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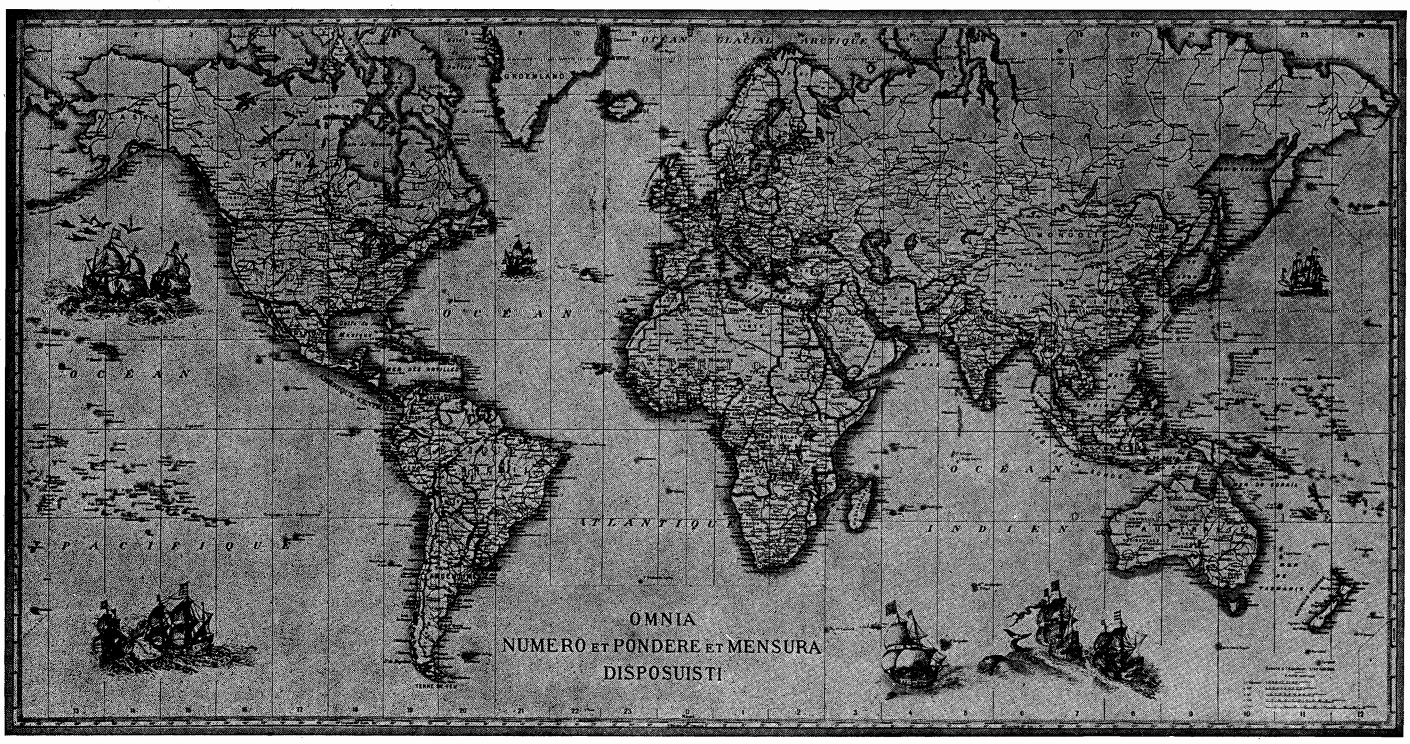
DE

L'ORGANISATION INTERNATIONALE DE MÉTROLOGIE LÉGALE



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BELGIQUE

MÉTROLOGIE DES PRODUITS CONDITIONNÉS ET DANS LES BOURSES DE COMMERCE

par **M. JACOB,** ancien Président
du Comité International de Métrologie Légale
Membre d'Honneur du Comité

Il semble bien qu'actuellement dans beaucoup de pays les Gouvernements admettent l'utilité et même la nécessité d'une législation et d'une réglementation en matière de métrologie, afin d'imposer l'emploi d'*unités de mesure bien définies et d'instruments de mesure* suffisamment exacts partout où entrent en jeu, à un titre quelconque, l'intérêt général ou des intérêts opposés, par exemple ceux de l'acheteur et ceux du vendeur.

Mais il est deux domaines où les bienfaits de cette législation et de cette réglementation sont en partie perdus et où les services nationaux de métrologie légale ne sont généralement pas suffisamment armés, surtout dans les pays de l'Ouest et, bien entendu, dans les pays en voie de développement.

Ces domaines sont celui, de plus en plus développé, des produits conditionnés et celui des bourses de commerce internationales. Dans les deux cas, l'aspect international du problème présente une importance considérable, voire même prépondérante. C'est pourquoi des solutions doivent être recherchées et adoptées en commun entre les divers pays.

Le cas des conserves de légumes est typique du problème des *produits conditionnés*. Il fut un temps où l'on ne vendait que des légumes frais ou séchés, puis un temps où l'on vendait des conserves en boîtes, l'unité étant la « boîte », avec cependant des « demi-boîtes » c'est-à-dire des boîtes de contenance moitié moindre (ou d'autres fractions simples ou encore des multiples de l'unité « boîte »). On créait ainsi une unité de mesure arbitraire et aucun instrument de mesure à la disposition du public ou des autorités n'était établi ou gradué suivant cette unité.

Lorsque divers pays exigèrent l'indication sur l'emballage du contenu net exprimé en unités légales, le problème suivant se posa dans les pays européens exportateurs de conserves de légumes, et notamment en Belgique, Les premiers pays ayant exigé l'indication du contenu net en unités légales étant anglo-saxons, on se mit à fabriquer des boîtes contenant 1 livre anglaise avoirdupois (1 lb = 454 g), pour le format moyen. Ceci représentait un double progrès : l'emploi d'unités générales bien définies et l'adoption de valeurs rondes en fonction de ces unités. Mais ces valeurs ne pouvaient pas être rondes à la fois en unités anglo-saxonnes et en unités métriques. La solution de fabriquer des boîtes de contenance différente, l'une pour les pays anglo-saxons, l'autre pour les pays métriques, par exemple 1/2 kg ou 500 g, se heurte à un grave obstacle. En Belgique notamment, à cause du climat, la récolte des légumes, des petits pois par exemple, dure peu de temps ; il s'agit d'une denrée périssable. Il faut donc la mettre en boîte aussitôt après la récolte ; la vente s'étalera sur toute l'année, mais on ne sait pas d'avance combien de boîtes seront vendues dans les pays anglo-saxons et combien dans les pays métriques. Pour éviter des pertes et des frais, on doit ainsi se contenter d'un format unique.

On dira peut-être que ce format unique peut être une valeur ronde du système métrique, puisque celui-ci est légalement admis pratiquement dans tous les pays, tout au moins à titre facultatif. Oui, mais le consommateur moyen anglo-saxon est habitué à ses unités. Si un pays exportateur lui impose des valeurs métriques rondes, alors que d'autres pays exportateurs lui offrent des valeurs rondes en unités anglo-saxonnes, le premier pays risque de voir ses ventes diminuer au profit des autres, d'autant plus que la livre anglo-saxonne est nettement inférieure à 500 g.

Le problème est international ; la solution doit l'être également.

J'ai pu constater que dans les régions tropicales, il arrive que des boîtes, des bouteilles ou des caisses, servent de mesures de capacité après qu'elles ont été vidées de leur contenu initial. Cela crée évidemment des unités arbitraires, assez variables, auxquelles ne répond directement aucun instrument de mesure.

Les pays européens seraient mieux armés pour faire comprendre aux habitants de ces régions les inconvénients de l'emploi de ces vidanges comme instruments de mesure s'ils n'avaient pas souvent eux-mêmes un système trop peu normalisé de bouteilles, de futailles et de verres à l'usage des consommateurs dans les lieux où l'on vend à boire. Plusieurs pays se sont attaqués à ces problèmes, et parfois depuis longtemps, mais là aussi, à l'heure des avions à réaction, qui suppriment les distances, et des unions douanières, qui suppriment les frontières économiques, la solution devrait être internationale.

En attendant, on ne saurait trop attirer l'attention sur le fait que le développement de la vente en emballages scellés par le fabricant tend *à détruire les deux principaux objets de l'activité des services nationaux de métrologie légale* : les *unités* et les *instruments* de mesure. En fait, il se répand dans le pays des unités nouvelles, telles que la « boîte », ou des unités étrangères. Quant aux instruments de mesure, le commerce de détail en a de moins en moins besoin pour un même volume de transaction. Si l'on n'y prend garde, on retournera, plus ou moins insidieusement, au chaos auquel voulurent remédier les auteurs du système métrique.

