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Can legal metrology help the container transport sector?

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■ Editorial

Stephen Patoray
BIML Director

Responding to change

As we make the final preparations for the Fiftieth CIML Meeting, which coincides this year with the Sixtieth Anniversary of the OIML, it is quite remarkable to think of all the changes that have taken place in metrology over the last sixty years. But it is even more remarkable how the *speed* of the change has increased; in fact many recent changes in technology are now an integral part of the instruments used in legal metrology today.

When the OIML was founded in the 1955 nearly all of the "typical" legal metrology instruments used for measuring weight or volume were mechanical. But after those short sixty years, numerous measuring instruments fully utilize the latest developments in electronics and software. It is essential that this Organization keep pace with these technical changes.

However, a large number of economies in the world still do not have the infrastructure to take full advantage of these technological changes and many still rely on mechanical instruments. One of the challenges our Organization faces as we move forward is to develop publications that address the requirements of the newer fast-changing technologies without neglecting the older ones.

Another major challenge is to reduce the lead-time required to develop new publications or revise existing ones, in order to keep pace with the ever-changing technologies. To accomplish this, the BIML has put a great deal of resources into the modernization of the OIML website which now incorporates many tools that allow each user to find and use the information they need. For example:

- it allows for online commenting and voting on the critical steps in the development of new OIML publications, Project Group Committee Drafts, CIML Preliminary Drafts and CIML Final Draft Publications,
- it allows for each Project Group to have its own individual workspace, where it can develop and complete the necessary work on a Committee Draft, and
- it allows for review of OIML Publications by the respective TC or SC as well as the CIML, seeking input on whether an OIML publication should be revised, reconfirmed or withdrawn.

The changes to the website have the most impact in the area of the OIML's technical work. Some projects have been underway for a number of years and some Project Groups have created several Committee Drafts. The text in OIML B 6 *Directives for Technical Work* was approved before these new tools on the website were available, and so the BIML has made every possible effort to ensure that these new tools accommodate the needs of the various users of the site while complying with the current requirements.

With change comes uncertainty. However, change also offers the opportunity for improvement. It is my belief that it is a priority of all involved in the OIML to improve the process of our technical work and reduce the development time of OIML Publications. As a standards development organization I believe we all have the goal of keeping our publications current and up to date. However, we must also remember to create a balance in our standards so they are appropriate for all member economies.

With these words the BIML is putting the final touches to our preparations for what will be a key meeting for our Organization. The BIML staff and I extend our thanks to all our Members for their commitment and support, and we look forward to the coming years and the challenges they will bring. ■

FLOW MEASUREMENT

A gravimetric method to verify LPG road dispensers

Giuseppe Ardimento, Deputy Director
Consumer Affairs Service
Camera di Commercio di Napoli

Introduction

In the *Review of LPG Flow Measurement Technologies and Measurement Issues* (NEL – Flow Programme – November 2006 [1]) the following can be read:

> *"Weighing is recognised as a common method of calibrating and verifying LPG flowmeters. This is often carried out by weighing a transport tank, truck or rail, before and after filling. The method is sound as long as all precautions are taken to accurately carry out the weighing process and avoid the measurement being affected by environmental conditions or changes in the weight of the vehicle between weight determinations… The conversion mass to volume has to be carried out accurately and the small buoyancy correction applied to the weighing"*.

A typical bombola prover along with the ancillary pump used in Italy to verify LPG dispensers

This paragraph of the report refers to bulk measurement, in which a high capacity weighing instrument allows a sound estimate of a large amount of LPG to be made and considered as typical in bulk transfers of the product.

This article deals with the attempt to describe the weighing method applied to the verification of LPG road devices which typically dispense a limited amount of product in every transaction (e.g. 20 L, as described in [2]).

1 Choice of the weighing instrument

The choice of the weighing instrument to be used in the gravimetric verification process is related to the minimum indicated quantity of the dispenser and the actual density of the LPG. For road LPG dispensers the typical minimum indicated quantity is 10 mL. The LPG density range is 510 kg/m^3 – 540 kg/m^3 and this renders a scale division of the weighing instrument of 5 g, which corresponds to a volume range of 9.26 mL to 9.80 mL for the verification process. A typical bombola prover used in Italy for volumetric verification is shown in the illustration; its minimum scale division is 20 mL.

A typical bombola prover along with the ancillary pump used in Italy to verify LPG dispensers

Moreover, the LPG containing the bombola weight has to be considered as a dead load or as a subtractive tare effect and the minimum weight interval of the weighing instrument must still be fit for use as shown above.

2 The weighing model

The weighing instrument used to determine the weight of the LPG in the storage bombola indicates a value of weight (or, correctly expressed, a conventional mass) which is correlated to the conventional mass used to calibrate it according to the following equation:

$$W = a + b \times M \qquad [1]$$

where a and b are coefficients and M is the conventional mass on the weighing instrument load receptor.

Using a calibration weight P which has a value near the LPG mass contained in the bombola, and considering the weight indication when no LPG is in the bombola, we have:

$W_E = a$ when weighing with no LPG
$W_F = a + b\,P$ when weighing with the bombola full of LPG [2]

From Equations [2] we can determine the coefficients and achieve the following simple model:

$$W = W_E + \frac{W_F - W_E}{P} \cdot M \qquad [3]$$

Thus, the conventional mass on the load receptor, expressed in terms of weight indication of the weighing instrument, is:

$$M = P \cdot \frac{W - W_E}{W_F - W_E} \qquad [4]$$

where:

M is the conventional mass of the gas inside the bombola as defined in Equation [6]

P is the conventional mass value of the calibration weight

W is the weighing instrument indication when M is on the load receptor

W_E is the weighing instrument indication when no load is on the receptor

W_F is the weighing instrument indication when the calibration mass P is put onto the receptor

As the indicated mass is the conventional mass and the LPG displaces no air when injected in the closed bombola, the equilibrium weighing is as follows:

$$\rho_l \times V_l = m_{LPG} \qquad [5]$$

where:

ρ_l is the LPG density

V_l is the LPG volume amount delivered into the bombola

m_{LPG} is the real mass of the LPG

The relationship between the real mass and the conventional mass is:

$$m_{LPG} = M \cdot \left(1 - \frac{\rho_a}{\rho_S}\right) \qquad [6]$$

From Equations [5] and [6], considering the air density as equal to the conventional value of 1.2 kg/m^3 and the reference density of weights ρ_s is 8 000 kg/m^3 it can be expressed:

$$\rho_l \cdot V_l = m_{LPG} = M \cdot \left(1 - \frac{\rho_a}{\rho_s}\right) =$$

$$= 0.99985 \cdot P \cdot \frac{W - W_E}{W_F - W_E}$$

Thus, the volume delivered in usual environmental conditions is:

$$V_l = 0.99985 \cdot \frac{P}{\rho_l} \cdot \frac{W - W_E}{W_F - W_E} \qquad [7]$$

This has to be compared with the device indication V_m, and the relative error is as follows:

$$e = \left(\frac{V_m - V_l}{V_l}\right) \times 100 = \left(\frac{V_m}{V_l} - 1\right) \times 100 =$$

$$= \left(\frac{V_m}{0.99985 \cdot \frac{P}{\rho_l} \cdot \frac{W - W_E}{W_F - W_E}} - 1\right) \times 100 \qquad [8]$$

3 Uncertainty estimation in the gravimetric method

In order to obtain a simplified estimate of the uncertainty we suppose that the input quantities in Equation [7] are all uncorrelated.

Then we can avoid estimating the correlation terms and use a simplified method of calculus as reported below.

Let us suppose, without losing the sense of generality in the model, that a measurement process can be modelled as an output which depends on two input quantities:

$$V = V(x, y) \qquad [9]$$

The mean value of the two input quantities are $\bar{x}$ and $\bar{y}$, that respectively present the two variances, is:

$$u^2(x) = E\left[(x - \bar{x})^2\right]$$

$$u^2(y) = E\left[(y - \bar{y})^2\right]$$

where E is the statistical expectation operator.

The output quantity can be written by means of the Taylor series as follows:

$$V(x,y) = V(\bar{x},\bar{y}) + \frac{\partial V}{\partial x} \cdot (x - \bar{x}) + \frac{\partial V}{\partial y} \cdot (y - \bar{y}) \qquad [10]$$

Neglecting the smaller terms of order greater than one, Equation [10] can be written as follows:

$$V(x,y) - V(\bar{x},\bar{y}) = \frac{\partial V}{\partial x} \cdot (x - \bar{x}) + \frac{\partial V}{\partial y} \cdot (y - \bar{y})$$

Squaring the two terms, we have:

$$[V(x,y) - V(\bar{x},\bar{y})]^2 = \left(\frac{\partial V}{\partial x}\right)^2 \cdot (x - \bar{x})^2 +$$

$$\left(\frac{\partial V}{\partial y}\right)^2 \cdot (y - \bar{y})^2 + 2 \cdot \left(\frac{\partial V}{\partial x}\right)\left(\frac{\partial V}{\partial y}\right)(x - \bar{x}) \cdot (y - \bar{y})$$

Applying the statistical expectation operator to the last equation we obtain:

$$E[V(x,y) - V(\bar{x},\bar{y})]^2 = \left(\frac{\partial V}{\partial x}\right)^2 \cdot E[(x - \bar{x})^2] +$$

$$\left(\frac{\partial V}{\partial y}\right)^2 \cdot E[(y - \bar{y})^2] + \qquad [11]$$

$$2 \cdot \left(\frac{\partial V}{\partial x}\right)\left(\frac{\partial V}{\partial y}\right) E[(x - \bar{x}) \cdot (y - \bar{y})]$$

In the case of uncorrelated terms, Equation [11] becomes:

$$E[V(x,y)-V(\bar{x},\bar{y})]^2 = \left(\frac{\partial V}{\partial x}\right)^2 \cdot E[(x-\bar{x})^2] + \left(\frac{\partial V}{\partial y}\right)^2 \cdot E[(y-\bar{y})^2]$$

i.e.

$$u(V)^2 = \left(\frac{\partial V}{\partial x}\right)^2 \cdot u^2(x) + \left(\frac{\partial V}{\partial y}\right)^2 \cdot u^2(y)$$

Thus it can be said that, in the case of uncorrelated input terms, the variance of the output quantity is the weighted sum by means of the derivative of the input quantity variances.

Formally, in this case, the output standard uncertainty can be calculated by means of the differential form of the output equation and substituting to the input differential the homologous standard uncertainty with a "plus" sign.

Considering Equation [7] we can thus calculate the differential of V_l:

$$dV_l \approx \frac{dP}{\rho_l} \cdot \frac{W-W_E}{W_F-W_E} - \frac{P}{\rho_l^2} \cdot \frac{W-W_E}{W_F-W_E} \cdot d\rho_l + \frac{P}{\rho_l} \cdot \frac{dW}{W_F-W_E} \qquad [12]$$

Considering the relative terms, Equation [12] becomes:

$$\frac{dV_l}{V_l} \approx \frac{dP}{P} - \frac{d\rho_l}{\rho_l} + \frac{dW}{W-W_E} \qquad [13]$$

Thus, from Equation [13] we can express, for the relative standard uncertainties:

$$u_r^2(V_l) = u_r^2(P) + u_r^2(\rho_l) + u_r^2(W) \qquad [14]$$

4 Final analysis of the output variance

Let us analyze the terms of the right hand side of the equality [14]:

$u_r(P)$ is the relative standard uncertainty of the standard mass used to calibrate the weighing instrument:

$$u_r(P) = \frac{mpe}{P \cdot \sqrt{3}} = \frac{5 \times 10^{-5}}{\sqrt{3}} = 0.0029\%$$

where *mpe* is the tolerance for M_1 class weights from [3] and the factor 1/√3 depends on the application of a type B estimate of the standard uncertainty due to the weight tolerance.

$$u_r(\rho_l) = \frac{u(\rho_l)}{\rho_l} = \frac{0.5 kg/m^3}{530 kg/m^3} = 0.094\%$$

where the standard uncertainty for the density measurement, according to current technological standards, is supposed to be 0.5 kg/m^3 and 530 kg/m^3 is the average LPG density.

$u_r(W)$ is the standard relative uncertainty due to the repeatability characteristics of the weighing instrument because the linearity has been supposed to hold by means of the linear weighing equations. We thus accept that repeatability is bound within the $1.5 \cdot e$ values for weighing instruments for legal use in trade. The $1.5 \cdot e$ values are conservative because the weighing instrument must bear a dead load capacity that counterbalances the bombola weight when empty and thus the weighing range used can be small relative to the subtractive tare effect. We can assume that the most probable field of use of the weighing instrument is near to the mid-point of the second precision interval in a class III instrument with service error. Assuming a rectangular distribution for that error, we can estimate the relative uncertainty value as follows:

$$u_r(W) = \frac{2e}{(W-W_E)\sqrt{3}} = \frac{2e}{1000e\sqrt{3}} = \frac{2}{1000\sqrt{3}}$$

With these values Equation [14] yields:

$u_r(V_l) = 0.094$ %

Using a coverage factor of 2, we can conclude that the relative extended uncertainty of the method can be estimated to be:

$U_r(V_l) = 0.19$ %

From the calculus above we can say that the method is fit for use in verification testing because the test uncertainty is estimated as less than 1/5 and the test uncertainty ratio rule holds. ■

References

Review of LPG Flow Measurement Technologies and Measurement Issues (A Report for the national Measurement System – Department of Trade & Industry) – November 2006

J. Goellner, *Survey of methods used in Europe for the verification of LPG Dispensers* (OIML Bulletin No. 114, March 1989

OIML R 111 *Weights of classes E_1, E_2, F_1, F_2, M_1, M_{1-2}, M_2, M_{2-3} and M_3. Part 1: Metrological and technical requirements*

HISTORY OF SCALES

Part 15: Automatic gravimetric filling instruments (AGFIs) - Weighing and bag filling machines for loose bulk products

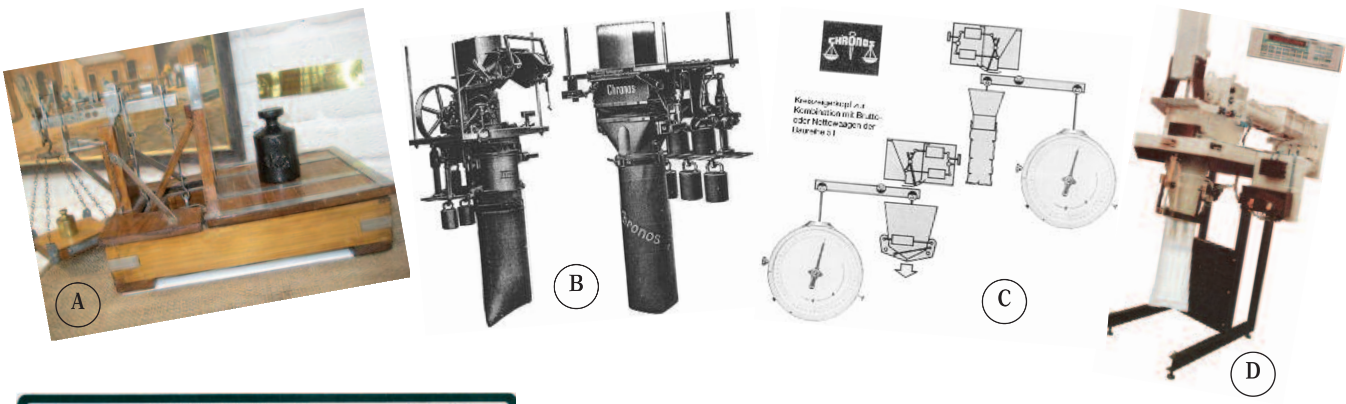
WOLFGANG EULER, Hennef/Sieg

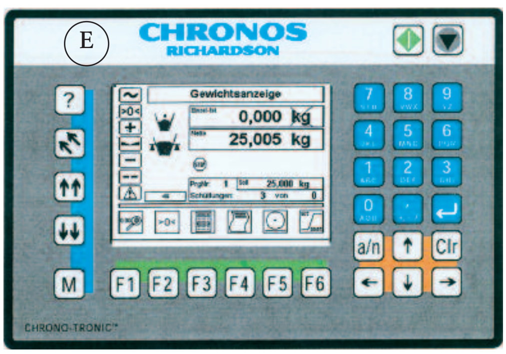
Scales have regulated the flow of money and goods for thousands of years. Without these measuring instruments, an orderly economic cycle could not exist today for trade and markets.

