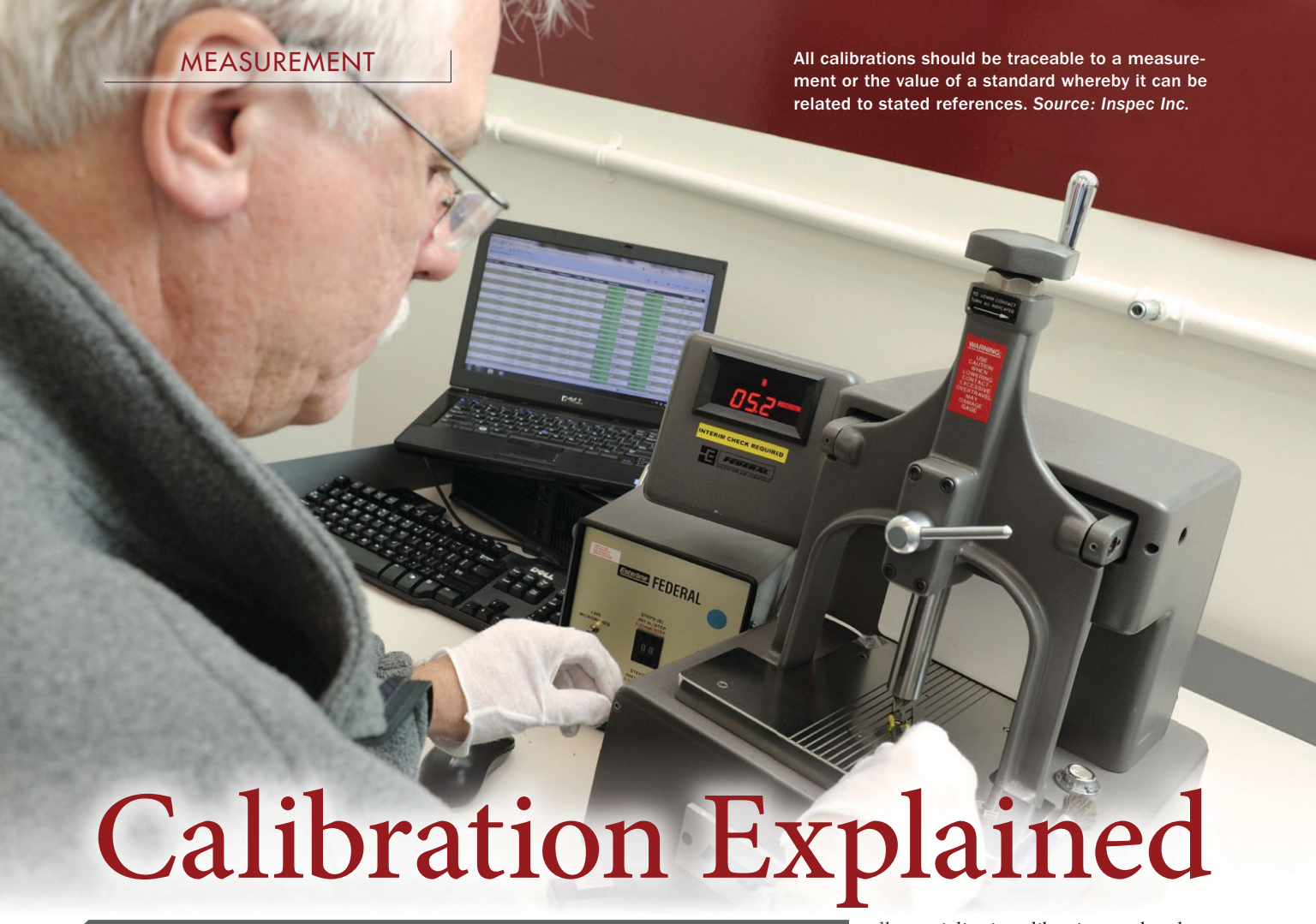

All calibrations should be traceable to a measurement or the value of a standard whereby it can be related to stated references. *Source: Inspec Inc.*

Calibration Explained

Every day there are numerous applications proving how useful calibration is. BY ED ROCHELEAU

Metrology comes from the Greek word *metro,* meaning "to measure something." Therefore metrology is the science and practice of measurement. The measurement is conducted using quantitative equipment which requires calibration on a regular basis.

Calibration is a comparison of two measurement devices or systems, one from a known uncertainty (the standard) and one of unknown uncertainties (the test equipment or instruments being used). Every day there are numerous applications proving how useful calibration is. Without calibration, or with incorrect calibration procedures, we may pay more at the gas pump or for food incorrectly weighed at the checkout counter or even encounter problems as simple as our car door not shutting properly.