Il ne faut pas oublier que la tendance au chaos en matière de métrologie est une faiblesse naturelle, souvent inconsciente, de l'âme humaine et l'on pourrait citer beaucoup d'exemples de ce fait.

Un de ces exemples, qui est d'ailleurs un peu lié au cas des produits conditionnés, est celui des *bourses de commerce.* Un cas typique est celui du « boisseau », en anglais « bushel ». Pendant des millénaires, on a vendu les matières sèches, et en particulier les céréales, sur la base du volume, déterminé au moyen de mesures de capacité. Ce n'est qu'au XX^{e} siècle que le pesage s'est substitué au mesurage, du moins dans les pays évolués (On y procède encore à certaines déterminations de volume, généralement d'ailleurs au moyen d'instruments tout à fait spéciaux, mais uniquement sur échantillon, en vue de déterminer une qualité des grains qu'on appelle le « poids naturel »).

La quantité totale de céréales est déterminée par pesage, aussi bien aux U.S.A., au Canada et au Royaume-Uni qu'en Europe continentale, mais l'usage a subsisté dans le commerce de gros de coter les prix en bushels. En réalité, le bushel devient alors une unité conventionnelle de masse (poids dans le langage courant). Cette unité varie toutefois très fortement pour deux raisons principales. La première est qu'à un même volume correspond une masse différente suivant la masse volumique, laquelle n'est évidemment pas la même suivant qu'il s'agit de froment, d'avoine, de seigle ou d'autres grains. Même si l'unité de volume était constante, elle devient variable avec la marchandise si l'on en fait une unité de masse. L'autre raison est qu'autrefois on remplissait parfois les mesures de capacité pour matières sèches au-dessus du bord supérieur, tant qu'on pouvait, ce qu'on appelait faire mesure « comble » (en anglais « heaped bushel », et non pas à ras, comme l'on prescrit à juste titre les premières lois sur le système métrique. A ces deux raisons principales, s'ajoutent celles qui poussent à la diversification des unités de mesure en général, suivant les lieux et les époques.

C'est ainsi qu'on en arrive encore aujourd'hui aux résultats suivants :

L'avoine est cotée à Chicago en cents USA par bushel de 32 lbs (14,515 kg) tandis qu'elle est cotée à Winnipeg en cents canadiens par bushel de 34 lbs (15,422 kg), alors que le froment et le soya sont cotés à Chicago par bushel de 60 lbs (27,216 kg) et l'orge à Winnipeg par bushel de 48 lbs (21,773 kg). Pour la graine de lin, on cote à Minneapolis (USA) par bushel de 56 lbs (25,401 kg) tandis que ce bushel sert à Chicago pour le maïs et pour le seigle.

En Grande-Bretagne, on cote en « quarters » de 320 lbs pour l'avoine, de 400 lbs pour l'orge, et de 480 lbs pour le froment, le maïs et le seigle.

L'accord international sur le blé a pris pour unité de quantité un bushel de 60 lbs, mais en le définissant à partir d'unités métriques, bien que la majorité des producteurs (comprenant surtout les USA) et la majorité des consommateurs (comprenant surtout le Royaume-Uni) appartiennent à des pays anglo-saxons.

Un exemple de création d'unités de masse portant le nom d'une unité de volume s'est rencontré dans nos régions lorsqu'on a autorisé les paysans à réclamer le paiement, sur la base d'un nombre de litres, du lait qu'ils livraient à la laiterie et que celle-ci déterminait par pesage et non par mesurage. (Aujourd'hui, le mesurage revient à l'honneur parce que le lait est stocké à la ferme, non plus en cruches transportées et pesées à la laiterie, mais bien dans un réservoir réfrigéré, dont le contenu est pompé par un camion-citerne).

On peut regretter que le système métrique ne soit pas encore d'un emploi universellement obligatoire et que l'on ne dispose pas encore d'une monnaie mondiale qui serait un étalon des valeurs aussi stable que les étalons fondamentaux de mesure.

Mais en attendant, on s'explique que l'on cote les produits ou matières en unités monétaires du pays par unité de quantité du pays, par exemple, le cuivre à Londres en livres sterling par long ton (1016 kg) et à New-York en cents USA par livre de 454 g, bien que des confusions résultent de l'existence d'unités anglo-saxonnes de même nom mais de valeur différente, telles que par exemple l'once avoirdupois, l'once troy et l'once liquide ou bien le gallon (3,78 l aux U.S.A. et 4,54 l au Royaume-Uni).

Mais ne pourrait-on pas commencer par supprimer les unités fictives, telles que le bushel, la « bouteille » de 76 lbs (34,473 kg) pour le mercure, la « balle », le « baril », la « caisse », le « sac », etc...

Nous avons dû lutter contre l'emploi du « sac » à l'hectare pour les fermages et les rendements des cultures et cependant la situation était plus claire que pour le café actuellement dans le monde.

Voici en effet les valeurs du « sac » de café dans différents pays :

Brésil	60 kg
Colombie	70 kg
Congo	60 kg
Costa-Rica	69 kg
Cuba	90 kg
Inde	77 kg (170 lbs)
Jamaïque	90 kg (198 lbs)
Tanganyka	90 kg (198 lbs)
Venezuela	59 kg.

N'est-ce pas là un bel exemple, parmi beaucoup d'autres, du chaos auquel l'humanité tend constamment en matière de métrologie et contre lequel les fondateurs du système métrique et leurs successeurs ont dû et doivent encore lutter avec force et ténacité ?

Les chiffres du présent exposé sont tirés tels quels d'une édition assez récente d'une publication d'une grande banque. A supposer même qu'il puisse y avoir lieu à l'une ou l'autre rectification de détail, cela ne changerait en rien la conclusion.

CANADA

ERRORS IN LARGE CAPACITY WEIGH SCALES

by **E. GREEN**
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Le présent article décrit les méthodes utilisées au Canada pour le contrôle des installations d'appareils de pesage de grande portée.

Les facteurs qui contribuent aux erreurs de pesage lors de l'emploi usuel de ces appareils sont examinés et des évaluations numériques de leurs limites sont données. De plus, l'auteur donne un court aperçu de la structure de la réglementation sur le contrôle légal des appareils de pesage et des poids au Canada ainsi que de la liaison entre les étalons de mesure canadiens et le Système international d'unités.

1. INTRODUCTION

In the handling of raw and semi-finished produce in bulk the quantity being processed or transported is in many instances, contrary to appearances, measured with very great accuracy. This is necessary because, even though the unit price of the commodity or the freightage rates may be low, a measuring error of only a fraction of one percent on the large volumes transferred can result in considerable monetary losses. A study of weighing practices in the grain trade was recently made by the National Research Council (NRC) at the request of the Board of Grain Commissioners in Canada. The standards set by the Board are most stringent and greater perfection can only be achieved by taking into account factors formerly considered to be of academic interest only.

2. SCALE TOLERANCES

Scales used throughout Canada for trading and billing purposes must be initially tested and their design approved by the Standards Laboratory of the Department of Trade and Commerce. Thereafter the scales are periodically tested by inspectors of the Department to ensure that they conform to the prescribed tolerances. The tolerances which apply are based on the type and style of the scale and the purpose for which it is used, They are fully listed in « The Canada Gazette », Part II, Statutory Orders and Regulations, 1952, and two of the tabulations are reproduced here in Tables 1 and 2.

TABLE 1*

SCALE TOLERANCES

Known Test Load	*Tolerance in Excess or Deficiency*
Less than 100 lbs	2 oz (0.125 %)
Over 100 lbs to 800 lbs	2 oz per 100 lbs of load (0.125 %)
Over 800 lbs to 1000 lbs	1 lb (0.125 to 0.100 %)
Over 1000 lbs	1 lb per 1000 lbs of load (0.100 %)

Tolerances specified in Table 1 apply to all scales, such as floor portable and suspension scales over 400 lbs capacity, dormant and portable heavy duty scales, except where other provision has been made within the Regulations or by approval listing for special conditions.

Approval

For the purpose of approval of type of scale covered in Table 1 the tolerances shall be three-quarters of those shown in Table 1.

* Reproduced from the Canada Gazette, 1952, Table 5.

TABLE 2**

SCALE TOLERANCES (ELEVATOR SCALES)

Capacity of scale in lbs	*Sensitive tolerance empty or fully loaded*	*Greatest error allowed in excess or deficiency empty or fully loaded*
2 — 3,000 lbs ***	1 lb	1 lb (0.033 % of capacity load)
6 — 9,000 lbs	1.5 lbs	2.5 lbs (0.028 %)
12 — 15,000 lbs	2.5 lbs	5 lbs (0.033 %)
18 — 24,000 lbs	4 lbs	6 lbs (0.025 %)
30 — 36,000 lbs	6 lbs	8 lbs (0.022 %)
42 — 48,000 lbs	7 lbs	10 lbs (0.021 %)
60 — 80,000 lbs	8 lbs	15 lbs (0.019 %)
100 — 120,000 lbs	9 lbs	18 lbs (0.015 %)

For intermediate capacities the tolerance of error shall be proportional, the same tolerance to apply to both original and subsequent inspection.