Measures of length and dry and liquid measures as well as scales are the oldest measuring instruments in the world. The origin of the weighing instrument – which is also a symbol of parity, truth and justice – dates back to the oldest cultures 10,000 years ago. Therefore, metrology has been the most important companion of human beings, so to say, since nomadic life was abandoned.

Since then, markets and trade have formed the economic and cultural centre of human beings living together in communities. From the "Forum Romanum" of ancient Rome to today's supermarkets and fresh produce markets worldwide, weights and weighing instruments have been indispensible components for the flow of money and goods. Age-old history-charged pieces of wisdom have been passed on to us from time immemorial. For example, there must be no injustice in the courts of law with regard to units of length, weight and dry and liquid measures, and only correct weighing instruments and weights are to be used. Another historical quote says that weights and measures should always be reliably complied with, so that the belongings of human beings are not in any way impaired.

"Mühle + Mischfutter" Issues No. 13, 15 and 19/2014 as well as the OIML Bulletin No. 4, Oct. 2014 already featured automatic totalizing weighing instruments in accordance with OIML R 107. These automatic hopper weighers serve to weigh different masses of a bulk product which depend on the product flow from weighing to weighing. Such bulk weighers are, for example, used as receiving weighers and/or shipping weighers for loose bulk products such as cereals, rice, soya, flour or concentrated feed (raw materials) for the loading and unloading of ships in harbors worldwide.





A = Decimal balance - invented in 1821 by Friedrich Alois Quintenz
B = Gross weighing and bag-filling machine, equal-arm beam balance (left side: with transmission propulsion)
C = Dial-type weighing scale, Chronos/Tacho-Berkel type
D = Electronic gross weigher GE 55 DS (including load cell)
E = Electronic indicator

According to OIML R 61, automatic weighing instruments for the weighing of loose bulk products are also called automatic gravimetric filling instruments (AGFIs).

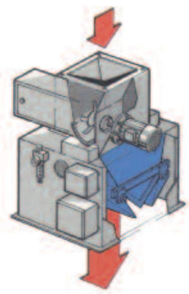
AGFIs were developed to produce "identical preadjustable filling quantities" (e.g. 5 kg, 25 kg or 50 kg), whereby loose bulk products with target quantities of only a few grams (e.g. seeds, spices) up to 1000 kg and more are automatically weighed. Filling capacities in the packaging industry are between 60 and several thousand weighing operations per hour, depending on the filling quantity, the product and the type of weighing instrument. Following the invention of automatic net weighing instruments, the gross bag weigher was quickly developed which is based on the principle of the equal-arm beam balance. The advantage of this gross weigher is its considerably higher bagging capacity, as the required filling quantity – unlike in the case of the ratio weighing machine – was automatically achieved in one process step.

Friedrich Alois Quintenz (born 1774 in Gengenbach, died 1822 in Strasbourg) is deemed to be the inventor of the ratio weighing machine. In 1821 in Strasbourg, he applied for a patent for a portable platform weighing machine with a decimal transformation of speed, which soon became known throughout Germany as the ratio weighing machine. It largely superseded the equal-arm beam balance. The ratio weighing machine is thus the first fundamental new development after several thousand years of weighing instrument history. The ratio weighing machine principle is such that 1/10 of the load to be weighed is put in the weighing pan in the form of weights. In order to weigh a 1 kg load, one no longer needs a counterweight of 1000 g – as is the case with the equal-arm beam balance – but only a 100 g weight.

Due to the invention of the dial-type weighing scale, the utilization of the gross weigher – which is based on the principle of the equal-arm beam balance – decreased. By means of the dial-type weighing scale, a constantly higher bagging capacity was achieved, and the user could read out the weight directly on the measuring instrument.

This series will be continued with the basic technical setup as well as with a functional description of automatic gravimetric filling instruments (AGFIs) (bagging weighers) in accordance with OIML R 61. ■

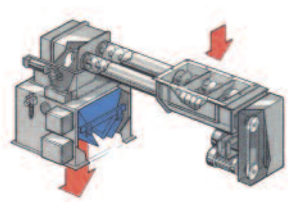
Dosing facility	Type	Type of bulk products	Bulk product, e.g.	Bulk density (kg/m³)
G	Pneumatically controlled dosing flap gate for coarse and fine feed	Free-flowing materials such as granulate, cereals, chemical fertilizer, salts, etc.	Granulated PVC Cereals	600 750
A	As G, but with an additional agitating device in the inlet	Free-flowing coarse flour or bruised grain such as animal feed flour, bran, grass seeds, etc. following a trigger	Animal feed flour Bran	570 240
DS	Twin screw, designed as coarse and fine feed screw, propulsion via separate engines with end cap	Flour-like, powdery (as mentioned above) and chemical powders such as E-PVC, pesticides, herbicides, insecticides, etc.	Flour and milk powder Emulsion PVC powder	550 400 400
B	Tape feed, propulsion via pole-changing engine for coarse and fine feed, with layer heights and end cap	Non free-flowing ones, such as animal feed flours, pellets, bran, bruised grains, scraps, washing powder, crude sugar, etc.	Animal feed flour Pellets: Ø 12 × 30 mm	570 600



Net weighing instrument with flap gate feeding

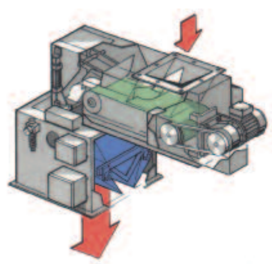
G

A



Net weighing instrument with dosing screw

DS



Net weighing instrument with belt feed

B

HISTORY OF SCALES

Part 16: Basic technical setup and description of the functions of automatic gravimetric filling instruments according to OIML R 61

Wolfgang Euler, Hennef/Sieg
(Region Cologne/Bonn) in cooperation with
Reinhold Pottebaum and his Team, Verlag Moritz Schäfer (Detmold)

In accordance with the automatic mode of operation and the product flow, automatic gravimetric filling instruments/bagging weighers (AGFIs/BWs) have the following main components (see Figure 1).

A Basic technical setup of AGFIs/BWs according to OIML R 61

- 1 Supply hopper for the bulk product
- 1.1 Level indicator in the supply hopper for release of the weighing instrument when a sufficient material reserve (at least 1 1/2 to 2 weighings; in the case of fluidified products: up to 10 weighings) is available.
- 2 Feeding device (also called “proportioning device”), with coarse feed and fine feed, as well as with material in flight. For details, please see Part 15.
- 3 Load-measuring device, mechanical (beam balance or circular head)
- 3.1 Weight receptor
- 3.2 Material-in-flight compensating device
- 4 Electronic evaluation unit with digital display (see Issue 17/2012)
- 4.1 Load measuring device with load cell(s)
- 4.2 Load transmission between load receptor/weighing container (5) in the case of net spouts or spouts with bag (for gross weighing instruments and load cells) (4.1). Depending on the construction of the weighing instrument, load transmission is performed via a lever system (hybrid system) or – as is almost standard today – by direct coupling by means of suspension frames (4.2) between the load receptor (5) and the load cell (4.1).
- 5 Load receptor and weighing container with discharge device in the case of net weighing instruments, or with bag spout and bag buckle without discharge device for direct loading into bags or packages in the case of gross weighing instruments (5.1)
- 6 Bag or packaging
- 7 Inlet flap(s) at the weighing instrument

B Functional principle of automatic gravimetric filling instruments (AGFIs) for weighing loose bulk materials, bagging weighers (BWs) – in accordance with OIML R 61

When a sufficient material reserve is available and the instrument is released by the level indicator (1.1), the inlet flaps of the weighing instrument (Fig. 7) open. While the inlet flaps open, the bulk product contained in the supply hopper (1) is transported – first in coarse feed – via the feeding device (2) (e.g. screw or belt, see page 11) as follows: in the case of net weighing, it is fed to the weighing container (5); in the case of gross weighing, it is fed to the bag/package (5.1 and 6). Load transmission (4.2) to the load cells (4.1) is performed by weighing container suspensions (for net weighing) or by bag spout suspensions (for gross weighing).

The load cell measurement signal is forwarded to an electronic evaluation unit (4), e.g. to an AGFI/bagging controller, in compliance with the EMC (electromagnetic compatibility) rules in force. The bagging controller (electronic weighing system) now controls the filling in coarse feed, fine feed and material in flight until the declared weight has been reached.

In accordance with pre-selectable test intervals, the weight of the filled weighing instrument is assessed (check value control). If adjustable tolerance limits are exceeded in the course of the weight assessment, the weighing cycle is stopped automatically and an alarm signal is triggered. Weight deviations from the check value which are within the tolerance limits are acquired and analyzed by the electronic weighing system. The fine feed cut-off point is corrected according to the deviation from the check value, so that due to the optimization of the material in flight, the next weighing represents a weight result which is within the tolerance limits. Adjusting the fine feed cut-off point serves especially to compensate for changes in the product flow as well as in the bulk density of the bulk product. This allows constant weighing results within the maximum permissible error on verification to be obtained.

If the automatic weighing instrument is equipped with a mechanical weighing-out device, the deviation from the check value is to be determined by adding small weights (e.g. weights applied either on the side of the weighing container/bag spout or on the side of the weight receptor). The weight thus determined is the measure by which the weight of the material-in-flight compensating device must be adjusted.

After the weight has been assessed, the weighing container is emptied (for net weighing instruments) or the bag/package is released (for gross weighing instruments). As a matter of course, all automatic weighing instruments are equipped with a zero check, a zero control and an initial zero-setting device.

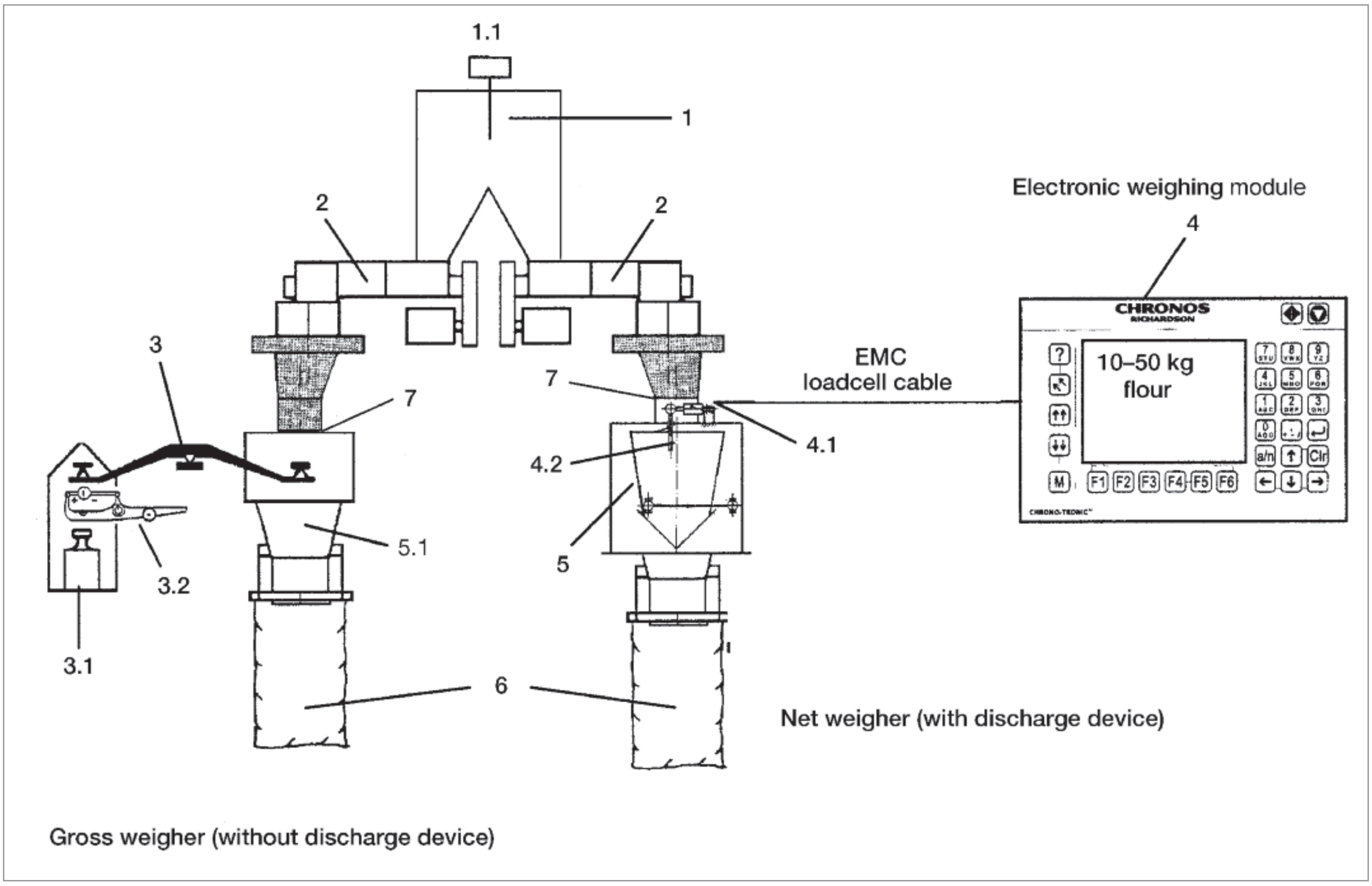


Figure 1 Comparison of a gross weigher (without discharge device) with a net weigher (with discharge device)

Guidance on net weighing instruments (net weighers, weighing instruments with discharge device): such weighing instruments have, as a matter of principle, a higher bagging capacity, since the weighing instrument can begin **at once** the next weighing cycle as soon as the bulk product from the previous weighing has been emptied into the bag and while a new bag is being placed underneath the bagging hopper. This technique is, however, only recommendable for bulk products with good flowing properties and which do not stick to the bagging hopper (e.g. when filling cereals, sugar and pellets). In the case of gross weighers, the bagging capacity is considerably lower, since the balance can only begin with a new weighing cycle **after the bag has been replaced**. What is seemingly a disadvantage turns out to be an advantage when filling bulk products with poor flowing properties, since no material residues can form in the next bagging hopper as the bulk product to be weighed is conveyed directly into the package. This also minimizes the risk of contamination.

