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JOURNAL OF WEIGHTS AND MEASURES

40 NAYE PAISE

ABBREVIATIONS FOR METRIC UNITS

(1) DECIMAL MULTIPLES AND SUBMULTIPLES

Prefix		Value in Terms of Unit	Abbreviation
kilo	..	1,000	k
centi	..	0·01 (10^{-2})	c
milli	..	0·001(10^{-3})	m
micro	..	0·000 001(10^{-6})	μ

(2) WEIGHTS

Denomination		Value	Abbreviation
tonne	..	1 000 kg	t
quintal	..	100 kg	q
kilogram	..	1 kg	kg
gram	..	1 g	g
milligram	..	1 mg	mg
carat	..	200 mg	c

(3) CAPACITY

kilolitre	..	1 000 l	kl
litre	..	1 l	l
millilitre	..	1 ml	ml

(4) VOLUME

cubic metre	..	m^3	m^3 or cu m*
cubic centimetre		cm^3	cm^3 or cu cm*
cubic millimetre		mm^3	mm^3 or cu mm*

(5) LENGTH

kilometre	.	1 000 m	km
metre	.	1 m	m
centimetre	..	1 cm	cm
millimetre	..	1 mm	mm
micron	..	1/1 000 mm or 10^{-3} mm	μm

(6) AREA

square kilometre		1 000 000 m^2	km^2 or sq km*
square metre	..	1 m^2	m^2 or sq m*
square centimetre		1 cm^2	cm^2 or sq cm*
square millimetre		1 mm^2	mm^2 or sq mm*

(7) LAND MEASURE

arc	..	100 m^2	a
hectare	..	100 a	ha
centiare	..	m^2	ca

*Both these abbreviations are current, but the first set should preferably be used. The former abbreviation is used more commonly internationally than the latter.

Rules for Abbreviations :

(1) Do not make any change, such as addition of 's' to indicate plurality *e.g.*, write 1 kg, 10 kg, 20 g, 5 g, 10 t, 20 ml, 27l, 165 km, 2 mm, 100 cm^3, 66 km^2;

(2) Do not capitalize the abbreviations. For example, do not write 1 Kg, 2 Kg, 20 MM, 50 MM, the right way is to write 1 kg, 2 kg, 20 mm, 50 mm, etc.;

(3) Do not use any other abbreviations except those given above.

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Development of Length and Area Measures in South India—Part 1

L. RAJU AND V. B. MAINKAR

Ministry of International Trade
New Delhi

IN the earlier series of articles we have traced the possible origins and the development and resultant chaos in the weights and capacity measures used until recently in South India.[1]

We shall now consider the development of the various length and area measures in this region of India. As in the previous articles, South India is taken to mean the region covered broadly by the present States of Andhra Pradesh, Kerala, Madras and Mysore.

Length measures are now used in commerce mainly for the sale of cloth, wires, structural materials etc. or for measuring distances and like operations. In the present article we shall not consider the use of length measures for architectural and building purposes as this can form the subject matter of a separate series of articles.

Area measures, though used in transactions involving such commodities as plywood, glass, floor coverings and the like, find their most important use in the measurement of area of fields for revenue and other purposes.

The usual method of deriving the area of a field consists of measuring the lengths of its component sides and calculating the area from these lengths according to well-established geometrical formulae.

If the field is a regular geometrical figure like a triangle, square or rectangle the calculations are comparatively easy. If, however, the field has an irregular shape, the method usually employed is to divide it into discrete regular geometric figures like squares or triangles and measure the lengths of each of these figures and add up the areas of the component figures to obtain the area of the field. The length measure used for these operations may be a chain, tape, wooden pole or even a rope, usually long enough to enable the measurements to be made quickly and accurately.

In this article we shall examine only certain distinctive area measures which can be evaluated in terms of modern units.

It is because of this close relation between the length and area measures that we shall consider them together in this series of articles.

Length Measures

The various *Weights and Measures Laws* which were current in South India prior to the introduction of the metric system in 1958, are unanimous in adopting only the yard

and its multiples and submultiples as legal length measures. For areas, normally the squares of length measures are recognised. The units of land area are, however, rarely defined in the old Weights and Measures Acts. The only exception is that the guntha is defined as 121 square yards in the Weights and Measures Act (No. XIV of 1356 Fasli) of Hyderabad.

For the commonly used land area measures we have to look into other sources such as revenue records, gazetteers, manuals of administration, traditional tables of areas or even arithmetic textbooks.

It should be noted that in the area tables now used, the basic length unit used is usually the inch, foot or yard. There is a good reason for this situation.

The administration of any country which depends largely on revenues obtained from land would take care to enforce area units with great vigour. That is why the British, as soon as they could, after taking over a territory would have tried to standardise the land area units of the region. The basic unit, however, would be that of length. It would be natural to standardize the then existing length units in terms of units they could easily comprehend viz., the yard, the foot, the inch. Moreover, the apparently plentiful variety of length measures used for various purposes would have made it difficult for them to adopt one of them as a standard unit. The principal old unit was the hasta. This had a variable length in India (15—30 inches) but was accepted in England under the name of the cubit, as 18 inches or half a yard exactly. The obvious conclusion would, therefore, be to take, wherever possible, the equivalent of it in terms of rationalized English units. For example, as will be shown in Part 4 the rope of 158¼ feet was standardized by the British at 160 feet in Madura district. by such means, the area unit could be standardized in terms of discrete numbers of square feet, square yards or acres. This leaves open the question of what could have been the units of area used in ancient and medieval South India which were replaced by the British.

If we wish to examine this question we have to evaluate the basic length measures used by the ancients for measuring commercial lengths and for measuring areas of fields. As in the case of weights and capacity measures, we have to go back to the earliest periods of Indian history to understand the stages of development which could have led to the great variety of measures in later times.

Indus Valley Civilization

We, therefore, go back to the ancient times in India, viz., the time when the Indus Valley civilization flourished in the period 2500-1500 B.C. over a vast territory in North and Western India, measuring some 1500 km in length and equally broad. Surprisingly enough, although a large number of weights of uniform standard were found all over this vast area, only three pieces of length measures were discovered.

In Mohenjo-daro was found[2] a piece of shell on which certain lines were finely marked. There was a full circle on one mark and five marks later a hollow circle was inscribed. The line indicating each division was about 0·5 mm thick. Each division itself was 6·7 mm (0·264 inch), the distance between the five divisions being 33·528 mm. It may be assumed that the scale was divided decimally because there were 5 divisions between the full circle and the hollow circle. The next full circle would occur after another 5 divisions, giving 10 divisions between two full circles. The recurring unit, therefore, should be 67·056 mm. (2·64 in). The mean error of graduation of each division is estimated at 0·075 mm. We may then take the length of the basic recurring unit as 67 mm within limits of tolerance.

mentioned are the aratni (TS 5.2.5.1; AV 19.57.6), vyama (TS 5.1.1.4; 5.1.10.5; AV 6.137.2) paurusha (TS 5.1.1.5; 5.1.10.5; 5.2.5.1.), pada (TS 6.2.4.5), and ashwina (AV 6.131.3.).

The *Vedic Index*[9] lists a number of additional units mentioned in the literature that followed the four Veda. The krosa, traipada, angustha, prakrama, pradesa, bahu, sala etc. are some examples. It is not possible to establish any coherent relation among them. The *Vedic Index*, however, notes with reference to traipada, that it is a 'measure of distance, three quarters of a yojana in the *Pancavimsa Brahmana*, where half a yojana is termed gavyuti and a quarter a krosa'.

The *Satapatha Brahmana* (12.2.1.3)[10] mentions an interesting method of measuring depths, by using the suffix *daghna* e.g. upapaksha daghna (reaching upto armpits), kanthadaghana (reaching upto the neck) urudaghna (thigh deep), janudaghna (knee-deep) etc.

Kautiliya Arthasastra

The literature in the post-Vedic period is also not very helpful in establising the relations of units. As in the case of weights and capacity measures we have to travel through centuries to the 3rd-4th century B.C. before we come across a systematic attempt to establish tables of weights and measures. The book is the inevitable Kautiliya *Arthasastra*.[11]

Being the first systematic analysis, it is intended to analyse Kautilya's table on length and area measures (*Book 2. Ch XX*) somewhat exhaustively; more so, as it forms, with modifications, the very foundation of later traditions in metrology.

There appear to be two editions of *Arthasastra* differing from each other in certain respects. In so far as the field of metrology is concerned besides other comparatively minor differences, one edition prescribes a goruta of 1000 dhanu, while the second one lays down that the goruta is 2000 dhanu. Sanskrit scholars have been making extensive studies to establish the correct text. Prof. Kangle has recently published an edition after considerable research and has accepted the goruta as 2000 dhanu. The goruta of 1000 dhanu is accepted by Shamasastry. Traditions have a peculiar way of establishing themselves. It is, therefore, intended to analyse both the versions of *Arthasastra* tables. It should, however, be remembered that even a wrong tradition could have taken root in some parts of India and an analysis of both the texts may be desirable for the sake of completeness of our examination.

The English translation of the portion relating to length and area measures is reproduced below from Shamasastry's book and the Sanskrit text from Kangle's edited text.

English Translation

The superintendent of lineal measure shall possess the knowledge of space and time.

8 atoms (Paramanavah) are equal to one particle thrown off by the wheel of a chariot.

8 particles	=	1 liksha.
8 likshas		the middle of a yuka (louse) or a yuka of medium size
8 yukas	=	1 yava (barley) of medium size.
8 yavas	=	1 angula (three fourths of an English inch). Or the middlemost joint of the middle finger of a man of medium size may be taken to be equal to an angula.
4 angulas	=	1 dhanurgraha
8 angulas	=	1 dhanurmushti
12 angulas	=	1 vitasti or 1 chhayapaurusha.
14 angulas	=	1 sama, sala, pariraya or pada.
2 vitastis	=	1 aratni or 1 prajpatya hasta.
2 vitastis plus 1 dhanurgraha	=	1 hasta used in measuring balances and cubic measures, and pasture lands.
2 vitastis plus 1 dhanurmushti	=	1 kishku or 1 kamsa

42 angulas	=	1 kishku, according to sawyers and blacksmiths, and used in measuring the grounds for the encampment of the army, for forts and palaces.
54 angulas	=	1 hasta used in measuring timber forests.
84 angulas	=	1 vyama, used in measuring ropes and the depth of digging, in terms of a man's height.
4 aratnis	=	1 danda, 1 dhanus, 1 nalika, and 1 paurusha.
108 angulas are equal to		1 garhapatya dhanus (i.e. a measure used by carpenters called grhapati). This measure is used in measuring roads and fort walls.
The same (108 angulas)	=	1 paurusha, a measure used in building sacrificial altars.
6 kamsas or 192 angulas	=	1 danda, used in measuring such lands as are gifted to Brahmanas.
10 dandas	=	1 rajju.
2 rajjus	=	1 paridesa (square measure).
3 rajjus	=	1 nivartana (square measure).
The same (3 rajjus) plus 2 dandas on one side only	=	1 bahu (arm).
1 000 dhanus	=	1 goruta (sound of a cow).
4 gorutas	=	1 yojana.

Thus are the lineal and square measures dealt with.

Original Sanskrit Text

मानाध्यक्षो देशकालमानं विद्यात् ।१।

अष्टौ परमाणवो रथचक्रविप्रुट् ।२। ता अष्टौ लिक्षा ।३। ता अष्टौ यूका ।४। ता अष्टौ यवमध्यः ।५। अष्टौ यवमध्या अङ्गुलम् ।६। मध्यमस्य पुरुषस्य मध्यमाया अङ्गुल्या मध्यपर्वो वाऽङ्गुलम् ।७।

चतुरङ्गुलो धनुर्ग्रहः ।८। अष्टाङ्गुला धनुर्मुष्टिः ।९। द्वादशाङ्गुला वितस्तिः, छायापौरुषं च ।१०। चतुर्दशाङ्गुलं शमः शलः परिरयः पदं च ।११।

द्विवितस्तिररत्निः प्राजापत्यो हस्तः ।१२। मधनुर्ग्रहः पौतवविवीतमानम् ।१३। मधनुर्मुष्टिः किष्कुः कंसो वा ।१४। द्विचत्वारिंशदङ्गुलस्तक्षणः काकचिकष्किः स्कन्धावारदुर्गराजपरिग्रहमानम् ।१५। चतुष्पञ्चाशदङ्गुलः कुप्यवनहस्तः ।१६।

चतुरशीत्यङ्गुलो व्यामो रज्जुमानं खातपौरुषं च।१७।

चतुररत्निर्दण्डो धनुर्नालिका पौरुषं च गार्हपत्यम्।१८।

अष्टशताङ्गुलं धनुः पथिप्राकारमानं पौरुषचाग्निचित्यानाम् ।१९। षट्कंसो दण्डो ब्रह्मदेयातिथ्यमानम् ।२०।

दशदण्डो रज्जुः ।२१। द्विरज्जुकः परिदेशः ।२२। त्रिरज्जुकं निवर्तनम् एकतः ।२३। द्विदण्डाधिको बाहुः ।२४।

द्विधनुःसहस्रं गोरुतम् ।२५। चतुर्गोरुतं योजनम् २६। इति देशमानम् ।२७।

(*Arthasastra 2.20*)

Examination of Table

While analysing this table we shall neglect the very small units from paramanu upto yava as these could not have been used for commercial purposes and we may treat them more as notional than real. The yava is important as it defines the angula, the fundamental unit of Kautilya's table. It has some significance in understanding later conventions.

The yava is defined here as of '*middle size*'. Prof. Kangle[12] is of the opinion that *yavamadhya* is 'the middle of the barley grain' i.e. its width at the maximum, rather than 'middle-sized barley grain'. For the latter, we should have had *madhyamayava*. The explanation appears to be logical and should be accepted. It would, however, be shown later on that the dimension of the yava as mentioned in *Arthasastra* is different from that accepted later on although the word has remained unchanged.

We may now examine the table taking the angula as the fundamental unit. It should be mentioned here that the angula at this time was probably related with the human finger as defined by Kautilya. We have established this fact in Part 1 of the article on capacity measures.[1] In the same article

e have also evaluated the hasta (28 angula) nd aratni (24 angula) from available evidence f the traditions of metrology in India and he dimensions prescribed for cubic measures. Ve arrived at the following results :

Angula = 17·86 mm
Prajapatya hasta = 42·86 cm (24 angula)
Commercial hasta = 50 cm (28 angula)

The Hasta Measures

An examination of the *Arthasastra* table shows that at least 3 hasta measures, viz. 24, 28 and 54 angula have been prescribed for different uses. It is, however, rather strange that the hasta (28 angula) used for administrative and commercial purposes should work out to 50 cm or half a metre. Why did the ancients not use the Prajapatya hasta of 24 angula which could be more easily defined, being the length from the elbow to the end of the middle finger ? Why was it necessary to use another hasta, 4 angula longer, for commercial and administrative or practical measurements ?

The very fact that the commercial hasta is ½ metre would immediately lead us to believe that it was perhaps derived on the basis of the same principles as were used in defining the metre originally. The metre at its birth was taken as the ten millionth part of the quadrant of the meridian of the earth passing through Dunkirk and Barcelona.

Could such a derivation have been possible in those distant days ? It is now well-known that the science of astronomy was fairly well advanced in the ancient times in many countries like Egypt, Babylonia and India. In fact, there have been many convincing arguments put forth to establish that the Egyptian cubit was related with the circumference of the earth[13]. Even the Babylonian cubit is taken to be based on the dimensions of the earth.[14] It is fascinating to believe that the ancient Indians may also have calculated fairly accurately the circumference of the earth and subdivided it until they arrived at a fraction, in this case eighty millionth part, which gave them a unit which could be easily handled. The unit happened to be 4 angula longer than the traditional hasta of 24 angula.

Other theories that could be advanced to explain the hasta of 28 angula are that it was derived on the basis of some geometrical relationship which is not clear to us now, or that it was just a sheer accident that the hasta had a value of ½ metre, there being no geodetic or geometric origin for it. The correct explanation, however, eludes us at the moment.

There are differences of opinion among scholars as to whether the 50 cm commercial hasta had an Indian origin. Some scholars are unwilling to attribute originality to the Indian mind and would strongly maintain that the hasta was imported from Egypt, Babylonia, Assyria or some other place. It is maintained by some that the Indian commercial hasta of 50 cm was based on Gudea's rule, (2175 BC[13,15]). Gudea's rule was divided into 30 parts and had a length of 50·29 cm (19·8 in) each division thus being 16·7 mm. (*See* also Part 4 for 50·3 cm hasta used in India, under *Godavari District*).

There are others who do not subscribe to this view.

We need not enter into the controversy. For our purpose, what matters is that whatever its origin, Indian or foreign, terrestrial or geometric, the 50 cm hasta occupies an extremely important place throughout the long history of commercial metrology in India.

Seeds of Multiplicity

As we have already seen, the *Arthasastra* table lays down three different hasta measures

(24, 28 and 54 angula). It also prescribes two kishku (32 and 42 angula), 2 danda (96 and 192 angula), 2 dhanu (96 and 108 angula) and 2 paurusha (96 and 108 angula). There are also 2 goruta (1000 dhanu according to Shamshastry and 2 000 dhanu according to Prof. Kangle) and as a result of two dhanu measures and 2 goruta, 4 yojana measures could be derived, as shown later. This multiplicity of length units also leads to two values for the nivartana and paridesa and 4 for the bahu.

The seeds of later confusion of interpretation of the length and area units can be distinctly seen in the *Arthasastra*.

We may now attempt an explanation to clarify certain concepts and traditions.

The first important point that can be noted from the use of pattern laid down by Kautilya, is that the units related with 28 angula hasta are generally used for measurements of a commercial or practical nature or what may be called *vyavaharik* measurements. Thus subunits and multiples like 14, 28, 42, 84 angula are used for measurements connected with ropes for area measures, palaces, forests, depth of digging, capacity measures, balances, areas of pasture lands etc.

The second series of units connected with the 24 angula hasta like paurusha (4 aratni and 108 angula) appear to be used more often for religious purposes than commercial.

The third section consists of units which are not directly related with the 24 or 28 angula hasta viz. kamsa (32 angula), or kishku (54 angula), the garhapatya dhanus or paurusha of 108 angula. The paurusha and the 28 angula hasta have an important place in the area measures used in South India.

A fourth section relates to units indicating long distances.

The fifth covers area measures.

In Table 1 are presented the values of the principal useful *Arthasastra* units. Both metric and inch values are given for ease of reference. Calculations are, however, based on metric values only.

Do you Know

Time can now be measured to an accuracy of one second in 3000 years. This has been made possible by the advances in atomic sciences. The cesium atomic makes possible this astonishing precision measurement of time. Such accuracy is now necessary as we are in the age of sputniks and satellites hurtling around the earth at speeds of over eight kilometres per second. It has **bean** estimated that an error of 1/10 of a second in the measurement of time may mean that the tracking of the orbiting satellite may be out by one kilometre.

(6) (*a*) *Yajur-Veda*-Translated by R. T. H. Griffith, Third Edition, (E. J. Lazarus & Co., Benares) 1957

(*b*) वेदप्रकाश-यजुर्वेद संहिता (Sanskrit Text with Marathi Translation), Edited and Translated by S. Pathak, (*Manohar Granthamala*, Poona), Saka 1864.

(7) (*a*) *Taittiriya Samhita*—Translated by A. B. Keith, (Harvard University Press, Cambridge, Massachusetts), 1914.

(*b*) तैत्तिरीय संहिता (Sanskrit Text), (Anand Ashram Edition), 1948

(8) (*a*) *Atharva-Veda*-Translated by R. T. H. Griffith, (E. J. Lazarus & Co. Benares), 1916.

(*b*) अथर्ववेद संहिता (Sanskrit Text), (Bharata Mudranalaya, Aundh), 1939.

(9) Macdonell, A.A. and Keith A.B., *Vedic Index of Names and Subjects*, (John Murray, London), 1912.

(10) (*a*) *Satapatha-Brahmana*—Translated by Julius Eggeling (Sacred Books of the East, Vol 4)

(*b*) शतपथब्राह्मणम् (Sanskrit Text), (Laxmivenkateswar Press, Bombay, *1940*.

(11) (*a*) *Kautilya's Arthasastra*—Translated by Shamasastry, R, Third Edition, 1939.

(*b*) *The Kautiliya Arthasastra*, Part 1, (Sanskrit Text) R. P. Kangle, (University of Bombay), 1960

(12) Kangle, R. P., *in a communication to authors.*

(13) Berriman A. E., *Historical Metrology*, (J. M. Dent & Sons Ltd, London). 1953.

(14) Warren, General Sir Charles, *The Early Weights and Measures of Mankind*, (Committee of Palestine Exploration Fund, London), 1913.

(15) Warren, General Sir Charles, *The Ancient Cubit and Our Weights and Measures*, (The Committee of the Palestine Exploration Fund, London. 1903).

(16) *Tandyamaha Brahmana*—Part 2, Edited by Chinnaswami Sastri, A. &. Pattabhirama Sastri, (Kashi Sanskrit Series, No 105, Jayakrishnadas Haridas Gupta, Benares), 1936.

Arithmetic & Abbreviations

Textbooks for arithmetic are now being revised to use metric units predominently. It of foot-pound and seer units is rather restricted. It has, however; been noticed that certain standard books on arithmetic have been using the wrong abbreviations like 'kilog' for kilogram, 'Dm' for decametre and so on. These abbreviations have now been internationally rejected and textbook writers and publishers should take note of the abbreviations published on cover page 2 of this issue as also those which have been laid down by the Eleventh General Conference of Weights and Measures in 1960. The latter were published in the September 1961 issue of **Metric Measures** on pages 23 and 24.

Let the new generation be taught the correct usages of the metric system.

*Introduction of Decimal Coinage in India**

INDIA switched over to the decimal system of coinage on 1 April 1957 when new decimal coins of the denominations of 10 nP, 5nP, 2 nP and 1 nP were issued all over the country. Under this system the rupee remains the monetary unit of the country but it is divided into 100 equal parts, each part being termed a 'naya paisa'. The system envisaged the issue, in addition, of coins in the denominations of a rupee, 50 nP, and 25 nP but as these denominations were exactly equivalent to the rupee, the half rupee and the quarter rupee coins of the anna-pie series their issue was deferred till such time as the Mints were able to produce and accumulate enough stocks of coins in the lower denominations. All the coins of the series have since been issued in gradual stages; the 25 nP was put into circulation from 1 December 1959, the 50 nP from 1 November 1960 and the decimal rupee coins from 2 July 1962.

Background

The question of decimal coinage and the manner in which it should be introduced had been before the Govenrment and the public for over ten years before it was actually introduced. As far back as 1945, the undivided Government of India had sought to elicit public opinion in the matter through various bodies like the State Governments, Chambers of Commerce, scheduled banks etc. The views received were on the whole favourable to the introduction of the reform and in February 1946, a Bill was introduced in the Legislative Assembly to convert the anna-pie coinage into decimal coinage, retaining the rupee as the standard unit and dividing it into 100 cents. The Bill was circulated for public opinion in April 1946, and in February 1947, the Government of India had decided to proceed with the Bill. But partition of the country, with its consequential unsettlement, intervened and the matter was allowed to lapse. In 1949, the Indian Standards Institution set up a Special Committee to make recommendations on the introduction of the metric system of weights and measures in India. The Committee after extensive consultations with practically all interests concerned, recommended that it would be an advantage if the adoption of decimal currency preceded the introduction of the metric system of weights and measures. In April 1955, the Planning Commission made the same recommendation that, as a first step towards the adoption of the metric system, a Bill should be introduced in Parliament providing for the decimalisation of coinage. A Bill amending the Indian Coinage Act, 1906, was introduced and passed by the Parliament in 1955.

The change-over to decimal coinage has been on the whole very smooth and well received by the public at large. However this has not been without complaints which was expected. Some sections of the people have been inconvenienced but almost invariably in a small way. There has never been any nation-wide reform in any country without inconvenience or annoyance to some people. A pertinent question here

*Contribution from the Ministry of Finance (Department of Economic Affairs) New Delhi.

would be if people were cautioned well in advance. A wide publicity and wider propaganda through leaflets and brochures, newspaper articles and advertisements, films and radio talks, had been undertaken months in advance and continued even after the introduction of the reform to instruct the people about what the reform meant and how it would affect the individual. It has been stated time and again that there would be petty annoyances to the individual for a short while, but this had to be viewed against the large and permanent gains which the country would make from the reform.

Educating the Public

The fact that the reform had a smooth passage is an indication of the amount of thinking done and preparatory steps taken by the authorities concerned prior to the introduction of the reform, so as to overcome any conceivable difficulty that might be encountered particularly in the field of banking, accountancy, etc. In a country of of the size of India where the people with low level of literacy were accustomed through generations to the anna-pie system, the reform had to be preceded by publicity and propaganda on a very extensive scale. In addition, the incorporation in textbooks of lessons in the new coinage to suit the different grades of pupils in schools was also arranged. A Handbook on decimal coinage for distribution among teachers was also prepared. Innumerable sets of new coins mounted on card-boards were distributed to the State Governments, Community Development Blocks, etc. for purposes of demonstration. Copies of conversion tables indicating the values of anna-pie coins converted in terms of decimal coins in accordance with the provisions of the Indian Coinage (Amendment) Act, 1955, with suitable instructions were printed and supplied free to various organisations all over the country. As a result of these measures the change-over went through smoothly.

Early Steps

Besides the question of educating the public about the need and advantages of the reform, there were certain other problems which had to be tackled before the reform could be introduced. Arrangements had to be made to provide facilities to the public all over the country to exchange their holdings of anna-pie coins into decimal coins through the offices of the Reserve Bank of India and the State Bank and its agency banks, all Government Treasuries and Sub-treasuries, etc. The manufacture of coins of the anna-pie series had to be stopped and the Mints switched on to the production of the new decimal coins a long time in advance of the introduction of the reform and the working hours of the Mints also had to be increased to enable them to stockpile the coins required to be distributed among all these coin issuing offices. Although both the anna-pie and the decimal coins were to be in circulation simultaneously for some time, it was found necessary that the decimalised system of coinage should be officially adopted with effect from the date of introduction of the reform as the sole medium of accounting by Government departments, semi-government organisations and other public institutions, banks, commercial houses etc. Revised procedures and forms had to be devised in consultation with the Reserve Bank of India and the Comptroller and Auditor General and suitable instructions were issued to all concerned.

Railways, Posts & Telegraphs

The Railways had to undertake a heavy programme of preparatory work, in refixing rates and fares in terms of the new coinage and reprint their calculation tables for distribution throughout the country. The Indian Post Office Act was amended to enable the refixation of postal rates in terms of

decimal coinage and new stamps etc. were issued. As there were considerable stocks of postage stamps, post cards, envelopes, etc. of the old series, the destruction of which would have involved Government in a considerable loss, it was necessary to continue to sell and accept these items of postal stationery even after the introduction of the reform but after equating the value of the various denominations of stamps and other stationery in the old series to the corresponding denominations in the new series by means of Gazette notification under the powers conferred by the Indian Post Office Act. Non-postal stamps of over 300 varieties and denominations such as revenue stamps, entertainment tax stamps, copying fee stamps, etc. issued by the Central and State Governments had to be reissued in terms of decimal values, in consultation with the State Governments concerned. Adding —, accounting—, calculating—machines in use in the various Government and non-government offices had to be converted to the decimal system. Discussions were held with the concerned Ministries and suppliers of the machines, 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 existing machines, to re-export unsold surplus machines and to import new machines suited to the decimal system. All these and allied problems had to be tackled in consultation with the various authorities and suppliers concerned and with patience and precision. Thanks to the general enthusiasm for the coinage reform, all these matters were satisfactorily settled although not always in time. For instance Postal franking machines suited to indicate the postal rates in anna-pie coins had to be used till the very day of the introduction of the reform and their conversion to decimal coinage to a large extent could be undertaken only after the reform was actually introduced. Pending such conversion they had to be continued in use and any additional postage required made up by affixing stamps. Except for a few items like the one mentioned above, all administrative arrangements were completed well in time, and there had been hardly any bottlenecks in the smooth progress of the reform from the date of its introduction.

Withdrawal of Old Coins

The issue of the coins of all denominations in the decimal series does not by itself complete the reform. A reform of this type can be said to have been completed only when all the coins of the earlier series have been demonetised and withdrawn from circulation. At the time of the introduction of the reform it was envisaged that coins of both the anna-pie and decimal series would circulate simultaneously for about three years by which time, the coins in the anna-pie series would be withdrawn from circulation in a phased programme of demonetisation. The first step towards the withdrawal of anna-pie coins was taken in 1958 when the nickel-brass two anna, the half pice and the pie coins were demonetised with effect from 1 January 1959. This was followed by the demonetisation of the nickel brass one-anna and the nickel-brass half anna coins from 1 January 1960 and of the cupro-nickel two anna and the cupro-nickel half anna from 1 October 1960. Thereafter, due to the development of the economy of the country, there was a phenomenal increase in the demands for small coins and the Mints had been hard put to meet the rising demands for coins. Consequently it was not possible to launch the demonetisation of the cupro-nickel one anna and the copper and bronze pice coins which continued to be legal tender. In order to enable the Mints to increase their production and to accumulate enough stock of decimal coins to facilitate the demonetisation of these coins, the working hours of the Mints were

increased from April 1961. Now, it would be possible to demonetise these coins from 1-1-64. With this, all the coins in the anna-pie series which did not have exact equivalents in the decimal series would have been demomenetised, and to that extent the reform may be stated to have been completed.

It is only apt and proper that India should switch over to decimal coinage, as she has a very close association with the decimal system from the historical point of view. In the whole history of mathematics there has not been a more revolutionary discovery than the one which the ancient Indians made when they invented the sign 'Zero' to stand for the empty columns of the counting frame. The Greeks, in spite of their advance in other fields like geometry, had failed to develop algebra and it was only the Indians and the Arabs who succeeded in this important branch of the science of measurement and calculation which is the corner stone of modern mathematics. The inventors of the 'shunya' or the 'zero' had liberated the human intellect from the confines of the counting frame. As the brilliant mathematical astronomer Laplace (1749-1827) has stated :

> It is India that gave us the ingenious method of expressing all numbers by means of ten symbols, each symbol receiving a value of position as well as an absolute value; a profound and important idea which appears so simple to us now 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; and we shall appreciate the grandeur of this achievement when we remember that it escaped the genius of Archimedes and Appolonius, two of the greatest men produced by antiquity.

Permissible Error in Biscuit Packets

J. RAY

Assistant Director (Weights & Measures)
Ministry of International Trade, Calcutta.

While purchasing a packet of biscuits you might have noticed the net content marked on the wrapper. An average customer has to be satisfied with this as he has no means to verify whether the packet actually contains the declared quantity.

This is, of course, not peculiar to biscuits alone, but holds good for almost every commodity we purchase in a sealed cover. If we wish to safeguard the interest of the consumers, mere marking of the contents on the body would not be enough. The marked weight or measure must be verified by an independent agency. Weights and Measures (Enforcement) Rules trade by State Governments, therefore, invest the Inspector of Weights and Measures with full authority to check the net contents of all sealed packages offered for sale. If the actual net content is found to be deficient, the seller is liable to prosecution.

It need not be emphasized that the marked net contents cannot be exactly equal to the actual contents due to various factors. If the commodity in question is highly hygroscopic like tea it may, while in storage and transit gain or lose weight to the tune of 8 percent Tea packed in Calcutta would lose consi derable weight by the time it is offered fo sale in Rajasthan after 2 or 3 months.

tors Causing Variation

Biscuits have peculiarities of their own. the first place, biscuits are manufactured pre-determined sizes. The manufac- er does not have complete control er the thickness of the biscuit due to vari- on in atmospheric condition as well as in quality of the raw materials used. Packet es are also pre-determined. A packet of scuits must contain a whole number of scuits. We cannot put half or quarter scuit in a packet. Now suppose that a rtain packet is designed to contain 10 bis- its. If for any reason the thickness of the scuit is more than the normal the packet ill contain only 9 biscuits. Similarly, if e biscuits are slightly thinner the packet ay hold 11 biscuits. In a small pack, ierefore, this factor alone will introduce a ariation of the order of 10 percent of the arked weight.

Materials used for packing may also cause ariation in the weight of the final package. he usual procedure is that packets are eighed only after they are filled with bis- uits and are ready for the market. If, herefore, the weight of packing material is xcessive, the net weight of biscuits will be hort. Tin containers themselves vary onsiderably in weight. The same applies o cartons and other stuffing materials. In ertain cases packing materials account or 67 percent of the gross weight of a pack.

It is necessary, therefore, to allow for easonable variations in the net weights of biscuits in packages.

Investigation Undertaken

With a view to study the variations that normally occur in the net weights of biscuits in packages, an investigation was undertaken in the factory of the *Britannia Biscuit Co. Ltd.* Calcutta. This factory was selected in view of its being highly mechanised and where the processes of manufacture and packing are under strict control. Full facilities were extended by the Company for which the Directorate of Weights and Measures is grateful.

Britannia manufactures many brands of biscuits. As it was not possible to extend the scope of the study to all brands it was limited only to the more popular varieties, *viz.*, (1) Circus, (2) Cream Cracker, (3) Thin Arrowroot, (4) Cottage Cream and (5) Glaxo. In Cream Cracker and Thin Arrowroot three different sizes of packages were studied, in Cottage Cream two and one each for Circus and Glaxo. A sample of packages was drawn randomly for each variety and size. The selection was made from the store of the Company with the help of random sample numbers.

Once the packets were taken out, they were transferred to the laboratory of the Company for detailed study. The gross weight, the net weight of biscuits and the weight of packing material used were estimated for each package. The following table gives the actual net weights of the biscuits in the packages sampled.

TABLE 1—RESULTS OF INVESTIGATION)

Sample No.	Variety	Weight marked on the packs	Mean net weight of the sample	s=Estimate of population S.D: $\sqrt{\frac{(X-W)^2}{n-1}}$	3s	3s × 100 / W	Max. Positive error noticed in in the packs: Magnitude: Percentage		Max. negative error noticed in the packs: Magnitude: percentage	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8A)	(8B)	(9A)	(9B)
(1) Circus		4·50 kg	4·505 kg	0·065 kg	0·195 kg	4·3	0·115 kg	2·5	0·075 kg	1·7
(2) Creamr Cacker		4·50 kg	4·542 kg	0·059 kg	0·177 kg	3·9	0·098 kg	2·2	nil	nil
(3) Cream Cracker		225 g	217·3 g	14·0 g	42·0 g	18·7	8 g	3·5	22 g	9·8
(4) Cream Cracker		640 g	645·7 g	24·96 g	74·9 g	11·7	36 g	5·6	28 g	4·4
(5) Thin Arrowroot		5·25 kg	5·236 kg	0·041 kg	0·123 kg	2·3	0·020 kg	0·4	0·085 kg	1·6
(6) Thin Arrowroot		225 g	229·0 g	7·1 g	21·3 g	9·5	11 g	4·9	2 g	0·9
(7) Thin Arrowroot		650 g	627·5 g	33·6 g	100·8 g	15·3	12 g	1·8	55 g	8·5
(8) Cottage Cream		230 g	220·8 g	12·09 g	36·3 g	15·8	1 g	0·4	18 g	7·8
(9) Cottage Cream		900 g	874·2 g	33·06 g	99·2 g	11·0	4 g	0·4	40 g	4·4
(10) Glaxo ..		810 g	819·7 g	40·80 g	122·4 g	15·1	48 g	5·9	55 g	6·8

S.D.=Standard deviation

Figures in Col. 6 of Table 1 give the maximum variation on either side of the marked net weight that is likely to occur in packages manufactured and packed in the conditions prevailing in *Brittannia Biscuit Co.*

Conclusion

On this basis, we may conclude that the following margin of error has to be tolerated in biscuit packs offered for sale :

Net Weights of Package	*Limits of Error*
(1) Below 500 g	±7 percent
(2) 500 g and above but less than 1 kg	±6 percent
(3) 1 kg and above but less than 2 kg	±5 percent
(4) 2 kg and above	±2·5 percent

For Defence
Strength
For Strength
Planned
Development

Volume of One Metre Logs

G. VENKATESWARAN

Asstt. Director (Weights & Measures),
Ministry of International Trade,
Madras.

With the adoption of the metric system in transactions in timber and timber products from 1 October 1962, the existing volume tables for timber have become obsolete and a new volume table for timber giving at least the volume of log timber for girths ranging from 20 cm to 400 cm and length from 0.05 metre to 15.00 metres has become absolutely necessary to meet the requirements of the timber merchants, Forest Departments and Public Works Departments. The volume of log timber for one metre length and girth ranging from 20 cm to 400 cm with an interval of 1 cm is presented here in a table.

In order to arrive at the volume of log timber of any length having a given girth one has to multiply the volume for 1 metre length of timber of that girth by the length and put the decimal point in the correct place.

How to Use the Tables

If one wants the volume of a log of 12.5 m length and girth 15 cm, multiply the figure given in the column 'Volume for 1 metre length' against 175 cm girth by 12.5 *i.e.*

$$0.19140625 \times 12.5$$

=2.392578125 or 2.3926 m³, correct to 4 decimal places.

TABLE 1. LOGS OF VOLUME OF ONE METRE LENGTH FOR VARIOUS GIRTH

Mid Girth (cm)	Volume (m³)	Mid Girth (cm)	Volume (m³)
20	0·0025	55	0·01890625
21	0·00275625	56	0·0196
22	0·003025	57	0·02030625
23	0·00330625	58	0·021025
24	0·0036	59	0·02175625
25	0·00390625	60	0·0225
26	0·004225	61	0·02325625
27	0·00455625	62	0·024025
28	0·0049	63	0·02480625
29	0·00525625	64	0·0256
30	0·005625	65	0·02640625
31	0·00600625	66	0·027225
32	0·0064	67	0·02805625
33	0·00680625	68	0·0289
34	0·007225	69	0·02975625
35	0·00765625	70	0·030625
36	0·0081	71	0·03150625
37	0·00855625	72	0·0324
38	0·009025	73	0·03330625
39	0·00950625	74	0·034225
40	0·0100	75	0·03515625
41	0·01050625	76	0·0361
42	0·011025	77	0·03705625
43	0·01155625	78	0·038025
44	0·0121	79	0·03900625
45	0·01265625	80	0·0400
46	0·013225	81	0·04100625
47	0·01380625	82	0·042025
48	0·0144	83	0·04305625
49	0·01500625	84	0·0441
50	0·015625	85	0·04515625
51	0·01625625	86	0·046225
52	0·0169	87	0·04730625
53	0·01755625	88	0·0484
54	0·018225	89	0·04950625

Mid Girth (cm)	Volume (m^3)
90	0·050625
91	0·05175625
92	0·0529
93	0·05405625
94	0·055225
95	0·05640625
96	0·0576
97	0·05880625
98	0·060025
99	0·06125625
100	0·0625
101	0·06375625
102	0·065025
103	0·06630625
104	0·0676
105	0·06890625
106	0·070225
107	0·07155625
108	0·0729
109	0·07425625
110	0·075625
111	0·07700625
112	0·0784
113	0·07980625
114	0·081225
115	0·08265625
116	0·0841
117	0·08555625
118	0·087025
119	0·08850625
120	0·0900
121	0·09150625
122	0·093025
123	0·09455625
124	0·0961
125	0·09765625
126	0·099225
127	0·10080625
128	0·1024
129	0·10400625
130	0·105625
131	0·10725625
132	0·1089
133	0·11055625
134	0·112225
135	0·11390625
136	0·01156
137	0·11730625
138	0·119025
139	0·12075625
140	0·1225
141	0·12425625
142	0·126025
143	0·12780625
144	0·1296
145	0·13140265
146	0·133225
147	0·13505625
148	0·1369
149	0·13875625
150	0·140625
151	0·14250625
152	0·1444
153	0·14630625
154	0·148225
155	0·15015625
156	0·1521
157	0·15405625
158	0·156025
159	0·15800625
160	0·1600
161	0·16200625
162	0·164025
163	0·16605625
164	0·1681
165	0·17015625
166	0·172225
167	0·17430625
168	0·1764
169	0·17850625
170	0·180625
171	0·18275625
172	0·1849
173	0·18705625
174	0·189225
175	0·19140625
176	0·1936
177	0·19580625
178	0·198025
179	0·20025625
180	0·2025
181	0·20475625
182	0·207025
183	0·20930625
184	0·2116
185	0·21390625
186	0·216225
187	0·21855625
188	0·2209
189	0·22323625
190	0·225625
191	0·22800625
192	0·2304
193	0·23280625
194	0·235225
195	0·23765625
196	0·2401
197	0·24255625
198	0·245025
199	0·24750625
200	0·2500
201	0·25250625
202	0·255025
203	0·25755625
204	0·2601
205	0·26265625
206	0·265225
207	0·26780625
208	0·2704
209	0·27300625
210	0·275625
211	0·27825625
212	0·2809
213	0·28355625
214	0·286225
215	0·28890625
216	0·2916
217	0·29430625
218	0·297025
219	0·29975625
220	0·3025
221	0·30525625
222	0·308025
223	0·31080625
224	0·3136
225	0·31640625
226	0·319225
227	0·32205625
228	0·3249
229	0·32775625
230	0·330625
231	0·33350625
232	0·3364
233	0·33930625
234	0·342225
235	0·34515625
236	0·3481
237	0·35105625
238	0·354025
239	0·35700625
240	0·3600
241	0·36300625
242	0·366025
243	0·36905625
244	0·3721
245	0·37515625
246	0·378225
247	0·38130625
248	0·3844
249	0·38750625
250	0·390625
251	0·39375625
252	0·3969
253	0·40005625
254	0·403225
255	0·40640625
256	0·4096
257	0·41280625
258	0·416025
259	0·41925625
260	0·4225
261	0·42575625
262	0·429025
263	0·43230625
264	0·4356
265	0·43890625
266	0·442225
267	0·4455625
268	0·4489
269	0·45225625
270	0·455625
271	0·45900625
272	0·4624
273	0·46580625
274	0·469225
275	0·47265625
276	0·4761
277	0·47955625
278	0·483025
279	0·48650625
280	0·4900
281	0·49350625
282	0·497025
283	0·50055625
284	0·5041
285	0·50765625
286	0·511225
287	0·51480625
288	0·5184
289	0·52200625
290	0·525625
291	0·52925625
292	0·5329
293	0·53655625
294	0·540225
295	0·54390625
296	0·5476
297	0·55130625
298	0·555025
299	0·55875625
300	0·5625
301	0·56625625
302	0·570025
303	0·57380625
304	0·5776
305	0·58140625
306	0·585225
307	0·58905625
308	0·5929
309	0·59675625
310	0·600625
311	0·60450625
312	0·6084
313	0·61230625
314	0·616225
315	0·62015625
316	0·6241
317	0·62805625
318	0·632025
319	0·63600625
320	0·6400
321	0·64400625
322	0·648025
323	0·65205625
324	0·6561
325	0·66015625
326	0·664225
327	0·66830625
328	0·6724
329	0·67650625
330	0·680625
331	0·68475625
332	0·6889
333	0·69305625
334	0·697225
335	0·70140625
336	0·7056
337	0·70980625
338	0·714025
339	0·71825625
340	0·7225
341	0·72675625
342	0·731025
343	0·73530625
344	0·7396
345	0·74390625
346	0·748225
347	0·75255625
348	0·7569
349	0·76125625
350	0·765625
351	0·77000625
352	0·7744
353	0·77880625
354	0·783225
355	0·78765625
356	0·7921
357	0·79655625
358	0·801025
359	0·80550625
360	0·8100
361	0·81450625
362	0·819025
363	0·82355625
364	0·8281
365	0·832655625
366	0·837225
367	0·84180625
368	0·8464
369	0·85100625
370	0·855625
371	0·86025625
372	0·8649
373	0·86955625
374	0·874225
375	0·87890625
376	0·8836
377	0·88830625
378	0·893025
379	0·89775625
380	0·9025
381	0·90725625
382	0·912025
383	0·91680625
384	0·9216
385	0·92640625
386	0·931225
387	0·93605625
388	0·9409
389	0·9457625
390	0·950625
391	0·95550625
392	0·9604
393	0·96530625
394	0·970225
395	0·97515625
396	0·9801
397	0·98505625
398	0·990025
399	0·99500625
400	1·0000

News & Views

Recent Notifications

(1) Standards of Weights & Measures (Amendment) Rules, 1963

S.O. No. 2962 dated 7th October 1963.

In exercise of the powers conferred by Section 17 of the Standards of Weights & Measures Act, 1956 (89 of 1956), the Central Government hereby makes the following rules to amend the Standards of Weights and Measures Rules, 1958, namely :—

1. These rules may be called the Standards of Weights & Measures (Amendment) Rules, 1963.

2. In the Standards of Weights and Measures Rules, 1958,—

(*i*) To sub-rule (1) of rule 4, the following proviso shall be added, namely :— 'Provided that in the case of length measures made of fifty-eight per cent nickel steel, such interval shall not be more than ten years.'

(*ii*) for the Second Schedule, the following Schedule shall be substituted, namely '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

1	2	3	4
		mg	mg
	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
Bullion Weights	20 kg	+500	−250 to +500
	10 kg	+250	−125 to +250
	5 kg	+150	−75 to +150
	2 kg	+80	−40 to +80
	1 kg	+50	−25 to +50
	500 g	+30	−15 to +30
	200 g	+20	−10 to +20
	100 g	+16	−8 to +16
	50 g	+12	−6 to +12
	20 g	+10	−5 to +10
	10 g	+8	−4 to +8
	5 g	+6	−3 to +6
	2 g	+4	−2 to +4
	1 g	+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	500 c	+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 Capacity Measures

Type of Liquid capacity Measure	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	2 l	+30	—15	to	+30
	1 l	+20	—10	to	+20
	500 ml	+15	—7·5	to	+15
	200 ml	+8	—4	to	+8
	100 ml	+5	—2·5	to	+5
	50 ml	+3	—1·5	to	+3
	20 ml	+2	—1	to	+2
Conical Measures	20 l	+100	—50	to	+100
	10 l	+50	—25	to	+50
	5 l	+30	—15	to	+30
	2 l	+15	—7·5	to	+15
	1 l	+10	—5	to	+10
	500 ml	+8	—4	to	+8
	200 ml	+4		to	+4
	100 ml	+3	—1·5	to	+3
Special Measures	18·5 l	+100	—50	to	+100
	60 ml	+2 to —2	—2	to	+2
	30 ml	+1 to —1	—1	to	+1

MILLIE

It was reported in the *Daily News* of Perth in August 1963, that a baby born in May 1963 at the Mater Mothers' Hospital in Brisbane was nicknamed Millie, which is the shortened version of milligram. The baby had to wait for more than four months to be introduced to millions as the smallest baby the medical world has known to have survived. Millie weighed about 650 grams at birth and at one time Millie's weight dropped to about 500 g. In August 1963 she weighed 3·375 kilograms.

(Courtesy : W. J. Joyce)

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		
ml	ml			ml		
200, 180, 160	+3·0	to	—3·0	—		
140, 120 100	+2·0	to	—2·0	—		
90, 80, 70, 60	+1·5	to	—1·5	—		
50, 40	+1·0	to	—1·0	+1·0	to	—1·0
30	+0·8	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	—0·20	—		
3	+0·16	to	—0·16	—		
2	+0·12	to	—0·12	—		
1	+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 Measures.—For beaker measures presented for checking and stamping, the permissible errors shall not exceed +7 to —7ml for 1000 ml measure and +5 to —5 ml for 500 ml measures.

For 300 ml beaker measure, the following permissible errors are prescribed :—

Graduation mark	*Permissible Error (Verification and Inspection)*		
ml	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 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	3	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
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

1	2	3	4
	to any other graduation, shall not exceed ± 1·0 mm in the case of metallic measures and ± 2mm 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 10cm length of scale.		
Woven Metallic Tape (Tested on a horizontal surface under a tension of one Kilogram)			
Measure	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 m	Permissible Error Verification and Inspection 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 below, the error in the length of the tape shall not exceed the following limits:—

Mark m	Permissible Error (Verification & Inspection) 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 metres.
	+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 metre length shall be accurate with an error not exceeding +2 to —2 mm. The overall length shall be accurate within the limits shown below:

30m	+8 to —8 mm
20m	+5 to —5 mm

[No. WM-15 (4)/58.]

C. S. RAMACHANDARAN, Jt. Secy.

Adoption of Tex System in Jute Industry

A meeting of the Metric Sub-committee was held on 30 September 1963 under the Chairmanship of Shri G. C. L. Joneja, Jute Commissioner, Calcutta, to consider the proposal for the change-over to the tex system for specifying the yarn count in the jute industry.

At present the grist system is used in the jute industry. The grist is defined as the weight in pounds of 14,400 yards of jute yarn. This is a direct system. The tex is defined as the weight in grams of one kilometre of yarn. Thus both the systems are direct, being the weight for a specified length of yarn. The only difference would be that under the tex system a larger number would represent the yarn count. It was, therefore, generally agreed that the tex system should replace the grist system in three phases.

The first stage would be the use of the existing grist system with the corresponding tex equivalent number given in brackets for expressing yarn counts. This change would be effective from 1 July 1964. The main aims of this stage would be to familiarise industry and the trade with the use of the tex system.

In the second stage the tex system would be the principal system for expressing yarn count with the corresponding grist figures recorded in brackets. This would take effect from 1 July 1965.

In the third stage no reference would be made to the grist system only the tex number would be given. No specified time limit was laid for this stage and it was agreed that this change should be made when the system had come to be understood fully by the trade at home and abroad.

It was also agreed that the rounding off of the tex units would be done only on the unit basis *i.e.* the grist number would be multiplied by 34.45 and the resultant tex number would be rounded off to the nearest whole number.

A small working group was set up to chalk out the phased programme for a change-over in the industry in all aspects of its working to the use of tex system.

Naya Paisa to become Paisa

The Finance Minister stated in the Lok Sabha on 28 November 1963, in reply to a question that the smallest unit of Indian currency will cease to be 'new' (naya) from 1 July 1964. It will be Paisa instead of naya Paisa.

Standards News

(Indian Standards which have a particular bearing on the change-over to the metric system are indicated here. Copies would be available from the Indian Standards Institution, Manak Bhavan, 9, Mathura Road, New Delhi or their Branch Offices at Bombay, Calcutta, Madras and Kanpur).

Revised Indian Standard Specification for Engineers, Pattern Drawing Boards (IS:1444—1963)

The Indian Standards Institution has published the revision of Indian Standard Specification for Engineers' Pattern Drawing Boards (IS:1444—1963), which covers the

requirements for four sizes of engineers' pattern drawing boards designated as D0, D1, D2, and D3.

This standard covers the requirements for four sizes of engineers' pattern drawing boards; and it is intended primarily to assist the small scale sector of the industry in regulating the quality of its production. The sizes of drawing boards have been decided after taking into account the paper sizes included in IS:1064—1961 Specification for Paper Sizes (Revised), and also the sizes of drawings recommended in IS:696—1960 Code of Practice for General Engineering Drawings (Revised). It is proposed to cover in a separate standard students' pattern drawing boards as distinct from the engineers' pattern drawing boards.

Price : Rs. 1.50

Indian Standard for Beam Compasses (IS: 2466—1963)

The Indian Standards Institution has published Indian Standard Specification for Beam Compasses (IS: 2466—1963), which covers the requirements for slow-motion adjustment type beam compasses of sizes 250, 500, 1000 and 1500 mm.

A pair of beam compasses is a drawing instrument with an extension rod used by draughtsmen, engineers and surveyors to draw large circles.

Price : Rs. 1.50

Indian Standard Specification for Stainless Steel Milk Vats (IS: 2336—1963)

The Indian Standards Institution has published Indian Standard Specification for Stainless Steel Milk Vats (IS: 2336—1963), which prescribes the important constructional details and dimensional requirements for stainless steel milk vats of capacities of 500, 1000, 1500 and 2000 litres, designed to collect or store milk prior to its processing or despatch.

The milk vat is used for collection or storage of milk at the reception point and other places in the dairy. The construction of the milk vat is required to be such that the milk remains hygienic and retains all its natural properties.

Price : Rs. 2.00

Indian Standard Specification for Aluminium Milk Vats (IS : 2337—1963)

The Indian Standards Institution has published Indian Standard Specification for Aluminium Milk Vats (IS: 2337—1963), which prescribes the important constructional details and dimensional requirements for aluminium milk vats of 300, 500 and 1000 litres capacity, designed to collect or store milk prior to its processing or despatch.

The milk vat is used for collection or storage of milk at the reception point and other places in the dairy. The construction of the milk vat should be such that the milk remains hygienic and retains all its natural properties.

Price : Rs. 2.00

Indian Standard Specification for Tables for Volume of Cut Sizes of Timber (IS : 2377—1963)

The Indian Standards Institution has published Indian Standard Tables for Volume of Cut Sizes of Timber (IS: 2377—1963), which provides tables for the volume of cut sizes of timber covered by IS:1331—1958 Specification for Cut Sizes of Timber. Lengths from 30 to 500 cm are covered in steps of 10 cm. Volumes are given in cubic metres correct to the fifth place of decimal.

Indian Standard Specification for Cut Sizes of Timber (IS: 1331—1958) was published in 1958 in order to provide guidance to stockists and the timber trade and the general user. The object of the standard was also to channelize the demand for timber. The Committee responsible for the preparation of this standard, therefore, decided that the volume

tables for cut sizes of timber should cover only those sizes specified in IS: 1331—1958.

Price : Rs. 4.00

Indian Standard Specification for Sizes for General Purpose Lathes (IS : 2392—1963)

The Indian Standards Institution has published Indian Standard Sizes for General Purpose Lathes (IS: 2392—1963), which lays down series for swing diameters over bed, swing diameters over carriage and distances between centres for lathes used for general engineering purposes.

This standard has been prepared with a view to assisting the designers in designing new lathes. Variety reduction is one of the objects aimed at by the manufacturers engaged in mass production and it is hoped that this standard will be of help in reducing the prevalent variety of sizes of lathes in the machine tool industry and the designers will use their ingenuity to evolve improved designs within the sizes given in this standard which may prove more economical in the long run.

Standard sizes of machine tools assist the user in determining the types and sizes of machines which should be obtained for planned production. This standard will also help in planning the layout and installation of machines in the workshop. It would further assist in getting early deliveries, and in procuring spares and replacements from sources other than the original maker of the machine tools.

Price : Re. 1.00

Indian Standard Specification for Cylindrical and Taper Pins (IS : 2393—1963)

The Indian Standards Institution has published Indian Standard Specification for Cylindrical and Taper Pins (IS: 2393—1963), which prescribes the requirements for solid cylindrical pins and solid and split taper pins in the diameter range 1.6 to 50 millimetres.

Cylindrical pins and solid and split tap pins are used in shop work and assembli Cylindrical pins are used for accurate locati and as dowel pins. The taper pins are co monly used for force fit application, such in knuckle joints.

The taper commonly employed in inch countries is 1 in 48 and that used in metric countries is 1 in 50. Functionally, this difference is quite insignificant. This standard is based on the practice followed by metric countries and specifies a taper of 1 in 50.

Price : Rs. 2.00

Indian Standard Specification for Code of Practice for Selection, Installation and Maintenance of Domestic Water Meters (IS : 2401—1963)

The Indian Standards Institution has published Indian Standard Code of Practice for Selection, Installation and Maintenance of Domestic Water Meters (IS: 2401—1963), which covers the selection, installation and maintenance of inferential and semi-positive types of water meters conforming to IS: 779—1961 Specification for Water Meters (Domestic Type) (*Revised*).

Water meters being available in many designs, with different end connections and varying flow characteristics, due consideration will have to be given when selecting any one type of meter for a particular situation. Moreover, they have to be properly installed so that they may give the desired duty in service without involving frequent repairs and costly maintenance. This code of practice has been prepared with a view to giving useful guidance to consumers and water supply authorities in making proper selection, installation and maintenance of water meters.

Price : Rs. 1.50

Indian Standard Specification for Boiler and Superheater Tubes for Marine and Naval Purposes (IS : 2416—1963)

The Indian Standards Institution has published Indian Standard Specification for

Boiler and Superheater Tubes for Marine and Naval Purposes (IS:2416—1963), which covers the requirements of the following types of boiler and superheater tubes for marine and naval purposes :

(*a*) Cold drawn seamless carbon steel tubes (32 kgf/mm² minimum tensile strength);

(*b*) Hot finished seamless carbon steel tubes (32 kgf/mm² minimum tensile, strength), and

(*c*) Electrically welded carbon steel tubes (32 kgf/mm² minimum tensile strength);

The Institution has earlier published an Indian Standard Specification for Carbon Steel Boiler Tubes and Superheater Tubes, (IS:1914—1961), but it did not cover the special requirements regarding the close tolerance limits for outside diameter and thickness, minimum requirements of elongation test, and higher test pressures as applicable to tubes used for marine and naval purposes. It was, therefore, decided that a separate standard for boiler and superheater tubes should be prepared.