The tolerances prescribed in Table 2 shall apply to all elevator scales.

Approval

For the purpose of approval of type of scales covered by Table 2 the tolerances shall be the same as in Table 2.

** Reproduced from the Canada Gazette, 1952, Table 6.

*** To be read as 2000 to 3000 lbs etc.

3. METHODS FOR TESTING SCALES

The differences in the basic types, as well as the many different designs which fall within a single category, preclude a detailed study of the testing of scales in general. Corner tests, sensitivity checks and other similar items, which are part of the normal inspection routine, are adjuncts of the basic test requirements and essentially establish the efficiency of the maintenance and adjustment service for a particular scale. However, it is profitable to consider the technique fundamental to all scales and to concede that the test procedure must be modified or extended to prove the accuracy of features peculiar to a particular installation.

Direct method

There is one fundamental method for testing the accuracy of weighing devices and that is to apply known test-loads up to the capacity of the device and to verify that the recorded loads agree with the applied loads.

This is the direct method. However, under certain circumstances this method cannot be applied and two degenerative versions of it are in common use.

They are both applicable when the available calibrated test load is less than the fully loaded capacity of the scale or the capacity at which it is normally used. The methods are known as (1) :

(i) the substitution method

(ii) the strain-load method.

Substitution method

The principle of the substitution method is the successive substitution of a load of any available material for the test-load. Initially the scale is calibrated against the test weights which are then removed and an equivalent amount of material as indicated by the scale read-out device, placed on the scale. By now adding the test-load to this load of material the accurately known load available to the inspector is twice that of the test-load. Thus, by continuing the process of removing the test load and substituting an equivalent amount of material a load known to within the reading accuracy and the reproducibility of the scale can be generated up to the capacity of the scale.

Strain-load method

The strain-load method is essentially the verification that the scale accurately indicates a difference in load equivalent to the applied test load (which is only a fraction, 10 % to 20 %, of the scale capacity) when the scale is under some additional, but unknown, load which stresses the parts of the scale as they would be stressed under ordinary working conditions. The unknown strain-loads range from zero load up to that load which when applied additively with the test-load gives the fully loaded condition of the scale.

(1.) « The Examination of Weighing Equipment », National Bureau of Standards, Handbook 94, U.S. Department of Commerce.

4. THE RELATIVE ACCURACIES OF THE TESTING METHODS

Direct method

The direct method is the most accurate of the three. It is limited only by the reading accuracy and reproducibility of the scale at the applied load as well as the uncertainty in the value of the test load.

Substitution method

The accuracy of the substitution method is limited by the same factors as the direct method but the test load uncertainty is compounded at each substitution step by the inherent inaccuracy of the scale. The accuracy of the method is also dependent upon the stability of the auxiliary material used for loading the scale. The weight of the substitute load must remain constant over the period of time necessary to observe the scale readings and to make the weight transfers. Materials of a hygroscopic nature, those likely to evaporate or to oxidize, etc..., should not be used unless proved satisfactory for the purpose.

Strain-load method

The strain-load method is the most degenerative version of the testing methods and the extent of degradation is correlated to the number of strain-loads used. If the loads are generated in steps equal to the test-load, then with very little extra manipulative care, the method becomes identical to the substitution technique. However, the method is intended for use on the basis of economy in testing effort or for use in those instances where auxiliary material is not available in a form convenient for use in a simple substitution test. In either case the validity of the test results depends upon the number of strain-loads used. Two simple examples can be used to demonstrate the inadequacies of the method, one to show how an inaccurate machine may be misconstrued as indicating correct weights and the second to illustrate the converse.

(i) Obviously a single strain-load constitutes no test. An elementary consideration shows that a test based on two strain-loads, a zero load and a capacity load, is of questionable validity unless augmented by very delicate sensitivity tests. For example, if the relationship between the load (L) and the reading of the scale (R) is given by a cubic equation, then the conditions of the test are satisfied if the constants (m, p and q) of the equation

$$R = Lm + L^2p + L^3q$$

are such that the changes in scale readings (ΔR) at the zero strain-load and at the capacity strain-load are equal to the test load (ΔL). In other words, that the chords 0, a and b, c have the same slope, i.e. $\frac{\Delta R}{\Delta L} = 1$, as depicted in Fig. 1. The only indication of the non-linear relationship existing between the reading and the load is the change in sensitivity at all four loadings (i.e. at o, a, b and c) where

$$\left.\frac{dR}{dL}\right|_o \neq \left.\frac{dR}{dL}\right|_a \neq \left.\frac{dR}{dL}\right|_b \neq \left.\frac{dR}{dL}\right|_c \neq 1$$

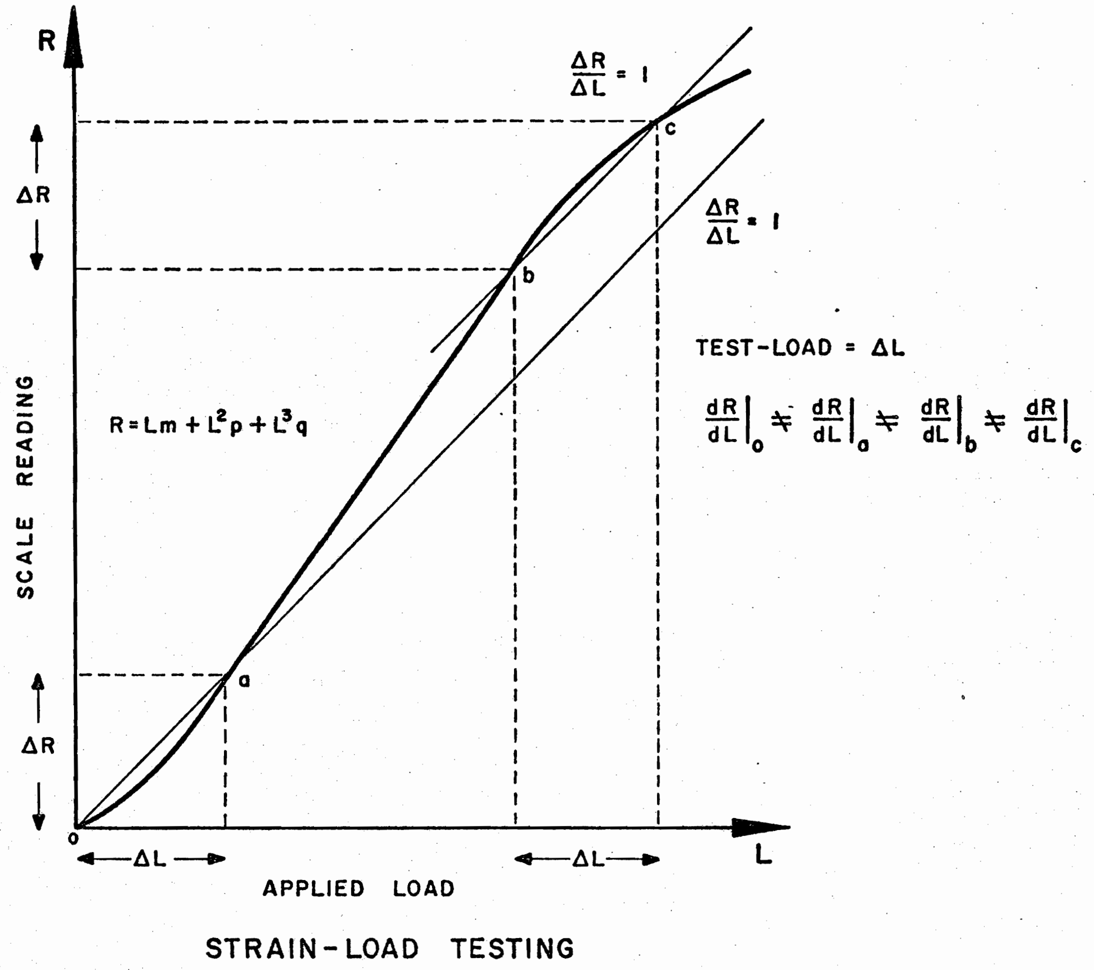


Fig. 1

In a normal routine test this condition would be difficult to detect even if it was suspected to exist. Sensitivity checks are made with weights of small denomination, 0.5 kg (1 lb), and a scale must have considerable error to cause any detectable reading error on the application of such weights. The deficiency of the test in this particular case can be rectified by making a third strain-load measurement in the vicinity of half the scale capacity. But even this does not ensure, in real cases, that anomalies are not present in the untested parts of the range.

