the enlarged photographs. The numerical cadastre in conjunction with index maps represents the most perfect cadastral survey obtainable and desirable at the present stage of knowledge,

d) All cadastral surveys can be done either by photogrammetrical methods or by ground survey. The method to be used depends upon the local circumstances,

e) It is inadvisable to represent on cadastral maps any more topographic details than necessary. The topographical maps which are needed for the whole area, or for a part of it, should be made separately on the same or on a smaller scale. These topographical maps can be derived in planimetry from the cadastral map or from the basic material used for the latter,

1. *Recommends* that, in planning cadastral work, these points should be borne in mind;

2. *Stresses* particularly that a cadastre will lose a great part of its usefulness if it is not available in time.'

This resolution has been accepted by the Government of India, who while forwarding a copy of it to all State Governments and Governments of Union Territories requested them to ensure that their survey work is based on the Geodetic Control of the Survey of India.

One of the recommendations made and resolutions passed at the All-India Cadastral Survey Conference mentioned above was to constitute a Standing Committee to carry out and implement the policies and decisions arrived at in the Conference.

SUMMARY OF CADASTRAL SURVEYS

A summary of the procedures followed in various States and Union Territories in cadastral survey is given in Tables 1 and 2.

TABLE 1 SUMMARY OF CADASTRAL SURVEYS IN VARIOUS STATES

SL No.	STATE	METHOD OF SURVEY	SCALE	ACCURACY	AREA
(1)	(2)	(3)	(4)	(5)	(6)
i)	Andhra Pradesh	Theodolite traverse along village boundaries and main village blocks. Main traverse connected to geodetic net. Holdings are demarcated and measured. Small holdings are clubbed together to form general survey field of 5 acres in wet and 10 acres in dry. Diagonal lines are run with chains and cross staff and field corners are offsetted. Maps show all survey fields with important topographic details. Special surveys also done of cities, towns, streets and lanes of *Panchayats* to facilitate municipal and revenue administration and detection of encroachments. Method of survey broadly the same as that of cadastral survey, but better accuracy is aimed at.	Village maps 8 in = 1 mile *or* 16 in = 1 mile	1:100 in linear measurement and 1 *minute in* 5 angles, in theodolite traverse and 1/782 in detailed cadastral survey	--

ii) Assam	Theodolite traverse is done along boundary of the village, closed on commencing station, taken as origin of co-ordinates. Internal lines by Gunter chain. Fields located by optical square. Cassini co-ordinates system. Area of traverse polygon is computed by co-ordinates (Universal Theorem method) and checked by planimeter. Land records comprise *Chitta* (Field catalogue), *Jamabandi* (Register of revenue paying holders) and cadastral maps.	16 in = 1 mile	1:1 000 in traverses	Areas recorded in *bigha* = 5 *kathas* *katha* = 100 *lessas* *lessa* = 144 sq ft Area of individual holdings by acre-comb and area-squares. Total area of holdings to agree with UT area within 1 percent
iii) Kerala	Old Travancore areas by triangulation, base lines and offset. Old Cochin areas by triangles and offsets. Old Malabar and Kasargode areas by triangulation, triangles and offsets, base lines and offsets and by planetabling.	Village maps 16 in = 1 mile 8 in = 1 mile Cadastral survey fields on 1 : 792 and 1 : 3 960	1:1 000 for village boundaries. 1 percent error in area. No plot-table errors in linear measurements on scale 16 in = 1 mile. Travancore and Malabar 1:100 in linear measurements	Areas in acres and cents

(*Continued*)

TABLE 1 SUMMARY OF CADASTRAL SURVEYS IN VARIOUS STATES — *Contd*

SL No.	STATE	METHOD OF SURVEY	SCALE	ACCURACY	AREA
(1)	(2)	(3)	(4)	(5)	(6)
iv)	Bihar	Main traverse by theodolite. Cadastral survey by plane table. Area of traverse polygon by co-ordinates (UT) and checked with planimeter.	—	Traverse 1:500	Total of plot areas to agree with village areas within 1 percent. Error allowed in plot areas: ·01 acre for plots up to 10 acres ·02 acre for plots up to 20 acres ·03 acre for plots up to 50 acres ·04 acre for plots up to 100 acres ·05 acre for plots from 100 acres upwards
v)	Gujarat (Kerala *see* P 359)	Minor triangulation and closed traverses connected to geodetic net. Detailed survey by plane table of agricultural and non-agricultural lands on different scales. Planetable survey of agricultural land on scale 1:990.	Detailed survey of agricultural lands on 1:990, village maps on 1:7920 & 1:3 960, non-agricultural areas, towns or cities on scale 1:192, 1:300,	4 ft-$1\frac{1}{2}$ in for agricultural lands on scale 1:990 and 6 in in the case of city surveys. Errors of 4 ft in linear measurements and 5	Village survey unit of area is 1 *guntha* = 1/40 acre = 0·010117 hectare. City surveys unit of area: sq ft

	Village maps prepared on scale 1:7 920 by reduction by pantograph. Old cadastral surveys in Saurashtra and Kutch have been made with cross staff and chain.	1:396, 1:400 and wall maps on 1:2 400	percent in area measure for cadastral surveys	
vi) Madhya Pradesh (Maharashtra *see* P 362)	Present State comprises the four integrated units of Mahakoshal, Madhya Bharat, Bhopal and Vindhya Pradesh. Triangulation and theodolite traverses connected to geodetic net. Detailed surveys carried out mostly by Gunter's chains on 16 in = 1 mile. Town surveys on 64 in = 1 mile, 128 in = 1 mile, etc, by theodolite traverses, chain and offset method. Many towns and villages in Bastar district still unsurveyed.	Cadastral surveys 16 in = 1 mile Town surveys 128 in = 1 mile 64 in = 1 mile 54 in = 1 mile 16 in = 1 mile 32 in = 1 mile 1 = 1 000	Main traverse 1:1 000 Sub-circuits 1:500 Detailed survey 1:200	Areas recorded up to 2 places of acres
vii) Mysore	Each village surveyed as independent unit. A base line surveyed traversing the major portions of the lands of a village and lands on either side measured by chain and cross staff.	—	—	—

(*Continued*)

TABLE 1 SUMMARY OF CADASTRAL SURVEYS IN VARIOUS STATES — *Contd*

SL No.	STATE	METHOD OF SURVEY	SCALE	ACCURACY	AREA
(1)	(2)	(3)	(4)	(5)	(6)
viii)	Maharashtra	The present State consists of districts of old Bombay, ex-Hyderabad, ex-Berar and ex-Madhya Pradesh. Theodolite traverses are run along village boundaries and theodolite triangulation connected to geodetic net also used. Detailed survey of individual holdings and survey fields and topo details done by cross staff, chain measurements and also by plane table.	Rice land 1 in = 330 ft Dry crop land 1 in = 660 ft Plane table survey 1:990 Non-agricultural land 1:498 City and town surveys 1=480 and 1=300	Linear measurements 1=1 000, angles recorded up to 1 minute. Detailed measurements made up to 1/32 part of 33 ft chains	Area of dry land in acres and *gunthas* (1/40 of acre) Areas of wet lands in acres and 1/4 *guntha* Urban lands unit of area is sq yd In districts of ex-Madhya Pradesh, areas in acres and cents, and Town areas in sq ft
ix)	Orissa	Main traverse by theodolite. Cadastral survey by plane table. Area of traverse polygon by co-ordinates (UT) and checked with planimeter to agree within 5 percent.	16 in = 1 mile	Traverse 1:500, Cadastral survey 1:100	

x) Punjab	Hilly area by triangulation. Cadastral survey by plane tables, compass and sighting rod. Consolidation of holdings is being done by rectangulation system.	24 in = 1 mile *or* 1 in = 40 × 66 in	Linear measurements: Plains 1 = 200 Hills 1 = 100	New unit of area: 1 *marla* = 1/160 acre = 0·6 cent = 0·002 4 hectares Old unit of area: 1 *Biswa* = 1/96 acre
xi) Rajasthan	Most Comman method is triangulation and *Murabbabandi* system.	16 in = 1 mile	1 link in one chain in plains and 2 links in one chain in deserts, are considered negligible	—
xii) Tamil Nadu (Madras)	Whole districts divided into main circuits of 100-150 sq miles. Theodolite traverses round main circuits and connected to geodetic net. Main circuits divided into lines also fixed by theodolite traverse. Theodolite traverse along village boundaries and *Khandams* (100-250 acres). Survey field generally 5 acres in wet and 10 acres in dry lands. Field by chaining and offsets. Village maps prepared from traverse co-ordinates and field measurements.	Cadastral surveys 40 in = 1 mile 80 in = 1 mile 16 in = 1 mile *Taluk* maps 1 in = 1 mile District maps 1 in = 4 miles	Traverses 1:1 000, angular error: 1 minute in 5 angles. Linear error: 1:1 000 in long lines increasing to 1:100 in short lines. Town surveys traverse: 1:2 000 in linear measurements and 1:1 000 in blocks	Areas of village from traverse co-ordinates (UT) to agree with total of field areas within 1 percent Areas of fields measured in acres and cents and of towns to 1 sq ft. In the metric system area of fields up to $\frac{1}{2}$ Are and in towns in hectares and sq m, nearest to $\frac{1}{2}$ sq m

(*Continued*)

TABLE 1 SUMMARY OF CADASTRAL SURVEYS IN VARIOUS STATES — *Contd*

SL No.	STATE	METHOD OF SURVEY	SCALE	ACCURACY	AREA
(1)	(2)	(3)	(4)	(5)	(6)
xiii)	Uttar Pradesh	Consolidation of holdings being done on rectangulation system.	16 in = 1 mile	—	1 *Bigha* = 3 025 sq yd (standard), and 1 936, 2 093·625, 2 526·25, 2 450·25, 2 730·625, 3 136 and 2 756·250 sq yd. In hill *bisis, nalis* and *muthis*, 4 800, 240 and 15 sq yd respectively
xiv)	West Bengal	—		Linear measurements: Plains 1 = 200 Hills 1 = 100	Unit of area 1/100 of acre on maps 16 in = 1 mile, 1/100 of cent of an acre on large scale maps. UT area and offset area to agree with total area of all plots within 1 percent, when the area is less than 500 acres and ½ percent for areas over 500 acres

TABLE 2 SUMMARY OF CADASTRAL SURVEYS IN UNION TERRITORIES

SL No.	UNION TERRITORY	METHOD OF SURVEY	SCALE	ACCURACY	AREA
(1)	(2)	(3)	(4)	(5)	(6)
i)	Andaman and Nicobar Islands	Theodolite traverse is done around entire village boundaries. Each field in the village is located. Quadrilaterals are formed and diagonal lines are run with chains. All field corners and bunds are offsetted from chain lines. All field boundary lines are measured.	1 cm = 50 m *or* 1:5 000 for village maps and 1:2 000 for maps of towns and other congested areas	Allowance permitted is 1 percent if the area is over 5 hectares	Computed to two places of decimal of a hectare in village and 4 places of decimal of a hectare in towns
		Maps show fields and other important details.			Hectares and Ares
ii)	Goa	Early maps up to 1959 prepared by plane table, chain and cross staff, based on theodolite traverse. Later maps made by triangulation, minor triangulation, theodolite traverse and details by tacheometric methods.	1:5 000, 1:4 000, 1:2 000 and 1:1 000, according to size of holding. Latest maps on 1:2 000	Minor triangulation 1:5 000 Traverse 1:1 000	Areas calculated from co-ordinates or graphically
		The co-ordinates are referred to triangulation station Agoda as origin.			

(*Continued*)

TABLE 2 SUMMARY OF CADASTRAL SURVEYS IN UNION TERRITORIES — *Contd*

SL No.	UNION TERRITORY	METHOD OF SURVEY	SCALE	ACCURACY	AREA
(1)	(2)	(3)	(4)	(5)	(6)
iii)	Himachal Pradesh	Cadastral survey by plane table, compass and sighting rod.	40 *Karam* = 1 in (1 *Karam* = 66 in)	—	Unit of area is square *Karam* or *Biswansi*
iv)	Laccadive, Minicoy and Amindivi Islands	Outer boundaries of the islands with theodolites. Islands divided into blocks surveyed with theodolite. Blocks divided into survey field of 5 acre areas. Fields surveyed with the diagonal and offset system. Cadastral maps plotted from theodolite points, blocks and field measurements.	Island maps on 1:4 000 *or* 1:2 000. Block maps on 1:2 000. Field maps on 1:500 *or* 1:1000	Theodolite work 1:1 000. Areas and linear measurements 1:100	Areas in hectares and Ares *or* Acres and cents
v)	Manipur	Theodolite traverse connected to geodetic net forms main control work. Cadastral survey of villages controlled by above.	Villages 16 in = 1 mile Congested areas 32 in and 64 in = 1 mile	Traverse 1:500, Cadastral survey 1:200	

vi) Pondicherry	Cadastral surveys and land records already in the metric system since 1912.	—	—	—
vii) Tripura	First organized settlement survey has been commenced in recent years. Area of village between 300 acres and 4 sq miles. Theodolite traverses along village boundaries connected to geodetic net. Cadastral surveys with plane table, offsets and chains. Records of rights and *Khasras* maintained. Area calculated from co-ordinates (UT) and by area-combs. Area and ownerships of holdings verified from land holders by superior officers.	Rural areas 16 in = 1 mile Urban areas 32 in = 1 mile	Main circuits 1 = 2 000 Village and sub-circuits 1=1 000 Jungle and undulating areas 1=500 Plane table survey 1=200 Hilly, Jungle 1 = 100	Village area from UT to agree with total of field areas within 1 percent *or* $\frac{1}{2}$ percent if area is over 500 acres

SUGGESTIONS FOR UNIFORMITY IN THE SYSTEM

Control or Framework — The provision of control or framework should commence with minor triangulation connected to geodetic net. Closed theodolite traverse—main, subsidiary and village traverses, 20-m and 30-m chains should be used for subsidiary control. Angular measurements should be made with theodolites reading at least to 30 seconds. Astro azimuths should be observed at every 25 or 30 stations. Computations should be done in Cassini rectangular co-ordinates with origin at the centre of each degree sheet. Distribution of errors may be done by distributing angular in direct proportion to stations, northings or eastings according to components of measured lengths.

Offset distances should not exceed 30 metres from the traverse lines.

Detail Survey — This should be done by chain and offset or by plane table, and should include survey of important topographical details so that cadastral maps can be used for compilation of small-scale maps.

Scales for surveys and maps have already been given earlier under CADASTRAL MAPS.

Standards of Accuracy Required

Linear measurements — Permissible errors are given below:

1) Main circuits, 1:1 000;

2) Sub-circuits and village traverse, 1:500;

3) Detailed village surveys, 1 : 500, subject to a maximum of 2 metres; and

4) Detailed town surveys, 1:5 000, subject to a maximum of 0·5 metre.

Unit of measurement should be 1 link (0·2 metre) for village surveys and 1 cm for town surveys.

Area measurements — Unit of area for villages should be 0·1 Are (10 sq m) and that for town areas should be 0·01 Are (1 sq m). In highly developed areas 0·1 sq m (0·001 Are), that is, 5 decimal places of a hectare should be used, the area being arrived at by calculation instead of by graphical methods.

Tolerance between different estimates of area of a plot by graphical methods should be 1 percent.

Permissible discrepancy between area calculated by the Universal Theorem method and offset areas and the area arrived at by summing up the different field areas arrived at by graphical methods (area-square, planimeter) should be 1 percent.

Instruments — Theodolites reading to 20 or 30 seconds, plane tables complete, 20-metre chains, 30-metre chains, 30-metre steel tapes, 3-metre offset rods, subtense bars and staves, traverse staves and flags, cross staffs for offsets, optical square, Abney or Hand levels for hilly country, planimeters, area-squares and acre-combs should be used as necessary.

IMPLEMENTATION OF POLICIES

The Standing Committee has held three meetings afterwards to carry out and implement the policies and decisions arrived at the All-India Cadastral Survey Conference. The progress achieved is as under:

1) Application of photogrammetry to cadastral surveys is being explored;

2) Diagonal scales, acre-combs and area-squares on various metric scales are being standardized;

3) A standard symbol table for all States is being evolved;

4) Syllabus of a 44-week training course for cadastral survey officers has been circulated to all the State Survey Organizations for comments before finalization. The syllabus is given in Table 3;

5) A bibliography of standard reference books on surveying for State Survey Organization Libraries has been drawn up; and

6) Switch over by State Governments of their maps and land records to the metric system.

CHANGE-OVER IN MANUALS, TABLES, FORMS, INSTRUMENTS, ETC

CONVERSION OF INDIAN FEET TO INTERNATIONAL METRES

The length and breadth of India has been surveyed in terms of a standard 10-foot steel bar since early nineteenth century. This bar has been compared against the international standard metre bars at different times. It has been found to have retained its length extremely well, and these comparisons have revealed that 1 Indian foot = 0·304 799 6 international metre*. As an interim measure to the revision of auxiliary tables, data pamphlets and computation forms, the sentence 'For conversion of feet to metres, use multiplying factor 0·304 799 6', is pasted in all the publications and forms. This factor is used in the Survey of India when very high accuracy is required. The following standards of lengths have been laid down in the *Standards of Weights and Measures Act, 1956**:

1 inch	=	0·025 4 metre
1 foot	=	0·304 8 metre
1 yard	=	0·914 4 metre
1 mile	=	1 609·344 metres

No change has been made in the elements of the spheroid of reference.

INSTRUCTION MANUALS

The following Topo Handbooks of the Survey of India have been revised and printed or are under print in the metric system:

Chapter III	Triangulation and Its Computations
Chapter IV	Theodolite Traversing
Chapter V	Planetabling
Chapter VI	Fair Mapping
Chapter IX	Forest Surveys and Maps
Chapter X	Map Reproduction
Chapter XI	Geographical Maps
Instructions to Planetablers	

Chapters IV and V (Theodolite Traversing and Planetabling) and Instructions to Planetablers, which deal with most of the field work required in surveying, had to be extensively revised and re-written to bring out and emphasize the various concepts in the metric system. The change-over to the metric system gave rise to many psychological difficulties for the traverser and the planetabler who were used to taking and computing linear measurements in chains and links, thinking of accumulation of errors in the fps system and contouring

*On the basis of the agreement between the United Kingdom and the USA, the present accepted value is: 1 ft = 0·304 8 metre exactly. Thus the Survey of India foot is nearly within 1 part per million of the internationally accepted and the legal Indian values arrived in 1956.

TABLE 3 PROPOSED SYLLABUS OF TRAINING FOR OFFICERS OF STATE SURVEY DEPARTMENTS

SL No.	ITEM OF TRAINING	DURATION (WEEKS)	
	A. PRE-FIELD WORK		
1.	Drawing and fusion practice	1	
2.	Use and adjustment of survey instruments	1	
3.	Projection and plotting for PT survey, triangulation chart, etc	1	
	Total duration		3
	B. FIELD SEASON		
4.	1/1 000 Chain survey	3	
5.	1/4 000 PT survey	5	
6.	Traversing, tertiary and secondary, including computations, determination of azimuth from sun and polaris	8	
7.	Levelling, tertiary and double tertiary	1	
8.	Triangulation including computations	3	
9.	1/25 000 PT survey	6	
10.	Photo verification	1	
11.	Tachymetric surveying	1	
12.	Rectangulation	1	
13.	Survey scheme	1	
	Total duration		30
	C. RECESS PERIOD*		
14.	Air survey practical including fair drawing	5	
15.	Technical theory (engineering and cadastral surveying)	6	
	Total duration		11
	Total duration (Items A to C)		44

*It is the practice in Survey of India to call the period of work done indoors at the Headquarters (as opposed to outdoors in the field) as Recess period.

in feet. The planetabler had difficulties in getting accustomed to new contour intervals, new tolerance allowed for height agreements, metric relative heights for depiction of tanks, embankments, river banks features, scarps, cliffs, mountainous features, etc, and calculation of clinometric heights in decimals of a metre. The eye and brain that has become used to one system finds it difficult to adjust itself suddenly to the other system. The transition is going to be a long and continuous process.

AUXILIARY TABLES

The Survey of India publishes the following unclassified series of Auxiliary Tables:

Part I	Graticule of Maps
Part II	Mathematical Tables
Part III	Topographical Survey Tables
Part IV	Geodetic Tables
Field Traverse Tables	

In view of the adoption of the metric system and consequent departmental decision to revise most of the scales of projection and fair mapping, Part I has been extensively revised and published. In Part II the newly adopted foot-metre conversion ratio has been adopted to prepare the concerned tables and to calculate the elements of the terrestrial spheroid, and the metric version has been published. The mathematical tables have been retained in terms of degrees, minutes and seconds for angles. Part III needed extensive changes and has been revised except for tables pending finalization of definitions of standard temperature, pressure, humidity, etc, in the standard atmosphere in the metric system. Conversion of Part IV is a simple conversion of feet and yards into metres and offers no difficulties in computations. Field Traverse Tables have also been revised to give distance in metres with 3-m and 2-m subtense bars, traverse heights and slope correction to 20-metre chains. A new pamphlet containing Metric Conversion Tables for Length and Area was published in 1959 by the Survey of India. Two other tables 'Indian Standard conversion tables for ordinary use' (IS : 1020-1957) and 'Indian Standard conversion factors and conversion tables' (IS : 786-1956) were published by the Indian Standards Institution. The former was revised in 1963 and the latter in 1967.

DATA PAMPHLETS

All new triangulation and levelling data pamphlets are being printed in the metric system. The old pamphlets are gradually being revised and printed. The practice of supplying manuscript data to indentors in the metric system is being followed with effect from 1 April 1958. In cases where data in the fps system are specially asked by our indentors, the data are supplied in that system with the appropriate conversion factors boldly entered on top of each page of the data sheets. On old pamphlets slips have been pasted on front cover giving the conversion factors.

Formulae have been worked out for calculation of probable errors of levelling from height differences in metres and distances in kilometres.

TIDE TABLES

Charts on which registration of tides is done with automatic tide gauges installed at the ports have been converted to the metric system so that heights of tides can be directly read off from them in metric values. Prediction of tides is also now done in metric values directly. The Indian Tide Tables are being published in the metric system since 1962. A separate pamphlet containing tide tables for the Hooghly River continues, however, to be published in the fps system as per requirements of the Commissioners for the Port of Calcutta (*see also* Chapter 18 Sec 7).

COMPUTATION FORMS

During the transition period, the computations have continued to be carried out in the fps system, the final result being expressed in metric terms.

Almost all the computation forms have now been converted to the metric system and many of them have been printed.

SPECIFICATIONS FOR AERIAL PHOTOGRAPHY

As the aerial photography must conform to the ultimate scale on which maps are to be surveyed and printed, the specifications for scales, flights, etc, are drawn up in metric values.

INSTRUMENTS

The policy that has been adopted during the transition period has been as follows. Whatever instruments the departments were in possession of will be wasted out gradually. Any new instruments to be obtained will have to be in the metric system. It has been decided not to introduce centesimal angular measure in surveying, mapping and computations. All other measuring devices can be used conveniently before being replaced by their metric counterparts. The conversion to metric units can be carried out at the initial stage of computations wherever necessary.

Metric specifications have been drawn up for most of the surveying instruments by the Survey of India and also by the Indian Standards Institution in consultation with the Survey of India. Their main features are highlighted below. In cases where Indian Standards have been issued, the number and title of the relevant standard has been given against each such item.

Metric Surveying Chains — conforming to IS : 1492-1959 'Specification for metric surveying chains'. Lengths: 20 metres, 100 links of 0·2 metre each and 30 metres, 150 links of 0·2 metre each. Tallies are fixed at every five-metre lengths and a small brass ring at every metre length except where tallies are attached.

Plane Tables — conforming to IS : 2539-1963 'Specification for plane tables'. The plane table boards and sight-rules are designed as large, medium and small in the following sizes:

	Plane Table Boards	*Sight-Rules*
Large	750 mm × 600 mm × 15 mm	750 mm
Medium	600 mm × 500 mm × 15 mm	600 mm
Small	500 mm × 400 mm × 15 mm	500 mm

The plane table stands are 1 250 mm in height. The material of large and medium sight-rules has to be brass or aluminium alloy and that of small ones, wood, brass or aluminium alloy.

4-Metre Levelling Staves — conforming to IS : 1779-1961 'Specification for 4-metre levelling staff, folding type'. The staff comprises two 2-m wooden pieces with the joint assembly. Each metre is subdivided into 200 divisions, the thickness of the graduations being 5 mm so that reading can be taken directly to 0·001 m.

The existing 14-foot telescopic tertiary and 10-foot secondary levelling staves are being re-graduated on the above system so that levelling observations can be done directly in metric values.

Ranging Rods — conforming to IS : 2288-1963 'Specification for ranging rods'. They are of two sizes, 2 metres and 3 metres.

Trough Compass — conforming to IS : 1764-1961 'Specification for trough compass'. The external dimensions of metal trough is 150 mm × 30 mm × 20 mm and the length of the needle 125 mm.

There is a graduated arc extending about 5° on either side of the central zero mark at each end of the compass.

Prismatic Compass, Non-liquid — conforming to IS : 1957-1961 'Specification for prismatic compass, non-liquid'. Sizes: 85, 100 and 110 mm. Magnetic moment of the needle is to be between 20 and 25 cgs units and each pole of the needle should have a flux of approximately 100 lines.

Prismatic Compass, Liquid — conforming to IS : 1955-1961 'Specification for prismatic compass, liquid'. Size 50 mm. Properties of the needle should be the same as for non-liquid compasses. Good quality kerosene, *iso*propyl-alcohol or anhydrous ethyl-alcohol is to be used as the liquid.

Metric Scales — conforming to IS : 1480-1960 'Specification for metric scales for general purposes'. Sizes: wooden scales of 10, 15, 20, 30, 50 and 100 cm and plastic scales of 10, 15, 20 and 30 cm. Wooden scales of 50 and 100 cm may be either end-measuring or edge-measuring. They are divided into tenths of a centimetre.

Metric Diagonal Scales—conforming to IS : 1562-1962 'Specification for metric diagonal scales (cartographers, surveyors and engineers)'. The scales are designated as A, B, C and D of sizes 150, 100, 50 and 150 cm respectively. The scales 'B' and 'C' have three different diagonal scales, namely, 1:100 000, 1:50 000 and 1:25 000 and the scale 'D' has 1:100 000, 1:8 000 and 1:4 000 diagonal scales. The front face of 'A' scale carries centimetre scale 1:1 along the bevelled edge and a diagonal centimetre scale 1:1 in the centre for all scales. In scales 'B', 'C' and 'D', this central scale of 1:1 also serves as a scale of 1:100 000. The back face of scales 'B' and 'C' carry two diagonal scales 1:50 000 and 1:25 000 centrally, and that of scale 'D' carries diagonal scale 1:8 000 and 1:4 000, while in the case of 'A' scale, back face is left blank.

Beam Compasses — conforming to IS : 2466-1963 'Specification for beam compasses'. Sizes 250, 500, 1 000 and 1 500 mm.

Protractors — conforming to IS : 1563-1962 'Specification for protractors for use of drawing offices'. There are three types: circular, semi-circular and rectangular. Circular and semi-circular ones are of sizes 100, 150 and 200 mm divided up to 1°, $\frac{1}{2}^\circ$ and $\frac{1}{2}^\circ$

respectively. The rectangular ones are of size 150 mm × 30 mm. In the blank spaces of these protractors, the following scales are shown:

Front face — Metric scales of 1:2 500, 1:25 000, 1:50 000 and 1:100 000.

Back face — Diagonal scale in centimetres 1:1, ordinary scale in centimetres 1:1 and ordinary scale in inches 1:1.

Paper Sizes — conforming to IS : 1064-1961 'Specification for paper sizes (*revised*)'.

Bubbles — conforming to IS : 1632-1960 'Specification for bubbles'.

Surveying Chain Pins — conforming to IS : 1842-1961 'Specification for surveying chain pins (arrows)'.

Set-Squares — conforming to IS : 1561-1962 'Specification for set-squares for use of drawing offices'.

Crinoline Chains — Sizes: 100-m and 110-m.

Steel Bands — Sizes: 20-m and 30-m.

Subtense Bars — Size: 2-m cum 3-m bars.

Precision Invar Metric Staves — These are 3 metres long. These can be read up to 0·1 mm by the help of parallel plate attachment to precise levels.

HEIGHT INDICATORS

These have been drawn for computation of clinometric heights in metric values on scales 1:50 000 and 1:5 000. The former indicators can also be used for surveys on scales 1:25 000 and 1:100 000 and the latter ones additionally for scales 1:2 500 and 1:10 000. Scales have also been drawn for calculation of corrections for curvature and refraction in metres.

SURVEY EDUCATION

A phased programme of change-over to the metric system in technical institutions has been drawn up. Measures taken for speeding up the change include assisting the technical institutions in adopting or changing the existing machinery and equipment, providing financial assistance and foreign exchange for importing replacements and components for conversion and assisting authors for writing text-books in the metric system. In addition to the technical institutions, all State Governments and technical educational authorities are kept posted with the recommendations and decisions arrived at from time to time. They are giving great fillip to the switch over in the shortest possible time.

All training in the Training Centre of the Survey of India is now being imparted in the metric system.

CONCLUSION

The metric system, with all the accompanied complicated problems affecting surveys, maps and land records, is generally considered a welcome change. Although the task is enormous and a complete change-over would inevitably take some more time, good progress has been made in settling the fundamentals of the change-over and actual implementation of the policies. The trade and industry are showing great enthusiasm, and the Central Government, in collaboration with the States, is doing all it can to complete the change-over in minimum possible time. All attempts are being made to reduce the transition period. The change-over is timely and perhaps a blessing in disguise, for it has afforded an opportunity to bring up-to-date, on the basis of a unified and accurate system, many surveys, maps and land records which were either out-of-date due to rapid development plans and re-organization of States, or were inaccurate and old, or were unsurveyed altogether. It is hoped to continue to tackle this project with the improved and advanced methods of surveying and reproduction available to us within a much shorter time than we visualized before. □

18

Specialized Area Problems

18.1 Education

V. B. Mainkar

A reform that has as its objective the eradication of old ideas and their replacement by new ones creates its own special difficulties. The necessary mental formulae for use in transactions are usually developed through generations and handed down for daily use. For the older generations it is, therefore, somewhat difficult to discard the old concepts and to accustom themselves to the new ones, even if the new ones happen to be much simpler and more easily understood than the old ones. The principal reason is the reluctance of the moulded mind to inculcate new ideas. The education of the mature mind is always a more difficult task than that of the young and more flexible mind. It can be achieved only through the constant and conscious use of the new concepts in daily life. This leads to the evolution of new mental formulae for calculations, which again form the basis for the practical use of the new system. This process has, however, to be spread over a few years. Today, after ten years, the older generation has evolved its own formulae and many of them find these formulae simpler than the older ones.

With the younger generation, however, such difficulties of mental adjustment do not exist. In a fundamental reform like that of weights and measures which goes to the very base of human progress and civilization, the younger generation should be secluded and sheltered from the older discarded influences so that they can be brought up in an atmosphere where, right from the beginning, words like kilogram, litre, metre and other similar terms fall constantly on their ears, and their mental abilities are developed by constant exercise of their talents in terms of the new units. It is this insulation of the younger generation from the past that deserves the attention of the older, if the reform of weights and measures is to be a success.

PRIMARY AND SECONDARY EDUCATION

In education the principal figure is that of the teacher. He normally belongs to the older generation but has to bring up the younger generation to which he has to impart the new concepts. He has, therefore, first to learn for himself the new units and methods of their use and to devise suitable exercises which will bring out the significance of the new system for the children.

In the early stages of the metric reform the key role of the teacher was recognized and the Ministry of Education brought out pamphlets indicating to the teachers how the decimal coinage and metric units of weights and measures could be used in teaching. These authoritative pamphlets were widely appreciated by teachers. They enabled teachers to devise exercises for students on the basis of principles described in them.

TEXT-BOOKS

The second difficulty which the educationists, particularly in the primary and middle schools, felt was that of text-books. Unlike college students, every school student is expected to have his own text-books. The text-book is the basic medium of communication between the school teacher and the student. It was obviously necessary to revise text-books so that the teaching of the metric system could be facilitated. In order not to upset examination programmes suddenly, and at the same time not to do away with the knowledge of old units which were then in use, it was decided that all the text-books should have, as a first step, an additional chapter dealing with metric units, the principles of decimalization and the use of these in mathematics and other subjects. The text-books were revised by the addition of a new chapter on metric units. In the meantime, the introduction of metric weights and measures in all spheres was proceeding apace. The use of old measures was made illegal, one after another, within 2 or 3 years. After this, the need to teach the old systems side-by-side with the metric system was not so pressing as a few years earlier. (This step proved to be unnecessary in the light of experience and is discussed more fully later.) The text-books could now be completely revised to omit all references to units other than metric.

FULL ADOPTION

This was the second stage of the change-over in school education. This stage was much more comprehensive than the first one. The educational authorities in the States revised the entire curriculum for subjects which involved the use of weights and measures, such as mathematics, geography, science, cookery and home science. On the basis of this revised curriculum, text-books were revised and approved for use. The curricula demanded the preparation of text-books only in metric units to the total exclusion of the older units. Text-book writers were given necessary guidance by the Union Ministry of Education through the publication of guides for text-book writers, so that the appropriate units, their abbreviations and principles of usage would be observed uniformly all over the country. The task of the change-over in the teaching and publication of new text-books for schools has now been completed and almost all the schools in the country are teaching subjects like mathematics, geography and others, only in the metric system. The question papers are also set only in metric units. The use of the fps units, as also the old Indian systems, has been discarded so far as school education is concerned. The younger generation, as it grows up, will now be accustomed only to metric units and would not have to waste its time in learning other systems of weights and measures.

TECHNICAL EDUCATION

While the change-over in the case of school teaching was in progress, the change-over in technical education was also being effected. A conference of representatives of the various universities, engineering and technical colleges and institutions, Ministry of Education, Ministry of Commerce and Industry and others concerned was held on 23 October 1960 under the chairmanship of Shri M. S. Thacker, then Secretary, Ministry of Scientific Research and Cultural Affairs. This Conference recommended a three-phase programme for the introduction of metric teaching in technical education. The normal duration of engineering and technical courses in India is five years. In order to give time to the teachers to prepare lecture-notes in the new system and to allow time for the calibration of the various instruments in metric units, and where it was not possible to do so, to prepare conversion tables, the programme was devised to start over a year and a half after the Conference.