In this standard due consideration has also been given to the need for international coordination with standards being followed in various countries of the world.

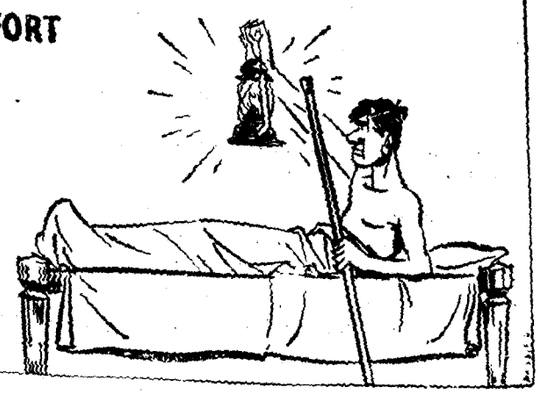
Price : Rs. 3.50

Freedom is in peril, defend it with all your might —Jawaharlal Nehru

DEFENCE OF THE COUNTRY NEEDS CONTINUOUS EFFORT

The external danger that faces us is not of today only. It may last for a considerable time. So the nation will always have to be on its guard. There can be no complacency, no slackening of effort to strengthen defence in every way.

WORK RESOLUTELY



Licensed Manufacturers and Repairers

(*Metric Measures* had been publishing in the past a series of lists of licensed manufacturers, dealers and repairers of weights and measures, weighing and measuring instruments licensed by the Governments in the various States and Union Territories under their Weights and Measures (Enforcement) Acts. To economise on paper, it is possible only to publish lists of licensed manufacturers and repairers.

A feature on statistics of verification and licences issued is also being published in *Metric Measures*.)

STATISTICS OF VERIFICATION OF WEIGHTS ETC. AND LICENCEES

States/Union Territories	Period	Weights	Capacity Measures	Length Measures	Weighing Instruments	Measuring Others Instruments		Total number of Mfrs.	Dealers	Repairers As on 1st day of Jan. 1964
(1) Andhra Pradesh	1 Apr. to 31 July 62	4,56,255	74,480	6,223	8,025	314	—	62	121	36
(2) Assam	1 Apr. 62 to 31 July 63	6,42,529	73,935	7,731	1,068	150		4	69	11
(3) Bihar	1 Apr. 62 to 31 Jan. 63	1,28,211	—	—	19,309	56		30	203	43
(4) Gujarat	1 Apr. 62 to 31 July 63	10,33,838	1,03,371	17,895	1,51,462	844	12	105	586	143
(5) Kerala	1 Apr. 62 to 31 July 62	—	—	—	—	—	—	73	459	142
(6) Jammu & Kashmir	1 Apr. 62 to 31 July 63	1,83,121	113	4,272	1,328	..		1	63	1
(7) Madhya Pradesh		—	—	—	—	—	—	—	—	—
(8) Madras		—	—	—	—	—	—	—	—	—
(9) Maharashtra	1 Apr. 62 to 31 Mar. 63	18,74,286	5,37,135	33,988	..	..	..	..	..	..
(10) Mysore	1 Apr. 62 to 31 Nov. 62	4,81,354	1,05,253	1,037	59,674	8,420		126	493	92
(11) Orissa	1 Apr. 62 to 31 March 63	4,23,597	86,060	3,089	1,596	2		8	103	6
(12) Punjab	1 Apr. 62 to 30 Sept. 63	15,01,606	84,078	41,826	2,07,347	407	—	10	34	2
(13) Rajasthan	N.A.	—	—	—	—	—	—	—	—	—
(14) Uttar Pradesh	1 Apr. 62 to 31 May 62	5,34,506	7,951	4,702	907	113	—	3	99	18
(15) West Bengal	1 Apr. 62 to 31 Jan. 63	20,03,339	12,762	2,061	88,041	..		116	684	80
(16) A and N Islands	N.A.	—	—	—	—	—	—	—	—	—
(17) Delhi	1 Apr. 62 to 30 Sept. 63	3,32,252	32,001	11,092	43,444	581	—	26	75	22
(18) Himachal Pradesh	1 Apr. 62 to 31 July 63	68,020	7,411	2,523	10,628	1	—	1	25	12
(19) L.M.A. Islands	1 Apr. 62 to Oct. 63	—	—	—	—	—	—	—	—	—
(20) Manipur	1 Apr. 62 to 30 Sept. 63	16,148	3,705	228	390	2,879	Nil	Nil	4	1
(21) Pondicherry	N.A.	—	—	—	—	—	—	—	—	—
(22) Tripura	1 Apr. 62 to 30 July 62	62,050	8464	720	9	8	—	4	35	3

N.A.—Statistics not available as yet.

GUJERAT

The following is the list of Manufacturers and Repairers licensed during the period from 1 February to 30 September, 1963

Manufacturer

Sl. No.	Name and Address of Manufacturer	Details of Articles Manufactured
(1)	Abdullabhai K. Tinwala, Zampa Bazar, Surat.	Conical Capacity Measures,
(2)	Dhiraj Metal Works, Street No. 6, Mill Para, Rajkot.	Dipping type cylindrical Measures.

Repairer

(1) Amery Scale Co., Tower Road, Surendranagar.

(2) Gandhi Anantrai Hirachand, Bazar, Damnagar.

(3) Kansara Ramjibhai Motilal, 1749, Kansara Street, Ahmedabad.

(4) Luhar Chinabhai Odhavji Gohel, Zavedi Bazar, Veraval,

(5) Luhar Manji Dava & Bros, Mota-Bhamodra, (Via. Kandla)

(6) Nutan Scale Works, Near Police Station, Idar.

KERALA

The following are the Manufacturers and Repairers licensed during period 1-7-63 to 30-9-63.

Sl. No.	Name and Address of Manufacturers	Details of Articles Manufactured
(1)	P. Abdulla, Chalil Road, Tellicherry.	Cylindrical Capacity Measures.
(2)	A. Abdulkaram, Kadayaravilakam, Thaiveedu, Balarampuram.	Cylindrical Capacity Measures and Beam Scales Class C & D—Coincal Capacity Measures.
(3)	Keerikandy Kuttan, Kallai Tin Mart, Near Kallai Rly. Stn. Kallai P.O.	Cylindrical and Capacity Measures.
(4)	National Switch Board Works, Bank Road, Calicut.	Wooden Length Measures.
(5)	Thomas George, Periyar Metal Products, Palai, Kottayam.	Cylindrical Capacity Measures.

REPAIRERS

(1) C.A. Abdulla, Churakattu Veedu, Iritty P.O., Via, Tellicherry.

(2) V.V. Cherian & V.V. Kunchako, Vazhapallykalam Market Ward, Alleppey.

(3) K. Chidambaram Asari, K. C. Mechanical Works, East of Patteri Illam, Thiruvambady.

(4) S. Krishnan Nair, Puthenpurlake House, Peermade.

(5) K. Sivankutty Asari, Alleppey Metal Industries, Near Stone Bridge, Alleppey.

TRIPURA

Manufacturers and Repairers licensed during June and July 1963.

MANUFACTURER

(1) National Mechanical Kasari Patti, P.O. Agartala, Tripura.

(2) Tirthamayee Aluminium Arundhutinagar, P. O. Agartala, Tripura.

REPAIRER

(1) Burmah Oil Company (P)., P. O. Digboi, Distt. Lakhimpur, Assam.

(2) National Mechanical Kasari Patti, P. O. Agartala, Tripura.

M140DPD—GIPF.

TYPICAL METRIC PRICING UNITS FOR WHOLESALE TRANSACTIONS

Serial No.	Commodity	Metric Unit
(1)	Gold	10 grams (g)
(2)	Grocery and Confectionery Biscuits, sweetmeats, cardamoms.	1 kilogram (kg)
	Textiles and Textile Fibres Cotton yarn, damaged and seconds cloth, raw silk, rayon, silk yarn, raw wool, wool manufacturers (when sold by weight).	
	Paints & Chemicals Paint (if sold by weight), indigo, liquid chlorine.	
	Hides, Skins & Leather Raw hides, leather (hides and skins).	
	Metals Silver, aluminium sheets, strips and circles, copper and brass wires and utensils.	
	Miscellaneous Tea, meat, camphor tablets, mica.	
(3)	Grains and Pulses Rice, wheat, jowar, arhar, moong, masur, gram.	1 quintal (q) (100 kilograms)
	Spices Black pepper, mustard, chillies, dhania, dalchini, turmeric, betelnuts.	
	Plantation Products Rubber, cashewnuts, cashew kernels, tobacco (raw and manufactured).	
	Forest Products Lac and lac products, gums, myrobalans, galnuts, soapnuts.	
	Textiles & Textile Fibres Raw jute, raw hemp, coir yarn.	
	Oils, Oilseeds & Oilcakes Vegetable oils, oilseeds, oilcakes.	
	Non-Ferrous Metals *Aluminium* : ingots, bars, blocks, slabs, 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, circles. *Brass* : ingots, rods, sections, pipes, sheets, strips, circles. *Zinc* : ingots, sheets, strips. *Tin* : blocks.	
	Chemicals Caustic soda, bleaching powder, glycerine, soaps, paper salt.	
	Others Sugar, gur, ice, fish, sugarcane, vegetables, tamarind.	
(4)	Minerals Iron ore, manganese ore, bauxite, coal.	one metric tonne (t) (1,000 kilograms)
	Iron & Steel Pig iron, iron and steel manufactures, semis (billets for rerolling etc.)	
(5)	Cloth (mill, handloom, silk, rayon and woollen cloth).	1 metre (m)
(6)	Jute carpets, coir mats and mattings, sheet glass.	one square metre (m^2)
(7)	Timber.	one cubic metre (m^3)
(8)	Paints (when sold by measure), spirits.	one litre (l)

Weights

(1) In place of the present units of seer, pound, rattal, viss etc., use the kilogram.

(2) In place of the tola, use the gram or 10 grams.

(3) In place of maund or corresponding unit, use the quintal *i.e.*, 100 kg.

Capacity Measures

In place of seer or gallon or any other measure use the litre.

Length Measures

(1) Use the metre in place of yard or foot and the centimetre in place of inch.

Square Measures

(1) Use the square metre in place of square yard or square foot, and square centimetre in place of square inch.

Cubic Measures

(1) Use the cubic metre in place of cubic yard or cubic foot and cubic centimetre in place of cubic inch.

Packaging

It is advantageous if sizes of packages correspond to series of commercial weights and measures prescribed.

These are: 50 kg, 20 kg, 10 kg, 5 kg, 2 kg, 1 kg, 500 g, 200 g, 100 g, 50 g, 20 g, 10 g, 5 g, 2 g, 1 g, and so on.

TYPICAL PRICING UNITS FOR RETAIL TRADE

Serial No.	Commodity	Metric Unit for Use
(1)	Foodgrains, cereals, pulses, spices, ghee, bread, vegetables, meat, fish, sweetmeats, tea, coffee, sugar, salt.	1 kg
(2)	Oil for cooking	1 kg or 1 litre depending upon prevale practice.
(3)	Fruits	1 kg or number depending upon pr valent practice.
(4)	Milk	1 litre
(5)	Cloth and related materials	1 metre
(6)	Prepackaged materials	Preferably sizes corresponding to ser of commercial weights and measur

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metric measures

THE PUBLICATIONS DIVISION

ABBREVIATION FOR METRIC UNITS

(1) DECIMAL MULTIPLES AND SUB-MULTIPLES

Prefix	Value in Terms of Unit	Abbreviation
Kilo ..	1,000	k
centi ..	0·01(10^{-2})	c
milli ..	0·001(10^{-3})	m
micro ..	0·000 001(10^{-6})	u

(2) WEIGHTS

Denomination	Value	Abbreviation
tonne ..	1,000 kg	t
quintal ..	100 kg	q
kilogram ..	1 kg	kg
gram ..	1 g	g
milligram ..	1 mg	mg
carat ..	200 mg	c

(3) CAPACITY

kilolitre ..	1 000 l	kl
litre ..	1 l	l
millilitre ..	1 ml	ml

(4) VOLUME

cubic metre ..	m^3	m^3 or cu m*
cubic centimetre ..	cm^3	cm^3 or cu cm*
cubic millimetre ..	mm^3	mm^3 or cu mm*

(5) LENGTH

kilometre ..	1 000 m	km
metre ..	1 m	m
centimetre ..	1 cm	cm
millimetre ..	1 mm	mm
micron ..	1/1 000 mm or 10^{-3}mm	um

(6) AREA

square kilometre	1 000 000 m^2	km^2 or sq km*
square metre ..	1 m2	m^2 or sq m*
square centimetre	1 cm^2	cm^2 or sq cm*
square millimetre	1 mm^2	mm^2 or sq mm*

(7) LAND MEASURE

are ..	100 m^2	a
hectare ..	100 a	ha
centiare ..	m^2	ca

*Both these abbreviations are current, but the first set should preferably be used. The former abbreviation is used more commonly internationally than the latter.

Rules for Abbreviations :

(1) Do not make any change, such as addition of 's' to indicate plurality *e.g.*, write 1 kg, 10 kg, 20 g, 5 g, 10 t, 20 ml, 27l, 165 km, 2 mm, 100 cm^3, 66 km^2.

(2) Do not capitalize the abbreviations. For example, do not write 1 Kg, 2 Kg, 20 MM, 50 MM; the right way is to write 1 kg, 2 kg, 20 mm, 50 mm, etc.

(3) Do not use any other abbreviations except those given above.

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—EDITOR

metric measures

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metric
measures

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The opinions expressed by authors are not necessarily those of the Government.

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Development of Length and Area Measures in South India-Part 2

L. RAJU & V. B. MAINKAR
Ministry of International Trade,
New Delhi

IN Part 1, it was pointed out that length and area measures were intimately linked with each other. Measurement of areas of land for revenue purposes is an important function for the Government and the British were keen to adapt many of the then existing length measures in terms of their own units of length like the inch, foot or the yard.

There were, however, indigenous length units in use before the British came. Many of these could still be noticed in trade till recently. Some of them were also used in ancient times for measuring land areas. To estimate the length of these units it was necessary to trace the history of some of the important length units from the earliest times. It was noticed that although the Indus Valley civilization had perhaps a well-developed system of length and area units, we do not have enough knowledge of them at present. The Vedic times also had a system of length and area measures, but a systematic effort to establish their relations was not made until Kautilya enumerated them in his *Arthashastra*. In view of the fundamental character of the data presented in the *Arthashastra*, the various units recorded therein were analysed and their values derived in terms of metric units.

Post-Arthashastra Changes

In the wake of Kautilya's times, numerous changes seem to have taken place in the domain of length and area measures. It is not possible to trace why such changes occurred. Perhaps a need to alter the old units to suit the convenience of the trade or calculations may have been keenly felt. Anyhow, the result was that a strange mixture of tradition and arithmetical novelty came into use, the interpretation of which led to many surprising deductions which have been the root cause of the bewildering variety of length and area measures in later years.

If the examination of the new trends which emerged after Kautilya is to be fruitful we should first assess the practical considerations which could have necessitated a change. The one reason that immediately strikes one is that the principal hasta measures of *Arthashastra* viz. $\frac{1}{2}$ of kisku of 42 angula, 24 and 28 angula, could not all be divided by any single number. Of these three numbers 24 had the best divisibility; it could be divided by 2, 3, 4, 6, 8 and 12. Neither 21 nor 28 had this advantage as they were divisible by 3 and 7 in the case of 21 angula and 2, 4, 7 and 14 for the 28 angula. For trading as also for other purposes it would have been

convenient to divide the commercial hasta into 24 parts instead of 28 parts as was the custom. This division into 24 parts could be achieved in two ways :

(1) Keep the length of the measure (50 cm) unchanged but divide it into 24 parts, thus increasing the angula,

or

(2) Keep the angula unchanged, and reduce the length to 24 angula (i.e. 42·86 cm), thus shortening proportionately all the other length measures.

It is obvious from later traditions, that the former course was adopted, perhaps because it meant that a complete change of the numerous length measures dependent on the commercial hasta would not be involved. This, however, involved an increase in the dimension of the angula and yava in the proportion of 28/24 or 7/6.

An almost exact parallel to this change occurred in the immediate past in India when decimal coinage was adopted. There was considerable discussion whether the old pice should be the principal unit and the rupee increased or the rupee should remain constant and be subdivided into 100 units. The latter course was preferred as it caused the least disturbance in the monetary system.

The alteration of the subdivision of the commercial hasta of 50 cm also involved an alteration of the two other hasta units (viz. the *Arthashastra* hasta of 24 angula and ½ kishku of 21 angula) which were also used for certain purposes. It is possible that people were not willing to discard these measures as superfluous. They had, therefore, to be accommodated in the new scheme of measures. Here again there were two possibilities:

(1) Reduce the 28 angula length to 24 parts, and reduce the content of the remaining two hasta proportionately. In this case the enlarged angula (in proportion of 28/24 or 7/6) remains constant for the three hasta, but the angula content varies.

(2) Divide all the three hasta units into 24 parts but define the angula in such a manner that the dimensions of the hasta remain unaffected. The best method would be to define the angula as 6, 7 and 8 yava of enlarged dimensions (7/6).

From later literature it would appear that both these systems were adopted, depending perhaps on the preference of the people of a region. With the passage of time, however, the second system appears to have slowly become more popular. We may analyse the salient points of the two trends in greater detail to get an idea of how the systems worked.

Proportionate Changes in Hasta

We may first consider the case where the *Arthashastra* hasta of 28 angula was reduced to 24 parts and others were reduced proportionately. This method gives the values recorded in Table 1.

TABLE 1—PROPORTIONATE CHANGES IN HASTA

Sl. No.	Arthashastra Hasta Angula (cm)	New Hasta New Angula (cm)	Change in Angula	
			Arthashastra	New
(1)	28(50)	24(50)	1·786 cm	2·08 cm
(2)	24(42·86)	21(43·75)	1·786 cm	2·08 cm
(3)	21(37·50)	18(37·50)	1·786 cm	2·08 cm

In Table 1 only the hasta units are examined. Other units dependent on them like danda or yojana, would not change in length unless their definitions were altered. Some important points should, however, be noted from Table 1.

The angula, which was apparently related with the dimension of the middle finger in

Kautilya's days, does not retain that relationship now. Its value increases from 1·786 cm to 2·08 cm. The yava unit also increases in length proportionately. The dimensions of the units related to the limbs of man, such as palm, vitasti etc. also lose their meanings as a result of this change. It must be stressed that much of the confusion in later literature arises from the fact that the names of units and the multiples and submultiples remained unaltered. Fantastic theories were evolved to correlate these new measures with the limbs of man.

Secondly, if the 28 angula hasta is reduced to 24 parts, the 24 angula would automatically be reduced to $\frac{24 \times 24}{28} = 20 \cdot 57$ angula. So the aratni, i.e. 24 angula hasta of *Arthashastra*, was reduced to an awkward number of angula i.e. 20·57. It was, therefore, rounded to 21. We cannot be sure whether the original length of 42·86 cm was retained or the new length of 43·75 cm was adopted. We may, for our purposes, assume that both values are correct.

We may illustrate these two points. The *Brahmanda Purana*[17] (1.7.95—101; 4.2.13—26) gives the following relationships.

8 yava	= 1 angula	
10 angula	= 1 vitasti	
21 angula	= 1 ratni	=(43·75 cm or 42·86cm)
24 angula	= 1 hasta	=(50 cm)
42 angula or 2 ratni	= 1 kishku	=(87·50 or 85·72 cm)
4 hasta	=1 dhanu or danda	=(2m)
2 dhanu	=1 nali	=(4m)
2 000 dhanu	=gavyuti	=(4 km)
8 000 dhanu	=yojana	=(16 km)

In the *Brahmanda Purana* the ratni or aratni is taken as 21 angula, whereas it ought to be 24 angula according to *Arthashastra*. The hasta is 24 angula and is distinguished from the ratni. It is obviously equal to the *Arthashastra* hasta of 28 angula. Note that names like vitasti and angula occur but have enhanced lengths in view of the aratni of 21 angula. The vitasti which is normally half of ratni of 24 angula now has 10 angula, and the ratni 21. It is also noteworthy that the kishku is equal to 42 new angula. This kishku was in use in India for a long time, but there was always a controversy whether it should be taken as 41, 41·5 or 42 angula. It should now be obvious why this controversy arose. We shall refer to it again later when we examine Akbar's length measures.

Proportionate Changes in Angula

Let us now examine the second method. Here both the angula and yava are affected in a manner different from the first method we examined. In this case, each hasta is divided into 24 angula but the angula contains 8, 7 or 6 yava. The yava is also larger than the *Arthashastra* yava. So both the angula as well as the yava acquire different magnitudes, the hasta being uniformly divided into 24 parts or angula. This interesting relation is shown in Table 2.

TABLE 2—PROPORTIONATE CHANGE IN ANGULA

Sl. No.	Arthashastra Hasta			New Hasta		
	Angula	Yava	cm	Angula (cm)	Yava	cm
(1)	28	28 × 8 =224	50	24 (2·08)	24 × 8 =192	50
(2)	24	24 × 8 =192	42·86	24 (1·82)	24 × 7 =168	43·75
(3)	21	21 × 8 =168	27·50	24 (1·59)	24 × 6 =144	37·50

An examination of Table 2 yields many interesting results. The new angula has values of 2·08, 1·82 and 1·59 cm respectively. The yava also increases in the proportion of 7/6. Thus 192×7/6=224 yava, 168×7/6 =196 yava and 144×7/6=168 yava. It will be noticed that here also the aratni (Sl. No. 2) gives rise to the same irregularity as noticed earlier; it is larger than the *Arthashastra* aratni by about 1/2 angula. Then again the yava and the angula have totally different dimensions from those used in *Arthashastra*.

The difference in the dimensions of the yava and angula as between the *Arthashastra* and the two later traditions indicated above should be carefully observed. It should again be stressed that any attempt to relate these later units with the actual lengths of yava, angula, palm, vitasti or hasta are bound to give erroneous results. The *average* lengths of these natural units could be utilized for explaining only the *Arthashastra* and earlier units.

The different hasta based on 6, 7 and 8 yava may be illustrated by examples drawn from mathematical and similar other sources.

In the *Ganita Tilaka*[18] by Sripati (1040 AD) the following table occurs for *Kshetra-Vyavahara* i.e. measurement of area etc.

6 yava (without tasu)	= 1 angula
24 angula	= 1 hasta, hastika, pani (37·5 cm)
4 pani	= 1 danda or dandaka (1·5 m)
20 dandaka	= 1 rajju (30 m)
2 rajju (samasri)	= 1 nivartana (30×2)² = (3600 m²)
2 000 danda	= 1 krosa (3 km)
4 krosa	= 1 yojana (12 km)

Here the angula of 6 yava is used for all length and area measurements. It is assumed that this angula gives the hasta of 37·5 cm.

Another interesting table occurs in *Lalitavistar*[19] written perhaps around 2nd century AD. In this table the progression is by seven from the smallest unit up to yava. We may take it that this progression is only notional. From the yava onwards the table is as follows:

7 yava	= 1 anguliparvan
12 anguliparvan	= 1 vitasti (21·88 cm)
2 vitasti	= 1 hasta (assumed to be 43·75 cm)
4 hasta	= 1 dhanusya (1·75 m)
1,000 dhanusya	= 1 krosa (1·75 km)
4 krosa	= 1 yojana (7 km)

The above two tables show that the 6 and 7 yava angula have been used as basic units, without in any way differentiating between the two different vitasti or hasta or danda or even yojana. Each of them acquires a different value.

In his *Ganita-Sara-Sangraha*[20] Mahavira (877 AD), a Jain mathematician, records the following table, given here from yava onwards.

8 barley measures	= 1 angula or vyavaharangula
6 angula	= 1 foot measure (measured across) (12·5 cm)
2 feet	= 1 vitasti (25 cm)
2 vitasti	= 1 hasta (assumed to be 50 cm)
4 hasta	= 1 danda (2 m)
2 000 danda	= 1 krosa (4 km)
4 krosa	= 1 yojana (16 km)

The common tradition of length and area measures in later times was laid down by Bhaskaracharya (1180 AD) in his *Lilavati*[21]. His tables were taken as authoritative and the units recorded by him were used in many parts of the country. We have already established that the hasta of Bhaskaracharya should be taken as 50 cm[1]. The table with metric equivalents is given below:

8 yava	= 1 angula (2·08 cm)
24 angula	= 1 hasta (50 cm)
4 hasta	= 1 danda (2 m)
2 000 danda	= 1 krosa (4 km)
4 krosa	= 1 yojana (16 km)

10 hasta	= 1 vamsa (5m)
20×20 vamsa	= 1 nivartana (1 hectare i. e. a square of 200 hasta a side)

This table is interesting. The nivartana of Bhaskaracharya works out to be 1 hectare. The *Arthashastra* gave us a nivartana of 10581 m².

We have now examined a few examples of the second type of change i.e. angula being 6, 7 or 8 yava. An example of how other attempts to devise sets of tables could have added to the confusion would be of interest.

The *Sukraniti*[22] (1.196-210) gives an interesting table for linear and area measures. Two angula are defined, one of 5 barleys which is equal to the breadth of the middle finger and the second of 8 barleys which is equal to the length of the middle portion of the middle finger. These two are taken as the fundamental units for deriving the length and area units. The 8 yava measures are called Prajapatya and 5 yava Manu. His table works out as follows:

Unit	Prajapatya	Manu
Angula	8 yava	5 yava
Kara	24 angula(68·58 cm)	24 angula (42·86 cm)
Danda	4 kara (2·743 m)	5 kara (2·143 m)
Krosa	5 000 kara(3·429 km)	4 000 kara(1·7144 km)
Nivar-tana	25×25 danda (68·58×68·58 m) =4703·2 m²	25×25 danda (53·575×53·575) =2870·8 m²

The values for the various units are derived by taking the 5 barley angula as equivalent to the *Arthashastra* angula, as they both represent the breadth of the middle finger. This is a rare instance of a 5 yava angula. It should be noted that the Prajapatya angula or kara cannot be related with these limbs of man. These are treated by *Sukraniti* merely as a convenient method of progression of the units.

Barnett[23] quotes the following table from a Jain *Ganita* as quoted by Peterson, in the *Third Report on the Search for MSS*, p. 7 :

4 tila (sesame seeds)	= 1 yava (corn)
4 yava	= 1 angula (finger)
4 angula	= 1 mushti (fist)
4 mushti	= 1 hasta or kara (cubit)
4 hasta	= 1 danda etc.

It is obvious that the above table is somewhat fanciful. Whether it had a real practical base or not is disputable.

Mahavira, Bhaskaracharya and many others use the 8 yava angula, the various units retaining the same old names. The 8 yava angula was apparently the most commonly used in trade. The units based on 7 and 6 yava angula also had their uses for certain purposes.

A confirmation of the traditions examined above occurs unexpectedly in a much later source, the *Ain-i-Akbari*[24] written in the 16th century A.D. A brief analysis of Akbar's measures may not, therefore, be out of place here.

Akbar's Contribution

The *Ain-i-Akbari* in Ain 8 states :

Throughout Hindustan there were three such(length) measures current viz. long, middling and short. Each was divided into 24 equal parts and each part called tassuj. A tassuj of the first kind was equal to 8 ordinary barley-corns, placed together breadthwise and the other two respectively to 7 and 6 barley corns.

The use pattern of the measures is recorded as follows :

Long Measure

(8 yava = angula = tassuj)

Measurement of cultivated lands, roads, distances, forts, reservoirs and mud walls.

Middling Measure

(7 yava = angula = tassuj)

Measuring buildings of stone and wood, bamboo built houses, places of worship, wells and gardens.

Short Measure

(6 yava = angula = tassuj)

Measuring cloth, arms, beds, seats of states, sedan chairs, palanquins, chairs, carts and the like.

The *Ain-i-Akbari* then records the various gaz measures used in India and elsewhere and finally informs us :

His majesty in his wisdom, seeing that the variety of measures was a source of inconvenience, abolished them all and brought the medium gaz of 41 digits in general use. He named it Ilahi gaz and it is employed by the public for all purposes.

What is the length of this Ilahi gaz? The answer to this question would establish whether it was based on Indian or foreign traditions. Many attempts have been made to determine the length of the Ilahi gaz. Duncan[25], after prolonged enquiry, estimated it at 33·6 in (85·34 cm), while others have valued it from 33 to 34·25 inches, a mean of these is 33·75 inches (85·73 cm). Jervis thinks it was exactly 33·5 inches (85·09 cm). In 'settling' the N.W. Provinces, a gaz of 33·5 inches (85·09 cm) was used. The Ilahi gaz has also been estimated at 30·75 inches (78·11 cm) by Moreland[26], and at 32 inches (81·28 cm) by Cracroft[27]. The most favoured length is, however, about 33·5 to 33·6 inches (85·09 to 85·34 cm).

The analysis we have made so far shows that the Ilahi gaz could have been derived from the kisku of 42 angula mentioned in the post-*Arthashastra* literature. But we must examine this kisku in relation to the *Arthashastra* units to understand its significance. The post-*Arthashastra* kisku of 42 angula is perhaps derived from twice the *Arthashastra* aratni of 24 angula i.e. kisku must be 48 angula. When the hasta was revised later on from 28 angula to 24 angula (50 cm), the 48 angula unit became $\frac{48\times24}{28}=41\text{-}1/7$ angula. The 1/7 angula may be neglected. Then at the rate of 24 angula = 50 cm, 41 angula would be 85·417 cm (33·63 in.). The length of the Ilahi gaz, if calculated as above on the basis of the *Arthashastra* tradition, works out to about 85·42 cm. This is in excellent agreement with the value generally accepted. If we do not neglect the 1/7 angula, the Ilahi gaz becomes 85·71 cm.

The bigha of Akbar was 60×60 Ilahi gaz. It works out to 2626·583 m² (3142 sq. yd). It is not surprising that the Akbari bigha is almost equal to the smaller nivartana of *Arthashastra* (2645·3 m²) as it is derived on the same principles. It would have been exactly the same had we not neglected the 1/7 angula in defining the Ilahi gaz. The basic calculation in both is the same.

There is another significant statement in Ain 8 that an 'Akbar Shahi gaz of 46 fingers was used as a cloth measure'. What is this 46 finger gaz? It can be explained as the converted *Arthashastra* hasta of 54 angula. $\left(\frac{24\times54}{28}=46\text{-}2/7 \text{ angula.}\right)$ It would work out to 95·83 cm, if we neglect the 2/7 angula and take the 24 angula as equal to 50 cm and to 96·43 cm, if we do not neglect 2/7 angula.

We thus obtain confirmation of the continuance of *Arthashastra* traditions under other names and garbs continuously through centuries.

Larger Measures

So far we have discussed mainly the units of hasta or double hasta and some of the area measures. Larger length units are danda or dhanusha, (4 hasta), the krosa, also called gavyuti, goruta etc. (1 000 or 2 000 danda) and the yojana, usually equated with 4 krosa. It should now be obvious that depending upon the length of the hasta used for measurement, the yojana or krosa would have differing values.

The larger length measures we have examined are recorded in Table 3.

TABLE 3—DIMENSIONS OF LARGER LENGTH MEASURES

Sl. No.	Source	Length of Units		
		Danda*	Krosa**	Yojana
(1)	*Arthashastra*	1·7143 m *1·9286 m* (Preferred)	1·7143 km *1·9286 km* 3·4286 km *3·8571 km*	6·8571 km *7·7143 km* 13·7143 km *15·4286 km*
(2)	*Ganita Tilaka*	1·5 m	3 km	12 km
(3)	*Lalitavistara*	1·75 m	1·75 km	7 km
(4)	*Brahmanda Purana*	2 m	4 km	16 km
(5)	*Ganita-sara-Sangraha*			
(6)	*Lilavati*			
(7)	*Sukraniti*	2·143 m 2·743 m	3·429 km 1·714 km	— —

*Danda is also called dandaka, dhanu etc.

**Krosa also called goruta, gavyuti etc.

It will be noted from Table 3 that it is possible to derive on the basis of the literature examined earlier, as many as seven different values for the yojana and an equal number for the krosa.

Confusion about Yojana

The unit of yojana has caused considerable confusion in the ancient geographical and astronomical literature. The geographical confusion is obvious from Table 3. In astronomy, the yojana is employed to indicate long distances or dimensions like the diameter of the earth and the planets, the distances covered by them in their orbits and the space between them.

A survey of the astronomical literature shows that the circumference of the earth is taken as either approximately 3 300 yojana or 5,000 yojana. Opinion on the acceptance of any one of these values seems to be equally divided.

Aryabhatiyam[28], *Panchsiddhantika*[29], *Mahabhaskariya*[30], *Shisyadhivriddhida*[31], *Vateswarasiddhanta*[32], and *Siddhantadarpan*[33] recognise the value of 3 300 yojana.

The votaries of the 5000 yojana circumference are *Suryasiddhanta*[34], *Brahmasphutsiddhanta*[35], *Mahabhaskariya*[29], *Siddhantasekhara*[36], *Siddhantasiromani*[37], *Somasiddhanta*[38], *Shakalyokta*[38], and *Brahmasiddhantar*[38].

It appears somewhat surprising that a natural constant dimension like the circumference of the earth should also acquire two values. The circumference of the earth is approximately 40 000 kilometres. Assuming that the ancients somehow measured the

circumference of the earth more or less correctly, the yojana according to the first group of astronomers would be approximately 12·12 kilometres while in the second set it would be 8 kilometres. The 12 kilometre yojana is mentioned in the *Ganitatilaka* but the *Vateswarasiddhanta* assumes an angula of 8 yava and the yojana of 32,000 hasta. This should give the yojana of 16 kilometres ! Similar is the case with many of the other authors including Bhaskaracharya II.

The 8 kilometre yojana would be rather difficult to explain because it has been mentioned by many authors that the yojana consists of 32,000 hasta and the angula of 8 yava —thus giving the yojana of 16 kilometres.

So far no satisfactory explanation has been given for the difference in the two values of the yojana occurring in astronomical works. The problem requires considerable research if it is to be explained rationally. For our immediate geographical purposes, however, the values given in Table 3 should suffice.

The Gaz and the Double Hasta

Gover[39] and Balfour[25] record the tradition that although the hasta differed in different parts of India the relation between the gaz and the hasta was usually in the proportion of 7 : 12. We had occasion to refer in Part 1 of this article to a possible explanation of this phenomenon. Commercial hasta of *Arthashastra* consisted of 28 angula. Apparently the 48 angula (double aratni) also came into use, perhaps, in the post-*Arthashastra* period. The relation between these two is 28/48 = 7/12. The 28 angula hasta was then reduced to 24 and therefore, the aratni was reduced to 21 angula and the double aratni or gaz became 41 or 42 angula. We showed earlier that this was the basis of the Ilahi gaz.

What applies to one type of hasta should as well apply to others and, therefore, it may be instructive to evaluate the gaz derived from the various hasta units in the proportion of 7 : 12.

It is also possible that some of the hasta units may have been merely doubled and used for certain purposes. Table 4 records the various hasta and double hasta units as also the gaz units derived from them on the basis of the ratio of 7 : 12.

TABLE 4—HASTA, GAZ AND DOUBLE HASTA

Sl. No.	Hasta Unit		Gaz (7:12)		Double Hasta	
	Arthashastra	Post-Arthashastra	cm	inch	cm	inch
(1)	21 angula (37·5 cm)	18 angula	62·49	24·6	75	29·5
(2)	24 angula (42·86 cm)	—	73·65	29·0	85·72	33·7
(3)	—	21 angula (43·75 cm)	75·00	29·5	87·50	34·4
(4)	28 angula (50 cm)	24 angula (50 cm)	85·71	33·7	100	39·4
(5)	32 angula (57·14 cm)	—	97·95	38·6	114·28	45·0
(6)	54 angula (96·43 cm) (38·0 in)	—	165·3	65·1	192·86	75·9
(7)	—	46 angula (95·83 cm) (37·7 in.)	164·3	64·7	191·66	75·5

Area Measures

Those who have studied the economic conditions in ancient or medieval India have been astonished at the richness and variety and the consequent confusion in the measures of area used in the various regions and periods.

So far as South Indian area measures are concerned many of them appear to have their foundations in the *Arthashastra*. We have, however, to examine the *Arthashastra* area measures from a somewhat different angle if we have to understand their development in South India.

The *Arthashastra* nivartana is a square, each side of which has a length of 3 rajju, or 30 danda, or 120 or 240 Prajapatya hasta (*see* Part 1). The area is thus 14 400 or 57 600 square hasta. Alternatively, the *side of the nivartana* is 12×10=120 hasta or 24×10=240 hasta. That means the nivartana is one hundred times the area units based or 12 or 24 hasta. This is an important South Indian tradtion. If we take the paridesa, the side is 80 or 160 hasta and the area 6 400 square hasta or 25 600 square hasta. Alternatively it is 100 times the area of a square of 8 or 16 hasta. The nivartana and paridesa are related to each other as 9:4 because the basic sides are 3 rajju and 2 rajju respectively.

The *Arthashastra*, however, prescribes other length units for measurement of areas for specialized purposes. Thus the 28 angula hasta is used for measuring pasture lands, the kishku of 42 angula is used for measuring ground for the encampment of army, for forts and palaces, while the 54 angula hasta is used in measuring timber forests. There are no instructions about how these length measures should be used for area measurements. We may, therefore, examine them on the same principles as used earlier for deriving the area of the nivartana and paridesa. Table 5 lists the magnitudes of the various area units derived from the hasta units defined in the *Arthashastra*.

TABLE 5—ARTHASHASTRA AREA MEASURES

Basis: (1) side of nivartana = 120 or 240 hasta — Nivartana = 14,400 or 57,600 square hasta
(2) side of paridesa = 80 or 160 hasta — Paridesa = 6400 or 25600 square hasta

Sl. No.	Basic Unit	Nivartana		Paridesa	
		m²	yd²	m²	yd²
(1)	Prajapatya hasta	2,645·3	3,163·7	1,175·7	1,406·1
	(24 angula i.e. 42·86 cm, for general use)	10,581·0	12,654·8	4,702·7	5,624·3
(2)	Hasta	3,600	4,305·6	1,600	1,913·6
	(28 angula i.e. 50 cm, for pasture lands)	14,400	17,222·3	6,400	7,654·3
(3)	Kishku	8,100	9,687·5 (2 acres)	3,600	4,305·6
	(42 angula i.e. 75 cm, for army, forts, palaces)	32,400	38,750 (8 acres)	14,400	17,222·3 (3·55 acres)
(4)	Hasta	13,390	16,014·6	5,951·2	7,117·6
	(54 angula i.e. 96·43 cm, for timber forests)	53,561	64,058·1	23,804·8	28,470·3

Table 5 helps us in understanding many South Indian traditions in area measures. It does not, however, cover the whole range. Other methods of calculation were also used which will be explained in Part 3 and Part 4.

It will be noted that Table 5 also covers the area units mentioned in *Sukraniti*, *Ganita Tilaka*, etc. Another point to be noted is that the word nivartana was also used for the paridesa unit as is evident from *Sukraniti*.

In Part 3, we shall examine the various South Indian length and area measures that were commonly used and an attempt made to explain them in the light of the traditions discussed in Part 1 and Part 2 of this article.

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Working Standard Balances : Part 4—Knife-edges

B. R. DHURANDHAR

Saple's Scale Manufacturing Company (P) Ltd., Bombay

IN the first three Parts* of this series of articles the guiding factors in design, the general specification and the beam design of working standard balances were considered in detail. It is now intended to discuss the various factors influencing the knife-edge, its material and design.

Knife-edge in a Good Beam

The moment of a force can be determined correctly if the distance between the point of application of the force and the point round which the force acts can be determined accurately. This will depend upon how fine these points can be drawn or made. The distance between the two pinpoints will not alter if the pinpoints are stationary or if they move in such a way that their focii are two parallel straight lines. A fine knife-edge can be looked upon as a fine line. Two parallel knife-edges would, therefore, form a long series of points which are equidistant from each other. A force acting through the edge can, therefore, be considered as a load acting through innumerable points which the edge is made of. The moments of force acting through one edge round the other parallel edge could, therefore, be determined accurately. These moments will not vary even if the application of load or force is shifted from one end of the edge to the other.

The beam of a working standard balance is a lever of the first order. So a comparison of weights is necessarily a comparison of moments. A good beam, therefore, is one in which moments can be compared accurately. The placement or fixing of well-made and finished knife-edges into the beam is, therefore, of the utmost importance in a good beam.

What is a Good Knife-edge ?

What do we mean by a well-made knife-edge and what is its proper placement in a beam?

The following aspects of a knife-edge are now considered important:

(1) Material.

(2) Shape i.e. cross-section.

(3) Size i.e. length at the base.

(4) Edge proper.

(5) Method of fixing.

*(1) Working Standard Balances : Part 1—Guiding Factors in Design—*Metric Measures*, Vol. 4, No. 3, pp 3—6, 1961.

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(3) Working Standard Balances : Part 3—Beam Design—*Metric Measures*, Vol. 6, No. 4, pp 10—14, 1963.

The choice of the appropriate material depends upon the following qualities in it:

(1) Retention of the edge over a long period

(2) Resistance to crushing loads

(3) Resistance to abrasion

(4) Resistance to corrosion

(5) Resistance to shear stresses, in certain cases.

The edge will retain its sharpness and efficiency if the material is hard enough to bear the specified load. It must be borne in mind that the intensity of the load carried by the edges is enormous. It can, however, be lessened by making the edges sufficiently long. The material to be selected should, therefore, be such that it is naturally hard or can be hardened by processing. A material which satisfies the first requirement is natural stones like agate or synthetic materials like carbides or corrundum, while material of the latter type is steel.

All the materials have been successfully used depending upon the loads they have to bear.

Cross-section and Size

The edge would not crush under load if it is sufficiently long and its base is broad enough to distribute the load evenly. The length and the cross-section of the edge have to be so chosen that for the size of the beam they are not too large. Generally, the length of the central knife-edge is 1/12 and of the end edges 1/24 of the length of the beam.

Cross-sections with base angle of 60° are common but base angles smaller than 60° have also been used where the load is to be distributed less intensely. The edge angle is usually formed out of two facets of the edge enclosing a maximum angle of nearly 120°. This facet angle is related to the shape of the bearings of the fulcrum and those fixed in pan suspensions. V—grooved bearings necessitate the use of smaller facet angles while flat planes allow larger facet angles to be used. The larger the angle of the facets the better would the edge retain its shape under the impact of the load through the bearings.

This is again limited by the deflection of the beam. In certain cases like the self-indicating weighing instruments where the deflection of the beam has to be considerable and the edge is working in a V—grooved bearing the facet angles are reduced to even 30°.

The above discussion indicates what a good knife should be. To achieve this in practice is difficult, and demands extreme precision of work and the use of high precision testing instruments.

The Edge

The knife-edge, as stated earlier, is formed out of two facets on either side. These are two geometrically perfect planes intersecting to form a good edge. The manufacturer, therefore, grinds the facets so as to form two perfect planes. The sharpness and perfection would naturally depend upon the grinding surfaces used. The grinding surfaces have to be rigorously plane throughout the grinding operation.

Equally great care has to be taken while polishing the facets. Polishing is necessary to get a smooth edge which thus acquires a very large number of points of contact throughout its length. More the points of contact, less is the intensity of load on the points of contact of the edge and better is the sharpness retention.

Method of Fixing

The performance of the beam will depend not only upon the quality of the edge and the

care taken to make it, but also on whether it has been properly fitted in the beam scale. Not only should the knife-edges be coplaner and parallel to each other, but also lie in a particular horizontal plane of the beam. Moreover, the side edges should be equidistant on both sides of the central knife-edge. Lastly, their fitting should be such that they are free from mechanical defects.

Defective mechanical fitting is one in which the edge is either loosely fitted or fitted too tightly, thus developing stresses in the edge itself. A non-defective fitting would be one in which the edge is perfectly in contact at its bottom surface and held firmly without stressing it.

There are many methods of achieving this depending on how the particular beam scale is likely to be used. The commonest method is fitting the edges directly in the beam or fitting them by means of a number of screws.

In the case of working standard balances, it is desirable to fit the edges directly into the beams themselves, as these balances are often moved from place to place. Knife-edges in heavier capacity beam scales are likely to get loose in transit. Direct fitting, however, limits precision and cannot be used where higher sensitivity and accuracy are needed. It has, therefore, to be abandoned when balances of precision higher than the working standard balances are to be made. So also the delicate beam of a small capacity balance does not permit direct fitting of knife-edges. In small capacity precision balances the edges are often not directly held by means of screws but are first embedded or sealed in sockets by means of lac and the sockets are then fitted by means of screws.

The performance of a good working standard balance, it should now be clear, depends largely on the quality of the raw materials used for the knife-edge, the method of fitting the knife-edges and the ability of the edge to maintain its sharpness over long periods of time.

In Part 5 we shall discuss how other accessories of the working standard balance are designed.

For Defence Strength
For Strength Planned Development

Ten Years of Weights & Measures Division in NPL

The National Physical Laboratory of India has recently compiled a brief account of the work of the Division of Weights and Measures during the 10-year period April 1953—March 1963.

The report which runs into 16 pages makes very interesting reading.

Creation of the Division

The planning and development of a chain of national laboratories in India under the Council of Scientific and Industrial Research goes back to the beginning of the Second World War, when the gross inadequacy of our scientific and technological organisations was keenly felt. The National Physical Laboratory of India was the first to be set up in 1947, in view of its importance to the growing industrial economy of the country. The laboratory was shifted to its new building early in 1950. The Weights and Measures Division was one of the main divisions organised in the laboratory. This Division was planned to be the custodian of the national prototype standards of length and mass, to be responsible for installing suitable apparatus and equipment for supplying sub-standards to other testing institutions, and to undertake for science and industry all work involving precise measurement of length and mass.

Functions

The functions assigned to the Weights and Measures Division are:

(1) to maintain standards of length, mass and time;

(2) to have equipment for the comparison of scales, surveying tapes etc. and for accurate comparison of the mass of weights of different denominations;

(3) to supply sub-standards of length and mass to other testing institutions;

(4) to equip for the measurement of density and gravity;

(5) to equip itself for testing of gauges, volumetric glassware, hydrometers, screw-threads, fine instruments and mechanical meters;

(6) to maintain a primary standard barometer;

(7) to install dividing machines and ruling lathes;

(8) to set up necessary equipment for carrying out periodical intercomparisons of the reference and the derived standards under continually improving conditions; and

(9) to develop and test new types of apparatus which will facilitate different types of measurements with increasing accuracy.

The work of the Division was organised in three sections—the Mass Section, Length Section and Horology Section. Priority was given to the development of the Mass Section which was of immediate importance to scientific institutions and industry. In addition to these Sections, a small Precision shop was also set up.

Mass Section

The Division started work with only a few balances and a set of uncertified analytical

weights. It is now equipped to carry out tests on weights from 50 kg to fractions of a milligram, volumetric glassware such as burettes, pipettes, graduated flasks, cylinders, butyrometers and other specialised glassware items, capacity measures, hydrometers, viscometers, balances of various capacitites and for the measurement of density, viscosity etc.

Length Section

Starting from scratch, the Length Section is now well-equipped for carrying out precision physical and engineering measurements such as calibration of precision linear measures, testing of different types of scientific, industrial and engineering measuring instruments; mathematical, drawing and surveying instruments; different types of engineering gauges; assessment of surface finish, surface straightness etc.; measurement of metric and inch slip gauges by means of mechanical comparators or with gauge interferometer; measurements on screw threads, gears, bearings, machine tools, hand tools and other small tools etc., test sieves, wire or silk cloth for test sieves; dimensional tests on various mechanical and electrical industrial, or household appliances such as bicycle components, sewing machine components, oil stoves, electrical motors, switches, cables, conductors, plugs and sockets, household irons etc.

Horology Section

This Section is equipped for carrying out craftsmanship test and other tests on watches, stop-watches, clocks and clockwork mechanisms for instruments as well as for testing various component parts of watches and clocks. Work on the setting up of a number of 'quartz crystal' clocks and 'Ammonia clock' was also carried out.

Precision Shop

The Precision Shop now has a linear dividing machine, circular dividing machine, a small jig borer, a pantograph, a rhodium plating unit, lapping equipment and several furnaces for hardening and tempering of gauges.

Maintenance of Standards

From the point of view of metrology in India, the NPL has been holding important responsibilities. Under the provision of the Standards of Weights and Measures Act, 1956, the National Physical Laboratory is the authority which will keep the National Standards of Weights and Measures as certified by the International Bureau of Weights and Measures.

In the enforcement of weights and measures in India, the Weights and Measures Division was required to adjust a large number of standard weights and measures which were then supplied to the Weights and Measures (Enforcement) Departments all over the country.

The Division is equipped with an SIP high precision comparator for linear standards and an NPL Hilger gauge interferometer for the absolute measurement of end standards of length. Several Krypton-86 lamps were presented by the President of the Physikalisch Technische Bundesanstalt.

The Division also possesses several other essential items of equipment for standard works, namely, a complete range of precision mass balances, a hydrostatic balance for the calibration of reference hydrometers, master viscometers and other necessary equipment for viscometry, line and end standards of length, standard angle gauges, polygons etc.

Developmental Work

Among specific items, the following may be mentioned :

1 kg special Balance

The designing and construction of a 1 kg very high precision balance with pan-interchange mechanism has been taken in hand.

The design of this balance, which will be used for the intercomparison of the laboratory standards against the National Prototype Kilogramme is broadly based on the balance constructed by the NPL, Teddington, for the same purpose.

Primary Standard Barometer

A primary standard barometer is being designed and would be ready within the next year or so.

Standard Weights

The construction of standard weights in brass and bronze, plated with rhodium, was taken up as a regular project with a view to derive the higher denominations of standards of mass. A series of weights are now being standardised against the standard weights.

Plane Surfaces

Highly accurate plane surfaces were expected to be produced for developing good quality surface plates and to make slip gauges.

Knife-edges etc.

A project for developing the techniques for the production of good quality agate and steel knife-edges and bearing planes for use in precision balances has been in operation for about a year.

A special gadget for testing the life of knife-edges of precision balances of different capacities under loaded condition is being set up with a view to assess the suitability of different types of locally available agate for making knife-edges and bearing planes. Large quantities of agate are being exported but little is known about the varieties suitable for making knife-edges. The manufacturers of balances are never sure of the quality of agate used by them.

Linear and Circular Scales

A project for the production of high precision linear and circular scales, precision graticules and glass scales was started some time back. Accurate circular scales on glass particularly for use in theodolites and different types of graticules for use in microscopes are made by specialised processes. This requires some amount of investigational work. This has been taken in hand. It is proposed to pass on the processes to industry after working them out successfully.

Special Projects

Two important projects were undertaken at the instance of the Ministry of Commerce and Industry for the Weights and Measures Enforcement Departments. These were designing and construction of :

(*i*) a machine for marking glassware by means of a jet of sand ; and

(*ii*) a comparator for the intercomparison of line standards of length.

The Weights and Measures Division was asked to evolve simple designs so that these items could be manufactured locally at reasonable cost and without importing any components. Prototypes of the length comparator and the glass marking machine have since been made and passed on to the authorities concerned. These two projects will result in a saving of half a crore of rupees in foreign exchange.

Popularization of Metric Weights

The NPL also helped in popularising metric weights by working out suitable designs for commercial weights and making sets for display in States and Union Territories. Among other projects, may be mentioned the construction of a double walled double door glazed chamber for testing balances at different temperatures. The testing can be carried

out from outside the chamber by manipulating the controls.

Technical Assistance to Industry

Weights and Chemical Balances

Firms producing weights and analytical balances for scientific purposes were assisted in production of weights and balances having the desired accuracy for scientific work. Sets of balances were tested in the laboratory, alterations suggested and the process repeated until satisfactory performance was obtained

Manufacture of Commercial Grade Weights

The manufacturers of commercial weights in India were assisted by providing them with adjusted sets of commercial weights for checking masses of weights produced by them. Similar assistance was also given regarding capacity measures.

Standard Weights and Capacity Measures

Designs of reference, secondary and working standard weights for use by the States' Enforcement Departments were worked out in collaboration with the India Government Mint, at Bombay and others. Twenty sets of reference standard weights were made by the Mint and were then stabilized and adjusted at the NPL within the prescribed limits of tolerance and issued to the States. Sets of secondary standard weights and capacity measures were also adjusted and supplied to the States with certificates.

Balances for Weights and Measures Departments

The Weights and Measures Enforcement Departments require accurate balances of capacities ranging from 50 kg to 2 g. To assist in their production, specifications were drawn up in consultation with the ISI, the Standing Metric Committee and others concerned and manufacturers of balances in the country were asked to prepare sample sets of balances and send them to the NPL for critical examination. Difficulties in design and faults in fabrication were set right and new sets of balances tested again until the manufacturers sent balances of the required quality. As a result of the work, an industry producing the complete range of balances has now come into being in the country. Designs for reference and secondary standard balances are now being considered and specifications are being drawn.

Training Facilities for the Industry

The Division has also assisted the industry in imparting technical training to their representatives in various fields falling in the purview of the Division.

Training of Inspectors

Besides co-operating in the work of the various Committees and Sub-committees set up by the Indian Standards Institution and the Ministry of Commerce and Industry, the NPL also undertook the major project of training of Inspectors of Weights and Measures intensively for one week in the testing of balances, weights, capacity measures and linear measures. This training included theoretical as well as practical aspects of testing, besides fully instructing the Inspectors in adjustments and the like of the knife-edges of the balances. In a Programme lasting for about 14 months, with a break of three months, 256 officers including 11 Controllers took the training.

Future Expansion

A new wing is to be added to the existing laboratory building for the use of the Weights and Measures Division. All the work relating to standards will be housed in this wing which will have several special features such as isolated floors, close temperature control in most

of the rooms, some draught-free rooms for balances and other special requirements for the electrical and the optical standards. It will also have a special room which will house a 50 metre tape measuring equipment for the calibration of geodetic tapes.

The procurement of several items of equipment such as 'Talyrond' roundness measuring instrument, 50 tonne dead weight tester, equipment for pneumatic gauging etc. which has been deferred for the time being will also be taken up.

When more space becomes available, the Division can expand its activities particularly in respect of developmental testing for the industry.

Change-over in Industries

THE Eighth Indian Standards Convention was held at Ahmedabad from 22 December to 28 December 1963.

A Session (S-5) held on Monday, 23 December 1963, was completely devoted to *Progress of Change-over to Metric System in Industrial Production.* In all seven papers listed below were considered. The resulting discussion was interesting.

S-5/1	Review of Change-over to Metric System in Tata Iron and Steel Company	Dr. A. V. Sukhatme
S-5/2	Problems in the Change-over to Metric System in Heavy Electrical Industry	B. S. Bhagowalia
S-5/3	Problems in Change-over to Metric System in Automobile Production.	N. V. Meswâni
S-5/4	Metric Change-over in Building Industry.	J. K. Varshneya
S-5/5	Metric Building Bricks	J. Walter
S-5/6	Problems of Introducing Metric System in Cotton Textile Industry.	M. R. Ramachandran
S-5/7	The Change-over to Metric Fasteners in India	S. K. Maini

Chairman's Opening Remarks

Shri T. Swaminathan, Secretary to the Government of India, Departments of Supplies and Technical Development, New Delhi, presided over the Session.

Speaking about the introduction of metric system in India, the Chairman stated that the move was initiated by India long back and it was welcomed by all. Since people are accustomed to a particular way of working and as different standards of weights and measures had been in vogue, the problem was quite difficult. In spite of it, standard specifications have been laid down for a variety of products and definite progress made towards achieving the goal of change-over to metric measurements.

He pointed out that the adoption of the metric system in the country was an opportunity as well as a challenge. It was an

opportunity as it helped in national integration through the adoption of uniform weights and measures and trading practices all over the country and also enabled us to step up our export trade with other countries, as 80 percent of the countries use the metric system. It was a challenge to engineers and others because the industries had now to solve a large number of problems of a fundamental nature in a rather limited period of time. He referred to the considerable rethinking undertaken in countries using the FPS system where production for export was required to be made both in the foot-pound and the metric systems.