The concept of a cubic relation for scales is not wholly theoretical, it occurs in practice although in many instances it is not so clearly defined as in the foregoing example and the slopes of the chords are not necessarily equal or identically unity.

From Fig. 1 it is obvious that the absolute reading error for any applied load can only be ascertained by taking the algebraic sum of the reading errors for a continuous series of end connected strain-load observations, from zero load up to the required load. Omission of any particular portion of the load range means that assumptions must be made concerning the behaviour of the scale throughout the omitted portion. The usual assumption is that the scale has a linear response characteristic or that any changes in response are regular and systematic throughout the range. If either is true and the test data have been treated appropriately then the calibration is prefectly valid, if they are not true the test results will be erroneous.

(ii) When a limit of accuracy is specified for a scale it is often expressed as a proportional part of the applied load, e.g. $\pm$ 0.1 %, and occasionally the scale may be simply checked to see whether it reads within the prescribed limit. This is known as tolerance testing. Under such a circumstance it is essential to appreciate an important difference in the interpretation of the reading errors as given by the different methods of test. In the direct and the substitution methods, all of the load on the scale at the time of making any test observation is regarded as being a known load, and any observed error is an error on the total load on the scale.

On the other hand, it is commonly accepted that in the strain-load method, observed errors are errors on the test-load only, and the tolerances to be applied to the scale are selected according to the value of the test-load. This statement again presupposes that the scale has a reasonably linear response characteristic. It may also be used to demonstrate the other limitation of the method; that an accurate machine may be misconstrued as being outside the prescribed tolerance.

If $\pm t$ is the specified tolerance,

τ_i is the proportional error for each application i of the test-load, i = 1 to n, and

if n applications of the test-load cover the complete range of the scale,
then the statement may be expressed :

if $-t \leq \tau_i \leq t$ for all i then the scale is within tolerance throughout its range.

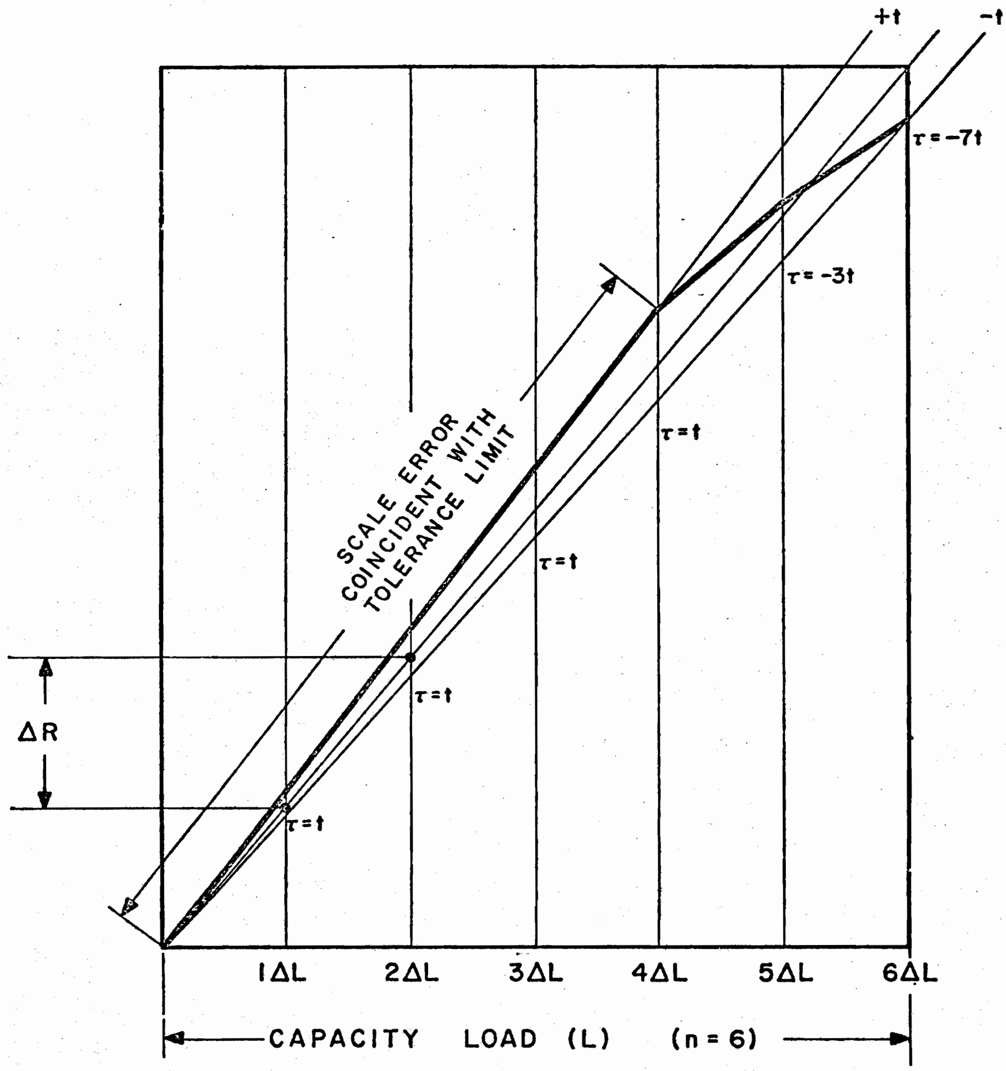
To insist that the preceding inequality hold for all i is to impose a more stringent tolerance on the scale than is implied by the specification. In effect it demands that the scale have the same sensitive response at full load as at no load and be relatively more accurate at full load. This is not reasonable and more correctly the following should hold :

$$-t \leq \sum_{i=1}^{j} \frac{\tau_i}{j} \leq t \qquad j = 1 \text{ to } n$$

Or alternatively, the proportional error Φ at any interval is given, in terms of preceding errors, by

$$\Phi_{n+1} = \frac{1}{n+1}\left(\sum_{i=1}^{n} \tau_i\right) + \frac{\tau_i + 1}{n+1}$$

These inequalities allow for an accumulation of errors of like sign in the lower ranges compensating for apparently excessive proportional errors of opposite sign at capacity load, Fig. 2.



t = Proportional Scale Tolerance
τ = Proportional Error on Test Load
ΔL = Test-load

TOLERANCE TESTING
BY THE STRAIN-LOAD METHOD

FIG. 2

This is important because it is at the higher loads that the scale readings tend to fall off, i.e. indicate less weight than is actually on the platform. Whether or not apparently excessive errors are acceptable can only be decided on the basis of a comprehensive test.

In conclusion it can be stated that the strain-load method is quick and simple to apply in the field but if used in an abbreviated form it is an inadequate test and can result in erroneous conclusions. It is most unsatisfactory for verifying scales to an accuracy of 0.02 % to 0.03 %.

5. FACTORS AFFECTING THE ACCURACY OF THE ACTUAL WEIGHING OPERATIONS

Common misconceptions are, that the pattern of behaviour exhibited by a scale during a test programme to establish its accuracy can be expected to apply during routine weighing operations, and that such weighings are accurate to within the reproducibility displayed by the scale during the test. Little or no account may be taken of adverse operating conditions or of the possible existence of systematic errors in the weighing system. Some of the factors which, if ignored, can cause a deterioration in absolute accuracy are as follows:

(i) *Differences between calibration and routine weighing techniques*

The full accuracy of a weighing device is unlikely to be achieved in the normal operation of weighing huge quantities of produce. The optimum scale accuracy is obtained at the calibration which is done slowly and leisurely under almost ideal conditions using precise and stable mass standards. The standards, as well as any substitution materials, are carefully placed in position and removed with equal care in order to preserve their accuracy as well as to prevent unduly disturbing the mechanism of the scale. On the other hand routine weighing must go on whether environmental conditions are favourable or not. The material being weighed must be processed as quickly as possible and as it is dumped onto the scale the mechanism is subjected to violent vibrations and shock loads.

The mode of operation of the scale may be different during testing and weighing. This is particularly true in the case of the counting scale and applies in some measure to the null-type instrument. Throughout the testing process the beam is carefully brought to the balance position. However in routine weighing the beam of the counting scale is accelerated through the null position and in the case of the classical machine the operator tends to manipulate his scale on the same principle. He bases his reading on the counterpoise position which causes the beam to swing from one rest position over to the other which is on the opposite side of the balance position. Thus is introduced the possibility of a systematic error since he habitually works with the beam swinging over in the same direction.

