Put real effort into finding a capable calibration laboratory, and cultivate a good relationship with the organization and its technicians

Calibrating Your Calibration Process

Note in this illustration of gage-block calibration that: waiting blocks are resting on a heat sink; the operator is wearing gloves; the operator is using the breath shield, has a cleaning brush at the ready, and is handling blocks with tongs to avoid any heat transfer from his fingers.

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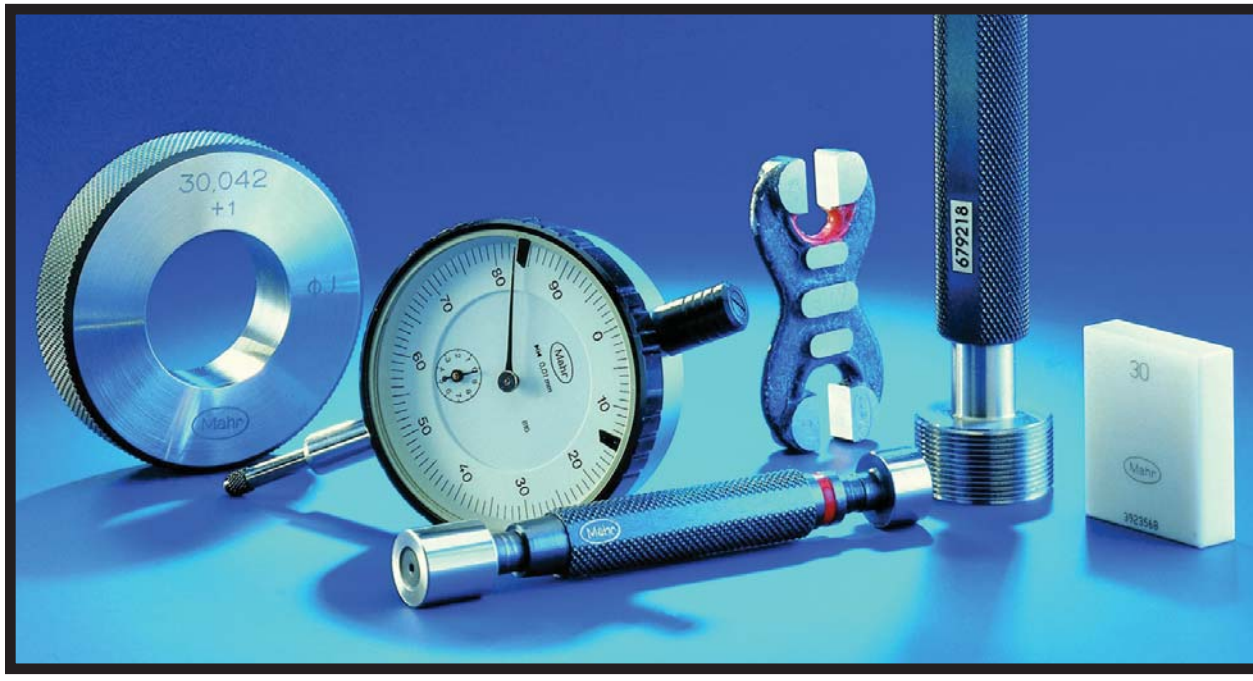
All calibration equipment should be periodically certified and documented with evidence of conformity to help ensure that parts get measured accurately. Quality-conscious manufacturers have always systematically calibrated items such as fixed standards (rings, disks, gage blocks) and calibration tools (indicator calibrators and length-measuring machines, or even hand tools) to maintain quality. But now there are additional external reasons to establish and maintain a regular program of gage calibration: customer requirements.

More and more, customers are demanding that suppliers document their quality efforts from start to finish. ISO 9001:2000 is one more manifestation of this trend, which is forcing companies to examine their calibration programs, identify areas of weakness, and improve wherever possible. Some large companies with thousands of gages and measuring tools can justify hiring or training specialists in gage calibration methods, and supplying them with the equipment and resources needed to perform these calibration duties in-house. For most manufacturers, however, the economical approach is to hire a calibration service.

ISO 9002 applies to all manufacturing operations, and requires suppliers to calibrate "all inspection, measuring and test equipment and devices that can



Quality-conscious manufacturers have always systematically calibrated items such as fixed standards and calibration tools to maintain quality. Pictured are a master ring, dial indicator, a go/no-go plug for IDs, a go/no-go gage for IDs, a thread gage, and a ceramic gage block.

affect product quality at prescribed intervals, or prior to use, against certified equipment having a known valid relationship to nationally recognized standards—where no such standard exists, the basis used for calibration shall be documented." (ISO 9002.4.10b). Let's take a closer look at some of these points:

Prescribed intervals usually translates into a minimum of once a year, but not necessarily. Where annual calibration is inadequate to ensure accuracy, a shorter interval must be established. *Certified equipment having a known valid relationship* means that the calibration house must have its own equipment certified.