The world of strain-gauge load cells (force measurement). DMS Technology

In the light of recent developments, "Weights, Scales and Weighing through the Ages" is, once again, dedicated to the topic of strain-gauge load cells (see OIML Bulletin, April 2013, pp. 17-23 *The World of Load Cells*).

By way of introduction, here is a simple initial consideration: In the case of the mechanical beam balance, the weight of a known mass is the reference force. When measuring force with a strain-gauge load cell, the electrical change in the resistance, which is produced through the geometric change of a loaded metallic body, is the measure for the reference force.

The "mass/force measurement" figures clearly show the difference between the two measuring processes. While in the "mass weighing", the unknown weight is determined by the addition of weights until equilibrium is reached – or, expressed another way, in the case of

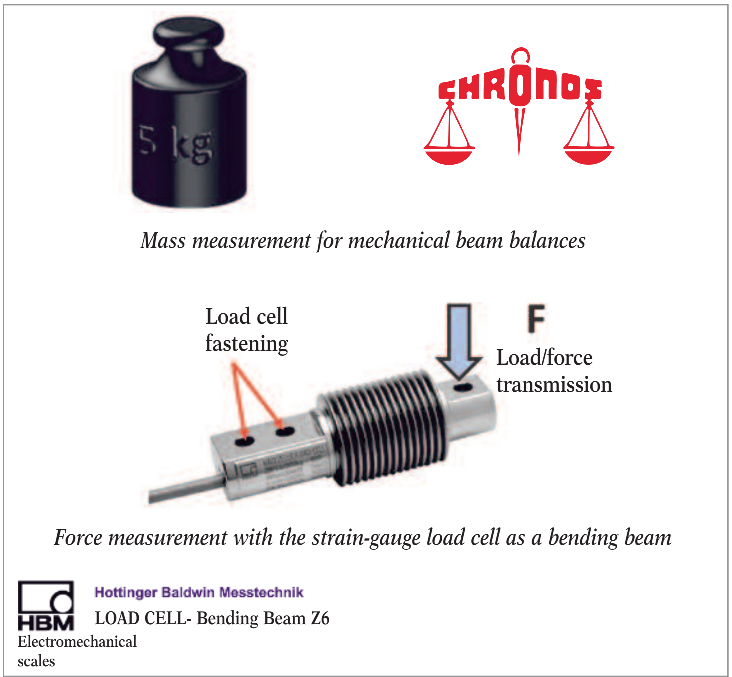


Figure 2: Mass measurement and force measurement

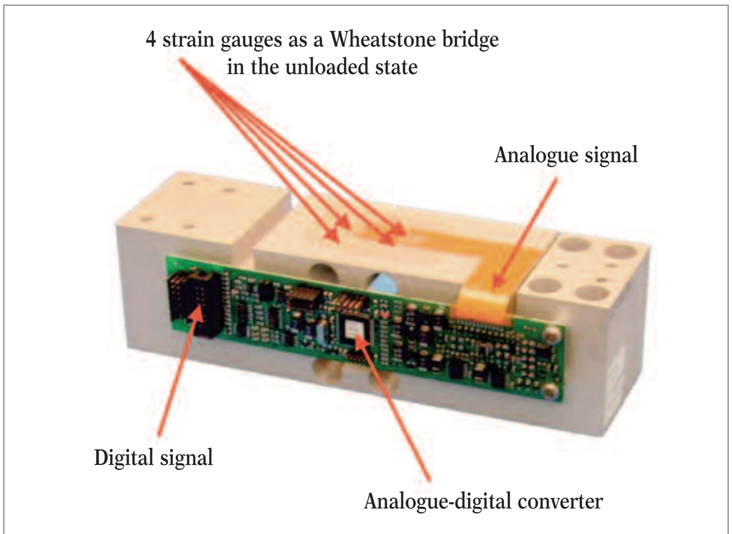


Figure 3: Strain-gauge load cell as a flexible link Bizerba

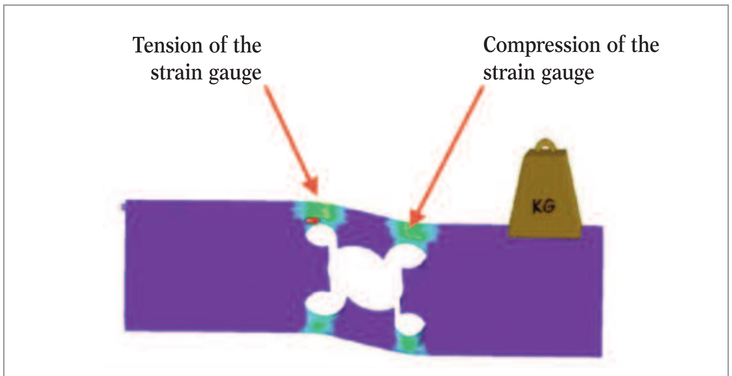


Figure 4: Schematic drawing of the deformation of the load cell metal body

mechanical scales, the weight of a known mass is the reference force – in the case of the strain gauge load cell, weight is determined by the deformation of a piece of metal with ohmic resistors attached as a Wheatstone bridge (Sir Charles Wheatstone, 1802–1875, English scientist). As already explained in detail, force measurement is an analogue process, i.e. the deformation of the metal body also results in an analogue deformation of the ohmic resistor attached to the metal. The stronger the deformation, the stronger the measurement signal of the resistor to the weighing module. In the weighing module the A/D (analogue/digital) conversion then takes place.

Today, "digital" load cells are frequently spoken of. This designation is not correct. The force sensing is still analogue; then, however, a conversion from analogue to digital signals takes place directly on or in the load cells (see diagrams below).

Since 1955, Hottinger Baldwin Messtechnik GmbH (HBM) in Darmstadt is the first German company to be particularly successful in the development and manufacture of strain gauges and load cells; this is also the case for Bizerba in Balingen since 1980. Out of the initially limited applications of strain-gauge technology, a breadth of application which can barely be taken in and which stretches across almost all technical fields and peripheral areas has developed up to the present day. In particular, strain-gauge load cells led to quite a fundamental change in weighing. Just as the Chronos scales of 1883 from the town of Hennef an der Sieg ended weighing by hand after many thousands of years and the age of automatic weighing began, so did weighing with weights (mass) almost exclusively end – after the invention of scales about 7 000 to 10 000 years ago – with the invention of the strain-gauge load cell.

Weighing technology today

Metrology has always had a special place in the technology of scales and weighing. The reasons for this are that

- scales are one of the oldest measuring instruments of all, dating back 7 000 to 10 000 years,
- the accuracy required is considerably higher than for other measuring instruments,
- weighing technology is subject to legislation in many cases,
- scales regulated and controlled the flow of money and goods in the past and still do today, and
- without scales, no orderly economic cycle would be possible.

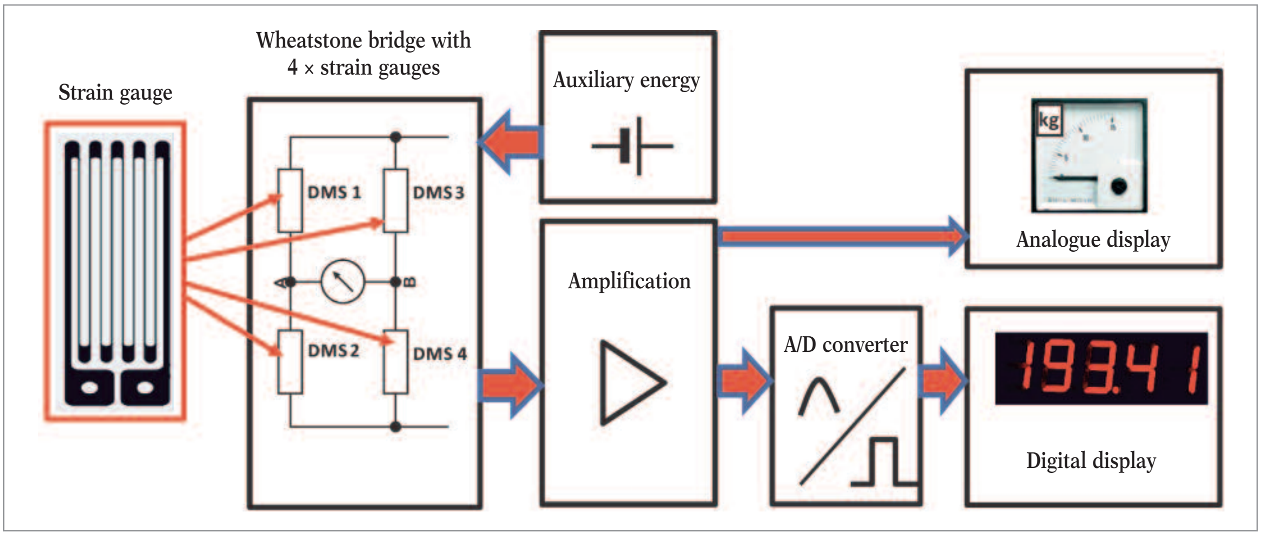


Figure 5: Analogue/digital conversion

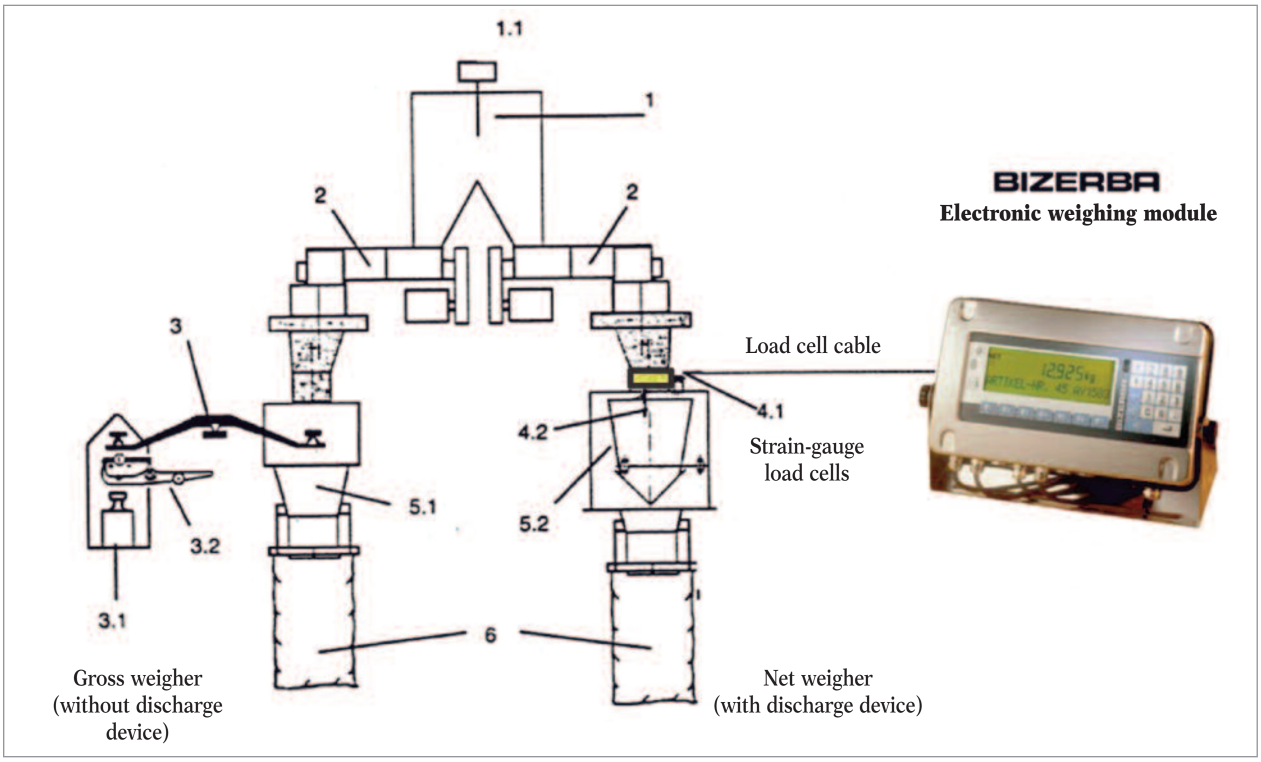


Figure 6: Comparison of a gross with a net weigher with and without discharge device

Technical change in weighing technology

Weighing technology, similar to the clock industry, has experienced a large and special structural change in the last few decades. Where lever systems for transformation, transmission and totalization did the work in the past, today we almost exclusively find strain-gauge load cells.

It has to be noted, however, that apart from strain-gauge load cells, there are also other principles for measuring force, e.g. EMFC (electromagnetic force compensation load cells) and vibrating string technology.

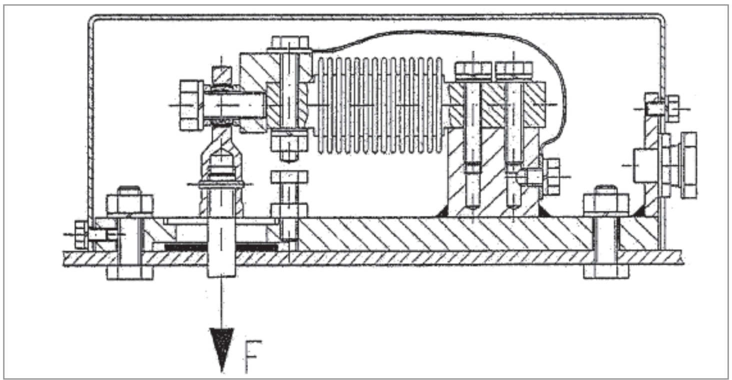


Figure 7: Current representation of a load cell

The measuring chain

The strains to be measured with strain gauges are usually very small. As a result of this, the changes in resistance are also very low and cannot be measured in a direct way, for instance with an ohmmeter. It is thus necessary to integrate the strain gauge into a measuring chain, whereby an exact determination of the change in resistance of the strain gauge becomes possible.

The first link in the measuring chain is formed by the strain gauges themselves. They change the mechanical "strain" or the "compression" into an electric "change in resistance".

This first link in the chain is a measuring circuit (here a Wheatstone bridge circuit), which consists of four strain gauges. Both the strain gauges and the measuring circuit are (in the physical sense) passive links. Energy must be supplied to them to receive a usable electric signal. This auxiliary energy is taken from a separate source.

Generally, a constant electric voltage is used, sometimes also a constant electric current. When the resistance of the strain gauge changes as a result of a strain, then the bridge circuit is no longer symmetrical, it becomes unbalanced and yields a bridge output voltage which is proportional/analogue to the unbalancing of the bridge.

The second link in the measuring chain is an amplifier, which amplifies the bridge output voltage to a value sufficient to run display units. In the case of a linearly operating amplifier, its output voltage is proportional to the amplifier's input voltage (that is the bridge output voltage) and thus, in turn, to the strain to be measured.

The third link in the measuring chain is formed by the display. It transforms the output signal of the amplifier into a form accessible to human senses. In the most simple case the pointer deflection of a voltmeter or the series of digits of a digital measuring instrument serves to show the measurement value. Today's amplifiers also contain analogue/digital conversion and thus allow both device types to be connected, either alternatively, or as shown in the example in Fig. 4.