(ii) *The reproducibility of scales during calibration and normal weighing operations*

The calibration of ten scales (three of the null-type, six direct reading-recording type, and one counting scale) having up to 27,000 kg (60,000 lb) capacity, by means of the substitution method, indicated that an accuracy of test of $\pm$ 0.01 % of the applied load was achievable. This estimate is based on the repeatability of the readings on the scales during any single test and on repeated tests made on selected scales on different occasions. The identical test-load was used for the repeated tests thus eliminating variations due to changes in the basic reference. The tests were made under the most satisfactory conditions.

An assessment of the variability of the same scales under normal working conditions was made by repeatedly weighing a load of about 230,000 kg (500,000 lb) of grain. The load was circulated and weighed on each scale 4 to 7 times. The number of hopperfulls which was required to accommodate the load was 8 on the null-type machines, 14 on the direct reading-recording and 25 on the counting type scale. The effects of changes in weight of the load throughout the tests, as well as the systematic differences between

TABLE 3

REPRODUCIBILITY OF DIFFERENT TYPES OF SCALES DOING ROUTINE WEIGHINGS

Scale	*Range of readings as a percentage of the load*		*Standard deviation as a percentage of the load*			
	NRC	NHB	NRC	No. of weighings	NHB	No. of weighings
Null-type						
NT1	0.049	0.034	0.021 (0.018)	5	0.017	3
NT2	0.047		0.018 (0.009)	5		
NT3	0.065	0.050	0.027 (0.002)	5	0.028	3
Direct-reading						
DR1	0.030		0.013 (0.013)	6		
DR2	0.018		0.008 (0.0005)	6		
DR3	0.024		0.010 (0.004)	5		
DR4	0.077	0.062	0.029 (0.029)	7	0.023	6
DR5	0.051	0.019	0.024 (0.019)	5	0.009	5
DR6	0.024	0.076	0.010 (0.009)	5	0.039	4
Counting-scale						
C1	0.199		0.062 (0.058)	6		
	0.079		0.029 (0.028)	6		
C2	0.090		0.033 (0.030)	5		

scales, were eliminated by suitably arranging the sequence of weighings and by an appropriate method of computation. From the experimental data the range of weight (maximum minus minimum reading of load) for the load given by each scale and the standard deviation of the scale were calculated and are given in the columns marked NRC Table 3. Some scales featured in more than one such test and in these cases the figures quoted are the average values for all the tests. In the case of counting scale C1 which was included in two tests, the two runs gave such dissimilar results that they have both been listed. A second counting scale C2, not one of the scales originally calibrated, was included in the series to obtain additional coverage of this type of machine.

The time and effort required to make this type of test limits the number of observations which can be made on each scale. Consequently the standard deviations which have been tabulated can only be interpreted as giving a rough measure of the variability of the scales. For both the null-type and the direct reading machines it is about twice the estimated uncertainty of the scale calibration procedure. It is three to six times greater in the case of the counting scales. Also, in very broad terms, the tests showed that for the sample loads used, two successive weighings of the same load on the same scale could differ by 0.08 % to 0.20 % for the counting type scales and 0.02 % to 0.05 % for the other two types. Or, when doing a normal routine operation, the performance of the different classes of scale deteriorated by 8 to 20 and 2 to 5 times that which they exhibited when being calibrated.

The above generalized comments have been applied to the scales as classes. However, two scales, null-type NT3 and direct reading DR4, deviate from other units in the same class. In the case of NT3, instability of the scale was detected just prior to starting weighing on the second day of a three day test. The gross effects of the anomaly were corrected before testing was resumed but the large spread and high deviation suggest that a small residual effect, unnoticed by the operator, may have persisted. No such simple explanation can be immediately advanced to explain the relatively poor performance of DR4 other than to note that this particular scale has exhibited similar dispersions in the past. A similar series of tests in connection with another project (2) was conducted some years prior to those reported here. At that time fewer repeated observations were made on each scale and in the main a different group of scales was used. It was, however, possible to extract from the test results the comparative data entered in the columns headed N.H.B. Table 3. Taking into account the fewer repetitions the dispersions are comparable with those given in the table for NT3 and DR4. Both NT1 and DR5 behaved somewhat better in the earlier works while DR6 was obviously inferior.

The most reasonable conclusion to be drawn is that the optimum pattern of behaviour for a particular class of scale can be established by this type of test. Departures from that pattern by individual scales indicate that an adjustment or servicing problem exists in those cases. The experiments also indicate that for critical work, and those instances in which confidence limits may have to be established for the end results, the scales should be tested in a manner which closely simulates their normal mode of operation. Such a test would augment the conventional scale testing and calibrating procedure.

(2.) Test data conveyed to the author in a private communication from Mr. E. Kristoffy, Elevator Engineer National Harbours Board, Montreal.

It has been stated that the changes in weight of the grain throughout the tests were compensated for in the subsequent calculations of the test results. The tests showed that there are two possible ways of making the calculations and each give a slightly different set of final statistics. Consequently it is imperative to define the approach used in arriving at the data in table 3. In the case of a material such as grain, the tendency is for the quantity, or weight, to decrease with handling. Superimposed on this real change in weight is an apparent change due to the natural drift of the scale with time. This drift may be caused by temperature effects, wear, etc... A close examination of the test data showed that in some experiments the successive readings on some scales implied that the rate of weight loss decreased throughout the test period whereas according to other scales, weighing the same grain, the loss rate increased. The two are contradictory and are obviously accounted for by drift of the scales. Since all the scales except the counting type are of the same reliability the only realistic treatment is to take the combined set of all scale readings as defining the decay rate of the test material. The alternative treatment is to consider the readings on each individual scale as constituting an independent test run. Thus each scale establishes its own measure of the rate of loss of material and into that measure are incorporated effects due to scale drift. The standard deviation and the spread of the readings for each scale, when derived on this basis, tend to be less than when obtained on the first consideration. The more a set of readings for a particular scale departs from the overall pattern of the weighings the greater will be the difference between the statistics computed on the two bases.

This alternative approach was rejected because it tends to give an overly favourable indication of scale accuracy. Typical figures for the standard deviation by this second approach are given in parenthesis in Table 3. The differences in the standard deviations, as given by the two methods of approach for scales NT3 (on wihch comment has already been made) and DR2 illustrate how the second method can lead to an erroneous conclusion respecting the repeatability of a scale. Obviously the drift of the weighings on these particular scales deviated considerably from that exhibited by the other scales in the same test group.

(iii) *Relative positions of the test-load and of the material being weighed*

The design of a scale installation may be such that the test-load cannot be applied to the scale in the same position that the produce occupies when it is being weighed. This is most likely to occur when the scale is of the hopper type intended for weighing granular material or liquids. In such cases, since the thin shell of the hopper cannot support a concentrated load, the test-load must be placed in special cradles hung from the girder work of the hopper. Due to the earth's gravitational gradient a correction of $+ 0.3 \times 10^{-6}$/m ($+ 0.1 \times 10^{-6}$/ft) should be made to the calibrated value of the test-load to correct for the distance its center of gravity is below that of produce when the latter is on the scale.

This is obviously of no significance in many applications and only a second order effect in most others.

(iv) *The buoyancy effect of the air*

The counterpoise members of scales and the weights which comprise the test-load are usually made of cast-iron or steel. Since both items are approximately of the same density (7.5 g/cm³), changes in air density during, or subsequent to, a scale test are inconsequential. However this is not necessarily true in the case of weighing produce, the density of which may only be of the order of 1 to 2 g/cm³. Consider the case of a load of material of density 1.0 g/cm³ initially weighed in air having a temperature of 23 °C, 80 % R.H. and at a barometric pressure of 750 mm Hg. If the same load is reweighed at — 3°C, 40 % R.H. and 770 mm Hg, then the second weighing will be lighter by approximately 0.014 % than the first.

In generalized form, the proportional difference in weight of a material of density ρ weighed in air of density σ_1 and then reweighed in air having a density σ_2 is,

$$\left(\frac{1}{\rho} - \frac{1}{\rho_m}\right)(\sigma_2 - \sigma_1)$$

where ρ_m is the density of the scale counterpoise material.

It should also be noted that a test-load of cast iron weights exerts forces differing by 0.002 % if used in environments having the temperatures, pressures and relatives humidities mentioned in the preceding example.

(v) *Temperature gradients and their effects on the scale*

Laboratory workers have long been familiar with the importance of thermally shielding weighing devices in order to minimize the effects of temperature variations on the equipment. On large industrial installations of limited accuracy temperature has not been a problem since the scales and operators have normally been housed in large open buildings. The ambient temperature has tended to be that of the prevailing weather and natural air currents around the scales have minimized temperature gradients.