In the context of the European Common Market, the Chairman observed that if India was to trade with these Common Market countries, she would naturally have to change-over as early as possible, so as to be able to walk side by side with other countries who were becoming more and more unified. He mentioned the statement issued by the British Standards Institution (BSI) on the adoption of the metric system in the UK. He said that it was a matter of pride for all of us that the BSI was now looking to India and the ISI for guidance and advice because India had already gone ahead with the adoption of metric system. Even then, if we have to catch up with the other 80 percent countries who use the metric system, we had to do a lot of work which remained to be done. Much of it has to be achieved by 1966, the target date for the full adoption of the metric system. It was thus necessary that the pace of the change-over should now be accelerated so that the industries do not find themselves in an awkward position with regard to raw materials, instruments, machines and other accessories.

Plan of Discussion

The papers were discussed in three groups, namely : Engineering Group, Civil Engineering Group and Textiles Group. The points that emerged from discussions were as follows:

(1) Phased Programme

The stage had now been set in India for a complete change-over to the metric system in industry. We have now to adapt ourselves psychologically to the new change. It is necessary for financial as well as technical reasons that we should work out a realistic programme for phasing the change-over. The Indian Standards Institution had now provided almost all the specifications for raw materials and other products required by the industry for the change-over of their designs, equipment and production to the metric system. It was now necessary that the industries should take steps to order raw materials to metric specifications and plan a programme for changing their production to the metric system. If these steps are not taken it is likely that many industries may create difficulties for themselves. The industries which have been procuring their raw materials and equipment in terms of the FPS system had apparently not given much thought to their requirements in the future. A large number of basic raw materials were now being made available in progressively larger quantities in the metric system.

(2) Training of Engineers

A complaint was also made that the engineers who are coming out of the universities had little knowledge of the metric system. It was, however, pointed out that a programme of change-over in engineering education had already been undertaken. According to this programme the first four year-classes in technical colleges had already changed over to metric teaching and the fifth-year classes were expected to go over to metric teaching from 1964-65. Thus within the next year or two the engineers who pass out will be fully conversant with the metric practices.

(3) Collaboration

There was considerable discussion about the role of collaboration and its effect on the change-over. It was pointed out that many production units had been started in collaboration with countries using the FPS system. The designs adopted by these foreign firms had been used for production. For such collaborating organisations, therefore, it was necessary that raw materials according to the old system should be available. The Chairman and many others pointed out that both the UK and USA were willing to supply equipment in the metric system, provided the partner country asked for it. They were already giving such equipment not only to the West European countries but also to India whenever asked for specifically. The problem of collaboration, said the Chairman, needed considerable attention. At the very outset when collaboration was considered, adequate care should be taken to ensure that metric equipment was obtained as also that products be designed to metric specifications. In cases where collaboration had already been entered into, the firms should go over to the metric design on their own at the end of the collaboration period. This should be possible, he said, as the producers would have obtained enough know-how during the period collaboration was effective. He pointed out that if even after this, FPS dimensioned products continued to be produced or collaborations entered into, Government should refuse foreign exchange for such collaborations. What was required was that we should adopt international practices.

(4) Metric Bricks

So far as civil engineering was concerned, it was found that the main problem was the manufacture and supply of metric bricks as standardised by the Indian Standards Institution. Certain difficulties in the table moulding of metric bricks were pointed out. It was agreed that these difficulties could be overcome by slight modifications in the mould and did not require a wholesale change in the specification. It was stressed that a beginning should be made with the use of metric bricks because most of the problems connected with their production, stability etc. had now been overcome. It was now a question of supply and use.

(5) French Count

The decision of the cotton textile industry to adopt the French count in preference to the tex was also discussed thoroughly. It was explained that the decision was taken after consultation with the industry and particularly for the benefit of handloom weavers. The general feeling, however, was that this decision needed reconsideration at the appropriate level in the Government.

Summing Up

Summing up, the Chairman said that the progress of the adoption of metric system in industrial production was not fast enough. A determined effort was now necessary if the industry was not to be caught on the wrong foot so far as raw materials and end products were concerned. The expenditure involved, it was pointed out again and again during the discussions, was not at all heavy. It was necessary to press on with the compulsions and make our engineers start thinking in terms of the metric system and using metric products.

With a vote of thanks to the Chair, the session concluded at about 12·30 p.m.

*A Move To Metric Has Wide Support**

AN early decision on the adoption by British industry of metric weights and measures is called for in the recent report of the BSI on *British Industry and the Metric System.*

Metric System

The report, based on discussions over the past year within BSI committees which are responsible for standards policy in 50 major industries, shows that there is now strong support for a speedy move to the metric system.

'There emerges' says the report 'a substantial majority view that changes are inevitable and that they should be directed towards the introduction of the metric system as the primary system of weights and measures in the United Kingdom within the shortest practicable period.'

Over a year ago, in view of the growing volume of opinion which advocated the adoption of the metric system, BSI issued a pamphlet (*Change to the metric system ?*) (see *Metric Measures*, Sep. 62, pp. 17-23—*Ed.*) reviewing the considerations involved for industry, the action which would have to be taken if it were decided to go metric, and suggesting a phased programme for the change.

Since then committees in BSI representative of manufacturers and other interested bodies in a wide range of industries have considered this review and the main questions which emerged from it—whether particular industries wished to change to the metric system, how long it would take, and whether it should be dependent on a parallel move by the United States or the Commonwealth, as well as detailed questions on the metric standards to be used.

The positive view now reported is, with only a few exceptions, not conditional on similar action by the United States or the Commonwealth.

Export Advantages

The BSI's high-level Export Panel favours a change to metric because of the increasing use of the metric system in the more rapidly expanding world markets, and in view of Britain's growing trade with Europe.

The report recognizes that the time required to make a change will vary from industry to industry and that certain of them—notably petroleum equipment, aircraft and automobiles—must remain basically on the inch/lb system of standards until a change is made in the parallel industries of the United States. In some other parts of the engineering industry the move would inevitably be protracted with dual production, to inch and metric standards, to cater for special customers and for spares and replacements over a considerable period. Close co-ordination between industries using one another's products would be required, the report points out.

BSI as Britain's national standards organization has to look at the question of a change

*From *BSI News* —November 1963, p 13.

primarily in terms of the dimensional standards which provide industry with its basic production and purchasing pattern, and the report indicates the general lines on which BSI's work would have to proceed. Though many other aspects of a change to metric are important, the dimensional standards of the engineering industries are unquestionably the key factor and it is changes in them that would be the major cause of the heavy costs which a change to the metric system would involve.

Changes made to standards (which in the main are voluntary in Britain) could be quickly reflected—even without government action—in trade and commerce and in daily life. Use of the metric system is permitted by law in this country, except for sale of a limited number of goods in specific weights. Clearly, however, a government pronouncement would decisively influence the pace of any change and the effectiveness of action throughout the economy.

The report underlines the need for systematic education in the metric system. The introduction of decimal coinage, though this is an entirely separate issue, would be a move towards the same decimal thinking inherent in the metric system.

Copies of the report have gone to the government and to a wide range of industrial, trade, technical and professional organizations.

CHANGE TO METRIC

(The following letter was published in the *BSI News* December 1963, p 22. It is hoped that readers of *Metric Measures* will find it of interest. —*Editor*)

Sir,—The report by the British Standards Institution, *British Industry and the Metric System*,)* is a timely document of fairly non-committal nature which reports a noticeable, but not pronounced, inclination towards the metric system. Perhaps it is regarded as an interim statement, a Phase 2 to the May, 1962 document—*Change to the Metric System* ? The wisdom of this careful approach by the British Standards Institution is unquestionable, but something more must come from the leading organizations in industry, trade and H.M. Government. As stated in the opening paragraphs of the report, it requires a decision by those concerned.

I venture to suggest that it is not possible to make a gradual decision to change to the metric system. The inch system can fade gradually and the metric system can take its place at a speed to be regulated; but, if a change is to be made, the decision must be taken at a point in time. Thus two decisions are required :

(*a*) Should Britain change to metric ?

(*b*) At what point in time should metric become the primary system ?

It seems to me that there are two approaches to question (a). Without doubt some manufacturing interests and a large share of the defence programme are so closely linked with the United States and Canada that the Imperial system must remain in use for so

*PD 5069.

long as America and Canada remain wedded to inches and pounds. It is equally certain that for life and vigour in the export market Britain must export and service in metric units. It would be vastly uneconomic for Britain to manufacture in two sets of units, and even worse to be schizophrenic in daily thought and action.

It therefore becomes vital that decisions should be made as to our future primary system, with free option to adopt, adapt or ignore as wisdom or whimsy may indicate. Given the decision, I have no doubt that time would find most people had come to accept it.

Unless and until a decision is made there are those of us serving in national and international work who are being torn apart. On the one hand increased participation in work between America, Britain and Canada is being advocated and on the other hand the same people, on the same subjects, are participating in ISO (International Organisation for Standardization) and IEC (International Electrotechnical Commission) work, and whispers of 'Perfidious Albion' pervade our best efforts.

It may be as difficult to provide an answer for question (b) as for (a), but its effect could have a mellowing influence on (a). Given a sufficient interval in which to brace ourselves (and perhaps to let off steam), the operative date for any change of primary system would come to be accepted with little more unfavourable impact than that occasioned by the exponents of a flat earth theory.

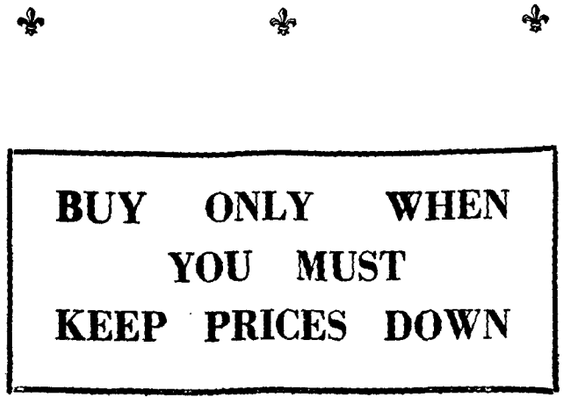
Never let it be said that I sit on the fence—

(*a*) Yes;

(*b*) 1 January, 1970 but, hedging a little, give official recognition to both systems, from January, 1965.

A. H. L. TRAPNELL

Kingsdown
Box, Wilts



Simple Area & Volume Conversions

M. L. KALSI

Directorate of Weights & Measures,
Ministry of International Trade
New Delhi

SOME easy methods of conversion of British length units to metric have been published in *Metric Measures*, September 1963, pp. 13—15. Conversion of area and capacity units is now taken up.

Area

(1) **Square metres to square yards**

Formula : Multiply the number of square metres (m^2) by 6/5 and subtract 1/10 of the number of square metres divided by 25. Results correct to two decimal places.

Example : Convert 305 m^2 into square yards :

$$305 m^2 = 305 \times 6/5 - \frac{305 \times 0 \cdot 1}{25}$$
$$= 366 - 1 \cdot 22$$
$$= 364 \cdot 78 \text{ yd}^2.$$

(2) **Square yards to square metres**

Formula : Multiply the number of square yards by 5/6 and add 0 ·07 for every square metre divided by 25. Results correct to two decimal places.

Example : Convert 312 yd^2 into m^2

$$312 \text{ yd}^2 = 312 \times 5/6 + \frac{312 \times 0 \cdot 07}{25}$$
$$= 260 + 0 \cdot 87$$
$$= 260 \cdot 87 \text{ m}^2$$

(3) **Acres to hectares**

Formula : Multiply the number of acres by 5/12 and subtract 6/5 of the number of acres divided by 100. Results correct to two decimal places.

Example : Convert 180 acres into hectares.

$$180 \text{ acres} = 180 \times 5/12 - 180 \times 6/5 \times 1/100$$
$$= 75 - 2 \cdot 16$$
$$= 72 \cdot 84 \text{ ha}$$

(4) **Hectares to acres**

Formula : Multiply the number of hectares by 12/5 and add the number of hectares divided by 14. Results up to 17 hectares correct to two decimal places. After 17 hectares subtract 0 ·01 for every additional 21 hectares from the above process as under :

			Subtract
18	—	38 ha	0 ·01
39	—	59 ha	0 ·02

and so on.

Examples : Convert 8 ha and 98 ha into acres.

(*a*) 8 hectares $= 8 \times 12/5 + 8/14$
$= 96/5 + 0 \cdot 57$
$= 19 \cdot 20 + 0 \cdot 57$
$= 19 \cdot 77$ acres.

(*b*) 98 hectares $= 98 \times 12/5 + 98/14 -$ 0 ·04.
$= 1176/5 + 7 \cdot 00 - 0 \cdot 04$
$= 235 \cdot 20 + 7 \cdot 00 - 0 \cdot 04$
$= 242 \cdot 20 - 0 \cdot 04$
$= 242 \cdot 16$ acres.

Capacity and Volume

(5) **Gallons (Imp.) to litres**

Formula : Multiply the number of gallons by 9/2 and add 4 ·6 times the number of gallons divided by 100. Results correct to two decimal places.

Example : Convert 109 gallons into litres.

$$109 \text{ gallons} = 109 \times 9/2 + 109 \times 4 \cdot 6/100$$
$$= 981/2 + 501 \cdot 4/100$$
$$= 490 \cdot 5 + 5 \cdot 014$$
$$= 495 \cdot 51 \text{ litres.}$$

(6) **Litres to gallons (Imp.) and pints**

Formula : Multiply the number of litres by 2/9 and subtract hundredth part of this product from itself. Results correct to two decimal places.

To convert the decimal fraction into pints multiply it by 8 and divide by 100.

Example : Convert 109 l into gallons and pints.

$$109 \text{ litres} = 109 \times 2/9 - 109 \times 2/9 \times 1/100.$$
$$= 218/9 - 218/900$$
$$= 24 \cdot 22 - 0 \cdot 24$$
$$= 23 \cdot 98 \text{ gallons}$$
$$= 23 + 98 \times 8/100 \text{ pints}$$
$$= 23 \text{ gallons and } 7 \cdot 21/25 \text{ pints.}$$

(7) **Liquid seers to litres**

Formula : Multiply the number of liquid seers by 15/16. Results correct to two decimal places.

Example : Convert 100 liquid seers into litres.

$$100 \text{ liquid seers} = 100 \times 15/16 = 375/4$$
$$= 93 \cdot 75 \text{ litres.}$$

(8) **Litres to Liquid Seers**

Formula : Multiply the number of litres by 16/15. Results correct to two decimal places.

Example : Convert 90 l into liquid seers.

$$90 \text{ litres} = 90 \times 16/15$$
$$= 96 \text{ liquid seers.}$$

(9) **Cubic feet to cubic metres**

Formula : Multiply the number of cu ft by 3 and divide by 100. This gives result up to 2 cu ft. Above 2 cu ft multiply the number of cu ft by 3, subtract 1/6 of the number of cu ft and divide the whole by 100.

Note : When dividing by 6, take only the whole number. Above 200 cu ft subtract further 1/100th part of cu ft from the above result. Results correct to one place of decimal.

Examples : Convert 298 cu ft & 900 cu ft.

(*a*) 98 cu ft $= (98 \times 3 - 98/6)/100.$
$= \frac{294 - 16}{100}$
$= 278/100 = 2 \cdot 78 \text{ m}^3$

(*b*) 900 cu ft $= (900 \times 3 - 900/6 - 1) \times 1/100$
$= (2700 - 150 - 1) \times 1/100$
$= (2700 - 151) \times 1/100$
$= 2549/100 = 25 \cdot 49 \text{ m}^3$

(10) **Cubic yards to cubic metres**

Formula : Multiply the number of cubic yards by 3/4 and add 0 ·15 for every cubic yard and divide by ten up to 10 cu yd. After 10 cu yd subtract 0 ·01 for every 20 additional cubic yd

i.e. from 11 to 30 subtract 0·01
31 to 50 subtract 0·02

and so on.

Examples : Convert 10 cu yd and 60 cu yd into cubic metres.

(*a*) 10 cu yd $=10\times3/4+10\times0\cdot15/10$
$=30/4+0\cdot15$
$=7\cdot50+0\cdot15$
$=7\cdot65$ m³

(*b*) 60 cu yd $=60\times3/4+60\times0\cdot15/10-0\cdot03$
$=45+0\cdot90-0\cdot03$
$=45\cdot90-0\cdot03$
$=45\cdot87$ m³

News & Views

Eighth Conference of Controllers of Weights & Measures

It has been decided to hold the eighth Conference of Controllers of Weights and Measures on 5, 6 and 7 March 1964, at Agra. Among the points which will come up for discussion are:

(1) Review of progress.

(2) Definition of the term 'transaction for trade' in Weights and Measures (Enforcement) Acts of the States.

(3) Classification of weighing machines used in industry according to use—that is, whether they are used in transactions for trade or not.

(4) Verification of net contents of sealed packages.

(5) Consideration of a proposal to do away with commercial brass weights (other than bullion weights) of the denominations 20 g to 1 kg, and to introduce a cast iron weight of 20 g.

(6) Consideration of a proposal to dispense with plating in the case of brass measures and to prescribe a procedure for testing the amount of plating in steel measures.

(7) Test weights and measures, for verifying measures and weighing and measuring instruments.

(8) Amendment of the Weights and Measures (Enforcement) Rules.

(9) Whether special balances should be provided for weighing precious stones.

(10) Marking of glass measures by etching.

(11) Sale of beam scales by capacity.

A review of the proceedings of the Conference will appear in the May 1964 issue of *Metric Measures*.

Report on Decimal Currency in UK

The Committee of Inquiry on Decimal Currency for UK set up under the Chairmanship of Lord Halsbury in December 1961 has now submitted its report.

The Committee has recommended, by a majority of four to two the adoption by the

UK of a £—cent—1/2 cent system, i.e. the present £ would be divided into 100 cents and the cent being further divided into 1/2 cent equal to 1.2 pence. The final choice of nomenclature, however, has been left to the Government and the people. The coinage would consist of three bronze coins of 1/2, 1 and 2 cents and three cupro-nickel of 5, 10 and 20 cents.

It is further recommended that decimalisation should be preceded by a three-year preparatory period calculated from the date of the Government announcement and followed by a period not exceeding 2 years when dual currency would be in use. The earliest year for the Decimalisation Day, according to the Committee, would be 1967.

The measureable costs, i.e. of conversion or replacement of £. s.d. business and coin-operated machines and of manufacturing decimal coins would increase, the Committee states, as the Decimalisation Day is postponed. In 1967, it would be £ 109 million, in 1968 £ 114 million and in 1970 £ 128 million. It is also recommended that official conversion tables should be issued with alternative tables for those organisations which wish to ignore half cents. Retailers should adopt dual price marking before and after the change-over, but this should not be mandatory.

The Report estimates that in 1962, there were in use 32,000 weighing machines operated mostly by pennies. Over 3 lakh price computing scales and over 50,000 price computing petrol pumps would require conversion. The total conversion and replacement cost for all machines is estimated to be around £ 66 million.

The two dissenters to the majority report in a special memorandum claim 10 s-cent system to be the best available and point out that the £—cent—1/2 system is not a pure decimal system although the majority had noted that the 1/2 cent would disappear due to normal inflation. The majority view is that it is important and essential to retain the status of the £ abroad and that dropping it would induce sinister dealings in sterling to the detriment of the economy. The dissenters do not agree with this.

(Condensed from *The Monthly Review*, October 1963, pp. 233-234).

The Thermometer—From Florence to Lyons

A very interesting history of the thermometer by M. Danloux Dumesnils, is reported in the *Bulletin Belge de Metrologie*. In it the author suggests that the real inventor of the Celsius scale (named after a Swede) was actually a Frenchman named Christin.

M. Maurice Jacob, in a commentary on the history, points out the truth of the saying 'No man is a prophet in his own country' in its application to thermometers. In France at the present moment they are using a scale attributed to a Swede, Celsius; the Germans have for a long time remained faithful to that of the Frenchman REAUMUR, and the British still use that of the Prussian FAHRENHEIT. Mention is made of the cautious introduction of the terms 'Celsius' and 'Centigrade' here.

(from *The Monthly Review*, October 1963, pp. 237)

Book Review

BROCHURE ON THE INTRODUCTION OF METRIC SYSTEM IN THE HIGHWAYS DEPARTMENT (English)—published by the Highways Research Station, Highways & Rural Works Department Government of Madras, Madras; Sept. 1963; pp 148.

This brochure which is a 'Special Report' published by the Highways Research Station, Madras, is an extremely important document and deserves the attention of the Highways Departments of other States as well.

It is divided into five main sections as follows:

I. Introduction
II. Madras Highways Manual—Volume I.
III. Specifications for Works and Method of Measurement and Payment
IV. Method of Measurement and Tolerances.
V. Tables.

After considering in detail the various steps to be taken, the Highways Department changed over to the metric system from 14 November 1962 on the following lines:

(1) All works under execution were to be continued till completion in the F.P.S. system with the same conditions and contract to avoid complications that would arise.

(2) The works for which estimates were sanctioned in F.P.S. system prior to 14-11-62 and tenders not settled, tendering was to be called for in metric units by converting the quantities but the work was to be executed in the F.P.S. system. Payment was expected to be in the C.G.S. system.

(3) All estimates sanctioned after 14-11-62 should be in C.G.S. system.

As a result of this programme of changeover, it was necessary to effect changes in the Schedule of Rates, Road Metal Rate Book, the Manuals, specifications and designs.

To facilitate the change-over, a large number of tables had to be prepared for many items of work and materials in terms of metric units to replace tables which were based on the F.P.S. system. The Madras Highways Manual—Volume I had to be amended to a certain extent.

The Chapter on 'Specifications for Works and Method of Measurement and Payment' contains considerable information which every Highway Engineer will find of interest and use to him. What is more, illustrative examples are given to explain the points made out.

The book is also embellished with 31 useful tables. Besides the usual conversion tables, there are tables to convert feet and inches into millimetres up to 10 feet by steps of 1/16 of an inch. Besides, a table of conversions from 0 to 1,000 feet, in steps of 10 feet is also provided. Other tables relate to various types of speeds, volumes, pressures, stresses etc. Such important information as weight, perimeter and area of metric steel bars, weight of reinforcement for square metre of slab, safe permissible loads on masonry and soils, road metal rate book, sample schedule of rates, conversion of prices per 1,000 or 100 cubic feet to cubic metre as also from 100 square or running feet to square metres or metres etc. is included in the book. This Section also contains information on sample estimate for special repairs to road work, sample estimate for constructing a building, typical worked out examples on reinforced concrete slab in metric system as also a worked out example for hydraulic calculation for bridge estimate.

This is the first book of its kind which has been published in India so far. It is exhaustive and is a mine of information for engineers. It deserves the attention of all who are concerned with Highways work.

VOLUME TABLES FOR ROUND OR SQUARED TIMBER UNDER METRIC SYSTEM—PART-I (English); Compiled by T. Janaky and published by Bharathee Bhooshanam Press, Viyyur (P.O.) Trichur, Kerala State; Price Rs. 8; June 1963; pp. 321.

The author has compiled tables covering girths from 21 centimetres to 180 centimetres in steps of 1 centimetre and lengths from 5 centimetres to 15 metres in steps of 5 centimetres. The volume of the timber is given correct to three decimal places as was decided in the Conference of Conservators of Forests held on 19 December 1961 in New Delhi.* The quarter girth formula has been used for working out the volumes.

An interesting feature of these tables is the calculation of co-efficient of girths for one metre length. These co-efficients have been calculated for mid girth ranging from 1 cm to 180 cm. From this co-efficient, the volume of any length of log can be worked out simply by multiplying the co-efficient by the length in metres and putting the decimal point in the correct place. This section of the tables covers four pages while another two pages are devoted to conversion factors and tables of British and metric units. The main tables for volume calculations run to 321 pages.

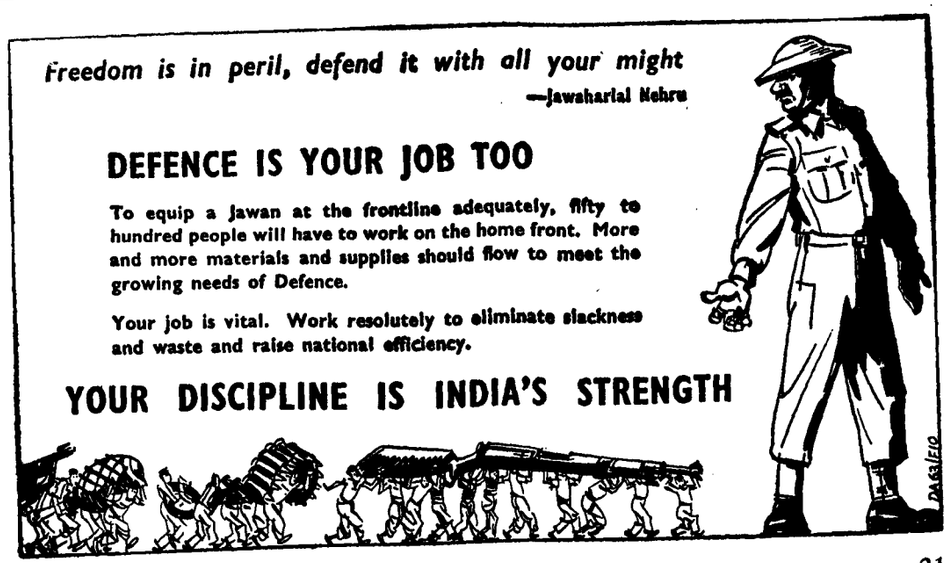
The volume tables are very exhaustive and it is obvious that the compiler has taken great pains to put all these values together.

These tables have been approved for use by the Kerala Forest Department and deserve the attention of other States as well.

The book has been printed in such a size that it is easy to locate the values at a glance. Each column gives values in steps of 2.5 metres which leads to ease of reference.

The book is printed in easy to ready type and can be conveniently carried about by users.

*See *Metric Measures*, Vol. 5, No. 2, pp. 18 & 19, 1962.



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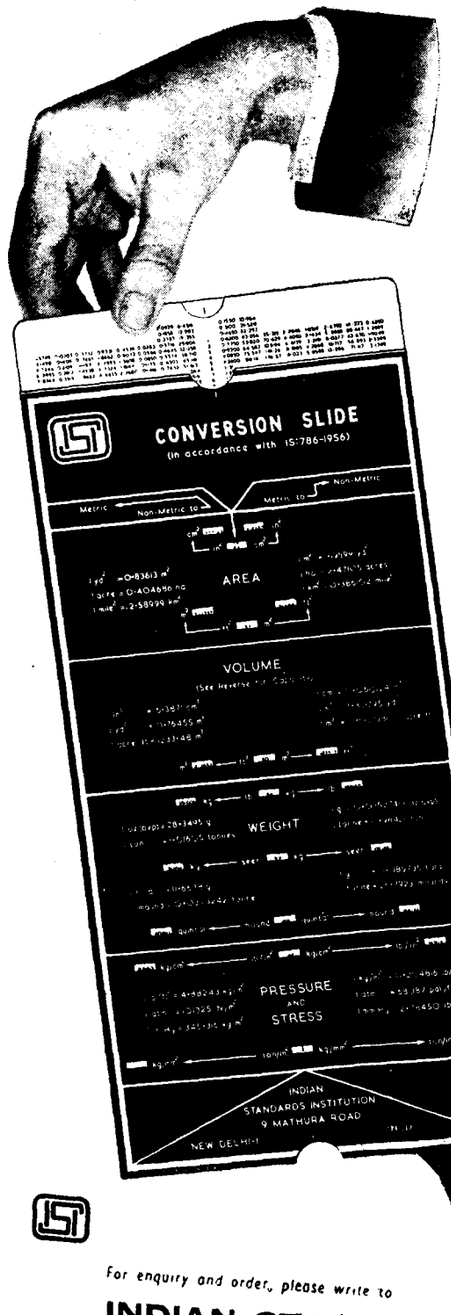

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TYPICAL METRIC PRICING UNITS FOR WHOLESALE TRANSACTIONS

Serial No.	Commodity	Metric Unit
		10 grams (g)
(1)	**Gold**	1 kilogram (kg)
(2)	**Grocery and Confectionery** Biscuits, sweetmeats, cardamoms.	
	Textiles and Textile Fibres Cotton yarn, damaged and seconds cloth, raw silk, rayon silk yarn, raw wool, wool manufacturers (when sold by weight).	
	Paints & Chemicals Paint (if sold by weight), indigo, liquid chlorine.	
	Hides, Skins & Leather Raw hides, leather (hides and skins).	
	Metals Silver, aluminium sheets, strips and circles, copper and brass wires and utensils.	
	Miscellaneous Tea, meat, camphor tablets, mica.	
(3)	**Grains and Pulses** Rice, wheat, jowar, arhar, moong, masur, gram.	one metric tonne (t) (1,000 kilograms)
	Spices Black pepper, mustard, chillies, dhania, dalchini, turmeric, betelnuts.	
	Plantation Products Rubber, cashewnuts, cashew kernels, tobacco (raw and manufactured).	
	Forest Products Lac and lac products, gums, myrobalans, galnuts, soapnuts.	
	Textiles & Textile Fibres Raw jute, raw hemp, coir yarn.	
	Oils, Oilseeds & Oilcakes Vegetable oil, oilseeds, oilcakes.	1 quintal (q) (100 kilograms)
	Non-Ferrous Metals *Aluminium:* ingots, bars, blocks, slabs, 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, circles. *Brass :* ingots, rods, sections, pipes, sheets, strips, circles. *Zinc :* ingots, sheets, strips. *Tin :* blocks.	
	Chemicals Caustic soda, bleaching powder, glycerine, soaps, paper salt.	
	Others Sugar, gur, ice, fish, sugarcane, vegetables, tamarind.	
(4)	**Minerals** Iron ore, manganese ore, bauxite, coal.	
	Iron & Steel Pig iron, iron & steel manufactures, semis (billets for rerolling etc.)	
(5)	Cloth (mill, handloom, silk rayon and woollen cloth)	1 metre (m)
(6)	Jute carpets, coir mats and mattings, sheet glass.	one square metre (m^2)
(7)	Timber.	one cubic metre (m^3)
(8)	Paints (when sold by measure), spirits.	one litre (l)

Weights

(1) In place of the present units of seer, pound, rattal, viss etc., use the kilogram.

(2) In place of the tola, use the gram or 10 grams.

(3) In place of maund or corresponding unit, use the quintal *i. e.* 100 kg.

Capacity Measures

In place of seer or gallon or any other measure use the litre.

Length Measures

(1) Use the metre in place of yard or foot and the centimetre in place of inch.

Square Measures

(1) Use the square metre in place of square yard or square foot, and square centimetre in place of square inch.

Cubic Measures

(1) Use the cubic metre in place of cubic yard or cubic foot and cubic centimetre in place of cubic inch.

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It is advantageous if sizes of packages correspond to series of commercial weights and measures prescribed.

These are: 50 kg, 20 kg, 10 kg, 5 kg, 2 kg, 1 kg, 500 g, 200 g, 100 g, 50 g, 20 g, 10 g, 5 g, 2 g, 1 g, and so on.

TYPICAL PRICING UNITS FOR RETAIL TRADE

Serial No.	Commodity	Metric Unit for Use
(1)	Foodgrains, cereals, pulses, spices, ghee, bread, vegetables, meat, fish, sweetmeats, tea, coffee, sugar, salt.	1 kg
(2)	Oil for cooking	1 kg or 1 litre depending upon prevalent practice.
(3)	Fruits	1 kg or number depending upon prevalent practice.
(4)	Milk	1 litre
(5)	Cloth and related materials	1 metre
(6)	Prepackaged materials	Preferably sizes corresponding to series of commercial weights and measures.

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metric measures

THE PUBLICATIONS DIVISION

ABBREVIATION FOR METRIC UNITS

(1) DECIMAL MULTIPLES AND SUB-MULTIPLES

Prefix	Value in Terms of Unit	Abbreviation
Kilo ..	1,000	k
centi ..	$0{\cdot}01(10^{-2})$	c
milli ..	$0{\cdot}001(10^{-3})$	m
micro ..	$0{\cdot}000\,001(10^{-6})$	u

(2) WEIGHTS

Denomination	Value	Abbreviation
tonne ..	1,000 kg	t
quintal ..	100 kg	q
kilogram ..	1 kg	kg
gram ..	1 g	g
milligram ..	1 mg	mg
carat ..	200 mg	c

(3) CAPACITY

kilolitre ..	1 000 l	kl
litre ..	1 l	l
millilitre ..	1 ml	ml

(4) VOLUME

cubic metre ..	m^3	m^3 or cu m*
cubic centimetre ..	cm^3	cm^3 or cu cm*
cubic millimetre ..	mm^3	mm^3 or cu mm*

(5) LENGTH

kilometre ..	1 000 m	km
metre ..	1 m	m
centimetre ..	1 cm	cm
millimetre ..	1 mm	mm
micron ..	1/1 000 mm or 10^{-3} mm	um

(6) AREA

square kilometre	1 000 000 m^2	km^2 or sq km*
square metre ..	1 m2	m^2 or sq m*
square centimetre	1 cm^2	cm^2 or sq cm*
square millimetre	1 mm^2	mm^2 or sq mm*

(7) LAND MEASURE

are ..	100 m^2	a
hectare ..	100 a	ha
centiare ..	m^2	ca

*Both these abbreviations are current, but the first set should preferably be used. The former abbreviation is used more commonly internationally than the latter.

Rules for Abbreviations :

(1) Do not make any change, such as addition of 's' to indicate plurality *e.g.*, write 1 kg, 10 kg, 20 g, 5 g, 10 t, 20 ml, 271, 165 km, 2 mm, 100 cm^3, 66 km^2.

(2) Do not capitalize the abbreviations. For example, do not write 1 Kg, 2 Kg, 20 MM, 50 MM; the right way is to write 1 kg, 2 kg, 20 mm, 50 mm, etc.

(3) Do not use any other abbreviations except those given above.

P. 883.

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metric measures

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Eighth Conference of Controllers

THE Eighth Conference of Controllers of Weights and Measures was held in Agra on 5, 6 and 7 March 1964. Shri P.N. Nayer, Director of Weights and Measures, Ministry of International Trade, presided. Controllers of Weights and Measures of the States and Union Territories and representatives of the National Physical Laboratory (NPL), Indian Standards Institution (ISI), Directorate General of Technical Development and Ministries of International Trade, Law, Finance, Information & Broadcasting attended the Conference.

Inaugural Speech

The Conference was to have been inaugurated by Shri Jagmohan Singh Negi, Minister, Food and Civil Supplies, Uttar Pradesh, but he was unable to be present in person. His speech inaugurating the Conference was read by Shree G.P. Mital, Controller of Weights and Measures, U.P. The Minister welcomed the delegates from all parts of India. Agra besides being a city of historical importance was the biggest centre for the manufacture of commercial weights in the country. The Agra industry had made a significant contribution to the success of the reform of weights and measures in India. The introduction of the metric system of weights and measures would bring much benefit to the country. The task of changing to a new system of measurement was big, but it had been successfully accomplished through the cooperation of trade, industry and the general public. He wished the Conference success in finding solutions to various problems which still confronted the authorities responsible for enforcing the metric system.

Shri G.P. Mital, Controller of Weights and Measures, U.P. referred to the progress achieved in the enforcement of weights and measures in the State. The State had a late start, but had succeeded in catching up with the rest of India.

Chairman's Remarks

In the absence of Shri C.S. Ramachandran, Joint Secretary to the Government of India, Ministry of International Trade, Shri P.N. Nayer, Director, Weights and Measures, presided over the Conference. He referred to the services rendered to the reform of weights and measures by Shri K.V. Venkatachalam who had presided over the first seven Conferences. The Conference placed on record its appreciation of the outstanding services rendered by Shri K.V. Venkatachalam to the reform of weights and measures, to the building up of Weights and Measures Organisations in the States and to the evolution of the Controllers' Conference. The Conference also decided to convey to Shri Kanwarjit Singh, Adviser on Weights and Measures to the Royal Saudi Arabian Government, its congratulations on his selection to his present assignment and its good wishes for success in his new tasks.

The Chairman spoke of the importance of technical training of personnel for enforcing weights and measures. The enforcement of

weights and measures was a higly specialised task. It required the use of complicated equipment and the employment of highly trained personnel. Weights and Measures Departments in the States had been provided with costly equipment in the form of Standard Weights and Measures and precision balances. It was of the utmost importance that Inspectors of Weights and Measures should be adequately trained to make the best use of their equipment. A large proportion of the Inspectors in service had yet to receive formal training. This could not be helped since with the limited training facilities available, it was not possible to train every Inspector in an Institute before inducting him into Office. Training facilities had since been improved and expanded. He hoped that Inspectors who had not received formal training would be sent in convenient numbers to the Bihar Institute of Weights and Measures for training.

The main conclusions and recommendations of the Conference are summarised below.

(1) Progress of Enforcement of Metric Weights and Measures

Metric weights had come into exclusive use all over the country, barring certain isolated areas, and unorganised trades like the trade in fruits and vegetables. The campaign to eliminate unauthorised weights and measures from these areas and trades would continue.

(2) Organisation For Enforcement

(*a*) *Status :* The Enforcement Organisation had statutory functions of a permanent nature. It should, therefore, be made permanent. Unless this was done, it would be difficult to recruit competent personnel or to retain the services of able men serving in the Organisation. The value of training imparted to Inspectors at considerable expense to Government, and their highly specialized experience would be lost, if due to the temporary nature of their employment they were compelled to seek opportunities elsewhere.

(*b*) *Strength :* Weights and Measures Departments should be staffed on the scale recommended by the 5th Conference of Controllers of Weights and Measures.

(*c*) *Financial Situation :* In many States, Weights and Measures Departments had become financially self-supporting. Other States should aim at becoming financially self-supporting, as soon as possible.

(*d*) *Equipment :*

(*i*) *Working Standard Weights:* The Mints have met the demand for Working Standard Weights in full.

(*ii*) *Secondary Standard Length Measures*: The Bombay Mint would begin manufacturing these standards soon. They would supply at least one standard measure to each State and Union Territory in the course of the year. On the basis of 1 secondary standard length measure for every 10 working standard length measures, the estimated demand for the whole country would be 80 to 100 standards.

(*iii*) *Secondary Standard Balances :* Secondary standard balances should be of the following capacities and sensitivities :

Capacity	Per division of the scale
20 kg	25·0
5 kg	7·5
1 kg	1·5
50 g	0·4
2 g	0·02

The lengths of the beams and other particulars of design would be left to the manufacturers, but the suggestions of the National Physical Laboratory would be circulated to them for guidance. The specification would be sent to the approved manufactures of Inspector's balances. They would be advised to submit prototypes for test to the National Physical Laboratory.

(*iv*) *Equipment for Marking Glass Measures:* A firm was working on a prototype of the sand blasting equipment designed by the National Physical Laboratory. If the firm failed to supply a prototype by the end of June 1964, or if their prototype was not of satisfactory quality, the manufacture of the equipment would be undertaken by the Bombay Mint.

(*v*) *Test Weights :* Commercial cast iron weights of 20 kg, adjusted to a high accuracy, should be used as test weights, except for testing very heavy weighbridges. The Mint Master, Bombay, would design roller type test weights for verifying heavy weighbridges.

(*vi*) *Test Measures :* Special test measures of the denominations 1 litre, 2 litres, 5 litres and 10 litres would be designed for verifying commercial measures, dispensing pumps and filling machines. Till these test measures were designed and supplied to the Weights and Measures Departments, ordinary conical measures, adjusted to high accuracy, should be used as test measures.

(*e*) *Training of Inspectors :* It would be enough to provide a single course of training for all Inspectors whether fresh recruits or persons who have been working as Inspectors for sometime. The duration of the course should be 3 months. The course would be conducted at the Bihar Institute of Weights and Measures, Patna which would make arrangements for the lodging and boarding of the trainees. Inspectors should be paid, during training, a fixed monthly allowance in addition to pay.

The general opinion was that the Institute for the training of Inspectors should be under the control of the Central Government. Till the Centre can make adequate arrangements, the Central Government must meet the entire expenditure on the training, through grants to the Bihar Institute of Weights and Measures.

(3) Scope of Enforcement Law

(*a*) *Definition of the term 'Use in transaction for trade or commerce'.*

The Weights and Measures (Enforcement) Acts applied to weights, measures and instruments used in transactions for trade or commerce. It was, therefore, necessary to give a clear and precise definition to the term. The following definition was recommended for adoption in all the States :

> '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—
>
> (*a*) any contract, whether by way of sale, or purchase or exchange or otherwise; or
>
> (*b*) any assessment of royalty, toll, duty or other dues; or
>
> (*c*) assessment of any work done or services rendered, except in respect of research and scientific studies or individual household purposes.

It was important that the scope of Weights and Measures (Enforcement) Acts should be indentical in all the States.

(b) Weights, Measures and Weighing and Measuring instruments used in Transactions for Trade or Commerce in the Sugar and Tea Industries.

The recommendations made by the Study Groups set up to study the use pattern in sugar and tea industries were approved. (*See* separate article on pp 9-12 in this issue for the recommendations of the Study groups—Editor)

(4) Verification of Contents of Sealed Packages

(a) Verification Procedure

The Contents of sealed packages should be verified at the place of manufacture or packing. The contents of individual packages, as well as the average content of a minimum of 10 packages should be of the specified accuracies. The limit of error which would be permitted on an average of 10 packages was roughly 1/3 of the permissible error on an individual package. To avoid waste, verification should, as far as possible, be carried out without opening the packages. This is generally possible at the place of packing, where it should be possible to make an estimate of the tare weight by weighing a number of containers.

Sealed packages would be verified at trading premises only if the Inspector had strong reasons to suspect that a trader had been committing fraud by tampering with the packages he received from the manufacturers. If it becomes necessary to open a package, the Inspector should buy the package, paying the full commercial price.

(b) Permissible Errors

The following errors would be permitted in the contents of individual packages of foodgrains, sugar, infant food, cotton and milk :

Foodgrains : ±0·5 per cent on the net weight of foodgrains, packed in bags holding 90 to 100 kg.
Sugar : ±0·1 per cent on white sugar packed in bags holding 1 quintal.

Raw sugar is more liable to moisture absorption than white sugar. A more liberal error would, therefore, have to be permitted for raw sugar. The National Sugar Institute would collect data both in laboratory and in the field, and recommend the reasonable error to be permitted.

Infant Food :

(*a*) Packages with net content between 1 kg and 2 kg ..	± 3 per cent
(*b*) Packages between 500 g and 1,000 g..	± 4 per cent
(*c*) Packages up to 500 g.. ..	± 5 per cent

Cotton yarn :

	Net Weight	Maximum permissible error
(*a*) Full Bale ..	200 kg	± 10 kg
(*b*) Three-quarter Bale	150 kg	± 7·50 kg
(*c*) Half Bale ..	100 kg	± 5 kg
(*d*) Quarter Bale ..	50 kg	± 2·5 kg

Cotton Cloth :

(*a*) Full Bale ..	1500 m	± 100 m
(*b*) Three-Quarter Bale	1125 m	± 75 m
(*c*) Half Bale ..	750 m	± 50 m
(*d*) Quarter Bale ..	375 m	± 25 m

Milk:

Capacity of Bottle	Permissible error
500 ml	± 10 ml
250 ml	± 8 ml
200 ml	± 8 ml

(5) Amendment of the Weights & Measures (Enforcement) Rules

According to the Weights and Measures (Enforcement) Rules, any weight, measure, or weighing or measuring instrument seized and detained under the Rules, which is not to be a subject of proceedings in a court, has to be dealt with, one month after seizure, as the Controller may direct. Further, any weight, measure, or weighing or measuring instrument, seized and detained, which is to be the subject of proceedings in a court, has to be produced before the court, and after conclusion of proceedings, taken possession of by the Inspector, and dealt with in accordance with the direction of the court. The Rule refers only to weights, measures and instruments, not to articles seized by Inspectors. The Rule should be amended by adding the words 'or article' after 'measuring instrument'.

(b) Use of Bullion Weights

The rules should be amended to ensure that only bullion weights were used in transactions in bullion.

(c) Use of Beam Scales of Appropriate Classes in Trade

The Rules should be amended making it an offence to use in any trade a beam scale which is not of the class prescribed for that trade.

(6) Licencing of Manufacturers

The Weights & Measures (Enforcement) Acts did not authorise a State Government to issue a manufacturer's licence to a manufacturer outside the State. A licence from the Government of the State in which his establishment was situated would entitle a manufacturer to produce weights, measures or instrument for sale in any part of the country.

(7) Abolition of Commercial Brass Weights Other than Bullion Weights

The use of a hexagonal cast iron weight of 20 g would be authorised under the Weights and Measures (Enforcement) Rules. Manufacturers would be advised to discontinue the manufacture of commercial brass weights other than bullion weights. Commercial brass weights of denominations 20 g to 1 kg would be replaced by cast iron weights, and those of denominations below 20 g by bullion weights. Commercial brass weights already in use would continue to be in use and would be reverified and stamped if they conform to specifications. References to these weights in the Weights and Measures (Enforcement) Rules cannot, therefore, be deleted, so long as appreciable numbers of these weights are in use.

(8) Plating of Metre Measures

Nickel and chromium plating would be dispensed with in the case of brass measures. Mild steel measures should be plated in conformity with the specifications in the Indian Standard : 1068-1958. The Indian Standards Institution would suggest a simple method for testing the quality of plating by Inspectors.

(9) Significance of Term 'Appreciable Movement of the Indicator'

According to the Weights and Measures (Enforcement) Rules, sensitiveness is the least weight which, on being added to or removed from the loading platform or pan, when the instrument is in balance, causes an 'appreciable movement of the indicator' from the equilibrium position. An instrument should be considered sensitive enough if on the addition or removal of a weight equal to the prescribed sensitiveness, there is a perceptible imbalance. It is not necessary to insist that the indicator should move over a minimum distance.

(10) Power to Inspectors to Stop Tank Vehicles on the Road.

An Inspector could enter premises where weights measures or weighing or measuring

instruments were kept for use in trade. But he had no power to stop a tank vehicle or any moblile measure or measuring instrument. The Weights and Measures (Enforcement) Acts should be amended to empower Inspectors to stop such vehicles and to examine whether they had been stamped by Inspector.

(11) Wheel-weighers

Wheel-weighers should be verified and stamped by Inspectors.

(12) Measurement of Lime Shells Etc.

The Indian Standards Institution would be requested to recommend specifications for convenient measures for measuring sand, aggregate, lime, shells etc.

(13) Automatic Bottle Fillers in Dairies

Automatic bottle fillers used in dairies and elsewhere, for filling articles in pre-determined quantities for sale were commercial measuring instruments. The Indian Standards Institution should be requested to suggest a method for verifying automatic fillers.

(14) Calibration of Tank Vehicles Plying in More than One State

Such Vehicles should be stamped on payment of full fees by Inspectors in all the States concerned, but they would be physically verified only in one State. The correctness of this verification would be accepted by Inspectors in the other States.

(15) Marking of Prices or Wages on Dials of Weighing Machines

In tea gardens, pluckers of green tea leaf are paid wages according to the weights of leaf plucked by them. In some gardens in Assam the dials of the balances on which tea leaf is weighed, show two parallel graduations, one showing the weights and the other wages payable. The use of such scales should be discouraged. They have, however, been traditionally in use for a long time, and it may not be possible to ban them outright. The Inspector would not take responsibility for verifying the wage graduations. He would verify only the weight graduations.

(16) Sale of Beam Scales by length

The price of a beam scale should depend on its class, capacity and quality. The length of beam should not be a relevant consideration in determining the price. Controllers would advise their licensed dealers not to quote prices in terms of length of beam.

(17) 9·25 litre Measure for Home Delivery of Kerosene

It was reported that a 9·25 litre measure was being used by certain oil companies for home delivery of kerosene. The measure was carried on cycle rickshaws or other vehicles. The Weights and Measures (Enforcement) Rules do not authorise a 9·25 litre measure. In measuring out kerosene oil for delivery, authorised commercial measures of the denominations 2 litres, 5 litres or 10 litres should be used.

(18) Replacement of Verification Certificate or Manufacturer's Licence

A fee of Re. 1 should be charged for replacing or amending a licence. Certificates of verification would be replaced, where necessary, free of charge.

(19) Miscellaneous

(*i*) *Round Metallic Metre Measures :* Round metallic metre measures should not be authorised for use in trade.

(*ii*) *Platform Machines of Capacities below 50 kg :* Platform machines of capacities 5 kg, 10 kg, and 20 kg should not be authorised under the Rules.

Classification of Weighing and Measuring Instruments in Industries

WEIGHTS measures and weighing and measuring instruments used in 'transactions for trade' are subject to regulation by the State. Weights, measures and instruments used in transactions for trade in industrial establishments must be offered for verification and stamping by Government Inspectors of Weights and Measures annually. Those used in shops and other establishments are to be verified once in two years. The term 'transaction for trade' includes not only buying and selling, but also such transactions as payment of wages or bonus for work done, or the levy of duties by the State or Municipal authorities. Any weight, measure or instrument, in short, which is used in any sort of deal between two parties will be subject to regulation.

The classification of weights, measures and instruments as those used in transactions for trade and of those not so used, has to be considered in detail. Broad instructions should be given to the Inspector of Weights and Measures regarding the weights, measures and instruments which should be regarded as used in 'transactions for trade' and hence falling within his responsibility.

Transactions for trade in the industry, may be broadly classified as follows :

(*i*) Buying raw materials, fuels, stores etc., and sale of products and by-products.

(*ii*) Payment of wages, bonus, etc., to workers.

(*iii*) Levy of excise and other duties on the products of the industry

All weights, measures and instruments used for any of these purposes would be subject to regulation by the State. Weights, measures and instruments used for other purposes, as for instance, in the laboratory for analysing materials, or in various departments purely for process control would not be subject to such regulation.

A classification of the weights, measures and weighing and measuring instruments has been completed for two industries : Tea and Sugar. The following is a summary of the recommendations of the Study Groups set up for the purposes. These recommendations were accepted in the 8th Conference of Controllers held at Agra in March 1964.

TEA INDUSTRY

A study Group comprising the various tea interests, some of the Controllers of Weights and Measures from the States and the Directorate of Weights and Measures, Ministry of International Trade, was formed under the Chairmanship of Shri K. M. Kidwai, Director of Tea Development in the Tea Board. The Study Group met on 4 December 1963 in Calcutta and made the following recommendations on the basis of a survey carried out earlier :

(a) Weighment of green Tea Leaf

In many Tea gardens in West Bengal and probably elsewhere, Salters' domestic type spring balances are used for weighing green

leaves. These machines do not conform to the specifications in the Weights and Measures Rules. The balances now in use may be allowed to run their normal course of life. They would be verified and stamped by Inspectors provided they are accurate within the prescribed limit of errors. But when these machines are worn out they would be replaced not by domestic type machines but by trade type machines which conform to the Rules. The Indian Tea Association would advise its members accordingly.

The estimation of the net weight of tea leaf with accuracy is made difficult by the substantial variation in the tare weight of the basket. Standardisation of baskets would be difficult and may not be practicable. Transferring the leaves into standard baskets before weighment would consume more time and labour and also adversly affect the quality of the leaf and ultimately of manufactured tea. It was agreed that the subject should be studied fully with a view to evolve a workable method to minimise the error in estimating the net weight of green tea leaf due to variation in the tare weight of baskets. Until the recommendations of the Working Group come out, Inspectors would be instructed not to enquire into the fixation of basket tare for leaf weighment.

(b) Machines used in rolling Section, Dryer-Mouth Tea Section and Grading Section

The weighments in these Departments are in the nature of internal checks. The machines were, therefore, not used in trade transactions and are not subject to periodic verification and stamping by Inspectors of Weights and Measures.

Every garden should, however, send a declaration to the Controller of Weights and Measures listing the machines exclusively used in these Sections.

(c) Packing

Most of the gardens sell their entire outputs through auctions. At the auctions, transactions take place on the basis of test weighments at the auction house and not on the basis of the weights marked on the chests. Gardens may, however, sell tea also to local customers at the gardens. These customers would normally accept the weights marked on the chests as correct. Machines which are likely to be used for packing chests for local use should be offered for verification by Inspectors. Tea gardens would not be under obligation to have machines used exclusively for packing tea for auctions verified.

Chests are weighed in the store room for assessment of excise duty. The machines used for this purpose must be verified by Inspectors.

(d) Ration Distribution Section

Distribution of Ration to the labourers is obviously a transaction in trade and commerce. Weights, measures and weighing and measuring instruments used for this purpose, are, therefore, subject to periodic verification and stamping.

The weights and Measures Department would carry out verification of weights, measures and weighing and measuring instruments in tea gardens, as far as possible during the cold season.

SUGAR INDUSTRY

A study Group was also set up to classify the various weights, measures and weighing and measuring instruments used in the sugar industry, under the Chairmanship of Shri G. R. Athavale, Director, National Sugar Institute. Besides the Controllers of Weights and Measures and Directorate of Weights

and Measures, Ministry of International trade, sugar interests were also represented on this Committee. As in the case of the tea industry, a survey of the various weights, measures, and weighing and measuring instruments etc. used in the sugar industry was carried out prior to the meeting of the Study Group. On the basis of this survey, the Study Group made the following recommendations.

(a) Weighing Machines

The following categories of weighing machines are used in transactions for trade, and should, therefore, be verified and stamped by Inspectors of Weights and Measures every year :

(1) Weighing machines used for weighing cane purchased by factories from growers, co-operative societies or other agencies.

(2) Machines used for packing sugar in bags to a pre-determined weight (100 kg.)

(3) Machines for weighing mixed juice, in factories where juice is weighed.

(4) Machines used for weighing molasses or bagasse for sale.

(5) Machines for weighing spirits for sale.

(6) Machines used in Stores Department for the purchase of stores. Machines used exclusively for weighing stores for issue to various departments of the factories, not being machines used in transactions for trade, need not be subject to verification and stamping.

Inspectors and other officials of the Central Excise Department and the States' Sugarcane Departments also have powers to inspect, test and where necessary, adjust weighing machines used for weighing sugarcane. They would continue to exercise these powers, but would report to Inspectors of Weights and Meaures any major adjustments they may find necessary to make in these machines.

Officials of the Central Excise Department also have the power to inspect, verify and adjust machines used in packing sugar in bags. They would, however, report to Inspectors of Weights and Measures any major adiustments they may find necessary to make in these machines.

(b) Litre-Measures

All litre measures used in weighing spirits for sale in distilleries attached to sugar factories should be verified and stamped by Inspectors of Weights and Measures.

(c) Calibration of Vats and Tanks in Distilleries

The quantities of spirits in vats or storage tanks are assessed for the purpose of levy of excise duties by the use of dipsticks or dip tapes and calibration charts. The State Excise Departments would continue to be responsible for the preparation of calibration charts, but the dipsticks or tape used for estimating the depths of spirit in the tanks, should be offered for verification and inspection by Inspectors.

(d) Polariscope

Polariscopes are used in assessing the purity of sugar. The price of sugar exported to foreign countries is related to purity. A polariscope, where it is used for assessment of the purity of sugar for export, is an instrument used in a transaction for trade. No procedure has, however, been framed for the verification of polariscopes. The National Sugar Institute would suggest a method for the verification of polariscope.

(e) Permissible Error in the Net Weight of Sugar in Sealed Bags

According to the relevant Indian Standard, the maximum error permitted in the net weight of sugar in a standard bag of 100 kg is 0·1 percent. The Indian Sugar Mills Association has suggested that the limit should be raised to 0·25 percent. The study Group considered a permissible error of 0·1 percent sufficient for white sugar. Raw sugar is more liable to gain or lose weight due to moisture absorption or loss than white sugar. A more liberal allowance may, therefore, have to be made for raw sugar. The National Sugar Institute would collect data both in the laboratory and in the field on the gains or losses in the weight of raw sugar due to variations in humidity and other causes and recommend to the Study Group what would be the reasonable error to be permitted.

A survey of the weights, measures and weighing and measuring instruments used in the Iron and Steel Industry and the Textile Industry is now under way. The recommendations of this Study Group will be published as they become available.

Development of Length And Area Measures in South India—Part 3

L. RAJU and V. B. MAINKAR

Directorate of Weights & Measures,
Ministry of International Trade,
New Delhi.

IN Part 1 and Part 2 of the article, we have examined the ancient traditions of length and area measures in South India, as recorded in Sanskrit and other sources.

It was found that a well-knit, and perhaps unified, use pattern of length and area measures may have existed 5,000 years ago in the Indus Valley civilization. But our knowledge of it, based on only three incomplete pieces of length measures, was too meagre to arrive at any fruitful conclusions.

Examination of the Vedic traditions showed that although names of certain units of length did appear in the Vedas, it was not possible to establish any relation among these units.