The above description of the measuring chain only roughly sketches the links which are absolutely necessary. In practice the measuring chain often has various extensions through additional components, such as selector switches, filters, peak value memory, limit switches, control output devices and others.

OIML Recommendations (R)

The OIML develops and publishes International Recommendations based on which many national metrology authorities issue, on demand and upon examination, OIML Certificates of Conformity.

There are numerous OIML Recommendations, e.g. for conveyor scales (R 50), for load cells (R 60), for automatic gravimetric filling instrument/AGFIs (R 61), for non-automatic weighing instruments/NAWIs (R 76), for discontinuous totalizing automatic weighing instruments (totalizing hopper weighers) (R 107), for weights (R 111) and more.

OIML Certificates are **not** type approval certificates. However, they make it considerably easier to obtain national type approvals which are the pre-condition for the national verification of weighing instruments.

National and international maximum permissible errors

Verification – Static test with weights and dynamic test with static weighing in automatic mode with product/load (e.g. grain or flour, etc.)

The testing of a weighing instrument submitted for verification includes testing for compliance with the constructional requirements, the verification regulation, and the type approval certificate. In addition, a variation test as well as a metrological test are carried out to check compliance with the maximum permissible errors on verification.

For the initial verification of automatic or non-automatic weighing instruments, assumes that two tests are always carried out for verification:

1 Static test with weights in non-automatic mode

For this purpose, when the load is increased by adding/removing weights, the automatic weighing instrument (e.g. R 61) must comply with the maximum permissible errors laid down in R 76 (NAWIs/non-automatic weighing instruments), accuracy class III (for medium-accuracy balances) or the appropriate national regulations.

2 Dynamic test with static weighing in automatic mode with product/load

For this purpose, the automatic weighing instrument must comply with the maximum permissible errors laid down in R 51 (catchweighers), R 61 (BW/bagging weighers or AGFIs/automatic gravimetric filling instruments), R 107 (Bulk weighers, discontinuous totalizing automatic weighing instruments for receiving/shipping balances) or in the corresponding national verification regulations.

If the weighing instrument complies with the requirements described in 1 and 2, the local verification office places a stamp on it.

OIML R 76 – Non-automatic weighing instruments (NAWIs)

The provisions applying to the accuracy classes and to the maximum permissible errors for the manufacturing, approval and verification of NAWIs are laid down in the Recommendation or national regulations.

Accuracy Classes

Special accuracy	I
High accuracy	II
Medium accuracy	III
Ordinary accuracy	IV

Maximum permissible error on initial verification according to R 76 (NAWI) or EN 45501

Maximum permissible errors at initial verification
For loads m expressed in verification scale intervals e

Table 1: Maximum permissible error on initial verification according to R 76-1

	Class I	Class II	Class III	Class IV
± 0,5 e	0 ≤ m ≤ 50000	0 ≤ m ≤ 5000	0 ≤ m ≤ 500	0 ≤ m ≤ 50
± 1,0 e	50000 < m ≤ 200000	5000 < m ≤ 20000	500 < m ≤ 2000	50 < m ≤ 200
± 1,5 e	200000 < m	20000 < m ≤ 100000	2000 < m ≤ 10000	200 < m ≤ 1000

e = verification scale interval/increment of the weighing instrument
n = number of verification scale intervals of the weighing instrument

Example:

Max. = 52 kg, verification scale interval:
$e = d = 0.02$ kg

Number of verification scale intervals
n = (52 kg / 0.02 kg) = 2600

For Class III, the maximum permissible error on initial verification amounts to:

- from 0 to 500 e (0 to 10 kg), maximum permissible error ± 0.5 e = ± 0.01 kg
- from 500 e to 2000 e (10 kg to 40 kg), maximum permissible error ± 1.0 e = ± 0.02 kg
- from 2000 e to 2600 e (40 kg to 52 kg), maximum permissible error ± 1.5 e = ± 0.03 kg

The maximum permissible errors in service are twice the maximum permissible errors at initial verification.

Figure 8 (see next page) shows the static maximum permissible errors on verification (W & M error limits) as a function of the number of verification scale intervals (***n***), and an example of the actual error on verification with regard to the relevant load. The static verification error curve was recorded at PBI Cambridge/UK on 19 October 1998 while testing a bagging weigher in order to obtain an OIML R 61 Certificate of Conformity from NMRO (then NWML), Teddington, UK.

OIML R 61 – Automatic gravimetric filling instruments (AGFIs)

In those countries where R 61 has already been adopted by the national governments, various accuracy classes X(x) are used for dynamic testing with a load in the case of AWIs/BW bagging weighers/automatic gravimetric filling instruments.

There used to be only one verification error accuracy class (except for very difficult products); R 61 now defines several classes.

Conventional accuracy classes according to R 61:
Class X(x): X(0.2), X(0.5), X(1)

After passing the laboratory and the field tests, each automatic gravimetric filling instrument (AGFI)/bagging weigher is attributed a reference accuracy class in the OIML Certificate of Conformity Ref (x). The AGFI/bagging weigher mentioned above was attributed, e.g., Ref x (0.2).

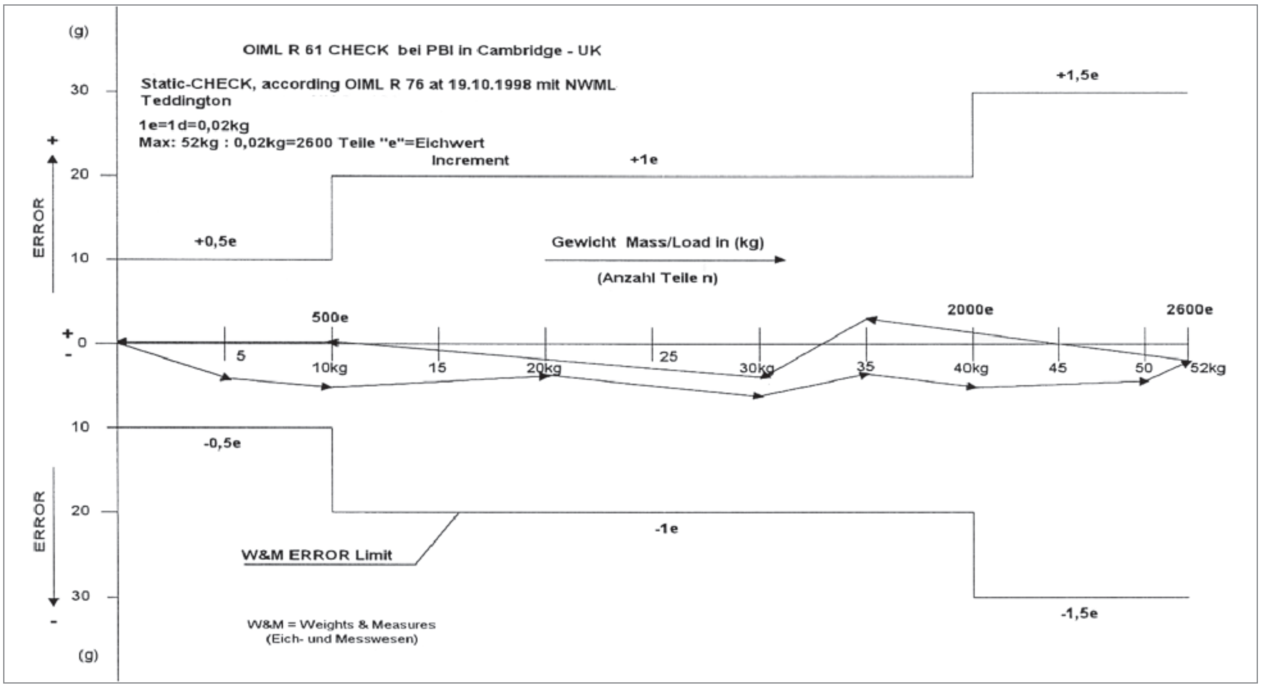


Fig. 8: Static maximum permissible errors on verification (W & M error limits) as a function of the number of verification scale intervals (*n*), and the actual error on verification with regard to the relevant load

Taking the various technical configurations of the AGFIs/bagging weighers, filling instruments as well as of the product to be filled and its (flowing) properties into account, it is now, according to R 61, possible to select and to determine smaller, medium and higher accuracy classes.

As a principle, only one accuracy class X(x) may be selected which is equal to or larger than the accuracy class Ref (x) mentioned and determined in the OIML Certificate.

Example:

X(x)	Ref x	Status
X (0.5)	Ref x (0.2)	OK
X (0.2)	Ref x (0.2)	OK
X (0.1)	Ref x (0.2)	not OK

The determined accuracy classes (there may be more than one for different products) and the reference accuracy class Ref (x) must be indicated on the verification plate (Weights & Measures – W & M label).

In the case of the dynamic test with static weighing of AGFI/bagging weighers with load, also the maximum permissible errors on verification corresponding to the accuracy classes stated on the verification plate X(x) must be complied with.

Maximum permissible deviations according to R 61

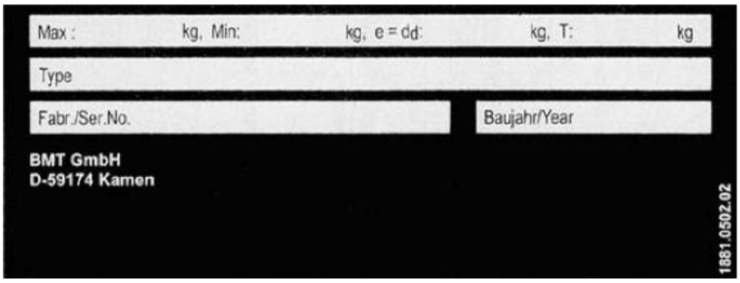
Table 2 lists the maximum permissible deviation of each fill from the average for class X(1) as a function of the mass M (filling mass) in g according to R 61.

Initial verification	maximum permissible errors on verification
In-service	maximum permissible errors in service

Note that the maximum permissible errors in service no longer account for twice the maximum permissible error on verification.

Maximum permissible preset value error (setting error) MPSE

In the case of automatic weighing instruments which are equipped with a preset value setting device for the filling mass, the difference between the preset weight and the mean value of the weighing may not exceed 1/4 of the maximum permissible deviation of each weighing from the mean value for transactions (see Table 2 "Maximum permissible deviations according to R 61"). This also applies to initial verification and in service.



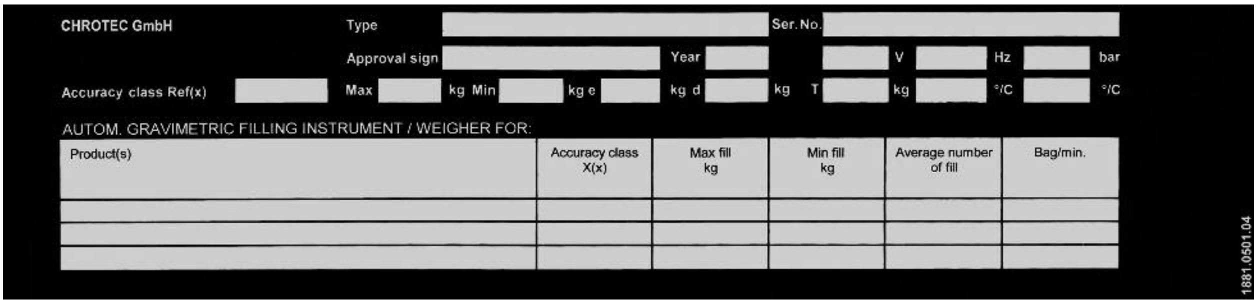


Fig. 9: Verification plate: The rating plate (top) is attached to the mechanical part on the weighing instrument, whereas the large verification plate is for the evaluation unit. Both of them document that these parts form the weighing unit.

Table 2: Maximum permissible deviation (MPD) of each fill

Value of the mass of the fills, *F* (g)	MPD of each fill from the average of the fills for class X(1) (as percentage of *F* or in grams)	
	Initial verification	In-service inspection
F ≤ 50	7.2 %	9 %
50 < *F* ≤ 100	3.6 g	4.5 g
100 < *F* ≤ 200	3.6 %	4.5 %
200 < *F* ≤ 300	7.2 g	9 g
300 < *F* ≤ 500	2.4 %	3 %
500 < *F* ≤ 1 000	12 g	15 g
1 000 < *F* ≤ 10 000	1.2 %	1.5 %
10 000 < *F* ≤ 15 000	120 g	150 g
15 000 < *F*	0.8 %	1 %

Table copied from OIML R 61:2004

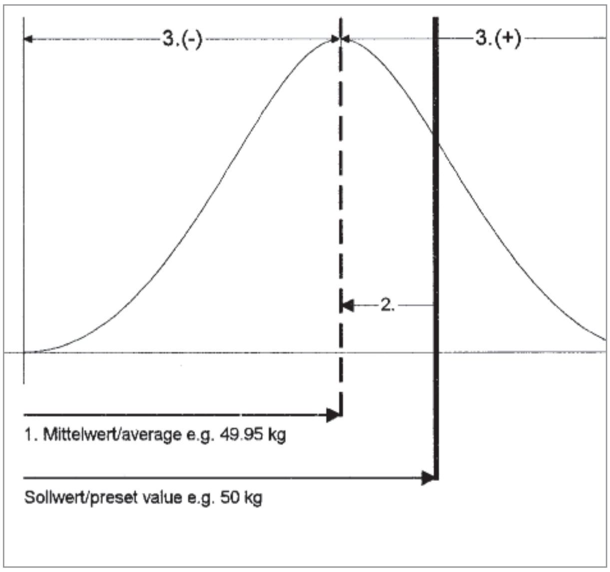


Fig. 10: Maximum permissible preset value error (setting error)

Table 3: Number of test fills

Preset value of the fills, F_P (kg)	Minimum number of test fills, n
$F_P \leq 1$ kg	60 fills
1 kg < $F_P \leq 10$ kg	30 fills
10 kg < $F_P \leq 25$ kg	20 fills
25 kg < F_P	10 fills

Table copied from OIML R 61:2004

Summary of the test criteria

1 = Average mass of fill = Σ *F*/*n* (*F* = fill, *n* = number of fills tested)

2 = Maximum permissible preset value error (setting error), see R 61, 2.3.

Taking the accuracy class X(x) into account, the setting error amounts to:

Average – preset value ≤ 0.25 of the maximum permissible in-service deviation of each fill M from the average:

Average – preset value

49.95 kg – 50 kg ≤ 0.25 × 0.5 kg (= 1 % of 50 kg)
–0.05 kg ≤ 0.125 kg

In the example, the preset value setting error is thus not exceeded.

3 = Maximum deviation (MPD) of each fill from the average (see R 61, 2.2.2).

Number of fills to be tested

The number of fills to be tested individually depends on the preset value (***m***), as indicated in Table 3:

Formerly in the UK, 20 consecutive bags used to be tested, regardless of the preset value. In Germany, the mean values from 10 consecutive weighed bags were checked, in addition to the individual weighings.

As described in the previous issues as well as in the tables, the testing of automatic gravimetric filling instruments (AGFIs) according to R 61:2004 has become considerably more time-consuming and more complex than it used to be.