All calibrations should be traceable to a measurement or the value of a standard whereby it can be related to stated references. This is usually national or international standards, through a valid chain of calibrations all having stated uncertainties. Uncertainty is an estimate of the limits, at a given confidence level, which contains true values.

Metrology laboratories are places where both metrology and calibration work are performed while calibration laboratories generally specialize in calibration work only. Calibration laboratories must demonstrate accuracy and repeatability that figures the state of closeness of a measured value to a known reference value.

Both metrology and calibration laboratories must make every attempt to isolate the work performed from influences that might affect it. These influences can include temperature, humidity, vibration, electrical power supply, radiated energy and others. Generally, it is the rate of change or instability that is more detrimental than whatever value prevails.

The sensitivity and stability of our measurement instruments must also be considered to provide us with precise measurements to achieve the utmost accurate results for our customers. All of these factors must be factored into the accuracy figures provided to your customers.

Stability is often expressed as the change in percentage in the calibrated output of an instrument over a specified period, spanning anywhere from 90 days to 12 months, under normal operating conditions. These variables

TECH TIPS

- All CMMs today are software corrected at some level, which means the wrong person could really mess up your machine.
- Recent quality standards have started requiring calibration services to be accredited in many industries.
- Accreditation is your way of knowing that the work being done on your machine has been validated by external experts.

determine when we must consider if recalibration is needed. It is very difficult to judge the stability and performance of your instrument without a set of calibration results. With standard certificates, these results should have been compared to the published specification by the calibration laboratory and will normally be categorized to show conformance to specification. ISO/IEC 17025 certificates often give the results in more detail, with an indication of any results that fall outside specification.

Calibration laboratories that are accredited to international standard ISO/IEC17025:2005 must demonstrate competence in both the technical aspects of the measurements and in the quality assurance aspects that ensure that you will get the service that you ask for, if you have specific requirements. It also ensures that you will receive a useful and valid certificate and set of results if you wish to leave the detailed requirements to the laboratory.

One example to review is the calibration of your coordinate measuring machine (CMM). We are primarily going to discuss two different performance tests: the international standard, ISO 10360, and the U.S. standard, ASMEB89.4.1.

The volumetric performance test involves measuring the length of the ball bar as the distance between its two end spheres. This measurement is repeated in many positions throughout the machine volume. Any change in the measured length reflects machine geometry errors. Though this is a good test, repeatability errors are averaged out and since the ball bar is not calibrated, this test does not provide any traceability. The ASME standard does provide tests to handle these other issues (the repeatability and linear displacement accuracy tests), but these tests must be used. In addition, any influence of probe tip calibration on size measurement must be tested for separately using the ASME bidirectional length test, as none of the other tests are sensitive to this error.

The ISO 10360 standard is really a series of standards. The most important part of the series is Part 2, which was first published in 1994. The official designation is ISO 10360-2:1994. As with all standards, the part number (2) and the date (1994) are both very important as the standard could, and will, change over time. The ISO standard is the youngest of all the CMM standards, but since it is the ISO standard, it is fast becoming the most popular, both in the U.S. and worldwide. The first is the length measuring performance, designated as "E," and the second is the probing performance, designated as "R." The E test is a complete test of the CMM to measure length, an important fundamental characteristic of a machine. The test procedure calls for a series of measurements of either calibrated gage blocks or a step gage.

So is this the best method of calibrating your CMM? In general, yes, this is the most practical industrial method for CMM calibration. This method shifts the burden of calibration completely to the manufacturer and ensures there is no difference in machine performance over the years. However, although it is relatively unimportant which standard is used, it is critical that the standard be used correctly and completely. This can be a big problem when using the ASME standard for calibration. As discussed before, the ASME standard is often misinterpreted as just being the ball bar test. The volumetric performance test is a good test, but it doesn't do enough to calibrate a CMM. At a minimum, the linear displacement accuracy test is also needed, as that is the key ASME test for the purposes of provided traceability.

Finally, be wary of anyone who is calibrating your CMM. All CMMs today are software corrected at some level, which means the wrong person could really mess up your machine. Recent quality standards have started requiring calibration services to be accredited in many industries. Accreditation is your way of knowing that the work being done on your machine has been validated by external experts. Whether you hire a third party for your CMM calibration or use the original machine manufacturer, make sure they are accredited for the calibration work they are doing. Q

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