Modern installations, in the interest of cleanliness and operator comfort, have included walls and shields to isolate the operator and scale reading head from the main hopper or weighing platform. In some instances the reading and control console has been housed in a special room which is heated during the winter. As a consequence temperature gradients exist in the scale levers connecting different parts of the scale which are in different thermal environments. The temperature gradients vary, depending upon the season of the year and upon the temperature in the control room.

If l_1 and l_2 are the lengths of the two arms of a lever,

T_1 and T_2 are the mean temperatures of each of the arms at the time of the scale calibration,

t_1 and t_2 are the mean temperatures of the arms at some other time,

α is the coefficient of linear expansion of the lever,

then the proportional change in the ratio of the arms is given by

$$\frac{\Delta\left(\frac{l_1}{l_2}\right)}{\left(\frac{l_1}{l_2}\right)} = 1 - \frac{(1 + \sigma t_1)(1 + \alpha T_2)}{(1 + \alpha t_2)(1 + \alpha T_1)}$$

For example the ratio of a first order lever, ratio 1 : 5 at a uniform temperature of 20 °C, will change by 0.0148 % if the temperatures of its ends become — 3°C and + 21 °C and if α is 11×10^{-6}/°C.

(vi) *Pressure gradients, their causes and effects*

Hopper type scales used for weighing granular and dusty materials have the entry and exit ports to the hopper sealed by means of flexible dust tight curtains. Consequently care is taken in the design of such sealed systems to minimize the possibility of pressures, different from the external pressure, developing inside the hopper.

In bulk, a granular and porous material forms a large porous plug which, as it moves acts as a piston compressing the air in front of it and rarefying that behind. Thus pressure gradients are established and unless unrestricted air by-passes are provided the pressure differences tend to persist due to the air diffusing only slowly through the material from the high to the low pressure region. The vents fitted to most systems accommodate the large pressure differentials which develop during the rapid filling and emptying of the hopper. They do not, however, necessarily eliminate low pressure effects which persist after the peak pressures have dissipated. When the granular material is admitted to the hopper, air under pressure is entrapped in the porous medium. This air diffuses slowly out of the material and adequate venting must be provided at all times to allow the low but sustained pressure to bleed off to atmosphere. Only by providing vents of adequate size can the equalization of pressures above and below the weighing hopper be ensured. Naturally, any air vents must be isolated from dust extraction systems working on the suction principle and from any other pressure generating machinery.

Generalized expressions cannot be given for calculating the pressure within the hopper since it is a function of the relative size of hopper to load, rate of loading, nature of the material loaded, and the type of ducting system fitted to the hopper. However, the delicacy of this pressure effect is clearly demonstrated by the fact that a pressure differential, from within to without the hopper, of 0.01 mm Hg (0.76×10^{-5} atmosphere) gives rise to a reading error of 0.1357 kgf per square metre of hopper area (0.193×10^{-3} lbf per square inch.) Since the capacity load is roughly related to the cross-sectional area of the hopper, for the load in kgf and area in square metres the ratio varies from 1200 : 1 to 2200 : 1 (1.8 : 1 to 3 : 1 for the load in lbf and area in square inches), this relatively small pressure can give a reading error of 0.011 % to 0.006 % of the full load.

The main difficulty connected with this residual pressure effect is that it cannot be detected by use of the scale alone. For it to be present produce must be in the hopper, but rarely if ever, can an accurately known weight of the necessary material be introduced into the scale. Thus there is no possibility of comparing an actual scale reading with a predetermined weight. Since the pressure is systematic and decays only very slowly there is no perceptible change of the scale reading over a reasonable period of time. If the load is held for several hours, any change in reading which does occur may be due to deterioration of the pressure, simply due to the natural drift of the scale itself under load, or due to actual changes in weight of the material itself (hygroscopic, etc...).

Residual pressures in the hoppers of scales used for weighing granular porous materials were measured by means of pressure transducers during routine weighing operations. They were found to range as high as + 0.200 mm Hg and to remain constant while the weighing was being made. For the particular loads on the scales at the time, the pressures resulted in weighing errors of up to + 0.15 %*. On some scales pressures less

* The +ve sign indicates that the scale reading was greater than the actual load.

than the ambient were detected in the hoppers. They went as low as — 0.025 mm Hg which was equivalent to — 0.01 % of the load. These suction effects were usually traceable to mechanical causes such as ancillary machinery and poorly fitting valves in the air ducts.

6. THE ACCURACY OF THE TEST-LOADS

The basic control on all scale calibrations and hence on all weighing operations is the test load. The accuracy of the load, which usually consists of a collection of weights of small denomination, is dependent upon the accuracy to which the individual weights have been established. Since a direct calibration of such a composite test-load cannot be made it is only possible to derive a statistical estimate of its accuracy based on the number and the accuracy of the incremented weights.

7. THE SYSTEM FOR GENERATING STANDARDS OF MASS

The accuracy of standards of mass, or weights, used for scientific, technical, and trade purposes is assured by a comprehensive system for maintaining the reliability of selected master reference weights and for generating a series of submasters or working standards against which general purpose weights may be compared,

The system which is used in Canada is similar to that used in other countries.

Two acts of Parliament :

« An Act respecting Units of Length and Mass », 1959, (chapter 38) and

« An Act respecting Weights and Measures », 1951, (Chapter 36)
delineate and regulate the Canadian system.

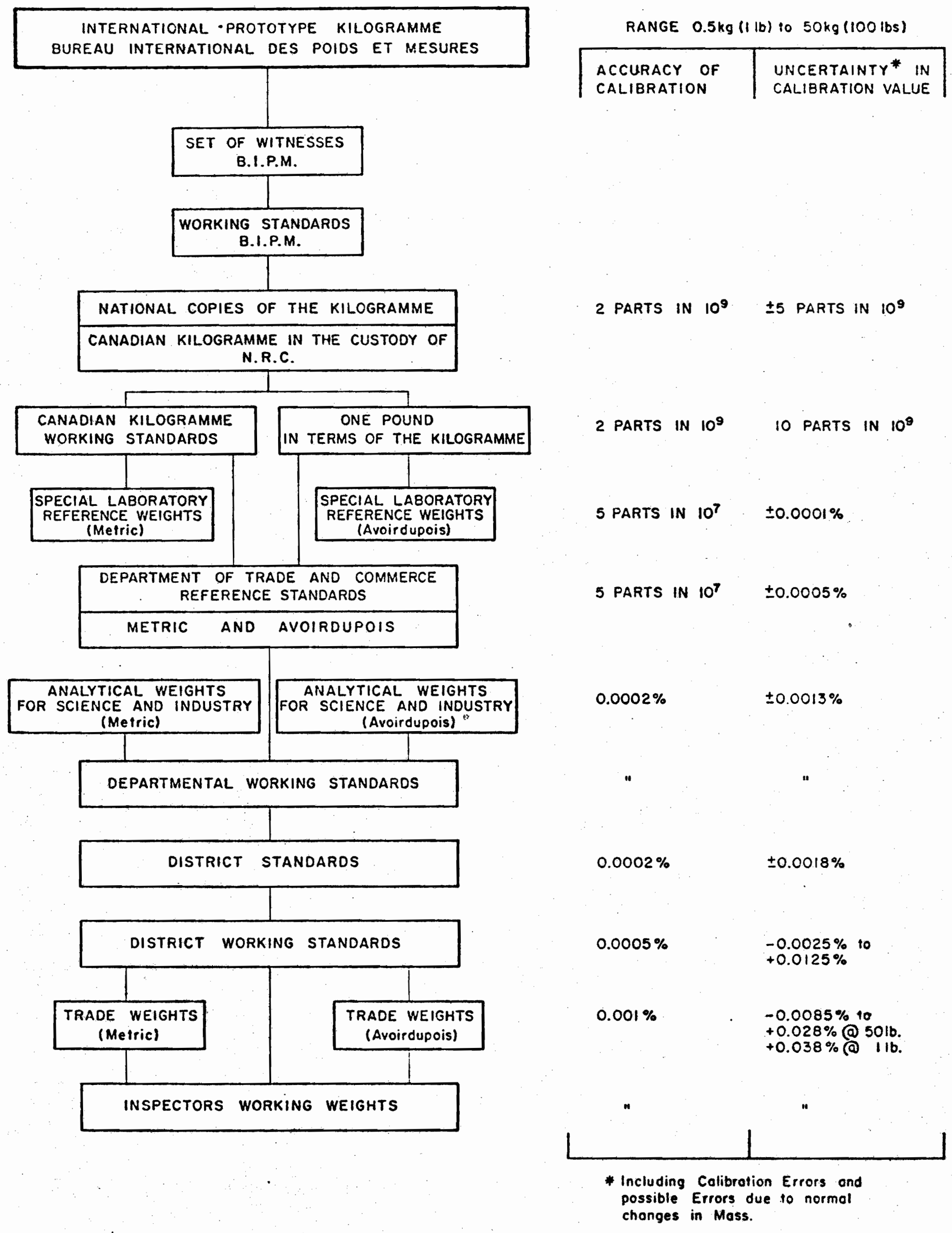
Under the terms of the first Act the National Research Council maintains standards representative of the defined units. The standard unit of weight is the pound which is 0.45359237 of the International Kilogramme. The NRC retains a platinum-iridium copy of the kilogramme (serial number 50) which is returned periodically to the Bureau International des Poids et Mesures, Sèvres, France, to be recalibrated in terms of the prototype kilogramme.