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In the US, *nationally recognized standards* implies the National Institute of Standards and Testing (NIST), although other standards, such as DIN, may be used to satisfy overseas customers. "Where no such standard exists" usually refers to highly specialized industries or products where the manufacturer must develop his own standards and test methods (for example, a foam pad of known density, used to master a vanilla-pudding-consistency gage).

Calibration houses issue a certificate for every gage tested. These certificates are essential for users to document their calibration programs and to prove they conform.

If you're not a large manufacturer, you will probably have to make a decision on where to get your gages certified and obtain the proper documentation of that work. Companies that do calibration services have changed a lot in the past 10 years. Once, anyone with a piece of test equipment, an air-conditioner, and a set of gage blocks could begin providing calibration certificates. But this is no longer the case.

ISO Standard 17025 specifies the general requirements for competence of calibration and testing laboratories. This standard is meant to ensure that calibration labs are certified to a national standard. The document describes a process that calibration and testing facilities use to develop and put in place their own quality system. Because of its acceptance and international traceability, the two major accreditation bodies—NVLAP (National Voluntary Laboratory Accre-

ditation Program) and A2LA (American Association for Laboratory Accreditation)—use ISO Standard 17025 as their reference for accreditation.

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Once you decide to go outside for calibration services, the next step is to develop a list of requirements the calibration service must fulfill to meet your needs. Here are some of the things to put on that list:

At the top of the list: lab accreditation. The lab should be recognized by one of the above-mentioned accreditation services. This recognition ensures that they have:

- Gone through the process of determining what they are capable of doing;
- Documented their processes;
- Had their processes audited;
- Performed some form of competency testing; and
- Have estimated what their measurement error may be.

Once you find a lab with the right certification document bearing the appropriate accreditation logo, you need to start digging deeper to learn what—specifically—the lab is capable of doing. This information can be found in the *Statement of Scope* that accompanies the accreditation document. It defines what the lab has determined it can do. And it demonstrates that the lab is accredited as having demonstrated that it can, in fact, do it. It also means that the lab has determined a *Statement of Uncertainty.* This value means they have looked at their entire measurement process, estimated sources of error, and come up with a number that describes their confidence in the measurements they are making.

Usually, the closer in the traceability chain the lab is to NIST, the smaller this uncertainty number, but other things can also influence the number, including environmental controls, their test equipment, and the people who use the equipment. You should always ask for and review these statements before selecting a laboratory. They are the heart and soul of the calibration facility, and there is nothing wrong with asking for supporting documentation.

Take a trip to the facility. Calibration labs that have gone through the accreditation process will be proud of their facilities. Most likely they will welcome visitors and give you the grand tour. While you're there, look for cleanliness and organization. Get a sense for how busy they are, and make sure you talk to the people actually doing the work. In the metrology world, experience is priceless.

How long have the techs been in their jobs? It takes a special person to work in a calibration facility, which is a rather chilly environment. They must be motivated enough to work independently, doing measurements to sub-microns. They need to be meticulous and able to follow complex processes to a "T," and be smart enough to know when something is not quite right, and that they need to start over again. Getting to know these people is also a good idea because, sooner or later, a question will come up about some measurement or process, and you'll need to go back to them to get that question resolved.

During your site visit, check out the lab's processes, quality manual, and book of procedures. This set of factors is the backbone of the lab. These documents need to be readily available, easy to use, and up to date. Check to be sure that the items under test are really being measured on the equipment specified in the procedure. Do you feel comfortable with the equipment? Is it new and well cared for? Does it appear capable of making the measurement? Finally, check out the lab's reference masters, and ask to see their certifications. Are they certified by NIST or a lab certified to ISO Standard 17025? If you don't feel comfortable, maybe the place is not for you.

Check the actual facility or lab where the calibrations are going to be made. Environment is the largest contributor to measurement uncertainty, and assessing the investment your soon-to-be partner has made in controlling the facility's environment must at the top of the list. Is it designed from the ground up to be a measurement center, or is it tucked in some corner in a controlled room, but part of other activities?

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Controlling the environment means more than just the temperature. It also requires controlling humidity and both internal and external vibrations. To achieve measurements at the millionth level, a room air conditioner and shock foam under the gages cannot compete with a built-from-the-ground-up measurement center. Elaborate schemes are often employed to eliminate these sources of errors, including very expensive HVAC units to control temperature and humidity and room-isolation designs to eliminate external vibration. The investment made by the calibration facility is an indication of their commitment to the level of performance they can supply. Ask for a tour and an explanation of the environmental controls used to maintain the calibration lab.