Previously, initial verification and in-service MPE values for AGFI (SWA) with product were as follows under the old German Weights and Measures Law (EO 10-1 from 1965 to ca. 1994). As an example:

- single weighing/bag from 5 kg to 50 kg:
  MPE ± 4 g per kg of filling weight;
- average of 10 weighing/bags from 5 kg to 50 kg:
  MPE ± 1.6 g per kg of filling weight.

The maximum permissible errors in service are twice those at initial verification.

Figure 11: Left, top: Author Wolfgang Euler uses a mechanical gross weigher to bag loose products ready for delivery at manufacturer Fix-Waagen, Peter Steimel, Hennef/Sieg. Right, top: Palletizing bags. Below: Various loose products

A word from the Authors

With this series, the objective of the Editorial team is to pass on their knowledge about scales and legal metrology to the next generation, which is still being taught and trained and which will in turn take on responsibilities in companies in the future. The Authors have therefore decided to donate their fees to vocational colleges.

MEDICAL

National Legal Metrology Project on Medical Weighing 2014/15

CHRISTINE MUNTEANU
Assistant Director, Regulation Team
National Measurement and Regulation Office (NMRO), United Kingdom

Pharmaceutical scale

Since 1st January 2003 medical weighing equipment used in the practice of medicine has been prescribed under the Non Automatic Weighing Instruments Directive (NAWI) across the European Economic Area and Switzerland. This brought the weighing of patients and the prescribing of medicines within legal control for the first time in the UK and was a key step towards ensuring accurate measurements in medicine. Measurements are used throughout medicine and are often fundamental to treatments or interventions. For example, weight is used to determine treatment and dosage in many medical situations and often the measurement is critical for determining this, for example chemotherapy doses for small children and babies. Even weight gain/loss in infants and the elderly is critical for deciding what treatment or medical interventions may or may not be necessary. If measurements are wrong things could be missed or unnecessary interventions made.

That is why the National Measurement and Regulation Office (NMRO) has been working with Local Weights and Measures Authorities (LWMAs) to deliver a national legal metrology project assessing equipment used by pharmacies, doctors' surgeries, health centres and mobile health visitors, to improve measurement accuracy.

Baby weigher

An earlier project was carried out in 2008 to 2009 by LACoRS (the Local Authorities Co-ordinators of Regulatory Services) and NMRO (then the National Weights and Measures Laboratory) looking at weighing equipment used in hospitals with a view to assisting and promoting good practice. The non-compliance rates reported were 34 % in 2008 and 19 % in 2009. Demonstrable improvements were reported over the course of the project, in particular in relation to buying suitable equipment and using it properly.

Wheelchair weigher

Feedback from the Trading Standards Metrology Expert Panel and the annual returns from LWMAs indicated that this was an important area for Local Authorities, who had taken over responsibility for public health and that a national project would be an effective method of raising awareness and improving compliance.

In light of this, NMRO co-ordinated a project from 2014 to 2015 focussing on equipment used by pharmacies, doctors' surgeries, health centres and mobile health visitors. LWMAs from each region of the UK were represented and in total 27 % of all LWMAs participated in the project. The methodology used was to initially issue a standard letter explaining the remit of the project to suitable premises, followed up by an appointment for the Inspector of Weights and Measures to visit the premises to carry out inspections of the weighing equipment, checking for accuracy, suitability, etc.

Standard advice was issued to staff regarding the use of weighing equipment and appropriate equipment use. Where extensive problems were found in a particular area, then advice was offered to both inspected and uninspected premises. The overall results of the project showed that there was a 23 % non-compliance rate. This was a disappointingly high non-compliance rate and especially as 23 % of the equipment was also found to be not suitable for the medical purpose it was being used for. Examples of unsuitability were weighing equipment not having the correct scale interval for its intended use and a bathroom scale that was not approved. In some circumstances, the use of such equipment could have lead to errors in diagnosis or treatment.

Two case studies, included in the project report, revealed examples of inadequately trained staff and inadequate test methods for the calibration of the instruments. Examples found in-house testing being carried out by untrained staff and no testing of the instruments at maximum capacity, which led to significant errors at the upper end of the instruments' capacity.

One of the main problems identified was the lack of knowledge of all involved with this equipment and the legal and technical requirements that are there to ensure accurate measurement. This project has already gone some way to addressing the problems found through Inspectors of Weights and Measures helping bring those visited into compliance and through raising awareness. However, NMRO is also working with manufacturers of medical weighing equipment, those offering calibration services, the NHS Supply Chain and Trading Standards to increase knowledge and raise standards further within this area.

NMRO will add medical weighing equipment as a separate category to the risk matrix issued annually to LWMAs to help them make assessments of how to deploy their resources. The equipment will be rated as 'very likely to fail' with a 'high risk of impact'. ■

The full project report is available from the NMRO website at:

https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/441291/2014-15_National_Legal_Metrology_Project_Report_-_BRDO.docx

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Introduction

For the purposes of the present article, innovation must be understood as the set of organizational, scientific, technological, financial and commercial activities that make it possible to place in the market and in society a new or improved product or service or to introduce new organization management techniques or improve the existing ones in order to make them more efficient.

This view can be extended and specified on the basis of what NC ISO 9004:2009 lays down regarding innovation, which according to this standard can be applied to:

- products;
- processes and their interfaces;
- structures of the organization;
- management systems;
- human and cultural aspects;
- infrastructure, working environment and technology; and
- relations with the relevant stakeholders.

INIMET Research Team

Some of these elements are described below for the sake of understanding. For instance, the changes that can be made to:

- the technology or the product (that is, innovations responding not only to the changing needs and expectations of both the customers and other interested parties, but also considered to be a sign of possible changes within the organization and in the product's lifecycle);
- the processes (that is, innovations in the methods to make the product or to make the process more stable and reduce the number of variations);
- the organization (that is, innovations in its constitution and structure); and
- the organization's own management system (that is, in order to preserve its competitive edge and make the most of new opportunities when sudden changes take place within it).

In today's world, and particularly in developing countries, the path to progress is contingent on how the following paradigm is conceptualized and implemented:

- an entity's level of competitiveness depends on how it has undertaken and applied innovation;
- the innovation process must rely on the entity's strategy for development;
- the innovation process uses the information system and addresses industrial property-related issues.

This involves the existence of a culture of innovation based on the following:

- the top management must take on risks;
- everyone in the entity must participate;
- creativity must be encouraged; and
- responsibility must be shared.

An entity's innovative character can be seen in three main types of scenarios:

- the first is related to investment;
- the second has to do with a setting of changes, although commissioned to a third party (e.g. universities);
- the third is linked to a setting of changes, except in this case related to the human, material and financial resources available or accessible to the entity.

A fourth scenario would be contingent on a combination of two or more of the above.

These scenarios are very well defined by the level of development of the relevant country and the type of technology. ITC, biotechnology, nanotechnology and other fields of knowledge such as chemistry and biochemistry can be mentioned as examples.

A culture of innovation, the use of human resources in a participative environment, and systematic efforts to invest in research and development are essential to the proper performance of the innovation process.

Since all innovative ideas stem from within the company or entity and abide by the signals coming from the market and the planning processes of economic and societal needs, the strategy to be followed to reach any goal depends largely on the said entity's strengths.

Development

This article is intended to highlight the experiences of the National Metrology Research Institute (INIMET) regarding the use of innovation as the stepping-stone towards development and sustainable management. Details about the implementation of the aforesaid aspects, which are key to the good performance of the process, are included.

A culture of innovation

It is easy to understand how hard it can be to make progress in an organization with limited resources in which priorities must be carefully planned with a view to meeting existing needs in such a way that competitive goods and services can be produced without neglecting either the dissemination of units of measurement or the development and upkeep of its standard instruments and measuring systems, among other tasks.

Regardless of the management's formative influence to develop a culture of innovation among the staff, this situation has an impact on their necessary awareness that innovation can solve many of the problems that hinder the achievement of the organization's planned goals.

A culture of innovation is noticeable in INIMET's performance, and even if someone thinks of and suggests action to upgrade a piece of equipment, a method or a measuring process, nothing is left to spontaneity. Our priorities, and the ways to reach our goals, are properly defined through a process organized and headed by the top management that relies on innovation to bring science closer to the economy and foster its development.

The design of projects marked by innovation and focused mostly on research and development has made it possible to keep a working management-oriented infrastructure in place, using measuring equipment of different generations but with the technical and metrological features required to meet and even surpass sometimes our economic expectations.

INIMET publications to help the metrological community

Human resources

Just like in other countries, including some developed ones, we have faced difficulties to qualify university graduates in metrology, since there is no such degree course at that level of our education system. This is further aggravated by the typical scarcity of resources of an underdeveloped country unable to upgrade the scientific level of its staff, particularly abroad. Innovation stands as an alternative solution to minimize these difficulties through short-, medium- and long-term projects to enhance the qualification of newly graduated professionals and prepare them as much as possible for their integration into scientific-technical activities.

The use of the aforesaid aspects of the innovation process allows to develop and maintain the minimum necessary infrastructure for the progress of the organization and its human resources, supported by the value-adding qualification of the staff in the measurement of physical quantities of economic interest, which makes it possible in our case to assist those companies and entities once their scientific activity cycle is closed, taking into account that their improved equipment, procedures and processes are then marketed through the provision of metrological assurance services that contribute in turn to our economic development with competitive goods and services. It is worth mentioning that it is precisely because many Cuban enterprises and entities operate under these concepts and principles that we have made progress, despite the existing difficulties, with the creation of a culture of innovation and the strengthening of the foundations for development.

As to our human resources and their influence on the fulfillment of our goals, we must point out that the existence of a spirit of participation, a favorable working environment and a sense of commitment to the tasks at hand are essential to achieve success.

Investment in research and development

This is one of the most complex issues in any underdeveloped country. Many entities face economic difficulties in detriment of the systematic investment process required to develop scientific activity. Hence the need to foster their culture of innovation, train human resources and ensure objective and subjective conditions to innovate.

An assessment of how feasible it is to launch a research project on a cost-and-benefit basis is paramount to gain an idea of its potential scientific, technological, economic, social, environmental or any other impact. What will be done must be decided with as much objectivity as possible.

Starting from this premise has made it possible for us to work on the development of a sustainable material and documentary stock in order to guarantee management quality in our capacity as National Metrology Institute of the Republic of Cuba. INIMET's performance in making safe, reliable and comparable measurements is the driving force behind the development of almost every field in any country.

Lloyd's Register
LRQA

CERTIFICATE OF APPROVAL

This is to certify that the Quality Management System of:

INSTITUTO NACIONAL DE INVESTIGACIONES EN METROLOGÍA (INIMET)
Consulado 206 e/ Ánimas y Trocadero
La Habana
Cuba

has been approved by Lloyd's Register Quality Assurance to the following Quality Management System Standard:

ISO 9001:2008
NC ISO 9001:2008

The Quality Management System is applicable to:

Services of calibration and verification of measurent equipment. Training services in metrology.

Approval
Certificate No: SGI 6023318

Original Approval: 04 May 2015
Current Certificate: 04 May 2015
Certificate Expiry: 03 May 2018

Issued by: LRQA España, S.L.
For and on behalf of: Lloyd's Register Quality Assurance Limited

UKAS
001

C/ Princesa, 29 - 1° - 28008 Madrid, España
For and on behalf of 1 Trinity Park, Bickenhill Lane, Birmingham B37 7ES, United Kingdom

INIMET ISO 9001:2008 Certificate

INIMET building in Cuba

INIMET and its main achievements

Mission

- develop and maintain standard instruments and measuring systems of the physical quantities for which it is responsible;
- ensure measurement traceability to the SI units and other standard references, as befits its status as National Institute of Metrology (NIM);
- research, develop and innovate to achieve value-added products in the field of metrology;
- train people to contribute to the national economy in its effort to become internationally competitive in the provision of goods and services.

Vision

INIMET is an institution provided with staff of a high professional and scientific level, a certified quality management system, and competent laboratories that fulfill international requirements and perform quality work to meet the country's needs in the field of Metrology. It is present and plays an active role in related international organizations and its staff is committed to the shared values of the organization.

Physical quantities worked on by INIMET

Electricity, density, pressure, physicochemical, volume, mass, temperature and dimensional.

INIMET's professors and researchers count on the proper technical and pedagogical skills to teach training and other courses to specialists involved in production, research, services and education and thus increase their technical and professional competence.

Research, assistance for literature search, consultation, lending, photocopying and scanning are some of the scientific-technical services available at INIMET.

Research

INIMET's portfolio of projects is linked to a process for its staff's scientific grading and academic degrees so that their activity can be directed to subjects of interest in this field of knowledge, including:

- development of national standards;
- achievement of sustainable technical competence;
- solution of metrological problems in industry and fields of national interest;
- participation in national and international projects and intercomparisons of specific measurements of interest; and
- improvement to our culture of metrology in order to increase awareness of its values among professionals and in society at large.

International support

Cuba is:

- a Member State of the International Organization of Legal Metrology (OIML);
- an Associate member of the International Conference of Weights and Measures (CIPM);
- a Signatory of the CIPM Mutual Recognition Agreement (CIPM-MRA); and
- a Full member of the Euro-Asian Metrology Cooperation (COOMET).

It also engages in actions of cooperation in the physical quantities under its responsibility with similar institutions on every continent.

Some of INIMET's outstanding achievements

- Ever since 2007, the assessment body of the Euro-Asian Metrology Cooperation (COOMET) has awarded INIMET's measurement laboratories a Certificate of competence, according to the Cuban standard NC ISO IEC 17025:2006.
- In 2015, INIMET received a certificate issued by Lloyd's Register to demonstrate that there is an ISO 9001:2008-based quality management system in place, of a very high level and similar to those of its counterparts around the world, for services of calibration and verification of measuring instruments and the provision of staff training courses on metrology.
- In the last four years, four research and technological innovation projects have been finished, which have paved the way for significantly improved technologies and processes used in exports and in the replacement of imports; increased efficiency, productivity and people's quality of life; and new knowledge in metrological science and technology regarding the upgrading of a national standard, the development of books on metrology for the popularization of science, the training of professionals, and the qualification of human capital. These results have won awards bestowed by various national instances.
- INIMET has undertaken successful intercomparisons as a result of international cooperation to validate the country's most accurate standard instruments and support the best measurement capabilities published in the BIPM database with a view to worldwide recognition.
- As the sponsoring entity of the Cuban Academy of Sciences, INIMET issues a Scientific-Technical Bulletin, included in the National Registry of Periodical Science and Technology Publications, to disseminate specific research works and information on metrology. This Bulletin is certified by the Ministry of Science, Technology and the Environment (CITMA) and indexed in the REDALYC database ("Scientific Information System for Latin America, the Caribbean, Spain and Portugal").
- INIMET staff teaches in Technical Schools of Standardization and Metrology, as well as in the School of Physics of the University of Havana and the School of Mechanical Engineering of the "Jose Antonio Echeverria" Higher Pedagogical Institute (ISPJAE).
- Our specialists play an active role in International Symposiums on Metrology hosted by Havana in the years 2008, 2011 and 2014.
- INIMET also provides experts who act as members of task forces organized by the Office of the General Controller of the Republic for national internal control exercises conducted by that institution, as well as in the Metrology Technical Committee for Standardization, through which highly influential standards have been issued, namely NC 994 "Technical conditions and requirements for the fiscal measurement and the transfer of custody or property of oil and its by-products".

