Installing a Balance

by George DeZiel

This is the second article in a multi-part series. In the first article, George DeZiel stressed the importance of operating and maintaining a balance in accordance with the manufacturer's instructions. DeZiel also listed and explained the factors that can influence balance selection for various applications. These factors are: Capability • Readability • Capacity • Accuracy vs. Readability • Repeatability and Linearity • Units of Measure • Platform Dimensions • Environmental Consideration • Communications Interface • 21 CFR Part 11 Compliance • Data Reporting • Legal-for-trade Requirements

It is important to know how to identify and minimize the factors that can influence weighing results. Most balances are considered to be "catalog," "commodity," or "out-of-the-box" items. The natural conclusion of such thinking is that the balance simply comes out of the box and works. This is true, to a minimal point, but there is much more to installation and use. A balance is a precision weighing instrument. It is designed to conduct a specific test and report unique data that only a precision weighing device can—precision weight! As with any other laboratory testing device or sensor, a complete understanding of the factors influencing proper weighing (test) results is critical. You've probably heard the adage about computers that goes "garbage in, garbage out!" With precision weighing equipment, something similar is just as true: "careless use, useless results!"

For the purpose of this article, it is presumed that certain factors contributing to uncertainty have already been minimized. These include balance indication, sensitivity of the weighing device, application of the load, and proper zero setting. It is also presumed that those elements originally under control of the device manufacturer (i.e., overall design, accuracy, readability, sensitivity, drift and off-center loading characteristics) are within the device's design specifications.

For desirable, predictable and repeatable results, limit uncertainty. Uncertainty can be defined as a statistical estimated amount or percentage by which an observed or calculated value may differ from the true value.

It's necessary to identify and determine the impact of external influences on the uncertainty of test results—a critical step that is frequently overlooked at best and considered insignificant at worst. This starts with understanding how a balance works.

A current is regulated by a servo amplifier so that the electro-magnetically generated force and the weight force applied to the platform by the object being weighed are in equilibrium (balanced) and in direct opposition to each other by 180 degrees. Maintenance of this equilibrium is controlled by a small sensor know as a position sensor. If weight is added to the weighing pan, this destabilizes the state of equilibrium and the overweight load causes the force-transmitting lever to move into the range of the position sensor. This in turn generates an input signal at the servo amplifier, causing a greater amount of current to flow through the coil and therefore increase the counter force until equilibrium is restored. The force-transmitting lever then moves back to its neutral or balanced position. The current simultaneously flows through a resistor where it causes a drop in voltage proportional to the change in weight on the platform. This voltage drop is digitized in an analog/digital converter so that the result is processed in a digital signal-processing unit (microprocessor), which can then in turn be indicated on a digital display with the appropriate mass indicator, for example "g."

With all of that going on instantaneously and simultaneously, it is easier to understand how a balance might be sensitive to external stimuli, be it active or passive. These unwanted influences could easily cause an undesirable change in test results. This error increases the uncertainty in the measurement process and makes the entire method of testing fallible.

The environment surrounding a balance will reduce uncertainty and increase the reliability and predictability of testing procedures.

These factors include: level condition, environmental and physical considerations of the laboratory layout, commodities under test, installer, user, and traceability.

Level condition. This can also be considered as controlling the direction of gravitational attraction on the sample. On virtually every precision balance there is a "bubble" or "bull's-eye" level. Along with this feature, two or more of the legs on which the balance stands are adjustable. This allows for the adjustment of the horizontal plane of the device, compensating for an uneven working surface. Using the bubble level as a visual reference, adjust the legs until the "bubble" is centered inside the level indicator. An out-of-level balance will add uncertainty to test results. If the balance is not properly leveled, the gravitational force exerted on the commodity and the compensating force exerted by the balance do not directly oppose each other. Known as eccentric loading, this condition introduces uncertainty into the testing result to the extent of the angel of inclination with reference to the gravitational forces being exerted on the commodity being examined.

In the next article, DeZiel will give a thorough examination of the laboratory layout such as: access, personnel, windows, work surface, ergonomics, air currents, vibration, magnetic influences, RFI/EMI, temperature, humidity, and static.

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