It was decided that the first two-year classes of technical education should change over to the new system of teaching with the academic year commencing from July 1962, the third and fourth years in 1963-64 and the fifth year in 1964-65. This programme was expected not to upset the education of students already in the colleges.

It was further recommended that the instruments in use should be re-calibrated and new instruments should be purchased only if they were calibrated in the metric system.

It was also decided that steps should be taken to encourage the production of text-books either by translation from French, German, Russian or other languages, or by adaptation of English text-books.

Finally, it was suggested, and later agreed to by the Union Public Service Commission that from 1970 onwards, the metric system would be exclusively used for the all-India engineering examinations. In the intervening period, both the fps and metric units would be permitted.

IMPLEMENTATION

The programme of introduction of the metric system in technical education, as drawn up by the 1960 Conference, was implemented by a large number of technical colleges, and with the beginning of the academic year 1967-68, all the colleges are giving instruction in metric units, except a few which might be using both the fps and metric units. The reasons for this duplicate teaching are many. For example, certain colleges did not re-calibrate the instruments in time. Some, imparting instruction in civil engineering, put forth the plea that the Public Works Departments, for instance, in their States, had not changed their schedule of rates, manuals or calculations. These were, of course, temporary difficulties which have been substantially overcome. With the metricization of the bulk of Indian Standards for raw materials, engineering items, codes of practice, by-laws, methods of test, etc, difficulties faced by the colleges in the technical change-over have been minimized.

Text-Books — The principal difficulty, however, has been in the field of text-books. As recommended by the 1960 Conference, the Government of India encouraged the writing of text-books by Indian authors to suit Indian conditions. It offered to the writers assistance by way of stationery, engineering drafting, typing, etc, so that books compiled by Indian authors could become available in good time. The work of adaptation of English books was also taken in hand while some authors preferred to translate books from German, French, Russian, etc, into English. By and large, it may now be said that the tempo of the availability of text-books on engineering subjects written by Indian authors, taking into account the Indian conditions, raw materials, practices, etc, is on the increase. However, the pace needs to be further accelerated if the change-over is to become fully effective within the next few years.

The Government of India on its part has been entering into agreement with certain foreign publishers for publishing some of the well-known technical text-books in cheap editions in India. While such books could be published in the original form without any change in the case of literary works and the like, care has been exercised that technical text-books should be printed only after they had been written or adapted to the use of metric units. The picture today is that while the Indian effort in the field of production of technical text-books is gathering momentum, there is also a parallel effort to adapt foreign books to Indian conditions, which supplements the former.

Système International d'Unités (SI) — During the last 150 years, many efforts have been made to adopt a coherent system of units which could be used by all countries. In 1960, the *Conférence Générale des Poids et Mesures* (CGPM) adopted what is now known as the *Système International d'Unités*, called SI, in which six fundamental units and a number of secondary, derived and supplementary units are included (*see* Appendix 1). The six fundamental units are for length, mass, time, electric current, scale of temperature and luminous intensity. These units were included in the *Standards of Weights and Measures Act* in 1956, in anticipation of their acceptance by the CGPM.

After 1960, the CGPM considered the principles of the use of the SI units for various purposes. Agreement on this point is in sight. While the teaching of the metric system in India does cover knowledge of SI units in schools and colleges, their incorporation in text-books and their comprehensive use would have to await international agreement on their selection for various purposes, the mode of their use and other relevant points. As soon as agreement is reached, it would be possible to revise the text-books again to incorporate their use on a long-term basis with benefit to the country.

HANDBOOKS, MANUALS AND REFERENCE BOOKS

There is a peculiar technical problem which needs immediate attention. Indian students and technologists are using fps-based handbooks, manuals, reference books, etc. Such books, besides being written in fps units, additionally refer only to the specification of the country of publication. With the adoption of the metric system, the utility of such books has become limited. India has standardized raw materials, semi-finished materials, parts, components, codes of practice, methods of test, etc, in metric units. All these standards have to be used in practice. There is thus a divergence between what is practical and what is given in foreign handbooks and reference books. The solution is to compile our own reference books based on Indian specifications and practices. The Indian Standards Institution (ISI) has already published a few handbooks in the field of structural engineering and has plans to publish others. But ISI cannot hope or attempt to cover all fields of engineering. It is, therefore, necessary that competent bodies like the Institution of Engineers (India), the Institution of Chemical Engineers, the Institution of Telecommunication Engineers, the National Institute of Sciences and some of the National Laboratories and Universities should take up the responsibility of compiling one or more such reference books and create a facility which will be appreciated by the engineering profession of India generally.

CONCLUSION

It may be stated that the adoption of the metric system in schools is, more or less, complete and the change-over in technical education would be completed within the next few years. It is necessary at this stage to draw certain lessons from our own experience which may guide us and others in the future. In school education the addition of a chapter on the metric system merely led to the increase of the workload on the children. Besides learning the existing systems of weights and measures and solving examples based on them, they had to learn the new metric system and its principles. By the time the chapters were written and introduced in the text-books the enforcement of the metric system had proceeded so far that the use of old units had become illegal throughout the country. The interim facility of an additional chapter on metric units was useful only for a very short duration. It would be more desirable to proceed with the complete revision of the curriculum and re-write the text-books only in terms of metric units. In the case of technical text-books also considerable vigilance should be exercised to ensure that the appropriate metric text-books are available to the students in good time. The insistence on the teaching of metric as well as British units by certain colleges is not very desirable as it merely doubles the load of work on the students.

The principal lesson is that in the field of education it is necessary to devote very early and urgent attention to technical publicity and compilation of text-books for the teachers so that metric units and, if possible, the SI units, are used uniformly and in appropriate contexts all over the country. Additionally, it would be necessary to publish at least the most essential handbooks and manuals based on the national standards of the country, brought up-to-date in terms of the metric system. In the absence of such guidance the modern developments in technology would not reach the students at the appropriate time. There is no reason to assume that even in a vast country like India, the technical change-over in engineering education, though difficult, could not be achieved successfully within a reasonable period of time. □

18.2 Official Statistics

S. Subramanian

A change in the system of measurement in any country necessarily has a far reaching effect on the statistics of that country to the extent they depend on complex quantitative observations as distinct from simple counting or description. The change entails not only the collection of current data in the new system and alteration of the forms and schedules for the purpose but also conversion of past data into the new system for purposes of presentation and publication in the shape of time series. An important prerequisite for starting the collection of data in new units is the actual use of such units in the various sectors of the country's economy from which the data are to be collected. It should be clear that conversion of past data into the new system for comparative purposes could become meaningful only after the collection of current data begins on the basis of the new system. Presentation of data also implies proper sifting, sorting and collating of the information collected from various quarters. A programme of change-over involving not only vertical phasing (by type of measure, that is, weight, length and capacity affecting different commodities or characteristics at given points of time) but also horizontal phasing (by geographical areas affecting same commodities or characteristics at different points of time according to location) apparently poses further difficulties in matters of collection and consolidation of data. The difficulties would be aggravated if certain activities are given a conversion holiday within a given phase.

Such were the circumstances in which statisticians in India were required to adopt the metric system of weights and measures in official statistics. For a proper appreciation of the setting in which the change-over in official statistics took place, the difficulties encountered and the steps taken, it is necessary to recount briefly the process of change-over in the system of weights and measures in India from the conventional fps system to the metric system. The decision to adopt the metric system was taken by the Government of India in April 1955 and legislation to give effect to this decision was introduced in Parliament in August 1956. The *Standards of Weights and Measures Act, 1956* which was thus enacted in December 1956 allowed a transitional period of ten years for complete change-over.

ENACTMENTS

The Meteorological Department began using the metric system for recording data and publishing weather reports in January 1957, even before the law began to be widely enforced with effect from 1 October 1958. The purchase of raw jute and sale of jute products on metric basis had begun from 1 July 1958. The decimal coinage was introduced in the country on 1 April 1957 and the first phase for the enforcement of the *Standards of Weights and Measures Act, 1956* commenced from 1 October 1958, when the areas, industries and Government departments to which the Act became applicable were notified, making a beginning with the introduction of metric weights. The usage was kept optional for two years, that is, up to 30 September 1960, during which period both the old and the new systems of weights could be used simultaneously. To begin with, the law was applied to the purchase and sale of goods. However, even this did not uniformly cover all areas, commodities, industries and Government departments. For example, the law was not made applicable to the Railways, post offices, the customs houses or the excise department during the two-year option period. However, one implication of the notification enforcing the *Standards* *of Weights and Measures Act, 1956* with effect from 1 October 1958 was that Government departments were authorized to adopt the metric system in respect of studies or publications of technical, scientific and marketing data.

PHASED PROGRAMME

It would thus be seen that the transition period for adoption of the metric system of weights and measures was diffused in more than one direction. While this gradual phasing was necessary in the interest of smooth change-over, it did pose practical problems to the statisticians in respect of formulating a programme of uniform collection and publication of statistics, since statistics in different fields of economic activity had to cut across many areas, industries and governmental transactions, where, in respect of some, the old system continued to be prevalent, while in others the new system was introduced. However, when once the decision to adopt the metric system in the country was taken, it was inescapably necessary for the statisticians to keep pace with the changing times, to smoothen out the difficulties in the path and generally to so organize their affairs during the transition period as not to lag behind in the adoption of the metric system in the current statistical publications. It was, therefore, necessary to draw up a plan for the conversion of statistics to the new system quickly in consultation with the statistical departments concerned so that this plan could be a part of the national plan for the adoption of the metric system and the statisticians could move at the same pace as others working in the fields to which the statistics referred.

CONFERENCE OF STATISTICIANS

The question of drawing up a programme for the conversion of statistics to metric units, in fact, began receiving active consideration even before the enactment of the *Standards of Weights and Measures Act, 1956*. The Standing Metric Committee in the then Ministry of Commerce and Industry which had the overall responsibility for the change-over had recommended broadly that after the metric system was established by law, all official statistics would ultimately have to be in terms of metric units and that the statistical departments concerned be asked to draw up a practical programme for the conversion of statistics to the metric system.

The subject was, therefore, brought up before a Conference of Central and State statisticians held in Lucknow in November-December 1956. According to the phased programme considered by the Conference, firstly, the intention to use the metric system of measurement progressively in official statistics was to be prominently announced in all statistical publications. Secondly, as soon as possible, after the Indian Standards of Weights and Measures Bill, 1956 became law, at least selected aggregates in all official statistical publications were to be given in both systems of units, namely, the units then prevailing and metric units respectively. Thirdly, from the date the metric system was brought into force in a particular field of activity, all statistics relating to that field should be expressed in metric units. The main aggregates would, however, continue to be expressed in both the systems. Finally, by the end of the transition period all statistics would have been converted to the metric system of measurement, but the main aggregates would continue to be expressed in both the systems for some time more.

MINIMUM PROGRAMME

As decided at the Conference, a Working Party comprising representatives of the State statistical bureaux, statistical offices of the Central Ministries, the Indian Statistical Institute and the Standing Metric Committee was set up by the Central Statistical Organization, with the author as Chairman, for framing what was called a minimum programme for putting through the reform. The Working Party, after a detailed examination of the facilities available as well as the difficulties in the way, recommended that the following steps should be taken effectively from April 1957[1]:

1) The statistical series in respect of values, prices, rates, etc, hitherto expressed in rupees, annas and pies, should, in future, be expressed in rupees to two places of decimals, the figure to the right of the decimal representing *naye paise*; and

2) Quantities and dimensions (as, for instance, areas under crops, crop yield, industrial production, etc) can continue to be expressed in the prevailing units till such time as the metric system has actually been introduced in the concerned field, but all

aggregates and summary figures should, in anticipation, be expressed also in the corresponding metric units.

The above minimum programme recommended by the Working Party was communicated in early May 1957 to the different statistical offices of the Central Ministries and the statutory bodies, such as the Indian Central Cotton Committee and the Indian Coffee Board, as also to the State statistical bureaux. The ready response that it drew was highly encouraging. Thirteen important statistical offices at the Centre and an equal number of statistical bureaux in the States and Union Territories communicated their immediate concurrence to implementing the programme. By the end of 1958 some of the statistical offices had already brought out their first publications on the new pattern and others were gradually falling in line.

EXPANDED PROGRAMME

The issue of a notification under the *Standards of Weights and Measures Act, 1956,* allowing simultaneous use in the specified areas, industries and Government departments of old and new units for a period of not more than two years from 1 October 1958 after which metric units were to become compulsory, introduced a new factor in the situation. It became clear that implementation of merely the minimum programme recommended by the Working Party would not be enough; more vigorous steps towards conversion of statistics into metric units were called for. Luckily, one of the major difficulties in showing particular statistical series in metric units before the metric system had actually been introduced in the concerned fields would disappear with the phased implementation of the Act. It was agreed in this context that the statistical offices which had not been able so far to implement the recommendations of the Working Party owing to practical difficulties should now try to implement them expeditiously and that as in the case of decimal currency, all statistics in such other fields where the metric system came to be legally adopted, should be published in metric units soon after the introduction of this system. This would also apply to the collection of the primary data in metric units in these fields. In the remaining fields, the minimum programme recommended by the Working Party would continue to be applicable. In fields where the metric system is adopted, efforts should be made to bring out particular series in new units for as many back years as possible, say, for a period of 10 years.

In the period that followed, swift progress was made in adopting metric units in statistics and a sizable portion of statistics published was converted into the metric system by the end of September 1960. During the transition, that is, the period of two years between 1 October 1958, when the law began to be enforced, and complete change-over to the metric system after 30 September 1960, when it was considered desirable to publish data in both the units, the major difficulty was that the format of statistical publications was found unsuitable for accommodating simultaneous presentation. The solution ultimately adopted in such cases was to publish only the aggregates in metric units, invariably appending a conversion table to facilitate expressing metric equivalents of the published figures and, at the same time, keeping an eye on the ultimate aim of complete switch over to the metric system.

CONVERSION OF PRIMARY DATA

The problem was not merely of conversion of data reported in old units into metric equivalents but also of starting the collection of new primary data in metric units. To avoid undue hardship to the reporting agencies, it was necessary to synchronize this step with the progressive usage of metric units in the concerned field of economic activity. This step had to be more carefully planned in the case of statistics collected under statutory regulations, where suitable notifications had to be issued by the Government for furnishing the statutory returns in metric units. Collection of primary data in metric units also simultaneously required intensive training of the concerned field agency staff.

TECHNICAL FOLLOW-UP

The transition period was also utilized for making certain analytical studies of the effect of the change-over. For example, in expressing the old currency of rupees, annas and pies into their rupee-*naye paise* equivalents, the official conversion table prepared for the purpose did not give exact *naye paise* equivalents in all cases. When quotations had to be so converted and used for certain derived statistics, such as cost of living (consumer price) index numbers and wholesale price index numbers, the process of conversion and rounding was popularly believed to introduce a certain bias. The problem was studied in the Central Statistical Organization, and it was observed that the magnitude of such bias was in general negligible[2].

CONCLUSION

Although the law to adopt the metric system was enacted in December 1956 and its phased implementation started in October 1958, a decade had been allowed for complete adoption of the system in all branches of economic activity. Central and State statisticians gave an early lead for conversion of statistics into the metric system. The thinking process started even before the enactment and much ground had been covered by the time the first phase of enforcement started in October 1958. The tempo of active planning was maintained and the process of sorting out the difficulties encountered continued throughout the transition period. The statisticians in their own sphere kept firmly in step with the gradual enforcement of the metric system in the Indian economy and a complete switch over to the metric system in statistics was accomplished, by and large, ahead of the time schedule.

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18.3 Tariffs

D. P. Anand

Adoption of the metric system in the field of customs and central excise taxation was, to a large extent, dependent upon the progress in this direction made by trade and industry. This was so because any commodity taxation system should, as far as possible, follow, and be in line with, the normal standards and arrangements in trade and industry. At the same time, the change-over in the tax system could not lag behind unduly. A few years had, therefore, to pass before we could think of making changes in the Customs and Excise. It was decided in 1959 to change over to the metric system with effect from 1 April 1960. This was announced in a press note issued on 1 October 1959. However, as the trade and other interests desired some more time to elapse before effecting the change-over, their wishes were accommodated and a second press note, issued on 22 November 1959, announced that the change-over would take place about August 1960. It was finally decided to effect the change from 1 October 1960.

LEGISLATION

As customs and central excise duties are levied on the authority of laws made by Parliament, legislation had to be undertaken to amend these laws suitably before the Department could change over to the metric system. The central excise duties are levied mainly under a schedule to the *Indian Central Excise and Salt Act, 1944*, and the customs duties mainly under the schedules to the *Indian Tariff Act, 1934*, and under various cess Acts. Two amending bills were, accordingly, introduced in the *Lok Sabha*— the Central Excises (Conversion to Metric Units) Bill, 1960, on 8 August 1960 and the Customs Duties and Cesses (Conversion to Metric Units) Bill, 1960, on 17 August 1960. The first bill carried the following statement of objects and reasons:

> 'As a further step towards the introduction of the metric system in the country, it is proposed to amend the *Central Excise and Salt Act, 1944*, and other allied Acts which provide for the levy and collection of central excise duties. It is not, however, possible to adopt the exact equivalents of the existing units and rates in the metric system, since such conversion would result in odd fractional rates in a number of cases, and operation of such rates will be inconvenient both to the assessee as well as to the administration. It is, therefore, proposed to round off the rates resulting in minor variations thereof, but the overall effect of such variations would be insignificant. It is also proposed to avail of this opportunity to re-arrange the existing items of the central excise tariff on a more systematic basis.'

The statement of objects and reasons for the second bill also emphasized that while it was not possible to adopt the exact equivalents of the existing units and rates in the metric system, since the exact equivalents would, in most cases, run to many places of decimal of a *naya paisa*, rendering the assessment and collection of the duties needlessly arduous, it was proposed to round off the rates with minor variations so that the overall effect of such variations would be insignificant. The bills were, therefore, really conversion bills rather than revenue measures. Both the bills provided that the changes would come into force from a date to be notified in the official gazette.

In converting the rates of duties, due regard had also to be paid to the inter-relationship between different comparable commodities or different grades and qualities of the same commodity to ensure that this inter-relationship did not get unduly disturbed. This was particularly necessary in Central Excise as it is a tax on local production. On the Customs side there was another type of complication in our international agreements. Besides the UK-India

Trade Agreement under which preferential rates are allowed for imports from the UK and the British Colonies, we are also a signatory to the General Agreement on Tariffs and Trade. Under the latter Agreement we are bound to certain maximum rates, or margins between standard and preferential rates, of import duties on a number of commodities. For some items of import both the preferential arrangement and the GATT arrangement apply. In fixing the new rates it was necessary to ensure that neither of these was disturbed. These requirements were also taken care of by keeping the variations in rates on conversion to the metric system to the minimum.

The method adopted was to round off to the nearest convenient *paisa*, rupee or other unit. A further refinement to achieve the same result of minimum change with maximum administrative convenience was to have a larger unit of measure for applying the rate of duty. For instance, the pound and the gallon were replaced in many cases by the quintal and the kilolitre, with the result that the rate of duty could be rounded off more conveniently to a neat figure which would not involve too many detailed fractional calculations and yet the tax burden would remain at about the same level. Incidentally, in many cases the larger unit was also found to be the standard unit in production or wholesale trade.

PREPARATION AND IMPLEMENTATION

The principal aim of the Department throughout this operation was to ensure a smooth change-over avoiding undue inconvenience or cost to trade and industry and administrative complications. This aim, we feel confident, was fully achieved. This was possible because of two important steps that were taken — adequate notice was given to trade and industry at different stages, and secondly, during the transitional period, the Department accommodated individual difficulties, and departmental arrangements were adjusted to the convenience of the public.

Reference has been made earlier to the two press notes that were issued in 1959 notifying to the public Government's intention to effect the change-over to the metric system in the Customs and Central Excise Departments sometime during the following year. Thereafter, even while the legislative measures were being considered, formulated and put through, adequate consultation with representatives of trade and industry was instituted through the customs houses and the Central Excise Collectorates. For instance, the Customs Advisory Committees at the major ports, presided over by the Collectors of Customs, and on which organizations of trade and industry like the Federation of Indian Chambers of Commerce and Industry, Associated Chambers of Commerce and Industry, etc, are represented, discussed the various practical arrangements that would have to be made and the difficulties that would have to be faced and resolved well in advance of the actual change-over.

One of the very first results of these consultations was the decision of Government to postpone the change-over from 1 April 1960 to a later date, which, as stated earlier, was finally fixed for 1 October 1960. The trade was consulted on various matters concerning documentation and equipment. Details of how the registers were to be maintained by licensed manufacturers of excisable commodities, how invoices from foreign suppliers for imported goods as also invoices for our own export goods should be prepared and how declaration should be made on the assessment documents like bill of entry, shipping bill, etc, were all discussed with representatives of trade and industry and settled. It was also arranged to provide conversion tables and ready reckoners for use in making assessments, particularly during the transitional period. The Indian Standards Institution extended us considerable help in preparing some of these conversion tables.

The cost factor could not be totally avoided in the field of equipment. All attempts were, however, made to keep the cost of replacing equipment to the absolute minimum. Weights and measuring instruments had to be replaced not only by manufacturers and other organizations but also by the Department itself. This was, however, allowed to be done gradually, items being permitted to be replaced, as far as possible, in the normal course. A major earner of customs and excise duties is petroleum with its products. These are generally stored in tanks which are calibrated to measure the total capacity and also the quantity of product stored at any given time. The re-calibration of these tanks under the metric system was taken in hand and completed on a phased basis.

Even with all these notices and advance preparations, difficulties could and did arise here and there, but these were solved promptly, sympathetically and in a manner which caused least inconvenience to the trade. For instance, even after the metric system was brought into force, certain tea factories had weigh-scales under the old system. These were allowed to be used, and the weights which were read off these scales converted to the metric system with the help of conversion tables. Packings also created some problems. Factories manufacturing paints and varnishes had tins for packing varnish in gallons. They were allowed to use up these tins, and assessment was made with the help of conversion tables. Similar was the case with sugar or cement, where packing was being made in hundred-weights. Exports in long ton measures were also allowed to be made during the transition.

This smooth change-over was possible because the Central Excise staff is spread throughout the length and breadth of the country and they were alive to the nature of the problems and the types of solution they were expected to find. Administrative instructions, classification and other rulings, and the direction and close supervision of senior officers during this period, helped in ensuring this constructive approach at all levels of officers and staff.

CONCLUSION

It is not necessary for me to stress that the change-over to the metric system has proved very beneficial. It has greatly simplified calculations and the administration of the customs and central excise tariffs generally. The experience has also shown that, given the desire and determination for the change, even a major change like this can be effected without any undue inconvenience or cost, if the concerned trading and industrial interests and the Department's own officers and staff are adequately prepared for it in advance through mutual consultations, issue of timely instructions and proper emphasis on the need for co-operative effort. □

18.4 Meteorology

L. S. Mathur

Since the beginning of meteorological observations in India in 1796, the British or the fps system of units had been in continuous use. Surface temperature was read and reported in degrees Fahrenheit, pressure in inches of mercury, wind speed in miles per hour, rainfall in inches and cents, etc. As is well-known, the fps system of units was also in use in a number of other countries with which meteorological data had to be constantly exchanged. The change-over, therefore, had necessarily to be gradual, although the scientists the world over had long recognized the suitability of the universal use of the metric units for scientific work.

A noteworthy but curious exception, even among countries using the fps system, was that all upper air temperatures, pressures and wind speeds were taken and reported in the metric system from the very beginning of these observations.

The first important step to introduce the metric system of units in India was taken during World War II, when it was decided to discontinue the practice of reporting atmospheric pressure in inches of mercury. From 1 January 1943, the India Meteorological Department adopted the metric unit of millibar (10^3 dynes per sq cm) for reporting pressure.

INTERNATIONAL RECOMMENDATIONS

The Commission for Synoptic Meteorology of the World Meteorological Organization (WMO) at its first session in Washington (April 1953) recommended that:

1) degrees Celsius be used for coding temperatures in all upper air reports; and

2) in coding surface temperatures for international exchange of information, degrees Celsius be accepted in principle.

This recommendation was further endorsed by the Second Congress of the WMO (Geneva, April-May 1955) which in its Resolution 28 decided to adopt degrees Celsius in principle for temperature values and the metric system of units for the evaluation of all other elements in meteorological reports for international exchanges. Accordingly, the India Meteorological Department adopted the metric system of units in all meteorological reports for international exchanges, with effect from 1 January 1956. For this purpose, the meteorological offices disseminating meteorological information were required to convert the meteorological reports received by them from the various observing stations into metric units before they were broadcast. This was the second important step taken by the Department to introduce the metric system of units.

GENERAL ADOPTION OF METRIC UNITS

After the Act for the adoption of the metric system in India was passed in December 1956, the Government decided that the date of statutory introduction of metric units in India should be 1 April 1958. However, for special reasons referred to below, the India Meteorological Department decided to adopt in full the metric system about a year in advance, namely, from 1 January 1957.

The Special Committee of the International Council of Scientific Unions adopted a co-ordinated scientific programme of collection and processing of geophysical data of the world during the period 1 July 1957 to 31 December 1958. This period had been designated as the International Geophysical Year. Noting its importance, the Second Congress of the WMO urged the meteorological services of the world to participate actively, to the greatest possible extent, in this programme which envisaged collection and processing of co-ordinated meteorological and other geophysical data on global basis. If the India Meteorological Department had adopted metric units in their observational practices from 1 April 1958, so as to make the change coincide with the adoption of the metric weights and measures in the country, the data collected for the International Geophysical Year would have been in two different units, namely, from 1 July 1957 to 31 March 1958 in fps units and from 1 April 1958 to 31 December 1958 in metric units, giving rise to a number of avoidable complications and extra work in the preparation of annual averages of rainfall, temperature, etc, for the year and their scientific studies. In order to avoid this difficulty and to give itself a comfortable margin for change-over, the India Meteorological Department decided to adopt metric units from 1 January 1957 instead of from a later date.

PROGRAMME FOR CHANGE-OVER

The change-over implied the recording of temperatures in degrees Centigrade instead of degrees Fahrenheit, rainfall in millimetres instead of inches and cents, heights and distances in metres instead of feet from 1 January 1957.

The actual change-over was, however, not as simple as it might have otherwise appeared. It meant replacement of the various instruments at all the observatories and rainfall stations in the country with those directly reading in metric units. At the end of 1956, the network of meteorological observatories comprised about 380 surface observatories, 53 pilot balloon observatories, 200 hydro-meteorological observatories, 12 radiosonde/radio wind stations and one principal agro-meteorological station. In addition to these, there also existed about three thousand rain-gauges and a number of agro-meteorological stations belonging to States but functioning under the technical guidance of the Meteorological Department and 100 selected ships taking meteorological observations over high seas. It would have been best to replace simultaneously all the instruments graduated in fps units at the various observatories by instruments graduated in metric units. However, this was not feasible as instruments reading in metric units were not immediately available and their replacement could only be done in easy instalments. A phased programme was, therefore, followed.

PHASE 1: FROM 1 JANUARY 1957

Suitable conversion tables were supplied to all observatories for reporting data in metric units although actual observations were still taken with instruments reading in fps units. Tables giving climatological normals in metric units were supplied to meteorological offices for their daily work.

PHASE 2: FROM 1 MARCH 1957

1) *Thermometers and Measure Glasses in Metric Units* — Four thousand different types of thermometers graduated in degrees Centigrade and 1 000 new measure glasses graduated in millimetres for the measurement of rainfall for supply to various observatories and selected ships were purchased. These instruments were calibrated in the Instruments Division of the India Meteorological Department at Poona and supplied to various observatories and selected ships.

2) *Modification of Anemometers* — The anemometers which were installed at the observatories gave wind speeds in miles per hour. To enable readings to be taken in metric units, it was necessary to change the worm-gear and the front-plate of the instruments. These instruments from different observatories were recalled in convenient batches and replaced after completing the necessary modifications at the departmental workshops.

3) *Open-Pan Evaporimeters* — The hook gauges reading in inches and hundredths of an inch (fixed with open-pan evaporimeters) were replaced in stages by new gauges reading in millimetres.

4) *Charts for Self-Recording Instruments* — The charts for thermographs, self-recording rain-gauges, anemographs and microbarographs were originally graduated in fps units. New charts for all these instruments reading in metric units were designed and printed.

Besides the above, the change-over necessitated the purchase of some special machinery in metric units for the departmental workshops at Poona and Delhi, the preparation and printing of hygrometric and barometric tables in metric units and the introduction of metric units regarding receipt, issue and accounting of stores.

RAINFALL ORGANIZATION

In addition to the observatories maintained by the India Meteorological Department, there are about 3 500 rain-gauge stations maintained by the State Governments, under the technical advice of the Meteorological Department. With the change-over to the metric system, the rainfall records printed by the State authorities had also to be changed from inches to millimetres. This was effected in the States of Assam and Himachal Pradesh from 1 January 1957, while the rainfall registration authorities in the other States agreed to the change-over with effect from 1 January 1958. As the supply of measure glasses, calibrated in millimetres, to all the rain-gauge stations was not immediately possible, the records are being converted from inches and cents to centimetres and millimetres before publication and use. It is, however, hoped that the physical replacement of all the measure glasses, calibrated in the metric system, at the various rain-gauge stations would be completed soon.

METEOROLOGICAL REPORTS FOR AVIATION

With the concurrence of the Civil Aviation Department of the Government of India, supply of meteorological information in metric units to aviation interests, namely, Aircraft Commanders, Air Traffic Control Units, etc, was introduced from 1 September 1957. It may, however, be stated that many air services and also the Indian Air Force could not agree to an immediate change-over as their aircraft had British instruments and they, therefore, desired that information may be made available in both the metric as well as the British systems. To meet this difficulty meteorological information was also supplied to aircraft in British Units on request-reply basis.

METEOROLOGICAL INFORMATION IN NEWSPAPERS AND OVER RADIO

From 1 January 1957, the weather reports supplied to newspapers for publication were given in metric units. However, to make the public familiar with the new units of temperature and rainfall, arrangements were made to add a foot-note along with the meteorological reports explaining the conversion of degrees Centigrade into degrees Fahrenheit and rainfall in millimetres into inches and cents. Arrangements were also made for some years for the publication of the rainfall and temperature values both in the metric system and the fps system, so that the general public could gradually get accustomed to the metric system of units. This practice was continued for well over six years, up to May 1963.

An interesting aspect of the introduction of the metric system in meteorological reports published in newspapers was the initial strong and adverse reaction by correspondents in the papers. Letters appeared condemning the adoption of Centigrade scale for reporting temperature. A number of enthusiastic people came forward with formulae for conversion of Centigrade temperature readings to the Fahrenheit scale and some went to the extent of proposing new scales of temperature. Some objected to the change-over because, according to them, the body temperature was measured in Fahrenheit scale and even a change of 0·1° was felt by the physico-mental body and the daily atmospheric temperature was unconsciously noted by the mind relative to the body temperature. However, these objections gradually died down, and as stated above, the practice of giving weather reports in newspapers both in the fps system and the metric system of units, was discontinued from May 1963.

PRECAUTIONS WITH PAST DATA

The possibility of confusion that may arise due to the use of two different systems is quite real as may be seen from the following example. In a paper published in the well-known journal, 'Bulletin of American Meteorological Society*' on the rainfall at Nagpur, the following statements were made:

1) While the annual total rainfall of Nagpur in Lat 21° 06′ N Long 79° 03′ E for the year 1885 to 1949 averaged 47·3 in (with an extreme range of annual values from 13 in in 1938 to 76 in in 1933) the average annual rainfall from 1950 to 1961 was 113·1 in (with extreme annual range from 67·0 in in 1952 to 153·6 in in 1961).

2) Between 1950 and 1961, monthly rainfall exceeded 40 in in July 1954, August 1955, July 1959, July 1960 and August 1961, the highest 60 in occurring in July 1960. This would suggest that the average yearly rainfall of Nagpur has increased markedly after the year 1950.

*Bull. Amer Met Soc V 45 (March 1964), P 175.

The above conclusions were due to the unfortunate fact that the author had inadvertently used the centimetre values of rainfall at Nagpur as 'rainfall in inches'. This was discovered after a careful examination of the data utilized by the author, as pointed out in another paper in the same Journal*. This example is enough to stress the need for care in discussions utilizing past and present data. Suitable notes are being included in the various publications to avoid such confusion.

FINANCIAL IMPLICATIONS

It will be of interest to know what did the change-over actually cost the Indian Government as far as the India Meteorological Department was concerned. The following is the expenditure on this account up to April 1963:

	Rs
Replacement of weights and measures	431 200
Conversion of weighing machines and measuring instruments	1 700
Conversion of drawings and specifications	5 000
Employment of additional staff	128 600
Total	566 500

GENERAL REMARKS

From the above brief survey it may be seen that the change from the fps system to the metric system of units in the field of meteorology was beset with difficulties. But these were not peculiar to India alone. Meteorological services in many of the advanced countries in the West had also to face similar problems and when the subject of world-wide adoption of metric units for meteorological purposes was discussed in the World Meteorological Organization Congress in 1955 and again in 1959, even advanced countries like Canada and the United Kingdom were in favour of a 'go-slow' policy. The difficulties have, however, been happily resolved and today the metric system of units has been universally adopted for

*Bull. Amer Met Soc V 46 (July 1965), P 410.

meteorological purposes. While the decision of the Government of India to introduce metric units in all activities in the country accelerated the process, the scientific needs and requirements played quite a significant and major role in their introduction in meteorological services of the country. □

18.5 Civil Aviation

G. C. Arya

In civil aviation, safety of operations is of fundamental importance. And, a standard system of measurement in all rules and regulations pertaining to air traffic, particularly on international and inter-continental airways, would contribute greatly to this basic objective. The widespread acceptance of the metric system, in this context, assumes special significance, because it simplifies calculations materially. Also, it is the most appropriate system for adoption in the air transport industry, the progressive development of which is so much dependent on international co-operation. For these reasons, the International Civil Aviation Conference, which met at Chicago in November 1944, and which preceded the setting up of the world body in civil aviation — the International Civil Aviation Organization (ICAO), an affiliated body of the United Nations — had assumed the use of the metric system as a primary international standard and recommended that in those cases in which this appeared impracticable or undesirable, 'units in publications and codes of practice directly affecting international air navigation should be expressed both in the metric and the British systems'.