Conclusion

The above summary about INIMET and the description of some of its main achievements in the last few years validate the adequate methods of management implemented in our Institute to conduct the current innovation process.

Acknowledgments

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Y., Reyes Ponce; A. R., Hernández Leonard; A. D. Hernández Ruiz Libro Metrología para la Vida. Editorial Académica Española. 2012 .Edición digital en internet. ISBN 978-3-659-05249-1. www.morebooks.com.

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NCISO 9004: 2009 gestión para el éxito sostenido de una organización – enfoque de gestión de la calidad.

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Curso "Dirección por objetivos". 2007 Instituto Superior Politécnico José Antonio Echeverría. Centro de Estudios de Técnicas de Dirección. La Habana. Cuba.

NC ISO/IEC 17 025: 2006. Requisitos generales para la competencia de los laboratorios de ensayo y de calibración.

Evento Nacional IX Seminario Científico del Instituto Técnico Militar José Martí. s.a Procedimiento para medir y evaluar el impacto de los resultados de la ciencia e innovación tecnológica en una entidad empresarial. La Habana, Cuba.

ISBN 978-959-270-099-4.

Y. Reyes Ponce, N. E. Valdés Pereira. , 2004 .Las mediciones, su impacto en la innovación y el comercio. Ponencia presentada en: IV Encuentro Internacional "Mujeres Creadoras". Palacio de Convenciones de La Habana. Cuba. Junio de 7 a 8.

Y. Reyes Ponce, N.E. Valdés Pereira.,Y. Reyes Rivero, 2003 .Las mediciones, su impacto en la innovación y el comercio. Ponencia presentada en: Convención Internacional de Ciencia, Tecnología y Sostenibilidad. CITMA. Centro de Convenciones Capitolio de La Habana. Cuba. Diciembre de 9 a 12.

The Author of this article, Dr. Ysabel Reyes Ponce, presenting a technical paper at a scientific conference

OIML Systems

Basic and MAA Certificates registered 2015.06–2015.08

Information: www.oiml.org section "OIML Systems"

The OIML Basic Certificate System

The *OIML Basic Certificate System for Measuring Instruments* was introduced in 1991 to facilitate administrative procedures and lower the costs associated with the international trade of measuring instruments subject to legal requirements. The System, which was initially called "OIML Certificate System", is now called the "OIML Basic Certificate System". The aim is for "OIML Basic Certificates of Conformity" to be clearly distinguished from "OIML MAA Certificates".

The System provides the possibility for manufacturers to obtain an OIML Basic Certificate and an OIML Basic Evaluation Report (called "Test Report" in the appropriate OIML Recommendations) indicating that a given instrument type complies with the requirements of the relevant OIML International Recommendation.

An OIML Recommendation can automatically be included within the System as soon as all the parts - including the Evaluation Report Format - have been published. Consequently, OIML Issuing Authorities may issue OIML Certificates for the relevant category from the date on which the Evaluation Report Format was published; this date is now given in the column entitled "Uploaded" on the Publications Page.

Other information on the System, particularly concerning the rules and conditions for the application, issue, and use of OIML Certificates, may be found in OIML Publication B 3 *OIML Basic Certificate System for OIML Type Evaluation of Measuring Instruments* (Edition 2011) which may be downloaded from the Publications page of the OIML web site. ■

The OIML MAA

In addition to the Basic System, the OIML has developed a *Mutual Acceptance Arrangement* (MAA) which is related to OIML Type Evaluations. This Arrangement - and its framework - are defined in OIML B 10 (Edition 2011) *Framework for a Mutual Acceptance Arrangement on OIML Type Evaluations*.

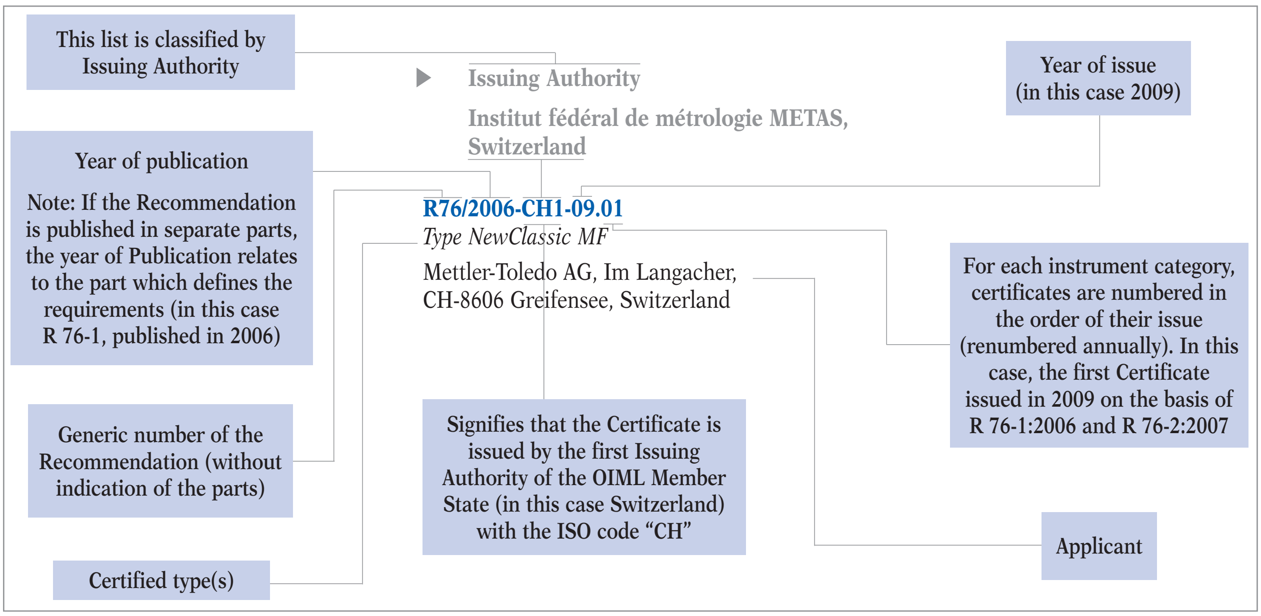
The OIML MAA is an additional tool to the OIML Basic Certificate System in particular to increase the existing mutual confidence through the System. It is still a voluntary system but with the following specific aspects:

- increase in confidence by setting up an evaluation of the Testing Laboratories involved in type testing,
- assistance to Member States who do not have their own test facilities,
- possibility to take into account (in a Declaration of Mutual Confidence, or DoMC) additional national requirements (to those of the relevant OIML Recommendation).

The aim of the MAA is for the participants to accept and utilize MAA Evaluation Reports validated by an OIML MAA Certificate of Conformity. To this end, participants in the MAA are either Issuing Participants or Utilizing Participants.

For manufacturers, it avoids duplication of tests for type approval in different countries.

Participants (Issuing and Utilizing) declare their participation by signing a Declaration of Mutual Confidence (Signed DoMCs). ■



INSTRUMENT CATEGORY
CATÉGORIE D'INSTRUMENT

Water meters intended for the metering of cold potable water
Compteurs d'eau destinés au mesurage de l'eau potable froide

R 49 (2003)

▶ Issuing Authority / *Autorité de délivrance*

Czech Metrology Institute (CMI), Czech Republic

R049/2003-CZ1-2015.02
Water meter - Type: DS TAR
Lianyungang Lianli - First Meter Co. Ltd., 9# Yuzhou South Road, Haizhou Development Zone, Lianyungang, Jiangsu, P.R. China

INSTRUMENT CATEGORY
CATÉGORIE D'INSTRUMENT

Water meters intended for the metering of cold potable water and hot water
Compteurs d'eau pour le mesurage de l'eau potable froide et de l'eau chaude

R 49 (2006)

▶ Issuing Authority / *Autorité de délivrance*

NMi Certin B.V., The Netherlands

R049/2006-NL1-2012.01 Rev. 6
Water meter - Type: WATERFLUX 3070
Krohne Altometer, Kerkeplaat 12, NL-3313 LC Dordrecht, The Netherlands

▶ Issuing Authority / *Autorité de délivrance*

Physikalisch-Technische Bundesanstalt (PTB), Germany

R049/2006-DE1-2008.01 Rev. 2
Water meter intended for the metering of cold potable water - Type: MTK-AM, MTK-N, MTK-I, MTK-8R, MTK-CC, MTK-45, MTK-D
Zenner International GmbH & Co. KG, Römerstadt 4, DE-66121 Saarbrücken, Germany

R049/2006-DE1-2008.04 Rev. 1
Water meter intended for the metering of cold potable water - Type: MTK-AM-8, MTK, MTK-AM, MTK-N, MTK-I, MTK-5, MTK-8, MTK-S
Zenner International GmbH & Co. KG, Römerstadt 4, DE-66121 Saarbrücken, Germany

R049/2006-DE1-2012.02 Rev. 1
Water meter intended for the metering of cold potable water. Multijet meter with mechanical register - Type: MTK, MTK-S
Zenner International GmbH & Co. KG, Römerstadt 4, DE-66121 Saarbrücken, Germany

R049/2006-DE1-2012.06 Rev. 1
Water meter intended for the metering of cold potable water and hot water. Multijet meter with mechanical indicating device - Type: MTK-S1
Zenner International GmbH & Co. KG, Römerstadt 4, DE-66121 Saarbrücken, Germany

INSTRUMENT CATEGORY
CATÉGORIE D'INSTRUMENT

Water meters for cold potable water and hot water
Compteurs d'eau potable froide et d'eau chaude

R 49 (2013)

▶ Issuing Authority / *Autorité de délivrance*

Czech Metrology Institute (CMI), Czech Republic

R049/2013-CZ1-2015.01
Water meter - Type: 208W-. . .
Spire Metering Technology, 15 Craig Road, MA 01720 Acton, Massachusetts, United States

R049/2013-CZ1-2015.03
Water meter - Type: MJ-SDC PLUS
Ningbo Water Meter Co. Ltd., 355 Hongxing Road, Jiangbei District, CN-315032 Ningbo, P.R. China

INSTRUMENT CATEGORY
CATÉGORIE D'INSTRUMENT

Automatic catchweighing instruments
Instruments de pesage trieurs-étiqueteurs à fonctionnement automatique

R 51 (2006)

▶ Issuing Authority / *Autorité de délivrance*

NMRO Certification Services (NMRO), United Kingdom

R051/2006-GB1-2008.01 Rev. 0
CW3 Checkweigher

Loma Systems Group and ITW Group, Southwood, Farnborough GU14 0NY, United Kingdom

R051/2006-GB1-2012.01 Rev. 2
Type: LI-700E/CWL-700E

Digi Europe Ltd., Digi House, Rookwood Way, Haverhill CB9 8DG, United Kingdom

R051/2006-GB1-2014.04 Rev. 1
Type: DACS-G-S015 and DACS-G-S060 Series

Ishida Europe Ltd., 11 Kettles Wood Drive, Woodgate Business Park, Birmingham B32 3DB, United Kingdom

▶ Issuing Authority / *Autorité de délivrance*

Physikalisch-Technische Bundesanstalt (PTB), Germany

R051/2006-DE1-2015.01
Automatic catchweighing instrument - Type: HC . . ./ EC . . .

OCS Checkweighers GmbH, Max-Planck-Str. 7, DE-74523 Schwäbisch Hall, Germany

INSTRUMENT CATEGORY
CATÉGORIE D'INSTRUMENT

Metrological regulation for load cells (applicable to analog and/or digital load cells)
Réglementation métrologique des cellules de pesée (applicable aux cellules de pesée à affichage analogique et/ou numérique)

R 60 (2000)

▶ Issuing Authority / *Autorité de délivrance*

NMi Certin B.V., The Netherlands

R060/2000-NL1-2014.24 Rev. 1 (MAA)
Compression load cell with strain gauges - Type: RC3, TC3-TS

Flintec GmbH, Bemannsbruch 9, DE-74909 Meckesheim, Germany

R060/2000-NL1-2015.07 (MAA)
Single point load cell, with strain gauges - Type: 651HSxx, 651KSxx, 651TS, 651JS

Anyload Transducer Co. Ltd., 6994 Greenwood Street, Unit 102, Burnaby, BC V5A 1X8, Canada

R060/2000-NL1-2015.09 (MAA)
Tension load cell, with strain gauges - Type: H3L5-Cx-xxx-xx Series

Zhonghang Electronic Measuring Instruments Co. Ltd. (ZEMIC), Xinyuan Road, The North Zone of EDZ, Hanzhong, P.O. Box 2, CN-723000 Hanzhong- ShaanXi, P.R. China

R060/2000-NL1-2015.10
Single point load cell, with strain gauges - Type: NA... and NA...M

Hope Technologic (Xiamen) Co. Ltd., 3FL Heng Sheng Building, Yue Hua E. Rd., CN-361006 Hu-Li Xiamen, P.R. China

R060/2000-NL1-2015.12 (MAA)
Tension load cell, with strain gauges - Type: 620-X000kg

Vishay Precision Group - Transducers, 26 Harokmim St., 5885849 Holon, Israel

R060/2000-NL1-2015.13 (MAA)
Single point load cell, with strain gauges - Type: PC5H

Flintec UK Ltd., W4/5 Capital Point, Capital Business Park, Wentloog Avenue, Cardiff CF3 2PW, United Kingdom

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R060/2000-NL1-2015.14 (MAA)
Bending beam load cell, with strain gauges - Type: EH-01
Nanjing Easthigh Measurement Co. Ltd., No. 77 Tangton Road, Hushu Town, Jiangning, Nanjing, P.R. China

R060/2000-NL1-2015.15 (MAA)
Bending beam load cell, with strain gauges - Type: CZL601
Dongguan South China Sea Electronic Company Ltd., Dashen Industrial Estate, Mayong Town, Dongguan City, CN-523136 Guangdong, P.R. China

R060/2000-NL1-2015.16 (MAA)
Compression load cell, with strain gauges - Type: RCW3
Rudiger Wohrl GmbH, Goldbergstrasse 1, DE-74629 Pfedelbach/Windischenbach, Germany

▶ **Issuing Authority / *Autorité de délivrance***
NMRO Certification Services (NMRO), United Kingdom

R060/2000-GB1-2015.04
Load cell - Type: T 34
Thames Side Sensors, Ltd., Unit 10 - Io Trade Center, Deacon Way, Reading RG30 6AZ, United Kingdom

▶ **Issuing Authority / *Autorité de délivrance***
Physikalisch-Technische Bundesanstalt (PTB), Germany

R060/2000-DE1-2008.11 Rev. 1
Strain gauge compression load cell for weighbridges
Sartorius Mechatronics T&H GmbH, Meiendorfer Strasse 205, DE-22145 Hamburg, Germany

CATÉGORIE D'INSTRUMENT

Automatic gravimetric filling instruments
Doseuses pondérales à fonctionnement automatique

R 61 (2004)

▶ **Issuing Authority / *Autorité de délivrance***
NMRO Certification Services (NMRO), United Kingdom

R061/2004-GB1-2015.01
290 Series
Applied Weighing International Ltd., Unit 5, Southview Park, Marsack Street, Caversham, Reading RG4 5AF, United Kingdom

INSTRUMENT CATEGORY
CATÉGORIE D'INSTRUMENT

Nonautomatic weighing instruments
Instruments de pesage à fonctionnement non automatique

R 76-1 (1992), R 76-2 (1993)

▶ **Issuing Authority / *Autorité de délivrance***
NMRO Certification Services (NMRO), United Kingdom

R076/1992-GB1-2010.04 Rev. 4 (MAA)
SW Series
CAS Corporation, #262 Geurugogae-ro, Gwangjeok-myeon, Yangju-si, Gyenonggi-do, Korea (R.)