It was only when we came to the *Arthasastra* that we could establish a coherent system of length and area measures. As two editions of *Arthasastra*, one differing somewhat from the other, are known to exist, the *Arthasastra* tables were examined using both the texts, the hasta of 28 angula being

taken as 50 cm as established in the articles on capacity measures. (1)

In the wake of the *Arthasastra* period, changes took place in the manner of dividing the 3 hasta measures of 28, 24 and 21 angula. Keeping the length of the principal hasta unchanged, *i.e.* 50 cm, the hasta measures were subdivided by two distinct methods. In the first method the commercial hasta was reduced to 24 parts from the original 28, the other units being adjusted proportionately. According to the second method all the three hasta units were divided into 24 'parts', these constituent 'parts' having proportionate dimensions. Evidence of the use of both these traditions was analysed and the Akbari length and area measures were shown to be related to the *Arthasastra* traditions as modified later.

Area measures based on the *Arthasastra* and other hasta measures were evaluated. The possible variations of these area measures with a view to explain certain traditions in South India were also examined.

It is now intended to analyse the traditional measures of length and area used in South India in the light of the examination carried out earlier.

Length Measures

The mathematical analysis presented so far is of a conjectural nature. We have now to find out whether we can get actual data which indicates the magnitudes of these length and area measures to substantiate the conclusions.

Actual samples of commercial length measures of the old type are now rarely available. There exist, however, records of many measurements carried out by the British in the last two centuries which are available for comparison. In examining these length measures, a certain amount of caution has to be exercised. Quite often units which had been influenced by the British system like the 36 inch yard, were also in use side by side with the traditional units. It is sometimes difficult to isolate cases where such influence is strong and where it is negligible. We have, therefore, to look for the more obvious influences and try to re-establish the original magnitudes of the units.

Another point needs to be stressed. Length measures used for commercial transactions wherein the length alone is to be measured may not necessarily be used for calculations involving areas of fields. This should be evident from the fact that exclusive or special length measures are prescribed for only area purposes even in the *Arthasastra*.

From studies which have been carried out by the 18th and 19th century British scholars and administrators one fact emerges clearly: the most common hasta unit (called moolam in Tamil and Malayalam, moora in Telugu, and mola in Kannada) had an average length of about 19·7 inches or 50·04 cm.

British Studies

Gover, (39) who carried out in 1865 remarkable studies of weights and measures in India, is of the opinion that the common 'hauth' all over India was 19·55 inches *i.e.* 49·91 cm.

Brown (40) (1899) states :

> Moolum (translated covid or cubit) used for cloth, from 18-21 inches (0·4572-0·5334 m). Average about 19¼" or 19⅜" *i.e.* 0·4953 or 0·4995 m. Subdivided into 24 unglums or finger-breadths.

The most important and comprehensive compilation of weights and measures used in the old Madras Presidency is found in the *Manual of the Administration of the Madras Presidency*, (41) published in 1885. It lists

the known weights and measures of all the districts in the Madras Presidency, with explanatory notes. While commenting on the length measures used in the Madras Presidency the following statement has been made :

The term (hasta, moolum mooda) is translated cubit but it invariably exceeds the 18 inch cubit of England. In this (Madras) Presidency it averages about 19·7 inches, varying from 19¼ to 20.

The *Manual* does not list the various length measures under each district as it considers it unnecessary 'to refer further to linear measures', after having made the above statement.

Balfour [25] also states that the commercial linear measure called mulum in Tamil and mora in Telugu averages 19¼ inches. He states :

It is always translated cubit, though invariably exceeding the English cubit of 18 inches by 1½ or 2 inches.

The Silberrad Report [42] (1913-14 Committee) says regarding length measures in Madras Presidency :

The British linear measure is used in most districts in the Presidency, but there are a few districts from which it has not been reported *e.g.* Anantpur, South Canara, Chingleput, Chittoor, Ramnad, Nilgiris and Trichinopoly. In these districts the table of length, 2 cubits or muras, mulams or muzams=1 yard or gaz, is used and a cubit is divided into 2 spans or janas. The cubit has generally been translated as 18 inches but it is 20 inches in Anantpur, 19 or 20 inches in rural tracts of Vizagapatam.

There is, therefore, a valid base for our assumption that the normal hath or its equivalent used generally in commercial transactions in South India was equal to about 50 cm. This is the same hasta that has been constantly used in India from the times of Kautilya and possibly even much earlier.

Certain scales were used as length measures in some trades *e.g.* carpenter's kol *i.e.* measuring rod or mason's kol—tutcha-kol, tutcha-mulam. These were based not on the hasta of 50 cm, but on the paurusha of *Arthasastra*, called bauham in South India. It may, however, be mentioned here that sometimes length measures used for area measuring, may also have been used as length measures for some specialized purposes.

There were in use other hasta units which go under various names. To facilitate reference, the recorded 'length' units in use in South India are collected in Table 1. These are based on various sources indicated under the column 'source'. Ancient equivalents for most of these, though indicated here will be discussed later on in this part and also in Part 4.

TABLE 1—COMMERCIAL LENGTH MEASURES USED IN SOUTH INDIA

Sl. No.	Name of measure	District where used	Length		Source	Ancient Equivalents
			Cm	inch		
(1)	Hath (other than 50 cm).	Bangalore	48·51	19·1	43, 44	48·79 cm
		Musalipatam	48·59	19·13	44	48·79 cm
(2)	Gaz,Gajam kol ..	Trichur	71·12	28	45	71·15 cm
		Tellicherry	72·14	28·4	43, 44	71·15 cm
		Palamkotta	75·95	29·9	44	76·2 cm
		Travancore	76·2	30	46	76·23 cm
		Palamkotta	82·96	32·66	44	83·86 cm
		Dharwar	83·18	32·75	43, 44	83·86 cm
		Madurai	83·82	33	25, 41	83·86 cm

Sl. No.	Name of measure	District where used	Length		Source	Ancient Equivalents
			Cm	inch		
(2)	Gaz, Gajam, kol	Tirunelveli	83·82	33	25, 41	83·86 cm
		Ramnad	83·82	33	42	83·86 cm
		Travancore	83·87	33·02	43	83·86 cm
		Tirucherapalli	83·87	33·02	25, 44	83·86 cm
		Thanjavur	85·09	33·50	25, 41	85·71 cm
		Tirucherapalli	86·54	34·07	44	85·71 cm
		Hyderabad	89·74	35·33	43, 44	—
		Palamkotta	92·08	36·25	44	91·46 cm
		Tirucherapalli	92·08	36·25	44	91·46 cm
		Palamkotta	92·58	36·45	43	91·46 cm
		Bangalore	97·03	38·2	44	97·58 cm
		Masulipatam	97·16	38·25	43, 44	97·58 cm
		Srirangapatam	98·04	38·5	43, 44	97·58 cm
		Bangalore	98·87	38·9	43	99·09 cm
(3)	Bauham	Salem	194·3	76·5	41	194·36 cm
		Coimbatore	194·3	76·5	41	194·36 cm
		Guntur	200·2	78·8	41	100×2 cm

It will be noted that most of the units presented above have a base in ancient tradition. Strangely enough, practically every unit in Table 1 is derived for land area measurement rather than for use as a length measure of commerce. That is why equivalent length measures are not easily available for comparison directly from length measures. This lends further weight to the conclusion that the usual hath of commerce had a length of 50 cm.

Angulam—Its Peculiarities

Another peculiarity should also be noted. Many of these gaz units were sub-divided into 24 parts. Each part was called an angulam. The angulam, therefore, acquired values which could not be explained in the normal manner as the breadth of the middle finger. The angulam examined in Part 2 had values ranging from 1·79 cm, to 2·08 cm. Some examples would clarify how the length of the angula increased beyond these limits :

The Travancore [46] table runs as follows :

1 angulam =1½ inches=3·175 cm
24 angulam =1 ko =30 inches=76·20 cm

The Trichur table [45] is on the following lines :

8 barley-corns=1 angulam=1-1/6 inches =2·96 cm

24 angulam (viral)=1 carpenter's cole=2½ feet =71·12 cm.

In Tanjore :[41]

1 angulam =1·4 inches=3·56 cm
24 angulam =gaz of 33·5 inches=85·09 cm

To explain away the Tanjore angula a novel method was devised. The angula was taken as the distance between the thumb joint and the tip of the nail. This angulam was then considered equal to 2 virulcaday or finger-tip-breadths [41] each of 1·78 cm, or the angula of *Arthasastra* ! But the word virulkaday itself was used interchangeably with angulam itself was used the 24th part of a normal hasta *i.e.* about 2 cm. We shall have many occasions to present varieties of angulam later on. It would appear that the word angulam was used more often to denote a sub-division of a main unit as we use the words half, quarter etc.

Even the definition of the hasta undergoes a change. In the *Arthasastra* the angula is

the breadth of the middle joint of the middle finger of a medium sized man. If we take 24 of these, they give the measure of 42·86 cm, as we have seen in Part 1. The 50 cm hasta was commonly used for commercial transactions. So the definition of the hasta also undergoes a change. In South India the hasta is taken as the length 'from the elbow joint to the tip of the finger of any *tall man* chosen as the standard. [41] Note that the change is from a 'medium sized' to a 'tall man'.

It will now be clear that there has been a continuous tradition of the use of the 50 cm hásta for ordinary length measurements in South India, dating from the Maurya period or even earlier.

Long Distances

We may also examine certain South Indian traditions for longer measures. The kos was taken as 2,000 danda, the danda being equal to 4 commercial hasta. The coss, therefore, works out at 4 km, the hasta being taken as 50 cm. [41] This corresponds with the krosa of *Lilavati*.

There was, however, another unit which was also commonly used. It was called nali-vali and is derived from *vali*, a road or way, and *nali*, which is equal to the 60th part of 24 hours or 24 minutes. The distance normally walked in 24 minutes is called nali-vali. This is a very vague unit of measuring distance and there can be large variations in its actual value. This distance is estimated to be about 1½ miles (2·4 km). The kadum is a more reliable unit and is usually taken as 10 miles or 16 km. Seven nali-vali were also supposed to make a kadum. The kadum is obviously equal to the yojana of 16 km recorded in the *Lilavati*. No other outstanding measures of distance have been noted in available literature.

Land Areas and Revenue

Having considered briefly how the length measures in South India were related to the ancient traditions of metrology in India, we can now examine how far area measures, particularly those used for measuring land areas, were related with ancient practices.

Before taking up the actual study, we may consider briefly how certain practices in the domain of land areas could have taken shape in the course of centuries.

Land revenue formed an extremely important source of revenue for ancient Governments. Great care was usually taken in assessing it.

The land was first classified, then it was actually measured and the areas recorded suitably. The tax was then assessed. The simplest mode of realising payment was usually in kind, though cash and kind or cash payment were also not uncommon. The amount of produce to be given to the Government depended on the grain sown, type of land use of facilities like irrigation, wells [11] etc. [Book 2, Ch. 24].

Quantity Area Relations

On realising the revenue in kind for a few years, it would be possible to make estimates of the crop yield at a suitable time during the crop season. The Government usually realised its portion of the produce on the basis of these estimates, and if necessary, by actual measurement. After paying in kind for a number of years, the piece of land would be associated with a certain quantity of a given grain and its area would be related with this quantity. This may be one of the sources for the practice of denoting the area of land according to some weight or measure *e.g.* a garce or khari of land would mean the area which would produce that much of a specified grain. Such an area unit is usually very

vague because the yield can vary depending upon the type of land, the efficiency of the farmer, the irrigation facilities used, the rainfall, floods, the quantity of seed sown and so on. Statements of area in terms of produce should not, therefore, be taken to indicate well-defined areas, unless they are supported and corroborated by traditional area measures.

There is a second and perhaps a more reliable quantity-area relation: the area sown with a specified quantity of grain. The approximation here would be nearer the truth as the variants are fewer. Examples from ancient literature are khanduga and putti in the Kannada region and tum in Telugu inscriptions[47]. Even in this case the units had a close relation with traditional area measures. The possible reason for relating area with quantity of seed sown could be that in wet or irrigated lands the yield would not be too dependent on external factors and a practicable ratio could be established among the quantity of seed sown, quantity produced and the revenue to be realized.

Vague Units

Even more vague units than the two types mentioned above are found in ancient literature. The hala or plough of land, often referred to in old Sanskrit and Prakrit charters of the Pallavas, is an example. It is taken to signifiy the area of land which could be conveniently cultivated with a plough and a pair of bulls in a given time[47]. This is estimated to be about 5 acres or 2 hectares [48].

Even the nivartana, which is otherwise well-defined in literature, is sometimes taken to indicate the extent of land bounded by a line travelled by a person starting from a particular point and coming back to it within a specified time[47]. These vague definitions merely indicate etymological meanings and are not to be taken literally.

Ancient Surveys

It is against this background of a mixture of vague and well-defined traditions that we have to examine the variety of land measures in South India. The initial step, *viz.* the actual measurement of land areas for revenue purposes was usually carried out in ancient times at suitable intervals and to great accuracy[49]. Inscriptions of the Vakataka period [49] (3—5 century) show that land was carefully surveyed with the measure prescribed by the State and the areas recorded.

The extreme accuracy of measurements is evident from an inscription on the walls of the Brihadeswara temple at Thanjavur which mentions that the land was measured to an accuracy of $\frac{1}{52,48,800,000}$ of a veli [47,50] (about 2.6780 hectares) for assessment. This fraction is nearly 0.5 mm². This astonishing and impossible looking survey was undertaken in 1002 AD in the reign of the Chola King, Rajarajadeva !

Later Chola kings like Kulottunga I (1086 AD) Vikrama (1134 AD), Kulottunga III (1216 AD) also appear to have carried out at least partial surveys of the lands in their kingdoms.

In the Karnataka areas also land surveys were carried out, as for example, in 1100 AD. Krishnadeva Raya of Vijayanagar (C. 1510 AD) is also credited with having carried out a land survey [47].

Variety of Ko

The areas were usually measured with a kol *i.e.* rod or pole of a specified length, which was not necessarily the same in all cases. For example, Rajarajadeva used three

different kol, the Ulagalanda kol, Sirrambala kol and Pangitta kol, each measuring 16 spans in length[47]. In the Chola period, rods of 12, 14, 16, 20 feet (steps) were in use. Besides these, other kol whose names alone but not lengths have come down to us, like the kalinjaik-kol, attu-kol, sri-padakol, maligai-kkol etc. were used. Krishnadeva Raya used a kol of 20 feet (steps) in length, though originally it was said to be 18 feet (Steps)[47]. Other Vijayanagar rods measured 12, 16, 24, 30, 32, 34, feet (steps) in length.[47]

The Kadambas used rods of 4, 12, and 16 spans. Rods of 13 spans, 18 spans, 36 steps, 48 steps were also used. Rods called bherunda kol ganga kol, kaccavi kol varisaik kol and a host of others are mentioned. The length of most of these rods is unknown as physical samples are usually not avaiable for examination. Only in a few temples have some marks been provided to indicate the length of the rods used. These are our main guides, and our further analysis is based on inscriptions. It is from this profusion of measuring rods that we have to trace out traditions. It is impossible to seek out the tradition behind each and every measure, but an attempt will be made to analyse the principal traditions.

Five Inscriptions

In order to understand the more important South Indian traditions in land area measures it is necessary to examine certain inscriptions. The more important of these from our point of view but apparently unconnected with each other are :

(1) An inscription of the Chalukya period (11-13th century) mentions that the mattar consisted of 76 kol[49] [SII, xi, (i), 88].

(2) A second inscription of the same period says that land was measured in terms of mattar and kamma, and apparently 900 kamma made one mattar. [SII, IX, (i), 165].

(3) A third inscription[49,51] says that the Kannada word mattar, was called martu in Telugu (plural marturu), and was identical with the nivartana.

(4) The fourth inscription, in which fortunately a *physical standard is also inscribed*, is reported[52] from the Reddy or Kakatiya kingdoms of the period 1325 AD to 1448 AD. In this kingdom it was a custom to sketch a a portion of the measuring rod on a pillar in the temple. A Sanskrit inscription at Moparru (Ep. Coll. No. 659 of 1920) defines the units as follows:

> Half the circumference of a thumb is an angula. Twelve angula make one vitasti and thirty-two vitasti one dandaka.

The Telugu passage states that the Kesaripati-gada is equivalent to the dandaka. The sketch of a jena *i.e.* vitasti drawn on one of the sides of a pillar in the Dandeswaraswami temple at Prattipadu temple (Ep. Coll., No. 145 of 1917) *measures exactly one and a half foot or eighteen inches with a footrule* (*i. e.* 45.72 *cm.*)

The inscription further states that 112.5 kunta, measured with this gada, make one kesaripati-tumu. Twenty kesaripati-tumu made one putti.

(5) An inscription of the 13th century from Nellore [52] district defines the nivartana (N.D., I.I. C.P., No. 17, V. 28. p. 147) as follows:

> Ten hasta make one danda; thirty danda make one nivartana; ten nivartana make a gocharma.

Paurusha of Arthasastra

The connection among all these inscriptions would be clear only if we assume that the paurusha or garhapatya dhanu of 108 angula mentioned in the *Arthasastra* is the basic length mesure used. This measure in turn is twice the hasta of 54 angula which was

prescribed for use in measuring areas of timber forests (*See* Part 1). This measure and its various multiples and sub-multiples formed the foundation of a large number of South Indian land measures as shown later.

The paurusha 1.9286 m. (*See* Part 1). We assume this to be the kol of inscription (1) above and further, for rough calculation that exactly 76 kol made the side of the mattar. Then :

$76 \times 1.9286 = 146.5736$ m should be the side of the mattar.

So mattar $= (146.57 \text{ m})^2 = 21482.76 \text{ m}^2$

Now according to inscription (2) :

900 kamma = mattar $= 21482.76 \text{ m}^2$

$\therefore$ kamma $= 21482.76 \text{ m}^2 = 923.8697 \text{ m}^2$

$\therefore$ The side of the kamma $= \sqrt{23.8697} \text{ m}^2$

$= 4{\cdot}88$ m

An important point ought to be noted. If we take 10 kamma *i.e.* 238.697 m^2, the side of 10 kamma $= \sqrt{238.697} = 15.4508$ m. This is an extremely interesting result. It is almost equal to $8 \times 1.9286 = 15.4288$ m. The difference between the two values is $15.4508 - 15.4288 = 2.2$ cm *i.e.* 1 : 700, which is negligible.

Important Units Derived

In the above analysis, we have assumed that there were exactly 76 kol in the mattar. The difference of 2.2 cm between two values derived from two sources, though negligible, ought to be taken into account if we wish to examine the traditions in the light of the units mentioned in the *Arthasastra*. So we revise the above units, replacing 15.4508 m by 15.4288 m. The following note worthy results are obtained :

10 kamma $= (15.4288 \text{ m})^2 = 238.0479 \text{ m}^2$

$\therefore$ kamma $= 23.80479 \text{ m}^2$

$\therefore$ side of kamma $= \sqrt{23.80479} = 4.879$ m

It should also be noted that the kamma is a thousandth part of the *Arthasastra* paridesa based on 54 angula (23804.8 m^2 of Table 5, Part 2 of this article).

Now, mattar = 900 kamma $= 23.80479 \times 900$

$= 21424.308 \text{ m}^2$

$\therefore$ 76 kol, which form the side of the square of the mattar $= \sqrt{21424.308} = 146.3704$ m.

The side of the mattar, therefore, would be 75.895 kol (146.3704 ÷ 1.9286) and not exactly 76 as assumed earlier. In the process of rounding off it easily became 76. Strangely enough, $(75.895)^2 = 5760$. This immediately reminds us of the *Arthasastra* nivartana of 57600 sq. hasta. We may assume that this unit of 5760 was derived from another unit, ten times higher (21.424308 hectare). We shall refer to this again while examining inscription (5).

We should carefully note the units just derived for the purpose of further analysis of South Indian traditions.

Kunta Tradition

Now let us examine inscription (4). Here the jena is 45.72 cm or 18 in as measured by the footrule. Minor corrections to this length may be necessary but we shall carry the analysis further before examining the correction required. Now, as measured :

Jena $= 45{\cdot}72$ cm

$\therefore$ 32 jena = Kesaripati-gada $= 45{\cdot}72 \times 32$

$= 14{\cdot}6304$ m

This gada is about 7 mm smaller than tenth part of the length of the so called 76 kol mattar calculated above *i.e.* 14.637 m. This introduces an error of 0.2 mm between the measured and the calculated values of the jena which is impossible to detect with a footrule on a stone pillar.

The equations of inscription (4) may now be worked out as follows taking the gada to be 14.637 m :

angula=3·8117 cm
12 angula =1 vitasti (jena)=45·74 cm
32 vitasti =1 kesaripati-gada=14·637 m
=(dandaka)
Kunta=(dandaka)²=214·24308 m².
112·5 kunta=1 Kesaripati-tumu=24102·35 m²
20 Kesaripati-tumu=1 putti=48·20469 ha.

(The jena of 42.72 cm can also be derived from the *kamsa* of 32 angula (57.14 cm) mentioned in the *Arthasastra*. In fact, the danda of 192 angula is defined as 6 *kamsa* in the *Arthasastra*. But South Indian traditions can be explained satisfactorily if we take it as 8 hasta *i.e.* 24×8=192 angula and treat other area units similarly. The kamsa does not seem to have much importance in South Indian area measures. We may have occasions to use it when examining area measures in the rest of India.

The jena of 45.72 cm could then be treated as the tenth part of 8 kamsa *i.e.* $\frac{57.1\times48}{10}$ = 45.71 cm as there is not much support in available literature for this derivation, it has not been used further in this article).

It should be made clear that though the above analysis is based on the *Arthasastra* units, the nivartana does not indicate the same unit as in *Arthasastra*. One hundred kunta above make the mattar *i.e.* nivartana. This tradition of the main and sub-unit being 100 times the other is seen to advantage in the measures called kani and ma, which occur in many old inscriptions.

Kani and Ma

According to the usual definitions, the kani, ma and veli are related as follows:

ma
16 jena =1 kol
1 sq. kol =1 kuli
100 kuli =ma
20 ma =veli
kani
32 jena =1 kol
1 sq. kol =1 kuli
100 kuli =1 kani
5 kani =1 veli

The words kol and kuli indicate different measures in this table. The veli has the same magnitude in both the cases.

The two kol measures were in use since ancient times but were again standardized at the end of the 18th century by Royaji, the Dewan of Muhammed Ali (Wallajah), Nawab of Karnatak[25,41]. Their lengths worked out to 12 ft (3.6576 m) and 24 ft (7.3152 m) respectively. The areas of ma, kani and veli then are 1337.8 m², 5351.2 m² and 2.67 hectares respectively (14,400 ft², 57,600 ft² and 6.6. acres). It should be obvious that the Kesaripati-gada and the length units are related as $1:\frac{1}{2}:\frac{1}{4}$. On the basis of the Kesaripati-gada, therefore, the values of the two kol would be:

$\frac{14\cdot63704}{2}=7\cdot31852$ m
$\frac{14\cdot63704}{4}=3\cdot65926$ m

The magnitudes of ma, kani and veli derived from these units would be:

ma =(3·65926)²×100=1339·019 m²
kani =(7·31852)²×100=5356·077 m²
veli =(5×kani) or (20×ma)=2·678038 ha

It may also be mentioned[53] that :
500 kuli=5 ma=kurukkam=6695·1 m²

It should be noted that the kani and ma are respectively equal to 1/10 of the *Arthasastra* nivartana based on the 54 angula hasta (*See* Table 5, Part 2 of this article). The kani is also equal to 25 kunta of 214.24 m. The veli is half of the nivartana. Further, both the kani and ma are also in agreement with those standardized from ancient traditions by Royaji.

Nivartana Transformed

After examining inscriptions (1) to (4), we may now find out how inscription (5) also falls into the pattern.

We noted earlier that the nivartana or mattar was equal to a square with a basic side of 75.895 kol, the kol being 1.9286 m garhapatya dhanu or paurusha of *Arthasastra* i.e. twice the hasta of 54 angula. The square of 75.895 is 5,760. If we can find a unit having 57,600 sq. units, this new nivartana would merely be one-tenth of it. The *Arthasastra* nivartana is 57,600 square units. Inscription (5) fulfils these requirements. We may evaluate the equations of inscription (5) directly, taking the nivartana as equal to mattar (21424.308 m²) and also by treating the gocharma in the tradition of the *Arthasastra nivartana.*

hasta =48·79 cm (19·21 in)
10 hasta =1 danda=4·879 m (16·01 ft).
30 danda =1 nivartana=146·3708 m
1 nivartana=(146·37 m)²=mattar=900 kamma
=21424·3 m²
1 gochma=10 nivartana=21·424303 hectares

Let us now divide the gocharma into 57,600 square units.

$\frac{214243.08\ m^2}{57,600}=3\cdot7194979\ m^2.$

Now (1.9286 m)²=3.7194979 m²

So the statements made in inscriptions (1) to (5) corroborate each other in every detail.

We must remember one important point. The *Arthasastra* traditions have been modified in inscription (5) in a peculiar manner, particularly the division of the danda into 10 hasta, instead of 8 as in *Arthasastra*. This results in a new hasta unit. The gocharma would be equal to the *Arthasastra* nivartana with the 108 angula paurusha as the unit. It is also 4 times the *Arthasastra* nivartana of 53561 m² or 5.5361 ha. (*See* Table 5, Part 2 of this article).

The word kani in Tamil is said to mean 1/80th part. A glance at the earlier calculations will show that the kani is 1/80th of the double gocharma i.e. 20 nivartana, (214243.08×2/80=5356.077 m²). The popularity of the number 20 for the final unit *viz* 20 ma=veli, 20 kudu=1 khanduga, 20 kesaripati tumu=1 putti, etc. is a peculiar feature of South India. It should not, therefore, be surprising if kani was taken as 1/80th of 20 nivartana (mattar).

Khanduga Tradition

The khanduga is a unit which is supposed to be the area of land that could be sown with a khanduga measure of seed. The unit thus appears to be very vague, but some estimates, which are said to be near the truth, have been made in the past. According to one of the most commonly used traditions[54] there were two different khanduga, one for dry land and one for wet land. The estimated areas of the various units are as follows:

Unit	Dry Land		Wet Land	
	yd²	m²	yd²	m²
payali or padi	200	167·225	31¼	26·129
2 padi =1 seer	400	334·451	62½	52·258
2 seer =1 balla	800	668·90	125	104·516
4 balla =1 kudu	3,200	2,675·6	500	418·064
20 kudu=1 khanduga	64,000	53,152	10,000	8,361·3

Each of these tables deserves detailed consideration. Examining the dry land units, we notice immediately that the khanduga is almost 1/4 of gocharma of 21.4243 hectares derived above and is consequently equal to 2250 kamma as kamma=23.80479 m^2. The difference between the estimate and this value is only 0.1 per cent.

The wet land area units have to be evaluated in terms of the square of the paurusha (garhapatya dhanu). The khanduga works out equal to 2250 such units. The difference between the estimated and the calculated values is less than 0.1 per cent. The khanduga, therefore is not just an estimated area but a definite and well-measured area unit. The following table summarises the above analysis:

Unit	Dry Land		No. of Kamma	Wet Land		No. of Square Paurusha
	Estimated m^2	Calculated m^2		Estimated m^2	Calculated m^2	
Payali or padi	167·2	167·4	7·031	26·13	26·15	7·031
2 padi =1 seer	334·5	334·8	14·062	52·26	53·30	14·062
2 seer =1 balla	668·9	669·5	28·125	104·5	104·6	28·125
4 balla =1 kudu	2,676	2,678	112·5	418·1	418·4	112·5
20 kudu =1 khanduga	53,512	53,561	2,250	8,361	8,369	2,250

The dry khanduga is also equal to the *Arthasastra* nivartana of 53561 m^2 based on the 54 angula hasta (*see* Table 5, Part 2 of this article) *i.e.* 57,600 square hasta. It is also ten times the kani derived earlier and 40 times the ma and twice the veli of 2·678 ha.

It will be noted that all the main units we have considered *viz* mattar, nivartana, kunta, kani, ma, khanduga have all a definite relation one with the other and with the nivartana and paridesa of *Arthasastra* shown in Table 5, Part 2 of the article.

We have so far discussed the more important ancient units based on the *Arthasastra* garhapatya dhanu, or paurusha of 108 angula (1.9286 m). A large number of other comparatively modern area units based on this length measure will be examined in Part 4.

Goru Tradition

We may now examine area units based on length measures other than the 108 angula of paurusha of *Arthasastra*. In some regions of South India, there were in use area measures based on the hasta of 19.7 in *i.e.* 50 cm. The tradition of the goru is historically interesting and occurs in many inscriptions in the Andhra Pradesh area. The general equation[47,55] with equivalents calculated on the basis of the 50 cm hasta is as follows :

32 hasta=1 rod=16 m

1 rod square=1 kunta=256 m^2

50 kunta=1 gurtu or goru=12,800 m^2=1·28 ha

8 gurto=1 kuchchala=1,02,400 m^2=10·24 ha.

This kuchchala is obviously 16 times the paridesa having a side of 80 metres (*see* Tables, Part 2). In Part 4, we shall have occasion to discuss many area units based on the 50 cm hasta.

Adi

There is another peculiar length unit which also enters into many ancient area measures. It is called the adi. The varieties of this adi and its peculiarities are so many that it does not lend itself easily to analysis. It is, however, examined in Part 4 in the light of modern data.

So far we have seen that most of the important area measures used in South India in ancient times had a definite relation with the *Arthasastra* units. This harmony becomes discordant later on because many tenuous liberties were taken with the ancient units. For example, in the Vijayanagar empire land was measured with a kol of 18 feet (adi) up to 1447 AD, but the kol was increased to 20 feet (adi) so as to mellow down the rigours of taxation[47]. If such a tradition survives it can only serve to confuse the land measures later on.

Having analysed some of the commonly used ancient land measures, we shall examine in Part 4, other important but comparatively later measures mentioned in British records of the 17th-19th centuries.

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News & Views

Coal Mines Rescue Rules Amended

Dated New Delhi, the 11th Jan., 1963

Notification

GSR/122 in exercise of the powers conferred by clauses (r) to (w) of section 58 of the Mines Act, 1952 (35 of 1952) the Central Government hereby makes the following rules further to amend the Coal Mines Rescue Rules, 1959, the same having been previously published as required by sub-section (1) of section 59 of the said Act, namely :—

(1) (i) These rules may be called the Coal Mines Rescue (Second Amendment) Rules, 1963.

(2) They shall come into force on the 1st March, 1963.

(2) In the Coal Mines Rescue Rules, 1959 (hereinafter referred to as the said rules), in sub-rule (1) rules 13, for the figure and words, '2 naya paise', the figure and words '1/3 naye paise' shall be substituted.

(3) For rule 16 of the said rules, the following rule shall be substituted, namely—

'Location and Maintenance of Rescue Stations

(1) The Committee shall establish and maintain rescue stations of such standards, in such numbers and located at such places as the Central Government may consider necessary for providing rescue facilities to the Coal Mines to which these rules apply.

(2) The Chief Inspector shall, in consultation with the Committee, notify the coal mines served by each rescue stations.'

(4) In the first proviso to rule 21 of the said rules, for the words, 'two miles', the words, 'three kilometres' shall be substituted.

(5) In schedule 1 to the said rules, in item (2) for the figures and word '120 feet', the figures and word, '36 metres' shall be substituted.

(6) In part 1 of Schedule V to the said rules, under sub-heading 'B Practices', in paragraph (c),

(i) in item (i) for the words, figures and notation 'a weight of 56 lb. to and from a height of six feet', the words and figures. 'a weight of 25 kilograms to and from a height of 1·8 metres' shall be substituted; (ii) in item (iii), for the words 'thirty feet' the words 'ten metres' shall be substituted; (iii) in item (vi), for the figures and notation '150 lb.', the figures and word '70 kilograms' shall be substituted.

[F. No. 1/17/62-MI/Am(4)]

R. C. SAKSENA,
Under Secretary to the Govt. of India.

(Published in Part II Section 3(i) of the Gazette of India dated 19-1-63).

Change-over in Sizes of Readymade Clothes

It is understood that the Clothing Manufacturers Association of India, Bombay, has informed all its members that from 1 Mar. 1964, new metric sizes would be adopted for designating the sizes of various clothes like Manilla shirts, pyjama suits, dressing gowns, trousers (waist), shirts etc.

In the case of shirt sizes, instead of collar sizes from 13½ to 17½ inches, the following centimetre sizes would be adopted :

34, 35, 36, 37, 38, 39, 40, 41, 42, 43, 44. This means that instead of selecting from nine shirt sizes which are now prevalent, customers could make their choice from 11 sizes. Manilla shirts, pyjama suits and dressing gowns are now sold in chest sizes ranging from 32 inches to 42 inches. The new metric sizes would be in centimetres : 80, 85, 90, 95, 100, 105, 110, 115. Here also from the old 7 sizes, after the change-over there would be 8 sizes for selection.

Trousers are normally sold in waist dimensions. The new centimetre sizes would be 70, 75, 80, 85, 90, 95, 100, 105. The old sizes were ranging from 28 to 42 inches by steps of 2 inches.

Until the new range of sizes is introduced, the garments will carry a hang-ticket, or some stamping arrangement will be made to indicate the existing inch sizes converted into approximate centimetres.

It is understood that the Association is also devising new metric sizes for many other readymade clothes.

The Association has apparently given considerable thought to the change-over and have now decided to adopt rational sizes in metric units, so that odd sizes in metric units are avoided.

International Committee on Weights & Measuers Meets

At the 52nd meeting of the International Committee of Weights and Measures, held in October 1963, in Paris, a number of important decisions were taken :

(1) It was decided that the 12th General Conference of Weights and Measures, originally scheduled to be held in 1966, should be convened in October 1964. Normally, the General Conference meets every 6 years. The 11th General Conference was held in October 1960. The interval has been reduced because the International Committee found that the 6 year period between Conferences was too long.

(2) At the 12th General Conference, a proposal to double the present budget would be put before the participating countries. Extra contributions would also be asked for to facilitate the equipping of a laboratory for standards for measuring ionizing radiations.

(3) If the increased budget is approved, the International Bureau would also undertake work on the improvement and extension of the temperature scale and the realization of the full potential afforded by the wavelength definition of the metre.

(4) The Committee is also studying the programme of precision measurements at very high radio frequencies. In the light of recent developments, the co-ordination of measurements at very high radio frequencies has become pressing.

(5) If the work now in progress matures, a proposal to define the second in terms of an atomic constant would be placed before the Conference for approval.

(6) The litre and the cubic decimetre are slightly different. This difference, which is of the order of 28 parts in a million, frequently causes difficulties in precision measurements

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The International Committee will recommend to the General Conference that the litre and the cubic decimetre should be identical in value and the old definition of the litre should be given up. The word litre, however, will be recognised as a special name for the cubic decimetre.

(7) Among the secondary standards of length approved by the Committee were four additional transitions in krypton 86, four transitions in mercury 198, and four in cadmium 114.

(8) The Committee has recognised the curie, (Ci.), as a special unit of activity equal to $3{\cdot}7\times10^{10}$ disintegrations per second.

(9) Roentgen, (R), has also been recognised as a special unit for radiation dose.

(10) An international journal *Metrologia* would be started under the editorial guidance of the International Committee. Formal announcements are expected shortly. The new journal will publish articles on research in the fields of precision measurements and the development of standards. Review articles in various branches of metrology will also be an important feature of the journal. The articles will be published in the language used by the author.

Standards News

(Indian standards which have a particular bearing on change-over to the metric system are indicated here. Copies would be available from the Indian Standards Institution, Manak Bhavan, 9, Bahadur Shah Zafar Marg, New Delhi or their Branch Offices at Bombay Calcutta, Madras and Kanpur.)

Cold Rolled Carbon Steel Sheets (IS : 513—1963)

The Indian Standards Institution has published the first revision of Indian Standard Specification for Cold Rolled Carbon Steel Sheets (IS : 513-1963), which covers the requirements for the following types of steel sheets :

O Ordinary, DD Deep drawing and D Drawing, EDD Extra deep drawing.

This standard was first issued in 1954 as Specification for Special Qualities of Steel Sheets. In view of the decision of the Government of India to change-over to metric system, the revision of this standard has become necessary. This standard covers the requirements for cold rolled carbon steel sheets up to 1·6 mm thickness required for panelling, enamelling, deep drawing and for general engineering purposes. Sheets conforming to this standard are of weldable quality and are suitable both for fusion and spot welding.

Price : Rs. 2.50

Hot Rolled Carbon Steel Sheet & Strip (IS:1079-1963)

The Indian Standards Institution has published the first revision of Indian Standard Specification for Hot Rolled Carbon Steel Sheet and Strip (IS : 1079-1963), which covers the requirements for five grades of hot rolled carbon steel sheet, strip and coiled strip intended for the manufacture of cold formed structural members and for other general engineering purposes. Sheet and strip shall have the following ranges of thicknesses and widths :

Thickness	Below 5 mm
Width :	
Sheet	600 mm and above
Strip	Below 600 mm

This standard was first issued in 1958 as Specification for Light Gauge Structural Quality Hot Rolled Carbon Steel Sheet and Strip. In view of the decision of the Government of India to change-over to metric system, the revision of this standard has become necessary. This standard covers the requirements for five grades of hot rolled carbon steel sheet, strip and coiled strip intended for the manufacture of cold formed structural members and for other general engineering purposes. The five grades are designated as 0-1079, St 34-1079, St 42-1079, St 50-1079 and St 52-1079 respectively. Grades St 34-1079, St 42-1079 and St 52-1079 (surface descaled) included in this standard are of weldable quality. For spot welding, only Grade St 34-1079 steel is recommended, as spot welding becomes increasingly difficult with carbon is excess of 0·15 per cent.

Price : Rs. 1·50

Steel Tubes for Structural Purposes (IS : 1161—1963)

The Indian Standards Institution has published the first revision of Indian Standard Specification for Steel Tubes for Structural Purposes (IS: 1161-1963), which covers the requirements for plain carbon steel tubes for structural purposes not exceeding 225 mm nominal bore of the following types :

HFW—Hot finished welded.

HFS—Hot finished seamless.

ERW—Electric resistance or induction butt welded.

This standard was first issued in 1958 and specified the requirements for plain carbon steel tubes for structural purposes and does not cover tubes required for pressure purposes. In this revision, certain additional tube sizes have been included, and all the clauses.

This specification is one of a series of Indian Standards for commercial metric weights and measures being prepared by the Indian Standards Institution.

Price. : Re. 1.00

Rectangular Tins (IS : 1406—1963)

The Indian Standards Institution has published the first revision of Indian Standard Specification for Rectangular Tins (IS : 1406-1963), which covers the requirements of 10-litre, 5-litre, 3-litre, 2-litre, 1 litre, 500-millilitre and 250-millilitre rectangular tins manufactured from tin plate, and normally used for packing liquids.

The rectangular range of tins is perhaps the most generally useful and familiar form of liquid containers in the market today. It is certainly one of the most popular among manufacturers, retailers and the public. The rectangular tins are used for packing burning oils, lubricating oils and solvents, insecticides and disinfectants, varnishes and paints, paint strippers, soldering fluids, brake fluids, liquid can cleaners, essential oils and numerous other products.

Till recently, it has been the common practice to market the products packed in these containers in gallons. It is considered that the adaptation of the metric sizes covered by this standard will be advantageous to the industry and that all packers and users will use this standard as a guide and select their range of sizes of tins accordingly.

This standard as originally issued in 1959 covered four sizes, namely, 5-litre, 1-litre, 500-ml and 250-ml only. Subsequently, there was need for introducing the 10-litre size largely used for gasoline and for sandalwood oil. The paint trade was also in the need of the 3-litre and 2-litre sizes. This revision provides for these additional sizes. In addition, requirements for the corner radius have also been introduced; and overall height and inside height requirements have been replaced by those for overseam height in line with the practice adopted in other Indian Standards on metal containers.

Price : Rs. 2·00

Large Metric Capacity Calibrating Measures (Non-Tilting Type) (IS : 2341—1963)

The Indian Standards Institution has published Indian Standard Specification for large Metric Capacity Calibrating Measures (Non-Tilting Type) (IS: 2341-1963), which covers the requirements of large metric capacity calibrating measures of the stationary and portable types intended for use in checking commercial bulk measures, vehicle tanks, bulk meters, etc.

Measures up to and including 20 litres are covered by IS: 1058-1962 Specification for Commercial Metric Capacity Measures (Revised). For calibrating bulk vehicle tanks, meters and large filling measures, it is necessary to have large capacity calibrating measures. It was realized that Controllers of Weights and Measures would require these measures, and that in the interests of uniformity, an Indian Standard was called for. It was felt that such a standard giving essential constructional features would also assist in the manufacture of measure of reliable quality.

Price : Rs. 2·00

Specification for Water Meters (Domestic Type) (*Revised*).

While the manufacture of domestic water meter has made considerable strides in the country, manufacture of bulk water meters is still in the initial stages of development, and most of the requirements are being met by imports. It is hoped that this standard will give useful guidance to the indigenous bulk water-meter industry, in making rapid development and also in making meters of satisfactory quality and adequate performance level.

Price : Rs. 4·00

Water Meters (Bulk Type) (IS : 2373—1963)

The Indian Standards Institution has published Indian Standard Specification for Water Meter (Bulk Type) (IS: 2373-1963), which covers inferential (horizontal flow) water meters including 'full-flow' type, ranging in size from 40 mm up to and including 300 mm and semi-positive meters ranging in size from 40 mm up to and including 100 mm, both types having flanged end connections. This standard applies to both wet and dry dial meters.

This standard covers the requirements for bulk water meters generally used in metering supplies to large consumers, such as industrial installation, block of flats or bungalows, drawing supply from a single main, and estates. Requirements for domestic water meters have already been covered by IS: 779-1961 relating to general requirements for the supply of material conforming to this standard have been deleted and a reference has been made to IS: 1387-1959 General Requirements for the Supply of Metals and Metal Products.

Price : Rs. 3·00

Licensed Manufacturers and Repairers

(*Metric Measure* had been publishing in the past a series of lists of licensed manufacturers, dealers and repairers of weights and measures, weighing and measuring instruments licensed by the Governments in the various States and Union Territories under their Weights and Measures (Enforcement) Acts. To economise on paper, it is possible only to publish lists of licensed manufacturers and repairers.

A feature on statistics of verification and licences issued is also being published in *Metric Measures*.)

STATISTICS OF VERIFICATION OF WEIGHTS ETC. AND LICENCES

States/Union Territories	Period	Weights	Capacity Measures	Length Measures	Weighing Instruments	Measuring Instruments	Others	Total number of Mfrs.	Dealers	Repairers As on 31st May, 1964
(1) Andhra Pradesh	1st Oct. '62 to 31 March '63.	2,00,101	64,362	6,408	21,747	527	26	14	59	24
(2) Assam	1st Apr. to 30 Nov. '63.	2,05,852	58,406	5,570	1,668	70		17	210	145
(3) Bihar	1 Apr. '62 to 31 Jan. '63.	1,28,211	—	—	19,309	56		30	203	43
(4) Gujarat	—	1,19,006	7,987	1,005	19,155	174	—	105	570	145
(5) Kerala	1 Apr. '62 to 31 July '62.	—	—	—	—	—	—	73	459	142
(6) Jammu & Kashmir	1st Oct. to 30 Nov. '63.	10,043	868	1,377	1,286	20	8	8	171	10
(7) Madhya Pradesh	—	—	—	—	—	—	—	—	—	—
(8) Madras	—	—	—	—	—	—	—	—	—	—
(9) Maharashtra	1 Apr. '62 to 31 Mar. '63.	18,74,286	5,37,135	33,988	—	—		—	—	—
(10) Mysore	1 Apr. '62 to 31 Nov. '62.	4,81,354	1,05,253	1,037	59,674	8,420		126	493	92
(11) Orissa	1 Apr. '62 to 31 Mar. '63.	4,23,597	86,060	3,089	1,596	2		8	103	6
(12) Punjab	1 Apr. '62 to 30 Sept. '63.	15,01,606	84,078	41,826	2,07,347	407	—	10	34	2

States/Union Territories	Period	Weights	Capacity Measures	Length Measures	Weighing Instruments	Measuring Instruments	Others	Total number of Mfrs.	Dealers As on May, 1964	Repairers As on 31st
(13) Rajasthan	N.A.	—	—	—	—	—	—	—	—	—
(14) Uttar Pradesh	1st June to 30 Nov. '62.	8,95,335	8,897	20,506	7,505	298	—	200	979	187
(15) West Bengal	Up to 23 Mar. '64.	46,09,820	65,000	15,007	2,57,173	—	—	116	684	80
(16) A and N Islands	N.A.	—	—	—	—	—	—	—	—	—
(17) Delhi	1st Oct. to 30 Nov. '63.	41,094	4,139	1,386	6,028	16	—	26	70	24
(18) Goa	1 Apr. to 31 May, '62.	18	3	—	—	—	—	—	—	—
(19) Himachal Pradesh	1 Apr. '62 to 31 July '63.	68,020	7,411	2,532	10,628	1	—	1	25	12
(20) L.M.A. Islands	1 Apr. '62 to Oct. '63.	—	—	—	—	—	—	—	—	—
(21) Manipur	1 Apr. '63 to 31 Dec. '63.	19,835	4,115	239	599	8	—	—	—	—
(22) Pondicherry	1st Apr. to 30 Nov. '63.	5,403	4,591	5	678	8	—	14	62	7
(23) Tripura	1 Apr. '62 to 30 July '62.	62,050	8,464	720	9	8	—	4	85	3

N.A.—Statistics not available as yet.

GUJARAT

Manufacturers and Repairers licensed during 1st October to 31st December, 1963.

MANUFACTURERS

Sl. No.	Name and Address of Manufacturers	Details of Articles Manufactured
(1)	Ambica Scale Manufacturing Works, Mangaldas Photographer's Chali, Behind Kasturbhai's Ghali Opp. Ashok Mill, Naroda Road, Ahmedabad.	Weigh-Bridges.
(2)	Luhar Bechar Narshi, Nadi Kantha, Savarkundla.	Beam Scales Class (C & D).
(3)	Luhar Jadav Jiva, Jamadar Pada, Savarkundla.	Beam Scales Class (C & D).

REPAIRERS

(1) Bhagwan Kakabhai, Savarkundla.
(2) Bhailal Gordhanbhai Panchal, Jambusar, District Broach.
(3) Chhaganlal Maganal, Oravad Sheri, Kalvad (Sitla).
(4) C. & G. Chokshi, Rajkot.
(5) Dinishing Scale Repairing Works, Salapose Road, Ahmedabad.
(6) National Scales and Weights Repairing Works, Danapith, Bhavnagar.
(7) Roshan Scale Repairing Works, Bhavnagar
(8) Veraval Lokhand Kam Karigar Sahakari Mandli Ltd., Veraval.

PONDICHERRY

List of manufacturers and repairers of weights, measures and instruments licensed during the period from 1-4-1963 to 31-11-1963.

MANUFACTURERS

Sl. No.	Name and Address of Manufacturers	Details of Articles Manufactured
(1)	Honesty Engineers & Contractors, 3, Bis, Surcouf St., Pondicherry.	Peg Measures and Beam Scales Class C & D.
(2)	Jayam Engineering Works, 258, West Boulvard, Pondicherry.	Weighing Instruments Class C & D.
(3)	M. Kannan, 9/63, Vazakulam, Pondicherry.	Cylindrical and Conical capacity measures, and metal length measures.
(4)	V. Latchumanan, North Boulvard, Pondicherry.	Cylindrical and Conical capacity measures, and metal length measures.
(5)	Raju Achari, 81, Barathi Street, Pondicherry.	Bullion Weights.
(6)	Swamy Foundry, 232, Bis West Boulvard, Pondicherry.	Cylindrical and Conical capacity measures, and metal length measures.
(7)	Tamilarasan Industries, 160, North Boulvard, Pondicherry.	Cylindrical and Conical capacity measures, and metal length measures.

REPAIRERS

(1) Avery & Co., of India (Private) Ltd., 16-17, Armenian Street, Madras-1.
(2) Honesty Engineers and Contractors, 3, Bis, Rue Brcouf, Pondicherry.
(3) T. Natesa Achari, 78, Mahatma Gandhi Road, Pondicherry.
(4) Thiagaraja Engineering Works, Market, Karaikal.

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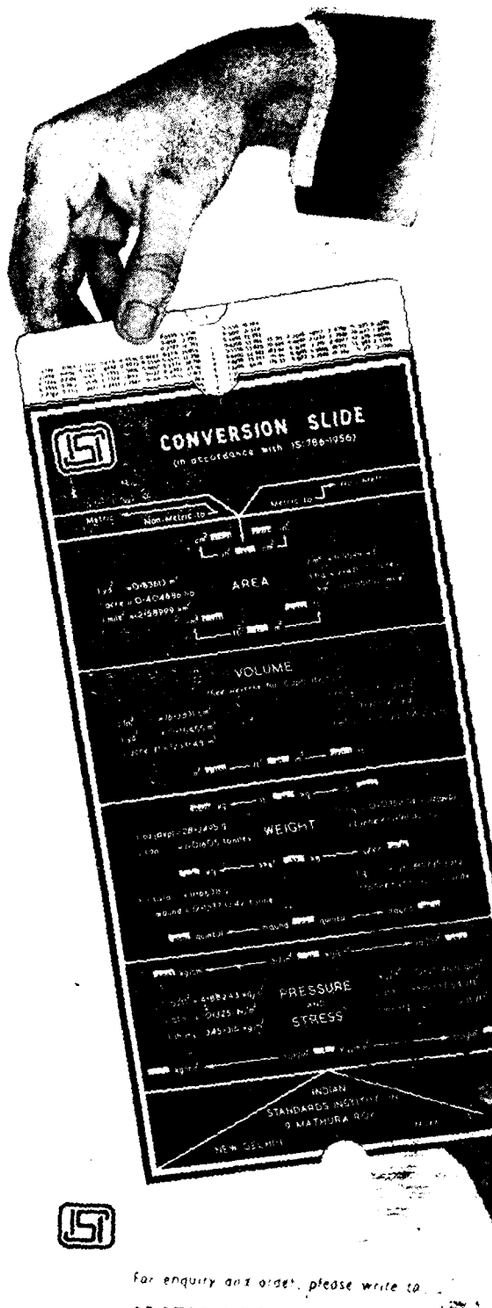

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TYPICAL METRIC PRICING UNITS FOR WHOLESALE TRANSACTIONS

Serial No.	Commodity	Metric Unit
		10 grams (g)
(1)	**Gold**	1 kilogram (kg)
(2)	**Grocery and Confectionery** Biscuits, sweetmeats, cardamoms.	
	Textiles and Textile Fibres Cotton yarn, damaged and seconds cloth, raw silk, rayon silk yarn, raw wool, wool manufactures (when sold by weight).	
	Paints & Chemicals Paint (if sold by weight), indigo, liquid chlorine.	
	Hides, Skins & Leather Raw hides, leather (hides and skins).	
	Metals Silver, aluminium sheets, strips and circles, copper and brass wires and utensils.	
	Miscellaneous Tea, meat, camphor tablets, mica.	
(3)	**Grains and Pulses** Rice, wheat, jowar, arhar, moong, masur, gram.	1 quintal (q) (100 kilograms)
	Spices Black pepper, mustard, chillies, dhania, dalchini, turmeric, betelnuts.	
	Plantation Products Rubber, cashewnuts, cashew kernels, tobacco (raw and manufactured).	
	Forest Products Lac and lac products, gums, myrobalans, galnuts, soapnuts.	
	Textiles & Textile Fibres Raw jute, raw hemp, coir yarn.	
	Oils, Oilseeds & Oilcakes Vegetable oil, oilseeds, oilcakes.	
	Non-Ferrous Metals *Aluminium :* ingots, bars, blocks, slabs, 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, circles. *Brass :* ingots, rods, sections, pipes, sheets, strips, circles. *Zinc :* ingots, sheets, strips. *Tin :* blocks.	
	Chemicals Caustic soda, bleaching powder, glycerine, soaps, paper salt.	
	Others Sugar, gur, ice, fish, sugarcane, vegetables, tamarind.	
(4)	**Minerals** Iron ore, manganese ore, bauxite, coal.	one metric tonne (t) (1,000 kilograms)
	Iron & Steel Pig iron, iron & steel manufactures, semis (billets for rerolling etc.)	
(5)	Cloth (mill, handloom, silk rayon and woollen cloth)	1 metre (m)
(6)	Jute carpets, coir mats and mattings, sheet glass.	one square metre (m^2)
(7)	Timber.	one cubic metre (m^3)
(8)	Paints (when sold by measure), spirits.	one litre (l)

Weights

(1) In place of the present units of seer, pound, rattal, viss etc., use the kilogram.

(2) In place of the tola, use the gram or 10 grams.

(3) In place of maund or corresponding unit, use the quintal *i. e.*, 100 kg.

Capacity Measures

In place of seer or gallon or any other measure, use the litre.

Length Measures

(1) Use the metre in place of yard or foot and the centimetre in place of inch.

Square Measures

(1) Use the square metre in place of square yard or square foot, and square centimetre in place of square inch.

Cubic Measures

(1) Use the cubic metre in place of cubic yard or cubic foot and cubic centimetre in place of cubic inch.

Packaging

It is advantageous if sizes of packages correspond to series of commercial weights and measures prescribed.

These are: 50 kg, 20 kg, 10 kg, 5 kg, 2 kg, 1 kg, 500 g, 200 g, 100 g, 50 g, 20 g, 10 g, 5 g, 2 g, 1 g, and so on.

TYPICAL PRICING UNITS FOR RETAIL TRADE

Serial No.	Commodity	Metric Unit for Use
(1)	Foodgrains, cereals, pulses, spices, ghee, bread, vegetables, meat, fish, sweetmeats, tea, coffee, sugar, salt.	1 kg
(2)	Oil for cooking	1 kg or 1 litre depending upon prevalent practice.
(3)	Fruits	1 kg or number depending upon prevalent practice.
(4)	Milk	1 litre
(5)	Cloth and related materials	1 metre
(6)	Prepackaged materials	Preferably sizes corresponding to series of commercial weights and measures.

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metric measures

THE PUBLICATIONS DIVISION

ABBREVIATION FOR METRIC UNITS

(1) DECIMAL MULTIPLES AND SUB-MULTIPLES

Prefix	Value in Terms of Unit	Abbreviation
Kilo ..	1,000	k
centi ..	0·01(10^{-2})	c
milli ..	0·001(10^{-3})	m
micro ..	0·000 001(10^{-6})	u

(2) WEIGHTS

Denomination	Value	Abbreviation
tonne ..	1,000 kg	t
quintal ..	100 kg	q
kilogram ..	1 kg	kg
gram ..	1 g	g
milligram ..	1 mg	mg
carat ..	200 mg	c

(3) CAPACITY

kilolitre ..	1 000 l	kl
litre ..	1 l	l
millilitre ..	1 ml	ml

(4) VOLUME

cubic metre ..	m^3	m^3 or cu m*
cubic centimetre ..	cm^3	cm^3 or cu cm*
cubic millimetre ..	mm^3	mm^3 or cu mm*

(5) LENGTH

kilometre ..	1 000 m	km
metre ..	1 m	m
centimetre ..	1 cm	cm
millimetre ..	1 mm	mm
micron ..	1/1 000 mm or 10^{-3} mm	um

(6) AREA

square kilometre	1 000 000 m^2	km^2 or sq km*
square metre	1 m2	m^2 or sq m*
square centimetre	1 cm^2	cm^2 or sq cm*
square millimetre	1 mm^2	mm^2 or sq mm*

(7) LAND MEASURE

are ..	100 m^2	a
hectare ..	100 a	ha
centiare ..	m^2	ca

*Both these abbreviations are current, but the first set should preferably be used. The former abbreviation is used more commonly internationally than the latter.

Rules for Abbreviations :

(1) Do not make any change, such as addition of 's' to indicate plurality *e.g.*, write 1 kg, 10 kg, 20 g, 5 g, 10 t, 20 ml, 271, 165 km, 2 mm, 100 cm^3, 66 km^2,

(2) Do not capitalize the abbreviations. For example, do not write 1 Kg, 2 Kg, 20 MM, 50 MM; the right way is to write 1 kg, 2 kg, 20 mm, 50 mm, etc.

(3) Do not use any other abbreviations except those given above.

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metric measures

(JOURNAL OF WEIGHTS AND MEASURES)

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Born 14 Nov. 1889

JAWAHARLAL NEHRU

Died 27 May 1964

JAWAHARLAL NEHRU

The passing away of India's beloved leader and Prime Minister, Jawaharlal Nehru, on 27, May 1964, has plunged the whole nation into the profoundest grief. A valiant fighter for the people of India all his life, Jawaharlal Nehru was the chief architect of modern India. His entire life was dedicated not only to the ideals of national freedom, unity and solidarity but equally to those of world peace and progress.