INTERNATIONAL CIVIL AVIATION ORGANIZATION

The Provisional ICAO was formed on 6 June 1945, and when the First Interim Assembly of the Provisional ICAO met at Montreal in May 1946, in which India had participated as a founder member, it decided to take suitable steps to secure the application of the metric system in civil aviation. A year later, when the ICAO held the first regular session of its Assembly, it resolved that the ICAO Council should adopt as an ICAO standard, as rapidly as may be practicable, the following system of units for use in air-ground communications and relevant publications in international air navigation:

Distances	Nautical miles and tenths
Altitudes, elevations and dimensions on aerodromes	Metres
Horizontal speed	Knots
Vertical speed	Metres per second
Wind velocity	Degrees and knots
Cloud height	Metres
Visibility	Metres
Altimeter setting	Millibars
Temperature	Degrees Centigrade
Weight	Kilograms and metric tons
Time	24 hours, the day beginning at midnight Greenwich time

The Assembly did not recommend a rapid change-over to the metric system, as that would have created confusion, but preferred the wiser course of allowing it to take place over a number of years. It recognized the possibility that some States will find it impracticable to use these units in all cases and, therefore, recommended that the Council should incorporate into the standards suitable alternatives to be adopted by those States, in order to reduce the hazards resulting from the absence of uniformity.

The 'International Standards and Recommended Practices', which the Council adopted on 16 April 1948, accorded as closely as possible with the Assembly resolution. As an interim measure, four tables, in addition to the ICAO table of units, were introduced. Three of these were eliminated, having been considered no longer necessary, when the first phased plan for the switch over to the metric system was adopted by the ICAO Council in December 1951.

When, therefore, India decided to go metric and the Parliament adopted the *Standards of Weights and Measures Act* in 1956, and decimal coinage a year earlier, the Department of Civil Aviation was already anxious for the change-over. Indeed, if the Act had not come into being, the difference between the Indian practices and procedures on the one hand, and the Standards and Recommended Practices formulated by ICAO on the other, would have increased, as in terms of the Chicago Convention on International Civil Aviation, the implementation of these standards and procedures is subject to practicability for compliance by member States. The Convention permits departures from International Standards and Procedures by States finding it impracticable to bring their own regulations and practices into full accord with such standards and procedures. The Civil Aviation Department, therefore, welcomed the decision for change-over to the metric system, as it was commensurate with the objective of securing uniformity in the implementation of ICAO Standards and Recommended Practices relating to units of measurements to be used in air-ground communications.

According to the 1956 Act, the change-over to the metric system was to be carried out in a period of ten years ending December 1966. In December 1961, the ICAO Council adopted an amendment which became applicable from 1 July 1964. This amendment brought the remaining interim table a step nearer the ICAO table, in that it provided for identical units in both tables except in respect of units for measurements of altitudes, elevations and heights, which could be given in metres or feet, and vertical speed for which the unit specified by the interim table was feet per minute against ICAO unit of metres per second (*see* Table 1).

However, the complete change-over to the metric system in International Civil Aviation being dependent on the widespread acceptance of the system by member States of ICAO, the Indian Civil Aviation authorities are obliged to make available both the metric and the fps systems of measurements in some respects until such time when the other countries also find the exclusive use of ICAO tables possible. The ICAO standards relating to the use of the metric system also provide for transmitting to aircraft in flight, units of measurement requested by aircraft that are unable to use temporarily the published ICAO table which is fully in line with the metric system.

TABLE 1 UNITS OF MEASUREMENT USED IN AIR-GROUND COMMUNICATIONS (ANNEX 5 TO THE CONVENTION ON INTERNATIONAL CIVIL AVIATION)

SL No.	MEASUREMENT OF	UNITS IN ICAO TABLE	UNITS IN INTERIM TABLE
1.	Distance used in navigation, position reporting, etc, generally in excess of 2 to 3 nautical miles	*NAUTICAL MILES and TENTHS	*NAUTICAL MILES and TENTHS
2.	Relatively short distances, such as those relating to aerodromes (e.g. runway lengths)	METRES	METRES
3.	Altitudes, elevations and heights	METRES	FEET
4.	Horizontal speed including wind speed	KNOTS	KNOTS
5.	Vertical speed	METRES PER SECOND	FEET PER MINUTE
6.	Wind direction for landing and taking off	DEGREES MAGNETIC	DEGREES MAGNETIC
7.	Wind direction except for landing and taking off	DEGREES TRUE	DEGREES TRUE
8.	Visibility including runway visual range	KILOMETRES or METRES	KILOMETRES or METRES
9.	Altimeter setting	MILLIBARS	MILLIBARS
10.	Temperature	DEGREES CELSIUS (CENTIGRADE)	DEGREES CELSIUS (CENTIGRADE)
11.	Weight	METRIC TONS or KILOGRAMS	METRIC TONS or KILOGRAMS
12.	Time	HOURS and MINUTES, THE DAY OF 24 HOURS BEGINNING AT MIDNIGHT GREENWICH MEANTIME	HOURS and MINUTES, THE DAY OF 24 HOURS BEGINNING AT MIDNIGHT GREENWICH MEANTIME

*International nautical miles, for which conversion into metres is given by: 1 international nautical mile = 1 852 metres.

The extent of exclusive use of ICAO table as on 1 April 1968 is limited to 22 out of 116 member States as advised by ICAO. Nineteen States have not notified ICAO on the implementation of the provisions relating to units of measurements to be used. Among the 75 remaining States, where the ICAO table is not used exclusively without any difference, are Afghanistan, Australia, Ethiopia, Germany (West), Indonesia, Iraq, Italy, Japan, Kenya, Kuwait, Lebanon, Malaysia, Nepal, Pakistan, Switzerland, UAR, UK and USA. The implementation of the metric system exclusively in every branch of activity in civil aviation in India, therefore, has not been without impediments.

Nevertheless, having undertaken to collaborate in securing the highest practicable degree of uniformity in ICAO regulations, standards and procedures, India has taken all possible steps within her means to adopt the metric system progressively. The details of this adoption by the Civil Aviation Department in India in its various fields of activities are given in the following paragraphs.

AERODROMES AND AIR ROUTES

The metric system has been adopted in case of the following measurements:

1) Short distances, such as runway lengths;
2) Altitude, elevation and heights;
3) Vertical speed;
4) Visibility and runway visual range;
5) Altimeter setting;
6) Temperature; and
7) Weights.

AIR TRANSPORT

All operational traffic statistics and fuel data have been adopted in the metric system. This has resulted in miles being changed to kilometres, pounds to kilograms, feet to metres and gallons to litres.

AERONAUTICAL INFORMATION SERVICES

1) The metric system has been adopted for all aeronautical maps and charts on scales 1:15 000; 1:30 000; 1:50 000 and 1:250 000.

2) The land survey for aerodromes is conducted in the metric system including height survey.

3) The Survey of India is also conducting aerodrome surveys in the metric system.

4) All instrument-approach-to-land procedures are implemented in the metric system with foot and pound equivalents also given in parenthesis.

5) Air Traffic Control instructions are in the metric system (the fps system is also used when asked for).

6) All meteorological data to aircraft is transmitted in the metric system.

TECHNICAL EQUIPMENTS IN THE FIELD OF AERONAUTICS

The conversion into the metric system of aircraft instrumentation on various types of aircraft belonging to Air-India and Indian Airlines involves various considerations. The operational aspects include flight of Indian aircraft to foreign countries where the metric system is not exclusively in use and the cost factor for conversion of the existing instruments and machines is the other consideration that has delayed a complete switching over to the metric system in the field of civil aviation. However, at the request of Air-India, Boeing Company have amended crew operating manual, flight manuals on fuel flow, fuel quantity and weight data to the metric system of measurement. The cockpit instruments in Boeing 707 aircraft like temperature gauges, fuel flow indicator, fuel quantity indicator and distance measuring equipment are in metric units. Some of the placarding in the control cabin relating to air speed correction and operation limitations are also rendered in metric units. Weight and balance data, and aircraft trim sheets and flight reports are prepared in the metric system.

RESEARCH AND DEVELOPMENT

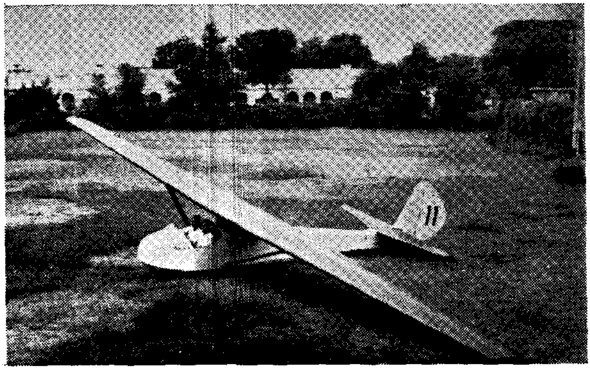
TESTING OF AIRCRAFT MATERIALS

All materials which are required to be used on aircraft have to be aircraft quality. Various materials like aluminium, alloy, steel, plywood, fabrics, etc, are received at the Technical Centre of the Research and Development Directorate for test and approval.

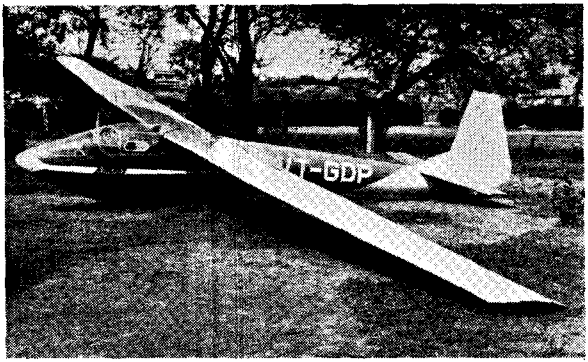
With the introduction of the metric system, test results are reported in the metric system to the farthest extent possible. The exceptions to this are those materials which have no Indian Standard, and are required to be tested to specifications of UK and US origin, since these are generally in the fps system. In these cases also, values are recorded, as far as possible, in the metric system.

DESIGN OF SAILPLANES AND LIGHT AIRCRAFT

Till 1957, all design calculations and prototype and production drawings of gliders designed and developed at the Technical Centre were in the fps system. Since then, however, the design calculations



Two-seat training glider, side-by-side seating Rohini



Single seat high performance sailplane Kartik KS-II and drawings of the various gliders, sailplanes and light aircraft and glider launching winches designed and developed have been made in metric units. Among these, mention must be made of the Ashvini and Rohini gliders, the Kartik high performance sailplane, the Revathi 2/3 seater light aircraft for club purposes and the different models of the Arjun glider launching winches.

QUALITY CONTROL TESTS OF AIRCRAFT FUEL, OIL, ETC

These tests were, to some extent, carried out even earlier in the metric system. Since the change-over to the metric system, the Indian Standards Institution (ISI) has formulated a large number of specifications for items like kerosene type turbine fuel, wide cut gasoline and high flash point turbine fuel, aviation gasoline, thinners, dopes, etc. These Indian Standard specifications follow the metric system. Therefore, all the tests carried out on these materials at the Technical Centre also follow the metric system. This change-over has necessitated certain changes in the test equipment which have been successfully carried out.

TYPE CERTIFICATION OF AIRCRAFT, GLIDERS AND EQUIPMENT

Since the aircraft industry in the country, including the major public sector undertakings, have continued to follow, to a large extent, the fps system, due to the problem of spares, materials, standard parts, etc, which have, in the past, been largely imported, the design calculations submitted by the industry have been in the fps system. However, in recent years, there has been a shift in these undertakings which have adopted the metric system wherever practicable.

The certification of gliders recently designed and developed at the Technical Centre, Civil Aviation Department, Safdarjung Airport (New Delhi), all documents, design data and drawings have been in the metric system. □

18.6 Roads and Road Transport

J. M. Trehan
M. K. Chatterjee

In 1956 India decided to change over to the metric system and the Parliament adopted the *Standards of Weights and Measures Act, 1956*, laying down a time limit of ten years for the transition in all spheres of activity. The very first step suggested by the Standing Metric Committee, set up by the Government of India, as far as roads were concerned, was that, to make the public metric-minded quickly, milestones and furlong stones should be replaced by kilometre stones and 200-metre stones. As national highways cover the whole country and State highways are also important State-wide roads, priority was to be given to the change-over on these roads. On other roads, the replacement would follow in due course. Milestones were, however, not to be removed and were to be retained until all road records had been converted to the metric system. On *new* roads, however, only kilometre stones were to be installed. Installation of kilometre stones quickly was also considered important as road tariff could be based on kilometres more easily if road distances were marked in kilometres.

Highways in India are mostly planned, designed, constructed and maintained by departments of the Central Government as well as of the States. To carry out the change-over in the field of roads and road transport, these departments had to metricize their schedules of rates, estimates, codes, specifications, etc. For this purpose, 'metric cells' were established in the various public works departments. In order that the work of these cells might proceed on uniform lines, the Indian Standards Institution (ISI) had published its standard on 'Conversion factors and conversion tables' (IS : 786-1956*), and the Indian Roads Congress, which is the premier body of highway engineers in the country, took up the task of converting its own standards and specifications to the new system.

The Indian Roads Congress had earlier published in the fps system several codes of practice and standard specifications for the use of highway engineers. The two main committees of the Congress which deal with these subjects, namely, the Specifications and Standards Committee and the Bridges Committee went to work on the conversion of the codes and specifications and, with the help of subcommittees of specialists, converted a large number of its standards into metric units. In addition to tackling the task of converting old standards, IRC has issued numerous other new standards in metric units, since the metric system came into force.

Notable among the converted or the new standards are the following:

1) Standard specifications and code of practice for road bridges;

2) Type designs for kilometre stones; 200-metre stones and boundary stones;

3) Route marker signs for national highways;

4) Recommended practice for the layout of motor-fuel filling stations and motor-fuel filling-cum-service stations;

5) Standards for (Roman) letters and numerals (for use on kilometre stones, road signs, etc);

6) Recommended practice for 2-cm thick bitumen and tar carpets;

7) Specification for two-coat surface dressing;

8) Standard specifications and code of practice for water-bound-macadam (WBM) and surface-treated WBM;

*Since revised in 1967. The revised edition is bilingual (English and Hindi).

9) Specification for bituminous macadam;

10) Specification for 4-cm asphaltic concrete surface course;

11) Standard specification and code of practice for the construction of cement concrete roads; and

12) Specification for the construction of stabilized soil roads with soft aggregates in areas of moderate and high rainfall.

Many of these standards (whether new or converted) contain the fps equivalents of the values specified in metric units, as it is felt that engineers who are educated mostly on the fps system find it conceptually easier to appreciate the values given in that system. As education in India is expected to go over completely to the metric system by 1971, the future editions of the standards may be without the fps equivalents.

It can be well realized that, while the change-over in the office is time-consuming, the adoption of metric units in the actual field work can be much more difficult. To make the task smooth for the field engineer, some of the highways departments have prepared manuals, giving detailed instructions in respect of every type of measurement or calculation which may have to be made. Some departments have laid down that during the transition period both the systems should remain in force. For example, in one State, in the case of works for which estimates had been sanctioned in the fps system, but tenders had not been settled, it was laid down that tenders should be called for in the metric system by converting the quantities; the work should be executed on the fps system, measurements taken and quantities worked out on the fps system but converted to the metric system for the purpose of payments to contractors in the terms of the tender. All estimates after a specified date were to be sanctioned in the metric system.

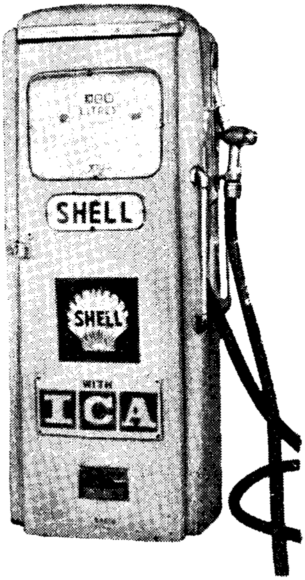
As regards the replacement of milestones with kilometre stones, the thinking, to start with, was that 5 furlongs should be taken as equivalent to one kilometre, the difference of about 19 feet being ignored (5 furlongs = 3 300 ft; 1 km = 3 280·8 ft). In this way, the process of replacement could be simplified and a kilometre stone could be fixed in place of every fifth furlong stone. While this might not matter much on a short road, on long routes the cumulative error could become appreciable. Over a distance of 1 000 miles, the error would be about 9 kilometres. It was, therefore, decided that on national highways the distances should be actually measured afresh and kilometre stones fixed accurately. This would also afford an opportunity of rationalizing the marking of distances on national highway (NH) routes, which had never been properly measured since the inception of the NH system. These highways consisted of bits of old State and local roads with milestones on sections of the same national highway having distances marked to different destinations, often in contrary directions. Kilometre stones have been fixed on most of the national highways by now after proper measurement. Some States have, however, followed the easier course on their local roads of fixing a kilometre stone at every fifth furlong stone.

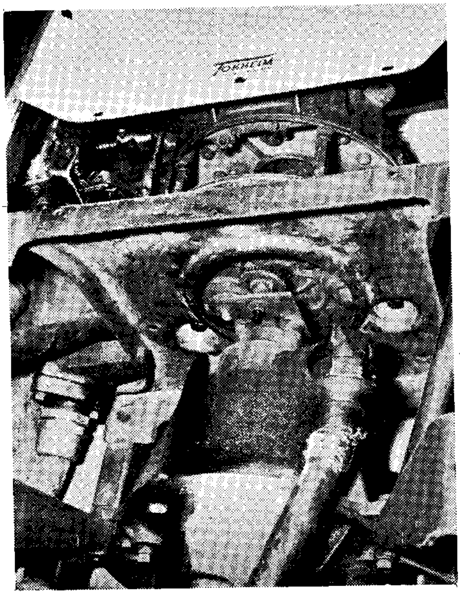
PROGRESS

The progress towards metricization is at different stages in the different States. On the whole, however, at present both the systems are in use simultaneously in most of the States. While old estimates framed on the fps system continue to be operated on that system, new estimates are mostly framed in metric units. Although the 10-year period laid down for the transition is already over, a complete change-over will take a few years more. It is only when engineers, educated and trained in the metric system and thinking basically in that system, constitute a majority in the services that the change-over will be completed.

ROAD TRANSPORT

Coming to the subject of road transport, the problem of metricization has eased to some extent due to the fact that almost all the transport vehicles are now being manufactured indigenously in the country. The motor cars, scooters, goods lorries (trucks) and passenger buses turned out by the factories in India have all the significant parts and appliances relating to speed, fuel, oil, etc, in the metric system. The ancillary industries which cater for the automobile industry have also been producing parts and components in metric dimensions. One has now to pay the fare on the basis of kilometres travelled, whether one travels by a taxi or a bus. Similarly, the freight charges on transport of goods are also now based on distances in kilometres and the weight in metric





The petrol pump as it is today

A close view of the pump with the cover removed. Note the gear arrangement designed to make the same mechanism register in litres instead of gallons

The petrol pump which dispensed in gallons before the change-over

A dispensing pump with a moving dial indicator which required only re-calibration and no additional gear mechanism to register in litres

tonnes. Petrol, diesel oil and lubricants are packed and sold in litres. The dispensing pumps also deliver petrol in litres. The scales of those with a moving dial indicator have been re-calibrated. In others, a suitable gear arrangement enables the same mechanism to register in litres instead of gallons. Tyres and tubes are available in metric sizes. India appears to have gone a long way in the direction of metricization so far as this aspect of road transport is concerned.

The *Motor Vehicles Act*, which lays down unladen weights of the various classes of vehicles, has been amended and now specifies these weights in metric tonnes and kilograms. The same Act also specifies the traffic signs to be used on roads. By the same amendment of the Act the sizes and dimensions of these traffic signs have also been given in metric units.

In amending the *Motor Vehicles Act,* opportunity has been availed of to liberalize the provisions to some extent as regards the unladen weights of various classes of vehicles as well as the maximum speeds of various classes of motor vehicles. For instance, the registered laden weight of a 'light motor vehicle' has been converted from 6 000 lb to 3 000 kg (the equivalent of 6 614 lb); the unladen weight of a 'motor cycle' inclusive of a side car has been converted from 900 lb to 500 kg (1 102 lb). In the matter of speeds, a speed limit of 35 miles per hour has been converted to 60 km per hour (instead of 56 km per hour), 30 mph (48 km per hour) to 50 km per hour and 20 mph (32 km per hour) to 35 km per hour.

Most of the road signs which indicate the presence of a traffic hazard are pictorial in design and do not need any modification on account of the change-over to the metric system. The few signs which carry numerals (like the speed limit in miles per hour) are being changed to indicate kilometres.

In general, the adoption of the metric system in the matter of roads and road transportation can be claimed to have progressed smoothly and satisfactorily, in spite of the magnitude of the problems involved, multiplicity of the authorities concerned (Central Government, State Governments, District Boards, City Corporations and Municipalities), finances required, educational background of professional engineers and so on. □

18.7 Shipping

G. S. Singh

When the proposal for introducing the metric system of weights and measures in India was in its initial stages, the study of the effect of introducing this system, in so far as shipping is concerned, was taken up by the Ministry of Transport in consultation with the Ministry of Commerce and Industry. From the outset it was appreciated that the change-over would not only affect the ship-owners but also the ports and port administrations, chambers of shipping, shippers, shipping conferences and the ship-building industry.

A standing committee consisting of representatives of the Ministry of Transport, Ministry of Commerce and Industry, the port organizations, shipowners, chambers of commerce and the marine technical institutions in India was, therefore, set up under the Directorate General of Shipping to work out a phased programme for the introduction of this system, and to bring about the change-over in an organized and practicable manner.

In so far as shipping is concerned, the introduction of the metric system affects the basic items discussed in the following paragraphs.

MEASUREMENT

TONNAGE

The word 'ton' appears to have originated from the old English word 'tun' meaning a barrel or cask containing wine. At a certain period, the English Law prohibited tuns of less than 250 gallons. It weighed about 2 240 lb and occupied a shipping space of about 57 cubic feet. In the old days, if a vessel was referred to as being of 300 tons burden, it meant that she was capable of carrying a load of 300 barrels of wine.

As the size and shape of vessels underwent a change, the accepted practices regarding tonnage also changed. Many attempts were made to standardize the system of measurement; the system now used is known as the Moorsom System, after George Moorsom, the Secretary of the Royal Commission, the recommendations of which, embodied in an Act of Parliament in 1854, gave birth to the current system of measurement.

This system had, as its underlying principle, the basic idea that assessment of dues should be on the tonnage of the vessel. The intention was to make tonnage a measurement of a vessel's potential earning capacity. Under the Moorsom System, tonnage has been accepted as a measure of the internal capacity or volume of the vessel.

The Moorsom System has been adopted by almost all the maritime countries in the world including France, Germany, Italy, Japan, Sweden, USA and USSR.

Even the Suez Canal authorities who normally use the metric system for all purposes, require the tonnage measurement of ships to be made in 'tons', reckoned at 100 cubic feet of space per ton. This was adopted by the International Tonnage Commission which met at Constantinople in 1873, and forms the basis of dues levied on ships of all countries passing through the Suez Canal. In the new Indian *Merchant Shipping Act, 1958*, a provision has been made to make rules for the survey and measurement of ships for tonnage, and suitable Indian Tonnage Measurement Rules are being framed.

The British Rules relating to tonnage prescribe that the tonnage measured in the present units may be converted into cubic metres by multiplying by 2·83. That is to say, one hundred tons will be equal to 283 cubic metres.

For the purposes of port, pilotage and other dues, the tonnage of ships as measured by the Moorsom System, in tons, each of 100 cubic feet, may be converted into cubic metres by the above factor. This ton is normally referred to as one register ton. This is the unit measure in which a ship's tonnage has been expressed since the introduction of the Moorsom System of measurement in 1854. This register ton is a unit of volume and must not be confused with the English ton which is a unit of weight of 2 240 pounds as mentioned earlier. In tonnage certificates, the tonnage is also converted and expressed in cubic metres at the final stage. The cubic metre so defined is known as one metric measurement ton (mmt), which will be used when the Port Authorities decide to levy dues using the metric system.

In so far as the measurement of tonnage is concerned, the tonnage calculations in respect of Indian ships are carried out using both the systems, that is, the British system and also the metric system.

MARKING OF VESSELS

Ships on the Indian registry are required to be marked as per the requirements of the *Merchant Shipping Act, 1958,* before they are registered. This includes the marking of the draft marks both in the forward-part and after-part of the vessel, and the draft indicates the extent to which the vessel is submerged in the water. In order to effect the change-over smoothly, Indian ships' draft marks are now marked both in feet and inches and in metres and centimetres, side-by-side. This dual marking system will continue for some time after which the draft marks will be marked in the metric system only.

LOAD-LINES

Load-lines, which in fact indicate the maximum permissible depth to which a ship is to be loaded, are assigned and marked on both sides of the ship in the centre in accordance with the requirements and provisions contained in the International Load-Line Convention. This is an international requirement, and a ship, which is by the very nature of her trade required to proceed to any port of the world, has to be very accurately marked. In so far as Indian ships are concerned, a decision has been taken to indicate the actual draft and the freeboard for the appropriate load-lines in metres. At present the load-line markings are in feet and inches. Change-over to the metric system will be accomplished soon after the Government of India ratifies the 1966 Load-Line Convention.

NAVIGATIONAL CHARTS

The basis of all deep sea navigation depends on charts being constructed on the Mercator's System. This is a representation of the curved surface of the earth on a flat sheet of paper. Latitudes and Longitudes are drawn as straight lines enabling a true Rhumb line to be drawn as a straight line.

Distances on a navigational chart are measured in nautical miles. The nautical mile is defined as the length of a meridian which subtends an angle of one minute of arc at the centre of curvature. Since the curvature of the earth's surface is not constant, the value of the nautical mile is a variable factor. Since the units used in constructing charts are taken from the measurement of the earth's surface, distances on navigational charts continue to be shown in nautical miles. According to the *Standards of Weights and Measures (Amendment) Act, 1964*, 'a nautical mile, which is equal to 1 852 metres, may be used as the unit of length in relation to navigation by sea or air'.

DEPTHS OF THE OCEAN

The depths of the ocean on navigational charts are indicated in fathoms and feet, or metres, depending on the country where these charts have been produced. In the charts produced by the British Hydrographic Department, the standard unit used for indicating depths is 'fathoms', which is the equivalent of six feet. Because of the British maritime supremacy and their sovereignty over many countries in the past, the British were in a position to chart practically the whole world. In fact, they were the only suppliers of navigational charts and other equipment required for navigation purposes for a long time. The British Hydrographic Department produces, besides navigational charts, several other publications useful to the shipping industry like Tide Tables, List of Lights, Sailing Directions and Nautical Almanac.

In view of these facts, and because of the historical British connection with India, the Indian shipping industry is very much dependent on the charts and other publications produced by the British Hydrographic Department. Although the Government of India also has a Hydrographic Department, and it has commenced compiling its own charts as a result of surveys carried out by it, we still have a long way to go to replace the existing charts covering the entire coasts of India and the seas bordering those areas. Since this Department of the Government of India is in its infancy, the replacement of existing charts will take many years, as vast areas have to be re-surveyed, because existing British charts are based on surveys conducted many many years ago. It is thus not likely that the Indian Hydrographic Department will be in a position to undertake printing of charts published by other countries covering their coasts and adjacent seas in the near future. Until such time as the Indian Hydrographic Department matures into a fully self-sufficient organization, our dependency on the British Hydrographic Department will continue. It was, therefore, considered desirable that the unit of depth indicated on the charts should continue to be shown in fathoms and feet, as hitherto, for some more time. When we are in a position to cover the entire area with our own charts, the depths may be shown in metres. The fact that Indian ships are now plying all over the world covering all the seas only emphasizes the need for caution in effecting any hasty changes in so far as the navigational charts, instruments, etc, are concerned in the interest of the Indian shipping industry.

It may be argued that the existing soundings on the British charts, which are in fathoms and feet may be simply converted into metres. While in a small-scale ocean chart, there may be no serious objection to converting the existing soundings from fathoms to metres, such direct conversions will be unsatisfactory in large-scale charts depicting comparatively shallow waters. This is principally because vast areas have not been physically re-surveyed by the British for many years, and it is possible that the data on such charts is not very accurate. In the circumstances, no useful purpose will be served in reprinting such charts merely to indicate the converted values. On the other hand, the converted values of constant depth lines, which will not be in whole numbers, are likely to cause confusion in navigating vessels in coastal waters. If soundings have to be shown in metric units, that should be done after conducting new surveys in which the actual soundings are taken in metres. However, it may be stated that very recently the Hydrographic Department has started using the metric system.

With regard to navigational equipment, such as echo sounders, there is no point in effecting changes in the system of marking of such equipment until the charts are produced in the metric system. These instruments, therefore, give depths in fathoms and feet. However, echo sounders with metric scales are now available for use on board ships.

CARGO

The weight of cargo in the past was expressed in long tons, each of 2 240 lb. The dead weight and displacement data provided to Indian ships were also tabulated in these units.

To introduce the metric system and to create as little confusion as possible, it was considered desirable that the metric ton or tonne may be adopted in expressing the weight of cargo. The metric ton is equal to 1 000 kg or 2 204·6 lb. It was decided that Indian ships should, in future, also have the dead weight and displacement data in metric measure, although they may continue to have this in fps units also.

Certain articles are assessed at a shipping ton of 50 ft^3 to the ton. The shipping ton is a measurement of space arrived at by taking an average of the space occupied by various cargoes in ships and in cargo sheds so that the rate charged will generally be in parity with the earning space occupied. For the purposes of freight rates, the measurement ton until recently was 40 ft^3 to the ton at Bombay and 50 ft^3 to the ton both at Calcutta and Madras; this has now been amended and equivalent metric units fully adopted.

In so far as the introduction of the metric system to weights of cargoes is concerned, most of the Indian trade has already adopted the metric ton as a standard weighment of cargo. To this extent the port dues have also been revised to take into account this system, and the metric system has been introduced fully.

NAUTICAL TABLES INCLUDING THE NAUTICAL ALMANAC

In so far as astronomical observations to arrive at the ships position from time to time are concerned, a navigator has necessarily to use the various arithmetical tables which deal with solution of spherical triangles as also the nautical almanac which provides tabulated information in respect of the movement of heavenly bodies. When the question of introduction of the metric system, in so far as it could affect navigation, was considered, it was felt that considering the basis on which the various formulae for solving spherical triangles have been evolved, as also the tabulated information contained in the nautical almanac, and the information contained in the arithmetical tables, it would be prudent not to attempt any change-over to the metric system in so far as navigation is concerned. A navigator is essentially interested in finding out the position of the ship from day-to-day, the speed that she has been making over the ground and these items being dependent on the results of the astronomical observations mentioned above, no change has been possible in this direction.

TIDE TABLES

A navigator is necessarily interested in finding out the heights of water in the approaches to the various ports. This information which indicates the time and heights of tide at high water and low water for everyday of the year is contained in the Indian Tide Tables. The information obtained from the tide tables has to be correlated to the information contained in navigational charts, and although the units of measurement of the chart still continue to be in fathoms and feet, the Survey of India, which is responsible for producing the Indian Tide Table, has switched over to indicating their results in the metric system. This is a step in the right direction, as it will hasten the process of production of navigational charts based on the metric system. At present the presentation of information in the tide tables does not involve undue difficulties or inconvenience to the navigators, as, after working out the heights of tide for any port at any time of the day or night, the navigator has to simply use the conversion table and obtain the height of tide in feet and inches.

EXAMINATIONS FOR CERTIFICATES OF COMPETENCY

These examinations are conducted by the Ministry of Transport for grant of Certificates of Competency to navigating officers and engineer officers of the Merchant Navy. The syllabus for these examinations consists of several written papers where knowledge of navigation, mathematics, physics, general science, marine engineering, etc, is required. It was considered desirable that steps be taken to introduce a few problems dealing with metric weights and measures in the appropriate papers so that the future serving officers of the merchant navy are made conversant with the metric system. This has been done and Indian Merchant Navy officers are now well-versed with the new units.

CONCLUSION

In summing up, it may be stated that although a decision in principle was taken to introduce this system in all spheres of shipping, there have been certain inherent restrictions which have not made it possible for this system to be introduced in all the spheres. However, the industry is fully conscious of the fact that everything connected with shipping should be changed over to the new system as early as possible, and this, it is hoped, will be achieved in the very near future. □

18.8 Electrical Cables Industry

Y. S. Venkateswaran

The metric system is not in any way new to the field of electrical technology. Electrical and electronic engineers have been following this system from the very beginning, and in fact, the units in vogue in this field have all been based on the cgs or MKS system, and the multiples and sub-multiples have also been derived from them, such as the basic units for current, voltage, charge, magnetic field and electrostatic field.

In the electrotechnical industry, however, because of the dependency on other technologies, namely, mechanical, chemical and metallurgical engineering, a measuring system other than the metric had been adopted. The reason for this is quite apparent because any piece of electrical equipment is essentially a machine, to be used in conjunction with other machines and structures. The same system in vogue for measurement, both linear as well as gravimetric, will perforce have to be followed in the electrotechnical industry as in other industries in a country. In India, the fps system was in vogue, because of our historical association with Great Britain.

The same state of affairs prevailed in the case of cables and wires for electrical and electronic industries. The sizes of conductors were expressed in terms of inches and square inches, the linear measurements in inches, feet and yards and, in the case of power cables, where long lengths were involved, in miles and fractions of a mile.

In the general framework of the change-over to the metric system, the Indian Standards Institution (ISI) was recognized as the focal point for the change, not only because metric standards were considered as essential prerequisite but also because it had the necessary machinery for preparing and co-ordinating the various industry programmes. The electrical cables industry, dependent largely on dimensional properties, happens to be one of the several where standards have to be first established before production could take place.