INSTRUMENT CATEGORY
CATÉGORIE D'INSTRUMENT

Non-automatic weighing instruments
Instruments de pesage à fonctionnement non automatique

R 76-1 (2006), R 76-2 (2007)

▶ **Issuing Authority / *Autorité de délivrance***
Dansk Elektronik, Lys & Akustik (DELTA), Denmark

R076/2006-DK3-2014.05 Rev. 1
Non-automatic weighing instrument - Type: A31P
Ohaus Corporation, 7 Campus Drive, Suite 310, 07054 Parsippany - NJ, United States

R076/2006-DK3-2014.07
Non-automatic weighing instrument - Type: RW / RWS / RWP / ROW
TScale Electronics Mfg (Kunshan) Co. Ltd., No. 99 Shunchang Road, Zhoushi Town, Kunshan City, CN-215300 Suzhou Jiangsu Province, P.R. China

R076/2006-DK3-2014.08
Non-automatic weighing instrument - Type: S29 / SW / SW-II / SW-III
TScale Electronics Mfg (Kunshan) Co. Ltd., No. 99 Shunchang Road, Zhoushi Town, Kunshan City, CN-215300 Suzhou Jiangsu Province, P.R. China

▶ **Issuing Authority / *Autorité de délivrance***

Institut fédéral de métrologie METAS, Switzerland

R076/2006-CH1-2015.02 Rev. 1 (MAA)
Non-automatic analytical/precision weighing instrument - Type: MS. . .TS/ML. . .
Mettler-Toledo GmbH, Im Langacher 44, CH-8606 Greifensee, Switzerland

R076/2006-CH1-2015.03 (MAA)
Non-automatic analytical/precision weighing instrument - Type: MS. . .TS/ML. . .
Mettler-Toledo Instrument (Shanghai) Co. Ltd., 589 GuiPing Road, CN-200233 Shanghai, P.R. China

▶ **Issuing Authority / *Autorité de délivrance***

Laboratoire National de Métrologie et d'Essais, Certification Instruments de Mesure, France

R076/2006-FR2-2015.02 Rev. 0 (MAA)
Digital data processing unit - Type: X241-PMNET
Precia SA, BP 106, FR-07001 Privas Cedex, France

R076/2006-FR2-2015.03 Rev. 0 (MAA)
Analogue data processing unit - Type: X241-TR
Precia SA, BP 106, FR-07001 Privas Cedex, France

R076/2006-FR2-2015.04 Rev. 0 (MAA)
Analogue data processing unit - Type: X1309-TR
Precia SA, BP 106, FR-07001 Privas Cedex, France

▶ **Issuing Authority / *Autorité de délivrance***

NMi Certin B.V., The Netherlands

R076/2006-NL1-2014.55 Rev. 1 (MAA)
Non-automatic weighing instrument - Type: bMobile and bDrive
Mettler-Toledo (Changzhou) Measurement Technology Ltd., N° 111 West TaiHu Road, ChangZhou XinBei District, CN-213125 Jiangsu, P.R. China

R076/2006-NL1-2015.11 (MAA)
Non-automatic weighing instrument - Type: PCSK
Grupo Epelsa S.L., c/Punto Net, 3, Polígono Industrial TECNOALCALÁ, ES-28805 Alcalá de Henares (Madrid), Spain

R076/2006-NL1-2015.12 Rev. 1 (MAA)
Non-automatic weighing instrument - Type: AB, RJ
Shinko Denshi Co. Ltd., 3-9-11 Yushima, Bunkyo-ku, JP-113-0034 Tokyo, Japan

R076/2006-NL1-2015.23 (MAA)
Indicator - Type: Intuitive 20i, Intuitive 22i
VPG - Transducers, 2 Ha'ofan St., P.O. Box 2502, 5881419 Holon, Israel

R076/2006-NL1-2015.24 (MAA)
Indicator - Type: 480-2A, 480 Plus-2A, 482 - 2A, 482 Plus - 2A
Rice Lake Weighing Systems, 230 West Coleman Street, Rice Lake, Wisconsin 54868, United States

R076/2006-NL1-2015.28 (MAA)
Non-automatic weighing instrument - Type: RM-5800II
Shanghai Teraoka Electronic Co. Ltd., Tinglin Industry Developmental Zone, Jin Shan District, CN-201505 Shanghai, P.R. China

R076/2006-NL1-2015.28 Rev. 1 (MAA)
Non-automatic weighing instrument - Type: RM-5800II
Shanghai Teraoka Electronic Co. Ltd., Tinglin Industry Developmental Zone, Jin Shan District, CN-201505 Shanghai, P.R. China

R076/2006-NL1-2015.29 (MAA)
Weighing module - Type: AD2000
Shanghai Teraoka Electronic Co. Ltd., Tinglin Industry Developmental Zone, Jin Shan District, CN-201505 Shanghai, P.R. China

R076/2006-NL1-2015.30 (MAA)
Indicator - Type: XK3118T1
Keli Sensing Technology (Ningbo) Co. Ltd., No. 199 of Changxing RD, Jiangbei District, Ningbo, P.R. China

R076/2006-NL1-2015.31 (MAA)
Indicator - Type: IT2000M
SysTec Systemtechnik und Industrieautomation GmbH, Ludwig-Erhard-Str. 6, DE-50129 Bergheim, Germany

R076/2006-NL1-2015.33 (MAA)
Non-automatic weighing instrument - Type: LEXUS Foxter 70, Foxter-T, Foxter-T 70, Foxter RS
Xiamen Pinnacle Electrical Co. Ltd., 4F, Guangxia Building, North High-Tech Zone, Xiamen, CN-Fujian, P.R. China

R076/2006-NL1-2015.35 (MAA)
Non-automatic weighing instrument - Type: MC-980A, MC-980MA, MC-980A Plus, MC-980MA Plus
Tanita Corporation, 14-2, 1-Chome, Maeno-cho, Itabashi-ku, JP-174-8630 Tokyo, Japan

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R076/2006-NL1-2015.36 (MAA)
Non-automatic weighing instrument - Type: SM-100. ., SM-5100 . .
Shanghai Teraoka Electronic Co. Ltd., Tinglin Industry Developmental Zone, Jin Shan District, CN-201505 Shanghai, P.R. China

R076/2006-NL1-2015.37 (MAA)
Non-automatic weighing instrument - Type: RM-60
Shanghai Teraoka Electronic Co. Ltd., Tinglin Industry Developmental Zone, Jin Shan District, CN-201505 Shanghai, P.R. China

R076/2006-NL1-2015.39 (MAA)
Non-automatic weighing instrument - Type: HC. . . Moisture analyzer
Mettler-Toledo Instrument (Shanghai) Co. Ltd., 589 GuiPing Road, CN-200233 Shanghai, P.R. China

▶ Issuing Authority / *Autorité de délivrance*

NMRO Certification Services (NMRO), United Kingdom

R076/2006-GB1-2012.09 Rev. 3 (MAA)
LI-700E
Digi Europe Ltd., Digi House, Rookwood Way, Haverhill CB9 8DG, United Kingdom

R076/2006-GB1-2014.01 Rev. 1 (MAA)
Type: DPS-800s
Digi Europe Ltd., Digi House, Rookwood Way, Haverhill CB9 8DG, United Kingdom

R076/2006-GB1-2014.06 (MAA)
Price computing scales - Type: ACS-RA11-15, ACS-RA11-30, ACS-RA12-15, ACS-RA12-30, ACS-RA21-15, ACS-RA21-30, ACS-RA22-15 and ACS-RA22-30
Chengdu Jiuzhou Electronic Information System Co. Ltd., A2 Building - Tianfu Software Park, No. 765 Mid Tianfu Street, Chengdu City, Sichuan Province, P. R. China

R076/2006-GB1-2015.03 Rev. 1 (MAA)
260/290 Series
Applied Weighing International Ltd., Unit 5, Southview Park, Marsack Street, Caversham, Reading RG4 5AF, United Kingdom

R076/2006-GB1-2015.06 (MAA)
Checkmaster
Ian Fellows Ltd., 3D/E Centurion Way, Crusader Park, Warminster BA12 8BT, United Kingdom

▶ Issuing Authority / *Autorité de délivrance*

Physikalisch-Technische Bundesanstalt (PTB), Germany

R076/2006-DE1-2015.01 (MAA)
Weighing module - Type: MPGI
Mettler-Toledo (Albstadt) GmbH, Unter dem Malesfelden 34, DE-72458 Albstadt, Germany

INSTRUMENT CATEGORY
CATÉGORIE D'INSTRUMENT

Dynamic measuring systems for liquids other than water
Ensembles de mesurage dynamique de liquides autres que l'eau

R 117 (2007) + R 118 (1995)

▶ Issuing Authority / *Autorité de délivrance*

NMi Certin B.V., The Netherlands

R117/2007-NL1-2015.01 Rev. 1
Density sensor (a sensor as part of a densitometer) - Type: CDM 100M; CDM 100P
Emerson Process Management Micro Motion Inc., 7070 Winchester Circle, Boulder, Colorado CO80301, United States

ERRATUM

OIML Bulletin Volume LVI Number 2 (April 2015)

In the paper entitled *Metrological confirmation of volume measuring systems installed at PETROBRAS' fuel road tanker loading terminals*, published in the OIML Bulletin Volume LVI Number 2 (April 2015), the Authors would like to make the following statement:

> The term "verification" was not used according to the definition either of the International Vocabulary of Terms in Legal Metrology (VIML), published by the OIML, or according to the definition of the International Vocabulary of Metrology – Basic and General Concepts and Associated Terms (VIM), published by the BIPM.
>
> The term "verification" was used in the sense of "volume meter calibration check", within the maintenance program of fuel-loading terminals, and not in the sense of OIML R 117-1:2007, which is the responsibility of the national authority of metrology. ■

INSTRUMENT CATEGORY
CATÉGORIE D'INSTRUMENT

Automatic instruments for weighing road vehicles in motion and measuring axle loads
Instruments à fonctionnement automatique pour le pesage des véhicules routiers en mouvement et le mesurage des charges à l'essieu

R 134 (2006)

Issuing Authority / *Autorité de délivrance*

Dansk Elektronik, Lys & Akustik (DELTA), Denmark

R134/2006-DK3-2015.01
Automatic instrument for weighing road vehicles in motion - Type: AR-WIM
VaaaN Infra Pvt. Ltd., Villa-8, Block-II, Eros Garden, Charmwood Village, Surajkund Road, Delhi NCR - 121 009 Faridabad, India

OIML

The OIML is pleased to welcome the following new

CIML Members

Bulgaria:
Mr. Ilchev Paun

Russian Federation:
Dr. Sergey Golubev

South Africa:
Mr. Nnditsheni Thomas Madzivhe

Zambia:
Ms. Himba Cheelo

INSTRUMENT CATEGORY
CATÉGORIE D'INSTRUMENT

Gas meters
Compteurs de gaz

R 137 (2012)

Issuing Authority / *Autorité de délivrance*

Laboratoire National de Métrologie et d'Essais, Certification Instruments de Mesure, France

R137/2012-FR2-2015.01
Diaphragm gas meter ITRON – Type: Gallus/CQ3000
Itron France, 1 rue Chretien de Troyes, FR-51061 Reims, France

Issuing Authority / *Autorité de délivrance*

NMi Certin B.V., The Netherlands

R137/2012-NL1-2014.03 Rev. 1
Turbine gas meter - Type: FMT-L, FMT-S, FMT-Lx and FMT-Dc
Flow Meter Group B.V., Menistraat 5c, NL-7091 ZZ Dinxperlo, The Netherlands

R137/2012-NL1-2015.01 Rev. 1
Rotary piston gas meter - Type: FMR and FMR-Dual
Flow Meter Group B.V., Menistraat 5c, NL-7091 ZZ Dinxperlo, The Netherlands

R137/2012-NL1-2015.04
Turbine gas meter - Type: MTM
Metreg Technologies GmbH, Trankeweg 9, DE-15517 Furstenwalde, Germany

R137/2012-NL1-2015.05
Rotary displacement gas meter - Type: GFO-RM
GFO Europe B.V., Magnesiumstraat 14, NL-6031 RV, Nederweert, The Netherlands

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There are no changes since the last issue of the Bulletin.

		R 16	R 21	R 31	R 35	R 46	R 49	R 50	R 51	R 58	R 60	R 61	R 75	R 76	R 81	R 85	R 88	R 93	R 97	R 98	R 99	R 102	R 104	R 105	R 106	R 107	R 110	R 112	R 113	R 114	R 115	R 117/118	R 122	R 126	R 128	R 129	R 133	R 134	R 136	R 137
AT1	Bundesamt für Eich- und Vermessungswesen (BEV)							■	■	■		■		■		■	■		■	■		■	■		■	■	■			■	■	■								
AU1	National Measurement Institute (NMI)						■	■	■		■			■		■									■	■						■		■		■				
BE1	SPF Economie, PME, Classes Moyennes et Energie													■					■	■																				
BG1	State Agency for Metrology and Technical Surveillance (SAMTS)													■						■																				
BR1	Instituto Nacional de Metrologia, Normalização e Qualidade Industrial (INMETRO)													■																										
CH1	Institut fédéral de métrologie METAS	■		■			■	■	■		■	■		■					■	■				■	■	■						■						■		
CN1	General Administration of Quality Supervision, Inspection and Quarantine of P. R. China (AQSIQ)			■		■		■	■		■	■		■					■	■						■						■						■		
CZ1	Czech Metrology Institute (CMI)						■							■	■	■								■								■						■		
DE1	Physikalisch-Technische Bundesanstalt (PTB)			■	■		■	■	■	■	■	■		■		■	■		■	■	■	■	■	■	■	■	■			■	■	■		■	■	■	■		■	
DK1	The Danish Accreditation and Metrology Fund (DANAK)							■	■		■	■		■						■				■	■	■						■				■		■		
DK2	FORCE Certification A/S						■																																	
DK3	Dansk Elektronik, Lys & Akustik (DELTA)							■	■		■	■		■											■	■										■		■		
ES1	Centro Español de Metrología (CEM)						■		■		■	■		■					■	■														■						
FI1	Inspecta Oy							■	■		■	■		■		■									■	■						■								
FR1	Ministère de l'Economie, de l'Industrie et de l'Emploi (MEIE)	*All activities and responsibilities were transferred to FR2 in 2003*																																						
FR2	Laboratoire National de Métrologie et d'Essais (LNE)		■	■			■	■	■	■	■	■		■	■	■	■		■	■	■	■		■	■	■	■			■	■	■		■		■		■		■
GB1	NMRO Certification Services (NMRO)		■		■		■	■	■		■	■	■	■		■				■				■	■	■						■				■		■		
GB2	National Physical Laboratory (NPL)																		■																					
HU1	Hungarian Trade Licensing Office (MKEH)													■																										
IT1	Ministero dello sviluppo economico - Direzione generale mercato, concorrenza, consumatori, vigilanza e normativa tecnica						■																																	
JP1	National Metrology Institute of Japan / National Institute of Advanced Industrial Science and Technology (NMIJ / AIST)						■				■			■																	■	■								
KR1	Metrology and Measurement Division (KATS)													■																										
NL1	NMi Certin B.V.		■	■		■	■	■	■		■	■		■	■	■			■		■			■	■	■						■		■	■	■		■		■
NL2	KIWA Nederland B.V.						■																																	
NO1	Norwegian Metrology Service (Justervesenet)							■	■			■		■										■	■	■						■				■				
NZ1	Measurement and Product Safety Service (MAPSS Wellington)													■																										
PL1	Central Office of Measures (GUM)													■						■		■																		
RO1	Bureau Roumain de Métrologie Légale (B.R.M.L.)																		■	■							■			■	■									
RU1	Russian Research Institute for Metrological Service (VNIIMS)			■			■	■	■	■	■	■		■		■	■	■	■	■		■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■		■
SE1	Swedish National Testing and Research Institute AB (S.P.)							■	■		■	■		■		■				■					■	■						■								
SI1	Metrology Institute of the Republic of Slovenia (MIRS)													■																										
SK1	Slovak Legal Metrology						■							■																		■								
US1	NCWM, Inc.										■			■																										
VN1	Directorate for Standards and Quality (STAMEQ)													■																										

Peter Mason awarded the Mendeleev Grand Gold Medal of the Russian Academy of Metrology

Attending the XVII Congress of the Russian Academy of Metrology on 23 September, the President of the International Committee of Legal Metrology Mr. Peter Mason was one of four recipients of the Academy's Mendeleev Grand Gold Medal.