Born at Allahabad on 14 November 1889, Jawaharlal Nehru was the son of Pandit Motilal Nehru, an eminent lawyer and one of India's greatest patriots. At the age of 15 he went to England and after two years at Harrow, studied at Trinity College, Cambridge. He was later called to the Bar from the Inner Temple and he returned to India in 1912.

Destiny had not intended him to confine himself to the legal profession and he was drawn irresistibly towards the movement for India's freedom. His meeting with Mahatma Gandhi in 1916 was the coming together of two great souls and was to prove to be a landmark in Jawaharlal Nehru's life. In the same year he was married to Kamala Kaul who stood by him through all the joys and tribulations of his life until her early death in 1936, leaving behind her only child and daughter, Indira.

Fight for Freedom

After the epochal meeting with Mahatma Gandhi Jawaharlal Nehru and his whole family were plunged in the main stream of the freedom struggle. In 1918 he was elected Secretary of the Home Rule League, Allahabad, and became a member of the All India Congress Committee of which he remained a member for the rest of his life.

In 1929 he was elected President of the Lahore Session of the Indian National Congress. The national struggle entered a new and significant phase when, on the sacred banks of the Ravi, the Congress took the pledge of complete independence as its goal.

On the solemn midnight when India became free Jawaharlal Nehru declared "Long years ago we made a tryst with destiny, and now the time comes when we shall redeem our pledge, not wholly or in full measure but very substantially"....."To the people of India, whose representatives we are, we make an appeal to join us with faith and confidence in this great adventure. We have to build the noble mansion of a free India where all her children may dwell".

Apostle of Peace

Jawaharlal Nehru was dedicated to the ideals of the United Nations and the principles of the Charter. He addressed the Third General Assembly Session in Paris in 1948. His last appearance at the United Nations was in 1960. There he moved a significant resolution stressing the need for world peace and urging the leaders of the great powers to renew their contacts. He was the first Head of Government to support the partial test-ban pact signed by the three Nuclear Powers in August 1963.

He strove tirelessly against war and for total disarmament. He initiated and supported action for the liberation of dependent countries. He fought against the exploitation of man by man and worked ceaselessly to bring freedom from fear and hunger not only to his own people but to the world at large. He set his face against all political and military blocs as the greatest impediments to world peace.

Secular India

Jawaharlal Nehru was unremitting in his endeavour for the unity and solidarity of the Indian nation. He struggled ceaselessly to blend the different elements of our national life into an integrated social structure. He fought against all the barriers of caste, religion and language and for the uplift of the less privileged. He constantly affirmed the secular concept of our State as necessary for all sections of the people to live together in peace and harmony.

There could be no finer epitaph for Jawaharlal Nehru than that which he himself suggested in a pensive mood,—with characteristic humility—"If any people choose to think of me then, I should like them to say 'This was a man who with all his mind and heart loved India and the Indian people. And they, in turn, were indulgent to him and gave all their love most abundantly and extravagantly'."

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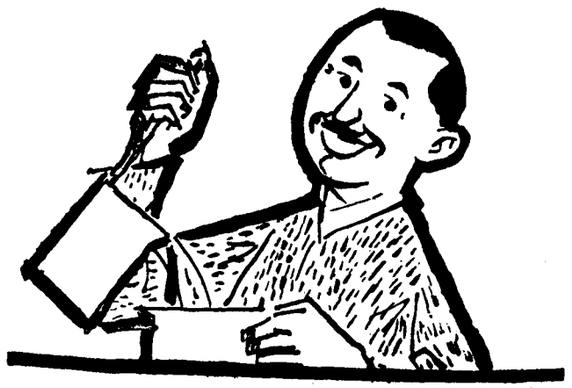

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Development of Length and Area Measures in South India—Part 4

L. RAJU & V. B. MAINKAR

Directorate of Weights and Measures, Ministry of Commerce, New Delhi

IN Parts 1, 2 and 3 we examined the various twists and turns in the traditions of length and area measures in South India in the light of the *Arthasastra* measures and their transformed relations in later periods.

Two More Inscriptions

Before proceeding to analyse the more modern variants of the ancient measures, it is intended to discuss two more inscriptions which are also apparently related with the kisku of 32 angula *i.e.* 57·14 cm. In Part 3, the 'jena' of inscription 4 was explained as being 8/10 or 4/5 of this kisku *i.e.* 57·14 ×4/5=45·71 cm. This was an alternative independent explanation of the jena.

The first inscription (659 of 1920) is referred to in Part 3 under the section ***Five Inscriptions***. The reference[56] further mentions that 'A vertical line is cut over the inscription to give the exact measurement, evidently of the vitasti. It measures a little over 1 foot and 3 inches'. Apparently the modern metrologist has not been very exact in measuring the length! Assuming that it is exactly 1 foot 3 inches *i.e.* 15 inches or 38·10 cm, it can easily be seen to be equal to 10 angula of 3·812 cm. Alternatively it could also be treated as 2/3 of the kisku of 32 angula mentioned in the *Arthasastra* *i.e.* 57.14×2/3=38·09 cm. This inscription could represent the basic unit used in the Trivandrum district which is described later. It should also be noted that like the 45·74 cm jena, this 38·10 cm jena is also divided into 12 angula, thus giving an angula of 3·175 cm.

The second inscription[57] belonging to the Chola dynasty occurs on the north of the mandapa in front of the Tirthapurisvara temple in the village Tiruvaduturai in Vriddachalam taluk of South Arcot district. It gives the length of the measuring rod Muvairavan-kol by two marks which are 'nearly 15 feet apart'. The measurement is rather vague, but if it is assumed to be 15 feet *i.e.* 4·572 m, it is clearly equal to 8 kisku of 32 angula *i.e.* 57·14×8=4·5712. Alternatively it is ten times the jena of 45.74 cm derived in Part 3.

There are many other inscriptions in which the vitasti has been sketched but the measurements are not recorded in the available literature. Even in the above two inscriptions, the measurements have been inaccurately recorded as 'a little over' or 'nearly'. We have approached the Archaeological authorities to arrange accurate measurements of these and other length

measures. We shall, therefore, discuss these further when the results are made available.

British Records

It is now intended to analyse, in the light of the discussions earlier, the comparatively modern land area measures mentioned in certain British records of the 17th—20th centuries. The most important source for this information is the *Manual of Administration of South India*,[41] published in 1885. It is supplemented by data derived from other sources like the *District Gazetteers*.

While commenting generally on the area measures in the old Madras Presidency, the *Manual* cautions that the measuring rod often varied in length but the term by which its square was known was the same. The terms kunta and kuli are the land measures next below the maximum of the place. Thus the putti of Rajahmundry, the kathi of Masulipatam, the kuchchala of Guntur, the gurtu of Nellore, the kani of Chingleput, the acre of Bellary and the ma of Thanjavur are all subdivided into kunta and kuli. These two units need not, therefore, be the same everywhere.

It should also be noted that the smaller unit may be taken 24, 32, 35, 40, 50, 56, 64 &100 or any suitable number of times to give the higher unit. So it is necessary to analyse in many cases both the smaller unit and its basic length measure as well as the final unit to discover their relation, if any, with old traditions.

In order to evaluate the area or length measures it is necessary to examine certain peculiar length measures. The adi or 'foot' is one such measure and the tutcha-kol or artificer's rod is another. The mura and the bauham also deserve attention because they are the very base of many South Indian area measures.

Adi Tradition

The kani, ma and many other area measures are sometimes based on a unique length measure called adi which exists in a large variety. Adi means the length of the foot, *i.e.* pada of *Arthasastra* ($\frac{1}{3}\times 42=14$ angula). So the adi could have a value of 25 cm (9·84 in.) .. .. .. (1)

According to South Indian tradition however, the adi is usually taken as $\frac{1}{3}$ of double hasta or a kol. The hasta and kol measures can vary as we have seen earlier. So depending upon the hasta measure or kol used, the adi acquires different values; alternatively it is 7/6 of the vitasti value. But what is worse, in course of time, it lost its traditional meaning and merely became a subdivision of another larger unit, the adi then varying in length from 23 cm to 29 cm. We shall have occasions to refer to such variants later on.

We may, however, examine the adi units that can be derived on the basis of ancient literature.

The *Arthasastra* defines the pada as 14 angula and the vitasti as 12 angula. As we have seen earlier in the South Indian tradition the kol or measuring rod was also divided into jena (vitasti) and angula, the proportion being 12 angula=jena, but the angula was variable and could be as large as 3·812 cm. To obtain the magnitude of the adi, let us take the kol of 7·31852 m and divide into 32 jena. The resultant jena is 22·87 cm. Assuming that the relation between the pada (adi) and vitasti (jena) is the same as in *Arthasastra viz.* 14/12, we have:

$$\text{adi}=\frac{22\cdot87\times 14}{12}=26\cdot68\text{cm}\quad(10\cdot50\text{ in})\cdots(2)$$

A third adi can be derived from the 108 angula paurusha as follows: The bauham

in South Indian tradition is equal to the distance between the outstretched arms of a man. This is normally equal to the paurusha of 108 angula of *Arthasastra*. The South Indian tradition sometimes requires that it be divided into 4 parts called mulam, which is not necessarily equal to the mulam of commerce. This mulam is again divided into 24 angula, 12 of which form a jena or vitasti. If we take the *Arthasastra* pattern 14 angula should make an adi. Thus the adi would have a length of 28·1254 cm, as derived below:

bauham=1·9286 m (75·93 in)

$\therefore \frac{1}{4}$bauham=48·215 cm (24 angula) (18·98 in)

$\therefore \frac{1}{8}$ bauham or vitasti=24·1075 cm (12 angula) (9·491 in)

$$\text{So adi}=\frac{24\cdot1075\times 14}{12}=28\cdot1254\text{ cm}\ (11\cdot073\text{ in})\ \ldots\ \ldots(3)$$

A fourth adi can be derived in a similar manner from the hasta measure of 48·79 cm calculated in Part 3 while examining inscription (5), assuming the hasta to be divided into 24 angula.

$$\therefore\ \text{adi}=\frac{14\times 48\cdot79}{24}=28.46\ (11.21\text{ in})\ \ldots(4)$$

A fifth adi based on the tutcha-kol examined later, has a value of:

$83.86\times\frac{1}{3}=27\cdot95$ cm (11.00 in) .. ..(5)

This is sufficient indication of the immense variety of adi that can be derived from ancient traditions. The number of adi which are merely a subdivision of a larger unit are discussed later on.

The ancient adi measures, therefore, cannot be evaluated unless we have more knowledge about their lengths or the area units derived from them. An example or two will indicate the difficulties in the way of an adequate analysis.

In the Pudukottai region[53] kol of 9, 12, 16, 18, 22 and 24 'country feet' or adi were in vogue from the 12th to the 19th century. Further, an inscription[53] mentions that 522 kuli measured with the kol of 18 'feet' or adi gave a ma. Two other inscriptions mention a ma of 256 kuli measured by the kol of 16 'feet' or adi. Unless we know something about the length of the kol or at least the approximate value of the ma it is not possible to assign a value either to the adi or the ma.

Tutcha-kol

An extremely peculiar unit of length is what is called tutcha-kol (artificer's rod) in Madurai and Tirunelveli and tutcha-mulam (artificer's cubit) in Tirucherapalli. Its value can be derived by correlating the following statements:

(1) The tutcha-kol is about 33 in (83·82 cm) and according to inscriptions represents the length between two marks on a temple.[41]

(2) It is also equal to 44'finger breadths'[41]

(3) The angulam is considered to be equa to 2 virulcaday or finger-breadths [25,41]

In Part 3, it was noted that the jena found in certain inscriptions measured 45·74 cm and was supposed to be divided into 12 angulam, each measuring 3·81 cm. From statements (2) and (3) we may assume that the tutcha-kol is 22 of these angulam.

Let us assume that the above jena of 12 angulam is the basic length measure, then 22 angulam$=\frac{45\cdot74\times 22}{12}=83\cdot86$ cm. This should be taken as the original length of the tutcha-kol.

Then 32 jena (14·63704 m) contain 17·454 tutcha-kol. Why such an odd

measuring rod was devised by the ancients is not clear. Perhaps it represented half the average height of man. It should also be noted that the calculated value and the measured values differ by 0·4 mm, (83·86—83·82), a difference which is almost imperceptible when lengths are measured on stone.

It may also be mentioned that the tutcha-kol was also divided into 3 adi, each adi being thus $\frac{83\cdot86}{3}$=27·95 cm (11·00 in), as shown earlier.

In Part 3, another derivation for the jena of 12 angulam was given which was related with the kisku of 32 angula laid down in the *Arthasastra*. In essence it worked out to be 4/5 of the kisku *i.e.* 57·14×4/5=45·71 cm. If the tutcha-kol is worked out on this basis it works out to be $\frac{45\cdot71\times22}{12}$ =83·80 cm. This is 0·6 mm smaller than the value derived above. The difference is negligible.

Mura-Mulam

Another important unit which occurs again and again is the cubit, called mura, mora, moolam etc. It is often between 19·5—19·8 in (49·53—50·30 cm) though it can be less or more. We shall discuss the variations later on.

Bauham

The bauham is a very peculiar unit and has many values. By definition it would appear to be related to the paurusha of 108 angula (1·9286 m). But there are other bauham which have different values. Some of them could be satisfactorily explained on the basis of the angulam of 3·812 cm derived in Part 3. It will be shown later on that the angulam played a very important role in South Indian area measures. We have, therefore, taken the angulam basis for explaining the length of the bauham. Normally, the bauham varied between 1·9 m to 2·5 m.

We may now examine the various area measures district by district.

MADRAS STATE

Arcot, North

In North Arcot, the kani was the most generally used measure. It was equal to the kani of 5356 m² derived in Part 3.

In some of the taluks, area measures other than the kani were in use. Of these, 4 types of goru are important from our point of view mainly because the lengths of the basic 'ropes' by which the measurements were carried out were *actually measured and recorded*. The unit immediately below the goru was called kunta and varying number of kunta went into the goru.

Another peculiar factor should also be noted. The 'rope' is divided into 'country feet' which we shall call adi. Two sets of values are recorded below, one of which is tabulated from the data in the *Manual* [41] and the other is derived on the basis of ancient traditions and suitably rounded off. The reasoning for the second set is explained later.

			As given	As Calculated
(1)	84 adi	=1 rope	79·25 ft	=24·155 m	24·108 m
	square rope	=1 kunta		= 583·5 m²	581·2 m²
	35 kunta	=1 goru	5 acres	= 20421 m²	20341 m²
(2)	72 adi	=1 rope	66 ft	= 20·117 m	20·124 m
	sq. rope	=1 kunta		= 404·7 m²	405·6 m²
	40 kunta	=1 goru	4 acres	= 16188 m²	16199 m²

				As Given	As Calculated
(3)	64 adi	=1 rope	60·25 ft	=18·364 m	18·296 m
	sq. rope	=1 kunta		=337·2 m²	334·8 m²
	56 kunta	=1 goru	4.66 acres	=18885 m²	18746 m²
(4)	48 adi	=1 rope	42 ft	= 12·802 m	12·806 m
	sq. rope	=1 kunta		=163·9 m²	164·0 m²
	25 kunta	=1 goru	1·01 acres	=4097 m²	4100 m²

The 'ropes' present an interesting study. If we work out the values of the adi in the four cases, they work out to be 28·76 cm, 27·94 cm, 28·69 cm and 26·67 cm. Of these we can find parallels for only two, *viz.* 27·95 cm and 26·68 cm derived earlier. The adi in the other two cases has apparently no traditional equivalent and has to be treated merely as a subdivision of the rope into 84 or 64 parts for convenience, the subdivision being called an adi because it had a dimension of the order of an adi. The equivalents for (2) and (4) have, therefore, been worked out from old traditions (adi= 27·95 cm and 26·68 cm) and the difference between the actual and calculated values is less than 7 mm and 4 mm in the two cases, *i.e.* 1 in 3000 which is negligible. We may also note that the goru of (2) is about 2 times the nivartana based on 75 cm kishku (*see* Table 5, Part 2), the difference being 16200—16199=1 m², which is negligible.

Let us now examine the 'rope' of equation (1). An equivalent for it can be obtained only if we take 25 *Arthasastra* hasta of 54 angula *i.e.* 96·43 cm=24·108 m. This length was perhaps subdivided into 84 parts for convenience. While examining the equivalence of the calculated value against the actual length, we should note that a rope of 158·25 ft. was also used in Madura (*see later*). The 79·25 ft. rope should obviously be half of the Madura rope. It is, however, slightly larger *i.e.* by 1¼ in. We should then reduce the rope in (1) to 79·125 ft. (24·117 m). The difference between this value and the calculated value is 24·117—24·108=9 mm or about 1 in 2500 which is negligible.

The remaining rope of 60·25 ft. is peculiar. If we, however, assume that the actual measurement was made to the nearest ¼ ft., then it could be equated to 5 times the kol used for evaluating the ma in Part 3 *i.e.* 3·65926×5=18·296 m. The difference between the measured and actual values is 18·364=18·296=70 mm, *i.e.* 1 in 250. Even this difference is not substantial as the actual measurement may have been carried out correct to the nearest ¼ ft. At the moment, this explanation seems to be the most satisfactory.

The goru contains 35, 40, 56 and 25 kunta, and the kunta itself varies. So it is not likely that except for value (2) explained earlier, any relation can be established between these area units and the standardized ancient ones. The main point is that the basic 'rope' has in every case a very close relation with old traditions.

These area measures have been examined in detail because the 'ropes' were actually measured and their lengths recorded. This fact will be of value in later analysis.

The *Manual*[41] also records that kunta based on 'ropes' of 56 and 60 adi were also known. But as no indication of the length of the adi or the area of kunta is given it is not possible to assign any value to these two 'ropes'.

Arcot, South

In South Arcot, as in North Arcot, the standard kani of 5356 m² was in general use. Ancient Sanads are said to mention a kol of 72 feet, but it is not known whether the kani was 100 kuli. The 72 'feet' or adi, are reminiscent of the rope of 72 adi discussed under Arcot, North.

Chingleput

In Chingleput district the kani of 5356 m² was used, as in South and North Arcot. There was, however, a peculiar variation. The kol of 7·31852 m did not consist of 32 'jena' but of 28 adi. The possibility is that the kol was divided into 28 portions, and each called adi, to suit perhaps some ratio with 6·364 m if we take the kani as 4050 m² and the adi would be 26·52 cm. But out of what is called 'charity' the kol was made equal to 26 adi and resulting customary kani became 5708 yd² or 4772·6 m².

The 'mani' or ground, equal to 24th part of the kani, was also used.

Coimbatore

The traditional kani of 5356 m² was in general use for irrigated land. There were, however, in use certain specialized units *e.g.* balla for unirrigated land. The equation for it was also follows :[58]

			As Given	As Calculated
1 bauham		6 ft. 4½ *in*	1·943 m	1·944 m
16 bauham	=1 rope	102 ft.	31·090 m	31·098 m
4 ropes	=1 sangili	408 ft	124·36 m	124·39 m
1 sq. chain	=1 balla	3·82 acre	15459 m²	15464 m²

The bauham of 1·943 m is possibly based on the angula of 3·812 cm derived in Part 3. The derivation is as follows: 3·812×51= 1·94412 m=1·944 m. The reason for taking 51 angula is not clear but such peculiarities of derivation are common and will occur later on also.

coinage or for some other convenience, as we saw earlier under Arcot, North in the case of the 84 adi kunta. The adi in this case, however, works out to be $\frac{7{\cdot}31852}{28}$ = 26·14 cm, which does not appear to have an equivalent in old tradition.

The peculiarity of the adi is not restricted to only one. There was in existence another adi leading to the following equation:

24 adi=kol

1 sq kol=kuli

100 kuli=1 kani=43778 ft² or 4067 m²

This unit is perhaps equal to ½×8100 =4050 m² (*see* 8100 m² nivartana, Table 5 Part 2).

Here the adi acquires a value of 26·56 cm and the kol 6·374 m. The kol would be

This balla was also used in Salem district.

The ma was also taken as equal to 240 kuli or 2·4 kani *i.e.* 12855 m², as the kani is 5356·077 m² as derived in Part 3.

The sei or chei was half of the above ma *i.e.* 120 kuli or 1.2 kani=6427 m².

Madura

The district of Madura provides a large variety of area measures based on different units, although the kani of 5356 m² was generally in use. Other varieties are discussed below.

According to early accounts a kuli c kunta, a square with each side of 158·25 f

·235 m) was used in certain regions. is gives a kunta or kuli or 2781 yd² or 25·3 m². The basic side was made 160 by the British Government. The kol 48·235 m is just the double of the 84 adi ›pe', we examined under Arcot, North. ı the same assumption, it should be 96·43 ı× 50=48·215 m. The difference between e two is 48·235—48·215=20 mm or in 2400 which is negligible. The real ınta based on the traditional length of ·215 m, is then 2324·7 m².

A kol of 21 ft. (6·401 m) was also in use, ving a kani of 44100 ft² or 4097 m² . This

There were two varieties of chey as shown below.

The chey in (1) can also be looked upon as the square of 124 tutcha-kol (7¾×16). It is difficult to explain why 124 tutcha-kol made the basic length.

The second chey is even more peculiar.

The adi in (2) works out to be 23·88 cm, which does not seem to have any basis in ancient tradition. The basic length measure for chey, however, could be looked upon as 100 tutcha-kol (83·86 m).

(1)		As Given	As Calculated
tutcha-kol		33 in	83·82 cm	83·86 cm
7¾ tutcha-kol	=1 kol	21-5/16 ft.	6·496 m	6·499 m
kuli	=(kol)²	—	42·20 m²	42·24 m²
256 kuli	=1 chey	2·6695 acre	10803 m²	10813 m²

(2)		As Given		As Calculated I	As Calculated II
22 adi	=1 kol	17·25 ft.	5·258 m	5·24 m	5·259 m
(kol)²	=1 kuli	—	27·65 m²	27·46 m²	27·66 m²
256 kuli	=1 chey	1·7488 acres	7078 m²	7032·5 m²	7081 m²
16 kol	=	276 ft.	84·128 m	83·86 m	84·147 m

ol is ½ of the rope of 12·806 m analysed ınder Arcot, North, and could be reated as equal to 24 adi, the kani then ›eing 4100 m², being equal to the North Arcot goru.

There were in use in certain regions units :alled chey for denoting areas of irrigated ands, the kurukkam for unirrigated ands and the garden kunta for garden ands.

Another way of looking at the kol is that it is equal to 138 angulam *i.e.* 138×3·811= 5·259 m. The 138 angula are equal to 23 vitasti or jena (jena=6 angulam). The value of 16 kol is then 84·147 m and chey is 7081 m².

There were in use the following 4 types of kurukkam:

			As Given		As Calculated
(1)					
72 tutcha-kol	=1 chain	198 ft	60·350 m		60·379 m
1 sq. chain	=1 kurukkam	0·9 acres	3642·1 m²		3646 m²
(2)					
210 tutcha-kol	=1 chain	577½ ft	176·022 m		176·106 m
1 sq. chain	=1 kurukkam	7·656 acres	30984 m²		31013 m²

			As Given	As Calculated
(3)				
24 bauham	=189 adi=1 chain	156 ft.	47·549 m	47·561 m
1 sq. chain	=1 kurukkam	0·559 acre	2260·9 m²	2262·0 m²
(4)				
32 bauham	=1 chain	208 ft.	63·398 m	63·415 m
1 sq. chain	=1 kurukkam	0·993 acre	4019·3 m²	4021·5 m

The first two kurukkam are based on the *tutcha-kol*, and the extent of variation is dependent upon the difference in the two values of the *tutcha-kol* as given and as calculated *i.e.* 83·82 cm and 83·86 cm.

The third and fourth values require some explanation.

For Irrigated Gardens

			As Given	As Calculated
(1)	rod (kol)	14¼ ft.	4·953 m	4·953 m
	kunta	264·6 ft²	24·53 m²	24·53 m²
(2)	rod (kol)	7-1/16 ft.	2·153 m	2·143 m
	kunta	51·36 ft²	4·635 m²	4·592 m²
(3)	rod (kol) =21 adi	16-1/6 ft.	4·896 m	4·899 m
	kunta	258·3 ft²	23·97 m²	24·00 m²
(4)	rod (kol) =8 adi	6¼ ft.	1·905 m	1·905 m
	kunta	—	3·629 m²	3·629 m²

The bauham in (3) and (4) works out to be 6¼ft. or 6 ft. 6 in (1·9812 m). This is equal to 52 angulam *i.e.* 3·812×52=1·98224 m= 1·982 m. This bauham is one angulam longer than the Coimbatore bauham discussed earlier. The reason for such minor differences is not available in literature. The values are calculated for (3) and (4) on the basis of this bauham. Was the Kurukkam in (4) intended to be equal to half-nivartana *i.e.* $\frac{8100}{2}$=4050 m² (*see* Table 5, Part 2) ?

The adi is peculiar. The 24 bauham are divided into 189 adi, thus giving an adi of 47·561/189=25·16 cm. Had the *Arthasastra* relation been valid here, there would have been 192 adi. It is not clear why the chain was divided into 189 adi, unless it was to suit some land revenue practice or to have a convenient relation with coinage.

There were four garden kunta, also called kuli as, shown below:

It is also stated that there were 7 lengths of rod used *viz.* 21, 18, 16, 11, 10, 9 and 8 adi. The length of adi is not mentioned in every case.

Let us, however, analyse the four garden kunta, taking (3) and (4) first. The adi in these two cases is 23·31 cm and 23·81 cm respectively. These adi measures have no apparent basis in tradition. The kol of (3), however, appears to be related to the 64 adi rope of North Arcot and is equal to $\frac{3\cdot65926\times4}{3}$=4·899 m *i.e.* it is 1½ of the kol we derived for the ma measure in Part 3.

Now let us take kol in (4). We saw in Part 3 that the angulam was 3·811 cm. The 1·905 m kol is then 50 of these angulam.

The kol in (2) would appear to be 1/4 ×(42·86 × 5)=2·143 m. This hasta (42·86 cm) is the Prajapatya hasta of *Arthasastra*. The difference between the values is 2·153—2·143=10 mm, which would have been introduced as the measurements given here appear to be correct to 1/16 of a foot (20 mm) and also because there is already a divergence between the measures given in the *Manual* and those derived from ancient literature, supported by tradition.

Another possible explanation of the kol in (2) is that it is 113 viral-kadai or 56-1/2 angulam *i.e.* 3·811 ×56·5=2·153 m which is exactly equal to the given value. Why 56·5 angulam should be chosen as a unit is not very clear.

The kol in (1) is exactly 2·6 times the kol in (4) *i.e.* 1·905 × 2·6=4·953 m *i.e.* it is equal to 130 angulam of 3·811 cm. Why such an odd relation was necessary is not clear.

Salem

In Salem district all the taluks except 5 were subjected to field measurements by *local rods* early in the 19th century, and the results entered in terms of local area measures. In the remaining five taluks measurements were carried out with a 33 ft chain and results entered in acres and kunta (40 kunta=1 acre) as in Bellary and Cuddappah. We shall examine here only those area measures which were measured with the local rods. The measures were divided into two groups—those used for unirrigated land and those for irrigated land.

For Unirrigated Land

The fathom *i.e.* bauham used was 8 ft and the table is as follows:—

	As Given		As Calculated
bauham	8 ft	2·438 m	2·439 m
24 bauham=kol	192 ft	58·522 m	58·548 m
(kol)² =kunta	0·846 acres	3424·8 m²	3427·9 m²

The bauham of 2·438 m is peculiar. It reminds us of the basic kol for kamma derived in Part 3 *i.e.* 4·879 m. The bauham is ½ of this *i.e.* $\frac{4\cdot879}{2}$=2 439 m. The difference of 1 mm between the given and calculated values is negligible. The kunta is then equal to 144 kamma.

In other taluks, however, the bauham was usually taken as 6 ft 4 ½ in (1·9431m). On the basis of the Coimbatore tradition this bauham should be 1·944m. The following kunta based on this bauham were in use.

Kunta	As Given	As Calculated
(36 bauham)²	(229·5 ft 69·951 m)² =1·209 acres 4897 m²	(36× 1·944=69·984 m)² =4898 m²
(64 bauham)²	(408 ft or 124·358 m² =3·82 acres 15459 m²	(64×1·944=124·416 m)² =15479 m²
(96 bauham)²	(612 ft or 186·538 m)² =8·6 acres 34803 m²	(96 ×1·944=186·624m)² =34829 m²

A chain of 36 ft. (10·973 m) was also in use. This will be explained later under Tirunelveli district.

For Irrigated Land

A chain of 32 ft (9·754 m) was in use as the base for the kunta. This is obviously twice the besic length for the kamma *i.e.* 4·879×2 =9·758 m. a difference of 4 mm in about 10 m *i.e.* 1 in 2500, which is negligible. The kunta is then equal to 4 kamma, or 95·2 m².

In one taluk, a kunta based on a 32-adi kol or 29 ft (8·839 m) was in use, the adi being 27·62 cm. This adi is also non-traditional. Another kol used was based on 24 adi and measured 21·7435 ft (6·627m) the adi being 27·61 cm as derived above.

These two kol have to be looked upon as based on the angula of 3·811 cm. The first is 232×3·811=8·842 m. and the 24 adi-kol is 174×3·811=6·631 m. The ratio of 232 to 174 is 4:3 the same as 32:24 adi.

A third kol measured 9 bauham, or 17·496 m, the kunta being 306·1 m².

Thanjavur

The ma of 1339 m² and veli of 26780 m² was generally in use.

Tirunelveli

The tutcha-kol again figures prominently in the area measures used in this district. Unirrigated land was measured in sangili or chains, and irrigated land in vitheicottay or seed-cottay.

The most fantastic ratios were taken to represent the basic kol. The following is an example:

16 adi=4-60/64 inches (4·140 m) tutcha-kol=162-60/64

If we take the true tutcha-kol to be 83·86 cm, the 16 adi work out to be 4·141m, the adi being 25·88 cm, which has no basis in old tradition except the tenuous one with the tutcha-kol given above.

We have now to examine the area units.

For Unirrigated Land

		As Given	As Calculated
4-17/32 tutcha-kol	=1 kol	12-7/16 ft	3·791 m
(32 kol)²	=	(398 ft or	121·310 m²
1 chain	=	3·636 acres	14716 m²

57·2 ft (17·435 m). The bauham works out to be 6 ft 4-11/32 in (1·939 m). If this bauham is equated with the Coimbatore bauham of 1·944 m, the kol has a length of

The tutcha-kol here works out to 32·94 in (against the usual 33 in) on the basis of the given data. The basic length for chain is made up of 145 tutcha-kol.

For Irrigated Land

			As Given	As Calculated
7·5 tutcha-kol	= kol	20·5 ft	6·248 m	6·290 m
1 kuli	= 1 padi	420·5 ft²	39·03 m²	39·56 m²
	= 1 nali			
8 padi	= 1 markkal	3362 ft²	312·3 m²	316·46 m²
	= 1 kuruni			
21 marakkal	= 1 seed-cottay	1·621 acres	6556 m²	6646 m²

The seed-cottay is comparable with the kurukkam of 6695 m² derived in Part 3.

The tutcha-kol here works out to 32·8 in. or 83·31 cm which is much lower than the traditional value of the tutcha-kol (83·86 cm). Hence the differences between given and calculated values.

Tirucherapalli

The kani of 5356 m² was generally in use. The kol, however, was divided into 28 adi, instead of 32 jena. In certain taluks a kol of 21 ft. (6·401m) was used as follows:

(kol)² = 1 kuli=441 ft² (40·97 m²)
100 kuli= 1 kani= 4097 m²

In the *Gazetteer* the kol has been given as 21-1/6ft (6·452ft) but the 6·4m kol has a parallel in North Arcot, Madura etc. and is therefore more acceptable.

References

(56) *Annual Report on South Indian Epigraphy* for the year ending 31 March 1921, No. 659 of 1920.

(57) *Annual Report on South Indian Epigraphy* for the year ending 31 March 1929, No. 249.

(58) Nicholson, F. A., *Madras District Manuals, Coimbatore*, Vol. 2 (Government of Madras), 1898.

*New Values for the Physical Constants**

A NEW consistent set of values for the physical constant has been recommended by the Committee on Fundamental Constants of the National Academy of Sciences-National Research Council. The work of this committee is a continuation of the work of an earlier NAS-NRC Committee.

The National Bureau of Standards has adopted these values[1] for use in all NBS publications, except where for some special reason the author is required to use others. No doubt these constants will have additional wide use. It is anticipated that the International Union of Pure and Applied Chemistry and the International Union of Pure and Applied Physics will encourage their employment on an international basis.

Previous to this action of the NAS-NRC Committee, several lists of "best values" for the physical constants were available. The current issue of the Smithsonian physical tables, for example, lists three separate sets of values. The individual research worker is then forced to make a choice as to which list he is going to follow.

Uniformity and consistency in the use of such values are necessary for an adequate exchange of information among scientists. For example, the Faraday constant is given by $F=N_A e$. Different values for all three of these constants appear in the various

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tables, but in order to satisfy the equation it is necessary that all values be taken from the same consistent set.

The members of the NAS-NRC Committee are J.A. BEARDEN, E.R. COHEN, J.W.M. DUMOND, L.P. McCULLOUGH, N. RAMSEY, F. D. ROSSINI, J. S. THOMSEN, G. WADDINGTON, and ALVIN G. McNISH, Chairman. Many of these individuals have been very active in the development of consistent sets of constants over the past few years.

The Committee eports: "In arriving at these values the Committee had available a large amount of experimental information not all of which appeared to be of consistent reliability and accuracy. In some cases where experiments were suspected of having significant errors and the results were discrepant with other experimental results believed to be of greater reliability, the data were rejected. Inclusion of these rejected data would have altered the rules in the table somewhat but not greatly".

The results of several recent experimental researches of the National Bureau of Standards have been of great importance in extablishing the new values. These were the new determinations of the gyromagnetic ratio, of the electrochemical equivalent of silver, the relative abundances of the isotopes of silver and the value of the absolute ampere. A full report of the calculations and considerations entering into this new set of values was discussed by J.W.M. DuMond and E.R. Cohen at the Second International Conference on Nuclidic Masses in Vienna, in July 1963 (to be published in the Conference Proceedings).

The new values of the constants are given in table 2. The uncertainties assigned represent established limits of error; namely, three standard errors based on standard deviations assigned to the data retained for input to the least-squares adjustment. Those calculated from the residuals of the final least-square adjustment are even smaller. It is therefore unlikely that the true value of any of the constants differs from the value given in the table by as much as the stated uncertainty. The uncertainties in constants computed from elemental ones may be either greater or less than is obtained by a simple combination of the elemental uncertainties because

TABLE 1

Defined Values and Equivalents

Meter	(m)	1650 763·73 wavelengths in vacuo of the unperturbed transition $2p_{10} - 5d_5$ in ^{86}Kr
Kilogram	(kg)	mass of the international kilogram at Sevres, France.
Second	(s)	1/31 556 925·974 7 of the tropical year at 12^h ET, 0 January 1900.
Degree Kelvin	(°K)	defined in the thermodynamic scale by assigning 273·16 °K to the triple point of water (freezing point, 273·15 °K=0 °C).

Unified atomic mass unit	(u)	1/12 the mass of an atom of the ^{12}C nuclide.
Mole	(mol)	amount of substance containing the same number of atoms as 12 g of pure ^{12}C.
Standard acceleration of free fall	(g_n)	9·806 65 m s^{-2}, 980·665 cm s^{-2}.
Normal atmospheric pressure	(atm)	101 325 N m^{-2}, 1 013 250 dyn cm^{-2}
Thermochemical calorie	(cal_{th})	4·1840 J, 4·1840 ×10^7 erg.
International Steam Table Calorie	(cal_{IT})	4·1868 J, 4·1868 × 10^7 erg.
Liter	(l)	0·001 000 028 m^3, 1 000·028 cm^3 (recommended by CIPM, 1950).
Inch	(in)	0·0254 m, 2·54 cm.
Pound (avdp.)	(lb)	0·453 592 37 kg, 453·592 37 g.

TABLE 2

Adjusted Values of Constants

Constant	Symbol	Value	Est‡—error limit	Unit: Systeme International (MKSA)		Unit: Centimeter-gram-second (CGS)	
Speed of light in vacuum	c	2·997925	3	X10^8	m s^{-1}	X10^{10}	cm s^{-1}
Elementary charge	e	1·60210	7	10^{-19}	C	10^{-20}	cm $^1/_2$ g $^1/^{2*}$
		4·80298	20	———		10^{-10}	cm $^{3/2}$ g$^{1/2}$s^{-1}†
Avogadro constant	N_A	6·02252	28	10^{23}	mol^{-1}	10^{23}	mol^{-1}
Electron rest mass	m_e	9·1091	4	10^{-31}	kg	10^{-28}	g
		5·48597	9	10^{-4}	u	10^{-4}	u
Proton rest mass ..	m_p	1·67252	8	10^{-27}	kg	10^{-24}	g
		1·00727663	24	10^{0}	u	10^{0}	u
Neutron rest mass	m_n	1·67482	8	10^{-27}	kg	10^{-24}	g
		1·0086654	13	10^{0}	u	10^{0}	u
Faraday constant ..	F	9·64870	16	10^4	C mol^{-1}	10^3	cm$^{1}_{2}$ g$^{1/2}$ mol^{-1}*
		2·89261	5	———		10^{14}	cm$^{3/2}$g$^{1/2}$ mol^{-1}†
Planck constant ..	$\hbar$	6·6256	5	10^{-34}	Js	10^{-27}	erg s
	h	1·05450	7	10^{-34}	Js	10^{-27}	erg s
Fine structure constant	α	7·29720	10	10^{-3}	———	10^{-3}	
	$1/\alpha$	1·370388	19	10^{2}	———	10^{2}	
	$\alpha/2\pi$	1·161385	16	10^{-3}	———	10^{-3}	
	α^2	5·32492	14	10^{-5}	———	10^{-5}	
Charge to mass ratio for electron ..	e/m_e	1·758796	19	10^{11}	C kg^{-1}	107	cm $^1/_2$g$^{-1/2}$*
		5·27274	6	———		10^{17}	cm$^{1/2}$g$^{-1/2}$s^{-1}†
Quantum-charge ratio	h/e	4·13556	12	10^{-15}	JsC^{-1}	10^{-7}	cm$^{3/2}$g$^{1/2}$s^{-1}*
		1·37947	4	———		10^{-17}	cm$^{1}_{2}$g$^{1}_{2}$†

‡Based on 3 std. dev.; applied to last digits in preceding column.
*Electromagnetic system.
†Electrostatic system.
C—coulomb J—joule Hz—hertz W—watt N—newton T—tesla G—gauss.

Table II—contd.

Constant	Symbol	Value	Est.‡ error limit	Unit: System International (MKSA)		Unit: Centimeter-gram-second (CGS)	
Compton wavelength of electron	λc	2·42621	6	10^{-12}	m	10^{-10}	cm
	λc/2π	3·86144	9	10^{-13}	m	10^{-11}	cm
Compton wavelength of proton	λc, υ	1·32140	4	10^{-15}	m	10^{-13}	cm
	λc, υ2π	2·10307	6	10^{-16}	m	10^{-14}	cm
Rydberg constant	R_{co}	1·0973731	3	10^{7}	m^{-1}	10^{5}	cm^{-1}
Bohr radius ..	a_o	5·29167	7	10^{-11}	m	10^{-9}	cm
Electron radius ..	r_e	2·81777	11	10^{-15}	m	10^{-13}	cm
	r^2_e	7·9398	6	10^{-30}	m^2	10^{-26}	cm^2
Thomson cross section	$8\pi\gamma^2_e/3$	6·6516	5	10^{-29}	m^2	10^{-25}	cm^2
Gyromagnetic ratio of proton ..	γ	2·67519	2	10^{8}	rad $s^{-1}T^{-1}$	10^{4}	rad $s^{-1}G^{-1}$*
	γ/2π	4·25770	3	10^{7}	HzT^{-1}	10^{3}	$s^{-1}G^{2}$*
(uncorrected for diamagnetism, H_2O)	γ^1	2·67512	2	10^{8}	rad $s^{-1}T^{-1}$	10^{4}	rad s^{-1}/G^{-1}*
	$\gamma^1/2\pi$	4·25759	3	10^{7}	Hz T^{-1}	10^{3}	s^{-1} G^{-1}*
Bohr magneton ..	μB	9·2732	6	10^{-24}	JT^{-1}	10^{-21}	erg G^{-1}*
Nuclear magneton..	μN	5·0505	4	10^{-27}	JT^{-1}	10^{-24}	erg G^{-1}*
Proton moment ..	μ_p	1·41049	13	10^{-26}	JT^{-1}	10^{-23}	erg G^{-1}*
	$\mu^1p/\mu N$	2·79276	7	10^{0}	———	10^{0}	
(uncorrected for diamagnetism, H_2O)		2·79268	7	10^{0}	———	10^{0}	
Anomalous electron moment corrn ..	$\mu e/\mu_o$-1	1·159615	15	10^{-3}	———	10^{-3}	
Zeeman splitting constant	μB/hc	4·66858	4	10^{1}	m-T-1	10^{-5}	cm- G^{-1}*
Gas constant ..	R	8·3143	12	10^{0}	$J°K^{-1}$ mol^{-1}	10^{7}	erg $°K^{-1}mol^{-1}$
Normal volume perfect gas ..	V_o	2·24136	30	10^{-2}	m^3mol^{-1}	10^{4}	cm^3 mol^{-1}
Boltzmann constant	k	1·38054	18	10^{-23}	$J°K^{-1}$	10^{-16}	erg $°K^{-1}$
First radiation constant ($2\pi hc^2$) ..	C_1	3·7405	3	10^{-16}	Wm^2	10^{-5}	erg cm^2 s^{-1}
Second radiation constant	C_2	1·43879	19	10^{-2}	m°k	10^{0}	cm °K
Wien displacement constant	b	2·8978	4	10^{-3}	m°k	10^{-1}	cm °K
Stefan-Boltzmann constant	σ	5·6697	29	10^{-8}	$Wm^{-2}°K^{-4}$	10^{-5}	erg cm^{-2} $s^{-1}°K^{-4}$
Gravitational constant	G	6·670	15	10^{-11}	$N m^2kg^{-2}$	10^{-8}	dyn cm^2g^{-2}

‡Based on 3 std. dev.; applied to last digits in preceding column.
*Electromagnetic system. Electrostatic system.
C—coulomb J—joule Hz—hertz W—watt N—newton T—tesla G—gauss

TABLE III
Energy Conversion Factors

	Formula	Factor	Error limit	Conversion: Systeme International (MKSA)		Conversion: Centimeter-gram-second (CGS)	
Electron-volt ..	eV	1·60210	7	X10^{-19}	J$(eV)^{-1}$	X10^{-12}	erg $(eV)^{-1}$
Energy associated with							
Unified atomic mass unit ..	c^2/Ne	9·31478	15	10^{8}	eV u^{-1}	10^{8}	eV u^{-1}
Proton mass ..	mpc^2/e	9·38256	15	10^{8}	$eVmp^{-1}$	-10^{8}	$eVmn^{-1}$
Neutron mass ..	m_nc^2/e	9·39550	15	10^{8}	eV mn^{-1}	10^{8}	eV mn^{-1}
Electron mass ..	m_ec^2/e	5·11006	5	10^{5}	eV me^{-1}	10^{5}	eV me^{-1}
Cycle	e/h	2·41804	7	10^{14}	$Hz(eV)^{-1}$	10^{14}	$s\text{-}1(eV)^{-1}$
Wavelength ..	ch/e	1·23981	4	10^{-6}	eV m	10^{-4}	eV cm
Wave number ..	e/ch	8·06573	23	10^{5}	$m\text{-}1(eV)^{-1}$	10^{3}	$cm\text{-}1\ (eV)^{-1}$
°K	e/k	1·16049	16	10^{4}	°K $(EV)^{-1}$	10^{4}	°K $(eV)^{-1}$

of the correlation among the elemental constants introduced by the least-squares adjustment (*see* ref. Du Mond and Cohen). The values are based upon the assumption that the acceleration of gravity is correctly given by adding −0·013 gal to the value of g given in the Potsdam system. All the values where pertinent are referred the unified system of atomic mass in which the atomic mass of the atom of the nuclide ^{12}C is assigned the numerical value 12 exactly. Symbols recommended by the Commission on Symbols, Units, add Nomenclature (SUN Commission) of the international Union of Pure and Applied Physics, are employed. (*See* June 1962 Physics Today.)

[1] A wallet-size card presenting recommended values of selected physical constants may be obtained upon request from the Office of Technical Information, National Bureau of Standards, Washington, D.C. 20234.

Metric System in Industry

THE Government of India have recently announced a series of important steps to introduce the metric system in production of industrial equipment and designs of products.

The Standards of Weights and Measures Act, 1956 which provides for the adoption of the metric system in the country, has been fully brought into force. The metric system is the only system which the law recognises for transactions of any kind. It has come into almost exclusive use in trade, retail as well as wholesale, as well as in transactions by the Railways, Post Offices and Industrial Undertakings. A substantial beginning has yet to be made, however, in adopting the metric system in the design of products an equipment of industry.

Much preparatory work had been done to facilitate the adoption of the metric system in design in industry. Indian standards based on the metric system are available for all important materials used in industry as well as for tools and measuring instruments. Indian manufacturers are able and willing to produce materials, tools and instruments according to these standards. Almost the entire production of steel sections in the country is now in standard millimetre sizes. Manufacturers of fasteners have agreed to all demands for fasteners conforming to Indian Standards. Manufacturers of measuring instruments and tools are able and willing to meet all reasonable demands for instruments calibrated in metric units, and tools in metric sizes. The metric system has been adopted at all stages of instruction, in engineering colleges and other higher technical institutions. It should, therefore, be possible to make a substantial beginning in the manufacture of instruments, tools and other equipment designed on the metric system, within the next two years. In view of this progress the Government of India has now laid down the following policy for the change-over in industries within the next two years.

1. New Industrial Enterprises

In all licences for setting up new industrial enterprises to start production on or after 1-4-1966, a condition will be imposed that both the products and, to the extent possible, the machinery installed, should be of metric system design.

2. Existing Industrial Undertakings

Existing undertakings will be advised to re-design their products in the metric system. The aim will be to complete the task and to start production according to the revised designs by 1-4-1966. A longer period of preparation will be allowed if for special reasons, it is considered absolutely necessary. Even in such cases, the dimensions must be expressed in metric units, by exact conversion. Arrangements will be made to meet essential demands for spares and accessories designed on the foot pound system, for the maintenance of existing equipment.

3. Small Scale Industry

The Development Commissioner, Small Scale Industries (DCSSI) will advise undertakings in small scale industry to be prepared by 1-4-1966, to meet demands from large industry for components and accessories designed in the metric system. While granting assistance of any kind, financial or technical, the Department will draw the attention of the managements to the necessity to re-design all products and to provide themselves with tools and instruments to manufacture according to the revised designs. All officials under the DCSSI will be instructed accordingly. All training imparted by the Department will be based on the metric system.

4. Purchase of Stores for Government Departments

The Directorate General of Supplies and Disposals will request all indenting departments to give, in all indents, dimensions for machinery, spares, components and stores of various kinds in metric units. It is illegal to use the inch or the pound, in documents connected with purchases, sales or other transactions of any kind.

Weighing and Measuring Instruments in Textile Mills

WEIGHTS, measures and weighing and measuring instruments used in transactions for trade or commerce are subject to regulation by States. Those used in industry for purposes connected with purchase or sale of commodities, assessment of output for determination of wages or duties payable to the State, etc., must be verified by Government Inspectors of Weights and Measures annually. When they are used for purely technical and scientific purposes they are not subject to any such control.

A Study Group appointed by the Central Government, has classified the following weighing and measuring instruments used in the different departments, in cotton mills, as those serving a commercial purpose and hence subject to regulation.

Mill Gates

Weigh bridges at the mill gates, on which raw materials, fuels, etc., brought into the mill as well as finished products sent out of the mill, are weighed. Purchases and sales take place on the basis of these weighments.

Cotton and Waste Godowns

Scales in the cotton and waste godowns which are used in the purchase of cotton or sale of waste.

Carding and Ring Departments

Hank indicators on the drawing and speed frames in the Carding and Ring Departments. These indicators are used in assessing output for payment of wages.

Ring Department

Scales used in the Ring Department for weighing yarn for sale or for assesssing the output of winders for the payment of wages or bonuses.

Reeling Department

Scales used in the Reeling Department for weighing bundles of yarn. These weighments form the basis of sales as well as payment of wages to reelers.

Winding Department

Scales used in the Winding Department for weighing cones for sale as well as for assessing winders' production.

Warping Machines

Yardage indicators of the warping machines. These indicate the output of warpers for payment of wages and bonuses.

Sizing Department

Scales in the Sizing Department in mills which sell yarn on sized beams.

Weaving Shed

Pick counters on the looms, in mills where pick counters are used for assessing weaver's output for payment of wages.

Grey and Finished Folding Department

Scales on the Grey and Finished Folding Department used for weighing fents, chindies, and rags which are generally sold by weight. Where grey cloth is sold by weight, scales used for this purpose must also be brought under State regulation.

Folding Machines.

Stores Department

Scales used in the Stores.

Canteen and Grain Shop

All scales used in the Canteen and Grain Shops, in the purchase or sale of materials.

Studies would be made to devise efficient methods for the verification of hank indicators, yardage indicators, pick counters and folding machines.

Non-Commercial

Scales used in blow room, mixing room carding department, the sizing department for mixing the size ingredients, in the processing department for big weighing chemicals and dyestuffs, and in the laboratories, are not subject to regulation by the State, since they do not serve any commercial purpose.

Devnagri Abbreviations for Metric Units

ABBREVIATIONS for metric units recommended by the General Conference of Weights and Measures in 1960 were published in '*Metric Measures*', September 1961.

The Commission on Scientific & Technical Terminology of the Government of India has suggested terminology complete as well as abbreviated, for use in Indian languages. These are reproduced below:

Terminology in Indian languages for metric units of measurement

English Term	Abbreviation	Devnagri (or other Indian scripts) Term	Abbreviation
Micro	M	माइक्रो	मा
Milli	m	मिलि	मि
Centi	c	सेन्टि	से
Deci	d	डेसि	डेसि
Deca	da	डेका	डेका
Hecto	h	हैक्टो	हे
Kilo	k	किलो	कि
Mega	M	मेगा	मेगा

Length

English Term	Abbrevation	Devnagri (or other Indian scripts) Term	Abbreviation
Micron (Micro-metre)	Mm	माइक्रोन	मामी
Millimetre	mm	मिलिमीटर	मिमी

English Term	Abbreviation	Devnagri (or other Indian scripts) Term	Abbreviation
Centimetre	cm	सेन्टिमीटर	सेमी
Decimetre	dm	डैसिमीटर	डेसिमी
Metre	m	मीटर	मी
Decametre	dam	डेकामीटर	डेकामी
Hectometre	hm	हैक्टोमीटर	हेमी
Kilometre	km	किलोमीटर	किमी
Megametre	Mm	मेगामीटर	मेगामी

Area

English Term	Abbreviation	Devnagri (or other Indian scripts) Term	Abbreviation
Square millimetre	mm^2	वर्ग मिलिमीटर	मिमी^{2}, वर्ग मिमी
Square centimetre	cm^2	,, सेन्टिमीटर	सेमी^{2}, वर्ग सेमी
Square decimetre	dm^2	,, डेसिमीटर	डेसिमी^{2}, वर्ग डेसिमी
Square metre	m^2	,, मीटर	मी^{2}, वर्ग मी
Square decametre	dam^2	,, डेकामीटर	डेकामी^{2}, वर्ग डेकामी
Square hectometre	hm^2	,, हेक्टोमीटर	हेमी^{2}, वर्ग हेमी
Square kilometre	km^2	,, किलोमीटर	किमी^{2}, वर्ग किमी
Square megametre	Mm^2	,, वर्ग मेगामीटर	मेगामी^{2}, वर्ग मेगामी

Volume

English Term	Abbreviation	Devnagri (or other Indian scripts) Term	Abbreviation
Cubic millimetre	mm^3	घन मिलिमीटर	मिमी^{3}, घन मिमी
Cubic centimetre	cm^3	,, सेन्टिमीटर	सेमी^{3}, घन सेमी
Cubic decimetre	dm^3	,, डेसिमीटर	डेसिमी^{3}, घन डेसिमी
Cubic metre	m^3	,, मीटर	मी^{3}, घन मी
Cubic decametre	dam^3	,, डेकामीटर	डेकामी^{3}, घन डेकामी
Cubic kilometre	km^3	,, किलोमीटर	किमी^{3}, घन किमी
Cubic megametre	Mm^3	,, मेगामीटर	मेगामी^{3}, घन मेगामी

Weight

English Term	Abbreviation	Devnagri (or other Indian scripts) Term	Abbreviation
Microgram	Mg	माइक्रोग्राम	माग्रा
Milligram	mg	मिलिग्राम	मिग्रा
Centigram	cg	सेन्टिग्राम	सेग्रा
Decigram	dg	डेसिग्राम	डेसिग्रा
Gram	g	ग्राम	ग्रा
Decagram	dag	डेकाग्राम	डेकाग्रा
Hectogram	hg	हेक्टोग्राम	हेग्रा
Kilogram	kg	किलोग्राम	किग्रा, किलो
Quintal	q	क्विन्टल	क्वि
Megagram	Mg	मेगाग्राम	मेगाग्रा
tonne	t	टन	ट

Capacity

English Term	Abbreviation	Devnagri (or other Indian scripts) Term	Abbreviation
Millilitre	ml	मिलिलीटर	मिली
Centilitre	cl	सेन्टिलीटर	सेली
Decilitre	dl	डेसिलीटर	डेसिली
Litre	l	लीटर	ली
Decalitre	dal	डेकालीटर	डेकाली
Hectolitre	hl	हेक्टोलीटर	हेली
Kilolitre	kl	किलोलीटर	किली
Megalitre	Ml	मेगालीटर	मेगाली

Land Area

English Term	Abbreviation	Devnagri (or other Indian scripts) Term	Abbreviation
Centiare	ca	सेन्टिआर	सेआ
Are	a	आर	आ
Hectare	ha	हेक्टार	हेआ

Note:

(i) The Devnagri abbreviations are to be used only in trade, elementary education and in popular books.

(ii) For all other purposes *i.e.* in secondary and higher education, in Scientific and Technical text books & other literature etc. only the *international abbreviations* should be used.

News & Views

New Packages for Salt from 1 July 1960

A meeting of representatives of salt industry and trade, convened by the Ministry of Industry to consider the introduction of uniform packages in the salt industry has recommended that, from 1 July 1964, salt should be packed only in bags of the capacities 40 kg, 75 kg and 100 kg. 80 kg bags, which are currently in vogue will not be permitted beyond 30 June 1964. Special varieties of salt like table salt and dairy salt may be packed in bags of 50 kg.

Naya Paisa to Become Paisa

From 1 June 1964, the *naya paisa* will be designated *paisa*. The naya paisa coins in circulation will continue to be legal tender. The text of the Indian Coinage (Amendment) Act, No. 17 of 1964, is given below :

THE INDIAN COINAGE (AMENDMENT) ACT, No. 17 of 1964

An

Act

further to amend the Indian Coinage Act, 1906.

Be it enacted by Parliament in the 'Fifteenth Year of the Republic of India as follows :—

Short title and commencement

1. (1) This Act may be called the Indian Coinage (Amendment) Act, 1964.

(2) It shall come into force on the 1st day of June, 1964.

Amendment of section 13

2. In section 13 of the Indian Coinage Act, 1906 (hereinafter referred to as the principal Act), after sub-section (3), the following sub-section shall be inserted namely :—

"(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. S.R.O. 1120, 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 ;

(*b*) in the case of any other coin, for any sum not exceeding one rupee."

Amendment of section 14

3. In section 14 of the principal Act, after sub-section (3), the following sub-section shall be inserted, namely :—

"(4) As from the commencement of the Indian Coinage (Amendment) Act, No. 17 of 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 paise 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."

Standards News

(Indian Standards which have a particular bearing on the change-over to the metric system are indicated here. Copies would be available from the Indian Standards Institution, Manak Bhavan, 9 Bahadur Shah Zafar Marg, New Delhi or their Branch Offices at Bombay, Calcutta and Madras).

Indian Standard for Single Faced Sluice Gates [(Doc : BDC—3 (745)]

The Indian Standards Institution has prepared draft Indian Standard Specification for Single Faced Sluice Gates (100 to 1,200 mm sizes) [Doc: BDC 3(745)], which covers single faced sluice gates from 100 to 1,200 mm sizes of different shapes with sliding and rotating spindle.