APPROACH TO CHANGE-OVER

It was in 1958 that a beginning was made for the change-over to the metric system in the Indian Standards for electrical cables and wires. While deciding on the pattern of the change-over, the following factors were kept in mind.

CURRENT-CARRYING CAPACITIES OF CABLES AND CONDUCTORS

This capacity depends on permissible temperature-rise which, in turn, is a function of the resistance of the conductor. Any change in the cross-sectional area, therefore, means a change in the resistance and, consequently, the current-carrying capacity. Further, any change in the cross-sectional area would result in a change of

The conductor resistance of a cable being determined in a test field control room

the rated current-carrying capacities of cables and wires, and it was considered necessary that as little change as possible should be made in the existing cross-sectional areas.

OVERALL SIZES OF INSULATED CABLES AND WINDING WIRES

In the case of cables, their size influences the design of the accessories for electrical equipment, such as terminal boxes on motors, transformers and switchgear and jointing boxes both straight-through and T boxes. In the case of winding wires, apart from the current-carrying capacity being altered as a result of change in the dimension, the diameter influences the space factor which has to be kept in mind while designing electrical equipment. This affects the magnetic and electrical circuits.

PROCESS OF CHANGE-OVER

Prior to 1960 all the Indian Standards on wires, conductors and cables were based on the fps system, in view of the manufacturing practice in the country following the British practice. The more important of the standards were as follows:

*IS : 282-1951	Hard-drawn copper conductors for overhead power transmission
*IS : 396-1953	Bare annealed high-conductivity copper wire for electrical machinery and apparatus
*IS : 398-1953	Hard-drawn stranded aluminium and steel-cored aluminium conductors for overhead power transmission purposes
*IS : 434-1953	Rubber insulated cables
*IS : 692-1957	Paper insulated lead-sheathed cables for electricity supply
*IS : 694-1955	PVC insulated cables (for voltages up to 1 100 V)

When the work of revising these standards on the basis of the metric system was taken up, it had to be ensured that in the process of change-over there should be a minimum amount of dislocation to the electrotechnical industry as a whole. At the same time a

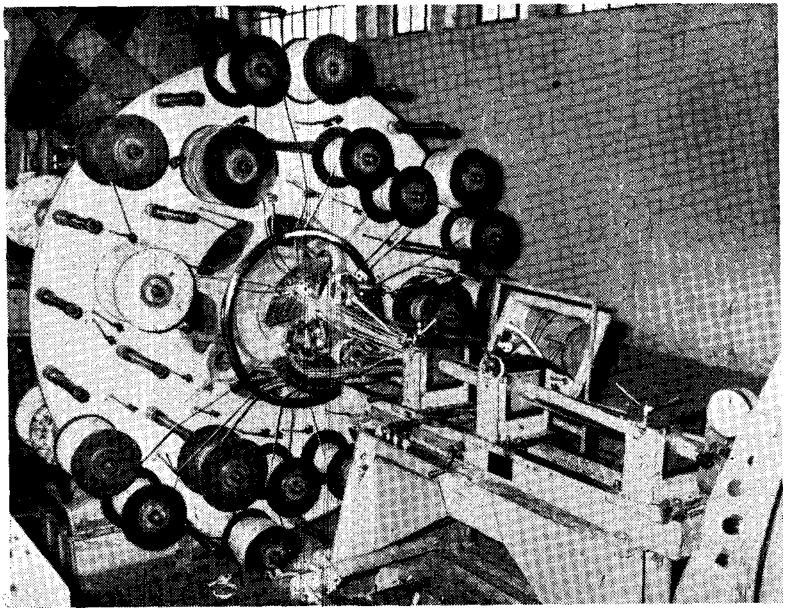
*These standards (except IS: 396-1953, which has been withdrawn) have since been revised. The latest versions are IS: 282-1963, IS : 398-1961 (in 2 parts), IS: 434-1964 (in two parts), IS: 692-1965 and IS: 694-1964 (in two parts).

proper lead had to be given to the industry so that within as short a time as possible the change-over to a rational set of metric standards could be effected.

In the standards in existence at that time the wire sizes were all derived from those given in IS : 396-1953. Consequently, it was logical first to have a new metric standard to replace it. The two possibilities that could be followed were (1) to convert the existing inch sizes into metric and then, wherever it was practicable, to round them off suitably, or (2) to evolve a completely rational series of dimensions-diameter as well as cross-sectional area — on the basis of the well-known Renard numbers, and also to keep in view the conductor area series in vogue in the continent of Europe known as the CEE* series. Undoubtedly, the latter was the correct approach, but to minimize the problems in the interim period, it was decided to convert the existing sizes into metric and to give, in addition, the rational metric dimensions. On this principle, IS : 1594-l 960 'Metric sizes of copper wires and conductors for electrical purposes', was evolved. This standard contained the diameters of all wires, whether for use as winding wires, single conductors or for use in stranded conductors. In addition, this standard specified cross-sectional areas of conductors for overhead lines, non-flexible cables, flexible cables and flexible cords. While specifying these, an attempt was made to use the minimum number of wire diameters. As can be expected, in view of adopting both the principles enumerated above, a very large number of wires and also areas of conductors resulted. The wire diameters included in this standard were primarily from the R-40 series, with a few additions from the R-8 series to accommodate the need of specialized consumers on the basis of their requirements at that time. The new wire diameters were so chosen that they did not differ by more than 2 percent from the corresponding inch sizes covered in the earlier standards, as this could enable the minimum of change in design for electrical equipment manufacturers using these wires as winding wires.

The next step in evolving the metric Indian Standards was to amend the existing standard for overhead conductors and insulated

*International Commission on Rules for the Approval of Electrical Equipment.



Core laying up machine in a cable making factory

cables utilizing the new wire sizes and conductor areas. The revision of all the standards was taken up for this purpose. As may be expected, the change in wire and conductor sizes naturally brought about the changes in the thickness of insulation, thickness of sheath, thickness of finishes and also overall diameters wherever they were specified. These changes, however, were marginal and it was visualized that they would not bring about any difficulties in the use of these new cables. So far these revisions were concerned with conductors and cables having copper as the conductor material, as till then all the Indian Standards on these subjects covered copper conductors only, except in the case of IS:398-1953* which was specifically for aluminium conductors for overhead transmission purposes. It was at this juncture that the Government of India took a decision in favour of the change-over from copper to aluminium in the electrotechnical industry, beginning with the change-over in the cable industry.

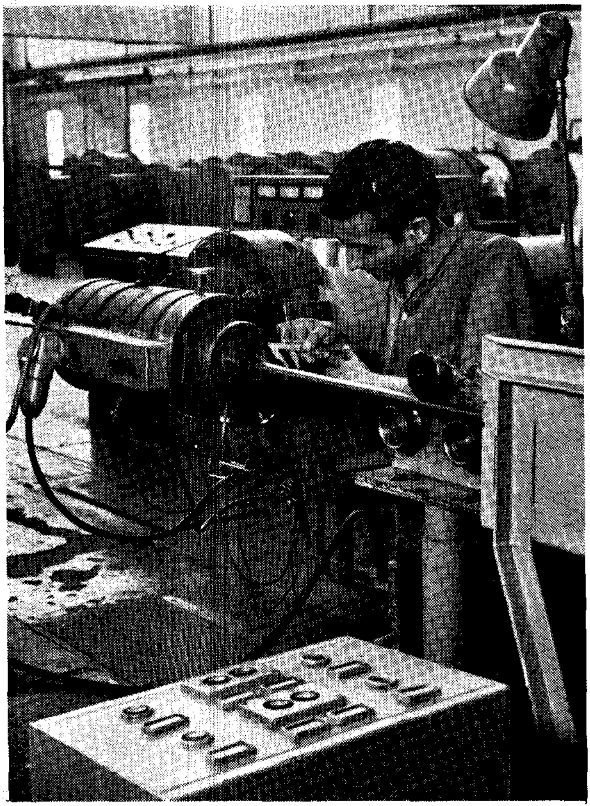
*Since revised in 1961.

HOW IMPORT SUBSTITUTION INFLUENCED THE METRIC CHANGE-OVER

The decision to change over from copper to aluminium in the cable industry was motivated by the desire to reduce dependency on imported materials. Although at that time both copper and aluminium were being imported, the known bauxite deposits in the country held out every hope of attaining self-sufficiency within a short time for electrical-conductor grade aluminium, whereas there was no such prospects for electrolytic copper. Since the cable industry consumed a very large proportion of electrolytic copper, this was chosen to be the first item in the electrotechnical field for the change-over. The formulation of the required Indian Standards had, therefore, to be expedited to pave the way for this change. While doing this, the differing properties of copper and aluminium as electrical conducting materials had to be kept in mind. It was also decided that this opportunity should be utilized to make a clean break with the earlier sizes of cables and conductors which, though metric, had been largely derived from the fps system. The final series for conductor sizes that emerged after taking all these aspects into consideration was the one following the International series (CEE) with only one additional size of 225 mm^2 included, as this was a very popular size for power transmission.

Another aspect of preparing new standards was related to insulating materials. Although for house wiring cables, both rubber insulated cables as well as PVC insulated cables were in vogue, large-scale use of thermoplastic materials as insulation to replace rubber, and also paper, in the case of power cables had started. In preparing the new Indian Standards, therefore, this aspect had to be kept in mind, as this new trend brought about considerable economy in the cable cost.

Although the Government of India had decided that only aluminium should be the conductor material for all power cables and most of the non-flexible cables for fixed wiring, it was considered expedient to have Indian Standards either with copper or aluminium as conductor material to provide specifications for the purchase and use of copper-conductored cables if required. The revised Indian Standards, therefore, were mostly in two parts — one covering



PVC outer sheath being extruded on to a cable made to Indian Standard. The hiameter is being checked by a millimetre caliper

copper-conductored cables and the other aluminium-conductored cables. In some cases both types of cables were included in the same standard.

As far as dimensional requirements of copper conductors or aluminium conductors were concerned, it was agreed that the range of sizes for these should be the same irrespective of the conductor material, it being the responsibility of the user to choose the corresponding higher size of aluminium-conductored cable on the basis of the current-carrying capacity. In other words, the essential result was in the inclusion of larger sizes of conductors to provide for larger quantum of power to be transmitted through aluminium conductors.

RESULTANT PROBLEMS FOR THE MANUFACTURER AND USER

As far as the manufacturer was concerned, there was very little difficulty in the change-over to the metric system or to the use of aluminium as conductor material. In the normal course the dies would slowly wear out and when the limit of maximum diameter die for a particular size was reached the same die would be used for drawing the wire of a larger diameter. The only precaution that had to be taken, if the die which had so far been used for drawing copper wires was to be used for drawing aluminium wires, was to clean the die effectively so that no copper particles were left in the die, as the presence of copper on the aluminium wire would bring about bi-metallic corrosion. The use of new insulating materials was also no problem, as by judicious adjustment, the required thickness of insulation or sheath could be extended or laid on the conductor.

The problem of the user, however, was slightly more difficult, inasmuch as he had mentally to get used to the metric sizes and their relation to the amount of current (or power) the cable could carry. This was irrespective of whether it was a copper-conductored cable or aluminium-conductored cable, except that if the latter was the case, the user had also to keep in mind the lower conductivity of aluminium.

In the case of the manufacturer of electrical equipment, however, the problem assumed a more serious proportion, since the change in the dimensions of the winding wire sometimes resulted in changes in equipment design. Such changes are still going on, and it is only a matter of time rather than a question of development of any new or specialized technique that is needed here. Even in the case of small accessories for wiring, such as plugs, sockets and other terminations, marginal changes in sizes of terminations have been carried out to cater for the new conductor sizes.

CONCLUSION

From the foregoing it may be seen that the change-over in the cable industry was more a problem of mathematical conversion for the evolution of metric sizes of conductors. By and large, the manufacturer of cables and wires had very little difficulty. The user, however, had to re-orient his thinking from the point of view of power transmission or current-carrying capacity. Furthermore, new techniques had to be evolved for cable jointing and cable terminations mostly because of the use of aluminium replacing copper as conductor. The manufacturer of electrical equipment had the major share of the problem inasmuch as in some instances considerable design changes had to be effected. cl

18.9 Paper Sizes

R. Ramaswamy

The multitude of Indian paper sizes just grew. Each paper mill produced its own speciality, such as wrappings, ledgers, writings, or printings, and developed methods and equipment, and used raw materials according to its own knowledge and convenience. The size of the paper-making mould was that which could best be handled and thus differed in different mills. In this way, a multiplicity of sizes grew up without any common basis. This was not a great disadvantage to the paper maker: his deckle was flexible, and his policy was to deal individually with customers, provide what they wanted, and of course, to charge accordingly. The printer, however, has tended to buy machinery to take the largest paper size he was likely to be called upon to print, and then to use this machinery less economically for smaller sizes also. In addition, the stocking of a multiplicity of paper sizes has been wasteful of capital and storage space.

For a long time the printing industry, as a whole, had not paid much attention to economy in the use of paper. The designer or customer prepared his dummy with little reference to standards or stock sizes of paper, and the paper store had to supply a suitable size from the multifarious sizes, several of which over the years had become recognized. The practice of calling a size of paper by a name led to confusion, as in some cases one name denoted more

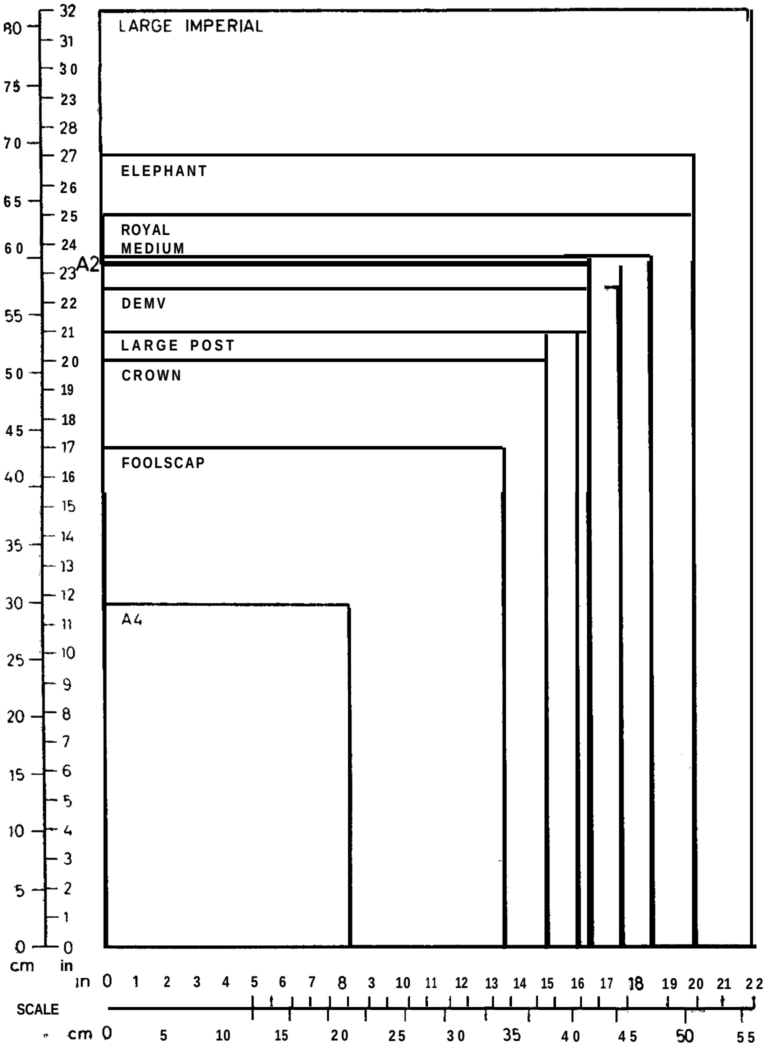


Fig. I Well-known paper sizes and the international A2 and A4 sizes shown in proportion than one size, and to add to this confusion, the names were multiplied — post, small post, large post, pinched post; demy, small demy, large demy, ledger demy and so on. Further, the sheet size in one ream often differed from that of another ream in the same consignment, with disconcerting results on production, while the number of sheets in a so-called 'ream' was a matter which had been equally indeterminate. Figure 1 shows in proportion some of the sizes, several of which are still in current use in this country; imposed on this diagram are the international A2 and A4 sizes. It will be seen that none bears any relationship to another.

In this background, the Indian Standards Institution (ISI) had taken upon itself the formulation of national standards to assist the paper trade and printing industry, even before the decision for the adoption of the metric system was taken. For information of readers not familiar with the evolution of world paper sizes, it would be useful first to give a brief historical account so that the Indian effort for the metric change in this sphere may be made meaningful.

WHY A STANDARD IS NECESSARY AT ALL?

It is generally accepted that standardization gives a number of advantages to the makers and users of products. In regard to paper, the more important advantages are detailed below:

1) It would generate keener competition which would result in economy of time and use of material;

2) The purchase of machines, of sizes which are not co-ordinated, results in a wasteful production line. There is need for planned machine sizes in conjunction with selected paper sizes;

3) It would satisfy the demand for internationally co-ordinated correspondence sizes and stock sizes from large industrial and commercial firms in India, particularly those engaged in import and export business;

4) Suppliers of printing and processing machines, filing cabinets, filing materials and so on. would be able to show production economies if home and export sizes for their products were rationalized and identical; and

5) A series of paper sizes based on a logical progression, with well-established substance ratios, would simplify making, ordering, storage and utilization.

INTERNATIONAL PAPER SIZES

ORIGIN

The preparation of international standards is undertaken by the International Organization for Standardization (ISO) with the co-operation of all national standards institutions which care to take part in this work.

The establishment of paper sizes on a thoroughly systematic basis had originally resulted from the work carried out by the International Federation of the National Standardizing Associations (ISA), the predecessor body of the present ISO.

BASIC PRINCIPLES

The system of paper sizes recommended for general adoption by the ISA and subsequently issued in the form of an international recommendation by ISO (ISO/R 216-1961 'Trimmed sizes of writing paper and certain classes of printed matter') is based on the following principles:

1) *Halving* — Two successive formats of a series of sizes are obtained by halving or doubling. Consequently, the surface areas of the two successive sizes are in ratio of 2:1 or 1: 2 (see Fig. 2).

2) *Similarity* — The form or the aspect ratio of the successive sizes remains the same on doubling or halving.

From (1) and (2), the equation X: Y = 1: $\sqrt{2}$ is obtained for the two sides X and Y of a format (see Fig. 3), because

$$\frac{X}{Y} = \frac{Y/2}{X} \text{ or } \frac{X^2}{Y^2} = \frac{1}{2}$$

Consequently, the ratio between both sides is the same as that of the side of a square to its diagonal (see Fig. 4).

3) *System of Measurement* — The metric system of measurement is adopted for the paper sizes.

Thus, the surface area of the basic format is equal to one square metre, that is, $X \times Y = 1$.

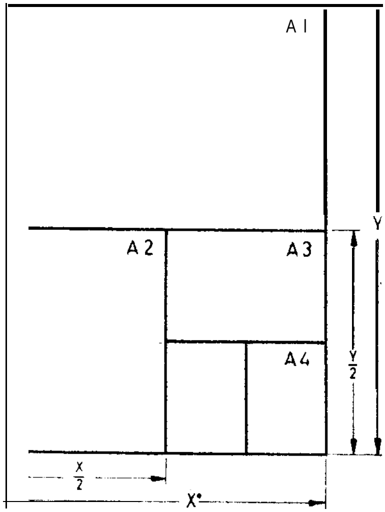


Fig. 2 Consecutive sizes in A-series

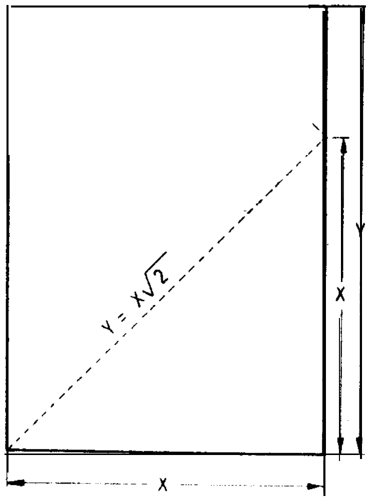


Fig.3 Geometricalrelationship between the sides in A-series of sizes

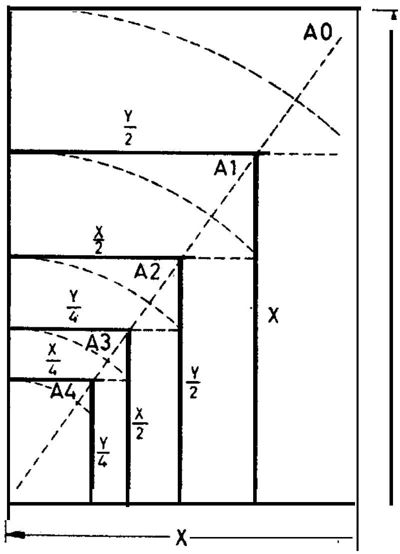


Fig. 4 A simple method of deriving consecutive sizes in A-series

A-SERIES OF SIZES

The basis of the international series of paper sizes, or A-series of sizes, is a rectangle having an area of one square metre and the sides in the proportion of $1:\sqrt{2}$. In other words, taking one side as X and the other as Y, this basic size provides the two equations: $X : Y = 1 : \sqrt{2}$ and $X \times Y = 1$. It is of interest to note that, as illustrated in Fig. 3, the proportions $1:\sqrt{2}$ have a geometrical relationship, the side and the diagonal of any square being in this proportion. As the basic size is one square metre in area, this means that X = 841 mm and Y = 1 189 mm. The effect of this arrangement is that if the shorter side is doubled or the longer side halved, that is, if the area of the sheet is doubled or halved, the shorter side and the longer side of the new sheet will still be in the proportion of $1:\sqrt{2}$. This provides advantages in the preparation of copy, as any size in the series can be obtained from one copy by enlargement or reduction.

The designation or description of the A-series is simple: it consists of capital 'A' followed by a figure, for example, Al. The higher the figure which follows the letter, the greater is the number of subdivisions and, therefore, the smaller the sheet. The basic size has the description AO; half A0 is Al and half Al is A2. Figures 2 and 4 show these subdivisions as they might be cut from a sheet AO. Where larger dimensions are required, the 'A' is preceded by a figure. Thus 2A means twice the size of A0 and 4A means four times the size of AO. Notice that 1A is omitted from the series; it is the same as AO.

Table 1 shows the designations and the sizes in the A-series. It is an essential feature of this series that the dimensions are of the trimmed or finished sizes.

A4 is the size usually recommended and actually used in many countries for business correspondence (see Fig. 1). From the table, it will be seen that the older terms, folio, quarto, etc, are quite unnecessary; in fact, they are more ambiguous and less expressive than the new ones. It is well-known that the word 'folio' has several different meanings while the word 'quarto' means little more than a quarter of an undefined area. On the other hand, A4, for example, is a definitely expressive size, the dimensions of

TABLE 1 DESIGNATIONS AND SIZES IN THE A-SERIES IN THE METRIC AND FOOT-POUND-SECOND SYSTEMS

DESIGNATION	MILLIMETRES	INCHES
2A	1 189 × 1 682	46·81 × 66.22
A0	841 × 1 189	33.11 × 46.81
Al	594X 841	23.39 X 33·11
A2	420 × 594	16.54 × 23.39
A3	297 × 420	11·69 × 16.54
A4	210 × 297	8.27 × 11·69
A5	148X 210	5.83 × 8.27
A6	105 × 148	4.13 × 5.83
A l	74X 105	2.91 × 4·13

which, 210 mm x 297 mm. even if not known, can be easily worked out from the fact that its area is one-fourth of a square metre and its sides are in the ratio of $1 : \sqrt{2}$.

EXPRESSION OF DIMENSIONS

For unprocessed paper, by established custom and international agreement. the smaller dimension is given first. The use of the symbol, for example, A4, for a printed or processed sheet means that the shorter side is the base. Sheets, which are printed or processed for landscape use, are designed by the symbol followed by the letter b, for example, A4b.

LONG SIZES

It is generally agreed that the proportions of the sizes in A-series are pleasing but where different effects are required, these can be obtained by the use of 'long sizes' which are provided for in the international agreement. These sizes are also useful for tickets, cheques, labels and the like. The use of basic paper sizes for such work ensures the availability of paper and machines to carry out the work.

The long sizes, which are internationally recognized, are obtained by dividing an appropriate size from the regular series by three, four or eight, parallel to the shorter side. As examples:

ISO Sizes	*Millimetres*	*Inches*
$\frac{1}{3}$ A4	99 x 210	3·89 x 8·27
$\frac{1}{4}$ A4	74 x 210	2·9 x 8·27
$\frac{1}{8}$ A4	37 × 210	1·45 × 8.27

B- AND C-SERIES OF SIZES

Each size in the A-series being twice the next size, the adoption of only the A-series would have left big gaps and created difficulties in finding equivalent new sizes by which the existing sizes falling in these gaps could be replaced. Certain items like school exercise books and envelopes fall in this category. Again, some of the current sizes, such as foolscap, demy, etc, correspond more to sizes intermediate between two steps of A-series. Taking all this into consideration, it was decided, in the interest of effective and smooth change-over, to introduce a B-series consisting of geometrically intermediate sizes between the formats of the A-series and C-series, consisting of geometrical intermediate sizes between the formats of the A- and B-series. A further intermediate D-series was also suggested but experience in several countries has proved that there is no need for retaining this series.

TOLERANCES

The international sizes are trimmed sizes and these can usually be achieved with remarkable accuracy. Tolerances are, however, provided for in the international agreement and unless closer tolerances are stipulated at the time of ordering, the following tolerances are considered permissible by ISO:

For dimensions up to and including 150 mm	$\pm 1{\cdot}5$ mm
For dimensions greater than 150 mm and up to and including 600 mm	± 2 mm
For dimensions greater than 600 mm	± 3 mm

NOMENCLATURE

Having originated in Germany, the international sizes, before being taken up by ISA, were originally known as the DIN sizes. The term DIN series is derived from the German title ***Deutsche Industrie Norm*** (German Industrial Standards). Nowadays, however, the terms International Paper Sizes, IS0 Metric Paper Sizes, or just A-sizes, are internationally accepted, and are considered more appropriate.

ADOPTION

It is clear that much careful thought has been put into the devising of this paper size system. From the information available, it would appear that some 31 countries have so far issued national standards covering the A-sizes. In some countries the A-sizes have been made mandatory for certain purposes.

The following list shows the years in which the A-sizes were accepted as national standards by the countries listed:

Year	*Country*	*Year*	*Country*
1922	Germany	1951	Japan
1924	Belgium	1953	Denmark
1925	Holland	1953	Czechoslovakia
1926	Norway	1954	Israel
1927	Finland	1954	Portugal
1929	Switzerland	1957	India
1934	USSR	1957	Poland
1938	Hungary	1959	UK
1939	Italy	1960	Colombia
1941	Sweden	1960	Pakistan
1942	Uruguay	1962	Guatemala
1943	Argentina	1964	Yugoslavia
1943	Brazil	1965	East Germany
1947	Spain	1965	France
1948	Austria	1966	South Africa
1949	Romania		

SUBSTANCE IN THE METRIC SYSTEM

Quite apart from the standardization of paper sizes, yet another important progress made is in expressing the substance of paper in terms of grams per square metre (g/m^2). For a long time, paper was designated at so many pounds per ream of a particular size. It was not, therefore, possible to know which was the heavier paper. Wherever comparison was decided to be made, the weight of a standard ream of paper in the same size had to be calculated. For instance, one did not know which weighed more — 26 lb D/Crown paper in size of 20 in x 30 in or a 40 lb Q/Cap of size 27 in × 34 in. It was, therefore, necessary to convert the weight of the 26 lb paper D/Crown to the equivalent weight in Q/Cap to arrive at a comparison. Under the new system, which has now been accepted internationally

(ISO/R 58-1958 'Substances of paper') as well as by ISI (IS: 1763-1961 'Specification for substances of paper and pulp board'), the weight of paper is expressed in so many grams per square metre, or the weight in grams of a square metre of a sheet of paper. This system enables one to understand straightaway the relevant stock weights of different sizes and widths of paper, and has been considered adequate for the purpose in the paper and board industry without ambiguity. So far as the paper user is concerned. no calculation is required.

ADVANTAGES

The advantages of the new system can be summarized as follows:

1) Calculations are unnecessary;

2) The g/m^2 figure for any one kind of paper is the same whether the paper consists of one sheet, a ream, a reel, or even a fragment;

3) Substance is more accurately expressed in g/m^2 than in pounds per ream:

4) It applies equally to board as it does to paper;

5) It makes possible the use of simpler paper balances, as only one scale is required; and

6) Its use brings Indian printers in line with printers in many other countries, and will assist exporters.

WORK OF ISI PAPER SECTIONAL COMMITTEE

The Indian Standards Institution had set up a Special Committee on Weights and Measures in 1948 in concurrence with the Ministry of Industry and Supply of the Government of India. This Committee had come to the conclusion that India should adopt the metric system of weights and measures and had submitted a report in December 1949 to the Government of India in which detailed recommendations were made about the change-over. In consequence of this, India decided to adopt the metric system in 1955 and the Indian Parliament passed the *Standards of Weights and Measures Act* in December 1956.

In June 1950, the newly set up Paper Sectional Committee of ISI appointed a Paper Sizes Subcommittee, and the Subcommittee considered at its first meeting held in February 1951 the question of adopting the international sizes of paper discussed above. The initial reaction was that the printers and other users of paper would feel much inconvenience in accepting the proposal, and that, as the metric system was not being used in the country, the Committee could not recommend metric sizes for adoption, particularly because it might create some confusion. The Subcommittee considered also a joint note submitted by the Calcutta Printing Press Owners' Association and Calcutta Paper Traders' Association and recommended that 14 different sizes of paper, namely, small foolscap, foolscap, double foolscap, demy, medium, large post, John, royal, super royal, double crown, extra double crown, imperial, extra imperial and postal (only for post card board) should form the actual standards. It was further stated that these sizes could be extended upwards or downwards by doubling or halving, and all sizes were of rotary cut edges from the paper mills.

CONTINUED OPPOSITION

The opposition to the proposal to standardize paper sizes on metric basis continued for a long time, the general opinion being that these sizes could be adopted only after the country had switched over to the metric system of measurement in all the fields of industry. On the side of the paper mills, it was contended that they should not be hustled into accepting the international paper sizes until it had actually been standardized at the international level in the form of an ISO Recommendation. A further argument put forward was that so long as India continued to depend mainly on countries utilizing the inch-pound system, specially in respect of imported machinery, it would serve little or no purpose to adopt new dimensions in metric sizes.

Plea of ISI Directorate-The ISI Directorate put in a strong plea that although the existing sizes may not exactly fit into the international schedule of standard sizes, the matter should be given deep consideration partly because the difference in some cases was not considerable and partly because the Government of India itself was actively considering the proposal to introduce metric measurements for all purposes. The United Kingdom was also thinking on the same lines, and there could, therefore, be no question of shelving an important issue. There was, thus, a case for studying the matter on its merits. A negative attitude would also rule out the possibility of India participating in international discussions.

Notwithstanding all these arguments, there was still great opposition. It was finally at the fifth meeting of the Paper Sectional Committee held in joint session with the seventh meeting of the Paper Sizes Subcommittee on 21 December 1956, that is, just nine days before the metric system was officially adopted by an Act of the Indian Parliament, that the draft standard on metric paper sizes was ultimately finalized. At this meeting, the main argument advanced against the acceptance of the standard was the loss of machine capacity. All the technical aspects of the objections raised were thoroughly gone into, which included consideration of the various types of machines utilized in India, their maximum sizes and so on. It was conclusively proved that with the exception of crown 8vo or crown 4vo publications, for which also special provision had been made for the interim period, all the other publications and forms, if re-laid carefully to A-series, would yield exactly the same number of pages in the forme as at present on the existing machines. Thus, there was no fear of the existing printing capacity being rendered useless.

The ISI Directorate recognized the fact that both the printing industry and paper industry were in a stage of large expansion and that they would be needing more and more machinery and equipment. Both industries were, therefore, advised to ensure that the new machinery and equipment required either for replacements or for expansion should have to be for taking the new metric sizes of paper. It was realized that during the interim period it was necessary for both the mills and the printing industry to continue to use the old sizes of paper and to educate the public about the implications of the metric sizes. Consequently, it was agreed that both the new ISI series as also the prevailing sizes of paper would continue side-by-side initially for a period of ten years. To facilitate the switch over to the new metric sizes, Government presses tried to utilize double demy ($22\frac{1}{2}$ in x 35 in) size of paper for as large a number of publications as possible, because this size was very near to the Al size of paper.

The Chairman took pains to explain at the meeting that the problems of machinery and loss of capacity had also been looked into very thoroughly by the Development Wing of the Ministry of

Commerce and Industry which had conducted a survey of the printing machinery in use in the country. He said that as a result of this survey, the Department had come to the same conclusion that most of the machines could accommodate the A-series of sizes. There was, furthermore, provision for an ample transitional period to replace a machine, if necessary, as also for the continued use of the crown and foolscap sizes. The latter were actually taken care of by the B- and C-series of sizes. In due course, the draft standard finalized at the meeting was published as IS: 1064-1957 'Specification for paper sizes'. It covered only the trimmed sizes recommended by ISO. The standard was revised in 1961 mainly to include untrimmed (raw stock) sizes, described below.

UNTRIMMED (RAW STOCK) SIZES

The sizes described in the previous paragraphs are all trimmed sizes. Raw stock sizes in which paper is manufactured and stocked must necessarily allow for a margin for trimming. The untrimmed raw stock sizes are given in Table 2. They represent a compromise between the wide range of deckle widths of existing paper mills in the country and the minimum trimming margin required by the printing industry for various types of work. The ordinary raw stock sizes are appropriate to cover a large amount of general work, but for bleeding work and where extra trims are necessary, the special size may have to be ordered.

TABLE 2 UNTRIMMED (RAW STOCK) SIZES

Untrimmed Size Designation	Corresponding Trimmed Size	Standard Size (cm)	Special Size (cm)
RAO	A0	86 × 122	88 × 124*
RA1	A1	61 × 86	62 × 88*
RB1	B1	75 × 105	—
RC1	Cl	67 × 94	68 × 96*

*For bleed work or where extra trim is required.