At the National Research Council the Mechanics Section of the Division of Applied Physics calibrates, by means of the Canadian Kilogramme ≠ 50, national working standards of 1 kg denomination and platinum-iridium reference copies, as well as working standards of the pound. This group of working standards is used to verify specialized analytical weights for science and industry and the reference weights used by the Department of Trade and Commerce.

The Standards Laboratory of the Department, using these reference standards, establishes working standards which are then used in the day to day operations of the laboratory, are used to test analytical type weights for industry and in particular to calibrate the district standards which are issued to the various district offices of the Department.

From these district standards the district offices establish their own district working standards which are used for verifying the weights used by the district inspectors and also for trade weights. At all stages except the last one, that is the comparison of the district working standards and trade weights, corrections are applied to allow for errors in the standard being used.

The system is shown schematically in Fig. 3.



THE GENERATION OF STANDARDS OF MASS

FIG. 3

In such a system the standard of accuracy deteriorates as the weight being tested becomes more removed from the original reference weight.

At each stage of the system a calibration value for a weight may be obtained. The difference between this experimentally determined value and the true value of the weight at any time is never known. It may, however, be construed as being composed of two components.

(i) That component which is usually described as the experimental uncertainty. This incorporates the actual uncertainty and errors of the comparison process itself and the uncertainty in the value of the standard weight against which the unknown weight is calibrated. At the immediate time of the calibration it can be said that the weight is known to within this error of test.

(ii) Changes in mass due to damage, wear, adsorption and desorption of gases and vapours, oxidation, etc..., constitute the second and unpredictable component of the uncertainty in the value of the weight.

In the case of the primary standards, changes of the order of 3 parts in 10^8 have been known to occur. However, the technique for intercomparing a group of such standards eliminates the possibility of such a change going undetected. The marginal change which could affect the accuracy of such weights is of the order of 1 part in 10^8. The reference standards of the Department of Trade and Commerce have been observed to change by a maximum of 0.0005 % between statutory recalibrations. Similar weights and industrial type analytical reference weights preserved under laboratory conditions have remained stable to within 0.0001 % over a six year period. These random changes largely set the limit of accuracy for any calibrations based on these weights since they tend to be larger than the errors due to the testing procedure itself.

Weights of lesser calibre, for example the district working standards, trade weights, etc..., are normally tested to ascertain that they are within the prescribed tolerance range. No attempt is made to determine their actual mass. This method of test, unfortunately, gives no direct indication of the stability of the weights or the extent to which they wear during use. However, it has been possible to estimate from the records of the laboratory responsible for correcting and adjusting such weights, that trade weights average an annual loss in mass of 0.001 %. For weights at this lower level of accuracy, the wear between reverifications tends to be less than the prescribed tolerance whilst the inaccuracy of the testing procedure is of very little significance and makes virtually no contribution to the uncertainty of the weight.

Analytical weights and industrial reference weights in Canada usually comply with the class S and class S1 tolerances as given in the National Bureau of Standards, Washington, Circular 547, « Precision Laboratory Standards of Mass and Laboratory Weights ». When calibrating such weights both the National Research Council and the Department of Trade and Commerce report the value, together with an appropriate uncertainty, for each individual weight.

Specifications for trade weights are given in The Canada Gazette Part II, Statutory Orders and Regulations, 1952. Table 4 gives the tolerances for this type of weight in the range 1 lb to 100 lb.

TABLE 4*

TOLERANCES FOR TRADE WEIGHTS (1 lb and over)

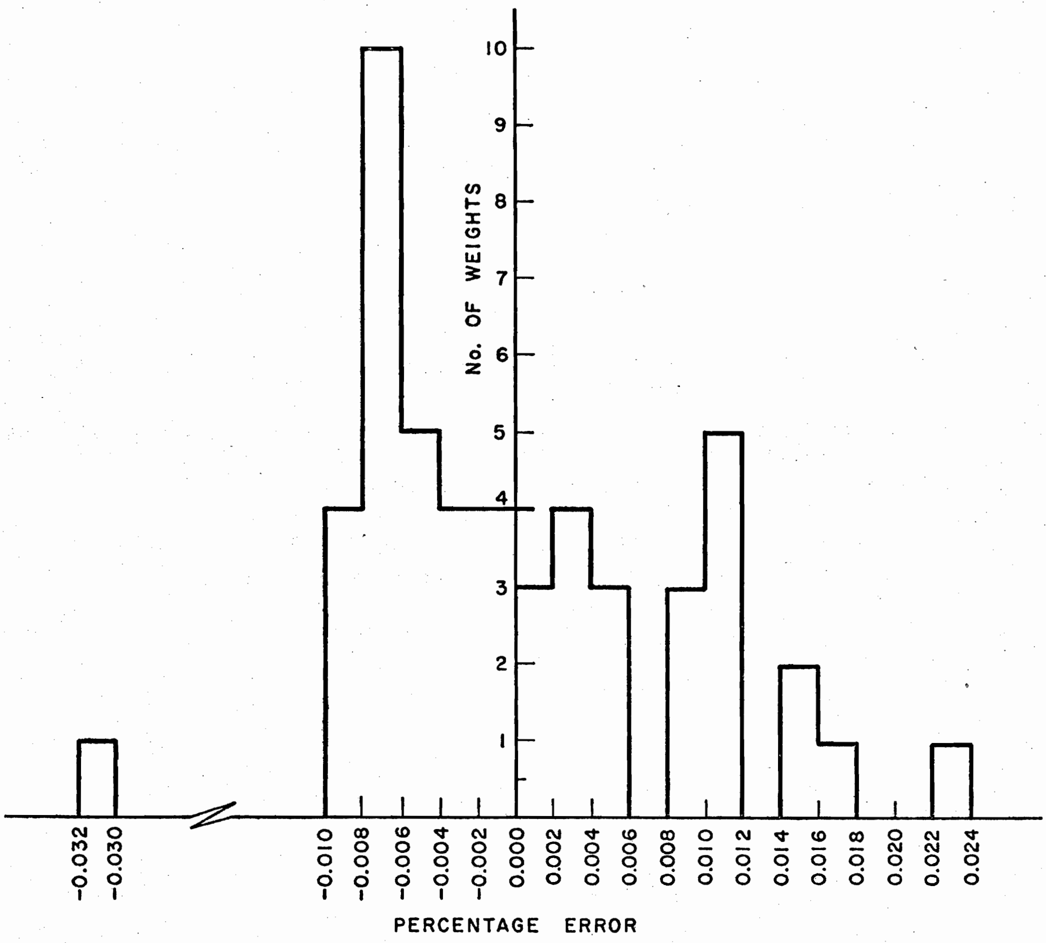
Nominal Weight		*Tolerance (in excess)*
Kilogrammes	*Pounds*	*Percent*
	100 (and over)	0.015
20	50	0.015
	30	0.105
10	20	0.020
5	10	0.020
	5	0.020
	3	0.020
	2	0.020
2		0.025
1	1	0.025

Numerical estimates of the accuracy of the verification procedures and the uncertainty to be expected in the certified values of the weights, have been included in Fig. 3.

For weights down to and including the level of the district standards the estimates have been based on experimental data accumulated over many years. In the case of inferior weights the estimates are based on examinations of the tolerances, the type of equipment used to verify the weights, the methods of test and the environment in which the work is executed.

The estimate of accuracy for trade weights, given in Fig. 3, was validated by reverifying fifty 50-lb cast iron trade weights, submitted from scattered points in Canada, in terms of the National Research Council working standards. These weights comprised a special group of weights previously tested and adjusted to a tolerance of — 0.00 % to + 0.01 % in terms of the district working standards. On the basis of the estimates given in the figure and correcting for the difference between the tolerance for these particular weights and conventional trade weights (as given in Table 4), they were expected to have errors in the range — 0.0085 % to + 0.023 %. The range of the measured deviations was — 0.0098 % to + 0.0232 % with 56 % of the weights less than nominal weight. A single weight was found to be in error by — 0.0304 %. A histogram of the actual distribution is given in Fig. 4.

* Based on Tables 1 and 3 of the Canada Gazette, 1952.