Single faced sluice gates are extensively used in water supply and drainage works. The consuming department do not have at present any standards on which they can base their requirements. The standard which is intended to fulfil the need, gives the dimensions, materials and constructional requirements for two classes of single faced sluice gates from 100 to 1,200 mm sizes.

The draft standard will shortly be circulated to all interests concerned, for eliciting technical comments.

Indian Standard for Glass Milk Bottles [Doc : AFDC 12 (331)]

The Indian Standards Institution has prepared draft Indian Standard Specification for Glass Milk Bottles [Doc : AFDC 12 (331)] (revision of IS: 1392—1959). This draft revision specifies the requirements for glass milk bottles of 1 litre, 500 ml, 250 ml and 200 ml capacities. In the revised draft 200 ml bottle has been included in view of its use, particularly for supply of milk to school children.

The draft standard will shortly be circulated to the interested manufacturers, consumers and technologists for eliciting technical comments.

Steel Drums (Galvanized and Ungalvanised) (IS : 2552—1963)

The Indian Standards Institution has published Indian Standard Specification for Steel Drums (Galvanized and Ungalvanized) IS: 2552—1963), which covers the requirements for a range of galvanized and ungalvanized steel drums up to 150-litre nominal capacity in 13 sizes.

The Indian Standards Institution had issued IS: 442—1954 Specification for Drums for Paints and IS: 618—1956 Specification for Kegs (Open Top Drums) for Paints, for the exclusive use of the paints industry. In 1960, the position was reviewed and it was decided to draw a more comprehensive specification for drums and kegs for use in paints and other industries as well, in the form of IS: 1549—1960 Specification for Steel Drums and Kegs (Galvanized and Ungalvanized) which superseded the earlier two specifications mentioned above. In that standard an attempt was

made to rationalize the sizes of drums and kegs manufactured in the country, based on the principle that the standard on metal containers should specify them by volume and not by the weight of material packed in them. Fifteen preferred sizes ranging from 1 to 150 litres were specified in a preferred range of diameters to meet all requirements. In addition to these, a set of non-preferred diameters was also given in order to assist the industry in effecting a smooth changeover.

The Committee responsible for the preparation of this standard recently reviewed IS: 1549—1960 and felt that there should be two separate Indian Standards, one dealing with drums and the other with kegs, as the constructional details and test requirements of these two types of containers are widely different. This standard, therefore, covers drums only and partly supersedes IS: 1549—1960. A separate Indian Standard on kegs and open top drums is under preparation. Further, all requirements relating to closures have been omitted in this standard and a reference is given to the more comprehensive IS: 2474—Specification for Closures for Drums.

Price : Rs. 2·00

Road Milk Tankers (IS : 2492—1963)

The Indian Standards Institution has published Indian Standard Specification for Road Milk Tankers (IS: 2492—1963), which prescribes the requirements for tanks and tank fittings for road milk tankers.

The tanks of road milk tankers are used to transport by road precooled milk, ice cream mix and other fluid milk products in bulk from milk collecting centres to dairies and from one processing plant to another. The tank shall be designed for mounting on trucks or built as a semi-trailer. Precooled milk and milk products are held in these tanks within required temperature limits for long hauls. The capacity and the type of the transportation tank has to be decided by each dairy or processing plant depending on the volume of the dairy products to be moved and the distance to be covered, the weather conditions and the road regulations.

Price Rs. 1·50

Bright Bars for Threaded Components (IS : 2517—1963)

The Indian Standards Institution has published Indian Standard Specification for Bright Bars for Threaded Components (IS: 2517—1963), which covers the sizes and tolerances of Bright bars for the manufacture of threaded components.

While special consideration has been given to cover round and hexagonal bright bars required for the threaded fastener industry, the requirements regarding square bars have not been included in this standard as they are not used in the threaded fastener industry to any appreciable quantities. However, the sizes of square bars shall conform to those given is IS: 2073—1962 Specification for Steel Bars for Production of Machined Parts for General Engineering Purposes. These sizes are given in Appendix for information.

Price : Re. 1·00

Diameters of Wrought Aluminium and Aluminium Alloys Wire (IS : 2525—1963)

The Indian Standards Institution has published an Indian Standards Diameters of Wrought Aluminium and Aluminium Alloys, Wire (IS: 2525—1963), which lays down diameters and tolerances on the diameters for wrought aluminium and aluminium alloys in the form of wire.

The decision of the Government of India to adopt the metric system of weights and measures makes it essential that the sizes of metal products should be standardized in metric units. Uptil now, in trade and technology, the diameters of wire were

expressed in terms of various wire gauges used in the countries following fps system of weights and measures, for example, BG (Birmingham Gauge), SWG (Standard Wire Gauge), etc. The necessity for evolving a series of diameters of wire has been felt by all concerned. Accordingly, the Sectional Committee concerned decided to base it on IS: 1137—1959. Thickness of Sheet and Diameters of Wire, which lays down the basic diameters of wire in millimetres and which is now accepted in the trade.

This standard is one of a series of Indian Standard Specifications on wrought aluminium and aluminium alloys. Standards covering dimensions for wrought aluminium and aluminium alloys, sheet and strip, plate, drawn tube, and extruded tube are under preparation.

Price : Re. 1.00

Indian Standard Specification for Jute Bags for Packing Cement (IS : 2580—1963)

The Indian Standards Institution has published Indian Standard Specification for Jute Bags for Packing Cement (IS : 2580—1963), which prescribes the constructional details and other particulars of double warp heavy Cee jute bags for packing cement of dimensions 710×480 mm (or 28 ×19 in.).

The question of packing cement suitably has been under consideration of all the manufacturers for the past several years. In view of the fact that bags filled with cement are usually subjected to rough handle during transit and storage, it was found necessary to have packing which would satisfactorily withstand these normal hazards. It is expected that jute bags conforming to this specification would meet this demand.

Price : Rs. 3·00

Indian Standards Specification for Asbestos Cement Building Boards (IS : 2098—1964)

The Indian Standards Institution has published Indian Standard Specification for Asbestos Cement Building Boards (IS: 2098—1964), which lays down the requirements regarding composition, dimensions and tests of asbestos cement building boards.

Asbestos cement building boards find wide application in building industry because of their lightness and flexibility combined with adequate strength. They are mainly used as interior fittings where no load or little load comes on them, such as partitions, false ceilings, almirah panelling dado works, etc. It is important to note that asbestos cement building boards are different from the asbestos cement flats and slates and they are not intended for exterior use. In general, these boards can be worked with ordinary wood working tools.

Price : Rs. 2·00

Freedom is in peril,
defend it with all your might
—Jawaharlal Nehru

DEFENCE IS YOUR JOB TOO

Safeguarding our freedom demands our fullest effort, discipline and sacrifice. By working resolutely and increasing production, you help build up defence.

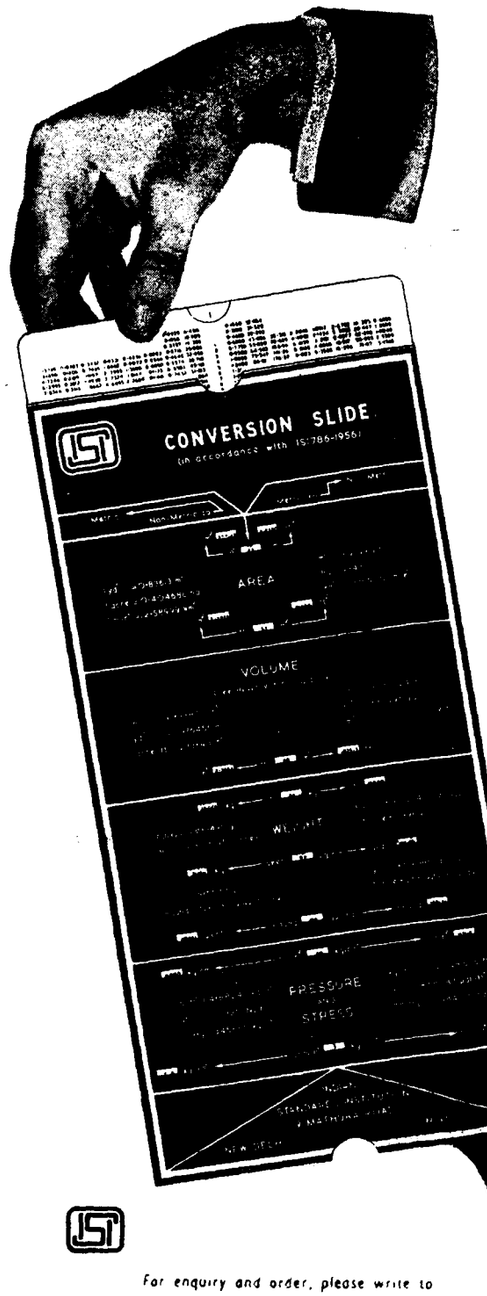
YOUR DISCIPLINE IS INDIA'S STRENGTH

DAVP 1

Licensed Manufacturers and Repairers

(*Metric Measure* has been publishing in the past a series of lists of licensed manufacturers, dealers and repairers of weights and measures, weighing and measuring instruments licensed by the Governments in the various States and Union Territories under their Weights and Measures (Enforcement) Acts. To economise on paper, it is possible only to publish lists of licensed manufacturers and repairers.

A feature on statistics of verification and licences issued is also being published in *Metric Measures*).



ISI

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STATISTICS OF VERIFICATION OF WEIGHTS ETC. AND LICENCES

States/Union Territories	Period	Weights	Capacity Measures	Length Measures	Weighing Instruments	Measuring Instruments	Total number of Others Mfrs.	Dealers	Repairers as on 1st day of....
(1) Andhra Pradesh	1st Oct. '62 to 31 March '63	2,00,101	64,362	6,408	21,747	527	26	14	59	24
(2) Assam ..	1st Dec. '63 to 31st Jan. 64	4,03,260	29,578	7,607	774	24	—	17	22	14
(3) Bihar ..	1 Apr. '62 to 31 Jan. '63	1,28,211	—	—	19,309	56	—	30	203	43
(4) Gujarat	1 Oct. to 30 Nov. '63	1,98,980	17,977	1,480	24,197	127	13	108	574	145
(5) Kerala ..	1 Apr. '62 to 31 July '62	—	—	—	—	—	—	73	459	142
(6) Jammu & Kashmir	1 Dec. '63 to 31 Jan. '64	5,849	174	579	1,079	1	—	8	171	10
(7) Madhya Pradesh.	—	—	—	—	—	—	—	—	—	—
(8) Madras	—	—	—	—	—	—	—	—	—	—
(9) Maharashtra	1 Apr. '62 to 31 Mar. '63	1,874,286	5,37,135	33,988	—	—	—	—	—	—
(10) Mysore	1 Apr. '62 to 31 Nov. '62	4,81,354	105,253	1,037	59,674	8,420	126	126	493	92
(11) Orissa ..	1 Apr. '62 to 31 Mar. '63	4,23,597	86,060	3,089	1,596	2	—	8	103	6
(12) Punjab	1 Oct. '63 to 31 Jan. '64	2,59,101	19,674	6,079	53,515	159	—	1	3	2
(13) Rajasthan	N.A.	—	—	—	—	—	—	—	—	—
(14) Uttar Pradesh.	1 June to 30 Nov. '62	8,95,335	8,897	20,506	7,505	278	—	200	979	187
(15) West Bengal.	up to 4-4-64	4,682,236	67,330	15,226	261,783	—	—	—	—	—
(16) A&N Islands.	N.A.	—	—	—	—	—	—	—	—	—
(17) Delhi ..	1 Oct. to 30 Nov. '63	41,094	4,139	1,386	6,028	16	—	26	70	24
(18) Goa ..	1 Apr. to 31 May '62	18	3	—	—	—	—	—	—	—
(19) Himachal Pradesh	1 Apr. '62 to 31 July '63	68,020	7,411	2,532	10,628	1	—	1	25	12
(20) L.M.A. Islands.	1 Apr. '62 to Oct. '63	—	—	—	—	—	—	—	—	—
(21) Manipur	1 Apr. '63 to 31 Dec. '63	19,835	4,115	239	599	8	—	—	—	—
(22) Pondicherry.	1 Feb. '64 to 31 Mar. '64	4,038	1,341	36	21	4	37 (Peg measures)	4	10	5
(23) Tripura	1 Apr. '62 to 30 July '62	62,050	8,464	720	9	8	—	4	85	3

N.A.—Statistics not available as yet.

ANDHRA PRADESH

Manufacturers of Weights and Measures Licensed from 1-10-62 to 31-3-63.

(1) Adabala Satyanarayana & Sons, Dowlaishwaram, E.G. Dist.

(2) Andhra Ratna Iron Foundry, Near Addanki Gate, Ongole, Guntur Dt.

(3) Andhra Scientific Co. Ltd., Cantonment Road, Masulipatam, Krishna Dt.

(4) Bhagavannarayana Iron Balance Works, Dowlaishwaram, E.G. Dt.

(5) Central Metal Works, (Prop: Sarparaz Khan) 15-1-45 Feel Khana, Hyderabad.

(6) Deccan Porcelain & Enamel Work Ltd., 2707 P.B. No. :3 Bakaram, Mushirabad, Hyderabad.

(7) Durga Foundry Works, Kothawada, Warrangal.

(8) Hilal Consumer Goods, (Prop: Maqsood Ali) Joshiwadi, Begum Bazar, Hyderabad.

(9) Federation of Industrial Co-operative Ltd., Bashirabagh, Hyderabad.

(10) Hyderabad Iron & Steel Works Ltd., P.B. No. 10, Industrial Area, Azamabad, Hyderabad-20.

(11) S. K. Industries, Bakaram, Mushirabad, Hyderabad.

(12) Jayakrishna Iron Industrial Works, Dowlaishwaram, E.G. Dist.

(13) Jamsheed Iron & Steel Co., Siddiamber Bazaar, Hyderabad.

(14) Kanakadurga Iron Works, Jagannayakapur, Kakinada, E.G. Dist.

(15) Marwadi Moulding Factory, Kasaratta Road, Hyderabad.

(16) Misrilal Motilal, Tope Khana-Quadeem, Opp. Osmangunj, Hyderabad.

(17) Majestic Metal Works, Mettikasher, Begum Bazaar, Hyderabad.

(18) Panduranga Engineering & Moulding Works, 13-56-A, Railway Feeder Road, Tadparthi, Anantapur Dist.

(19) Pappu Yerakayya & Sons, Dowlaishwaram E. G. Dist.

(20) Pappu Veeranna & Sons, Dowlaishwaram E.G. Dist.

(21) Saraswathi Iron Balance Works, Dowlaishwaram, E.G. Dist.

(22) Star Metal Works (Prop: Leeladhar Jiv Raj Shah) 14-2-179.

(23) Radha Krishna Iron Safe & Balance Work Shop, Dowlaishwaram, E.G. Dist.

(24) Scientific Engineering House, P. Ltd., Bashirbagh, Hyderabad.

(25) Swami Alivelu Industries, Prop: Mangina Sarvarayudu, Lakkavaram P.O., Rajole Tq, E.G. Dist.

(26) Sadananda Engineering Work, No. 1-9-7 Industrial Area, Azamabad, Hyderabad.

(27) Surya Engineering Works, Industrial Estate, Warrangal.

(28) Standard Foundries (Prop: K. L. Vithani), P.B. No. 16, Station Road, Nizamabad, Nizamabad Dt.

(29) Scientific Engineering House P. Ltd. Bashirbagh, Hyderabad.

(30) Taj Industries (Prop. Mohd. Jamaluddin) 5-5-274/7 Behind Gandhi Bhavan, Nampalli, Hyderabad.

(31) Safe Scale Co., 22-6-257, Kalikaman, Hyderabad.

(32) S & P Industries, Industrial Estate, Factory Unit, Warrangal.

(33) Venkateswara Iron Works, Dowlaishwaram, E.G. Dist.

(34) Watan Weight Works (Prop. M. A. Rahim), Behind Canara Bank, Pattargatti, Hyderabad.

M38DPD/64—GIPF.

TYPICAL METRIC PRICING UNITS FOR WHOLESALE TRANSACTIONS

Serial No.	Commodity	Metric Unit
		10 grams (g)
(1)	**Gold**	1 kilogram (kg)
(2)	**Grocery and Confectionery** Biscuits, sweetmeats, cardamoms.	
	Textiles and Textile Fibres Cotton yarn, damaged and seconds cloth, raw silk, rayon silk yarn, raw wool, wool manufactures (when sold by weight).	
	Paints & Chemicals Paint (if sold by weight), indigo, liquid chlorine.	
	Hides, Skins & Leather Raw hides, leather (hides and skins).	
	Metals Silver, aluminium sheets, strips and circles, copper and brass wires and utensils.	
	Miscellaneous Tea, meat, camphor tablets, mica.	1 quintal (q) (100 kilograms)
(3)	**Grains and Pulses** Rice, wheat, jowar, arhar, moong, masur, gram.	
	Spices Black pepper, mustard, chillies, dhania, dalchini, turmeric, betelnuts.	
	Plantation Products Rubber, cashewnuts, cashew kernels, tobacco (raw and manufactured).	
	Forest Products Lac and lac products, gums, myrobalans, galnuts, soapnuts.	
	Textiles & Textile Fibres Raw jute, raw hemp, coir yarn.	
	Oils, Oilseeds & Oilcakes Vegetable oil, oilseeds, oilcakes.	
	Non-Ferrous Metals *Aluminium :* ingots, bars, blocks, slabs, 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, circles. *Brass :* ingots, rods, sections, pipes, sheets, strips, circles. *Zinc :* ingots, sheets, strips. *Tin :* blocks.	
	Chemicals Caustic soda, bleaching powder, glycerine, soaps, paper salt.	
	Others Sugar, gur, ice, fish, sugarcane, vegetables, tamarind.	one metric tonne (t) (1,000 kilograms)
(4)	**Minerals** Iron ore, manganese ore, bauxite, coal.	
	Iron & Steel Pig iron, iron & steel manufactures, semis (billets for rerolling etc.)	
(5)	Cloth (mill, handloom, silk rayon and woollen cloth)	1 metre (m)
(6)	Jute carpets, coir mats and mattings, sheet glass.	one square metre (m^2)
(7)	Timber.	one cubic metre (m^3)
(8)	Paints (when sold by measure), spirits.	one litre (l)

Weights

(1) In place of the present units of seer, pound, rattal, viss etc., use the kilogram.

(2) In place of the tola, use the gram or 10 grams.

(3) In place of maund or corresponding unit, use the quintal *i. e.*, 100 kg.

Capacity Measures

In place of seer or gallon or any other measure, use the litre.

Length Measures

(1) Use the metre in place of yard or foot and the centimetre in place of inch.

Square Measures

(1) Use the square metre in place of square yard or square foot, and square centimetre in place of square inch.

Cubic Measures

(1) Use the cubic metre in place of cubic yard or cubic foot and cubic centimetre in place of cubic inch.

Packaging

It is advantageous if sizes of packages correspond to series of commercial weights and measures prescribed.

These are: 50 kg, 20 kg, 10 kg, 5 kg, 2 kg, 1 kg, 500 g, 200 g, 100 g, 50 g, 20 g, 10 g, 5 g, 2 g, 1 g, and so on.

TYPICAL PRICING UNITS FOR RETAIL TRADE

Serial No.	Commodity	Metric Unit for Use
(1)	Foodgrains, cereals, pulses, spices, ghee, bread, vegetables, meat, fish, sweetmeats, tea, coffee, sugar, salt.	1 kg
(2)	Oil for cooking	1 kg or 1 litre depending upon prevalent practice.
(3)	Fruits	1 kg or number depending upon prevalent practice.
(4)	Milk	1 litre
(5)	Cloth and related materials	1 metre
(6)	Prepackaged materials	Preferably sizes corresponding to series of commercial weights and measures.

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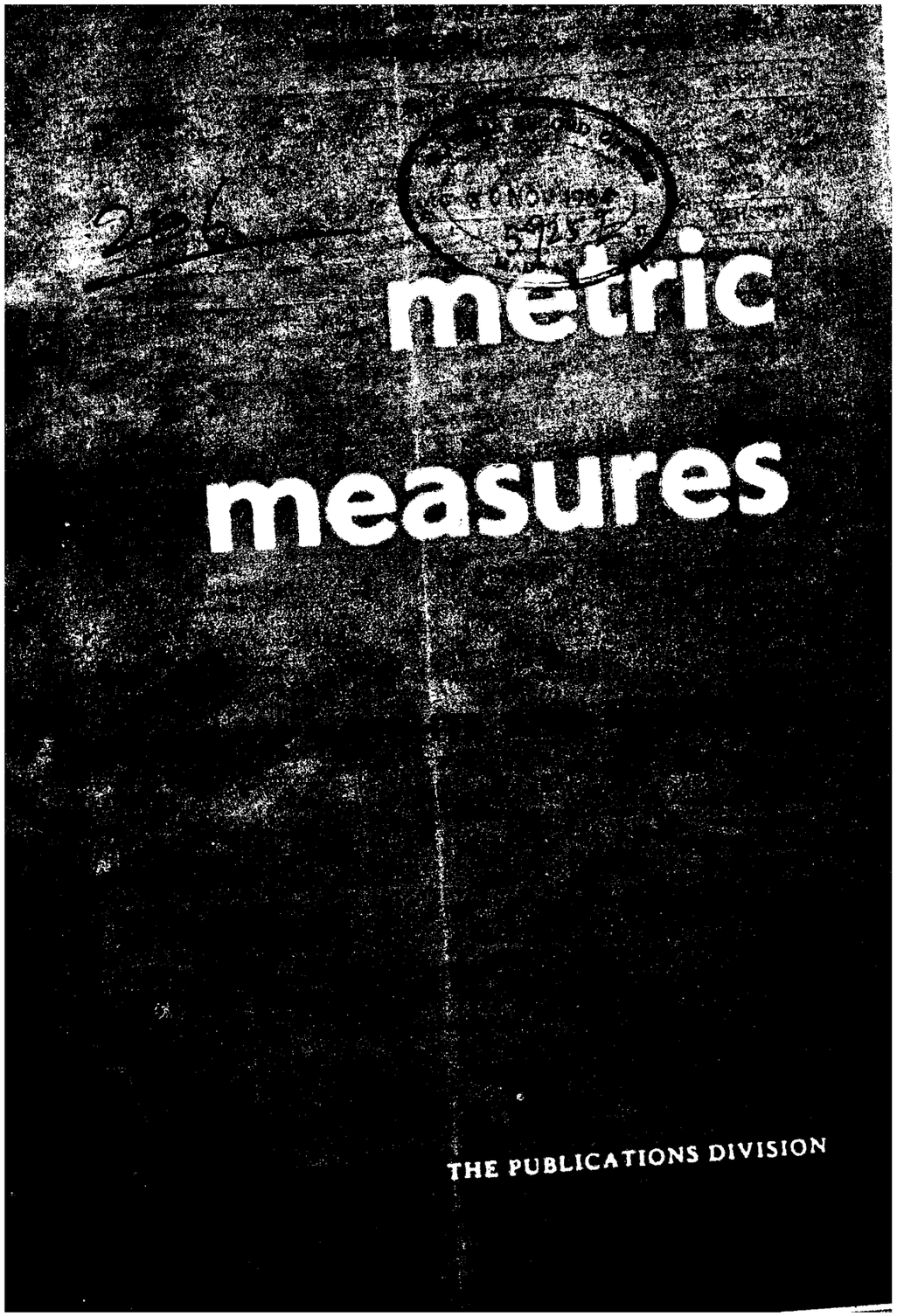

ABBREVIATION FOR METRIC UNITS

(1) DECIMAL MULTIPLES AND SUB-MULTIPLES

Prefix	Value in Terms of Unit	Abbreviation
Kilo	1,000	k
centi	0·01(10^{-2})	c
milli	0·001(10^{-3})	m
micro	0·000 001(10^{-6})	u

(2) WEIGHTS

Denomination	Value	Abbreviation
tonne	1,000 kg	t
quintal	100 kg	q
kilogram	1 kg	kg
gram	1 g	g
milligram	1 mg	mg
carat	200 mg	c

(3) CAPACITY

kilolitre	1 000 l	kl
litre	1 l	l
millilitre	1 ml	ml

(4) VOLUME

cubic metre	m^3	m^3 or cu m*
cubic centimetre	cm^3	cm^3 or cu cm*
cubic millimetre	mm^3	mm^3 or cu mm*

(5) LENGTH

kilometre	1 000 m	km
metre	1 m	m
centimetre	1 cm	cm
millimetre	1 mm	mm
micron	1/1 000 mm or 10^{-3} mm	um

(6) AREA

square kilometre	1 000 000 m^2	km^2 or sq km*
square metre	1 m2	m^2 or sq m*
square centimetre	1 cm^2	cm^2 or sq cm*
square millimetre	1 mm^2	mm^2 or sq mm*

(7) LAND MEASURE

are	100 m^2	a
hectare	100 a	ha
centiare	m^2	ca

*Both these abbreviations are current, but the first set should preferably be used. The former abbreviation is used more commonly internationally than the latter.

Rules for Abbreviations :

(1) Do not make any change, such as addition of 's' to indicate plurality *e.g.*, write 1 kg, 10 kg, 20 g, 5 g, 10 t, 20 ml, 271, 165 km, 2 mm, 100 cm^3, 66 km^2.

(2) Do not capitalize the abbreviations. For example, do not write 1 Kg, 2 Kg, 20 MM, 50 MM; the right way is to write 1 kg, 2 kg, 20 mm, 50 mm, etc.

(3) Do not use any other abbreviations except those given above.

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metric measures

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Development of Length and Area Measures In South India—Part 5

L. RAJU & V. B. MAINKAR
Ministry of Commerce,
New Delhi

WE have considered in the first four Parts the development of length and area measures in India from ancient times, derived a theory on the basis that the 28 angula hasta of *Arthasastra* measured exactly 50 cm, and applied the theory to the length and area measures available in South Indian temples, historical and other records or tradition.

In this fifth and concluding Part, we shall consider the application of the theory to the length and particularly the area measures in the States of Andhra Pradesh, Mysore and Kerala.

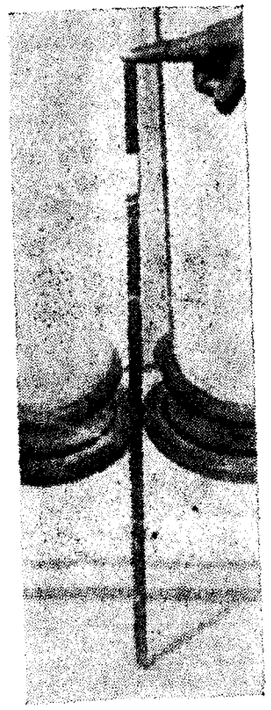

Fig. 1—The tutcha-kol was a popular length measure in South India. It measured 33 inches or 83·82 cm. Shown above is a sample recently obtained from the Tirunelveli area.

ANDHRA PRADESH

Ganjam

In Ganjam district the length of the mura is said to be estimated at 19·5 in (49·53 cm). This is equal to 3·811 × 13 = 49·54 cm, *i.e.* it is equal to 13 angula. It is also 1/10 of the kol for irrigated garden lands, and ½ of the bauham of 1·982 m discussed under Madura. On this basis, the 8 cubit rod, which was assigned a length of 13 ft (3·962m) works out to be 3·963 m. It is on the basis of the cubit or mura of 49·54 cm that we shall evaluate the area units in this district.

One of the commonly used equations is :

1 rod square	= kunta	= 15·71m²
50 kunta	= 1 bharnam of irrigated land	= 785·4 m²
100 kunta	= 1 bharnam of unirrigated land	= 1570·9 m²
600 kunta	= 1 garce	= 9425 m²

			As Given	As Calculated I	As Calculated II
manadi		2½ cents	= 101·2 m²	100 m²	101·25 m²
2 manadi	= 1 addedu	5 cents	= 202·4 m²	200 m²	202·5 m²
2 addedu	= 1 kunchedu	10 cents	= 404·7 m²	400 m²	405 m²
10 kunchedu	= 1 iddamu	1 acre	= 4046·9 m²	4000 m²	4050 m²
2 iddamu	= 1 yedumu	2 acre	= 8093·7 m²	8000 m²	8100 m²
2 yedumu	= 1 penduhumu	4 acres	=16187·4 m²	16000 m²	16200 m²
2 penduhumu	= 1 putti	8 acres	=32374·9 m²	32000 m²	32400 m²

The values recorded for these units are bharnam (1571m²) = 0·39 acre or 1578m² and garce = 2·33 acre or 9429m². The values given above agree.

The correctness of our assumptions is further confirmed by the fact that the 'wet' bharnam, by measure, was taken to be 8 kunta *i.e.* 8/40 of an acre and dry as 16/40 of an acre.

Odd lengths of rods like 7-½ cubits (3·716m) were also used. A rod of about 16 mura and 16 angula, equal to 27 ft (8·230m) was also used. This rod would be 8·257m, the mura being 49·54cm. Then 25 square rods = 1 mauna = 1704m².

An interesting rope of 22 cubits equal to 36 ft was used in this area. This works out to 11m (36·089ft.) if mura is 50cm the kunta being a square rope *i.e.* 121m².

A garce was equal to 80 kunta = 9680m² or 2·347 acres. This compares favourably with the garce calculated above.

Godavari

In Godavari district the cubit was about 19·8 in *i.e.* 50·29cm.

A commonly used table was[59] :

	As Given		As Calculated I	As Calculated II
5 cubits=1 rod or veesam	—	—	2·5m	2·516m
16 rods (80 cubits) = 1 puggum	132 t.	40·234m	40m	40·249m
1 sq. puggum = 1 kunta	0·4 acre	1618·8 m²	1600 m²	1620 m²
20 kunta = 1 putti (80 kuncham)	8 acres	32375 m²	32000 m²	32400 m²

Obviously, there is a certain amount of rounding off to make the iddamu equal to exactly 1 acre if putti is taken as equal to 32,000m².

Another point of view of looking at these tables would be to equate the putti with the 32400m² paridesa (*see* Table 5, Part 2) and from that derive the rest of the smaller units. In this case the cubit is 50·31cm (16 rods = $\sqrt{1620}$ = 40·249m and the cubit would be 50·311cm). This cubit reminds us of Gudea's cubit (*see* Part 1). The values based on a cubit of 50cm and 50·31 cm are presented as I and II in the above table. Similar results are also presented for other tables later on.

There was in use another table which corroborates the above table. It is :

There were other putti measures in use :

	As Given		As Calculated I	As Calculated II
32 cubits=1 puggum	—	—	16 m	16·1 m
1 sq. puggum=1 kunta	2787·84 ft.	259 m²	256 m²	259·2 m²
100 kunta=1 putti	6·4 acres	25900 m²	25600 m²	25919 m²

The putti under I is twice the goru examined in Part 3. The values under II are derived for comparison.

Another putti used in the islands in the Godavari river was :

	As Given		As Calculated I	As Calculated II
6 cubits = 1 rod or veesam	—	—	3 m	3·019 m
16 rods (96 cubits) = 1 puggum	—	—	48 m	48·3 m
1 sq. puggum = 1 kunta	25090 ft²	2331 m²	2304 m²	2333 m²
20 kunta = 1 putti	11·52 acres	46500 m²	46080 m²	46658 m²

Still another measure was used near Masulipattam :

	As Given		As Calculated I	As Calculated II
80 cubits=1 puggum	—	—	40 m	40·25 m
1 sq. puggum = 1 kunta	—	—	1600 m²	1620 m²
32 kunta = 1 kutti	12·8 acres	51800 m²	51200 m²	51840 m²

The calculated kutti in (I) is ½ of the kuchchala examined in Part 3.

Most of the above calculated kunta are supported by ancient literature, though the number of multiples taken for forming the higher units is not. The values derived from a cubit of 50 cm appear to be more acceptable in some cases than those based on the cubit of 50·31 cm.

An 84 cubit (42m) kunta (1764m²) was also used : 32 kunta gave a kutti of 56448m² and 20 kunta another of 35280m². Another kunta was 88 cubits (44m) a side, (1936m²), 20 kunta giving a putti of 38720m² and, 35 kunta giving a putti of 67760m². A kutti of 32 kunta, each kunta being a square of 96 cubits was also used. (48 × 48= 2304m² = 2304 × 32 = 73728m²). A still larger unit had 98 cubits (49m) to the side; 20 such kunta, each of 2401m², making 48020m².

Another measure mentioned is :

40 cubits	= 1 rope	= 20 m
1 sq rope	= kunta	= 400 m²
100 kunta	= 10 acres (4 ha)	

Most of these measures can be supported in ancient tradition, on the 50 cm cubit. The cubit could also be taken as 50·31.

Krishna

Krishna district is full of a variety of area measures. The land measure best

known is the kuchchala, generally subdivided into 64 kunta, but sometimes into 32, and even 100, 30 and 40.

The kunta is normally a square each side of which measures 80 cubits (40m) but the number of cubits may vary. The cubit is usually $\frac{1}{4}$ of a fathom, and the fathom is said to be 78·8 inches, giving a cubit of 19·7 inches or say 50cm. The following are some of the measures :

Sl. No.	Rope in cubits	Kunta		Kuchchala (64 kunta)	
		m²	Acre	Hectares	Acres
(1)	80(40m)	1600	0·396	10·24	25·30
(2)	76(38m)	1444	0·357	9·24	22·87
(3)	74(37m)	1369	0·339	8·76	21·68
(4)	72(36m)	1296	0·321	8·29	20·53
(5)	66(33m)	1089	0·269	6·97	17·25
(6)	64(32m)	1024	0·253	6·55	16·22

Of these (1) and (4) were most commonly used. They are also supported by ancient tradition. as also (6). No. (5) is in line with the 22 cubit tradition explained earlier under Ganjam district. No. (2) and No. (3) cannot be explained by any tradition. The kuchchala may also contain 32 or 100 kunta.

There is another cubit on which kunta may be based. Here 5-$\frac{1}{2}$ cubits make 9-$\frac{1}{2}$ ft (2·896m) *i.e.* cubit is 20·7 in (52·6cm) I

Two others are :

4½ cubits = 7 ft 8 in (2·337 m)
∴ cubit = 20·44 in (51·92cm) (Garden land cubit) II

4¾ cubits = 8 ft 2 in (2·489 m)
∴ cubit = 20·62 inches (52·37 cm) (Bezwada cubit) III

Areas are expressed as kutti, which normally contains 32 kunta, but occasionally 35 or 20 kunta.

The following table lists the values as given and as calculated from old traditions.

	As Given		As Calculated
(1) 88 cubits (I)	152 ft.	46·330 m	1·9286×24 = 46·286 m
kunta	0·53 acre	2144·8 m²	2142·4 m²
kutti			
=20 kunta	10·61 acres	42937 m²	42948 m²
=32 kunta	16·97 acres	68675 m²	68557 m²
=35 kunta	18·56 acres	75110 m²	74984 m²
(2) 80 cubits (I)	138·2 ft	42·123 m	42·078 m
kunta	0·44 acre	1781 m²	1770·6 m²
kutti			
=20 kunta	8·77 acres	35491 m²	35411 m²
=32 kunta	14·02 acres	56737 m²	56658 m²
=35 kunta	15·34 acres	62079 m²	61970 m²
(3) 72 cubits (II)	122·7 ft.	37·396 m	26·68cm×140= 37·352 m
kunta	0·35 acres	1398·5 m²	1395·2 m²
kutti			
=32 kunta	11·05 acre	44718 m²	44646 m²
=35 kunta	12·09 acres	48927 m²	48831 m²

	As given		As calculated
(4) 76 cubits (III)	130·6 ft.	39·807 m	28·46cm×140= 39·844 m
kunta	0·39 acre	1578 m²	1588 m²
kutti =32 kunta	12·54 acres	50748m²	50801 m²

From the values recorded under (1) above, it will be obvious that the calculated kutti of 20 kunta is exactly equal to 2 nivartana or mattar (21424·308m²) derived in Part 3, *i.e.* 10 of this kunta make a mattar. The above kunta is also 10 times the kunta derived in Part 3 (214·24308m² × 10). The other two kutti measures are mere multiples of the kunta.

The division of the rod into 88 parts or cubits also gives rise to a new cubit *viz.* 52·60 cm (46·286 ÷ 88), which can then be taken 80 times to give another unit for area measures *i.e.* 42·078m. The difference between the given and calculated values is 46·330-46·286 m = 44mm, which is 1 : 1000 which is within the limits of error for the best surveying chains even today.

The second value of the rod *viz.* 37·396 m is not easily derived from any measure unless we make the assumption that it is made up of 140 adi of 26·68cm each *i.e.* 37·352m, a difference of 4cm, which is not large, if we remember that the value of adi is derived from the paurusha of 108 angula mentioned in the *Arthasastra*. The cubit is then 51·88 cm (37·352 ÷ 72).

The third value of the rod *viz.* 39·807m is also derived from another adi = 28·46 × 140 = 39·844m, which is 4cm larger than that given in literature. The cubit is then 52·42cm.

Nellore

In Nellore district, a rod of 32 cubits which was found to measure 52·$\frac{1}{2}$ ft (16·002m) was used for measuring garden lands. This gives a cubit or mulam of 19·68 in (50 cm).

The usual table is :

	As Given	As Calculated
1 rod sq.= 1 kunta	2756¼ ft² 256·06 m²	256m²
50 kunta= 1 gurtu	3·1637 acres 12803 m²	12800m²

Garden or jareeb lands were measured with a rod of 21 cubits or 34-29/64 ft (10·50m), but the resulting gurtu is the same :

	As Given	As Calculated
1 rod sq. = 1 kunta	1187 ft² 110·28 m²	110·25m²
116 kunta = 1 gurtu	3·161 acres 12792 m²	12789 m²

In some parts 8 gurtu made one kuchchala of about 25 acres (10·1150 ha). These old measures have already been explained in Part 3, the kuchchala having a caculated value of 10·24 ha.

Vishakhapatnam

In certain parts of this district the following table was used :

	As Given	As Calculated
1 kol	9·4 ft 2·864 m	2·859 m
(kol)² = 1 kuncham	88 3/8 ft² 8·21 m²	8·17 m²
20 kuncham = 1candy	1768 ft² 164·3 m²	163·5 m²
=1 putti		
30 candy =1 garce	1·21738 acres 4927 m²	4904 m²

In other parts the following table is used :

		As Given	As Calculated
kol		57·57 ft 17·547m	17·508 m
$(kol)^2$	= para	3315 ft^2 308·0m^2	306·2m^2
16 para	=1 veesam	1·21738 acres	4904 m^2
	=1 garce	4927 m^2	
16 veesam	=1 kathi	19·4782 acres	78469 m^2
		78826 m^2	

The kol in the first equation can be equated with 75 angulam derived in Part 3 (75 × 3·811cm=2·859m). Alternatively, it could be 5 kisku of 32 angula (0·5714 × 5=2·857m) of *Arthasastra*. In the second case, it appears that the value of garce was taken as 4927m^2 and the subunits derived from it by dividing it into 16 parts to get the para and so on. Our calculated values are submutiples of 4904m^2 derived in the first equation.

KERALA STATE

Trivandrum

	As Given		As Calculated
1 angulam=	1¼ in	3·175 cm	3·176 cm
24 angulam =1 kol	30 in	76·20 cm	76·23 cm
4 kol=1 dandu	10 ft	3·048 m	3·049 m
1 sq. dandu=	100 ft^2	9·289 m^2	9·296 m^2
434 3/5 sq dandu=acre	43560 ft^2	4037 m^2	4040 m^2

It is obvious that the kol is just equal to 20 angulam, each of 3·812 cm, which was derived in Part 3. Jervis[60] has pointed out that a 'guz' of '20 tasoos' is used in Malabar, Canara and Dravid. It cannot be doubted that he is referring to this 'guz' of 76·23cm. This kol was then divided into 24 angulam of new imension. The dandu happens to be equal to 80 angulam.

The calculated acre of 4040m^2 should be looked upon as related with 4050m^2 *i.e.* ½ the nivartana of 8100m^2. (*see* Table 5 in Part 2).

Trichur

In Trichur district the following table was used :

	As Given		As Calculated
8 barley corns =1 angulam= 1 viral	1-1/6 in	29·63 mm	29·65 mm
24 angulam= 1 carpenter's kol	28 in	71·12 cm	71·15 cm
4 kol=1 dandu	9-1/3 ft	2·845 m	2·846 m
1 sq. dandu = 1 perukkam	9·649 yd^2	8·068 m^2	8·10 m^2
40 perukkam= 1 para	385·96 yd^2	322·7 m^2	324 m^2
500 perukkam= =acre	4825 yd^2	4034 m^2	4050 m^2

If we assume that 500 perukkam are equal to 4050m^2, *i.e.* half of nivartana of 8100m^2 (*see* Table 5, Part 2), then the perukkam acquires a value of 8·10m^2. Taking the square root, the length of the dandu works out to 2·846 metres. This dandu is divided into 4 kol and the kol is further divided into angulam etc. Curiously enough, the Trivandrum table starts by defining the kol and arriving at the value of the half nivartana. While the Trichur table starts with the final unit of half nivartana and subdivides it to obtain the smaller units.

MYSORE

In the Mysore area, the khanduga and its subdivisions were used. We have considered these in detail in Part 3. A unit called kollaga was also used and is mentioned in inscriptions but no value of its estimate is available; 12 or 20 of it are supposed to make a khanduga.

Estimated Units

There are certain units of land area which are estimates and they vary depending on type of land, grain and so on. Even well-defined units are expressed as estimates. For example, the *Manual*[41] informs us that in North Arcot, the kani was supposed to be the land (irrigated) which required 63 Madras measures or 75 local measures to sow it. For unirrigated land, the kani was the area requiring 15-¾ Madras measures or 18-¼ local measures to sow it, the kani being unaltered in area. Another estimated area unit is the moody, in South Kanara, which was supposed to be the area requiring 60 seers (of 80 tola weight of rice) to sow it. The moody could also be 56, 50, 48, 45, 40 or 35 seers.

Our analysis so far would show that such estimated area measures had perhaps a basis in old traditions of area measures but it was lost sight of in the mind of the general public in the course of time.

Conclusion

On the basis of the argument in this article, we can now conclude that for the ordinary transactions involving length measures, a scale measuring 50cm was generally in use in the whole of South India; side by side, length measures derived for use in measuring land areas were also used for certain specialized purposes. The tradition of the use of the 50cm measure appears to have had a continuity spread over a few millenia.

So far as measurement of land areas is concerned the roots of the various practices go back to the *Arthasastra* and even earlier times. The twists and turns through which the principal area units passed, led to a variety of units which became difficult to understand as years and centuries passed. The tendency to adapt the few units to serve a large variety of interests led to an apparent confusion which is without parallel.

An immediate lesson for India is that it is highly undesirable to adapt the units of an otherwise well-ordered system of weights and measures to overcome some temporary difficulty or to serve as a prestige issue. The metric system, which can be regarded to a certain extent as a beautifully refined version of the ancient Indian tradition in metrology, has now been adopted in our country. We should not vitiate its simplicity, uniformity and the gradation of its units by abusing the various units to suit our temporary conveniences. The history of metrology in India serves as a stern warning to people who indulge in such activities.

This article, concluded with this Part, touches only the fringe of the vast field of Indian metrology. It is not possible to explain each and every variant of units of weights and measures. An attempt has, however, been made to search out the roots of Indian metrology and the subsequent developments of the metrological traditions in South India.

It is intended to analyse the length and and area measures in Western, Northern and Eastern India in subsequent series of articles.

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Prototype Approval Centre for India

In countries where the manufacture and use of weighing and measuring instruments are in an advanced stage of development, control is exercised by the Central Authority on the design and construction of weights, measures and instruments which are used in trade transactions. Instances are the United States, Canada, U.K., France, Belgium and other countries in Western and Eastern Europe. Before designing a new product, or making any change in the design of an existing product, the manufacturer sends particulars of the design, complete with drawings, to a Central Authority. He also sends a prototype. These are examined by the central authority, which subjects the prototype to rigorous tests laid down for the purpose. If the Authority is satisfied that weights measures and instruments manufactured according to the design would be suitable for use in trade, it issues an approval certificate. An Inspector of Weights and Measures would not accept a weight, measure or instrument which does not conform to an approved prototype.

Procedure in France

In France, all new designs as well as changes to existing designs are subject to approval by a Central Organisation. The manufacturer furnishes the Organisation full particulars of the design, material, and performance of the instruments. In cases where only minor changes in existing designs are proposed, approval is given after examining the drawings and studying the descriptive data. In cases of major changes in vital parts, and in all cases of new designs, a rapporteur of the Central Organiation visits the manufacturing establishment and tests patterns. Before giving final approval, he may also study the performance of the instrument under actual working conditions.

Practice in the U.K.

In the U.K. examination of prototypes has been in vogue since 1904. Recently the U.K. Weights and Measures Act, 1963, broadened the scope of this examination. Under the new Act, the equipment made according to the design should be of good quality, design, and in every case, 'suitable for use for trade'. The Board would have to examine its suitability having regard 'to the principles, materials, and methods used in construction.'

The approval of a pattern may be limited to a specified period. The Board may revoke a certificate once granted. They may lay down specifications for the guidance of examiners.

The manufacturer ordinarily sends a pattern for approval after conducting elaborate experiments in his workshop. The final experimental model is sent to the Board of Trade with a descriptive note and a general arrangement drawing, outlining constructional features. The Board examines the design and tests the model. They may dismantle the machine to satisfy themselves that the design features are acceptable and in conformity with specifications. The Board may

carry out weighing tests to check whether the machine is so designed that it can be verified by Inspectors without difficulty. If the Board's examination brings any undesirable features to light, the manufacturer's attention is drawn to them.

Adoption of the System in India

In India regulation of weights, measures and instruments is limited to their verification by Inspectors of Weights and Measures. There is no control at the stage of the prototype. The institution of a system of examination and approval of prototypes would be of benefit to manufacturers and users as well as to the enforcement staff. It would promote the manufacture of weights, measures and weighing and measuring instruments of high quality and reliability. Verification by Inspectors guarantees accuracy at the time of verification, but not of continued reliable service. The approval of the prototype before manufacture by a Central Authority would correct this defect and also eliminate all disputes between manufacturers and Inspectors regarding design features.

It was against this background that the 7th Conference of Controllers held in Delhi in August 1963 recommended that a Prototype Approval Centre may be set up in India. A Committee consisting of representatives of the Directorate of Weights and Measures, Controllers of Weights and Measures of States, the Mint, Bombay, National Physical Laboratory, Indian Standards Institution, the Directorate-General of Technical Development, and certain manufacturers of weighing and measuring instruments was set up.

This Committee met on 4 August 1964 at Calcutta and recommended the following :

(1) NPL Offer to Set Up Centre

It was unanimously agreed that a Central Authority for approving prototypes before regular production was a necessity. In view of the facilities available with them the NPL offered to take up the testing work.

(2) Specifications

The specifications drawn up by the ISI for weights etc. did not provide for type testing in every case. For this purpose more comprehensive specifications specifying tests for raw materials, components and performance of assemblies have to be drawn up. It was, therefore, agreed that ISI should prepare proposals for drawing up specifications to enable type approval of the simpler instruments to be taken up in the near future.

(3) Coverage of the Scheme

The present ISI specifications for weights, and capacity measures give details of design. Type approval of these items would be made voluntary in the beginning. For length measures, weighing and measuring instruments it should be made compulsory by law to submit new designs for type testing to the Central Authority. Existing designs would have to be submitted for approval within a phased but specified period.

(4) Legislation

Necessary changes would be made in the Weights and Measures (Enforcement) Acts of the States to recognise that only such weights etc. would be accepted for verification as have been approved after type testing by the Central Authority.

(5) Fees

Fees would be levied for type approval. The basis for charging fees would be decided later.

News & Views

Metric System in Cadastral Survey

The Second All India Cadastral Surveys Conference 1964 was held at Mussoorie on 22 and 23 June 1964, under the Chairmanship of Brigadier Gambhir Singh, Surveyor General of India. The Conference was attended by officials of the Survey of India, Directorate of Weights & Measures, Ministry of Commerce, and representatives of the State Governments.

Among the points discussed was one relating to conversion to metric system in cadastral survey work. After reviewing the work done in implementing the programme drawn up at the last Conference in 1957* and noting the progress achieved in many States and Union Territories, the Conference resolved to adopt the following programme for the future :

(1) On a number of cadastral survey maps in many States metric scales and conversion charts have been incorporated. The work will be completed in all States and Union Territories as early as possible and not later than 1-1-66. In States where there are separate field books which give the measurements of all the plots or where separate conversion scales have been supplied, the drawing of these scales may be dispensed with.

(2) When fresh land records are prepared during resettlement operations or when existing records are rewritten, areas will be expressed in metric system *i.e.* in hectares, ares and centiares. Areas in old units may also be retained, where necessary.

(3) During new and revision surveys, maps will be redrawn on metric scales. Existing maps will be brought on to metric scales by photographic reduction for the purpose. In States where no revision surveys are planned in the near future (say within next five years) the existing maps will be converted to metric scales, gradually according to convenience, so that maps on metric scales may become available when resurvey is due.

*See *Metric Measures*, Jan. 1958, p 26.

Second Meeting on Change-over to Metric System i Building Industry

The first Conference for the adoptior of the metric system in building, architectur and town planning was convened by th Ministry of Works & Housing in New Delh on 2 and 3 September 1959. The Conferenc had passed a number of resolutions and frame a three-phased programme for the imple mentation of the metric system in buildin industry.

As nearly five years have since passec the time was now ripe to convene a busines meeting to review the progress made so fa to discuss the difficulties experienced in th change-over and to formulate future pr gramme of action. The second meeting proposed to be held by the National Buildin

Organisation, New Delhi, some time in October 1964.

Engineers from various Public Works authorities, public sector undertakings, municipal corporations and representatives of architects, contractors and town planners would attend this meeting.

It is proposed to hold at the time of the meeting an exhibition of metric building products, survey and drawing equipments and codes and certain other publications which are available in metric units.

Clinical Thermometers

The Indian Standard Specification for Clinical Thermometers was finalised and approved for printing at the Fourth Meeting of the Laboratory Glassware and Related Apparatus Sectional Committee (CDC 33) of the Indian Standards Institution of 29 June 1964. Earlier on 25 and 26 June the Thermometer Subcommittee (CDC 33:2) considered the comments on the draft standard as a result of wide circulation.

There was considerable discussion whether the Fahrenheit scale should also be provided on the stem of the thermometer. In view of the fact that the metric change-over in industries has to be completed by April 1966 (See *Metric Measures*, July 1964, pp. 19-20) it was generally agreed that the Celsius (Centigrade) scale alone should be recognised. For the interim period *i.e.* up to April 1966, manufacturers may, if they so desire, inscribe the Fahrenheit scale in addition to the Celsius (Centigrade) scale on the upper side of the thermometer with the bulb to the left when the thermometer is held in the horizontal position, the Fahrenheit scale being marked only in whole degrees *i.e.* 96°, 97°, 98° F. After April 1966 the provision relating to the Fahrenheit scale would remain withdrawn.

The stem of the thermometer would be graduated from 35°C to 43°C, the subdivisions being at every 0·1°C. In the absence of data on average normal human body temperature in India, the indication for normal temperature would be located at 37·0°C.

Besides the above important details other technical requirements and methods of test of the thermometer were also finalised. It is expected that the standard specification will be printed shortly.

For familiarising the public with equivalents of the two scales, the conversion table given below may be used :

CONVERSION TABLE °C to °F

°C	0	·1	·2	·3	·4	·5	·6	·7	·8	·9
35	95·0	95·2	95·4	95·5	95·7	95·9	96·1	96·3	96·4	96·6
36	96·8	97·0	97·2	97·3	97·5	97·7	97·9	98·1	98·2	98·4
37	98·6	98·8	99·0	99·1	99·3	99·5	99·7	99·9	100·0	100·2
38	100·4	100·6	100·8	100·9	101·1	101·3	101·5	101·7	101·8	102·0
39	102·2	102·4	102·6	102·7	102·9	103·1	103·3	103·5	103·6	103·8
40	104·0	104·2	104·4	104·5	104·7	104·9	105·1	105·3	105·4	105·6
41	105·8	106·0	106·2	106·3	106·5	106·7	106·9	107·1	107·2	107·4
42	107·6	107·8	108·0	108·1	108·3	108·5	108·7	108·9	109·0	109·2
43	109·4									

Alcoholometers

At present the volume of alcohol (ethanol) in an alcohol-water mixture is determined by the use of Sykes' hydrometers and appropriate tables which give the concentration of alcohol in terms of British proof strength. At the time of the change-over to the metric system in the field of alcoholometry, suitable tables were not available. The old tables were, therefore, converted to metric units and used.

The problem of compiling suitable alcoholometric tables was engaging the attention of the Indian Standards Institution (ISI) since about a decade. After consulting international and national authorities, the ISI has now laid down appropriate tables for density, temperature correction, and strength of alcoholic solutions in terms of percentage by volume of ethanol at 15°C etc.

The use of these tables requires that 'centesimal' hydrometers, called alcoholometers, be used.

The Indian Standards Institutions Glassware Committee in its recent meeting approved for wide circulation a draft Indian Standard Specification for Glass Alcoholometers. In this specification two types of alcoholometers have been recognised, Type A and Type B. Type A alcoholometers would be divided into 10° ranges and would have 11 alcoholometers *i.e.* 0-10°, 10-20°,..... 90-100° and 95-105°, graduated at every 0·1°. There will be 4 alcoholometers, in type B, the range being 5° and would read from 0-5, 5-10, 10-15, 15-20° graduated at every 0·2°. The draft specification would be shortly put into wide circulation for comments and would be finalised in the next meeting of the Committee on the basis of comments received.

Autorikshaw Meters

The Indian Standards Institution has already standardized taximeters. It is expected that the printed standard will shortly be made available.

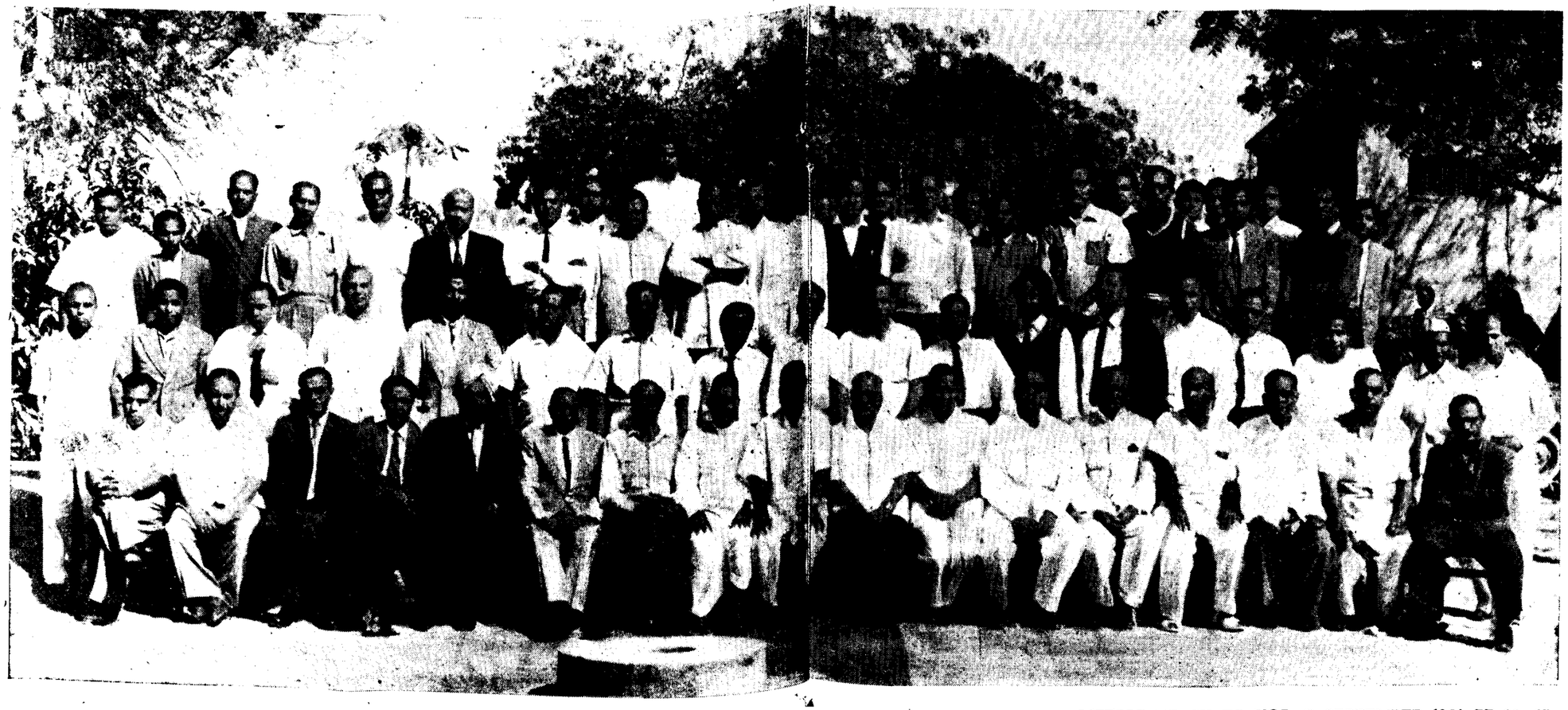
The Taximeter Subcommittee (EDC 41:3) has now taken up standardization of autorikshaw meters.