These sizes at the time were based upon an agreed draft proposal prepared by the relevant Subcommittee of ISO, in anticipation of its formal adoption. Since then, two IS0 Recommendations have been published on untrimmed sizes. These are ISO/R 478-1966 'Paper. Untrimmed stock sizes for the ISO-A series (IS0 primary range)' and ISO/R 593-1967 'Paper. Untrimmed stock sizes for the ISO-A series (IS0 supplementary range)'. The former specifies the width of reels as 43, 61, 86 and 122 cm and the trimmed sizes are:

RAO 86 cm × 122 cm
RA1 61 cm × 86 cm
RA2 43 cm × 61 cm

In ISO/R 593, the specified width of reels is 45, 64, 90 and 128 cm, while the trimmed sizes are:

RAO 90 cm × 128 cm
RA1 64cm × 90cm
RA2 45 cm × 64 cm

Such national adoption of international recommendations, even before they are formally adopted and officially issued, often becomes necessary, particularly in India, as no doubt in other countries. The practice which is unavoidable in the context of the needs of the developing countries amply emphasizes the urgency of streamlining the international procedures.

CONFERENCE OF HEADS OF PRINTING DEPARTMENTS

The adoption of metric paper sizes in public sector was expected to give a lead to the private sector industries. But this brought in its wake a number of problems which were found to be necessary to be ironed out with Heads of the various Printing Departments under the Government. The then Ministry of Commerce and Industry, therefore, held a conference of these Heads early in 1961. The Joint Secretary of that Ministry, Shri K. V. Venkatachalam, who presided over the Conference, stated that IS1 had already recommended standardizing the metric sizes of trimmed paper, and a draft standard on the untrimmed paper sizes had also been circulated to elicit comments from various quarters. He mentioned that these sizes conformed to IS0 Recommendations and paper makers in the country were ready and willing to supply the paper in accordance with the metric sizes. Unfortunately, he found that there was little demand for these sizes from the users. He pleaded that for the progressive adoption of the metric system in various fields in the country, it was most important that the users of paper also increasingly introduced standard metric sizes. The Government had a particular obligation in the matter as one of the biggest users of paper in the country, and it was but proper that they made an early beginning. He mentioned that the Chief Controller of Printing and Stationery (CCPS) had already adopted the A-series of metric sizes for a number of important stationery items and the Department of Printing and Stationery in the State Governments should follow the lead.

PROBLEMS AS ANALYZED BY CCPS

The CCPS stated that he had analyzed the objections and problems relating to the use of metric sizes of paper in various types of machines already working in the Central and State Government presses. His officers had taken pains to study the possible loss of capacity as a result of switch over to new series, and he was glad to report that although the number of pages might increase, there would not really be any increase in the quantum of printing work. He admitted, however, that there would be some increase of stitching and binding of books. At the same time, since two-thirds of Government work consisted of printing forms where no stitching was involved, the total increase in workload was not likely to be much. He said that B-sizes of paper could be used on machines which could not accommodate the A-series without heavy loss of machine capacity. In the circumstances, there was hardly any need to scrap any of the existing machines. He, however, hoped that the machines in use which could not accommodate A-series of sizes might come in for replacement in a period of less than 10 years, the time allotted by IS1 for this change. It may be, that in the switch over to new metric sizes, new chassis would have to be introduced with a view to using more and more of A-sizes of paper.

CONFERENCE DECISIONS

After some discussion, it was ultimately agreed at the Conference that the Central Government and the State Governments being the biggest users of paper in the country should make an early beginning in the use of A-sizes of paper. Amongst the other decisions taken were that all machinery coming as replacements must be able to use A-sizes of paper and that an officer may be appointed in each State, wherever necessary, to examine the forms in use and re-design them with a view to bringing as many of them as possible in the A-series of sizes. The denomination of paper sizes in centimetres, as also the expression of the weight of stock in terms of g/m^2 were also accepted.

REVISED INDIAN STANDARD

The revised Indian Standard (IS: 1064-1961) issued in December 1961 and referred to earlier in the chapter contained, besides the untrimmed (raw stock) paper sizes given in Table 2, the equivalent measurements in inches of the new sizes rounded off to half an inch for the convenience of the trade. The rounding off was done to the nearest or farthest half inch, keeping in view the capacity of the printing machines and other particulars, with a view chiefly to helping the manufacturers and the consumers to acquaint themselves with equivalents of the metric sizes during the interim period. The trade was, nevertheless, strongly advised to adopt the metric system of measurements from the very beginning for a smooth final change-over.

The exact sizes of the A-series suitable for various commercial formats were also given for the general information of the trade.

Thus, the revised standard contained the basic principles behind paper sizes, the system of measurement, the basic sizes in A-series, additional sizes in B- and C-series, all the trimmed sizes, untrimmed (raw stock) paper sizes, etc. Tables 2, 3 and 4 give these sizes both in millimetres and inches.

PROGRESS

The progress of the introduction of metric sizes of paper by various departments of the Government of India as also in the States has been steady. Even the private sector trade has started using these sizes liberally, for one finds a number of journals, house organs, circulars, leaflets and the like being printed in A4 size of paper.

On the Government side, the office of the Chief Controller of Printing and Stationery at the Centre, and Directors of Printing and Stationery in the State Governments, to whom all requisitions for printing are generally sent, scrutinize these indents very carefully

TABLE 3 PRINCIPAL SIZES — A-SERIES

SL No.	DESIGNATION	SIZE (mm)	EXACT SIZE (in)	ROUNDED SIZE (in)
i)	4A	1 682 × 2 378	66.22 × 93.62	66 × 939
ii)	2A	1 189 × 1 682	46.81 × 66.22	47 × 66
iii)	A0	841 × 1 189	33·11 × 46·81	33 × 47
iv)	A1	594 × 841	23·39 × 33.11	$23\frac{1}{2} \times 33$
v)	A2	420 × 594	16.54 × 23.39	$16\frac{1}{2} \times 23\frac{1}{2}$
vi)	A3	297 × 420	11·69 × 16.54	$11\frac{1}{2} \times 16\frac{1}{2}$
vii)	A4	210 × 297	8.27 × 11.69	$8\frac{1}{2} \times 11\frac{1}{2}$
viii)	A5	148 × 210	5·83 × 8.27	$6 \times 8\frac{1}{2}$
ix)	A6	105 × 148	413 × 5.83	4 × 6
x)	A7	74 × 105	2.91 × 413	3 × 4
xi)	A8	52 × 74	2·05 × 2.91	2 × 3
xii)	A9	37 × 52	1·46 × 2·05	$1\frac{1}{2} \times 2$
xiii)	A10	26 × 37	1·02 × 1.46	$1 \times 1\frac{1}{2}$
xiv)	A11	18 × 26	0·73 × 1.02	$\frac{3}{4} \times 1$
xv)	A12	13 × 18	0·51 × 0·73	$\frac{1}{2} \times \frac{3}{4}$

and ensure that wherever possible jobs are designed for production in metric sizes of paper alone. It will, therefore, be found that Government publications both in the Centre as also in the States are now being printed in A4 size and other subdivisions.

The main sections of the official Gazettes in the Centre as also in the States, journals and magazines are now being printed in A4 size, while the annual reports and other publications which were produced normally in royal octavo sizes are now being laid out for printing either in A4 or A5 size. It has, however, to be appreciated that in the process of changing over from old sizes to the new metric sizes, certain publications which were produced in the form of a series would have to continue to be printed in the old sizes for some time to come. In the case of new publications, however, there can be an insistence on the adoption of metric sizes.

Turning then to the placement of orders for the new printing machines, in every case of purchase of a new machine coming in as a replacement for, or as an addition to the old presses, or for use in the new projects, the specifications are being carefully screened with a view to ensuring that each new machine ordered is able to take the metric size of paper. Since a majority of the printing machines has still to be imported into the country, the industry as

TABLE 4 PERMISSIBLE SIZES OF WRITING, PRINTING AND CARTRIDGE PAPERS IN ADDITION TO THE SIZES OF A-SERIES

Sl No.	Series Designation	Size of Series (mm)	Exact Size (in)	Rounded Size (in)	Existing Sizes		
					Designation	in	mm
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	B1	707 × 1 000	27.83 × 39.37	28 × 39½	Crown Quad	30x40	762 × 1 016
ii)	B2	500 × 707	19.68 × 27.83	20 × 28	Crown Double	20 × 30	508 × 762
iii)	B3	353x 500	13·90 × 19·68	14 × 20	Crown	15x20	381 x 508
iv)	C1	648x 917	25.51 × 36.10	25½ × 36	Foolscap Quad	27 × 34	686x 864
v)	C2	458X 648	18.03 × 25.51	18 × 25½	Foolscap Double	17x27	432x 686
vi)	C3	324x 458	12·76 × 18·03	13 × 18	Foolscap	13½ × 17	343 × 432

well as Government departments have sometimes to accept machines as designed and plan their publications in sizes acceptable to the indentors, without much loss of machine capacity. The Directorate General of Technical Development which clears the import licences for machinery from indigenous availability angle and the State Trading Corporation which imports the machinery from the East European countries take care to ensure that each unit is capable of taking metric sizes of paper.

On the question of production of paper in metric sizes, all objections from the paper manufacturers have practically disappeared since it has been proved that by a combination of sizes, it is possible to use the existing deckle width without loss of machine capacity. Mills have, therefore, started accepting freely orders for paper in metric sizes. The duplicating machines manufactured in India as also the duplicating paper are almost always now made in A-series. It can, therefore, be hoped that not many years from now India will be using metric sizes of paper and machinery for all its major requirements. □

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And the Present

Lal C. Verman
V. B. Mainkar

The material presented in earlier chapters of the book pertains mostly to the experience of the ten-year plan period, 1956-1966, which was originally set aside for a complete change-over in the country to the metric system. It would, however, be seen that in some sectors of the economy, complete change-over could not be regarded to have been achieved during the planned period in the fullest measure. But most sectors might be considered to have been fairly completely converted to the new system. In trade and commerce, of which decimal currency is an integral part, it may be claimed that as complete a change has been achieved as might be desired, both in retail as well as the wholesale markets. In certain other sectors, though the progress has been considerable, a good deal remains to be done, as in the case of engineering industries, particularly in the fields of mechanical and civil engineering. In certain other fields, a programmed change-over is approaching completion, for instance, in the field of higher technical education in the universities and in other institutes of engineering and technology. In one case, that is, the land records, the period for achieving complete conversion may extend to a few years more, though for the current operations, adequate conversion has been effected. Even old records have been systematically converted in many cases and are being converted in others.

The most significant fact that has emerged from experience is that the common man has proved to be extremely receptive to the new idea and the fact of the change. He has exhibited an extraordinary degree of understanding, both of the need for the change as also of what it implied for him personally. This was perhaps due to his prior familiarity with the normal decimal counting system and to his realization of the possible benefits resulting to himself and the country from the use of a simplified, uniform and rational system of weights and measures. In fact, the illiterate and the moderately educated were found to adopt the use of the new system more readily than the more sophisticated and educated classes. The older generation of engineers and technologists found it perhaps most difficult to change their habits of thought and usage, largely because it involved a process of unlearning something learnt and used for decades.

In spite of the various difficulties, whether psychological, practical or theoretical, all classes of people gave full support to the programme of change-over. The result is that India can today be classed among those countries of the world where the metric system is not only recognized as the only legal system of weights and measures but where it is also used in practice in almost all sectors of the national economy. Furthermore, it may confidently be stated that whatever gaps remain are well on their way to be eliminated.

Since the end of the ten-year change-over plan period (in

December 1966), several reviews are being made to assess the progress of change-over in individual sectors of economy and to determine what may still be necessary to be done. Among other things, it has been found that a few of the Government departments, both in the States and at the Centre, have found it difficult to achieve fully their targets within the stipulated period of time. Apart from the problems of the Land Record Departments referred to above, examples may be cited of the Public Works and Irrigation Departments. Certain commercial sectors, like the timber trade are also lagging behind. But every effort is being mounted to identify and quickly eliminate such gaps at the earliest possible opportunity.

SYSTEME INTERNATIONAL D'UNITES

Another feature of the Indian programme is of interest, and that is in regard to the International System of Units, otherwise simply known as the SI (see Appendix 1). At the time the metric reform was originally proposed by the Indian Standards Institution (ISI) in 1949, the SI had not yet been adopted by the *Conférence Générale des Poids et Mesures* (CGPM). Later, when the legislation was drafted and adopted in 1956, it was the SI set of units that was specified and legalized as the basic units, with the proviso that any power of 10 of these basic units may be used as secondary units. At that stage there was no serious or concerted move afoot in any country of the world, metric or non-metric, for the introduction of the SI units as such or units derived therefrom for daily use in trade and industry. It was later, in the early sixties that the International Organization for Standardization (ISO) began seriously to consider the adoption of the SI form of the metric units in a more general context and of course, the *Organisation Internationale de Métrologie Légale* (OIML) was also equally deeply involved.

India's primary concern, however, from the very beginning was naturally to replace the multiplicity of its weights and measures with one uniform system and to re-organize its economy on that basis. At that stage, in 1956, her concern with the question of SI as such, or any other system based on metric units, was entirely secondary. Nor did there exist internationally any agreed set of secondary, derived or supplementary units based on SI for practical adoption. lndeed the debate is still continuing on the question of the selection of such a set of units. In this debate, it would appear that the UK is inclined to advocate the adoption of an undiluted form of ST, while the older metric countries, for quite obvious reasons of existing practices, are hesitating to go the whole way in that direction. The field of disagreement has, however, been considerably narrowed down. It seems to be limited to a few units, such as those for stress, pressure and viscosity. These differences are expected to be resolved shortly. Having achieved the primary purpose of the adoption of the metric system, India is now revising its weights and measures laws to orient them towards the recognition of all the SI units recommended by the CGPM and the OIML.

TASKS AHEAD

India is also turning its attention to other matters directed to the strengthening and integration of the weights and measures administrations, extending the related legislation to fields other than purely commercial, critically examining the relative roles which the States and the Centre could play in promoting the efficiency of the various services involved, promoting the development of scientific metrology to meet the growing and complex needs of modern technology and so on. In these tasks, the main part is being played by the newly created Directorate of Weights and Measures. Two Central Government Committees — one concerned with the legislative questions and the other administrative matters — have been set up to examine the related issues in detail. While the deliberation and planning stages may take another year or so, there can be little doubt that India will move rapidly towards modernization and in doing so make every effort to profit from the experience of more developed countries. In this effort the deliberations and recommendations of the OIML will indeed be basic, as they pool the experience of the world as a whole.

It is too early to predict the exact nature of the extensions and changes that may be brought about in the near future in the present set-up, but some indication may be given of the matters that are currently under consideration. It is, for instance, being contemplated to extend the existing laws on weights and measures to cover additional fields of public health and safety, education and industry.

PUBLIC HEALTH AND SAFETY

The control of measures and measuring instruments, used to ensure public health and safety, is a comparatively new activity for weights and measures administrations, but it is important that all such equipment be regulated in terms of the normal measurement standards of the country. Under this category is to be included the verification of such measuring devices as clinical thermometers, blood pressure instruments, X-ray dosimeters, dioptometers, audiometers, illumination measuring instruments and other similar devices used for precision measurements, the accuracy of which is to be guaranteed in the interest of the well-being and health of the people. It must be recognized that a clinical thermometer or a blood pressure measuring device, which is not accurately calibrated, might give readings having little relation to the real state of health of the patient and lead to wrong diagnosis and medication. If illumination levels in factories, schools, colleges and on roads are not measured periodically against standard illumination devices, the requisite minimum amount of light may not be available. This may affect the eye-sight of millions of youngsters. It could also lead to traffic hazards. Instruments used for applying insecticides, pesticides or herbicides to crops, fruits and vegetables have to deliver the chemicals in measured quantities and doses. Unless the accuracy of application is properly controlled, under-dosing or over-dosing may result, leading to inadequate protection of the crop, or alternatively, to the produce becoming a health hazard for the consumer. Legislative measures are, therefore, being considered which will enable weights and measures administrations to help safeguard against such dangers.

EDUCATION

Since Independence, the educational facilities in schools and colleges in the country, particularly in science and technology, have increased phenomenally. The industry which produces the various measuring devices for use in these schools and colleges has not kept pace with this rapid development. Because the demand is high and pressing, the quality of measuring devices like balances, weights, measures, apparatus, etc, has not improved to the desired extent. Even a brilliant student would be faced with insuperable difficulty to learn his chemistry properly if his balance and weights were inaccurate.

Under the present legislation, though commercial transactions are required to be carried out in terms of standardized metric weights and measures, there exists no legal provision for controlling the accuracy of educational equipment and apparatus. However, instead of immediately resorting to legislative measures, it is proposed that facilities to verify periodically the weights, measures and measuring instruments used in schools and colleges should be informally and immediately made available by the weights and measures organizations. If the informal arrangements fail to produce the desired results, the objective may have to be achieved through extension of legislation.

INDUSTRY

In the field of industry, the accuracy of measurements is daily being pushed to higher and higher levels, largely because of the development of new technologies, such as automation, nuclear engineering, space science and so on. Even in developing countries like India, mass production of industrial goods is being organized more and more on a decentralized basis, in which parts and components are produced in numerous small, medium and even cottage-scale factories, spread all over the country, which are then assembled in a central plant. For such an operation to be economically profitable and technically successful, it is essential that the measuring and gauging equipment used at all stages of production be accurately made and maintained well within permissible limits of variation as measured in terms of the national standards. While the facilities of the National Physical Laboratory (see Chapter 9) provide services for checking all the subsidiary standards in terms of national standards, they cannot be extended to cover the nation-wide need for calibrating all the industrial measuring instruments used for ensuring reproducibility and interchangeability among all the widespread centres of production at all levels.

Several large complexes of industry, such as the Hindustan

Machine Tools Factory at Bangalore and the Machine Tool Prototype unit at Ambernath have their own facilities for this purpose. But for the use of numerous other relatively smaller units, which cannot afford an independent set-up of such an expensive nature, it is felt necessary to provide a central national calibration service under the weights and measures laws. Such a service, provided by the weights and measures organizations, would make available facilities for the calibration, checking and verification of the accuracy of every type of equipment used in industrial measurements. Slip gauges, length bars, precision scales, rollers, parallels, squares, straightedges, surface plates, optical flats, gauges, thread-measuring cylinders, calipers, micrometers, vernier calipers, dial gauges and angle-measuring instruments are a few examples of mechanical measuring instruments which would have to be dealt with. In the field of electrical industry, the calibration of resistance, inductance, capacitance, voltage, current, power, frequency, etc, may be covered. Instruments for the measurement of fluid flow, time, temperature, luminous intensity, sound and ionizing radiations would all come under the umbrella of the calibration service.

The scheme for providing such a calibrating service for industrial purposes will be ushered in under the weights and measures laws. It may then be necessary that certain accuracies and allowable limits of variations should be legally specified for specific types of instruments used in critical measurements. It may further require certain important types of instruments to be calibrated from time to time at a specified periodicity.

WEIGHTS AND MEASURES ORGANIZATIONS

In addition to such organizational and legislative measures, it is expected that in the years ahead, the sphere of work of the weights and measures organizations would generally be enlarged in other useful directions. Today, the total number of inspectors of weights and measures and officers exceeds 1 200, while the total staff strength is over 3 500. There will be progressive increase in inspectors, officers and staff as trade and industry increase. There is a strong feeling that the new lines of work should be in keeping with the recommendations of the International Organization for Legal Metrology (OIML) which deals with the totality of weights and measures legislation, and of which India is an active member.

Besides its legal and administrative character, the work of standardization and enforcement of weights and measures is technical enough today. With the addition of the new tasks envisaged above it is bound to become even more technical and scientific. Necessary thought is, therefore, being given to orient the weights and measures policies at the Centre and in the States to facilitate meeting the new and more complex demands of the future.

Inspectors of weights and measures would have to be scientifically and technically better qualified and be given an adequate status. They would have to be trained thoroughly in all the scientific and technical aspects of their work, as also in their legal responsibilities and public obligations. With a view to enlarging the scope of their training, the Institute of Training which has been set up at Patna under the Government of the State of Bihar (see Chapter 8) is presently being taken over by the Centre. It is planned to be suitably equipped with such assistance from other countries as may be called for.

Active consideration is also being given to what would be the future pattern of the new organizations of weights and measures, how the load of work created by the new activities could be estimated and distributed, and how the weights and measures organizations could be systematically expanded and streamlined as the laws are gradually extended to newer fields. It would naturally be the constant endeavour of the weights and measures authorities to ensure that, in the domain of their work, India continues to promote and safeguard the interests of consumers, provide the requisite facilities to the growing complex of industries, and, in general, meet the ever-increasing demands of the developing economy of the country. □

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Appendices

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APPENDIX 1

Metric Based Systems of Units and the SI Units

Dr B. N. Singh

Any system of measurement is developed on the basis of a few well-defined units for certain basic quantities like length, mass, time, etc. These units constitute the basic units. The units for other quantities are derived from the basic ones by virtue of the relationship between the quantities concerned. It is a free choice as to which quantities are to be considered as basic. The two systems of units, namely, the fps system and the metric system, which have been in vogue for a long time, have considered the length, mass and time as the basic quantities, and the units corresponding to them have been taken as basic units. However, in another system of units, often used in engineering and referred to as the gravitational system, the length, force and time are regarded as basic quantities.

Whatever the system of units, it is imperative that the basic units are clearly and objectively defined as also that they remain invariant at different places. Accordingly, the use of the gravitational system is really not desirable as the acceleration due to gravity (g) being involved in the definition of the unit of force is a local constant and varies from place to place.

As regards the fps system, it is already giving way to the metric system even in the few countries where it has been in use until recently because of the obvious advantages of the metric system as discussed earlier in this book.

METRIC BASED SYSTEMS OF UNITS

The metric system of units has been improved from time to time ever since it was originally established in France after the French Revolution. However, since it did not recommend the use of any unique set of units for various types of quantities, different systems of units were adopted depending upon the practical needs and the stage of scientific and industrial development. The systems commonly recommended for use in science, engineering, technology and trade varied from time to time and until recently included the following:

1) centimetre-gram-second (cgs),
2) metre-kilogram-second (MKS),
3) metre-tonne-second (MTS), and
4) metre-kilogram-second-ampere (MKSA).

The cgs system of units has been used mostly for precise measurements in science, for example, in the laboratories. It has also been used for teaching science in the schools and universities. However, this system of units was not generally used by the engineers and technologists, nor in commerce and trade, because the units were too small to be of any practical value.

The object of establishing the MKS system was to make necessary modifications in the cgs system with metre as the unit for length and kilogram for mass, as these units were considered to be more suitable for practical engineering purposes. However, in certain cases, particularly in big industrial transactions, as also certain types of testing work, even kilogram as the unit of mass was not found adequate. Accordingly, a slightly different system of units, namely, metre-tonne-second (MTS) was also sometimes used.

It was felt later on that these units were not quite comprehensive in the sense that they did not cover certain other basic quantities like electric current, temperature, etc, and also the corresponding units were not uniquely chosen. As a result, different units were used for these quantities in practice. To obviate these difficulties, the ninth *Conférence Générale des Poids et Mesures* (CGPM) adopted in 1948, the 'ampere' as the fourth basic unit for electric current, thereby leading to the MKSA system of units. This system also helped in linking the mechanical units with electromagnetic units.

SI UNITS

In 1954, the tenth CGPM decided to adopt, apart from the MKSA units, degree Kelvin as the unit of temperature and candela as the unit of luminous intensity. These units were also adopted by the International Organization for Standardization (ISO) in 1956 and by the International Electrotechnical Commission (IEC) in 1959. The eleventh CGPM in 1960 formally designated the set comprising these units as "*Système International d'Unités*" (International System of Units), with the abbreviation 'SI' in all languages. This Conference also adopted two supplementary units and a number of derived units, besides the six basic units, as given on the next two pages.

BASIC UNITS

Quantity	*Name of the Unit*	*Unit Symbol*	*Definition of the Unit*
length	metre	m	The length equal to 1 650 763·73 wavelengths in vacuum of the radiation corresponding to the transition between the energy levels $2p_{10}$ and $5d_5$ of the krypton-86 atom.
mass	kilogram	kg	The mass of the international prototype kilogram. NOTE — The international prototype is in the custody of the *Bureau International des Poids et Mesures* (BIPM), Sbvres near Paris.
time	second	s	The interval occupied by 9 192 631 770 cycles of the radiation corresponding to the $(F=4, M_F=0)$ — $(F=3, M_F=0)$ transition of the caesium-133 atom when unperturbed by exterior fields.
electric current	ampere	A	That constant current which, if maintained in two parallel rectilinear conductors of infinite length, of negligible circular cross-section, and placed at a distance of one metre apart in a vacuum, would produce between these conductors a force equal to 2×10^{-7} newtons per metre length.
thermodynamic temperature	degree* Kelvin	°K*	The degree interval of the thermodynamic scale on which the temperature of the triple point of water is 273·16 degrees Kelvin exactly.
luminous intensity	candela	cd	The unit is such that the luminance of the integral radiator, at the temperature of solidification of platinum, is 60 candelas per square centirnetre.

SUPPLEMENTARY UNITS

Quantity	*Name of the Unit*	*Unit Symbol*
Plane angle	radian	rad
Solid angle	steradian	sr

*Degree Kelvin, °K, was changed to Kelvin, K, by the thirteenth CGPM held in November, 1967.

DERIVED UNITS

Quantity	*Name of the Unit*	*Unit Symbol*
Area	square metre	m^2
Volume	cubic metre	m^3
Frequency	hertz	Hz (s^{-1})
Density	kilogram per cubic metre	kg/m^3
Speed	metre per second	m/s
Angular velocity	radian per second	rad/s
Acceleration	metre per second squared	m/s^2
Angular acceleration	radian per second squared	rad/s^2
Force	newton	N (kg m/s^2)
Pressure	newton per square metre	N/m^2
Viscosity (dynamic)	newton second per metre squared	N s/m^2
Viscosity (kinematic)	metre squared per second	m^2/s
Work, energy, quantity of heat	joule	J (N m)
Power	watt	W (J/s)
Quantity of electricity	coulomb	C (A s)
Electric tension, potential difference, electromotive force	volt	V (W/A)
Electric field strength	volt per metre	V/m
Electric resistance	ohm	Ω (V/A)
Electric capacitance	farad	F (A s/V)
Magnetic flux	weber	Wb (V s)
Inductance	henry	H (V s/A)
Magnetic flux density	tesla	T (Wb/m^2)
Magnetic field strength	ampere per metre	A/m
Magnetomotive force	ampere	A
Luminous flux	lumen	lm (cd sr)
Luminance	candela per square metre	cd/m^2
Illumination	lux	lx (lm/m^2)

RATIONALE OF SI UNITS

The SI units comprise a ‘coherent system’, as the product or quotient of any two quantities or more in the system leads to the unit of the resultant quantity. Thus, in this system, unit area is obtained when unit length is multiplied by unit length; unit velocity is obtained when unit length is divided by unit time; unit of force ‘newton’ results from unit of mass being multiplied by unit of length and the product being divided by unit of time squared and soon.

SI is also universal in the sense that its unit of force ‘newton’ is independent of the acceleration due to gravity (g) and is, thus, applicable everywhere. Besides, one and the same unit ‘joule’ is applicable to the measurement of work, energy and quantity of heat, thereby linking the various forms of energy.

The SI units are quite comprehensive as they cover most of the basic quantities encountered in science, engineering, technology, industry and commerce.

The SI units are also more practical as they avoid either too small units (as in the cgs system) or too large units (as in the MTS system).

That is why the SI units are now being universally accepted by most international authorities, settling thereby a long existing controversy between various other systems of units devised and proposed from time to time.

In spite of the many advantages of the SI units, certain practical difficulties are encountered in using them in their purest form for many transactions. For example, it is very inconvenient to use kilogram, the SI unit of mass, for medical purposes or laboratory work where very small quantities are to be weighed. Similarly, metre, the SI unit for length, is rather too small for measuring distances between large cities. Accordingly, the tenth and twelfth *Conférence Générale des Poids et Mesures* (CGPM) recommended the following prefixes for forming suitable multiples and sub-multiples of SI units for practical purposes:

Factor by Which the Unit is Multiplied	*Prefix*	*Symbol*
1 000 000 000 000 = 10^{12}	tera	T
1 000 000 000 = 10^{9}	giga	G
1000000 = 10^{6}	mega	M
1 000 = 10^{3}	kilo	k
100 = 10^{2}	hecto	h
10 = 10^{1}	deca	da
0·1 = 10^{-1}	deci	d
0·01 = 10^{-2}	centi	c
0·001 = 10^{-3}	milli	m
0·000 001 = 10^{-6}	micro	μ
0·000 000 001 = 10-9	nano	n
0.000 000 000 001 = 10^{-12}	pico	p
0·000 000 000 000 001 = 10^{-15}	femto	f
0.000 000 000 000 000 001 = 10^{-18}	atto	a

ISO EFFORTS

However, any indiscriminate use of multiple and sub-multiple of units offered by a free choice of the above prefixes would result in an unimaginable array of units in practical use, defeating the very purpose of having a compact system of SI units. Hence, the need was felt for internationally recommending an appropriate rational selection of the multiples and sub-multiples of the SI units for use in specific sectors of industry and trade for specific quantities. Accordingly, the task was assigned to the Technical Committee on 'Quantities, Units, Symbols, Conversion Factors and Conversion Tables' (ISO/TC 12) of the International Organization for Standardization for making recommendations regarding the proper choice of the minimum number of units to cover most fields of industries and trade. The Committee was also to recommend as to which multiples and sub-multiples of any particular units were to be preferred and the actual method of introduction of such an extended set of Sl units both in metric and non-metric countries. ISO/TC 12 then set up a Subcommittee ISO/TC 12/SC 2 'General Rules for the Use of Sl Units, Their Multiples and Sub-multiples in the Various Industries' for studying in detail the problem regarding standardization of general rules for the use of SI units and the selection of suitable multiples and sub-multiples of these units for application in various trades and industries. The deliberations of this Subcommittee, duly ratified by ISO/TC 12, have led to the development of ISO/R 1000-1969 'Rules for the Use of Units of the International System of Units and a Selection of the Decimal Multiples and Sub-multiples of the Sl Units'. As an IS0 Recommendation, this document constitutes an important international guide for the universal adoption of Sl units in practice.

For further details regarding the various aspects of Sl units covered in this Appendix, reference is invited to the publication 'A Guide to the Use of International System (SI) Units' of the Indian Standards Institution (ISI). □

APPENDIX 2

Report of the Indian Standards Institution Special Committee on Weights and Measures, 1949

1. HISTORICAL BACKGROUND

1.1 Weights and measures in India have never been standardized for the country as a whole. As a consequence numerous systems exist resulting in a confusing state of diversity, significant variations occurring from village to village sometimes in the same district. With the increase in the commercial and industrial activities in the country, this diversity has created an element of uncertainty in trade and has rendered fraud, specially on the part of retailers, as easy as it is profitable. Attempts at standardization, however, date as far back as 1801. Since then the Central and the Provincial Governments have appointed several committees, at different times; notable among those are the committees appointed by the Government of India in 1867-68 and in 1913-14. But the results achieved did not go beyond the Regulation VII of 1833 which fixed the weight of the Furruckabad rupee at 180 grains English weight, the Government of India Resolution of November 1854 which fixed the standard railway maund at 40 seers ($82\frac{2}{7}$ lb) and the *Measure of Length Act of* 1889 which fixed the imperial yard with its subdivisions in feet and inches as the primary unit of length.

1.2 Failure of all these attempts displays a tragic lack of unity of purpose as between the Secretary of State for India and the then Government of India. The Committee of 1867-68 recommended the adoption of the English Standards of weights and measures with, however, a strong note of dissent from three of its members who recommended the metric system. The Government of India accepting the minority note of dissent, passed the *Indian Weights and Measures*

Act of 1870 which defined the kilogram as the standard of weight. The Act was, however, refused sanction by the Secretary of State on the ground that it was too severe and extensive. The Government then modified the Act, still keeping the unit of weight, the seer, equal to the kilogram, and reintroduced it in August 1871 (Act *XXXI of 1871*). But even this amended Act has remained a dead letter in the Statute Book, since no notification has ever been issued under it.

1.3 In 1901 the Secretary of State for India forwarded to the Government of India a paper presented to the Parliament regarding the adoption of the metric system by European countries. By that time, however, the Government of India had come to the decision that the adoption of the metric system by the UK should precede its adoption by India.

1.4 The Committee of 1913-14 made an extensive survey of all attempts at standardization of weights and measures since 1801. In their deliberations, the Committee issued two questionnaires, ascertained the views of all Provincial Governments and examined witnesses from Chambers of Commerce, leading citizens, merchants and traders. They made definite recommendations for the adoption of a standard system which they based on a combination of the Indian and the English systems. One of the three members, Mr A. Y. G. Campbell, however, submitted a strong note of dissent recommending that it was eminently desirable that the Government should take steps without further delay to constitute the metric system as the uniform system of weights and measures in India.

1.5 The report of the 1913-14 Committee met with the approval of the Central as well as the Provincial Governments. The Government of India, however, decided to adopt standards of weights only and not of length or area. They further felt that the enforcement should, for the time being, be carried out under Provincial Legislations till such time as a strong opinion for Central Legislation was formed.

1.6 By 1939 public opinion for a Central Legislation was considered as having crystallized to the extent that the Central Legislature could pass the *Standards of Weights Act (Act IX of* 1939) applicable to the whole of British India. The Act repealed the *Weights and Measures of Capacity Act XXXZ of 1871* in so far as the establishment of standards of weights was concerned. The Governor General gave his assent on 28 March 1939 and by Notification No. 33-(6)/37A dated 13 June 1942 the Act was brought into force from 1 July 1942. The Act defined the standard grain in terms of an iridioplatinum cylinder in the custody of the Mint Master, Bombay, and laid down the following standards of weights in terms of the standard grain:

a) the standard tola, being a weight of 180 standard grains;

b) the standard seer, being a weight of 80 standard tolas or 14 400 standard grains;

c) the standard maund, being a weight of 40 standard seers;

d) the standard pound, being a weight of 7 000 standard grains;

e) the standard ounce, being one sixteenth part of the weight of a standard pound;

f) the standard hundred-weight, being a weight of 112 standard pounds; and

g) the standard ton, being a weight of 2 240 standard pounds.