The President of the Academy, Prof. Dr. Vladimir Okrepilov, said that in presenting the award the Academy intended to recognize Mr. Mason's "outstanding contribution to the development of modern metrology".

Also honored in this way was Dr. Barry Inglis, President of the International Committee of Weights and Measures. Both Mr. Mason and Dr. Inglis had earlier been elected Honorary Members of the Academy, which consists of over 900 members drawn across the many different metrology institutes which operate in Russia at both the national and the local level.

Commenting on the award, Mr. Mason said that he felt extremely privileged to be honored in this way. He recognized that it was very unusual for someone whose background was as an administrator rather than as a scientist or engineer to be given such recognition. He noted, however, that the contribution of Prof. Mendeleev, already a world renowned chemist, to the world of metrology had been essentially that of a gifted and energetic administrator.

The Congress was held as part of the IV International Scientific and Practical Conference *Metrological Provision in Economies for Current Conditions*, which had been organized to coincide with the 115th Anniversary of the State Regional Center for Standardization, Metrology and Testing in Saint Petersburg "Test – St Petersburg" and the 90th anniversary of the establishment of the body which is now Rosstandart, the Federal Agency on Technical Regulation and Metrology. The Conference was addressed by both Aleksey Abramov, Head of Rosstandart, and Georgy Poltavchenko, the Governor of St Petersburg.

An article based on Mr. Mason's speech to the Conference, entitled "Valuing legal metrology", will appear in a future edition of the OIML Bulletin. ■

The President of the Academy, Prof. Dr. Vladimir Okrepilov, presents Mr. Peter Mason with the Mendeleev Grand Gold Medal

25-27 May 2016 **Amsterdam, the Netherlands**

NMi presents

MILESTONES IN METROLOGY V

FUTURE-PROOF

From 25 to 27 May 2016, the futuristic EYE building in Amsterdam forms the spectacular scenery for the Milestones in Metrology V conference.

Its fifth anniversary is not to be missed for those who are eager to learn about future developments in legal and industrial metrology. Since many years, MiM forms a high-profile knowledge sharing platform where the major worldwide stakeholders exchange ideas in an inspiring atmosphere. The conference offers extensive networking opportunities during breaks and social evening events in the heart of Amsterdam.

MiM V is set up around four markets in which measuring instruments play an important role: **Oil & Gas**, **Weighing**, **Utility** and **Mobility**. In addition to plenary speeches and panel discussions with overlapping topics, attendees will break out to their own business fields.

"The concept of future-proofing is the process of anticipating the future and developing methods of minimizing the effects of shocks and stresses of future events."

Technology behind measuring instruments has grown up. In the 21st century world, constant and rapid progress of design and applications is the new normal. Legal requirements and testing methods are evolving accordingly. It is therefore of invaluable importance to be prepared by evaluating the upcoming changes from different angles and points of view.

Milestones in Metrology V offers manufacturers, designers, end-users, regulators and metrologists the possibility to share their vision and to create innovative, future-proof solutions.

Don't miss it!

Sponsoring

During Milestones in Metrology V, you can raise your corporate profile and build your business relationships in various ways. Check out the MiMV website to learn more about the different packages of sponsorship that provide widespread exposure prior to and during the three days of the conference.

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www.milestonesinmetrology.nl

NMi is proud to announce that the conference will be opened by astronaut André Kuipers. Mr. Kuipers offers a unique look behind the scenes of international human spaceflight. He shares his story about his exceptional view of our planet and the importance of measurement during his space missions.

Dedicated topics per industry

UTILITY

- Future-proof smart meter roll out: lifetime reliability, power quality, privacy and security, interoperability /traceability of components
- International market access and testing possibilities
- From smart meters to smart devices
- New evolutions in metering

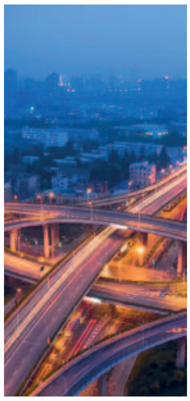
WEIGHING

- Future-proof products: software (downloads) & security, modular approach
- Regulatory developments that facilitate international trade
- International market access: (OIML) Mutual Acceptance
- Arrangements, New standards and acceptance of test results

OIL & GAS

- Future-proof: diagnostics as a smart metrology tool
- Measurement in the supply chain of new fuels: LNG/CNG/H2
- Metrological asset management of brownfield installations
- International market access: (OIML) Mutual Acceptance Arrangements & acceptance of test results

MOBILITY



- Future-proof mobility: increasing road safety & road management by measuring traffic flow
- Choices in dynamic speed enforcement: various countries, different applications
- Technical challenges for product development in police measuring equipment

CONTAINER WEIGHING

A technical seminar from ICHCA International

11 September 2015, London

Ian Dunmill, BIML

1 Introduction

New regulations from the International Maritime Organisation (IMO) requiring the verification of a freight container's gross mass will become mandatory across the world from 1 July 2016. Many organisations and countries are not yet prepared for this significant change to global container operations.

This technical seminar was held just before the second meeting, in London, of the body which developed this legislation, the IMO's Carriage of Cargoes and Containers (CCC) sub-committee. It was a practical one-day seminar which brought all the interested parties together to discuss how the new IMO regulations on container weighing can be implemented with minimum disruption to the container logistics chain. It was organised by the International Cargo Handling Coordination Association (ICHCA), an independent, not-for-profit organisation dedicated to improving the safety, security, sustainability, productivity and efficiency of cargo handling and goods movement by all modes and through all phases of national and international supply chains.

How can the mass of containers be measured in order to distribute the load evenly on the ship during loading?

2 Background

Until now, the gross mass of freight containers has simply been declared by the shipper when they are loaded onto a vessel, without a requirement for this mass to be checked by weighing. These declared gross mass values are very often significantly over or under the true mass value, both being a major problem for the safe loading of ships.

Over about seven years, results of incidents, published reports and concerns expressed by carriers and others within the transport supply chain have indicated problems with the mis-declaration of the gross mass of packed freight containers. The IMO has therefore amended the Safety of Lives at Sea (SOLAS) Chapter VI Regulation 2 to address these concerns.

From 1 July 2016, all freight containers will be required to have a verified gross mass before they are loaded onto a ship. Since the supply chain is a complex and dynamic system consisting of a number of different companies that work together to produce, transport and deliver goods from the supplier to the customer, compliance with these provisions will mean that these participants need to work together to ensure that verified gross mass values are available prior to loading.

3 Guidance on the new SOLAS requirements

The IMO has issued a guidance document on the new SOLAS requirements (MSC.1/Circ.1475 *Guidelines regarding the verified gross mass of a container carrying cargo* dated 9 June 2014) which is intended to establish a common approach for implementation and enforcement of the SOLAS requirements. It asks its Member Governments to bring the Guidelines to the attention of all parties concerned.

3.1 Main principles

It is the responsibility of the shipper to obtain and document the verified gross mass of a packed container. A packed container cannot be loaded onto a ship unless the master and terminal operator have received its verified gross mass in advance of loading.

Seminar Programme

09:00 Welcome and introductions
Rachael White, CEO Secretariat, ICHCA International

09:15 SESSION 1: WHAT IS REQUIRED UNDER THE NEW LAW AND HOW WILL IT BE ENFORCED?

09:15 Moderator's opening remarks
Capt. Richard Brough OBE, Technical Advisor, ICHCA International

09:20 IMO: the legislative route and global expectations
Loukas Kontogiannis, Technical Officer, Maritime Safety Division, International Maritime Organization (IMO)

09:40 Background and new operational reality
Lars Kjaer, Senior Vice President, World Shipping Council

10:00 Enforcement in the UK and the MCA approach to Methods 1 & 2
Keith Bradley, Hazardous Cargoes Advisor, UK Maritime and Coastguard Agency

10:20 A first look at the UK's Accredited Shipper approval scheme
Chris Welsh M.B.E., Secretary General, Global Shippers' Forum & Freight Transport Association

10:40 EDI and exchange of messages: Challenges and solutions
Alan Long, Chief Executive, Maritime Cargo Processing

11:40 SESSION 2: panel DEBATE: FROM LEGISLATION TO IMPLEMENTATION: MAKING IT HAPPEN

John Foord, President Designate, FONASBA
Peregrine Storrs-Fox, Risk Management Director, TT Club
Chris Welsh M.B.E., Secretary General, Global Shippers' Forum & Freight Transport Association
Robert Windsor, Policy & Compliance Manager, CLECAT

13:30 Moderator's opening remarks
Laurence Jones, Director Global Risk, TT Club

13:40 SESSION 3: LEGAL, CONTRACTUAL AND COMMERCIAL IMPLICATIONS

Matthew Gore, Senior Associate, Holman Fenwick Willan

14:00 session 4: CONSIDERATIONS AND OPTIONS FOR WEIGHING CONTAINERS UNDER METHOD 1

14:00 Evaluating alternative weighing methods
Bill Brassington, Owner, ETS Consulting

14:20 Weighing containers in ports - people, process and technology
Beat Zwygart, Manager, LASSTEC Container Weighing Systems, Conductix-Wampfler

14:40 Container weights and loads from the perspective of the Rail Regulator
Richard Thomas, HM Inspector of Railways, Track Team, Office of Rail and Road

15:00 Calibration and certification of weighing equipment from a global perspective
Ian Dunmill, Assistant Director, BIML

15:50 SESSION 5: PANEL DEBATE: WEIGHING PRACTICALITIES AND ISSUES WITH METROLOGY

Bill Brassington, Owner, ETS Consulting
Ian Dunmill, Assistant Director, BIML
Marc Lefebvre, Cargo / Terminals / Dry Ports Director, CMA CGM
Nichola Lund, Metrology Partnership Manager, UK Trading Standards
Beat Zwygart, Manager, LASSTEC Container Weighing Systems, Conductix-Wampfler

16:45 Conclusions and next steps
Capt. Richard Brough O.B.E., Technical Advisor, ICHCA International

17:00 Closing remarks and acknowledgements
Rachael White, CEO Secretariat, ICHCA International

3.2 Methods for obtaining the verified gross mass of a packed container

The SOLAS regulations prescribe two methods by which the shipper may obtain the verified gross mass of a packed container:

Method 1

Weighing the container once it has been packed and sealed using calibrated and certified weighing equipment. This equipment needs to meet "the accuracy standards and requirements of the State in which the equipment is being used".

Method 2

Weighing all packages and cargo items, including the mass of pallets, dunnage and other securing material to be packed in the container and adding the tare mass of the container to the sum of the single masses. This method may not be suitable for all types of cargo. The procedure used for *Method 2* is subject to certification and approval in the state in which the packing and sealing was completed.

Was excess container mass a contributory factor in the breakup of this ship?

4 The seminar

Around one hundred participants attended the seminar. The programme consisted of presentations covering the main regulatory and technical aspects of the new regulations as well as panel discussions following each of the sessions. The OIML was invited to participate in the seminar as a speaker following some initial approaches to the IMO and the World Shipping Council to explore the relevance of these new regulations to legal metrology.

5 Issues

During the seminar, a number of concerns were expressed, which have not yet been resolved:

- The timescale for the implementation of these regulations is very short considering the new infrastructure which may be required.
- Ports operators are generally not equipped to weigh containers on arrival at the port, and some are unwilling to invest in this area. There is also the issue of what to do with containers which arrive at a port unweighed, or which on weighing at the port are found to be illegal for the road transport which got them there!
- Although the procedure used for Method 2 needs to be "certified and approved", the way in which this is done may vary across the world since it is left to individual countries to decide.
- Method 2 also relies on the declared tare mass of the containers, which is usually calculated from the design and construction, and is frequently highly inaccurate.
- The guidelines contain no information on the required accuracy of the "verified gross mass", nor on the kind of weighing instruments to be used, which will lead to different rules being applied in different countries.
- Although accurate gross mass is an important step in maritime freight security, the uneven loading of the cargo inside a container will still be a problem for the safe handling of containers within ports, as well as being a contributory factor to a significant number of accidents during the road transport of freight containers.
- It is up to IMO Member States to bring these new requirements to the attention of all interested parties, but most legal metrology authorities do not appear to be aware of them, probably since they are not part of the same government departments or ministries as those responsible for maritime matters. There is also the issue of whether weighing instruments used for the weighing of containers under the SOLAS regulations will fall under legal metrology control in individual countries.

These issues, and others raised during the seminar are being discussed by the various industry and regulatory groups concerned. Due to its significance in world trade and the reduction of technical barriers to trade, we hope to publish a more in-depth article on this subject in a future OIML Bulletin. ■




Call for papers

OIML Members
RLMOs
Liaison Institutions
Manufacturers' Associations
Consumers' & Users' Groups, etc.

- Technical articles on legal metrology related subjects
- Features on metrology in your country
- Accounts of Seminars, Meetings, Conferences
- Announcements of forthcoming events, etc.

The **OIML Bulletin** is a forum for the publication of technical papers and diverse articles addressing metrological advances in trade, health, the environment and safety - fields in which the credibility of measurement remains a challenging priority. The Editors of the Bulletin encourage the submission of articles covering topics such as national, regional and international activities in legal metrology and related fields, evaluation procedures, accreditation and certification, and measuring techniques and instrumentation. Authors are requested to submit:

- a titled, typed manuscript in Word or WordPerfect either on disk or (preferably) by e-mail;
- the paper originals of any relevant photos, illustrations, diagrams, etc.;
- a photograph of the author(s) suitable for publication together with full contact details: name, position, institution, address, telephone, fax and e-mail.

Note: Electronic images should be minimum 150 dpi, preferably 300 dpi.

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