HISTOGRAM OF ERRORS IN TRADE WEIGHTS

FIG. 4

The close similarity between the analytical assessment of the probable magnitudes of the errors in the trade weights and the experimental results should not be misconstrued as firmly establishing the limits of error of the weights. To find a range of — 0.0304% to + 0.0232 % with 8 % of the sample in error by more than the predicted — 0.0085 %, especially on such a small sampling of all the weights in use, was unexpected. The inference to be drawn from finding a weight — 0.0304 % and the majority of the weights actually underweight, suggests that the total population may very likely be spread over the range — 0.04 % to + 0.03 %.

8. CONCLUSION

Inaccuracies in the routine weighing of produce are mainly due to errors inherent in the scales themselves and environmental influences on the operation of the scales. Uncertainty in the test load with which the scales are verified can give rise to small but systematic errors which may become evident when very large volumes of material are weighed and compared on different installations.

Acknowledgements

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Special mention must be made of Miss H. A. Tulloch (National Aeronautical Establishment) and Mr. G. O. West (Division of Applied Physics), both of N.R.C., who, working under very difficult and uncomfortable circumstances, installed measuring apparatus, collected and processed experimental data.

FRANCE

VIRGULE et SYSTÈME MÉTRIQUE

par **M. Francis VIAUD**
Ingénieur général, Directeur du Service des instruments de mesure
Membre du Conseil de la Présidence du Comité International de Métrologie Légale

Ainsi que le fait remarquer M. DANLOUX-DUMESNILS, Ingénieur Civil des Mines, Professeur à l'École nationale supérieure de l'Aéronautique, dans son très intéressant ouvrage « Étude critique du système métrique décimal », édité en 1962 chez Gauthier-Villars, depuis l'aube de la civilisation et dans tous les domaines accessibles aux mesures courantes, la diversité dans les « tailles » des quantités à évaluer a conduit les gens à convenir, pour chaque grandeur, telle que longueur, surface, volume, masse, etc... d'une série d'unités offrant elles-mêmes des tailles diverses. Souvent, on s'avisa de la commodité de rapports simples, généralement fournis par la série binaire : 1, 2, 4, 8, 16... ou par la même série multipliée par 3 : 3, 6, 12, 24... ; bien plus rarement on trouve des rapports aberrants (11, 21, 22...). Mais on constate, non sans surprise, jusqu'à la Révolution française, une absence presque totale d'échelonnement décimal, alors que la numération par 10 était en usage depuis des millénaires chez tous les peuples civilisés : l'homme a, depuis longtemps, 10 doigts, et les Tables de la Loi elles-mêmes ne portent que 10 Commandements.

La question de changer la numération décimale s'est cependant posée à la Commission de l'Académie chargée en 1790 de l'étude de la réforme des mesures. Si, vers 1790, peu de gens savaient lire, tous savaient compter par 10, 100, 1 000, et c'est en toute connaissance de cause que la Commission décida que le nouveau système métrique serait décimal. Son rapport, en date du 27 octobre 1790, expose que « l'échelle duodécimale aurait « quelques avantages de plus, mais que ce changement d'échelle ajouté à tous les autres rendrait le succès presque impossible... Nous conclurons donc que l'échelle décimale doit servir de base à toutes les divisions, et que même le succès de l'opération générale sur les poids et mesures tient en grande partie à cette échelle ».

C'est vers le milieu du 18e siècle que s'imposa la subdivision décimale systématique des mesures. Jusqu'alors, la plupart des commerçants et des comptables savaient fort bien exécuter les quatre opérations de l'arithmétique, mais ils ignoraient l'usage de la virgule. En dessous de l'unité, ils s'exprimaient par fractions binaires : $\frac{1}{2}$, $\frac{1}{4}$, etc...

Or, les propriétés des fractions décimales étaient connues depuis le 12e siècle, et en 1585, Simon STEVIN (1548-1620), Inspecteur des digues aux Pays-Bas avait publié un article de quelques pages intitulé « La Disme « (en flamand « Thiende »). Le titre complet est « La Disme, enseignant facilement expédier par nombres entiers sans rompus, tous les comptes se rencontrant aux affaires des hommes ».

Nous empruntons à l'une des annexes de l'ouvrage de M. DANLOUX-DUMESNILS déjà cité, les précisions suivantes :

Les principales propriétés des fractions ayant pour dénominateur des puissances entières de 10 étaient connues depuis Jean de SEVILLE (12e siècle), mais on se servait de ces fractions commes des autres, c'est-à-dire qu'on écrivait par exemple $23 \frac{16}{100}$ comme on aurait écrit $12 \frac{5}{7}$.

STEVIN va introduire un procédé d'écriture simple et ingénieux, à la portée de tous les écoliers.

La partie entière d'un nombre s'appelle **commencement** et se note : (0).

Le nombre de dixièmes s'appelle **prime** et se note : (1).

Le nombre de centièmes s'appelle **seconde** et se note : (2),
et ainsi de suite, de sorte que, par exemple :

$$23 \frac{473}{1\,000} \text{ s'écrit : } 23\ (0)\quad 4\ (1)\quad 7\ (2)\quad 3\ (3)$$

et se lit : « vingt-trois, commencement, quatre primes, sept secondes, trois tierces ». STEVIN donne ensuite les règles complètes d'exécution des quatre opérations sur les nombres fractionnaires, qui sont celles que nous appliquons encore.

Cette façon d'écrire et d'énoncer était certes bien lourde. Il devait appartenir au Français VIETE (1540-1603) de faire le pas suivant qui donnera aux nombres presque exactement leur forme actuelle, puisqu'il écrira : 23 / 473.

Nous pouvons conclure que Simon STEVIN peut être considéré comme l'inventeur, — dans son principe, — de la virgule dans l'écriture des nombres et par suite, comme le pionnier d'un **système décimal** de poids et mesures.

On sait qu'une mission de trois membres de l'Académie des Sciences : GODIN, BOUGUER, LA CONDAMINE, s'embarqua pour l'Amérique du Sud, le 16 mai 1735. Elle parcourut pendant neuf ans plusieurs pays de l'Amérique du Sud, en procédant à des mesures d'arc du méridien terrestre et à la détermination de la longueur du pendule battant la seconde à l'Équateur qui fut, un moment, proposée comme étalon de longueur. On conserve encore à l'Observatoire de QUITO une dalle sur laquelle une inscription latine rappelle ces travaux. Son fac-similé figura à l'exposition itinérante « De la coudée au micron » organisée en 1964-1965 par le Service français des instruments de mesure avec le concours du Conservatoire des Arts et Métiers. Une règle en fer était autrefois enchassée dans cette plaque et on y lisait :

« Mensurae Naturalis Exemplar : Utinam et Universalis ».

Dès son retour en France, LA CONDAMINE se fit l'ardent propagateur d'une réforme des mesures sur le plan international et fut probablement l'un des premiers à introduire dans ses calculs des fractions **décimales** de la toise. L'idée de la décimalisation et l'emploi de la virgule qui n'avait été jusqu'alors que l'apanage d'un petit nombre de savants se répandit dans les milieux cultivés.

Des oppositions assez inattendues, comme celle de MONTESQUIEU, se firent jour. Ce grand juriste, dans l'Esprit des Lois (XXIX, 18) dénonce « certaines idées d'uniformité » comme celles que répandait à cette époque LA CONDAMINE. Il pose cette surprenante question : « Le mal de changer est-il toujours moins grand que le mal de soufffrir ? ».

Il apparaît bien cependant que la notation décimale empêche de souffrir, mais que le monde entier souffre, pour plusieurs générations encore peut-être, de ce que, seul, le peuple anglo-saxon a reculé, en ce qui concerne ses mesures, devant le « mal de changer », auquel il devra bien remédier quand même un jour ou l'autre, il a d'ailleurs entrepris à cet égard une courageuse action.

En tout état de cause, seuls font parfois souffrir les longs et laborieux déplacements de virgule dans les textes administratifs. Mais cela, comme dirait KIPLING, est une autre histoire, bien connue des spécialistes.

INFORMATION

DISTINCTION HONORIFIQUE

Notre distingué Président Monsieur le Dr J. Stulla-Götz vient de voir récompenser son activité et ses travaux à la présidence du « Bundesamt für Eich- und Vermessungswesen » de Vienne qu'il a quitté récemment par mise à la retraite.

Le Gouvernement Autrichien lui a en effet décerné en janvier dernier la haute distinction de la « Grosse goldene Ehrenzeichen für Verdienste um die Republik Osterreich verliehen hat ».

Nous sommes heureux de lui exprimer ici nos plus vives et plus affectueuses félicitations.

GRANDE IMPRIMERIE
DE TROYES
Dépôt légal n° 3104-6-1967