1.6.1 In the ***Government of India Act of*** 1935, though 'standards of weights' is a Central subject, 'weights and measures' is in the Provincial List. Accordingly, the Government of India had to request the Provincial Governments to undertake legislations for enforcement, following the lead given in ***Act IX of*** 1939. In the present Constitution this ambiguity has been set right by including ***establishment of standards of weights and measures*** in the Union List of subjects and ***weights and measures except establishment of standards*** in the States' List.

1.6.2 The Government of C.P. in 1928 and the Government of Bombay in 1932 had already enacted legislations on weights and measures. As a result of the request from the Government of India, other Provinces, except Bengal and Assam, also passed similar Acts. The position of the Provincial Legislations, as it stands now, is as follows:

Assam	No Act on weights and measures.
Bihar	Weights Act, 1947 (Act XVII of 1947).
Bombay	Weights and Measures Act, 1932 (Act XV of 1932).
C.P.	Weights and Measures Act, 1928 (Act II of 1928).
Madras	Weights and Measures Act, 1948 (Act XXII of 1948).
Orissa	Weights and Measures Act, 1943 (Act VII of 1943).
Punjab	Weights and Measures Act, 1941 (Act XII of 1941).
U.P.	Weights and Measures Act, 1947 (Act XXIII of 1947).
West Bengal	No Act on weights and measures.

1.6.3 The various Provincial Legislations generally conform to the Central Legislation with a few exceptions, The unit for the measure of length is usually the yard, defined as the length of the standard yard maintained by the Mint Master at Bombay. For longer measures, the furlong (220 yards) and the mile (1 760 yards) are provided; for measures of area and volume, square and cube of the standards of length; acre (4 840 sq yd) being additionally allowed for area. Local units for dry and wet measures of capacity, which vary from Province to Province, are also allowed in the Provincial Acts, but they are usually made integral multiples or sub-multiples of the basic units.

1.7 By the time the Government of India passed the Act of 1939, unofficial opinion in the country grew more inclined to the adoption of the metric system on an all-India basis. In 1940 the Manufacturing Subcommittee of the National Planning Committee, in their interim report, made the following recommendation:

> 'Standardization of weights and measures on all-India basis should be carried out at an early date so that a uniform system of weights and measures is applicable to the whole country. For this purpose an institution similar to the British Standards Institution should be established at a central place. If other conditions permit, the metric system should be adopted for this purpose.'

1.8 On 4 February 1946 a Bill was introduced by the Government of India in the Legislative Assembly to convert the currency to the decimal system of coinage, retaining the rupee as a standard unit and dividing it into 100 cents. This Bill was circulated for eliciting public opinion.

1.9 The Indian Science Congress Association at its Bangalore session in 1946 passed a resolution strongly advocating the decimalization of currency and weights and measures, simultaneously if possible. The matter was further considered at a meeting of the Executive Committee of the Indian Science Congress Association held on 8 March 1946 and presided over by Pandit Jawaharlal Nehru, and the following resolution was passed unanimously:

> 'Resolved that the Science Congress notes with satisfaction that a Bill for the decimalization of Indian Currency has been introduced in the Legislative Assembly. The Science Congress is, however, of opinion that decimalization of currency alone is not enough, and considers the decimalization of weights and measures on the basis of the metric system to be equally urgent.'

1.10 By a resolution of February 1947, the Government of India requested the Provincial Governments to take up the question of adopting the metric system of weights and measures.

1.11 In 1946 the Government of India by Resolution No. 1-Std(4)/45, dated 3 September, had decided to establish the Indian Standards Institution, with the stated object, *inter alia*,

> 'to consider and recommend to Government of India, national standards for the measurement of length, weight, volume and energy.'

The Institution was inaugurated in February 1947 and actually started its activities in June of the same year. The Director immediately undertook to make a study of the position and compiled a report on the subject in September 1947 and suggested the adoption of the metric system with Indian nomenclature for basic units and an Indianized system of uniform nomenclature for fractions and multiples. This report was published subsequently in the ISI Bulletin of January 1949. Another report of the Director dealt with the decimalized coinage related, in respect of dimensions and weights, with the metric system.

1.12 The Engineering Division Council (EDC) of the Indian Standards Institution (ISI) at its first meeting held in November 1947 considered the reports of the Director and reviewed the prevalent state of standards of weights and measures in the country. The EDC felt that it was high time for the ISI to ascertain the general consensus of opinion in the country and recommend to the Government a definite plan for standardization in the field. The EDC resolved as under:

> '1. The Engineering Division Council of the Indian Standards Institution recommends that the Executive Committee of the General Council may appoint a special Sectional Committee to consider and report on Basic Standards for Weights and Measures for adoption in India, with a view to the Indian Standards Institution making recommendations to the Government of India in accordance with Para 3(*a*) of the Memorandum of Association of the Institution and Para 4(*a*) of Resolution No. 1-Std(4)/45 dated 3 September 1946, of the Department of Industries and Supplies, Government of India. This Sectional Committee should be representative of all Division Councils of the ISI.
>
> '2. The EDC further recommends that the terms of reference of the

proposed Sectional Committee should include the fullest possible consultation of all interested parties including Provincial and State Governments so that their Report will represent the best possible consensus of opinion on this very fundamental matter.

'3. The EDC further recommends, in order to avoid overlapping and confusions, that, until the Indian Standards Institution has submitted its recommendations to Government, the collection of interested and informed opinion should be left strictly to the Institution.'

1.13 The Executive Committee, duly approving the resolution, forwarded it to the Government of India for concurrence. The Executive Committee further requested that, in view of the executive responsibility of the Industry and Supply Ministry in this respect, an officer of the Industry and Supply Ministry of not below the rank of Joint Secretary be appointed as the Chairman of the proposed ISI Committee. The concurrence of the Government in the proposal was obtained in May 1948 and a special Committee on Weights and Measures, with terms of reference as given in the EDC resolution, was appointed. The personnel of the Committee is given in Annexure A*.

1.14 The Committee met thrice in New Delhi, on 17 March 1949, on 25 July 1949 and on 14 November 1949. At its first meeting the Committee decided to invite representatives of all Provincial and State Governments to the future meetings and with a view to ascertaining the consensus of opinion in the country, it was decided to issue a questionnaire to all interests concerned.

1.15 The second meeting of the Committee was representative of all Provincial and State Governments and all commercial interests in the country. After prolonged deliberations on the various points of view expressed by different authorities, the Committee concluded that the general consensus of opinion in India was in favour of the adoption of the metric system, but agreed that, in order to spread out the rather considerable expenditure involved in the change-over, the change-over should bc carried out in three stages covering a period of 11 to 15 years. A brief summary of the Proceedings of the Committee is given in Annexure B*.

1.16 Several resolutions were adopted at the first two meetings and a Sub-committee was appointed at the second meeting to formulate these proposals in exact terms. On the basis of these, the ISI Directorate was asked to draw up a report for adoption by the Committee at its third meeting.

1.17 All recommendations of the Committee, adopted at various stages, have been consolidated in the following section of this Report.

1.18 This Report was adopted at the third meeting of the Committee on 14 November 1949. The Executive Committee of the IS1 considered the Report on 15 November 1949 and directed that it be circulated to the General Council of the IS1 for adoption before being forwarded to the Government of India. The General Council adopted the Report on 22 December 1949.

*Not included in this Appendix.

2. ISI RECOMMENDATIONS

2.1 STANDARD SYSTEM OF WEIGHTS AND MEASURES-The Committee has reviewed the great diversity of weights and measures now in use in India and feels that, to facilitate the development of the national and international trade and to put an end to the colossal loss in time and energy that this diversity causes, the weights and measures of the country should be standardized as early as possible. For this purpose, the Committee endorses the resolution of the Interim Government of India of February 1947 (see 1.10) and recommends that the metric system be adopted as the standard system of weights and measures in India.

2.2 INTRODUCTION IN CENTRAL AGENCIES — In view of the impending development programmes for the establishment of centrally controlled industrial and technical establishments, the Committee recommends that, as early as practicable, metric standards should be introduced in all the agencies under the control of the Government of India, such as the Railways, the Postal Services, the Defence Services and other scientific, technical and industrial establishments.

2.3 INTRODUCTION IN PUBLIC LIFE — As regards the adoption of the metric system of weights and measures in the genera1 public life of the country and in everyday trade activities, the Committee appreciates that the process will have to be necessarily slow. After carefully considering the difficulties inherent in the change-over, the Committee has prepared detailed programmes for systematic and gradual adoption of the metric standards as outlined below.

2.4 USE IN SCIENTIFIC DOCUMENTS AND LITERATURE — The Committee endorses the decision of the IS1 to accept the recommendation of the Empire Scientific Conference of 1946 that whenever units are expressed in scientific literature in systems other than the metric, metric equivalents should always be indicated. The Committee recommends that this practice be immediately adopted as a general rule in all technical publications issued in India.

2.5 NOMENCLATURE — The Committee recommends that in the event of the adoption of the metric system of weights and measures, its international nomenclature be adopted *in toto*. The Committee further recommends that, in the event of the Central Legislature preferring the adoption of Indian or Indianized nomenclature for the corresponding metric units, it is important to avoid the retention of the existing names, such as 'sair', 'guz', etc, as they are liable to lead to confusion in the minds of the public.

(*Note of dissent* — Bawa Bachittar Singh, who represented the Federation of Indian Chambers of Commerce and Industry in the first meeting and then resigned, wished it to be recorded that he was not in favour of the adoption of the international nomenclature and preferred the nomenclature suggested in Dr Verman's report, both for basic units and for multiples and sub-multiples.)

2.6 EXPENDITURE IN THE CHANGE-OVER — The Committee is aware of the expenditure required for the change-over to the metric system, which is likely to be considerable. It is, therefore, recommended that the transition period be extended over a number of years and the actual change-over carried out in three stages as detailed below. The Committee is, however, satisfied that ultimately the standardization, along the lines recommended, would more than repay the expenditure inevitable in its introduction. Its uniformity will lead to security to the masses in their day-toddy commercial dealings; its simplicity would result in a tremendous saving of time, money and energy in commercial and technical calculations and in education and training of the younger generation; its international character would help stimulate overseas trade; etc.

2.7 TRANSITION-The Committee recommends that the change-over to the metric system be carried out in three distinct stages as follows:

a) The *Preparatory Stage* of three to five years when no extensive changes would be enforced, but intensive education and dissemination of information on the metric system of weights and measures would be carried out and, wherever practicable, gradual introduction of the metric system would be encouraged;

b) The ***Change-Over Stage*** of about five years in which the change-over will be effected in the agencies under the control of Central and Provincial administrations and in public life; and

c) The *Final Stage* of three to five years when the country would be brought over to the metric system entirely and after which no other system would be regarded as legal.

2.8 CENTRAL LIAISON AGENCY — The Committee recommends the creation of a Central Agency for guiding educational activity, for carrying on intensive propaganda to popularize the new system, for co-ordinating the activities of Central, Provincial and State Governments in respect of all the measures connected with the change-over, and for acting as a clearing house of all information connected with the subject. This agency may or may not be needed after the third period, since all questions of enforcement will be the responsibility of the Provincial and State units.

2.9 SALE BY WEIGHT AND VOLUME — The Committee considered the suggestion for specifically providing in Central and Provincial Legislations for the mode of sale of different commodities and feels that such a provision would, to a large extent, remove the malpractices at present prevalent in the trade.

2.10 DECIMALIZED CURRENCY — The Committee feels that it will be an advantage if the adoption of decimalized currency precedes the introduction of the metric system of weights and measures. The Committee, therefore, recommends that the decision of the Interim Government of India for the adoption of the decimalized currency should be implemented as early as possible. The Committee further recommends that weights and dimensions of the new coins should be related to the metric system of weights and measures, so as to facilitate propagation of general knowledge of the magnitude of the new units among the public.

2.11 CENTRAL LEGISLATION - With the above objectives in view, the Committee recommends that as soon as possible the Centre should initiate legislation on the subject of weights and measures which, among other things, should provide for the following.

2.11.1 Standards of weights and measures (linear, square, cubic and capacity) based on the metric system.

2.11.2 Nomenclature based on the international basic units and fractions and multiples thereof.

2.11.2.1 Use of international nomenclature for basic units to be compulsory and universal.

2.11.2.2 Indian nomenclature for multiples and sub-multiples may be adopted but in all these cases any name applying to a fraction or a multiple should contain the name of the basic unit, for example, 'Centimetre' may be termed 'Satakmeter', etc.

2.11.3 Schedule specifying commodities of everyday use to be sold on the basis of specific units of either weight, volume, linear measure, square measure or number. A schedule or schedules may be found necessary allowing use of more than one set of units for certain commodities.

(Some members of the Committee felt that this should form the subject matter of a separate Act.)

2.11.4 A model form of legislation for adoption by Provinces and States for the purpose of enforcement of standards. This model, among other things, should include tolerances of weights and measures to be allowed for different purposes. The Provinces and States should be required to adopt this model legislation as such but minor modifications may be permitted, if found absolutely necessary to suit local conditions.

2.11.5 Creation of a Central Agency for education, propaganda and co-ordination of activities of Central Departments and Provincial and State units in respect of all activities envisaged to be carried out during the three stages of development.

2.11.6 Defining the three stages of change-over and provision for periodic review of the time limits allocated for each.

2.12 **Programme of Action**-The Committee recommends the following programme of activities for the three stages of development.

2.12.1 *Preparatory Stage*

2.12.1.1 The Government of India to introduce the decimal system of currency in which the weights and dimensions of coins should be related to the metric system.

2.12.1.2 Intensive education and propaganda programme including among other things, the following:

a) teaching in elementary and secondary schools and in technical and engineering institutions; schools to keep samples of all standard metric weights and measures;

b) press and radio publicity;

c) public speeches and press conferences by eminent people;

d) publicity films (using mobile cinema wherever possible);

e) popular exhibitions;

f) publication of informative bulletins and pamphlets including conversion tables ;

g) free distribution of conversion tables through post offices;

h) public discussions and symposia;

j) publicity through village panchayats; and

k) the Government to sell to the public standard metric weights and measures at the beginning, later, private parties to produce and sell these units.

2.12.1.3 All Central and Provincial units to initiate preliminary preparations and estimates of cost of equipment for conversion to the new system.

2.12.1.4 Wherever regulated markets exist, the authorities controlling them might introduce the use of the metric system in their day-to-day operations.

2.12.1.5 All agencies to initiate designing their new schemes of development on the metric system with the ultimate object of going over to that system entirely at an appropriate stage.

2.12.1.6 All engineering designs and plans which may be considered necessary to be executed on the basis of foot-pound system to give metric equivalents.

2.12.1.7 Centre to establish an official agency for the preparation, deposition and checking of primary, secondary and reference standards.

2.12.1.8 Planning of enforcement agencies by Provincial and State units wherever they are needed and augmentation of existing agencies for the new task.

2.12.1.9 If any of the Provincial or State Governments feel ready for the adoption of the model form of legislation suggested by the Centre, they should be free to adopt it during this period.

2.12.2 ***Change-Over Stage***

2.12.2.1 Adoption by all Provincial and State Governments of the model legislation proposed by the Centre.

2.12.2.2 Implementation of the planning suggested in 2.12.1.8.

2.12.2.3 All Central Agencies to go over to the new system from a red letter day to be declared by each agency, retaining existing facilities only for replacement of parts of existing machinery.

2.12.2.4 All engineering designs and plans to be based on the metric system giving foot-pound equivalents where considered necessary.

2.12.2.5 In everyday public use and for trade purposes, the metric system to be gradually and progressively introduced.

2.12.2.6 Land records to be changed to the new system at the time of transactions, such as transfer, sale or any other registration of land.

2.12.3 ***Final Stage*** shall be in the nature of a period of grace during which the change-over to the metric system will be finalized and the use of all other systems eliminated from the legitimate activities of all departments, Central, Provincial or State, and from everyday public life. Old land records, however, may remain in the older system of measure until any transaction takes place, when they will have to be changed to the new system. After the end of this period the metric system shall be the only recognized system having legal sanction. □

APPENDIX 3

The Standards of Weights and Measures Act, 1956*
(No. 89 of 1956)

(as amended in 1960 and 1964)

An Act to establish standards of weights and measures based on the metric system.

BE it enacted by Parliament in the Seventh Year of the Republic of India as follows:

SHORT TITLE, EXTENT AND COMMENCEMENT

1. (1) This Act may be called the Standards of Weights and Measures Act, 1956".

(2) It extends to the whole of India.

(3) It shall come into force on such date, not being later than ten years from the passing of this Act, as the Central Government may, by notification in the Official Gazette, appoint; and different dates may be appointed for different provisions of this Act or for different areas or for different classes of undertakings or for different classes of goods:

Provided that, in relation to the State of Jammu and Kashmir, the said period of ten years shall be computed from the date on which the ***Standards of Weights and Measures (Amendment) Act, 1960*** comes into force.

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*The *Standards of Weights and Measures Act, 1956 (No. X9 of 1956)* received the President's assent on 28th December 1956. It was amended in 1960 and 1964.

DEFINITIONS

2. In this Act, unless the context otherwise requires,

a) 'First General Conference of Weights and Measures' means the *Conférence Générale des Poids et Mesures* held at Paris in 1889;

b) 'International Bureau of Weights and Measures' means the *Bureau International des Poids et Mesures* at Stvres in France;

c) 'Kilogram' means the mass of the platinum-iridium cylinder deposited at the International Bureau of Weights and Measures and declared international prototype of the kilogram by the First General Conference of Weights and Measures;

d) 'metre' means the length equal to 1 650 763.73 wavelengths, in vacuum, of the radiation corresponding to the transition between the $2p_{10}$ and $5d_5$ levels of the krypton atom of mass 86;

e) 'normal atmospheric pressure' means the pressure exercised by 101 325 newtons per square metre, a newton being the force which imparts to a mass of one kilogram an acceleration of one metre per second per second.

PRIMARY UNIT OF LENGTH

3. (1) The primary unit of length shall be a metre.

(2) For the purpose of deriving the value of the metre, the Central Government shall cause to be prepared a national prototype of the metre and shall cause the same to be certified by the International Bureau of Weights and Measures and shall deposit the same in such custody and at such place as the Central Government may think ft.

PRIMARY UNIT OF MASS AND STANDARD UNIT OF WEIGHT

4. (I) The primary unit of mass shall be a kilogram.

(2) For the purpose of deriving the value of kilogram, the Central Government shall cause to be prepared a national prototype of the kilogram and shall cause the same to be certified in terms of the international prototype of kilogram and shall deposit the same in such custody and at such place-as the Central Government may think fit.

(3) Notwithstanding anything contained in sub-section (1) of this section and section 12, the primary unit of mass for precious stones shall be a carat which is equal to one-five-thousandth of one kilogram.

(4) The standard unit of weight at any place shall be the weight of the primary unit of mass at that place.

UNIT OF TIME

5. (I) The primary unit of time shall be a second.

(2) A second means 1/31 556 925.9747 of the length of the tropical year for 1900.0, the year commencing at 1200 hours universal time on the 1st day of January, 1900.

UNIT OF ELECTRIC CURRENT

6. (1) The unit of electric current shall be an ampere.

(2) An ampere means that constant current which, flowing in two parallel straight conductors of infinite length, of negligible circular cross-section and placed at a distance of one metre from each other in vacuum, produces a force of 2×10^{-7} newtons per metre length between the conductors.

SCALE OF TEMPERATURE

7. The scale of temperature shall be the Centigrade scale otherwise known as Celsius where the temperature, under normal atmospheric pressure, is taken to be zero degree at the melting point of ice and one hundred degrees at the boiling point of water.

UNIT OF LUMINOUS INTENSITY

8. (1) The unit of luminous intensity shall be the candela.

(2) A candela means one-sixtieth part of luminous intensity normally emitted by one centimetre square of integral radiator (black body) at the temperature of solidification of platinum.

PRIMARY UNIT OF AREA

9. The primary unit of area shall be the square metre.

PRIMARY UNIT OF VOLUME

10. The primary unit of volume shall be the cubic metre.

UNIT OF CAPACITY

11. The unit of capacity shall be a litre which is the volume occupied by the mass of one kilogram of pure air-free water at the temperature of its maximum density and under normal atmospheric pressure.

SECONDARY UNITS OF MASS AND MEASURES

12. The Central Government may, by notification in the Official Gazette, declare in relation to the units of mass and measures referred to in sections 3 and 4 and sections 9 to 11, both inclusive, the magnitude and denominations of such units of mass and measures as it thinks fit to be the secondary units of mass and measures under this Act:

Provided that every such secondary unit shall be an integral power of ten (positive or negative) of any one of such units.

STANDARDS OF MASS AND MEASURES

13. (1) The units of mass and measures referred to in sections 3 and 4 and sections 9 to 11, both inclusive, and the secondary units of mass and measures declared under section 12 shall be the standards of mass and measures.

(2) No unit of mass or measure other than the units of mass and measures referred to in sub-section (1) shall be used as a standard mass or measure.

CONTINUANCE OF CERTAIN WEIGHTS AND MEASURES DURING TRANSITIONAL PERIOD

14. (1) Notwithstanding that this Act has come into force in respect of any area or class of goods or undertakings, the Central Government may, by notification in the Official Gazette, permit the continuance of the use, after such commencement, in respect of that area or class of goods or undertakings, of such weights and measures, in addition to the standards of mass and measures and for such period, not exceeding three years, as may be specified in the notification.

(2) Nothing in sub-section (1) shall be deemed to empower the Central Government to issue any such notification in respect of any weight or measure which was not in use immediately before the commencement of this Act.

SETS OF STANDARDS OF MASS AND MEASURES

15. (1) The Central Government shall cause to be prepared as many sets as it may deem necessary of such standards of mass and measures referred to in section 13 or multiples or sub-multiples thereof as the Central Government may consider expedient, and shall cause each mass and measure of such set to be authenticated as having been ascertained from the primary units of mass or measure, as the case may be.

(2) The Central Government shall supply to each of the State Governments as many such sets as it may deem fit.

15A. 'Notwithstanding anything contained in this Act, a nautical mile which is equal to 1 852 metres, may be used as the unit of length in relation to navigation by sea or air.'

CONVERSION OF EXISTING WEIGHTS AND MEASURES INTO STANDARD MASS AND MEASURES

16. (1) The value expressed in terms of any weight set forth in sub-section (1) of section 3 of the *Standards of' Weight Act, 1939 (9 of 1939)* or in terms of any measure expressed in inches, feet, yards or miles or in gallons may be converted into the value expressed in terms of a standard mass or measure at the rates specified in the First Schedule.

(2) The Central Government may, by notification in the Official Gazette, specify the rates at which the value expressed in terms of any weight or measure other than those referred to in sub-section (1) may be converted into the value expressed in terms of a standard mass or measure.

(3) All references in any enactment or in any notification, rule or under any enactment or in any contract, deed or other instruments to a value expressed in terms of any weight or measure other than those of a standard mass or measure shall be construed as references to that value expressed in terms of a standard mass or measure, as the case may be, converted thereto at the rates specified in the First Schedule or in the notification issued under sub-section (2), as the case may be.

(4) Where in any transaction the value expressed in terms of any weight or

measure is required to be converted into that value expressed in terms of a standard mass or measure under this section, the calculation, for the purposes of such transaction, shall be made in such manner as may be prescribed by rules.

POWER TO MAKE RULES

17. (1) The Central Government may, by notification in the Official Gazette, make rules to carry out the purposes of this Act.

(2) In particular, and without prejudice to the generality of the foregoing power, such rules may provide for all or any of the following matters, namely:

a) the preparation of the standards of mass and measures under section 15;

b) the custody of the set of standards of mass and measures which are to be maintained by the Central Government and the periodical verification and adjustment thereof;

c) the periodical verification and adjustment of-sets of standards of mass and measures supplied to the State Governments;

d) the limits of error which may be tolerated in the standards of mass and measures when they are manufactured for being used, or are being used, in transactions generally, or in any class of transactions in particular;

e) the manner in which the value expressed in terms of any weight or measure other than in terms of a standard mass and measure may be converted thereto; and

f) any other matter which has to be, or may be, prescribed.

(3) Every rule made under this section shall be laid as soon as may be after it is made, before each House of Parliament while it is in session for a total period of thirty days which may be comprised in one session or in two successive sessions, and if before the expiry of the session in which it is so laid or the session immediately following, both Houses agree in making any modification in the rule or both Houses agree that the rule should not be made, the rule shall thereafter have effect only in such modified form or be of no effect, as the case may be, so however that any such modification or annulment shall be without prejudice to the validity of anything previously done under that rule.

REPEAL

18. (1) The ***Measures of Length Act, 1889 (2 of 1889)*** and the ***Standards of Weight Act, 1939 (9 of 1939)*** are hereby repealed.

(2) The enactments specified in the Second Schedule shall, to the extent to which they contain any provision which corresponds to any provision of this Act, stand repealed.

(3) If, immediately before the commencement of this Act or any provision thereof in respect of any area or class of goods or undertakings, there is in force in respect of that area or class of goods or undertakings, any law which corresponds to this Act or to any provision thereof and which is not repealed by sub-section (1) or sub-section (2), that corresponding law shall stand repealed.

THE FIRST SCHEDULE

[*See* Section 16 (1)]

STANDARDS OF WEIGHT

1 grain	=	0·000 064 799	kilogram
1 ounce	=	0·028 349 5	kilogram
1 pound	=	0·453 592 4	kilogram
1 cwt	=	50·802	kilograms
1 ton	=	1016.05	kilograms
1 tola	=	0·011 663 8	kilogram
1 seer	=	0·933 10	kilogram
1 maund	=	37.324 2	kilograms

STANDARDS OF LENGTH AND CAPACITY

1 inch	=	0.025 4	metre (exact)
1 foot	=	0·304 8	metre (exact)
1 yard	=	0·914 4	metre (exact)
1 mile	=	1 609.344	metres (exact)
1 imperial gallon	=	4.545 96	litres

THE SECOND SCHEDULE

[See Section 18 (2)]

1. The Assam Adoption of Standard Weights Act, 1955 (IX of 1955).
2. The Bhopal State Weights and Measures Act, 1953 (XV of 1953).
3. The Bihar Weights Act, 1947 (XVII of 1947).
4, The Bombay Weights and Measures Act, 1932 (XV of 1932).
5, The Central Provinces and Berar Weights and Measures of Capacity Act, 1928 (II of 1928).
6. The Cochin Weights and Measures Act, 1112 (LXIII of 1112).
7. The Coorg Act, 1954 (VII of 1954).
8. The Hyderabad Weights and Measures Act, 1356 Fasli (XIV of 1356 Fasli).
9. The Madhya Bharat Weights Act, 1954 (21 of 1954).
10. The Madras Weights and Measures Act, 1948 (XXII of 1948), as in force in the State of Madras* or of Andhra.
11. The Mysore Weights and Measures Act, 1902 (III of 1902).
12. The Orissa Weights and Measures Act, 1943 (VII of 1943).
13. The Punjab Weights and Measures Act, 1941 (XII of 1941).
14. The Rajasthan Weights and Measures Act, 1954 (XIX of 1954).
15. The Travancore Weights and Measures Act, 1085 (VI of 1085).
16. The United Provinces Weights and Measures Act, 1947 (XXIII of 1948).

*Now known as the State of Tamil Nadu.

APPENDIX 4

The Standards of Weights and Measures Rules, 1958
(as amended in 1963)

1. These rules may be called the Standards of Weights and Measures Rules, 1958.

2. In these rules,

a) 'Act' means the ***Standards of Weights and Measures Act, 1956 (89 of 1956);***

b) 'Director' means the Director, National Physical Laboratory, New Delhi, and includes any person authorized by him in this behalf;

c) 'international prototypes' means the prototypes declared to be the international prototypes of the metre and kilogram by the ***Conférence Générale des Poids et Mesures*** held at Paris **in *1889;***

d) 'Mint' means the Mint of the Central Government either in Bombay or in Calcutta;

e) 'national prototypes' means the prototypes of the metre and the kilogram kept in pursuance of sub-section (2) of section 3 and sub-section (2) of section 4 of the Act;

f) 'reference standards' means the sets of standard weights specified in the First Schedule and supplied by the Central Government to State Governments in pursuance of sub-section (2) of section 15 of the Act;

g) 'Schedule' means a Schedule appended to these rules; and

h) 'Standard weight or measure' means any unit of mass or measure referred to in sub-section (1) of section 13 of the Act and includes any integral multiple or decimal fraction of such unit notified in this behalf by the Central Government.

3. (1) The national prototype of the metre shall consist of a platinum-iridium bar certified in terms of the international prototype of the metre by the International Bureau of Weights and Measures.

(2) The national prototype of the kilogram shall consist of a platinum-iridium cylinder certified in terms of the international prototype of the kilogram by the International Bureau of Weights and Measures.

(3) The national prototypes shall be kept in the custody of the National Physical Laboratory, New Delhi, and the Director shall cause them to be verified and certified before they are deposited in the National Physical Laboratory and at intervals of not more than ten years thereafter.

4. (1) Reference standards shall be prepared at the Mint and verified and certified in terms of the National prototypes by the Director before they are supplied to State Governments and at intervals of not more than five years thereafter:

Provided that in the case of length measures made of fifty-eight percent nickel steel, such interval shall not be more than ten years.

(2) A set of reference standards verified and certified by the Director shall be supplied free to each State Government; and, in respect of each subsequent verification, the State Government shall pay transport charges and such verification charges as may be fixed by the Central Government.

5. Where a weight or measure purporting to be a standard weight or measure is manufactured for being used, or used, in any transaction for trade or commerce (hereinafter in these rules referred to as a commercial weight or measure), the limits of error which may be tolerated in commercial weights and measures shall, at the time of their verification and inspection, be as specified in the Second Schedule.

THE FIRST SCHEDULE

[See Rule 2 (f)]

REFERENCE STANDARDS WEIGHTS

Denominations of Reference Standards Weights

KILOGRAM SERIES	GRAM SERIES	MILLIGRAM SERIES
5	500	500
2	200	200
2	200	200
I	100	100
	50	50
	20	20
	20	20
	10	10
	5	5
	2	2
	2	2
		1

THE SECOND SCHEDULE

(See Rule 5)

COMMERCIAL WEIGHTS AND MEASURES

1. *Weights*

TYPE OF WEIGHTS	DENOMINATION OF COMMERCIAL WEIGHTS	LIMITS OF ERROR WHICH MAY BE TOLERATED AT THE TIME OF VERIFICATION AND STAMPING	LIMITS OF ERROR WHICH MAY BE TOLERATED AT THE TIME OF INSPECTION FOR OTHER PURPOSES
(1)	(2)	(3)	(4)
		mg	mg
Cast Iron and Steel Weights	50 kg	+ 20 000	− 10 000 to + 20 000
	20 kg	+ 10 000	− 5 000 to + 10 000
	10 kg	+ 5 000	− 2 500 to + 5 000
	5 kg	+ 3 000	− 1 500 to + 3 000
	2 kg	+ 1 600	− 800 to + 1 600
	1 kg	+ 1 000	− 500 to + 1 000
	500 g	+ 600	− 300 to + 600
	200 g	+ 400	− 200 to + 400
	100 g	+ 320	− 160 to + 320
	50 g	+ 200	− 100 to + 200
Other Weights Except Bullion and Carat Weights	1 kg	+ 250	− 125 to + 250
	500 g	+ 150	− 75 to + 150
	200 g	+ 100	− 50 to + 100
	100 g	+ 80	− 40 to + 80
	50 g	+ 60	− 30 to + 60
	20 g	+ 50	− 25 to + 50
	10 g	+ 40	− 20 to + 40
	5 g	+ 30	− 15 to + 30
	2 g	+ 20	− 10 to + 20
	1 g	+ 10	− 5 to + 10
	500 mg	+ 8·0	− 4·0 to + 8·0
	200 mg	+ 6·0	− 3·0 to + 6·0
	100 mg	+ 4·0	− 2·0 to + 4·0
	50 mg	+ 2·0	− 1·0 to + 2·0
	20 mg	+ 2·0	− 1·0 to + 2·0
	10 mg	+ 1·0	− 0·5 to + 1·0
	5 mg	+ 0·4	− 0·2 to + 0·4
	2 mg	+ 0·2	− 0·1 to + 0·2
	1 mg	+ 0·1	− 0·05 to + 0·1

(1)	(2)	(3)	(4)
		mg	mg
Bullion Weights	20 kg	+ 500	— 250 to + 500
	10 kg	+ 250	— 125 to + 2.50
	5 kg	+ 150	— 75 to + 150
	2 kg	+ 50 80	— 40 to + 80
	1 kg		— 25 to + 50
	500 g	+ 30	— 15 to + 30
	200 g	+ 20	— 10 to + 20
	100 g	+ 12 16	— 8 to + 16
	50 g		— 6 to + 12
	20 g	+ 10	— 5 to + 10
	10 g	+ 6 8	— 4 to + 8
	5 g		— 3 to + 6
	2 g	+	— 2 to + 4
	1 g	+ 4 2	— 1 to + 2
	500 mg	+ 1.6	— 0·8 to + 1.6
	200 mg	+ 1.2	— 0·6 to + 1·2
	100 mg	+ 0·8	— 0·4 to + 0·8
	50 mg	+ 0·4	— 0·2 to + 0·4
	20 mg	+ 0·4	— 0·2 to + 0·4
	10 mg	+ 0·2	— 0·1 to + 0·2
	5 mg	+ 0·2	— 0·1 to + 0·2
	2 mg	+ 0·2	— 0·1 to + 0·2
	1 mg	+ 0·1	— 0·05 to + 0·1
Carat Weights	5OOc	+ 8·0	— 4·0 to + 8·0
	200 c	+ 6·0	— 3·0 to + 6·0
	100 c	+ 5·0	— 2·5 to + 5·0
	50 c	+ 4·0	— 2·0 to + 4’0
	20 c	+ 3·0	— 1·5 to + 3·0
	10 c	+ 2·0	— 1·0 to + 2·0
	5 c	+ 1·0	— 0·5 to + 1·0
	2 c	+ 0·8	— 0·4 to + 0·8
	1 c	+ 0·6	— 0·3 to + 0·6
	50/100 c	+ 0·4	— 0·2 to + 0·4
	20/100 c	+ 0·2	— 0·1 to + 0·2
	10/100 c	+ 0·2	— 0·1 to + 0·2
	5/100 c	+ 0·1	— 0·05 to + 0’1
	2/100 c	+ 0·1	— 0.05 to + 0·1
	1/100 c	+ 0·1	— 0·05 to + 0·1
	0·5/100 c	+ 0·1	— 0·05 to + 0·1

2. Liquid Caparity Measures

Type of Liquid Capacity Measures	Denomination of Commercial Capacity Measures	Limits of Error which may be Tolerated at the Time of Verification and Stamping	Limits of Error which may be Tolerated at the Time of Inspection for Other Purposes
(1)	(2)	(3)	(4)
		ml +	ml
Cylindrical Measures	21	+ 20 30	— 15 to + 30
	11		— 10 to + 20
	500 ml	+	— 7·5 to + 15
	200 ml	+ 15 8	— 4 to + 8
	100 ml	+ 5	— 2·5 to + 5
	50 ml	+ 23	— 1.5 to + 3
	20 ml		— 1 to + 2
Conical Measures	20 I	+ 100	— 50 to + 100
	101	+	— 25 to + 50
	51	+ 50 30	— 15 to + 30
	2 l	+	— 7·5 to + 1 5
	1 l	+ 15 10	— 5 to + 10
	500 ml	+ 48	— 4 to + 8
	200 ml		— 2 to + 4
	100 ml	+ 3	— 1·5 to + 3
Special Measures	18·5 ml	+ 100	— 50 to + 100
	60 ml	+2 to-2	— 2 to + 2
	30 ml	+1 to-1	— 1 to + 1

3. Dispensing Measures

Conical** Dispensing **Measures —

Conical dispensing measures have the denominations of 200, 100, 50, 20, 10 and 5 ml. The following are the prescribed permissible errors:

Capacity Corresponding to Graduation Mark	Permissible Error for Measures Except 50 ml (Squat)	Permissible Error for *50* ml (Squat) Measures
(1)	(2)	(3)
ml	ml	ml
200, 180, 160	+3·0 to — 3·0	—
140, 120, 100	+2·0 to — 2·0	—

(1)	(2)	(3)
ml	ml	ml
90, 80, 70, 60	+1·5 to —1·5	—
50, 40	+1·0 to —1·0	+1·0 to —1·0
30	j-O.8 to —0·8	+ 1·0 to —1·0
20	+0·6 to —0·6	+0·8 to —0·8
15	+0·5 to —0·5	—
10, 9	+0·4 to —0·4	+ 0·6 to —0·6
8, 7, 6	+0·3 to —0·3	—
5	+ 0.25 to — 0.25	—
4	+0·20 to — O-20	—
3	+0·16 to —0·16	—
2	+0·12 to —0·12	—
I	+0·08 to —0·08	—

NOTE- The permissible errors apart from those of the 50 ml (squat) measure, apply to graduation marks corresponding to the capacities stated, irrespective of the nominal capacity of the conical measures concerned.