In many cities autorikshaws are the popular and cheap mode of public transport used by people. In some cities, the rates are arbitrarily fixed by the driver and passenger and arguments ensue. In other cities, the rate is fixed but the reading of distance has to be made on the basis of the odometer and the fare looked up in a table.

In view of the popularity of this vehicle, the need has been felt to provide them with autorikshaw meters which could indicate the fare and avoid disputes and possibility of cheating. The ISI, therefore, took up standardization of suitable meters.

A meeting of the Subcommittee was held in Bangalore on 8 July 1964 to consider this problem. The Subcommittee decided to standardize two types of meters. In one type only the fare for the distance travelled is indicated. The waiting time charges are not indicated on the meter. The second type is a miniature taximeter wherein the distance and detention charges are both added up. The simple fare-meter has been taken up for immediate standardization in order to provide a simple and cheap instrument which the autorikshaw owner can afford. In this meter the total kilometres travelled, the speed indicator and the fare meter are all shown on one dial. The mechanism for calculating detention charges is not included in this meter. A device will also be provided to indicate to the intending traveller whether the autorikshaw

Group Photograph Taken on the Occasion of the Eighth Conference of Controllers of Weights and Measures at Agra, 5-7 March 1964



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is for hire or not. The draft standard specification would shortly be put into wide circulation for comments.

Data for standardization of the second type of autorikshaw meters is being gathered and would be processed into a draft specification in due course.

New Plasma Thermometer

A notable forward step in controlled fusion research is the development, at the General Electric Research Laboratory, Schenectady, of a new technique for measuring ultra-high temperatures of the order of millions of degrees. The technique takes advantage of the 'trace' impurities of oxygen and carbon existing in hot deuterium plasmas usually employed in fusion research.

Significant advances have been announced recently by both Russian and American scientists in the realization of highly stable, high-temperature plasmas. The development of the new technique provides the necessary means (a plasma thermometer) of accurate measurement of temperatures in the million degree range which was extremely difficult till now.

To heat the plasma up to ultra-high temperatures, a strong magnetic field in the form of a 'magnetic bottle' is used to compress the plasma. An intense electric discharge is created during this process which then strips some electrons from the 'impurity' atoms of oxygen and carbon. Measurements on the visible and ultraviolet radiations that are emitted as the electrons are torn loose are used to determine the temperature.

This technique has revealed that different types of particles in the plasma are not equally heated. The rapid magnetic compression causes the atomic nuclei to heat much faster than the electrons. Employing this technique it has been found that when the electrons reach a temperature of c. 3 million °C., the nuclei are energized to more than 10 million °C. This phenomenon is highly beneficial as the fusion reactions themselves result from the collisions of atomic nuclei [*Discovery* 24(9) (1963)6; *J. Sci. Industr. Res.* 23 (6) (1964) 264].

South Africa to go Metric?

News reports we have received recently indicate that the possibility of South Africa adopting the metric system is increasing. A Commission is shortly to publish its report on the estimated cost of a change, with its recommendations thereon. It is thought that the recommendation might be in favour of the metric system and if this is so, a Government spokesman has said there are unlikely to be any legal obstacles. (*Monthly Review, April* 1964, p 87).

Book Review

GUIDE TO METRIC SYSTEM IN TIMBER TRADE (English & Gujerati) published by the Bombay Timber Merchants Association Ltd., Victoria Road, Mustafa Bazar, Bombay 10; pp 66; Jan. 1964; Price not given.

The Book contains some valuable tables which are of direct use in day to day commercial transactions in timber trade. The first table gives direct conversions like 1 cm= 0·3937 inch and *vice versa*, or relation of cubic metre to other cubic units etc.

The second table is for direct conversion of inches to centimetres, values ranging from 3/8 in to 24 in, the cm figures being rounded off to the nearest cm after 1 in. The third table is for conversion of stock sizes of sawn timber. The existing inch sizes have been converted according to Table 2 to metric dimensions and volumes indicated in cubic decimetres for lengths of 10, 5, and 1 metre and 10 cm and 5 cm. The inch sizes range from $1'' \times \frac{1}{2}''$ to $18'' \times 18''$. The dm^3 figures are given to 3 places of decimals. The next table gives conversion of prices from the cubic foot to 10 cubic decimetres by steps of 25 P, from Re. 1 to Rs. 38 per cu. ft. A table showing conversion of prices from 1 ton to 1 cubic metre is also included, the range being Rs. 100 to Rs. 1000, in steps to Rs. 5.

A useful table showing 'new' sizes of timber in cm, and giving corresponding volume in dm^3 for lengths of 10m, 5 m, 1 m and 10 cm is also included. This table covers such items as battens and packing planks, reepers, scantlings, planks, flitches, posts, beams etc. The final table shows the comparative suitability of Indian timbers expressed as percentages of teak with relevant particulars.

Informative introductory notes explaining how the tables should be used are given for every table. These facilitate comprehension of the proper use of the new system.

The Government of India has recommended that the cubic metre should be used for pricing and other connected work. The use of 1/10 or 1/100 of the cubic metre as a unit was discouraged. These tables contain, however, a table indicating conversion of prices per cubic foot to 10 cubic decimetres *i.e.* 1/100 cubic metre. In view of the Government of India's recommendation, it is to be hoped that this particular table would be replaced by a new one. When we adopt the metric system, we should adopt it with all its implications. The use of fractions of the cubic metre as pricing units should be avoided if the adoption of the metric system in the timber trade is to be meaningful.

In other respects, this book is a mine of information and would be useful to those engaged in the timber trade.

VOLUME TABLES FOR ROUND OR SQUARED TIMBER UNDER METRIC SYSTEM (Part II)—Compiled by T. Janaky; Published by Bharathee Bhooshanam Press, Viyyur (P.O.), Trichur, Kerala; pp 321-661; March, 1964; Price Rs. 8.00.

This is Part II of the excellent volume compiled by Shri Janaky. Part I was reviewed in *Metric Measures*, Vol. 7, No. 2, p 31.

Part II carries forward the tables given in Part I. In this Part, girths from 181 cm to 500 cm have been covered. The pattern of presentation is the same as in Part I. The lengths are given in steps of 5 cm from 5 cm to 15 metres for each girth up to 200 cm. After that the tables go up to a length of 7·50 metres.

It is to be hoped that in the second edition, minor errors like use of wrong abbreviations *e.g.* c. ms. for cm etc. would be avoided. Otherwise, the presentation is handy and useful.

The volume tables have been approved for use of the Kerala Forest Department. There is no doubt that the tables are useful. Other States may also examine them for adoption.

THE TABLE OF THE AREA OF CIRCLES IN LITRES First Part (From 2.5 cm to 500 cm); Prepared and published by Sri U.C. Sarmah, Tinsukia, Assam; 1962; pp 25; Price Rs. 1.75.

The change-over to the metric system in the alcohol industry is complicated because in many cases the very basis of calculations has to be altered completely. It has also a financial aspect for the State as when gauging is required for excise purposes. The old tables cannot be used as they are based on the inch and the gallon. New tables have to be prepared. One such field is the recalibration of vats and tanks in distilleries and spirit warehouses. New tables had to be prepared based on the centimetre and the litre.

Shri U.C. Sarmah, Retired Excise Assistant of the Tinsukia Spirit Warehouse, Assam and Government Authorized Tank and Vat Calibrator, has brought his 30 years' experience to bear on the preparation of useful data for the Excise Department. This book gives the areas of circles in litres of one centimetre depth of a circular base. The assumption is that the vat is a perfect cylinder. The volume of one centimetre depth for a given diameter is then :

$$\frac{0{\cdot}7854 \times \textit{diameter (cm)} \times \textit{diameter (cm)}}{1000{\cdot}028} = \text{litres.}$$

The present tables in Part 1 range from 2·5 cm to 500 cm, by steps of one millimetre. It is obvious that the compiler has taken great pains to put together some 5,000 values, check and recheck them. Values have been given in litres to 4 places of decimals so that rounding off can be carried out by the user according to practice.

The second part, to be published shortly, will cover the range from 501 cm to 1000 cm.

There can be no doubt that Shri Sarmah has done a great service to the alcohol industry in its change-over. It is hoped that his service will be adequately utilized by the industry and others concerned

CORRECTIONS

Please note the following corrections in the July 1964 issue.

(1) On p 20, in place of the present item (1) New Industrial Enterprises, read as follows :

'Promoters of new industrial enterprises are advised to have the products and, to the extent possible, the machinery installed, designed on the metric system.

(2) p 22, abbreviation for micro is μ, and for micron μm. For हैक्टो read हेक्टो.

(3) p 23, for डैसिमीटर and हैक्टोमीटर, read डेसिमीटर and हेक्टोमीटर. Insert cubic hectometre, hm^3, घन हेक्टोमीटर, हेमी^{3}, घन हेमी.

(4) p 24, for (microgram) Mg read μg

(5) p 25, for 1 July 1960, in caption of first paragraph, read 1 July 1964.

Standards News

(Indian Standards which have a particular bearing on the change-over to the metric system are indicated here. Copies would be available from the Indian Standards Institution, Manak Bhawan, 9, Bahadur Shah Zafar Marg, New Delhi or their Branch Offices at Bombay, Calcutta, Kanpur and Madras.)

Hot-Rolled Mild Steel Strip for Cold-Reduced Tin plate (Draft).

Indian Standards Institution has prepared *draft* Indian Standard Specification for Hot-Rolled Mild Steel Strip for Cold-Reduced Tinplate [Doc: SMDC 5(416)], which covers the requirements for three grades of hot-rolled mild steel strip, namely (a) Deep drawing, (*b*) Ordinary temper, and (*c*) High temper.

The draft standard will be circulated shortly to those interested for technical comments.

Dimensions of Tables for General Office Purposes (Draft).

Indian Standards Institution has prepared *draft* Indian Standard Specification for Dimensions of Tables for General Office Purposes [Doc: BDC 35(437)], which covers the dimensions of tables for general office purposes.

The need for this standard has been felt for quite some time in relation to various sizes of furniture particularly office tables to be ordered by various Government Departments. The table top sizes have been specified taking into consideration the relevant standards on plywood, blockboards, hard boards, steel and aluminium sheet specifications. In sofar as the office tables are concerned, the proposal is restricted only to single pedestal type on the left hand side of the seat (though the sizes specified may permit two pedestals). Special large size tables have not been included in this. It is strongly suggested that no knee hole drawer be specified at all, since it is not convenient.

The knee space dimensions are based on chair dimensions assuming a height of 430 mm, the minimum width of seat of 400 mm measured at the point midway along with the depth of the seat. The Committee is actively considering the question of relating the dimensions of furniture to the anthropometric requirements of the Indian people in general. For this, data are now being collected. In the meantime, the dimensions, particularly in plan for table tops are related to the module of 10 cm.

The draft standard will be circulated shortly to all interests concerned for eliciting technical comments.

Heavy Cee Jute Bags and Jute Corn Sacks (Draft)

Indian Standards Institution has prepared two *draft* Indian Standard Specifications for :

(*i*) Heavy Cee Jute Bags [Doc: TDC 41 (765)], and

(*ii*) Jute Corn Sacks [Doc: TDC 41(766)].

Doc: TDC 41(765) prescribes the requirements for heavy cee jute bags of dimensions 102×71 cm (or 40×28 in).

Doc: TDC 41(766) prescribes the requirements for jute corn sacks (or jute corn bags) of dimensions 104×58 cm (or 41×23 in).

These draft standards are being circulated for eliciting technical comments.

Commercial Metric Weights (Draft)

The Indian Standards Institution has prepared *draft* Indian Standard Specification for Commercial Metric Weights [Doc: EDC 41 (923); Revision of IS: 1056-1957].

IS:1056, which was first published in 1957, prescribes the requirements for metric solid and sheet metal weights intended for use in normal commercial transactions. It does not cover proportional weights that are used, for instance, in certain types of weighing machines, weighbridges etc.

Main modifications made in the present revision are as follows:

(*a*) In order to conserve strategic imported material such as copper, zinc, tin, etc. non-bullion flat cylindrical weights have been eliminated;

(*b*) 50 g and 20 g cast iron and mild steel weights have been recognised; and

(*c*) Dimensions of weights have been revised in many instances.

The draft standard will be circulated shortly for eliciting technical comments.

Hard Drawn Carbon Steel Wire for Spring for General Engineering Purposes

The Indian Standards Institution has published the first revision of Indian Standard Specification for Hard Drawn Carbon Steel Wire for Spring for General Engineering Purposes (IS:727—1964), which lays down the requirements for hard drawn carbon steel wire for springs for general engineering purposes.

This standard was first issued in 1955. Based on the experience gained in the use of this standard during the last nine years, the Sectional Committee decided to revise this standard.

In this revision, besides metricization, the tensile properties and chemical composition have been brought in line with IS:1570—1961 Schedules for Wrought Steels for General Engineering Purposes.

Price Rs. 2.00

Withdrawal of IS:1138—1958 Sizes of Metal Strip, Sheet, Bars (Round and Square), Flats and Plate (For Structural and General Engineering Purposes)

It has been decided to withdraw IS: 1138—1958 Sizes of Metal Strip, Sheet, Bars (Round and Square), Flats and Plate (for structural and General Engineering Purposes) as separate standards for sizes of steel products, copper and copper alloy products, and aluminium and aluminium alloy products have been taken up for formulation.

The sizes of steel products have already been finalized and published. Dimensional standards for aluminium and aluminium alloy products have been finalized and are under print, while the dimensional standards for copper and copper alloy products have recently been finalized by the Copper and Copper Alloys Section Committee, SMDC 11.

Licensed Manufacturers and Repairers

(*Metric Measure* had been publishing in the past a series of lists of licensed manufacturers, dealers and repairers of weights and measures, weighing and measuring instruments licensed by the Governments in the various States and Union Territories under their Weights and Measures (Enforcement) Acts. To economise on paper, it is possible only to publish lists of licensed manufacturers and repairers.

A feature on statistics of verification and licences issued is also being published in *Metric Measures*.)

STATISTICS OF VERIFICATION OF WEIGHTS ETC., AND LICENCES

States/Union Territories	Period	Weights	Capacity Measures	Length Measures	Weighing Instruments	Measuring Instruments	Others	Total number of Mfrs.	Dealers	Repairers
(1) Andhra Pradesh	1 Feb. 64 to 31 May 64	2,00,101	64,362	6,408	21,747	527	26	14	59	24
(2) Assam ..	1 Feb. 64 to 31 May 64	1,60,587	31,022	1,480	3,345	50	—	18	248	129
(3) Bihar ..	1 April 62 to 31 Jan. 63	1,28,211	—	—	19,309	56	—	30	203	43
(4) Gujarat ..	1 Dec. 63 to 31 June 64	1,97,859	20,966	2,390	30,175	148	—	2	6	5
(5) Kerala ..	1 April 62 to 31 July 62	—	—	—	—	—	—	73	459	142
(6) Jammu & Kashmir	1 April 63 to 31 March 64	2,12,854	2,582	7,511	683	..3	4	36	36	2
(7) Madhya Pradesh	1 April 62 to 30 Nov. 63	12,76,615	2,15,103	16,837	*q* 41,920	457	—	60	462	46
(8) Madras ..	NA	—	—	—	—	—	—	—	—	—
(9) Maharashtra	1 April 62 to 31 March 63	1,874,286	5,37,135	33,988	—	—	—	—	—	—
(10) Mysore ..	1 April 62 to 31 Nov. 62	4,81,345	1,05,253	1,089	1,596	2	—	8	103	6
(11) Punjab ..	1 Feb. 64 to 31 March 64	1,18,584	5,732	4,121	14,993	127	—	—	4	3

States/Union Territories	Period	Weights	Capacity Measures	Length Measures	Weighing Instruments	Measuring Instruments	Others	Total number of Mfrs.	Dealers	Repairers
(12) Orissa ..	Jan. 63 to May 64	1,97,851	30,025	1,055	4,891	77	—	8	103	6
(13) Rajasthan	N.A.	—	—	—	—	—	—	—	—	—
(14) Uttar Pradesh	1 June 63 to 30 Nov. 63	8,95,335	8,897	20,506	7,505	278	—	200	979	187
(15) West Bengal	1 May 64 to 4 July 64	1,47,955	12,077	757	19,229	—	—	—	—	—
(16) Andaman & Nicobar Islands.	N.A.	—	—	—	—	—	—	—	—	—
(17) Delhi ..	1 Dec. 63 to 31 May 64	1,24,031	9,021	1,984	15,924	172		66	26	71
(18) Goa	1 April 64 to 31 May 64	13,523	1,012	23	26	—	—	—	353	—
(19) Himachal Pradesh	1 April 62 to 31 July 63	68,020	7,411	2,532	10,628	1	—	1	25	12
(20) L.M.A. Islands	N.A.	—	—	—	—	—	—	—	—	—
(21) Manipur ..	1 April 64 to 31 May 64	1,660	54	—	135	3 (Tanklorry)	—	—	—	—
(22) Pondicherry	1 Feb. 64 to 31 March 64	4,038	1,341	36	21	4	37 (Peg measures)	4	10	3
(23) Tripura ..	1 April 62 to 30 July 62	62,050	8,464	720	9	8	—	4	85	3

N.A.—Statistics not available as yet.

KERALA

Manufacturers and Repairers licensed from 1.4.1964 to 30.6.1964

MANUFACTURERS

Sl. No.	Name and Address of Manufacturers	Details of Articles Manufactured
(1)	Ashoka Foundry & Engineering Works, Pappanam Code, Trivandrum.	Cast Iron Weights.
(2)	Chathurthy Metal Industries, Mulanthuruthy, Ernakulam	Beam Scales Class C. & D.
(3)	H.S.M.A. Kader, H.J.T. Industries, T.C. 37/712, Valyasala, Trivandrum.	Beam Scales Class C. & D.
(4)	M. V. Kunjan, Mangalathu House, Thalacode Post, Trippunithena, Ernakulam.	Beam Scales Class C. & D.
(5)	P. B. Natarajan Chettiar, Setra Industries, Multan Bazar, Shertalai, Alleppey.	Beam Scales Class C. & D.

Sl. No.	Name and Address of Manufacturers	Details of Articles Manufactured
(6)	K. M. Ponnappanasary, Lakshmi House, South Aryad, Ashramamward, Alleppey.	Beam Scales Class C. & D.
(7)	Rafia Industries, Prof. Shri A. F. Meeran, Karnmkara, M.M.C. IV 96, Murattupuzha, Ernakulam.	Beam Scales Class C. & D.
(8)	Three Kings Metal Industries, Anchalpetty P.O., Via, Murattupuzha.	Beam Scales Class C. & D.
(9)	S. Velayudhan Achary, Pullathottathu Thekkathil Veedu, Punnathala, Quilon.	Beam Scales Class C. & D.

Repairers

(1) K. Anandan, Valathuthekethil Veedu, Pannivizha, Adoor.
(2) K. Damodaran, Kambiakathu Veedu, Mararikulam, N. Kanjikuzhi, S. L. Puram P.O.
(3) M. I. John, C/o K.V. Mathew & co., Govt. Wiring Contractors, and Engg. K.K. Road, Kottyam.
(4) K. P. Kani Rowther, Tin Manufacturing Co., Athirampuzha.
(5) Musaliar Industries (P) Ltd., Quilon-4
(6) Panoli Aydross, S/o Alavi Tin Maker, Eastern Road, Manjeri.
(7) P. Padmanabhan Achari, Lakshmivilasom, T.C. 983, Manacaud, Trivandrum.
(8) The Southern Scale Services, Kozhikode.
(9) B. Subramaniam, Proprietor, Sree Murugare Scale Service, Vegetable Market, Kottyam.
(10) Veliyam Parambil Cheeku, Onsep[illegible]thala Village, Cranganoor.

WEST BENGAL

Manufacturers

Sl. No.	Name and Address of Manufacturer	Details of Articles Manufactured
(1)	Avery [illegible] of India Private Ltd., 28/2, Waterloo Street, Calcutta	Beam Scale Weighing Machine,
(2)	Asiatic [illegible]hinery Corpn. (P) Ltd., 10/1, Kailaschandra Lane P.O. [illegible]gachi, Howrah.	CI. and Brass Weights. All types of Weighing Instruments
(3)	Balai Engineering Works, 82, Prem Chandra Bara St., Calcutta-12	Metallic Linear Measures.
(4)	Balai Chandra Das, 54/1/H/3, Sura East Rd., Calcutta-10	Beam Scales.
(5)	Banka Behari Laha, Bahabazar, Rajiganj, Burdwan, Asansol ..	Beam Scale (Class C&D)
(6)	Barangar Mechanical Industries, 295, Maharaja Nanda Kumar Road, Baranagar, Calcutta.	Brass Beam Scale, Brass Weights (Bullion & Non-Bullion Sheet Metal Weights)
(7)	Bag & Co. 239, Duttabad, Calcutta-48 (Barrackpore)	Beam Scale.
(8)	Bharati Scales & Engineering Co 4/1, Halder Para Lane, Howrah	C.I. Weights, Weighing Instruments and Beam Scales.
(9)	Bhagyadevi Factory, (Foundry Division) Shanpur, Dassnagar, Howrah.	C.I. Weights.
(10)	Balai Engineering Works, Prop. Sri Balai Talikdar, 82, Prem Chand Boral Street, Calcutta-12.	Metallic Linear Meassures.

Manufacturers—(contd.)

Sl. No.	Name and Address of Manufacturers	Details of Articles Manufactured
(11)	Bengal Chemical & Pharmaceutical Works, 164, Manicktala Main Road, Calcutta-11.	Precision Balance Metallic Volume Measures & Beam Scales (Class A&D).
(12)	Bharat Weighing Scales & Engineering, 75, Mala Chand Nandy Lane, Howrah.	All types of weighing Instruments including Beam Scales.
(13)	Bengal Steel Industries, 6, Kumarpara Road, Lilooah	Cast Iron Weights.
(14)	Calcutta Balance & Weight Works, 197, Maharaja Nanda Kumar Road (South), Calcutta-36 (Barrackpore).	Beam Scales & Brass Weights, (Bullion & Non-Bullion Sheet Metal Weights).
(15)	Diamond Metallic Tape Co., 385, Beeharam Chatterjee Road, Behala, Calcutta-34.	Woven Metallic Tapes, Steel Tapes and Wooden Scales.
(16)	Durga Galvanised Works, 7, Raja Naba Kissen St., Calcutta-5 ..	Capacity Measures.
(17)	Dinesh Chandra Karmakar, 74/4 Charak Danda Road, Calcutta-10	Beam Scales.
(18)	Dutson Engineering Corporation Private Ltd., 5, Mahendra Chandra Dutta Garden Road, Dum Dum, Calcutta-30.	C.I. Weights, Brass Weights, Weighing Instruments and Litre Measures.
(19)	M. C. Das & Bros., 10/18, Brindaban Mullick Lane, Howrah ..	All types of weighing instruments.
(20)	Dhirendra Nath Ghosh, 4, Hem Dey Lane, Calcutta-50	Beam Scales.
(21)	Dhirendra Metal Works, 7/1 Beneras Road, Howrah	Capacity Measures.
(22)	H. P. Das & Co., 22, Sree Gopal Mullick Road, Ariadah, 24 Parganas.	Beam Scales, Bullion and Non-Bullion Brass Weights.
(23)	D. C. Dey & Sons, 150, Narasingha Dutta Road, Howrah ..	Cast Iron Weights.
(24)	Durga Galvanised Works, 7, Raja Naba Krishna Street, Calcutta-5	Cast Iron Weights.
(25)	Dragon Iron Works, 31, Kissenlal Burman Road, Salkia, Howrah	Cast Iron Weights.
(26)	East Indian Engineering & Agency Co. 63/1 Beneras Road, North Bantra, Howrah.	C.I. Weights.
(27)	East India Metal Co. Private Ltd., 41/1B, Ram Kanta Bose Street, Calcutta-3.	C.I. Weights.
(28)	Education Emporium, 188/77, Prince Anwar Shah Road, Calcutta-31.	Precision Balance and Weights for Laboratory purposes.
(29)	Electro Gas Welding Co., Panihati, B. T. Road, 24 Parganas, (Barrackpore).	Beam Scales.
(30)	Eastern Weighing Machine Co., 89, Kasundia Road, Howrah ..	Counter Machine.
(31)	Eastern Scales Private Ltd., 12, Gurusadya Road, Calcutta-19 ..	Beam Scales, Class A & B and Brass Weights.
(32)	Economic Scientific Works, 97, A. Sree Ram Dhaug Road, Salkia, Howrah.	Beam Scales Class A & B and Brass Weights.
(33)	Free India Scales Corporation, 76/1, Beneras Road, Howrah ..	Weighing Instruments.
(34)	P. C. Ghosh & Sons, 21, Brindaban Mullick Lane, Howrah ..	C.I. Weights.
(35)	Girish Chandra Ghosh, 37, B.T. Road, Calcutta	Beam Scales, Counter Scales, Brass Weights, Bullion Weight, Litre and Linear Measures.

Manufacturers—(contd.)

Sl. No.	Name and Address of Manufacturers	Details of Articles Manufactured
(36)	A. C. Ghosh, 114, Makardah Road, Howrah	C.I. Weights.
(37)	General Metal Industries, 185/1A, Bepin Behari Ganguly Street, Calcutta-12.	Capacity Measures.
(38)	Gopal Chandra Das, 98/H/B, Charakdanga Road, Calcutta-10 ..	Beam Scales.
(39)	Great Eastern Machine, House Private Ltd., Dassnagar, P. 85, Beneras Road, Belgachia, Howrah.	C.I. Weights.
(40)	D. Ghosh & Co., 36, Bholanath Nath St., Calcutta-36 (B. K. Pore).	Beam Scales Class C & D.
(41)	Gopal Chandra Karmakar & Sons, 16/B, Tarak Bose Lane, Calcutta-2.	Beam Scales only.
(42)	Gopal Chandra Karmakar & Co., 16/C, Tarak Bose Lane, Calcutta-2.	Beam Scale.
(43)	Girish Chandra Ghosh, 37, B.T. Road, Calcutta-2	Beam Scales, Counter Scales, Brass Weights.
(44)	Ganga Iron & Galvanizing Works P. Ltd., 94, 'O' Road, Belgachia, Dassnagar, Howrah.	Cast Iron Weights.
(45)	A. C. Ghosh, 114, Makardah Road, Howrah	Cast Iron Weights.
(46)	A. K. Ghosh, 9, Natabar Paul Road, Kadamtala, Howrah	Non-Bullion Brass Weights.
(47)	India Scale Co., 74, Diamond Harbour Road, Calcutta	Beam Scales, Class C. & D.
(48)	Indian Machinery Co. Ltd., Dassnagar, Howrah	All Kinds of Weighing Instruments including Beam Scales, Cast Iron and Brass weights.
(49)	B. N. Industrial Corporation, 16, Motilal Gupta Road, Calcutta-8	Brass Weights.
(50)	Howrah Engineering & Galvanizing Works, 68, Beneras Road, Howrah.	C.I. Weights.
(51)	Jeewanlal (1929) Ltd., 95, G.T. Road, Belur, Howrah	All types of Litre measures.
(52)	Jewel Engineering Works, 10, Lower Chitpur Road, Calcutta-1 ..	Persons Weighing Scale.
(53)	James Scales & Engineering Co., 54/1/1 Kasundia Road, Howrah	Platform Machines.
(54)	Karmakar & Co., 76, D.H. Road, Barisha, Calcutta-8 (24 Pargs.) ..	Beam Scales, Class C & D.
(55)	Kali Iron Foundry, Shanpur, Makardah Road, Howrah	C.I. Weights.
(56)	Martick Chandra Das, 4/B, Jackson Lane, Calcutta-10	Litre Measures.
(57)	Karmakar & Co., 5, Sashi Bhuson Banerjee Road, Rarisha, Calcutta-8 (24 Pargs.)	Beam Scales, Class (C & D)
(58)	Kundu Sett & Co., 16, Ram Charan Sett Road, Ram Rajatola, P. O. Santragachi, Howrah.	C.I. Weights.
(59)	Kusheri & Co., 71/a, Dharmatala Street, P.O. Ghusuri, Howrah ..	Brass & Bronze Weights (Both Bullion & Non-Bullion).
(60)	R. K. Karmarkar & Sons, P.O. Mahula, Murshidabad	Beam Scales.
(61)	Kollay Engineering Works, Ichapur Road, Dassnagar, Howrah ..	Beam Scales (Class C & D.)
(62)	Krishna Iron and Steel Enterprises, 29 & 38 Chawk Para Road, Lilooah, Howrah.	Cast Iron Weights.
(63)	Kumar & Co., Prop. Sri S. Kumar, 11, Broad Street, Calcutta-19.	Conical Measures.

Manufacturers—(contd.)

Sl. No.	Name and address of Manufacturers	Details of Articles Manufactured
(64)	Krishna (P) Ltd., 39, G.T. Road, Lillooah, Howrah	Cast Iron Weights.
(65)	Laxmi Narayan Scale Industries, 26, Ratan Babu Road Calcutta-2	Metre, Litre and Beam Scales.
(66)	Luxmi Scale Works, 41, Chandi Charan Banerjee, Lane, Calcutta-35.	Brass Weights, Beam Scales and Counter Scales.
(67)	Lakshmi Foundry Works Private Ltd., 67, Beneras Road, Howrah	C.I. Weights.
(68)	Lilooah Iron Works, 6, Gaha Park, Lilooah, Howrah	Cast Iron Brass Weights
(69)	Laha Lalabazar, Bankura Town, Bankura (S)	Beam Scales.
(70)	Metric Scale Manufacturers and Repairers, P.O. Kolaghat, Puratan Bazar, Midnapore (Tamluk).	Beam Scales.
(71)	Monoranjan Karmakar, P.O. Nowbhanga, P.S. Bhangore, 24-Parganas.	Beam Scales Class C. & D.
(72)	Matiari Karmakar Samabay Samity Ltd., Vill. Maliari, P.O. Dhuturdah, 24-Parganas. (Basirhat).	Beam Scales, (C. & D.).
(73)	Majedar Rahman Molla & Son, P.O. Galsi, G.T. Road, Burdwan (S).	C.I. Weights.
(74)	Mahip Ram Shaw, 31/2, Kali Banerjee Lane, Howrah	Non-Bullion Brass Weights.
(75)	Naba Kumar Routh, P-33, Beneras Road, (2) 50/1, Fakirbagan Lane, Howrah.	C.I. Weights, Metallic Commercial Length Measures, Capacity Measures & (Dipping and Pouring.)
(76)	Nandi Keswari Iron Foundry Private Ltd., 10K Road, Belgachia, Howrah, Dassnagar.	C.I. Weights.
(77)	Nagendra Nath Karmakar, C/o Wooma Charan Karmakar, 16 & 17, Narikeldanga Main Road, Calcutta-11.	Beam Scale & Counter Scale.
(78)	Naresh Chandra Karmakar, 426, Jessore Road, Pantipukur, Barrackpore, 24-Parganas.	Beam Scales.
(79)	Nil Kanta Ray, 13/1 Radha Madhab Dutta Garden Lane, Calcutta-10.	Iron Beam Scale (C. & D.)
(80)	S. K. Nath, 8, Ratan Babu Road, Calcutta-2	Bullion Weights, Counter Scales, Brass Beam Scale, Brass Weights Non-Bullion Sheet metal weights (Bullion & Non Bullion).
(81)	Ram Raja Galvanizing Works, Ram Charan Sett Road, Ram Rajatola, Howrah.	Capacity Measures
(82)	Ram Kumar Agarwala, 88/A, Madan Mohan Barman St., Calcutta-7	Metallic Linear Measures.
(83)	Rohtak Weighing Machine & Engineering Co., 134/11, Kasundia, Howrah.	Counter Scales.
(84)	Progressive Engineering Co., Duttabad, Calcutta-48, Barrackpore ..	Iron Beam Scales, Class C. & D.
(85)	Poddar Iron Industries, V. Road, P.O. Dassnagar, Howrah ..	Cast Iron Weights.
(86)	Pioneer Engineering Scale Co. Cast Iron Ananda Karan Baltikuri, Howrah.	Cast Iron Weights.

Manufacturers (concld.)

Sl. No.	Name and Address of Manufacturers	Details of Articles Manufactured
(87)	Roy Engineering Works, 220, Netaji Subhas Road, Howrah ..	Brass Weights (Non-Bullion)
(88)	W. B. Scales Co. Private Ltd., 10, Kailash Chandra Lane, Santragachi, Howrah.	All types of Weighing Instruments including Beam Scales and C.I. Wts.
(89)	Satish Chandra Das & Sons., 23/1, 25A, Ratan Babu Road, Calcutta-2	Brass and Steel Metal Weights, Beam Scales and Counter Scales.
(90)	Sasanta Kumar Paul, 80, Institute Lane, Calcutta-36 (Barrackpore)	Brass Weights, Bullion & Non-Bullion Sheet Metal Weights (Bullion & Non-Bullion).
(91)	K. C. Samanta & Co., 19, Atul Krishna Bose Lane, Calcutta-36 (B. K. Pore).	Counter Balance Beam Scale Brass Weights (Bullion) Steel Metal Weights, (Bullion and Non-Bullion), Length Measure and Iron & Steel Weights.
(92)	Santosh Kumar Mandal, 13/11, Radha Madhab Dutta Garden (Small) Lane, Calcutta-10	Iron Beam Scales (Small).
(93)	B. K. Shaw Industries (P) Ltd., 10, Jessore Road, Calcutta-28 (Barrackpore), 24-Parganas.	Dispensing Measures.
(94)	Sankar Engineering Co., Prop. Sri Kamal Das, Sri A. P. Roy, Shri Amat Bose, 16A, Haldarpara Lane, Howrah.	Brass Weights & Beam Scales.
(95)	Tarak Nath Paul, 20, Abinash Sashmal Lane, Calcutta-10	Beam Scale, Class C. & D. (1 kg., 2 kg., 5 kg.).
(96)	Tulsi Charan Karmakar, 92, Diamond Harbour Road, Barisa, 24-Parganas.	Beam Scales.
(97)	Wooma Charan Karmakar, C/o Barindra Lal Karmakar, 22D/23A, Narikeldanga Main Road, Calcutta-11.	Beam Scales & Counter Scales.
(98)	Wooma Charan Karmakar, Dwijendra Lal Karmakar, 22D, 23A, Narikeldanga Main Road, Calcutta-11.	Beam Scales.
(99)	Wooma Charan Karmakar, 22D, 23A, Narikeldanga Main Road, Calcutta-11.	Weighing instruments including Beam Scales, Brass Weights (Non-Bullion).
(100)	Wooma Charan Karmakar, C/o Jogendra Nath Karmakar, 23/C, Narikeldanga Main Road, Calcutta-11.	Beam Scale.
(101)	Wooma Charan Karmakar, C/o Balai Chandra & Others, 23/B, Narikeldanga Main Road, Calcutta-11	Beam Scale (C. & D.) Vibrating type Counter Scale Brass Weight Bullion and Non-Bullion) and C.I. Weights.

CORRECTION

On page 19 of Vol 7, January 1964, *Metric Measures* under "How to use the Tables" second line, *read* "girth 175 cm."

M67DPD/64—GIPF.

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TYPICAL METRIC PRICING UNITS FOR WHOLESALE TRANSACTIONS

Serial No.	Commodity	Metric Unit
		10 grams (g)
(1)	**Gold**	
(2)	**Grocery and Confectionery** Biscuits, sweetmeats, cardamoms.	
	Textiles and Textile Fibres Cotton yarn, damaged and seconds cloth, raw silk, rayon silk yarn, raw wool, wool manufactures (when sold by weight).	1 kilogram (kg)
	Paints & Chemicals Paint (if sold by weight), indigo, liquid chlorine.	
	Hides, Skins & Leather Raw hides, leather (hides and skins).	
	Metals Silver, aluminium sheets, strips and circles, copper and brass wires and utensils.	
	Miscellaneous Tea, meat, camphor tablets, mica.	
(3)	**Grains and Pulses** Rice, wheat, jowar, arhar, moong, masur, gram.	
	Spices Black pepper, mustard, chillies, dhania, dalchini, turmeric, betelnuts.	
	Plantation Products Rubber, cashewnuts, cashew kernels, tobacco (raw and manufactured).	
	Forest Products Lac and lac products, gums, myrobalans, galnuts, soapnuts.	
	Textiles & Textile Fibres Raw jute, raw hemp, coir yarn.	
	Oils, Oilseeds & Oilcakes Vegetable oil, oilseeds, oilcakes.	1 quintal (q) (100 kilograms)
	Non-Ferrous Metals *Aluminium :* ingots, bars, blocks, slabs, 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, circles. *Brass :* ingots, rods, sections, pipes, sheets, strips, circles. *Zinc :* ingots, sheets, strips. *Tin :* blocks.	
	Chemicals Caustic soda, bleaching powder, glycerine, soaps, paper salt.	
	Others Sugar, gur, ice, fish, sugarcane, vegetables, tamarind.	
(4)	**Minerals** Iron ore, manganese ore, bauxite, coal.	one metric tonne (t) (1,000 kilograms)
	Iron & Steel Pig iron, iron & steel manufactures, semis (billets for rerolling etc.)	
(5)	Cloth (mill, handloom, silk rayon and woollen cloth)	1 metre (m)
(6)	Jute carpets, coir mats and mattings, sheet glass.	one square metre (m^2)
(7)	Timber.	one cubic metre (m^3)
(8)	Paints (when sold by measure), spirits.	one litre (l)

Weights

(1) In place of the present units of seer, pound, rattal, viss etc., use the kilogram.

(2) In place of the tola use the gram or 10 grams.

(3) In place of maund or corresponding unit, use the quintal *i. e.*, 100 kg.

In place of seer or gallon measure, use the litre.

Length Measures

(1) Use the metre in place of yard or foot and the centimetre in place of inch.

Square Measures

(1) Use the square metre in place of square yard or square foot, and square centimetre in place of square inch.

Cubic Measures

(1) Use the cubic metre in place of cubic yard or cubic foot and cubic centimetre in place of cubic inch.

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TYPICAL PRICING UNITS FOR RETAIL TRADE

Serial No.	Commodity	Metric Unit for Use
(1)	Foodgrains, cereals, pulses, spices, ghee, bread, vegetables, meat, fish, sweetmeats, tea, coffee, sugar, salt.	1 kg
(2)	Oil for cooking	1 kg or 1 litre depending upon prevalent practice.
(3)	Fruits	1 kg or number depending upon prevalent practice.
(4)	Milk	1 litre
(5)	Cloth and related materials	1 metre
(6)	Prepackaged materials	Preferably sizes corresponding to series of commercial weights and measures.

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metric measures

THE PUBLICATIONS DIVISION

ABBREVIATION FOR METRIC UNITS

(1) DECIMAL MULTIPLES AND SUB-MULTIPLES

Prefix	Value in Terms of Unit	Abbreviation
Kilo ..	1,000	k
centi ..	0·01(10-2)	c
milli ..	0·001(10-3)	m
micro ..	0·000 001(10-6)	u

(2) WEIGHTS

Denomination	Value	Abbreviation
tonne ..	1,000 kg	t
quintal ..	100 kg	q
kilogram ..	1 kg	kg
gram ..	1 g	g
milligram ..	1 mg	mg
carat ..	200 mg	c

(3) CAPACITY

kilolitre ..	1 000 l	kl
litre ..	1 l	l
millilitre ..	1 ml	ml

(4) VOLUME

cubic metre ..	m^3	m^3 or cu m*
cubic centimetre ..	cm^3	cm^3 or cu cm*
cubic millimetre ..	mm^3	mm^3 or cu mm*

(5) LENGTH

kilometre ..	1 000 m	km
metre ..	1 m	*m*
centimetre ..	1 cm	cm
millimetre ..	1 mm	mm
micron ..	1/1 000 mm or 10^{-3} mm	um

(6) AREA

square kilometre	1 000 000 m^2	km^2 or sq km*
square metre ..	1 m^2	m^2 or sq m*
square centimetre	1 cm^2	cm^2 or sq cm*
square millimetre	1 mm^2	mm^2 or sq mm*

(7) LAND MEASURE

are ..	100 m^2	a
hectare ..	100 a	ha
centiare ..	m^2	ca

*Both these abbreviations are current, but the first set should preferably be used. The former abbreviation is used more commonly internationally than the latter.

Rules for Abbreviations :

(1) Do not make any change, such as addition of 's' to indicate plurality *e.g.*, write 1 kg, 10 kg, 20 g, 5 g, 10 t, 20 ml, 271, 165 km, 2 mm, 100 cm^3, 66 km^2.

(2) Do not capitalize the abbreviations. For example, do not write 1 Kg, 2 Kg, 20 MM, 50 MM; the right way is to write 1 kg, 2 kg, 20 mm, 50 mm, etc.

(3) Do not use any other abbreviations except those given above.

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Cost of Adoption of Metric System

THE Standards of Weights and Measures Act received the President's assent in December 1956. The Act enjoined Government to enforce the metric system of weights and measures in commercial transactions throughout the country by December 1966. In 1958, metric weights were introduced in trade on a small scale. Later, metric weights and measures were introduced by stages in the whole country. By the end of 1963 the metric system had come into effective use in all commercial transactions.

An attempt has been made to estimate the cost to the Nation in changing its weights and measures. The cost was shared by the Governments both at the Centre and in the States, trade, industry, transport, communications, and by the public at large. The cost can be broadly classified under the following heads:

(1) Replacement of old weights and measures by metric weights and measures.

(2) Conversion of weighing machines.

(3) Cost of State Governments, in enforcing weights and measures, and in adopting the new system in Government departments.

(4) Cost to Central Government departments and undertakings.

(5) Cost to industry.

(6) Miscellaneous costs in sectors such as road-transport, shipping, etc.

(1) Replacement of Weights and Measures

The use of old weights and measures became illegal in certain parts of the country in October 1960. By March 1963, old weights and measures had been almost completely replaced by metric weights and measures throughout the country. Total replacement thus took place during a period of about three years. Every metric weight or measure was verified and stamped by a State Government Inspector before it was released for use in trade. State Governments thus have accurate and complete information on weights and measures which came into use during this period of three years. According to statistics supplied by them, the estimated cost of metric weights and measures which went into circulation during this period was Rs. 72 million. A part of this represented normal replacement of old and worn out weights and measurs which in any case, would have taken place. The normal life span of a commercial weight or measure is about five years. Every year about 20 percent of the weights and measures in circulation are, therefore, replaced. In a period of three years, 60 percent would be replaced in the normal course. Of the new weights and measures which came into circulation during the period April 1960 to March 1963, only about 40 percent represented accelerated replacement due to the introduction of a new system. The expenditure to the nation on this account was Rs. 28.8 million.

(2) Conversion of Weighing Machines

The estimated value of conversion carried out by recognised manufacturers of weighing

machines is Rs. 6.2 million. Of this Rs. 3.7 million represents work done for major industries like iron and steel, cotton textiles, etc., and the balance of Rs. 2.5 million for other industries including small scale industy, road transport, wholesale trade, etc.

(3) Cost to State Governments

Between 1958-59 and 1963-64, the State Governments spent about Rs. 47 million on the enforcement of weights and measures, publicity, training of staff, replacement of weights and measures, conversion of weighing machines in Government departments etc.

4) Cost to Central Government

The estimated expenditure of Central Government departments and undertakings is as follows:

	Rs. in millions
(1) Railways	10·2
(2) Posts & Telegraph	3·0
(3) Publicity	6·9
(4) Transport & Communications ..	1·0
(5) Other Departments & Undertakings	3·5
Total ..	24·6

(5) Cost to Industry

According to the Oil Industry Metric Committee, which represents all the oil companies, the oil industry spent Rs. 2.5 million on the conversion of petrol dispensing pumps and other measuring equipment, publicity, training of staff, etc.

The expenditure for other major industries was estimated through sample surveys conducted by the Directorate of Weights and Measures, Ministry of Commerce, Government of India. It was not possible to make such surveys for small industries or for small scale and cottage industries. A broad estimate of Rs. 5 million has been made for these industries. The cost to industry including small scale industry was as follows:

	Rs. in millions
(1) Cotton Textiles	2·0
(2) Jute Textiles	0·8
(3) Sugar	3·6
(4) Cement	0·3
(5) Iron and Steel	0·5
(6) Petroleum	2·5
(7) Tea	2·4
(8) Miscellaneous industries including small scale industry	5·0
Total ..	17·1

(6) Other Sectors (Including Road Transport)

The cost in these sectors was mainly for conversion of weighing machines and replacement of weights and measures which have been counted under other heads. Expenditure on other items would be relatively small and is estimated at Rs. 2 million.

Total Cost

The total expenditure incurred so far on the reform of weights and measures is roughly as follows:

	Rs. in millions
(1) Replacement of weights and measures	28·8
(2) Recalibration of weighing machines, except in major industries [the cost for major industries is counted in Item (5) below] ..	2·5
(3) Cost to State Governments ..	47·0
(4) Cost to Central Government ..	24·6
(5) Cost to Industry	17·1
(6) Other Sectors	2·0
Total ..	122·0

The total cost of Rs. 122 million (Rs. 12.2 crores) is modest in relation to the magnitude of the reform and its significance to the country's economy. The reform is, however, not complete since the metric system has yet to be fully adopted in engineering and technology. This is bound to be a slow process and would take considerable time. Further, engineers and technologists throughout the world have to be equally familiar with both systems. It is, therefore, not possible to anticipate a time when the foot-pound system would be completely climinated from these fields.

Medical Thermometer

TATV DARSHI BANSAL
NATIONAL PHYSICAL LABORATORY,
NEW DELHI.

THE manufacture of medical thermometers started in India during the Second World War. Now it is developing fast. Shortly the industry will be able to meet the country's annual demand of over 20 lakh medical thermometers, and also export them.

The industry, however, faces certain difficulties.

(1) Thermometer tubes have to be imported as Indian tubing has not yet been proved to be good enough.
(2) The usual thermometric liquid, mercury being imported, needs replacement by a suitable indigenous material.
(3) A standard specification for these thermometers for our conditions has yet to be laid down.

The last item is now being taken care of by the Indian Standards Institution and an I.S. Specification for Clinical Thermometers is under publication. Specifications for other varieties of medical thermometers will be taken up gradually.

Varieties of Medical Thermometers

There are many varieties of medical thermometers, each for a different application. The two broad classes are veterinary and those for human use. There are a number of varieties under the second class e.g. doctor's (clinical), premature birth, ladies' etc. The doctor's thermometer can again be oral, rectal or skin type.

Every medical thermometer is based on one of the following principles, arranged in order of increasing 'time lag' or 'time of response':

(1) Thermocouple;
(2) Semiconductor resistance (electrical);
(3) Metallic resistance (electrical);
(4) Thermal expansion of liquid-in-glass; and
(5) Thermal expansion of bimetals, solids, vapours and liquid-in-metal.

Those having lesser time of response are often said to be 'quick reading' or 'fast', while others are classified as 'slow or 'stubby'.

Although thermometers based on liquid-in-glass expansion are the most popular, primarily due to their cheapness and convenient handling, they are fragile and less dependable than the first three varieties. The first three are extensively used in research for study of vaccines, injections, chemicals, bacterial growth, metabolism, etc. They can be used when temperatures of several persons or temperatures at different places of the same person have to be simultaneously measured or recorded. Thermometers based on these three principles are at present very expensive, but their cost would be considerably reduced if a proper use of thermistors, transistors and magic eye is developed, instead of the age-old practice being used today. A differential thermometer based on the thermocouple principle has found much

application during recent years for studying the metabolic rate.

Although one or two manufacturers have developed medical thermometers based on the last principle, their time of response is long and they have not found much favour. More applied research is indicated in this variety.

Anatomical Factors Affecting Design

The bulb shape and dimensions, and sometimes the stem length of the various types of medical thermometers are limited by anatomical features. For example, the oral thermometer should have a bulb which will be fully covered under the axila (armpit) and groin of a new-born child as well as in the cavity below the tongue of an adult. Besides this, it must not be too small to leave appreciable air space when kept in contact with the root of the tongue of an adult.

Generally speaking the design of various types of medical thermometers depends on the following biological conditions:

(1) The size of available space where they have to be applied, depending on the anatomy of the organ;

(2) The temperature range met with under extreme conditions in that application;

(3) The minimum temperature variation whose effect could be appreciated clinically.

The various types have, therefore, different temperature ranges, least counts and bulb sizes.

Popular Types of Medical Thermometers

Due to the extreme cheapness, the liquid-in-glass type medical thermometers are far more popular than any other, almost in every country, so much so that many a doctor and the layman do not even know the others.

In India, as in other countries, the oral thermometers far outnumber all the others. As a result, the medical thermometer industry in India has developed only around the liquid-in-glass type, although there is no difficulty in manufacturing the other varieties with the skill, resources, raw materials and intermediary products now available in the country.

It is well-known how such thermometers are made but before examining the requirements of good medical thermometers, it would be profitable to point out certain important practical aspects of their manufacture and applications, which need particular attention in the present state of the industry in our country.

The Thermometer Tube

The Glass

The range of all medical thermometers is just a few degrees and it is very near the ambient temperature, while the bulb volume is only about 1,000 to 500 times the capillary bore volume as compared to 2,000 and more in the case of other thermometers. Due to the first reason, considerable ease in manufacture could be effected by using lead glasses for medical thermometers.

Tube Drawing

During the last century, thermometer tubes were made in the same way as our bangle makers make the tubes in India i.e. by the manual, horizonal drawing process. The increasing demand of precision gradually made it necessary to fabricate the tubes by automatic processes. The most popular section for medical thermometers is the prismatic or the lens-front section. Considerable improvement can, however, be effected by making the enamel at the back red instead of white, specially when the thermometer is mercury filled.

The tubes are manufactured and tested under very rigid control to ensure accuracy.

Glass Substitutes

There is a possibility of the use of plastics, specially thermoplastics, for fabricating medical thermometers. If and when it is achieved, the whole industry may be revolutionised. In India, we should also investigate this possibility of using plastic tubing.

Methods of Thermometer Manufacture

In the present state of development of the industry in this country, the fused bulb, engraved, solid stem type of construction is far more economical and efficient than any other for medical thermometers, although blown bulb types are also being fabricated.

As long as the glass and the thermometric liquid are of proper quality and the workmanship is fine, there is little to choose between these types except the price of the final product.

It is worthwhile studying some pros and cons of the processes of manufacture from the practical point of view.

Thermometric liquids

The most popular thermometric liquids for medical thermometers are: purest mercury and organic liquids like ethyl alcohol free from ketones and esters. Aviation petrol, kerosene, creosote, pentane, etc. have also been utilized. In order to improve the visibility of the meniscus the organic liquids are dyed with aniline dyes and a fine speck of thullium is sometimes inserted over the mercury surface.

The temperature range of medical thermometers is so small that almost any liquid could be used which does not damage or stick to glass and which does not tend to vaporise or solidify in our climates. Alcohol tends to vaporise in our hot weather and so produces uncertainties in temperature readings while mercury has to be imported. It seems necessary, therefore, to carry out systematic research on this subject for our conditions. Some promising liquids are: carbon tetrachloride, light oils like anisi, aviation petrols and, perhaps, water with some antifreeze agent like glycol, because ambient temperatures in our country (including military operations in the Himalayas) range from about—40°C to plus 55°C. Besides the thermometric properties, such liquids must also allow the use of the maximum indicating device.

Mercury has found greater favour than other liquids because it allows fine annealing of the thermometer glass, shines well, is opaque, has low thermal capacity, uniform expansion, positive surface tension with respect to glass, does not wet glass, can be easily purified to a high order, and does not develop organisms by neglect in manufacture.

Maximum Indicating Devices

Medical thermometers are essentially maximum indicating instruments. Several methods have been utilised for making them register the maximum. The most common method being used is the Hicks constriction. Another common method in Europe is the use of a sealed rod fused inside the bulb and protruding into the capillary. A few examples of maximum indicating devices are shown in Fig. 1.

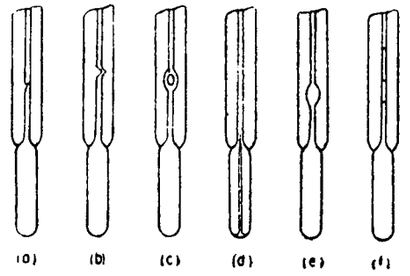


Fig. 1

Fig. 1—Examples of maximum indicating devices

The main principle utilised in the case of constrictions in mercury-in-glass thermometers is that the mercury cannot flow freely in glass if the capillary bore is less than 0.007 mm. On the other hand, in the case of the index method, the index either floats on the liquid column or remains attached to its surface by surface tension. A little consideration would show that the bent steel wire index and the constriction methods are the only two choices for medical thermometers.

Constriction devices have two major shortcomings:

(1) They require shaking down before use. Devices to facilitate this hazardous operation are being tried out. For example, the thermometer in case is just whirled round and the liquid goes back into the bulb by centrifugal force. These labour saving devices are likely to become common in the course of time.

(2) Constriction should neither be 'too hard' (requiring very great force for shaking), nor 'too soft', which might enable the liquid to go back into the bulb by slight handling, e.g. in taking out the thermometer from one's mouth for reading. As fabrication of the constriction entirely depends on manual skill, it does not always produce dependable results. About 15 percent of the production is wasted even in well established factories on this account while many more have to be rejected in Indian factories.

Most good medical thermometers require about the same force for shaking down. The International Organization for Standardization (ISO) has suggested that all the liquid must go into the bulb under an acceleration of 500 metres per second. This is, therefore, again a design factor with which we cannot compromise.

Filling

Broadly speaking, the process of 'filling' consists of :

(1) Filling the thermometer liquid in the glass blank ;
(2) Removing moisture and air bubbles from the filled liquid;
(3) Evacuating air from above the liquid column and sometimes replacing it with a chemically neutral gas like nitrogen or carbon dioxide, under pressure (gas filled thermometers); and
(4) Fusing the open end of the glass blank (sealing).

The last operation is too simple and well known. The first three operations are performed either by the 'vacuum chamber method' or by the 'repeated heating and cooling method', the latter being as old as the thermometer industry.

Marking

After 'pointing', i.e. locating 2 or 3 important temperature on the tube, the thermometers have to be 'engraved'. The operations in this process are : graduating, writing letters and numerals, etching and filling the etching with suitable pigment. Broadly speaking, the first three operations of this process are done either by the age-old hydrofluoric acid process, or by the modern sand-blasting process.

What is our normal Temperature?

Human beings are exposed to extremely hot weather in tropics as well as in some industries on the one hand, and to extremely cold weathers in the mountains, Arctic regions, during accidents in flight, etc. on the other. During these extreme sufferings the internal temperature of a person, without feeling ill, never crosses the narrow zone

of 36·4°C. to 37·6°C. In some medical treatments, however, the temperature of affected parts of the body is either suddenly or gradually raised to kill the maligning tissues and in some others, the temperature is considerably reduced to give rest to the patient.

The statistical average of human temperature lies within 37°±0·3°C. Consequently, some doctors prefer to take 37·0°C (98·6°F), as the normal human temperature, whereas others keep it at 36·9°C (98·4°F). A still different opinion has demanded that the region between 36·6°C and 37·3°C may be marked in the medical thermometers as the normal human temperature. Fig. 2 gives interesting data on human temperature under certain conditions. The doctors' or clinical thermometers should cover this range.

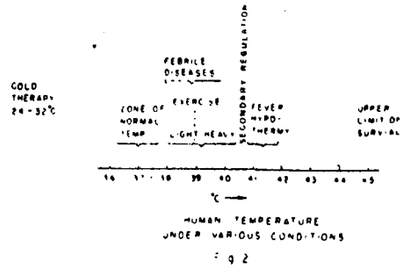


Fig. 2— Temperature under certain conditions

It is also well-known that our temperature is not the same all over the body. Mouth temperature is usually about 0·6°C lower than the rectal temperature. In warm environments, the naked skin averages 2°C lower than the rectal temperature. In cold environments, not quite cold enough to produce chills, it is 6·5°C lower.

