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Weights and Scales

The measurement of ingredients in processing is fundamental and it is important that the accuracy of the measurement is fit for purpose, in other words, it meets the requirements of the application. However, every measurement is inexact and requires a statement of uncertainty to quantify that inexactness.

Accurate measurement enables us to:

- Maintain quality control during production processes
- Calibrate instruments and achieve traceability to a national measurement standard
- Develop, maintain and compare national and international measurement standards

Successful measurement depends on:

- Accurate instruments
- Traceability to national standards
- An understanding of uncertainty
- Application of good measurement practice

Weighing Scales are devices used to determine weight and are divided into two main categories: Spring Scales and Balance Beam Scales. Balance beam type scales are the oldest type and measure weight using a fulcrum or pivot and a lever with the unknown weight placed on one end of the lever, and a counterweight applied to the other end. When the lever is balanced, the unknown weight and the counterweight are equal. Spring scales were introduced in the 1760's as a more compact alternative to the popular steelyard balance. Spring scales work based on the principal of the spring which deforms in proportion to the weight placed on the load receiving end. Strain gauge scales became popular in the 1960's and used a special type of spring called a load cell. Strain gauge scales are the most commonly used in today's market but electronic force restoration balances are used in laboratory and high precision applications.

When discussing weights and scales, one question that often gets asked is "What's the difference between accuracy and precision?"

Accuracy is the ability of a scale to provide a result that is as close as possible to the actual value. *Example, if a known calibration standard weight of 100.000 grams was placed on the scale and the display shows 100.002 grams, we could say the accuracy of the balance is 0.002 grams or 2 milligrams.* Accuracy tells how close a balance gets to the real value. The accuracy of the scale is very sensitive to the calibration process.

Low Accuracy but High Precision

Greensboro Division / Corporate Headquarters
Phone: 336.393.0100 / 800.334.0231
Fax: 336.393.0140

Louisville Division
Phone: 502.459.7475 / 800.459.7475
Fax: 502.459.7633

Nashville Division
Phone: 615.822.3030 / 855.749.4820
Fax: 615.822.3031

www.mgnewell.com **sales@mgnewell.com** **espanol@mgnewell.com**

Precision is the extent to which a given set of measurements of the same sample agree with their mean or the amount of agreement between repeated measurements of the same quantity. This may also be referred to as **repeatability**. A scale can be extremely precise, but not necessarily be accurate.

High Accuracy but Low Precision

Accuracy is a qualitative term relating the mean of the measurements to the true value, while precision is representative of the spread of these measurements. The accuracy of a scale is dependent on the calibration process. To learn about calibration principles, review one of our earlier papers: Calibration Principles

A Calibration Certificate is a document provided and signed by a calibration technician that documents the completion of a successful calibration. The certificate will typically list the standard that was used to calibrate the device and provides traceability to the internationally defined standard. Calibration certificates for weighing devices can only be issued by testing the device at the site in which it will be used. This is due to the change of local gravitational acceleration which can vary as much as 0.5% at various locations around the world. A calibration certificate is no longer valid if the device is shipped to another location.

The different regulatory organizations/institutes such as the FDA-USP, GLP, CLEA, ASTM, NIST, SQF and BRC set strict guidelines that must be carefully followed in all **calibration and repair procedures**. Using ISO 9001:2008 and/or ISO 17025:2005 accredited suppliers will guarantee that all of your scales and balances are calibrated and repaired to the specific standards set forth by your regulatory organization/institute. If you need a recommendation for a good company, check out The Scale People.

So, how robust is your scale? Does the accuracy get thrown off when splashed with water sprays? All scales are given an IP rating or **I**ngress **P**rotection rating. The IP rating system provides a means of classifying the degrees of protection from solid objects and liquids. The system is recognized in most countries and is specified in a number of standards.

The rating system is a 2-number classification that defines protection against solid objects and liquids:

IP First number - Protection against solid objects

0	No special protection
1	Protected against solid objects over 50 mm, e.g. accidental touch by persons hands.
2	Protected against solid objects over 12 mm, e.g. persons fingers.
3	Protected against solid objects over 2.5 mm (tools and wires).
4	Protected against solid objects over 1 mm (tools, wires, and small wires).
5	Protected against dust limited ingress (no harmful deposit).

6	Totally protected against dust.

IP Second number - Protection against liquids

0	No protection.
1	Protection against vertically falling drops of water e.g. condensation.
2	Protection against direct sprays of water up to 15° from the vertical.
3	Protected against direct sprays of water up to 60° from the vertical.
4	Protection against water sprayed from all directions - limited ingress permitted.
5	Protected against low pressure jets of water from all directions - limited ingress.
6	Protected against temporary flooding of water, e.g. for use on ship decks - limited ingress permitted.
7	Protected against the effect of immersion between 15 cm and 1 m.
8	Protects against long periods of immersion under pressure.

For example, a scale with an **IP-54 Rating** is "Protected against dust and splashing water". The "5" means that protection from dust is not totally prevented, but dust does not enter in sufficient quantity to interfere with satisfactory operation of the equipment. The "4" means water splashed against the enclosure from any direction shall have no harmful effect.

The highest IP rating for a scale is an **IP-69K Rating.** This rating means that a strong water jet directed at the sensor from 4 directions must not have any harmful effects. A jet nozzle at 0°, 30°, 60° and 90° to the scale on a rotating table at 176° + 8°F, 4-6 inches away at 1250-1500psi. The test time is 2 minutes.

References

Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices, NIST Handbook 44.; National Institute of Standards and Technology: Gaithersburg, MD., 2010

"The Fundamentals of Weighing Technology: Terms, Methods of Measurement, Errors in Weighing." Sartorius AG. 1996. Web. 8 Jan. 2010