Beaker A4eusure.s — For beaker measures presented for checking and stamping, the permissible errors shall not exceed +7 to -7 ml for 1000 ml measure and +5 to —5 ml for 500 ml measure.

For 300 ml beaker measure, the following permissible errors are prescribed:

Graduation Mark	*Permissible Error (Verification and Inspection)*
	ml
300, 250, 200, 180. 150	+3 to —3
120, 100	*+ 2 to -2*

4. *Length* Measures

TYPE OF LENGTH MEASURES	DENOMINATION OF COMMERCIAL LENGTH MEASURES	LIMITS OF EKROR WHICH MAY BE TOLERATED AT THE TIME OF VERIFICATION AND STAMPING	LIMITS OF ERROR WHICH MAY BE TOLERATED AT THE TIME OF INSPECTION FOR OTHER PURPOSES
(1)	(2)	(3)	*(4)*
	m	mm	mm
Metallic Measures	1	+1·0 to -0.5	+1·0 to —1·0
	0·5	+0·5 to —0·25	+0·5 to —0·5

(1)	(2)	(3)	(4)
	m	mm	mm
Wooden Measures	2	+4 to -2	+4 to -4
	1	+2 to -1	+2 to -2
	0·5	+1 to —0·5	$1 to —1

The distance between consecutive 5 centimetre marks shall not have errors positive or negative exceeding 0·25 mm in the case of metallic measures and 1 mm in the case of wooden measures. The error on the full length of the measure, or on the length from zero graduation to any other graduation, shall not exceed ±1·0 mm in the case of metallic measures and ±2 mm in the case of wooden measures.

Folding Scale	1	+0·50 to --0.50	+0·50 to —0·50
	0·5	+0·50 to -0.50	+0·50 to —0·50

In addition, error not to exceed +0·25 to -0.25 mm over any 10 cm length of scale.

Woven Metallic Tape Measure (Tested on a horizontal surface under a tension of one kilogram) :

50	+20·0 to -20.0	+20·0 to —20·0
30	+15·0 to —15·0	+15·0 to -15.0
20	+ 10·0 to -10.0	+10·0 to —10·0
15	+ 7·5 to — 7·5	+ 7·5 to — 7·5
10	+ 5·0 to — 5·0	+ 5·0 to — 5·0
5	+ 3·0 to — 3·0	+ 3·0 to — 3·0
2	+ 1·5 to — 1·5	+ 1·5 to — 1.5

In addition, in 20, 30 and 50 m tapes the errors from the beginning of the tape to the lengths specified below shall not exceed the following limits:

Length	*Permissible Error (Verification and Inspection)*
m	mm
10	+10 to -10
15	+12·5 to — 12.5
20	+15 to -15
30	+20 to -20

Steel Tapes

(Tested on horizontal surface with a tension of 5 kg for 50, 30, 20, 15 and 10 m tapes and 2 kg for 2 m and 1 m tapes. Permissible errors are the same for verification and Inspection.)

Length m	
50, 30, 20, 15, 10, 2, 1	Error between any two adjacent mm lines or between consecutive cm lines not to exceed +0·2 to —0·2 mm and between consecutive 10 cm lines or metre lines not to exceed +0·4 to —0·4 mm.

In addition, when measured from zero to the points specified below, the error in the length of the tape shall not exceed the following limits:

Mark	***Permissible Error (Verification and Inspection)***
m	mm
1	+0·4 to —0·4
2	+0·6 to —0·6
5	+ 1·0 to —1·0
Any metre mark beyond the first 5 metres.	+1·0 to —1·0 mm for the first 5 m
	+0·5 to —0·5 mm for each additional 5 m or part thereof

Survey Chains

When measured with a tension of 8 kg, every metrelength shall be accurate with an error not exceeding + 2 to -2 mm. The overall length shall be accurate within the limits shown below:

30 m	+ 8 to —8 mm
20 m	+5 to —5 mm

□

APPENDIX 5

The State (Model) Weights and Measures (Enforcement) Bill, 19....

A

BILL

to provide for the enforcement of standard weights and measures and for matters connected therewith.

It is hereby enacted as follows:

CHAPTER I

PRELIMINARY

SHORT TITLE, EXTENT AND COMMENCEMENT

1. (1) This Act may be called the.. Weights and Measures (Enforcement) Act, 19....

(2) It extends to the whole of the State of...

(3) It shall come into force on such date as the State Government may by notification in the Official Gazette, appoint; and different dates may be appointed for different provisions of this Act or for different areas or for different classes of undertakings or for different classes of goods.

DEFINITIONS

2. In this Act, unless the context otherwise requires,

a) 'commercial weight or measure' means a weight or measure purporting to be a standard weight or measure used in any transaction for trade or commerce;

b) 'Controller' means the Controller of Weights and Measures appointed under section 16;

c) 'Inspector' means an Inspector of Weights and Measures appointed under section 16;

d) 'measuring instrument' means any measuring instrument other than a weighing instrument and includes any instrument used for determining the length, area, volume, capacity, quality, temperature or density of any article;

e) 'Mint' means the Mint of the Central Government either in Bombay or in Calcutta;

f) 'prescribed' means prescribed by rules made under this Act;

g) 'standard weight or measure' means any unit of mass or measure referred to in sub-section (1) of section 13 of the ***Standards of Weights and Measures Act, I956 (Central Act 89 of 1956)*** and includes any other weight or measure permitted to be used by the Central Government in pursuance of sub-section (1) of section 14 of the said Act;

h) 'reference standards' means the sets of standard weights and measures supplied to the State Government by the Central Government in pursuance of sub-section (2) of section 15 of the ***Standards of Weights und Measures Act, 1956;***

i) 'sealed package or container' means a closed packet, bottle, casket, tin, barrel, case, receptacle, bag, sack, wrapper or other thing in which any article is placed or packed and which is intended to be sold with its contents, without any weighment or measurement of such contents at the time of sale;

j) 'stamping' means marking in such manner as to be, so far as practicable, indelible and includes casting, engraving, etching and branding;

k) 'use in transaction for trade or commerce' means use for the purpose of determining or declaring the quantity of anything in terms of measurement of length, area, volume, capacity or weight in or in connection with

i) any contract, whether by way of sale, purchase, exchange or otherwise; or

ii) any assessment of royalty, toll, duty or other dues; or

iii) the assessment of any work done or services rendered, otherwise than in relation to research or scientific studies or in individual house-holds for household purposes;

1) 'verification' with its grammatical variations used with reference to a weight or measure or weighing or measuring instrument, includes the process of comparing, checking or testing such weight or measure or weighing or measuring instrument and also includes re-verification; and

m) 'weighing instrument' means any instrument for weighing and includes scales with the weights belonging thereto, scale-beams, balances, spring balances, steel yards and other weighing machines.

CHAPTER II

STANDARD WEIGHTS AND MEASURES

WORKING STANDARDS

3. (1) For the purpose of verifying the correctness of commercial weights and measures and weighing and measuring instruments used in transactions for trade or commerce, the State Government may cause to be prepared as many sets of authenticated standard weights and measures as it may deem necessary to be called the working standards.

(2) The working standards shall be made of such material and according to such designs and specifications and shall be prepared by such agency and shall be stamped and authenticated by such person or authority and in such manner as may be prescribed.

(3) The working standards shall be kept at such places, in such custody and in such manner as may be prescribed.

(4) A working standard shall be verified with the secondary standard and marked by such persons, at such places, at such intervals and in such manner as may be prescribed.

(5) A working standard which is not so verified and marked within the prescribed period shall not be deemed legal or be used for the purposes of this Act.

(6) A working standard which has become defective shall not be deemed legal or be used for the purposes of this Act, until it has been verified and marked in the prescribed manner.

SECONDARY STANDARDS

4. (1) For the purpose of verifying the correctness of the working standards, the State Government may cause to be prepared at the Mint as many sets of authenticated standard weights and measures as it may deem necessary to be called the secondary standards.

(2) The secondary standards shall be made of such material and according to such design and specifications as may be prescribed and shall be stamped and authenticated by such person or authority as the Central Government may direct.

(3) The secondary standards shall be kept at such places, in such custody and in such manner as may be prescribed.

(4) A secondary standard shall be verified with the reference standard at least once in every period of five years and shall be marked with the date of verification in the prescribed manner by such person or authority as the State Government may direct.

(5) A secondary standard which is not so verified and marked within the aforesaid period shall not be deemed legal and shall not be used for the purposes of this Act.

REFERENCE STANDARDS

5. The reference standards shall be kept at such places, in such custody and in such manner as the State Government may direct.

STANDARD WEIGHING AND MEASURING INSTRUMENTS

6. (1) For the purpose of verifying the correctness of commercial weights and measures and of weighing and measuring instruments used in transactions for trade or commerce, the State Government may cause to be prepared as many sets of weighing and measuring instruments as it may deem necessary.

(2) Such instruments shall be of such kind, kept in such number and shall be verified and stamped in such manner as may be prescribed.

(3) Such instruments shall be kept at all places where secondary standards or working standards are kept.

PROHIBITION OF USE OF WEIGHTS AND MEASURES OTHER THAN STANDARD WEIGHTS AND MEASURES

7. (1) Notwithstanding anything contained in any other law or any custom, usage or practice, no unit of mass or measure other than the standard weights or measures shall be used in any transaction for trade or commerce in any area or class of goods or undertakings in respect of which this Act has come into force or be kept in any premises where such transactions are usually conducted.

(2) Any custom, usage, practice or method of whatever nature which permits in any trade a trader, seller or buyer to demand, receive or cause to be demanded or received any quantity of article in excess of, or less than, the quantity fixed by the weight or measure by which the contract or dealing in respect of the said article has been made, shall bc void.

(3) Any transaction, dealing or contract made or had after the expiry of three months from the commencement of this Act shall in so far as it contravenes the provisions of sub-section (1) be void.

POWER TO PRESCRIBE THE USE OF WEIGHTS ONLY, OR MEASURES ONLY, IN CERTAIN CASES

8. (1) Notwithstanding anything contained in this Act, the State Government may, by notification in the Official Gazette, direct that in any specified trade or class of trades, no transaction, dealing or contract shall be made or had except by weight only, or except by measure only.

(2) A notification issued under this section shall take effect in such area, with effect from such date, and subject to such conditions, if any, as may be specified therein.

CHAPTER III

VERIFICATION AND STAMPING OF WEIGHTS AND 'MEASURES

MARKING OF DENOMINATIONS ON COMMERCIAL WEIGHTS AND MEASURES

9. Every weight or measure manufactured for use as a commercial weight or measure shall bear the description of the weight or measure which it purports to be marked legibly on it in such manner as may be prescribed.

PROHIBITION OF SALE OF UNSTAMPED COMMERCIAL WEIGHTS AND MEASURES

10. No commercial weights or measures or weighing or measuring instrument shall be sold or delivered unless it has been verified or re-verified in accordance with the rules made under this Act and stamped in the prescribed manner by an Inspector with a stamp of verification.

PROHIBITION OF USE OF UNSTAMPED COMMERCIAL WEIGHTS OR MEASURES

11. No weight or measure or weighing or measuring instrument shall be used in transactions in trade or commerce unless it has been verified or re-verified in accordance with the rules made under this Act and stamped in the prescribed manner by an Inspector with a stamp of verification.

POWER OF STATE GOVERNMENT TO EXEMPT

12. Where the size of a commercial weight or measure renders it impracticable to have any denomination marked on it under the provisions of section 9 or to be stamped under the provisions of section 10 or section 11, the State Government may, by notification in the Official Gazette, exempt such weight or measure from being so stamped.

PROHIBITION OF MANUFACTURE, ETC, OF WEIGHTS AND MEASURES WITHOUT LICENCE

13. No person shall, in course of trade, manufacture, repair or sell any weight or measure or any weighing or measuring instrument, unless he has obtained in the prescribed manner a licence in this behalf from the State Government or any officer authorized by such Government.

MANUFACTURERS TO SUBMIT PROTOTYPES OF WEIGHTS, MEASURES AND WEIGHING AND MEASURING INSTRUMENTS

13A. (1) Every manufacturer of any prescribed weight or measure or weighing or measuring instrument shall,

a) in a case where such weight or measure or weighing or measuring instrument is being manufactured at the commencement of the.. . *Weights* *and Measures (Enforcement) Act,. . , .*on the pattern of an existing design, within such period as may be prescribed;

b) in any other case, before he commences to manufacture that weight or measure or weighing or measuring instrument, submit to the prescribed authority a prototype of the weight or measure or weighing or measuring instrument, as the case may be.

(2) Every prototype submitted under sub-section (1) shall be accompanied by such particulars as may be prescribed.

(3) The prescribed authority shall, after such examination as it considers necessary, submit a report to the Government on the prototype within the prescribed period.

(4) The Government may, after considering the report of the prescribed authority submitted under sub-section (3), accept the prototype or suggest modifications thereto or reject the same and shall give intimation to the manufacturer accordingly:

Provided that no modification to the prototype shall be suggested or no prototype shall be rejected under this sub-section unless the manufacturer has been given an opportunity of being heard in the matter.

(5) Where the Government has suggested any modification to the prototype under sub-section (4), the manufacturer shall not continue to manufacture or manufacture, as the case may be, the weight or measure or weighing or measuring instrument to which the prototype relates otherwise than in accordance with that modification.

(6) Where the Government has rejected any prototype under sub-section (4), the manufacturer shall not continue to manufacture or manufacture as the case may be, the weight or measure or weighing or measuring instrument to which the prototype relates.

MARKING OF WEIGHTS OR MEASURES ON SEALED CONTAINERS

14. No person shall sell, offer for sale, expose for sale, or have in his possession for sale, any article contained in a sealed package or container unless such package or container bears thereon, or on a label securely attached thereto, a description of the net weight or measure of the article contained therein:

Provided that the provisions of this section shall not apply to

i) any sealed package or container

a) of net weight of less than one hundred and twenty grams, if the sealed package or container contains biscuits, confectionery or sweets; and

b) of net weight of less than sixty grams, if the sealed package or container contains any other foodstuff;

ii) any articles contained in a sealed package or container, if such articles are ordinarily sold in transactions for trade or commerce by counting their number :

Provided further that the State Government may, if it is satisfied that the size of any class of such packages or containers renders it impracticable to comply with the provisions of this section by notification in the Official Gazette, exempt such class from the operation of this section.

PROHIBITION OF QUOTING PRICE, OR EXPRESSING QUANTITY, OF ANY ARTICLE OTHERWISE THAN IN TERMS OF STANDARD WEIGHT OR MEASURE

15. No person shall, in any transaction for trade or commerce, quote the price, or express the quantity, of any article otherwise than in terms of the standard weight or measure.

APPOINTMENT OF CONTROLLER, ASSISTANT CONTROLLERS AND INSPECTORS

16. (1) The State Government may appoint a Controller of Weights and Measures for the State and as many Assistant Controllers and Inspectors of Weights and Measures as may be necessary for exercising the powers and discharging the duties conferred or imposed on them by or under this Act.

(2) The State Government may, by general or special order, define the local limits within which each Inspector shall exercise the powers and discharge the duties conferred or imposed on Inspectors by or under this Act.

(3) Subject to the provisions of this Act, all Assistant Controllers of Weights and Measures and Inspectors shall perform their functions under the general superintendence and control of the Controller, and the Controller and the Assistant Controllers of Weights and Measures may, in addition to the power and duties conferred or imposed on them by or under this Act, exercise any power or discharge any duty so conferred or imposed on Inspectors.

VERIFICATION AND STAMPING BY INSPECTORS

17. (1) Every Inspector shall, for the purpose of verification of weights and measures and weighing and measuring instruments, attend at such place and time within his jurisdiction as may be appointed in this behalf by the Controller.

(2) The Inspector shall verify every weight or measure or weighing or measuring instrument which is brought to him for the purpose of verification and if he finds such weight or measure or weighing or measuring instrument correct and in conformity with the ***Standards of Weights and Measures Act, 19.56 (Central Act 89 of 1956)*** and the rules made thereunder, he shall stamp the same with a stamp of verification in the prescribed manner.

POWER TO INSPECT, ETC

18. (1) An Inspector may, within the area under his jurisdiction, inspect at all reasonable times, the weights, measures and weighing and measuring instruments which are used in transactions for trade or commerce or are in the possession of any person or are on any premises for such use and may verify every such weight or measure or weighing or measuring instrument with a working standard or weighing or measuring instrument prescribed for the purpose.

(2) For the purpose of verifying the correctness of any weight or measure

used in any transaction, an Inspector may also verify the weight or measure of any article sold or delivered in the course of the transaction.

(3) An Inspector may, at all reasonable times, require any trader or any employee or agent of a trader to produce before him for inspection all weights, measures, weighing and measuring instruments which are used by him or are in his possession or are kept on any premises used for trade and all documents and records relating thereto and such trader, employee or agent shall comply with such requirements.

(4) An Inspector may seize and detain any weight or measure or weighing or measuring instrument regarding which an offence under this Act appears to have been committed or which appears to have been or which might be used in the commission of such an offence, and may also seize and detain any article sold or delivered or caused to be sold or delivered by means of such weight or measure or weighing or measuring instrument together with any documents or records relating thereto.

(5) Where an Inspector has reasons to believe that a sealed package or container does not actually contain the net weight or measure of the article which it purports to contain, the Inspector may break open the sealed package or container and verify its contents; if, on such verification, the net weight or measure of the article is found to be correct, the Inspector shall tender the fair price thereof and may require a written acknowledgement therefor.

If, on the other hand, the net weight or measure of the article is found on such verification to be incorrect, the Inspector may seize the package or container and the article contained therein, after tendering the fair price thereof where the seizure is made from any person other than the manufacturer, and may file a complaint against the manufacturer for contravention of the provisions of section 14.

(6) For the purpose of such inspection, an Inspector may, at all reasonable times, enter into any place where weights, measures or weighing or measuring instruments are used or kept for use in transactions for trade or commerce and inspect such weights and measures and weighing and measuring instruments.

***Explanation*-Where** any premises is partly used for trade and partly for dwelling purposes, the whole of such premises shall, for the purpose of this sub-section be treated as a place where weights or measures or weighing or measuring instruments are used or are kept for use in transactions for trade or commerce.

POWER OF INSPECTOR TO ADJUST WEIGHTS OR MEASURES

19. Where it appears to the State Government desirable that an Inspector should be allowed in any area to adjust the weights or measures or weighing or measuring instruments, it may, if it thinks fit, authorize such Inspector to adjust weights and measures or such instruments accordingly.

MANUFACTURERS, ETC, TO MAINTAIN RECORDS AND DOCUMENTS

20. (1) Every manufacturer, repairer or dealer in weights and measures or

weighing or measuring instruments and every person using them in transactions for trade or commerce shall maintain such records and accounts as may be prescribed and if required so to do by an Inspector, shall produce such records and accounts before him.

(2) Notwithstanding anything contained in sub-section (1), if the State Government is of opinion that having regard to the nature of business carried on by any such manufacturer, repairer or dealer, it is necessary so to do, it may, by order exempt such person or class of persons from the operation of that sub-section.

APPEALS

21. (1) Subject to the provisions of sub-section (2), an appeal shall lie

a) from every decision of an Inspector under this Act, to the Controller; and

b) from every decision of the Controller under this Act, not being a decision made in appeal under clause (a), to the State Government or any officer specially authorized in this behalf by the State Government.

(2) Every such appeal shall be preferred within sixty days from the date of the decision.

(3) On receipt of any such appeal, the appellate authority shall, after giving the appellant a reasonable opportunity of being heard and after making such enquiry as it deems proper, decide the appeal and the decision of the appellate authority shall be final.

LEVY OF FEES

22. The State Government may charge such fees

a) for the grant of licences under section 13, for manufacture, repair or sale of commercial weights and measures and weighing and measuring instruments; and

b) for the verification, marking, stamping and adjustment of commercial weights and measures and weighing and measuring instruments, as may be prescribed.

VALIDITY OF WEIGHTS AND MEASURES DULY STAMPED

23. A weight or measure or weighing or measuring instrument, duly stamped by an Inspector under this Act, shall be a legal weight or measure or weighing or measuring instrument in all places in which this Act has come into force unless it is found to be false or defective and shall not be liable to be re-stamped by reason merely of the fact that it is used in any place other than that in which it was originally stamped.

CHAPTER IV

PENALTIES

PENALTY FOR SALE OR DELIVERY BY WEIGHT OR MEASURE OTHER THAN STANDARD WEIGHTS OR MEASURES

24. Whoever, after the expiry of three months from the commencement of this section, sells or causes to be sold or delivers or causes to be delivered in the course of any transaction for trade or commerce any article by any denomination of weight or measure other than one of the standard weights or measures or whoever after the commencement of the.... ***Weights and Measures (Enforcement) Act,***. ... keeps any unit of mass or measures other than the standard weights and measures in any premises where such transactions are usually conducted, shall be punishable, for a first offence, with fine which may extend to two thousand rupees, and for a second or subsequent offence, with imprisonment for a period which may extend to three months, or with fine, or with both.

PENALTY FOR SALE OF UNSTAMPED COMMERCIAL WEIGHTS AND MEASURES

25. Whoever sells or delivers any commercial weight or measure or any weighing or measuring instrument which has not been verified or re-verified or stamped in accordance with the provisions of this Act and the rules made thereunder shall be punishable with fine which may extend to two thousand rupees.

PENALTY FOR USE OF UNSTAMPED COMMERCIAL WEIGHTS AND MEASURES

26. Whoever uses in any transaction for trade or commerce or has in his possession for such use, any commercial weight or measure or any weighing or measuring instrument which has not been verified or re-verified or stamped in accordance with the provisions of this Act and the rules made thereunder shall be punishable for a first offence, with fine which may extend to two thousand rupees, and for a second or subsequent offence, with imprisonment for a period which may extend to three months, or with fine, or with both.

Explanation I -When any such weight or measure or weighing or measuring instrument is found in the possession of any trader or any employee or agent of such trader, such trader, employee or agent shall be presumed, until the contrary is proved, to have had it in his possession for use in transactions for trade or commerce.

Explanation 2 — Where any weight or measure or weighing or measuring instrument is used or possessed in contravention of this section by any employee or agent of a trader on behalf of such a trader, such trader shall, unless he proves that the offence under this section was committed by his employee or agent without his knowledge or consent, be also deemed to be guilty of the offence.

PENALTY FOR MANUFACTURE OF WEIGHTS, ETC, WITHOUT LICENCE

27. If any person manufactures, repairs, or sells any commercial weight or measure or weighing or measuring instrument, without obtaining alicence as required by section 13, shall be punishable with imprisonment for a period which may extend to three months, or with fine, or with both.

PENALTY FOR USE OF WEIGHTS OR MEASURES IN CONTRAVENTION OF SECTION 8

28. Whoever contravenes any of the provisions of a notification issued under section 8 shall be punishable with fine which may extend to two thousand rupees.

PENALTY FOR CONTRAVENTION OF SECTION 13A

28A. Whoever contravenes the provisions of section 13A shall, on conviction, be punished with fine which may extend to two thousand rupees.

PENALTY FOR FAILURE TO MARK WEIGHT OR MEASURE ON SEALED CONTAINERS

29. Whoever contravenes the provisions of section 14 shall be punishable with fine which may extend to two thousand rupees.

PENALTY FOR QUOTING PRICES OR EXPRESSING QUANTITIES OTHERWISE THAN IN TERMS OF STANDARD WEIGHT OR MEASURE IN CONTRAVENTION OF SECTION 15

30. Whoever contravenes the provisions of section 15 shall be punishable with fine which may extend to two thousand rupees.

PENALTY FOR FRAUDULENT USE OF WEIGHTS, MEASURES, ETC

31. Whoever fraudulently uses any standard weight or measure or weighing or measuring instrument which he knows to be false shall be punishable with imprisonment for a period which may extend to one year, or with fine, or with both.

PENALTY FOR BEING IN POSSESSION OF FALSE WEIGHT OR MEASURE, ETC

32. Whoever is in possession of any commercial weight or measure or weighing or measuring instrument which he knows to be false, intending that the same may be fraudulently used, shall be punishable with imprisonment for a period which may extend to one year, or with fine, or with both.

PENALTY FOR MAKING OR SELLING FALSE WEIGHT OR MEASURE

33. Whoever makes, sells or disposes of or causes to be made, sold or disposed of any standard weight or measure or weighing or measuring instrument which he knows to be false in order that the same may be used as true or knowing that the same is likely to be used as true, shall be punishable with imprisonment

for a period which may extend to one year, or with fine, or with both.

PENALTY FOR DELIVERING OR RECEIVING ANY QUANTITY OF ARTICLE LESS THAN, OR IN EXCESS OF THE QUANTITY FIXED BY THE WEIGHT OR MEASURE IN THE CONTRACT

34. Whoever

i) in selling any article by weight or measure delivers or causes to be delivered to the purchaser any quantity of that article less than, or

ii) in buying any article by weight or measure demands or receives or causes to be demanded or received from the vendor any quantity of that article in excess of the quantity fixed by the weight or measure by which the contract or dealing in respect of that article has been made,

shall be punishable with fine which may extend to five hundred rupees.

PENALTY FOR FORGING, ETC, OF WEIGHTS, MEASURES, ETC

35. (1) Whoever forges or counterfeits any stamp used under this Act for the stamping of any standard weight or measure or weighing or measuring instrument or possesses any such counterfeit stamp, or removes a stamp from any standard weight or measure or weighing or measuring instrument and inserts the same into another weight or measure or weighing or measuring instrument or wilfully increases or diminishes a weight or measure so stamped, shall be punishable with imprisonment for a period which may extend to one year, or with fine, or with both.

(2) Whoever knowingly uses, sells, disposes of or exposes for sale any weight or measure or weighing or measuring instrument with such forged or counterfeit stamp thereon, or a weight or a measure so increased or diminished shall be punishable with imprisonment for a period which may extend to six months or with fine, or with both.

PENALTY FOR NEGLECT OR REFUSAL TO PRODUCE WEIGHT OR MEASURE, ETC, FOR INSPECTION

36. Whoever

a) refuses or neglects to produce for inspection under section 18, any weight or measure or weighing or measuring instrument or any document or record relating thereto in his possession or on his premises, or

b) refuses to permit an Inspector to inspect and verify any such weight, measure, instrument, document on record, or

c) obstructs the entry of an Inspector under section 18, or

d) otherwise obstructs or hinders an Inspector in the performance of his duties under this Act,

shall be punishable with fine which may extend to two thousand rupees.

PENALTY FOR BREACH OF DUTY BY INSPECTOR

37. If an Inspector knowingly stamps a weight or measure or weighing or measuring instrument in contravention of the provisions of this Act or of the

rules made thereunder, he shall he punishable with imprisonment for a period which may extend to one year, or with fine, or with both.

CHAPTER V

MISCELLANEOUS

PROTECTION OF ACTION TAKEN IN GOOD FAITH

38. No suit, prosecution or other legal proceeding shall lie against the Controller or Assistant Controller of Weights and Measures or any Inspector or any other person appointed under this Act in respect of anything which is in good faith done or intended to be done in pursuance of this Act or rules made thereunder.

CONTROLLER, ETC, APPOINTED UNDER THIS ACT TO BE PUBLIC SERVANTS

39. The Controller, every Assistant Controller and Inspector appointed under this Act shall be deemed to be a public servant within the meaning of section 21 of the Indian Penal Code (45 of 1860).

COGNIZANCE OF OFFENCES, ETC

40. (1) No court shall take cognizance of an offence punishable under this Act except upon complaint in writing made by the Controller or any officer authorized in this behalf by the Controller by general or special order.

(2) No court inferior to that of a presidency magistrate or a magistrate of first class shall try any offence punishable under this Act.

COMPOSITION OF OFFENCES

41. (1) Any offence punishable under section 24, section 25, section 26, section 28, section 29, section 34 or section 36 other than a second or a subsequent offence under section 24 or section 26 may, either before or after the institution of the prosecution, be compounded by the State Government on payment of such sum as the State Government thinks fit.

(2) On payment by the offender of such sum, the offender, if in custody, shall be set at liberty and if any proceedings in any criminal court have been instituted against the offender in respect of the offence the composition shall be deemed to amount to an acquittal and no further criminal proceedings shall be taken against him in respect of such offence.

STAMPED WEIGHTS, ETC, TO BE PRESUMED TO BE CORRECT

42. A weight or measure or weighing or measuring instrument duly stamped under the provisions of this Act and the rules made thereunder shall be presumed to be correct until its inaccuracy is proved, if this is produced in any court by any Inspector having charge thereof or by any person acting under the general or special authority of the Controller.

OFFENCES BY COMPANIES

43. (1) If the person committing an offence under this Act is a company, every person who, at the time the offence was committed, was in-charge of, and was responsible to the company for the conduct of the business of the company as well as the company, shall be deemed to be guilty of the offence and shall be liable to be proceeded against and punished accordingly:

Provided that nothing contained in this sub-section shall render any such person liable to punishment if he proves that the offence was committed without his knowledge or that he exercised all due diligence to prevent the commission of such offence.

(2) Notwithstanding anything contained in sub-section (I), where an offence under this Act has been committed by a company and it is proved that th offence has been committed with the consent or connivance of, or is attributable to any neglect on the part of any director, manager, secretary or other officer shall also be deemed to be guilty of that offence and shall be liable to be proceeded against and punished accordingly.

Explanation -For the purposes of this section

a) 'company' means any body corporate and includes a firm or other association of individuals; and

b) 'director', in relation to a firm, means a partner in the firm.

DELEGATION OF POWERS

44. The State Government may, by notification in the Official Gazette, direct that any power exercisable by it under this Act or rules made thereunder shall, in relation to such matters and subject to such conditions as may be specified in the direction, be exercisable also by such officer or authority subordinate to the State Government as may be specified in the notification.

LIMITS OF ERROR TO BE-TOLERATED IN WEIGHTS AND MEASURES

45. Subject to any rules that may be made under the *Standards of Weights and Measures Act, 1956 (Central Act 89 of 1956)* in this behalf, the State Government may prescribe the limits of error which may be tolerated

a) in secondary standards referred to in section 4;

b) in working standards referred to in section 3;

c) in commercial weights and measures or in selling articles by weight or measure generally or as regards any trade or class of trades; and

d) weighing and measuring instruments.

REPEAL

46. The (name of Act) is hereby repealed.

POWER TO MAKE RULES

47. (1) The State Government may, by notification in the Official Gazette, make rules to carry out the purpose of this Act.