If we consider the various factors that affect human temperature, we may conclude that the normal temperature of a human being depends on : conditions of birth, physical environments, chemical actions, biological infections, time of observation and place of application.

One would like to know, in view of the above uncertainties, what is meant by the normal temperature of man. After a great deal of study it has now been possible to define this temperature as that which is obtained between 11 A.M. and 2 P.M. after allowing the person to remain lying in comfortable environments, without practically any physical or mental movement for 24 hours, the last food having been taken at 7 P.M. on the previous evening. This temperature is medically, known as the basal temperature. In our country we come across a very extensive range of climatic conditions and almost every human race. It seems desirable, therefore, to investigate the normal temperatures of human beings belonging to different races and geographical zones living under different climatic conditions. Unless such an investigation is carried out, it may not be quite easy to state a universally acceptable and logical normal temperature of human body for Indian conditions although it is very widely accepted as exactly 37·0°C on the basis of some statistical data collected in London and New York some 60 to 80 years ago.

Special Design Factors for Tropical Countries

The problems of design of medical thermometers, specially to suit Indian conditions, are varied and numerous.

Two difficulties have already been discussed viz. the fixation of normal temperature under our conditions, and the range of temperatures in which human beings, especially Indians would survive under our conditions. Other factors are discussed below.

A clinical thermometer lying in stock or otherwise often loses its calibration appreciably. This can be due to either bad ageing or annealing or due to the fact that our environmental temperatures often exceed the maximum temperature up to which such thermometers can be used. The result is that the liquid column fills up the whole

capillary and then it starts pressing out the bulb. This might permanently change the bulb volume and hence the calibration. This difficulty can be easily overcome by providing a safety chamber at the top of the thermometer, although nobody seems to have utilized this for medical thermometers. An investigation on this aspect is rather important for our conditions. Meanwhile, it might be worthwhile to introduce the above mentioned refinement in our country.

As a result of ambient temperatures often rising far beyond the patient's temperature, it is difficult to read the thermometer soon after it is taken out of the patient under such conditions. On this point, medical opinion seems to be lacking. After a large number of enquiries from medical practitioners it appears that in practice they cool down the thermometer before use in a glass of cold water kept very near the patient and they immerse the thermometer into it immediately after application. The temperature is read while the thermometer is dripping or still in water. Obviously, this is not a scientific solution of the problem.

Some doctors have pointed out that under such conditions they can observe the temperature while the thermometer is still in position with the patient. But this is neither convenient nor always permissible.

In recent years, bimetallic thermometers and liquid-in-metal thermometers have also been developed incorporating a maximum indicating device with a view to overcoming this difficulty. But they take an extremely long time to register and so are not convenient for the patient. It is possible to design a maximum-minimum type glass thermometer which could be used for such a purpose. But it will be rather costly and has not been introduced in the market.

Another problem is the choice of a suitable maximum indicating device. In our country we are importing thermometer from almost every corner of the world. Several types of maximum indicating devices are being used in these thermometers. The most common of them utilise the Hicks patent, namely, a notched constriction. The introduction of a rod in the bulb of the thermometer projecting up to the start of the capillary is another device being used on a very large scale in Europe for the purpose. Some other methods of achieving this employ bifurcation of the capillary, twisting or spiralling the capillary, making two jet sections in the capillary, and introducing a circular tube in the capillary at right angles to it. The basic requirement of all these devices is that the tube should become smaller than 7 microns or so at the point of constriction. A tube of such a small diameter does not allow mercury to pass through it.

There can be several arguments for advocating each of these devices and they have all been successfully used. So the choice can be left to the convenience of the manufacturer. However, the practical aspect is that if the constriction is too soft, the thermometer is useless for the application for which it is meant. On the other hand, if it is too hard the thermometer often breaks while shaking the mercury down.

Clinical thermometers have got to be used in the human body where they come into contact with the saliva and perspiration. They have to be sterilised before the next application, and have to withstand chemical reaction. Very often they also remain in water because they are washed with it after use. The filling used for marking these thermometers must be able to stand these chemical reactions for a considerable time. We have to evolve a suitable procedure for this purpose.

Clinical thermometers are often marked as fast or stubby, or half-minute, one-minute,

two-minute. It is now recognised that such marking is meaningless. Under different conditions of applications, the time required by the thermometer to acquire the human temperature is not the same. It is well-known that any thermometer would take considerably more time to acquire an ambient temperature in air than in water. The condition of skin and membraneous tissue with which the thermometers come into contact, differ not only from man to man and from one part of the body to another, but this also considerably depends on the condition of health and disease of the person. As such, it has now been widely recognised that the above mentioned markings are deceptive. Most countries are banning such marking in specifications for such thermometers. But some sort of guarantee is obviously necessary to be sure that the time lag of the thermometer is not unnecessarily large. It may be worthwhile studying the available thermometers and specifying a suitable test for this purpose.

The temperature of man is an important indication of his health. It is, therefore, very necessay to check up the thermometers against standards rather frequently. In France, there is a law that no factory can turn out a clinical thermometer unless it has been checked and found all right by their national laboratory. In USA it is criminal to use a clinical thermometer unless it has been checked by some Test House within a specified maximum time. In many other countries, like UK, people are themselves careful that the instrument which they use for checking their health is in good order. The importance of such legislation in our country cannot be over-stressed.

Weighing Mechanisms in Measurement & Control

L. SANDERS
Chief Development Engineer, Load Cells,
Avery Limited,
Birmingham

(We are glad to reproduce this extremely well prepared and informative article in *Metric Measures*. This has been reproduced from *Product Design Engineering*, Jan. 1964. We are grateful to the Editor, *Product Design Engineering* for the permission to publish the article and to Avery Ltd., Birmingham, for supplying the necessary figures.)

—*Editor.*

METHODS OF DETERMINING WEIGHT

By the Comparison of Masses

Equal and unequal armed levers. Weight may be determined by direct comparison of the mass of a body with the masses of known standard 'weights' using an *equal-armed* beam scale or a weighing lever system of known ratio. The balance (1) and the simple Roberval pattern counterscale (2) are examples of the equal beam. Accuracy obtainable with a precision balance is within one part in 10^6 'and with a micro-precision balance one part in 10^7. The steelyard (3) is the simplest form of *unequal-armed* lever.

Compound lever systems are used in platform and hopper scales and in weighbridges. Essentially the gauges between the fulcrum knife-edges 'a' and the load knife-edges 'b' on the main lever 'c' must be equal, so that accuracy of weighing is unaffected by the position of the load on the platform (4). Weight may be measured by the comparison of the mass-moment of the body with the mass-moment of a pendulum of known calibration (5). Since the ratio between the moment of the pendulum and its angular movement follows a sine law it is necessary to introduce a cam for the load suspension arm to obtain equal increments of movement for equal increments of load. A cam of circular profile gives sufficient accuracy for most practical purposes (6). The principle of a weighing pendulum with rolling fulcrum is a form extensively used in industrial dial scales.

Balancing Mass using Elastic Strain

The spring balance is a helical spring extended by the load hanging from it. By careful design a very close approach to linearity is possible (7).

When a rack and pinion are used to magnify the deflexion of the spring mechanically we have the basis of a spring dial scale (8). A ribbon-type weighing spring, held in tension, provides a torsional weighing resistant, suitable for use with sensitive scales

requiring a short range chart, such as a graticule with optical projection (9). A weighing spring used in bending is also suitable for scales requiring only a short range chart for difference weighing. These springs are usually arranged in pairs to provide lateral stability and symmetry (10).

Electric load cells are basically spring-operated scales (11). An elastic column 'C' supports the load to be weighed and is compressed. Electric strain-gauges 'S.G.' are bonded to the column and follow its deflexion, thereby suffering a change in electric resistance, which may be measured by suitable instruments and interpreted in terms of weight. In practice, groups of strain gauges are used, active gauges for load measurement and passive gauges for automatic temperature compensation.

Electro-magnetic force (or mass) balance system determines mass by balancing the weight of a body by forces set up in an electromagnetic field (12). The coil and magnet are similar to those used in a moving-coil loud-speaker.

A scale pan is supported on the coil and the mass to be weighed is balanced by passing a direct current through the coil. Current is measured and the instrument calibrated in terms of weight.

It is difficult to obtain good linearity over a wide range but these systems are used successfully in high-speed check weighers operating at a predetermined weight.

METHODS OF INDICATING WEIGHT

Marked Weights

Read-out of weight in its simplest form is provided by the denominations marked on loose weights used with the beam scale or balance. Correct weight is the sum of all the loose weights used. The method is time consuming and liable to error. Modern precision balances have mechanical means for depositing weights and their values are indicated by figures on the control knobs.

Dial indication

Weight indication by dial and pointer is used both for domestic and industrial scales. By having the pointer and chart in the same plane, giving edge-to-edge reading, parallax and shadow is entirely eliminated (13). For stamping, chart divisions on industrial scales must be at least 1/8 in apart. Dial sizes vary from 18 to 28 in. in diameter of reading line, and for special purposes such as in cattle market auction rings dials of 48 in diameter are used.

Dial capacity may be increased several times, without coarsening the minor division, by incorporating a system of unit weights each equivalent, in effect, to the dial capacity, and which can be deposited manually or automatically, Thus 4 unit weights may increase the weighing range of a weighbridge to 5 times that of the dial capacity with the same subdivision of weight (14).

Flashes in the chart automatically alter the major denomination figures so that weight reading is direct without mental arithmetic. Dial capacity is increased 5 times by sequenced deposition of unit weights either side of the weighing lever fulcrum (*a*). Each weight is equivalent to the dial capacity. In zero load condition two weights hang from saddle (*b*) suspended from left-hand side of the weighing lever fulcrum. When load exceeds dial capacity, hand lever (*c*) is knotched one step in quadrant which rotates forked rocker beam (*d*) through pinion (*e*) and relieves one weight from the saddle, thus balancing off the load. At the same time, linkage (*f*) connected to rocker indexes the dial. When load exceeds twice the dial capacity, knotching the lever another step rotates the beam until it engages and relieves the saddle of the second weight and again indexes the dial. Further rotations of the beam with successive

Balance

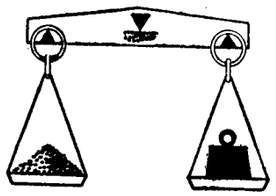


Fig. 1

Compound lever platform scale

Roberval counterscale

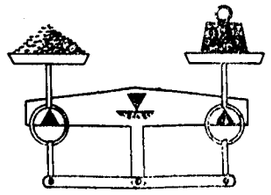


Fig. 2

Steelyard

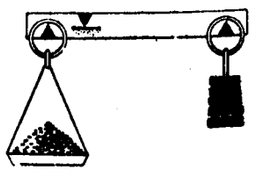


Fig. 3

Pendulum mechanisms

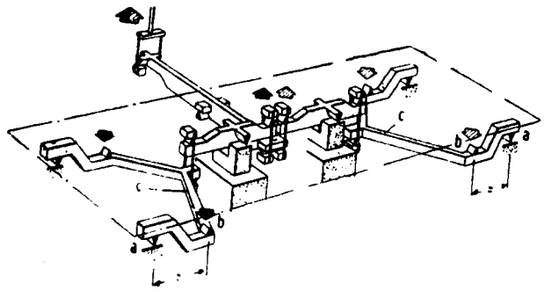


Fig. 4

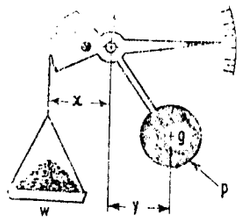


Fig. 5

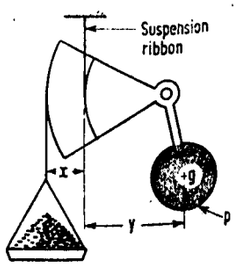


Fig. 6

W is mass being weighed. P is mass of pendulum with centre of gravity at g. Radius of load suspension cam is r. Equation for balance is Wx=yP

MECHANICAL

Spring balance

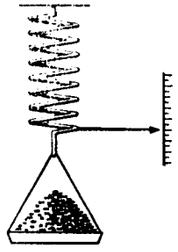


Fig. 7

Spring dial balance

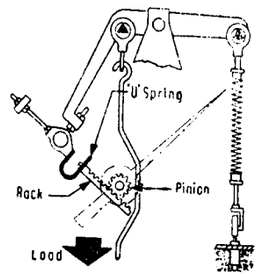


Fig. 8

Weighting ribbon scales—torsion

(a) Tensioned steel band
(b) Tension screw
(c) Lever connected to scale
(d) Connecting link
(e) Graticule

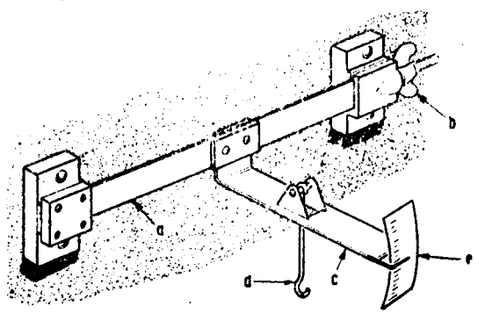


Fig. 9

Weighing ribbon scales —bending

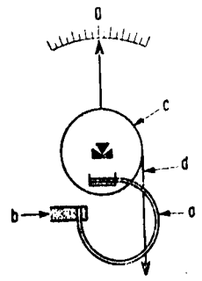


Fig. 10

(a) Steel bands in bending
(b) Band anchor
(c) Drum
(d) Load connexion to scale

ELECTRICAL

Load cells

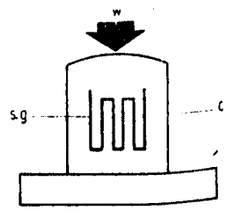


Fig. 11

Electromagnetic balance

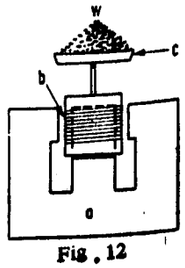


Fig. 12

knotching of the handle causes the other (descending) arm of the rocking beam to deposit unit weights on the right-hand saddle (*g*) which is connected to the opposite side of the weighing lever fulcrum, thus providing 5 times dial capacity.

Multi-revolution dial scales

As an alternative to unit weights, dial mechanisms capable of rotating their pointers several times are available and are used in scales of smaller capacity.

In order to keep lever movements within reason, the indicator pinion has to be small and this calls for an exceptionally high degree of accuracy in gear cutting.

Digital indication of weight

Advanced electronic techniques have made possible rapid direct digital indication of weight using the many forms of digital display devices now commercially available. Signals to operate the display are provided by photo-electric digital encoder units mounted on the scale mechanism or from analogue devices passing the signal through a digitizer system.

Optical magnification of weight indication

Magnification of the small angular movements of levers in a weighing system may be achieved by optical projection methods to give a brilliant image of chart graduations of large size (15).

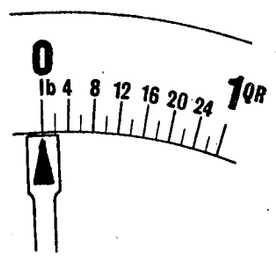


Fig. 13

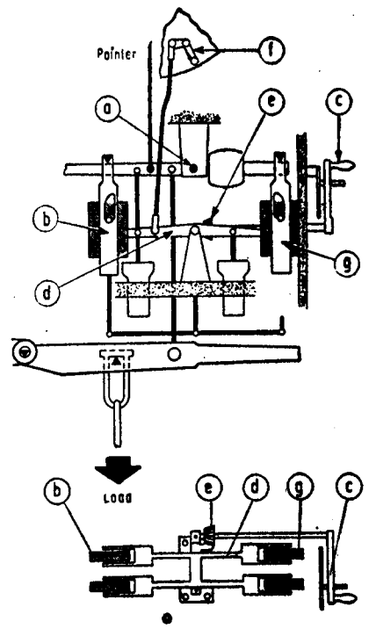


Fig. 14

A transparent chart, photographically produced, carries 1000 or more weight graduations in miniature and can be mounted directly on the weighing pendulum in the form of a quadrant or on an indicator spindle in the form of a circular disc. Magnifications of 30 or 40 diameters are common. Optical indication is also used on precision instruments and on the revolutionary 'Aristocrat' retail scale by Avery which displays weight, unit price and total value or to both vendor and purchaser. On the 8 in. diameter optical chart there are nearly half a million figures.

In optical projection of weight the figures and graduations are in movement until the scale comes to rest. This system is therefore not so convenient as the dial for weighing to a predetermined weight, but it is gaining in popularity for normal weighing. Compound lever system is connected to weighing arm (a)

via rod (*b*). Other end of arm is connected to weigh pendulum (*c*) through rod (*d*) and steel ribbon (*e*). The ribbon wraps round cam (*f*) integral with pendulum which has ball-bearing fulcrum slightly off centre from geometric centre of the cam profile. Mass moment of pendulum balances load on the arm and the geometry ensures that relationship between load and angular displacement is linear.

Peripheral displacement of graduated quadrant chart (*g*) fixed to pendulum is projected through magnifying optical and mirror system to ground glass read-out window (*h*) Forked lever (*i*) is motored to transfer weight (*m*) on to saddle on weighing arm which balances off the load when dial capacity is exhausted, zeroing the dial. Poise (*j*) positioned on weighing arm by hand wheel (*k*) flashes tare weight in subsidiary window (*l*).

Weight Integrators and Totalisers

In the continuous weighing of material in transit on conveyor belts or weighing successive like loads, such as the trucks in a mineral train, integrating or totalizing of weights is required.

Weight totalizers have various forms of automatic clutch which engage with the driving mechanism of a poise or with the motion of a weighing pendulum or spring and transfer these movements into a mechanical counter of conventional form geared so as to record a total of weight.

In the simple single-weigh roller-type belt-weigher, continuous integration is necessary to totalize the weight of material carried by the belt. Movement of the weighing mechanism is used to traverse a ball in a cone and cylinder or cone and disc type of infinitely variable gear driven from the belt pulley. By this means, weight and belt movement are integrated to give the total weight delivered.

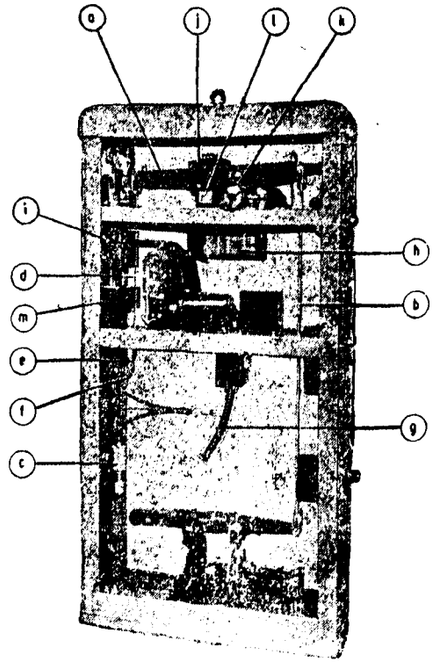


Fig. 15

Remote weighing indicator

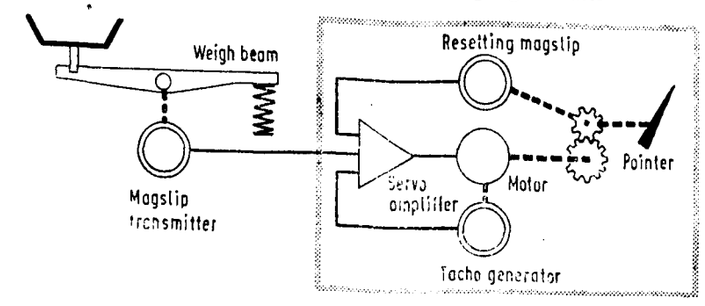


Fig.19

Outputs of the magslip transmitter at the weighing device and of the resetting magslip are connected *via* potentiometer networks and summing resistors to the input of the servo amplifier (16). The amplifier controls a servomotor and gearbox which are connected to the pointer and also drive the resetting magslip. Thus the signal from the weighing device controls the pointer through the servo system to balance against the resetting magslip. Stabilizing feedback is supplied by a tacho-generator integral with the motor. (Evershed and Vignoles Ltd.)

WEIGHT CONTROL SYSTEM

Weight as a parameter may be used to operate systems for automatic predetermined weighing, processing and mechanical handling.

The control devices, such as sensitive switches, ideally should absorb none of the very small amount of energy available in the weighing mechanism.

Analogue output generators

A continuous electrical output, bearing an extremely accurate linear proportionality to weight, is provided by the Avery analogue generator, operating on a voltage divider principle (17).

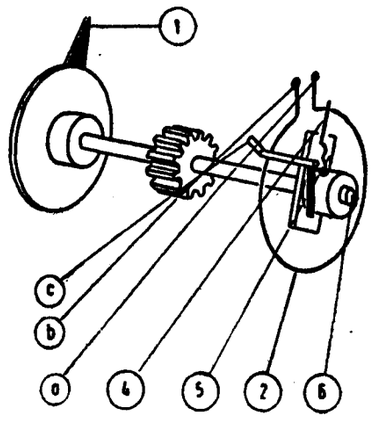


Fig. 17

This provides an infinite number of cut-off points around the dial, readily set from a remote control panel. By the use of a digitizer the analogue output can operate printers and card or tape punching machines.

Remote slave dials can also be operated from the master analogue by means of a servo-motor system.

Single turn of silver palladium alloy wire (2) is wound upon a fixed, rigid and accurately ground former of stable insulating material, Terminals (*a*) and (*b*) are connected to a low voltage alternating current supply and there is, according to the phase of the supply, a voltage gradient between (*a*) and (*b*) along the wire. Arm (5) rotates with the scale indicator (1) and spindle (6) and carries a fine gold alloy wire (4) which is in permanent light flexible contact with the wire loop (2) and picks off a voltage which bears an exact linear relationship to the angle through which the arm (5), indicator (1) and spindle (6) have rotated.

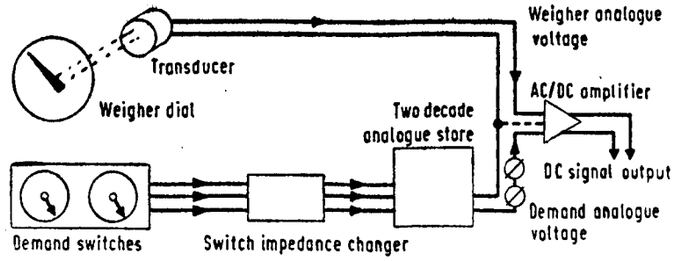
Pillar connected to terminal (*c*) carries a second fine gold alloy wire contacting an insulated bush on the arm (5) and completes the circuit.

Comparison of two voltage analogues of weight

One voltage analogue is generated by a transducer fitted to the operating spindle of a conventional weigh scale (19). The other analogue is produced by a digital/analogue store unit, which produces an analogue voltage in proportion to the demand weight required by the recipe as set into the system in digital form. The amplifier gives a d.c. output signal between its two output lines when the two analogues have the same value but not if the weigher is less than the demand analogue. (E.M.I. Ltd.)

Digital Encoder system

Introduction of the modern miniature photo-transistor has made possible the use



of optical digital encoder systems in conjunction with weighing mechanisms. The Avery digital encoder, using a Gray binary code, is an integral part of the scale mechanism requiring no extra spindles or bearings.

The electrical output, in binary digital form, is readily convertible by static state devices into any weight denomination and can operate scale controls, computers, printers and any data processing machinery.

Trip switches

For simple cut-off a microswitch or a mercury switch may be set to trip like a mouse-trap using the energy available on the removal of the load from the scale for re-setting (18).

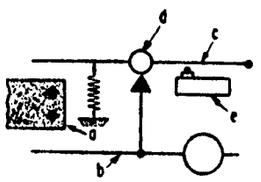


Fig. 18

Pneumatic cut-off

Pneumatic controls may be fitted to scale mechanisms with no measurable influence and with the advantage that no special precautions are required for their use in hazardous atmospheres.

In principle a fine air jet (*a*) issuing from a nozzle 0·015 in in diameter, is intercepted by a vane (*b*) mounted on the scale spindle and moving in a plane normal to the jet. The air jet is directed into a diaphragm relay valve (*d*) in which induced pressure normally holds the valve in the operative position. On interception of the jet by the scale controlled vane, the pressure in the relay collapses and the relay valve operates power line controllers (20).

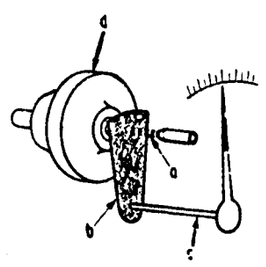


Fig. 20

Fine wire contacts

Wiping contacts consisting of a precious-metal wire wiper and contact plate can be fitted to most industrial scales, and absorb little energy. Current handled is of the order of a few milliamps; therefore, an electronic amplifier and relay are needed for the operation of power circuits. They are used to control feed cut-offs, alarms, etc. (21).

The number of such adjustable contacts that can be fitted to a dial is limited by design considerations. The Avery fine wire contact is certified as intrinsically safe for certain hazardous atmospheres.

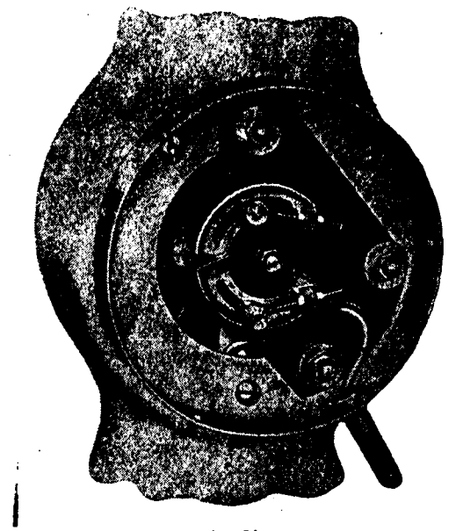


Fig. 21

COUNTING BY WEIGHT

Photo-electric cut-off

One of the most sensitive weight controls is the photo-electric cut-off. A beam of light is intercepted by a moving member of the weighing mechanism, and through an electronic amplifier the change in output of the photo-cell is used to operate controls. Miniature photo-transistors are now extensively used in fine weighing and in high-speed check weighters.

Similar articles in a production run may be counted quickly and accurately by comparing the mass of a single article with that of a batch using a weighing lever system of suitable ratio (22).

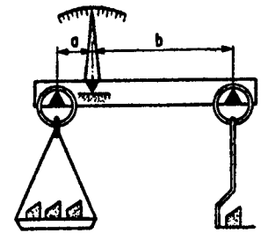


Fig. 22

In more advanced systems ratio levers are incorporated in standard dial scales, and in the case of the Avery Unit Counting Machine a counter balanced sliding ratio pan enables a count to the nearest article to be made.

News & Views

Ninth Conference of Controllers of Weights and Measures

The Ninth Conference of Controllers of Weights and Measures is scheduled to be held in Shillong on 30 and 31 October 1964. Among the subjects to be discussed at the Conferenec would be :

(1) A review of the progress of metric reform.

(2) The setting up of the central machinery for approval of prototypes.

(3) A plan to evolve standard designs for precision laboratories in the States.

Technical subjects like the marking of class on beam scales and the feasibility of reducing the varieties of commercial brass weights in use would also be discussed.

A report on the Conference will be given in the January 1965 issue of *Metric Measures*.

American Society for Testing Materials (ASTM) Metric Practice Guide

Last year the American Society for Testing Materials (ASTM) announced its decision to include in the publications the metric equivalents for other units of measurement, and drew attention to the need for American industry to be prepared for a wider use of the metric system. ASTM did not advocate a change in established dimensions or tolerances but—in addition to the inclusion of metric equivalents as standards were revised or reissued—it recommended that quantities and/or tolerances be selected, when publishing new standards, which will convert to convenient reasonable metric values.

To implement the use of the metric system by ASTM, a special committee has prepared a publication, *ASTM Metric Practice Guide*, presenting existing units and their equivalents in the recognized international units of the System International (SI). (*BSI News*, July 1964, p. 6).

Australian Decimal Currency

It has been reported that the new decimal currency notes to be issued during 1966 in Australia, will bear the denominations of $ 1, $ 2, $ 10 and $ 20. We have already reported that Australia would go over to decimal coins from February 1966 (*Metric Measures*, Vol. 6, July 1963, p. 22).

French Count System

Textile mills, especially the composite ones have been experiencing some difficulties in regard to the implementation of the French Count System. The reviewing Committee set up by the Textile Commissioner to watch the progress of implementation has made certain recommendations with a view to meeting these difficulties and other issues. The recommendations are :

(1) Composite cotton textile mills may spin and weave half French Count also in so far as the manufacture of coarse fabrics for domestic consumption alone is concerned.

(2) In regard to weaving of fabrics of other categories of cloth falling under medium 'B', medium 'A', fine and super-fine, mills should spin only integral French Count and utilise the same in the manufacture of cloth falling under the above mentioned categories of cloth for domestic consumption.

(3) As for manufacture of yarn and fabrics meant exclusively for export, mills have already been advised that they are free to spin yarn in any system (including fractional counts) and weave cloth also in any system, in accordance with the specifications of the foreign importers. If a portion of such production of yarn and fabrics manufactured for export is found later to be surplus to the export requirements by a mill and if it is required to divert that quantity to the internal market, after securing the specific permission of the Textile Commissioner in each case.

Weights and Measures Service in Israel

The annual report of the Weights and Measures Service, Ministry of Commerce and Industry, Israel, for the period 1-4-1963-31-3-1964 makes interesting reading. The work of the Weights and Measures Service is based on the Weights and Measures Ordinance, 1947, and the Rules, Orders and Official Notifications issued thereunder.

During the year 1963-64, 82,019 weights, 1,384 measures of length, 3,568 measures of capacity, 758 measuring pumps and 19,754 weighing machines *i.e.*, a total of 107,483 instruments were verified and reverified. Of these, 29,448 weights, 628 measures of length, 2,091 measures of capacity, 4,352 weighing machines were verified for the first time. Almost all the new appliances were produced locally, except liquid fuel measuring pumps.

The verification stamp was obliterated from 7,965 weights, 14 measures of length, 28 measures of capacity and 1,824 weighing machines. A total revenue of 47,925 Israel pounds was collected during the year. This gives the average revenue of 44·6 Agorot per instrument. A total of 19,593 inspections were carried out. Some 1949 traders were served notices regarding shortcomings in their instruments or non-reverification. In 296 cases further action was taken.

During the year 265 prosecutions were launched, resulting in 262 convictions and 3 acquittals. The total fines amounted to 14,338 Israel pounds. Among the offences, 194 related to possession, for use in trade, of false instruments ; 51 to possession, for use in trade of non-verified and unstamped instruments ; 26 for negligence in showing instruments for re-verification, 6 related to obstruction of Inspectors, 1 to fraud in use of instruments and one to overcharging. The main offence was, as in the previous years, possession for use in trade of self-indicating machines which were not properly balanced and indicated weight to the prejudice of the buyer.

Use of Illegal Measures—A Case

The judgement pronounced in the court of First Class Magistrate, Gulbarga, Mysore State, in the case of the State represented by the Inspector of Weights and Measures, Gulbarga and a Kirana and Grain Merchant, Bramhapur, Gulbarga, is summarised below, as it will be of interest to the general public. The case was taken in appeal before the Hon'ble Sessions Judge, Gulbarga, who upheld the judgement of the lower court and dismissed the appeal of the accused.

The accused had a kirana and grocery shop in Bramhapur. It was stated that the accused was using illegal measures in his shop and had contravened the Mysore Weights and Measures Act and had committed offences under Section 23 of the said Act. The accused was seen by the Inspector of Weights and Measures, measuring maize (jola) with seer dry measure. Other dry measures of the ounce series were also found on the premises. On behalf of the accused, it was argued that he was in possession of standard weights and measures in the metric system

and that the old measures had remained in the shop, but were not being used, and therefore, the possession of the old measures in a corner of the shop did not amount to any offence.

This plea was, however, not accepted and it was pointed out that this arguement would have been valid if the old illegal measures had been found in some area like a residential house and condemned as a useless article. On the basis of the evidence of witnesses, it was held that the accused was using illegal measures for sale of maize and, therefore, contravened the provisions of Section 7. According to the provisions of this said Act and Rules, maize is to be sold by weight and not by dry measure. As the accused used dry measures, he contravened Section 23. Further, the accused possessed illegal dry measures in the shop and used them. It was presumed that the accused knew that these were false measures under the Act. He was, therefore, also found guilty under Section 30 of the said Act.

The accused was thus held guilty of offences under Sections 7, 23 and 30 and sentenced to a fine of Rs. 51, for each of the offences. In default of payment of fine, he was to undergo simple imprisonment for a fortnight for each of the two counts.

3 Paise Coins from October 1964

A new coin in the denomination of 3 paise was issued from all offices of the Reserve Bank of India on 1 October 1964. As stocks of the new coin become available, it will be issued progressively from all agency banks of the Reserve Bank of India and all Government treasuries and sub-treasuries.

The metal composition of the new coin is aluminium with 3.5 to 4 percent magnesium. This alloy is being introduced in the country as a coinage medium for the first time. The coin is hexagonal in shape with rounded corners and its weight is 1.25 grams.

The obverse of the coin bears the Lion Capital of the Asoka Pillar with the words 'Bharat' in Hindi and 'India' in English inscribed on either side.

The reverse of the coin bears the value of the coin in the international numeral in the centre with its Hindi rendering and the year of coinage inscribed above and below the numeral, respectively. The Ears of Corn appear on either side of the International Numeral.

Indian Current Science Abstracts

The need has been felt for a long time for a bibliographical periodical covering the entire scientific output of the country quickly and comprehensively. The Conference of Information Scientists convened by the Council of Scientific and Industrial Research in Mysore during 1963 realised this need acutely and directed the Indian National Scientific Documentation Centre (INSDOC) to take immediate action for ensuring bibliographical control of scientific publication in India.

INSDOC has decided to start a monthly abstracting service from January 1965, reporting under the title 'Indian Current Science Abstracts' the work published by scientists in India. As far as possible efforts will be made to include scientific communications published abroad by Indian nationals. Original articles, short communications, critical reviews and informative articles published in scientific and technical periodicals or in proceedings of scientific conferences, symposia, etc., monographs and other *ad hoc* publications, as well as patents and standards, will be noticed in this publication. The annual subscription for the publication will be Rs. 50 only (Foreign £ 10 or $ 30).

This comprehensive coverage is possible only through the cooperation of various institutions, departments, societies and individuals who are bringing out scientific periodicals, reports, monographic publications etc. We appeal to all concerned to send us regularly such publications, including reprints of papers published in foreign periodicals, at he following address:

ndian Current Science Abstracts
ndian National Scientific
Documentation Centre
Hillside Road,
New Delhi-12.

Standards News

(Indian Standards which have a particular bearing on the change-over to the metric system are indicated here. Copies would be available from the Indian Standards Institution Manak Bhavan, 9, Bahadur Shah Zafar Marg, New Delhi or their Branch Offices at Bombay, Calcutta, Kanpur and Madras.)

The National Flag of India (Cotton Khadi)

Indian Standards Institution has published the first revision of Indian Standard Specification for The National Flag of India (Cotton Khadi) (IS: 1—1964), which prescribes the design, constructional details and other particulars of the national flag of India (cotton khadi) made of hand-spun and hand-woven cotton khadi bunting.

This standard was first published in 1951 in which all dimension and quantities were expressed in fps system units; the corresponding metric equivalents were also included in some cases. With the adoption of metric system in India, the Sectional Committee decided to revise the standard with a view to changing over completely to metric system.

Further, in view of the experience gained since the standard was first published, the Sectional Committee decided to take this opportunity to incorporate a few modifications of basic character. Therefore, in this revised standard, details of cotton yarn for the warp and weft of cotton khadi bunting and of cotton duck have been deleted. The dimensions of hemp cordage and those of wooden toggles used for different sizes of flags have been amended. The pH value of the aqueous extract of cotton khadi bunting and tolerances on the dimensions of the Flag and Asoka Chakra have been prescribed.

Price Rs. 3·50

Plywood Tea-Chests

Indian Standards Institution has published the Second Revision of Indian Standard Specification for Plywood Tea-Chests (IS: 10—1964), which covers requirements for plywood for tea-chests, standard sizes and requirements for tea-chests and their components, the tare and tests for plywood and tea-chests.

A tentative Indian Standard for Plywood Tea-chests was first published in 1949 and this was subsequently revised in 1953. The present one is the second revision of this standard in which values have been specified in the metric units in place of fps units given in the

original specification. Another important change is that the face and back veneers of plywood panels are permitted to be of different species of timber provided the construction is balanced and the two species have similar physical characteristics.

Price Rs 4·50

The National Flag of India (Silk Khadi)

Indian Standards Institution has published the first revision of Indian Standard Specification for The National Flag of India (Silk Khadi) (IS: 300—1964), which prescribes the design, constructional details and other particulars of the National Flag of India (Silk Khadi) made of hand-spun and hand-woven silk khadi bunting.

This standard was first published in 1955 in which all dimensions and quantities were expressed in fps system units; the corresponding metric equivalents were also included in some cases. With the adoption of metric system in India, the Sectional Committee decided to revise the standard with a view to changing over completely to metric system.

Further, in view of the experience gained since the standard was first published, the Sectional Committee decided to take this opportunity to incorporate a few modifications of basic character. Therefore, in this revised standard, details of silk yarn for the warp and weft of silk khadi bunting and of cotton duck have been deleted. The dimensions of hemp cordage and those of wooden toggles used for different sizes of flag have been amended. The pH value of the aqueous extract of silk khadi bunting and tolerances on the dimensions of the Flag and Asoka Chakra have been prescribed.

Price Rs 3·50

Mild Steel and Brass Cup, Ruler and Square Hooks and Screw Eyes

Indian Standards Institution has published the first revision of Indian Standard Specification for mild Steel and Brass Cup, Ruler and Square Hooks and Screw Eyes (IS: 724—1964), which lays down requirements for mild steel and brass cup, rulers and square hooks and screw eyes.

This standard was first issued in 1956 specifying the various dimensions and other requirements of cup, ruler and square hooks and screw eyes in the fps system. In view of the adoption of the metric system of weights and measures by the Government of India, the need for revision of this standard with a view to metricizing it and bringing it in line with IS: 451—1961 Specification for Wood Screws (*Revised*) in regard to form of screw thread and other relevant requirements, has long been felt by both the trade and consumers. This revision, therefore, specifies the various dimensions and other requirements of hooks and eyes made of mild steel and brass in the metric units, and the details of screw threads and other relevant requirements in accordance with IS : 451—1961.

The Sectional Committee responsible for the preparation of this standard has taken into consideration the views of producers, consumers and technologists and has related the standard to the manufacturing and trade practices followed in the country in this field. Due weightage has also been given to the need for international co-ordination among standards prevailing in different countries of the world.

Price Rs 3·00

Person Weighing Machines

Indian Standard Institution has published the first revision of Indian Standard Specification for Person Weighing Machines (IS : 1854—1964), which covers the requirements for person weighing machines.

This standard was originally published in 1961. From the experience gained and comments received from manufacturers and users, it has been considered necessary to

revise this standard. Main modifications carried out in this revision are as follows:

(*a*) The capacity of the person weighing machine has been specified as '120 kg' in place of '150 kg';

(*b*) The value of the smallest division on the steelyard has been given as 'shall be not more than 50 g' instead of 'shall be 50 g';

(*c*) The minimum graduations have been specified as 'shall be not more than 500 g' instead of 'shall be 500 g'.

This standard is one of a series of Indian Standards on commercial weighing machines, being prepared at the instance of the Standing Metric Committee (now the Directorate of Weights and Measures), Government of India in connection with the introduction of metric system of weights and measures in the country.

Price Rs 2·00

Dimensions for Pipe Threads for Fastening Purposes

Indian Standards Institution has published Indian Standard Dimensions for Pipe Threads for Fastening Purposes (IS: 2643—1964), which deals with the basic profile, design, dimensions and tolerances of pipe threads for fastening purposes intended for mechanical assembly of components and where pressure-tight joints are not required on the threads.

This standard deals with internal and external pipe threads for fastening purposes, intended for the mechanical assembly of component parts of pipes, fittings, cocks, valves, etc. where pressure tight joints are not required on the threads. Parallel internal threads specified in IS:554—1955 Specification for Pipe Threads for Gas List Tubes and Screwed Fittings, for obtaining a pressure-tight joint on the threads, provided such threads are not truncated. The profile of the thread specified in this standard is identical with that of the parallel thread specified in *IS: 554—1955. The internal and external threads covered in this standard are both parallel.

Price Rs 2·00

Dimensions for Wrought Aluminium and Aluminium Alloys, Sheet and Strip

The Indian Standards Institution has published Indian Standard Dimensions for Wrought Aluminium and Aluminium Alloys, Sheet and Strip (IS: 2676—1964), which lays down the dimensions and tolerances for wrought aluminium and Aluminium Alloys in the form of sheet and strip.

This standard is one of a series of Indian Standard on Wrought Aluminium and Aluminium Alloys. Other Standards in this series are :

IS: 2525—1963 Diameters of Wrought Aluminium and Aluminium Alloys, Wire.

IS: 2677—1964 Dimensions for Wrought Aluminium and Aluminium Alloys Plate.

IS: 2678—1964 Dimensions for Wrought Aluminium and Aluminium Alloys, Drawn Tube.

IS: 2673—1964 Dimensions for Wrought Aluminium and Aluminium Alloys, Extruded Tube.

Price Rs 2·50

Brass wire for cold-Headed and Machined Parts

The Indian Standards Institution has published Indian Standards Specification for Brass Wire for cold-Headed and Machined Parts (IS: 2704—1964), which covers the requirements of brass wire for hardware, such as nipples for cycle spokes, where cold-heading as well as machining properties are required, either in cut lengths or in coils.

Price Rs 1·50

Metric, Woven Metallic and Glass Fibre Tape Measures

Indian Standards Institution has published the first revision of Indian Standard Specification for Metric, Woven Metallic and Glass Fibre Tape, Measure (IS : 1269—1964), which prescribes the requirements for metric, woven metallic and glass fibre tape measures intended for use where it is not possible to employ rigid measures of length.

This standard was first published in 1958. The present revision is based on the suggestions received from the Controllers of Weights and Measures as a result of practical application of the standard. Tapes of 15 m denomination have also been included. Besides, glass fibre has been specified as an alternate material for the manufacture of tapes.

Price Rs 2·00

Burnt Clay Facing Bricks

Indian Standards Institution has published Indian Standard Specification for Burnt Clay Facing Bricks (IS: 2691—1964), which specifies the dimensions, quality and strength, and methods of sampling and testing for burnt clay facing bricks for use in buildings.

Facing bricks are intended for use in the exposed face of masonry without any further surface protection by plastering or rendering. Its use may be necessary for architectural reasons; sometimes, where external plastering or renderings have to be frequently renewed due to corrosive atmosphere, use of facing bricks will prove to be economical. The general practice in this country is to use common bricks selected for proper shape and degree of burning and use them as facing bricks. This may not be always satisfactory, as facing bricks require not only trueness in shape and good appearance but also resistance to the effects of atmospheric agents, and for the latter aspect specific requirements will be necessary, generally superior to those of common bricks.

Price Rs 2·00

Drawing Filing Equipment

Indian Standards Institution has published Indian Standard Specification for Drawing Filing Equipment (IS: 2695—1964), which lays down the dimensional and other requirements of filing equipment, such as plan chests, vertical filing equipment, lateral filing equipment for small drawings and roll files for large drawings.

It has been the experience of many architects, engineers and draughtsmen that old drawings, when required for reference purposes after a few years, are either found in a dilapidated condition or not found at all. This usually results in wastage of time as well as loss of valuable drawings. This standard is intended to provide guidance with regard to the drawing filing equipment and will help in the elimination of most of the defective systems presently in use.

While preparing this standard only the sizes of drawing sheets covered in IS:1064—1961 Specification for Paper Sizes (*Revised*) have been considered.

Price Rs 3·50

Flats and Flats' Screws

Indian Standards Institution has published Indian Standard Specification for Flats and Flats' Screws (IS: 2699—1964), which prescribes the essential requirements of flats and flats' screws for use in revolving flat carding engine of 1016 mm width.

This standard covers flats and flats' screws for use with flat driving chains conforming to IS: 1927—1961 Specification for Flat Driving Chains for Carding Engines.

This standard does not cover the fillets to be mounted on flats.

A flat is basically a long cast iron bar of T-shaped cross-section. In a revolving flat carding engines, the flats with mounted fillets move over the cylinder and work in conjunction with cylinder fillets effecting a combing action, thereby cleaning and to some extent making parallel the fibres which are under process. Flats are moved by means of two endless chains known as flat driving chains.

The revolving flat carding engines produced at present in this country are mostly of 1016 mm (or 40 in) width and, therefore, only flats intended for such carding engines have been covered in this standard.

Requirements for the material given in this standard are only the minium and, therefore, the use of other materials having characteristics equivalent or superior to those specified in this standard is not precluded.

All quantities and dimensions in this standard have been given in the metric system.

Price Rs 1·50

Memorandum on Screw Threads for Bicycle Components

Indian Standards Institution has published Indian Standard Memorandum on Screw Threads for Bicycle Components (IS: 2728—1964). This memorandum recommends suitable ISO metric threads for application in bicycle components and a suitable schedule for the smooth changeover from existing threads to the ISO metric threads.

In 1956, the Government of India took a decision to adopt the Metric System of Weights and Measures, and the Indian Standards Institution has prepared a plan to formulate Indian Standards in metric system, and also metricize all the existing standards within a period of ten years. The Screw Threads Sectional Committee of the Engineering Division Council examined the practices that are being followed in the country, and also the work that is being done by the Technical Committee No. 1 Screw Threads of the International Organization for Standardization (ISO), and after very detailed deliberations decided to adopt ISO Recommendations for metric screw threads as represented in ISO/R 63-1958, ISO Basic Profile for Triangular Screw Threads. Basic Sizes for Screw Threads in the Major Diameter Range 0·25 to 5 mm A number of Indian Standards on metric screw threads and fasteners has been published.

The Screw Threads Sectional Committee of ISI decided to investigate the possibility of adopting ISO metric screw threads and formulate standards to cover the screw threads for the interchangeable bicycle components. This memorandum has been prepared as a result of these investigations and contains recommendations for application of screw for bicycle components.

Price Rs 1·50

Recommendation for Preferred Dimensions for Storey-Heights

Indian Standards Institution has published Indian Standard Recommendation for Preferred Dimensions for Storey-Heights (IS: 2718—1964), which lays down recommendation for preferred dimensions for storey-heights.

Storey-height is one of the important controlling dimensions in the planning of a building and its selection has to take into consideration the climatic conditions, the living habits, the cost of construction, the local bye-laws, etc. and a fair amount of flexibility for its selection is necessary. However, a selection at random will result in counter-acting the benefits of dimensional co-ordination which one aims to achieve through the use of modular components. Therefore, there is a need for limiting the selection of storey-heights to a set of preferred dimensions. With the increasing emphasis now on the use of pre-fabricated components for buildings, need for preferred sizes of storey-heights has become all the more important. This standard is intended to give guidance with regard to such preferred dimensions for storey-heights.

This standard is one of a series of Indian Standards covering modular co-ordination in the building industry. Other standards published so far by the Institution in the series are:

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.

Price Rs 1·00

Mild Steel Tubes and Tubulars

Indian Standards Institution has published the first revision of Indian Standard Specification for Mild Steel Tubes and Tubulars (IS: 1239—1964), which covers the requirements of butt welded, seamless, screwed and socketed mild steel tubes and tubulars and plain-end steel tubes, suitable for screwing to pipe threads conforming to IS: 554—1955 Specification for Pipe Threads for Gas List Tubes and Screwed Fittings, of nominal bores ranging from 6 to 150 mm. Three grades of thicknesses, designated as 'Light', 'Medium', and 'Heavy', have been included in this standard.

'Light', 'Medium' and 'Heavy' tubes are suitable for conveying gas and water. Only 'Medium' and 'Heavy' tubes are recommended for conveying steam. The maximum permissible pressures and temperatures for different sizes of tubes for conveying steam are given in an appendix to the standard.

This standard, published in 1958, specified the requirements for three classes of mild steel screwed tubes and tubulars and plain-end steel tubes, designated as 'Light', 'Medium' and 'Heavy.' This standard did not specify all the details regarding the service for which the three classes of tubes were appropriate although broad indications were given. However, this revision clarifies that tubes conforming to this revised standard are suitable for conveying gas, water and steam. The maximum permissible pressures and temperatures for tubes conveying steam are also given for information in an appendix to the standard. Moreover all the clauses relating to general requirements for the supply of material conforming to this standard have been deleted and a reference has been made to IS: 1387—1959 General Requirements for the supply of of Metals and Metal Products.

Price Rs 5·50

Shri P. N. Nayer, Director of Weights and Measures, Ministry of Commerce, left India on Wednesday, 7 October 1964, to take over as Chairman of East African Metric Commission set up by the East African Common Services Organisation to examine the feasibility of adopting the metric system in these countries.

As Secretary of the former Standing Metric Committee and as Director of Weights and Measures, he has been closely associated with the adoption of the metric reform in India.

Last year the services of another Indian officer, Shri Kanwar Jit Singh, Controller of Weights and Measures, Punjab had been lent to Saudi Arabia as adviser on metric system.

Licensed Manufacturers and Repairers

Metric Measures had been publishing in the past a series of lists of licensed manufacturers, dealers and repairers of weights and measures, weighing and measuring instruments licensed by the Governments in the various States and Union Territories under their Weights and Measures (Enforcement) Acts. To economise on paper, it is possible only to publish lists of licensed manufacturers and repairers.

A feature on statistics of verification and licences issued is also being published in *Metric Measures*.

STATISTICS OF VERIFICATION OF WEIGHTS ETC. AND LICENCEES.

States/Union Territories	Period	Weights	Capacity Measures	Length Measures	Weighing Instruments	Measuring Instruments	Others	Total number of Mfrs.	Dealers	Repairers
								As on first day of Nov. 1964		
1	2	3	4	5	6	7	8	9	10	11
(1) Andhra Pradesh ..	1 Feb. 64 to 31 May64	2,00,101	64,362	6,408	21,747	527	26	14	59	24
(2) Assam ..	1 June 64 to 31 July 64	83,104	—	19,638	490	1,075	45	19	254	238
(3) Bihar ..	1 April 62 to 31 Jan. 63	1,28,211	—	—	19,309	56	—	30	203	43
(4) Gujarat ..	1 Feb. to 31 Mar. 64	—	1,95,320	15,671	3,368	29,759	169	114	585	155
(5) Kerala ..	1 Apr. 62 to 31 July 62	—	—	—	—	—	—	—	—	—
(6) Jammu & Kashmir	1 Apr. 63 to 31 Mar. 64	2,12,854	2,582	7,511	683	3	4	36	36	2
(7) Madhya Pradesh	1 Dec. 63 to 30 Mar. 64	3,80,668	51,514	4,145	69,937	129	63	63	825	291
(8) Madras	1 July to 31 Aug. 64	1,59,120	92,733	1,237	23,303	864	—	—	—	—
(9) Maharashtra	1 Apr. 63 to 30 Nov. 63	12,73,216	2,94,420	5,608	—	—	—	—	—	—
(10) Mysore	1 Apr. 62 to 31 Nov. 62	4,81,345	1,05,253	1,089	1,96	2	—	8	103	6

States/Union Territories	Period	Weights	Capacity Measures	Length Measures	Weighing Instruments	Measuring Instruments	Others	Total number of Mfrs.	Dealers	Repairers
								As on first day of Nov. 1964		
(11) Punjab	1 June to 31 July 64	83,047	30,664	2,490	15,598	112	—	1	7	5
(12) Orissa ..	Jan. 63 to May 64	1,97,851	30,025	1,055	4,891	77	—	8	103	6
(13) Rajasthan ..				N.A.						
(14) Uttar Pradesh	1 Apr. 63 to 31 May 63	46,845	24,513	8,602	5,932	162	—	200	979	187
(15) West Bengal	11 July 64 to 29 Aug. 64	1,14,578	7,483	600	16,392	—	—	—	—	—
(16) Andaman & Nicobar Islands				N.A.						
(17) Delhi ..	1 June 64 to 31 Aug. 64	59,032	5,444 +37 Petrol lorries	1,186	8,827	126	—	66	26	71
(18) Goa ..	1 Apr. 64 to 31 May 64	13,523	1,012	23	26	—	—	—	353	—
(19) Himachal Pradesh	1 Apr. 62 to 31 July 63	68,020	7,411	2,532	10,628	1	—	1	25	12
(20) L.M.A. ..				N.A.						
(21) Manipur ..	1 Apr. 62 to 31 July 64	21,705	4,173	239	981	17	—	—	5	—
(22) Pondicherry	1 Feb. 64 to 31 Mar. 64	4,038	1,341	36	21	4	37	4	10	3
(23) Tripura ..	1 Apr. 62 to 30 July 62	62,050	8,464	720	9	8	—	4	85	3

N.A.—Statistics not available as yet.

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TYPICAL METRIC PRICING UNITS FOR WHOLESALE TRANSACTIONS

Serial No.	Commodity	Metric Unit
(1)	Gold	10 grams (g)
(2)	Grocery and Confectionery Biscuits, sweetmeats, cardamoms. **Textiles and Textile Fibres** Cotton yarn, damaged and seconds cloth, raw silk, rayon silk yarn, raw wool, wool manufactures (when sold by weight). **Paints & Chemicals** Paint (if sold by weight), indigo, liquid chlorine. **Hides, Skins & Leather** Raw hides, leather (hides and skins). **Metals** Silver, aluminium sheets, strips and circles, copper and brass wires and utensils. **Miscellaneous** Tea, meat, camphor tablets, mica.	1 kilogram (kg)
(3)	Grains and Pulses Rice, wheat, jowar, arhar, moong, masur, gram. **Spices** Black pepper, mustard, chillies, dhania, dalchini, turmeric, betelnuts. **Plantation Products** Rubber, cashewnuts, cashew kernels, tobacco (raw and manufactured). **Forest Products** Lac and lac products, gums, myrobalans, galnuts, soapnuts. **Textiles & Textile Fibres** Raw jute, raw hemp, coir yarn. **Oils, Oilseeds & Oilcakes** Vegetable oil, oilseeds, oilcakes. **Non-Ferrous Metals** *Aluminium :* ingots, bars, blocks, slabs, 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, circles. *Brass :* ingots, rods, sections, pipes, sheets, strips circles. *Zinc :* ingots, sheets, strips. *Tin :* blocks. **Chemicals** Caustic soda, bleaching powder, glycerine, soaps, paper salt. **Others** Sugar, gur, ice, fish, sugarcane, vegetables, tamarind.	1 quintal (q) (100 kilograms)
(4)	Minerals Iron ore, manganese ore, bauxite, coal. **Iron & Steel** Pig iron, Iron & steel manufactures, semis (billets for rerolling etc.)	one metric tonne (t) (1,000 kilograms)
(5)	Cloth (mill, handloom, silk rayon and woollen cloth)	1 metre (m)
(6)	Jute carpets, coir mats and mattings, sheet glass.	one square metre (m^2)
(7)	Timber.	one cubic metre (m^3)
(8)	Paints (when sold by measure), spirits.	one litre (l)

Weights

(1) In place of the present units of seer, pound, rattal, viss etc., use the kilogram.

(2) In place of the tola, use the gram or 10 grams.

(3) In place of maund or corresponding unit, use the quintal *i. e.*, 100 kg.

Capacity Measures

In place of seer or gallon or any other measure, use the litre.

Length Measures

(1) Use the metre in place of yard or foot and the centimetre in place of inch.

Square Measures

(1) Use the square metre in place of square yard or square foot, and square centimetre in place of square inch.

Cubic Measures

(1) Use the cubic metre in place of cubic yard or cubic foot and cubic centimetre in place of cubic inch.

Packaging

It is advantageous if sizes of packages correspond to series of commercial weights and measures prescribed.

These are: 50 kg, 20 kg, 10 kg, 5 kg, 2 kg, 1 kg, 500 g, 200 g, 100 g, 50 g, 20 g, 10 g, 5 g, 2 g, 1 g, and so on.

TYPICAL PRICING UNITS FOR RETAIL TRADE

Serial No.	Commodity	Metric Unit for Use
(1)	Foodgrains, cereals, pulses, spices, ghee, bread, vegetables, meat, fish, sweetmeats, tea, coffee, sugar, salt	1 kg
(2)	Oil for cooking	1 kg or 1 litre depending upon prevalent practice.
(3)	Fruits	1 kg or number depending upon prevalent practice.
(4)	Milk	1 litre
(5)	Cloth and related materials	1 metre
(6)	Prepackaged materials	Preferably sizes corresponding to series of commercial weights and measures.

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