(2) In particular, and without prejudice to the generality of the foregoing

power, such rules may provide for ail or any of thefollowin mattersg, namely,

a) the material of which and the designs and specifications according to which working standards may be made, the agency by which such standards may be prepared, the person by whom or the authority by which and the manner in which such standards may be stamped and authenticated, the places at which and the custody and manner in which such standards may be kept;

b) the procedure for the verification or re-verification and marking of working standards, the persons by whom, the places at which and the intervals at which, they may be marked;

c) the material of which and the designs and specifications according to which secondary standards may be made, the places at which and the custody and manner in which such standards may be kept;

d) the procedure for the verification or re-verification and marking of secondary standards and the manner in which they may be marked;

e) the number of weighing and measuring instruments to be kept, the manner in which they may be verified and stamped and necessary particulars regarding the same;

f) the manner in which commercial weights and measures may be marked by manufacturers;

g) the form and manner in which, and the conditions subject to which licences may be granted to persons for manufacture, repair or sale of commercial weights and measures and weighing and measuring instruments;

h) the qualifications, functions and duties generally of Inspectors under this Act;

i) verification and stamping of weights and measures and weighing and measuring instruments and the period within which they are to be re-verified;

j) inspection of weights and measures and weighing and measuring instruments used in transactions for trade or commerce;

k) the seizure, detention and disposal of weights and measures which are not authorized by this Act;

1) the books, accounts and records relating to weights and measures and weighing and measuring instruments to be maintained and the manner in which they may be maintained or produced;

m) the limits of error which may be tolerated in secondary or working standards;

n) the limits of error which may be tolerated in weights and measures and weighing and measuring instruments used or intended to be used in transactions for trade or commerce;

o) the limits of error which may be tolerated in selling articles by weight and measure generally or as regards any trade or class of trades;

p) the form and manner in which appeals may be preferred against decisions of Inspectors and the procedure for hearing appeals;

q) the fees which may be charged for the grant of licences under section 13 and for verification, re-verification, adjustment and stamping of weights and measures and weighing and measuring instruments and the collection and levy of the same;

r) the material, form and specification and manufacture and sale of commercial weights and measures and weighing and measuring instruments; and

s) any other matter which has to be, or may be, prescribed.

(3) In making any rules under this section, the State Government may provide that a breach thereof shall be punishable with fine which may extend to five hundred rupees.

(4) The power to make rules under this section shall be subject to the condition of previous publication in the Official Gazette.

(5) All rules made under this section shall, as soon as may be after they are made, be laid before the State Legislature.

SAVING

48. Nothing in this Act shall apply to weights or measures or weighing or measuring instruments used by or in any unit or establishment of the Armed Forces of the Union.

[The State (Model) Weights and Measures (Enforcement) Bill includes amendments as of 2 February 1967] □

APPENDIX 6

The Indian Coinage Act, 1906 (3 of 1906)

(as amended up to 7 August 1968)

An Act to consolidate and amend the law relating to Coinage and the Mint.

WHEREAS it is expedient to consolidate and amend the law relating to Coinage and the Mint; It is hereby enacted as follows:

PRELIMINARY

SHORT TITLE AND EXTENT

1. (1) This Act may be called the Indian Coinage Act, 1906; and
(2) It extends to the whole of India.

DEFINITIONS

2. In this Act, unless there is anything repugnant in the subject or context,

a) 'deface', with its grammatical variations and cognate expressions, includes clipping, filing, stamping, or such other alteration of the surface or shape of a coin as is readily distinguishable from the effects of reasonable wear;

b) 'the Mint' includes the Mints now existing and any which may hereafter be established;

c) -'prescribed' includes prescribed by a rule made under this Act;

d) 'remedy' means variation from the standard weight and fineness; and

e) 'standard weight' means the weight prescribed for any coin.

POWER TO ESTABLISH AND ABOLISH MINTS

3. The Central Government may, by notification in the Official Gazette,

a) establish a Mint at any place at which a Mint does not for the time being exist; and

b) abolish any Mint, whether now existing or hereafter established.

SILVER COINS

4. Repealed.

STANDARD WEIGHT AND FINENESS

5. Repealed.

COINAGE

DENOMINATIONS, DIMENSIONS, DESIGNS AND COMPOSITION OF COINS

6. Coins may be coined at the Mint for issue under the authority of the Central Government, of such denominations not higher than one hundred rupees, of such dimensions and designs, and of such metals or of mixed metals of such composition as the Central Government may, by notification in the Official Gazette, determine.

STANDARD WEIGHT AND REMEDY

*7. The standard weight of the coins of any denomination coined under the provisions of section 6, and the remedy allowed in the making of such coins shall be such as may be prescribed in this behalf by the Central Government.

POWER TO DIRECT COINING AND TO PRESCRIBE DIMENSIONS AND DESIGNS

10. Repealed.

DEMONETIZATION OF SOVEREIGN AND HALF SOVEREIGN

11. Repealed.

SILVER COIN, WHEN A LEGAL TENDER

12. Repealed.

COIN, WHEN A LEGAL TENDER

13. (1) The coins issued under the authority of section 6 shall be a legal tender in payment or on account,

a) in the case of a coin of any denomination not lower than one rupee, for any sum;

b) in the case of a half-rupee coin, for any sum not exceeding ten rupees; and

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*Substituted by Ordinance 4 of 1942, section 2, for the former sections 7, 8 and 9.

c) in the case of any other coin, for any sum not exceeding one rupee:

Provided that the coin has not been defaced and has not lost weight so as to be less than such weight as may be prescribed in its case.

(2) All silver coins issued under this Act after the 10th day of March, 1940 and before the commencement of the *Indian Coinage (Amendment) Act, 1947,* shall continue as before to be a legal tender in payment or on account,

a) in the case of a rupee coin, for any sum;

b) in the case of a half-rupee coin, for any sum not exceeding ten rupees; and

c) in the case of a quarter-rupee coin, for any sum not exceeding one rupee:

Provided that the coin has not been defaced and has not lost weight so as to be less than

i) 176.4 grains Troy in the case of a rupee coin, or

ii) 88·2 grains Troy in the case of a half-rupee coin, or

iii) such weight as may be prescribed in the case of a quarter-rupee coin.

(3) All nickel, copper and bronze coins which may have been issued under this Act before the 24th day of January, 1942 shall continue as before to be a legal tender in payment or on account for any sum not exceeding one rupee.

(4) All new coins in the *naya paisa* series, designated as such under the notification of the Government of India in the Ministry of Finance, Department of Economic Affairs, No. SRO 1 120, dated 11th May, 1956 which may have been issued under this Act prior to the commencement of the *Indian Coinage (Amendment) Act, 1964,* shall continue to be a legal tender in payment or on account,

a) in the case of a half-rupee or fifty *naye paise* coin, for any sum not exceeding ten rupees; and

b) in the case of any other coin, for any sum not exceeding one rupee.

DECIMAL SYSTEM OF COINAGE

14. (1) The rupee shall be divided into one hundred units and the new coin representing such unit may be designated by the Central Government, by notification in the Official Gazette, under such name as it thinks fit, and the rupee, half-rupee and quarter-rupee shall be respectively equivalent to one hundred, fifty and twenty-five such new coins and shall, subject to the provisions of sub-section (1) and sub-section (2) of section 13 and to the extent specified therein, be a legal tender in payment or on account accordingly.

(2) All coins issued under the authority of this Act in any denominations of annas, pice and pies shall, to the extent specified in section 13, be a legal tender in payment or on account at the rate of sixteen annas, sixty-four pice or one hundred and ninety-two pies to one hundred new coins referred to in sub-section (1), calculated in respect of any such single coin or number of such coins, tendered at one transaction, to the nearest new coin, or where the new coin above and the new coin below are equally near, to the new coin below.

(3) All references in any enactment or in any notification, rule or order under any enactment or in any contract, deed or other instrument to any value expressed in annas, pice and pies shall be construed as references to that value expressed in new coins referred to in sub-section (1) converted thereto at the rate specified in sub-section (2).

(4) As from the commencement of the ***Indian Coinage (Amendment) Act, 1964***, all references in any enactment or in any notification, rule or order under any enactment or in any contract, deed or other instrument to any value in *naya paisa* **or** *naye* ***guise*** shall be construed as references to that value expressed respectively in *paisa* or ***paise,*** being the new coins designated as such from 1st day of June, 1964.

COIN MADE UNDER FORMER ACTS

15. Repealed.

POWER TO CALL IN COIN

15A. Notwithstanding anything contained in section 13, the Central Government may, by notification in the Official Gazette, call in, with effect from such date as may be specified in the notification, any coin, of whatever date or denomination, referred to in that section, and on and from the date so specified, such coin shall cease to be a legal tender save to such extent as may be specified in the notification,

DIMINISHED, DEFACED AND COUNTERFEIT COINS

POWER TO CERTAIN PERSONS TO CUT DIMINISHED OR DEFACED SILVER COINS

16. Where any silver coin which has been coined and issued under the authority of the Central Government is tendered to any person authorized by the Central Government to act under this section, and such person has reason to believe that the coin

a) has been diminished in weight so as to be more than such percentage below standard weight as may be prescribed as the limit of reasonable wear, or

b) has been defaced,

he shall, by himself or another, cut or break the coin.

PROCEDURE IN REGARD TO COIN CUT UNDER SECTION 16(a)

17. A person cutting or breaking coin under the provisions of clause (a) of section 16 shall observe the following procedure, namely:

a) if the coin has been diminished in weight so as to be more than such percentage below standard weight as may be prescribed as the limit of reasonable wear, but not more than such further percentage as may be prescribed in this behalf, he shall either return the pieces to the person tendering the coin, or, if such person so requests, shall receive and pay for the coin at such rates as may be prescribed in this behalf; and

b) if the coin has been diminished in weight so as to be more than such further percentage below standard weight so prescribed as aforesaid, he shall return the pieces to the person tendering the coin, who shall bear the loss caused by such cutting or breaking.

PROCEDURE IN REGARD TO COIN CUT UNDER SECTION 16(b)

18. A person cutting or breaking coin under the provisions of clause (b) of section 16 shall observe the following procedure, namely:

a) if such person has reason to believe that the coin has been fraudulently defaced, he shall return the pieces to the person tendering the coin, who shall bear the loss caused by such cutting or breaking; and

b) if such person has not reason to believe that the coin has been fraudulently defaced, he shall receive and pay for the coin at its nominal value.

Explanation — For the purposes of this section a coin which there is reason to believe has been defaced by sweating shall be deemed to have been fraudulently defaced.

PROCEDURE IN REGARD TO COIN WHICH IS LIABLE TO BE CUT UNDER BOTH CLAUSE (a) AND CLAUSE (b) OF SECTION 16

19. If a coin is liable to be cut or broken under the provisions of both clause (a) and clause (b) of section 16, the person cutting or breaking the coin shall deal with it,

a) if he has reason to believe that the coin has been fraudulently defaced, under clause (a) of section 18; and

b) in other cases, under section 17.

POWER TO CERTAIN PERSONS TO CUT COUNTERFEIT OR FRAUDULENTLY DEFACED COIN AND PROCEDURE IN REGARD TO COIN SO CUT

20. Where any coin purporting to be coined or issued under the authority of the Central Government is tendered to any person authorized by the Central Government to act under this section, and such person has reason to believe that the coin is counterfeit or has been fraudulently defaced, he shall by himself or another cut or break the coin, and may at his discretion either return the pieces to the tenderer, who shall bear the loss caused by such cutting or breaking, or in the case of silver coin receive and pay for the coin according to the value of the silver bullion contained in it.

SUPPLEMENTAL PROVISIONS

POWER TO MAKE RULES

21. (1) The Central Government may make rules to carry out the purposes and objects of this Act.

(2) In particular and without prejudice to the generality of the foregoing power, such rules may

a) Repealed;

b) provide for the guidance of persons authorized to cut or break coin under sections 16 and 20;

c) determine the percentage of diminution in weight below standard weight not being less than two percent in the case of silver coins or five percent in the case of pure nickel coins, which shall-be the limit of reasonable wear;

d) prescribe the further percentage referred to in clause (a) of section 17, and the rates at which payments shall be made in the case of coins falling under the same clause;

e) Repealed.

(3) Every such rule shall be published in the Official Gazette and on such publication shall have effect as if enacted in this Act.

BAR OF SUITS

22. No suit or other proceeding shall lie against any person in respect of any thing in good faith done, or intended to be done, under or in pursuance of the provisions of this Act.

SAVING OF MAKING OF OTHER COINS AT MINTS

23. Nothing in this Act shall be deemed to prohibit or restrict the making at the Mint of coins intended for issue as money by the Government of any territories beyond the limits of India.

TEMPORARY PROVISIONS WITH RESPECT TO CERTAIN HYDERABAD COINS

24. Notwithstanding anything in section 6 of the Part B ***States (Laws) Act,*** 1951, coins of such description as at the commencement of the said Act were in circulation as legal tender in the State of Hyderabad shall continue to be legal tender in that State to the like extent and subject to the same conditions as immediately before the commencement of the said Act for such period, not exceeding four years from such commencement, as the Central Government may, by notification in the Official Gazette, determine. □

APPENDIX 7

Indian Standards and Other Material Issued to Facilitate Metricization in India

BASIC	*IS :
Conversion factors and conversion tables *(first revision)*	786-1967
Conversion tables for ordinary use *(first revision)*	1020-1963
Guide for inter-conversion of values from one system of units to another	787-1956
Guide for specifying metric values in standards	1722-1960
Method for precise conversion of inch and metric dimensions to ensure interchangeability	1105-1957
Preferred numbers *(first revision)*	1076-1967
Recommendation on the international system (SI) units	3616-1966
Recommendations on fundamental quantities of units of the MKSA system and quantities and units of space and time	1890 (Part I)-1961
Recommendations on quantities and units of periodic and related phenomena	1890 (Part II)-1961
Recommendations on quantities and units of machines	1890 (Part III)4961
Recommendations on quantities and units of heat	1890 (Part IV)-1961

*An Indian Standard is designated by letters IS followed by its serial number and year of issue, or of revision, for example, IS : 44X-1967. Indian Standards issued before it was decided to go metric, and even some of those issued as a result of the change-over, have since been revised. The list given the designations and titles of latest versions of all such standards.

*Mathematical signs and symbols for use in the physical sciences and technology	1890 (Part XI)-1961
Rules for rounding off numerical values (*first revision*)	2-1960

Decimal Coinage in India, 1956. The Publications Division, Government of India, New Delhi

ISI conversion slide (see illustration P 269)

ISI structural engineers' slide (*see* illustration P 341)

Metric Measures (bi-monthly Journal). Vol 1 (1958) to Vol 8 (1965). Publications Division, Government of India, New Delhi

SHARMA (P D). Metric Weights and Measures -A manual for teachers, 1959. The Manager of Publications, Government of India, New Delhi

Teaching in Metric System, 1960. Directorate of Advertising and Visual Publicity, Government of India, New Delhi

Training in Metric System for Engineering Industry, 1965. The Manager of Publications, Government of India, New Delhi

BASIC ENGINEERING	IS :
Code of practice for architectural and building drawings ***(first revision)***	962-1967
Code of practice for general engineering drawings (*first* revision)	696-1960
Conversion factors and conversion tables for yarn counts	3689-1966
Equivalent metric units for quantities in mechanical engineering	1926-1961
Preferred sizes for wrought metal products	1136-1958
Recommendations for limits and fits (first ***revision)***	919-1963
Recommendations for limits and fits for sizes above 500 mm up to 3 150 mm	2101-1962
Thicknesses of sheet and diameters of wire	1137-1959

ISI Handbook of quantities, conversion factors, formulae and tables

ISI steam tables (including Mollier diagrams for temperature up to 800°C and pressure up to 500 kgf/cm²)

BOARDS AND SHEETS	
Asbestos cement building boards	2098-1964
Asbestos cement flat sheets	2096-1966
Asbestos cement sheets, unreinforced corrugated ***(first revision)***	459-1962
Block boards	1659-1960
Fibre hardboards (first ***revision)***	1658-1966
Fibre insulation boards	3348-1965
Gypsum plaster boards	2095-1964
High density wood particle boards	3478-1966

*Parts V to X are under preparation.

	IS :
Marine plywood	710-1957
Particle boards for insulation purposes	3129-1965
Plywood for general purposes (first *revision)*	303-1960
Veneered decorative plywood	1328-1958
Veneered particle boards	3097-1965
Wood particle boards (medium density) for general purposes	3087-1 965

BRICKS AND BLOCKS

Brickwork, Code of practice for	2212-1962
Burnt clay building bricks, heavy duty	2180-1962
Burnt clay facing bricks	2691-1964
Burnt clay hollow blocks for walls and partitions	3952-1967
Burnt clay perforated building bricks	2222-1962
Common burnt clay building bricks *(first revision)*	1077-1966
Construction of hollow concrete block masonry, Code of practice for	2572-1 963
Hollow cement concrete blocks *(first revision)*	21851967
Lime-cement-cinder solid blocks	3115-1965
Paving bricks	3583-1966
Soil-cement blocks used in general building construction	1725-1960

BUILDING MEASUREMENT AND REGULATION

Areas and cubical contents in buildings, Method of measurement of	3861-1966
Code of building by-laws *(first revision)*	1256-1967
Equivalent metric units for scales, dimensions and quantities in general construction work *(first revision)*	965-1963
Method of measurement of building and civil engineering works :	
Part VIII Steelwork and ironwork *(second revision)*	1200 (Part VIII)-1967

CEMENT AND CONCRETE

Plain and reinforced concrete, Code of practice for *(second revision)*	456-1 964
Prestressed concrete, Code of practice for	1343-1960

CONDUCTORS AND CABLES

Aluminium conductors for insulated cables *(first revision)*	1753-1967
Copper conductors in insulated cables and cords	2982-1965

DOORS AND WINDOWS

Aluminium doors, windows and ventilators	1948-1961

	IS :
Aluminium windows for industrial buildings	1949-1961
Steel door frames	4351-1967
Steel doors, windows and ventilators (*first* ***revision)***	10381968
Steel windows for industrial buildings	1361-1959
Timber door, window and ventilator frames	4021-1967
Timber panelled and glazed shutters:	
Part I Door shutters ***(first revision)***	1003 (Part I)-1966
Part II Window and ventilator shutters (first ***revision)***	1003 (Part II)-1966
Wooden flush door shutters (cellular and hollow core type):	
Part I Plywood face panels ***(first revision)***	2191 (Part I)-1966
Part II Particle board face panels ***(first revision)***	2191 (Part II)-1966
Wooden flush door shutters (solid core type):	
Part I Plywood face panels ***(first revision)***	2202 (Part I)-1966
Part II Particle board face panels (*first* ***revision)***	2202 (Part II)-1966

ELECTRICAL ACCESSORIES

Bayonet lampholders ***(first revision)***	1258-1967
Flexible steel conduits for electrical wiring	3480-1966
Link clips for electrical wiring	2412-1963
Preferred panel cut-out dimensions for electrical relays:	
Part I Flush mounting IDMTL relays	4483 (Part I)-1968
Rigid steel conduits for electrical wiring, Accessories for	3837-1966

ELECTRONIC VALVES

Dimensions of electronic valves:	
Part I Miniature 9-pin noval type	2684 (Part I)-1964
Part II Miniature 7-pin type	2684 (Part II)-1965

FANS

Air circulator type electric fans and regulators	2997-1964
Axial flow fans, electric	3588-1966
Fans and regulators, ceiling type, electric (*second* ***revision)***	374-1966
Fans and regulators, electric, for use in ships	4327-1967
Fans and regulators, electric, table type (second ***revision)***	555-1967
Fans and regulators, pedestal type, electric ***(first revision)***	1169-1967

FOOTWEAR

Footwear lasts, wooden	4512-1967
Sizes and fittings of footwear	1638-1960

FOUNDRY

Foundry moulding boxes of steel construction ***(first revision)***	1280-1967

	IS :
Ladles, geared, hand-operated, crane-suspended, for iron foundries	4475-1967
Ladles, geared, hand-operated, crane-suspended, for steel foundries	4476-1967
Machine building boxes, Pattern plates for	4604-1968

FURNITURE

Dimensions of tables and chairs for general office purposes	3663-1966
Shelving cabinets (adjustable type), metal	3312-1965
Shelving cabinets (adjustable type), wooden	4116-1967
Shelving racks (adjustable type), metal (first revision)	1883-1966
Tables (office type), metal	3498-1966

GEARS

Master gears (module range 1·25 to 10)	4071-1967

GLASS AND GLASSWARE

Glass beer bottles	2091-1962
Liquor bottles, glass (first *revision*)	1662-1962
Medicinal round glass bottles, narrow mouth (first revision)	1108-1965

ILLUMINATING ENGINEERING

Interior illumination, Code of practice for:	
Part I Principles of good lighting and aspects of design	3646 (Part I)-1966
Part II Schedule for values of illumination and glare index	3646 (Part II)-1966

INDUSTRIAL EQUIPMENT

Recommendation on nominal capacities for process equipment	2843-1964
Recommendation on nominal diameters for process equipment	2844-1964
Recommendation on nominal pressures for process equipment	2845-1964
Recommendation on nominal temperatures for process equipment	2846-1964
Recommendations for shaft diameters for chemical equipment	3132-1965
Sizes of process vessels and leading dimensions	4179-1967

INSTRUMENTS

4-metre, levelling staff, folding type	1779-1961

	IS :
Metric diagonal scales (cartographers, surveyors and engineers)	1562-1962
Metric scales for architectural purposes	1491-1959
Metric scales for general purposes	1480-1960
Metric scales for use with drafting machines	1482-1960
Metric steel scales for engineers	1481-1961
Metric surveying chains	1492-1959
Plane tables	2539-1963
Protractors for use of drawing offices	1563-1962

INSULATORS

Dimensions for clamping arrangements for bushings	4257-1967
Dimensions for disc insulators	3188-1965
Dimensions for porcelain transformer bushings:	
Part I Up to 1·1 kV bushings, Section 1 Porcelain parts	3347 (Part I/ Sec 1)-1965
Part I Up to 1·1 kV bushings, Section 2 Metal parts	3347 (Part I/ Sec 2)-1967
Part II 3·6 kV bushings, Section 1 Porcelain parts	3347 (Part II/ Sec 1)-1965
Part II 3·6 kV bushings, Section 2 Metal parts	3347 (Part II/ Sec 2)-1967
Part III 12 and 17·5 kV bushings, Section 1 Porcelain parts	3347 (Part III/ Sec 1)-1965
Part IV 24 kV bushings, Section 1 Porcelain parts	3347 (Part IV/ Sec 1)-1965
Part IV 24 kV bushings, Section 2 Metal parts	3347 (Part IV/ Sec 2)-1967
Part V 36 kV bushings, Section 1 Porcelain parts	3347 (Part V/ Sec 1)-1965
Part V 36 kV bushings, Section 2 Metal parts	3347 (Part V/ Sec 2)-1967
Insulator fittings for overhead power lines of 3·3 kV and above :	
Part II Dimensional requirements	2486 (Part II)-1963

MODULAR CO-ORDINATION

Modular co-ordination applied to RCC framed structures, Recommendation for	2375-1963
Modular co-ordination of dimensions in the building industry, Recommendations for	1233-195s
Preferred dimensions for storey-heights, Recommendation for	2718-1964

	IS :
MOTORS	
Induction motors, three-phase foot-mounted, Dimensions of ***(second revision)***	1231-1967
NON-FERROUS METALS	
Aluminium sheet, corrugated ***(first revision)***	1254-1965
Diameters of wrought aluminium and aluminium alloys, rivet, bolt and screw stock	3577-1967
Diameters of wrought aluminium and aluminium alloys, wire	2525-1963
Dimensions for wrought aluminium and aluminium alloys, drawn tube	2678-1963
Dimensions for wrought aluminium and aluminium alloys, extruded tube (round)	2673-1964
Dimensions for wrought aluminium and aluminium alloys, plate	2677-1964
Dimensions for wrought copper and copper alloy rods and bars	2826-l 964
Lead pipes (***first revision)***	404-1962
Lead sheet (first ***revision)***	405-1961
Sheet and strip, wrought aluminium and aluminium alloys, Dimensions for	2676-1964
Solder wire, rosin-cored, activated and non-activated (non-corrosive)	1921-1961
Wrought copper and copper alloys, plate, Dimensions for	3051-1965
Wrought copper and copper alloys, sheet, strip and foil, Dimensions for	3052-l 964
PACKING	
Cases, pent-top wooden	3805.1966
Cases, plywood — battened construction	2674-1964
Tea-chests, plywood ***(second revision)***	lo-1964
PIG IRON AND CAST IRON	
Cast iron spigot and socket drain pipes	3486-1966
Malleable cast iron pipe fittings	1879-1961
Pipes and fittings, cast iron rain-water ***(first revision)***	1230-1968
Pressure pipes for water, gas and sewage, Cast iron fittings for	1538-1960
Pressure pipes for water, gas and sewage, centrifugally cast (spun) iron	1536-1960
Pressure pipes for water, gas and sewage, vertically cast iron	1537-1960
Sand cast iron spigot and socket soil, waste and venti-Iating pipes, fittings and accessories	1729-1964

	IS :
Spigot and socket soil, waste and ventilating pipes, centrifugally cast (spun) iron	3989-1967
REFRACTORIES	
Firebricks, Sizes and shapes for	1526-1960
REINFORCEMENT	
Cold twisted steel bars for concrete reinforcement *(first revision)*	1786-1966
Fabric for concrete reinforcement, hard-drawn steel wire	1566-1960
SIEVES	
Test sieves *(first revision)*	460-1962
STEEL PRODUCTS	
Cold rolled steel strip for springs	2507-l 965
Expanded metal steel sheets for general purposes *(first revision)*	412-1962
Iron and steel wire, galvanized, for telegraph and telephone purposes *(jirst revision)*	279-1961
Mild steel wire for general engineering purposes *(first revision)*	280-1962
Steel castings, Deviations for untoleranced dimensions and weight of	4897-1968
Steel chequered plates	3502-1966
Steel plates for boilers	2002-1962
Steel sheets, galvanized (plain and corrugated) (first *revision)*	277-1962
Tolerances for steel drop forgings, upset forgings, press forgings and forged bars	3469-1966
STONE	
Dimensions and workmanship of natural building stones	1127-1957
Laterite stone block for masonry	3620-1966
Limestone slabs	1128-1957
STRUCTURAL DESIGN AND CONSTRUCTION	
Design of structural timber in building, Code of practice for *(second revision)*	883-1966
Structural safety of buildings: loading standards, Code of practice for *(first revision)*	875-1964
Unit weights of building materials, Schedule of *(first revision)*	1911-1967
Use of structural steel in general building construction, Code of practice for *(first revision)*	800-1962

ISI Handbooks for structural engineers:
No. 1 Structural steel sections
No. 2 Steel beams and plate girders
No. 3 Steel columns and struts
ISI structural engineers' slide (steel)

STRUCTURAL SHAPES	IS :
Aluminium channels	3921-1966
Aluminium equal leg angles	3908-1966
Aluminium unequal leg angles	3909-1966
Angle sections with legs of unequal width and thickness, Dimensions for	1864-1963
Cold formed light gauge structural steel sections *(first revision)*	811-1965
Crane rail sections	3443-1966
Hot-rolled and slit steel tee bars *(first revision)*	1173-1967
Hot-rolled steel channel sections for general engineering purposes	3954-1966
Hot-rolled steel products, rolling and cutting tolerances	1852-1967
Rolled steel beam, channel and angle sections *(first revision)*	808-1964
Rolled steel bulb plates, Dimensions for	1863-1961
Rolled steel sections, bulb angles	1252-1958
Round and square steel bars for structural and general engineering purposes, Dimensions for	1732-1961
Steel flats for structural and general engineering purposes, Dimensions for	1731-1961
Steel plate, sheet and strip for structural and general engineering purposes, Dimensions for	1730-1961
Steel sheet piling sections	2314-1963
Tubular steel poles for overhead power lines	2713-1964

TEXTILE	
Method for determination of:	
Breaking load and elongation at break of woven textile fabrics *(first revision)*	1969-1968
Bursting strength of woven and knitted fabrics	1966-1961
Dimensions of fabrics	1954-1961
Ends and picks per unit length in woven fabrics	1963-1961
Mean fibre length of wool	1377-1959
Twist in yarn	832-1964
Universal count of cotton yarn	1315-1959
Weight per square metre and weight per linear metre of fabrics	1964-1961

	IS :
THERMOMETERS	
Clinical thermometers	3055-1965
Thermometers, dairy, floating (*first revision*)	1672-1967
Thermometers, glass, general purpose	2480-1964
TILES	
Burnt clay flat terracing tile	2690-1964
Burnt clay tiles for use in lining irrigation and drainage works	3367-1965
Ceramic unglazed vitreous acid-resistant tiles	4457-1967
Flooring tiles, cement concrete	1237-1959
Flooring tiles, clay	1478-1959
Glazed earthenware tiles	777-1961
Plastic flooring and wall tiles, Methods of test for	3464-1966
Polystyrene wall tiles	3463-1966
PVC (vinyl) asbestos floor tiles	3461-1966
Ridge and ceiling tiles	1464-1959
Roofing tiles, Mangalore pattern, clay (*first* revision)	654-1962
Structural hollow clay floor tiles	3951-1967
TIMBER	
Coniferous sawn timber intended for further conversion *(second revision)*	190-1960
Cut sizes of timber *(first revision)*	1331-1966
Non-coniferous sawn timber intended for further conversion	1326-1958
Tables for volume of round timber logs	2184-1962
Tables for volumes of cut sizes of timber (*first revision)*	2377-1967
TUBES AND PIPES	
Asbestos cement building pipes, gutters and fittings (spigot and socket type)	1626-1960
Asbestos cement pressure pipes	1592-1960
Concrete pipes, Methods of tests for	3597-1966
Concrete pipes (with and without reinforcement) (*first revision)*	458-1961
Concrete porous pipes for under drainage	4350-1967
Dimensions for forged steel socket-welding fittings	4712-1968
Dimensions for steel tubes for bicycle purposes	2484-1964
Low density polythene pipes for cold water services:	
Part I Up to 50 mm size	3076 (Part I)-1965
Mild steel tubes, tubulars and other wrought steel fittings :	
Part I Mild steel tubes *(second revision)*	1239 (Part I)-1968
Prestressed concrete pipes	784-1959

	IS :
Salt-glazed stoneware pipes and fittings (second revision)	651-1966
Sheet metal rain-water pipes up to 10 mm size, gutters, fittings and accessories	1728-1960
Steel cylinder reinforced concrete pipes	1916-1963
Steel tubes for structural purposes (second *revision)*	1161-1968

WATER SUPPLY, DRAINAGE AND SANITATION

Basic requirements for water supply, drainage and sanitation *(first revision)*	1172-1963
Glazed earthenware, sanitary appliances *(third revision)*	771-1963
Sluice valves for water works purposes (350 lo 1 200 mm size)	2906-1964
Sluice valves for water works purposes *(third revision)*	780-1967
Vitreous sanitary appliances (vitreous china):	
Part I General requirements *(first revision)*	2556 (Part I)-1967
Part II Specific requirements of wash-down water closets *(first revision)*	2556 (Part II)-1967
Part III Specific requirements of squatting pans and traps *(first revision)*	2556 (Part III)-1967
Part IV Specific requirements of wash basins *(first revision)*	2556 (Part IV)-1967
Part V Specific requirements of laboratory sinks *(first revision)*	2556 (Part V)-1967
Part VI Specific requirements of urinals *(first revision)*	2556 (Part VI)-1967
Part VII Specific requirements of half-round channel *(first revision)*	2556 (Part VII)-1967
Part VIII Specific requirements of siphonic wash-down water closets *(first revision)*	2556 (Part VIII)-1967
Part IX Specific requirements of bidets *(first revision)*	2556 (Part IX)-1967
Part X Specific requirements of foot rests *(first revision)*	2556 (Part X)-1967
Water meters (domestic type), Code of practice for selection, installation and maintenance of	2401-1963
Water supply in buildings, Code of practice for	2065-1963

WEIGHTS AND MEASURES

Accuracy requirements for bulk meters used in petroleum trade	2801-1967
Accuracy requirements for dispensing pumps used in petroleum trade	3033-1965
Accuracy requirements for volumetric container filling machines used in petroleum trade	3047-1965
Automatic weighing machines	1437-1967
Auto-rickshaw meters, distance-cum-time type, Performance requirements for	4339-1968

	IS :
Baby weighing machines	2489-1963
Beam scales (*first revision)*	1433-1965
Calibration of vehicle tanks for petroleum products and other liquids, Code of practice for	2383-1963
Commercial metric capacity measures *(first revision)*	1058-1962
Commercial metric carat weights *(first revision)*	1057-1968
Commercial metric length measures (non-flexible)	1059-1958
Commercial metric weights (*first revision)*	1056-1965
Counter machines	1434-1959
Crane weighing machines	14381960
General requirements for testing the accuracy of commercial measuring instruments used in petroleum trade	3032-1965
General requirements for weighing instruments	1432-1959
Large metric capacity calibrating measure (non-tilting type)	2341-1963
Metric dispensing measures	1160-1957
Metric steel tape measures (winding tape) (first *revision)*	1270-1965
Metric woven metallic and glass fibre tape measures *(first revision)*	1269-1964
Performance requirements for taximeters	2747-1964
Person-weighing machines *(first revision)*	1854-1964
Platform weighing machines	1435-1960
Scale, portable, for jewellers	4532-1968
Self-indicating and semi-self-indicating counter type weighing machines	1853-1961
Spring balances *(first revision)*	1702-1967
Steelyards	1439-1959
Tapes for use in measurement of oil quantities	3515-1966
Totalizing weighing machines	3960-1967
Weigh-bridges	1436-1960
Wheel weighers	4070-1967

WINDING WIRES

Copper conductors, cotton covered rectangular	2068-1962
Copper conductors, enamelled, rectangular and square	3855-1966
Cotton-covered round copper conductors (*first revision)*	450-1964
Enamelled high-conductivity annealed round copper wire (oleo-resinous enamel) (*first revision)*	449-1962
Enamelled round copper wire for elevated temperatures	2659-1964
Enamelled round copper wire with high mechanical properties *(first revision)*	1595-1967
Paper-covered rectangular copper conductors for transformer windings	1666-1961
Paper-covered round copper conductors	3454-1966
Reels for covered, round electrical winding wires (second *revision)*	482-1968

□

(continued from flap 1)

as well as advanced countries involved or going to be involved in such an enterprise.

The breadth and inter-disciplinary nature of the contents of the book — basic standards; meteorology; railways; shipping; civil aviation; posts, telegraphs and telephone services; construction and engineering industries; etc — easily make it a most informative, authentic and well documented reference work on the subject.

The first hand account of historical, legislative, educational, public relations and other aspects of this bold and imaginative experiment should be a source of inspiration and absorbing interest to the specialist as well as the lay reader for whom it might even serve as a model to emulate.