At the other end of the spectrum, another issue often experienced but rarely discussed is precisely *where measurements are made* on masters such as rings and disks. Measurement Standards will recommend certain gaging locations, but the operative word here is "recommend." Some labs may interpret these recommendations a little more liberally, and you need to make sure that the artifact you are purchasing is certified in the areas that you need.

Test out the likely candidates *among the labs with some work.*

Take, for example, a master ring used on an air gage. Say the air ring was designed with a stop collar so the actual measurement is made 0.100" (2.5 mm) in from the face of the part. The master needs to simulate this condition. If the master ring was certified only at its center, then this certification leaves some question as to what may be happening out at the ends. Check that the measurement processes at the lab meet all of your gaging requirements.

Does the lab meet your performance requirements? As mentioned above, as part of its accreditation process, the lab has to estimate its uncertainty budget. Does this budget fall within your requirements? Does the uncertainty of the lab's measurement become so large that it eats up most of the master's tolerance for size? And if so, what effect will this have on your measurement process? Does it make your measurements questionable because of the potential error in the master? On the other hand, does the uncertainty budget being presented seem unreasonably good? Is the lab quoting numbers to the level of NIST when they are two or three levels removed from NIST? You must have confidence in your calibration source.

This aspect of lab qualification is probably most important for manufacturers involved in aerospace and medical industries. Here, tolerances can be extremely tight and documentation is a critical part of the manufacturing process. If a part has a diameter specified to measure to 0.0005" (0.013 mm), the rule of thumb is to have masters certified to 50 µin. (0.0013 mm) or better. If the lab's uncertainties are 25 µin. (0.0006 mm), then the actual size of the master could be using up more then 10% of the part tolerance.

Is the lab a member of various associations related to the metrology industry? Associations bring a wealth of knowledge to calibration service providers by sharing techniques, news and standards updates. Look for membership plaques from organizations such as NCSL, AMTMA and others that evidence lab participation and activity in metrology. Check out the lab's long-term data-storage capabilities. Will they be able to retrieve copies of your certificates if you misplace them or are called on by your auditors to produce more copies? You can never have enough copies of these certificates, and accidents happen.

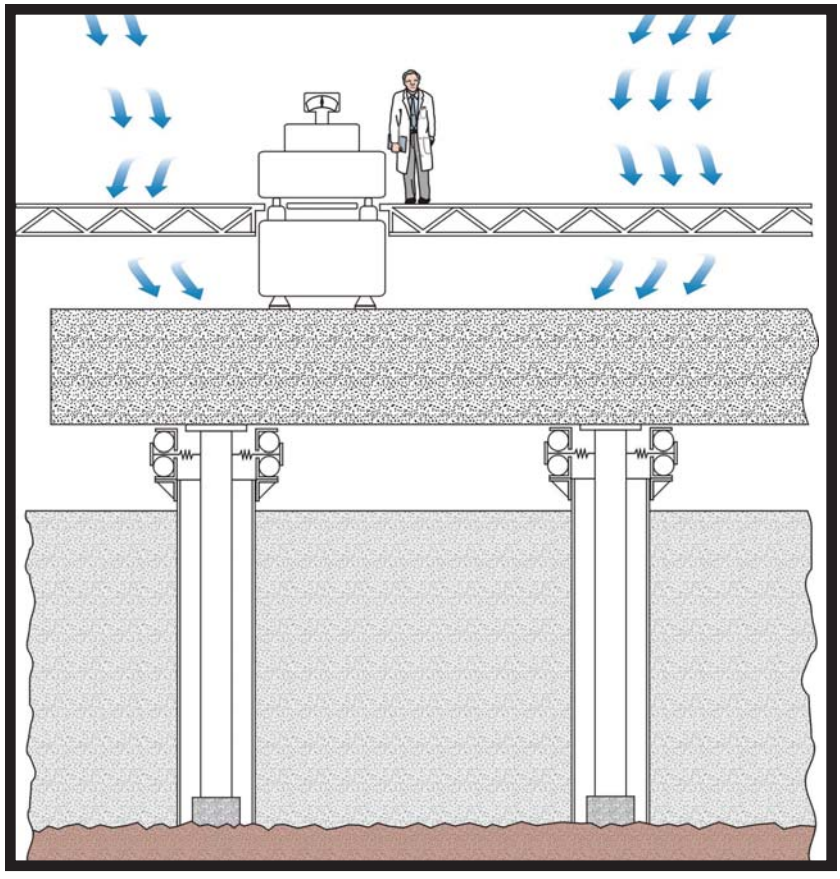
Ask if the lab participates in "Round Robins"—tests where they send out samples to other labs to compare their measurement results. They should be comfortable showing these records to you to demonstrate they are in the mix with their competitors. Identical readings are never going to be seen, but results should fall within a sta-

Look for This Information

At minimum, a report—your calibration certificate—should contain the following:

- The serial number and description of the gage tested.
- The serial number of the gage(s) used to perform the testing, its last calibration date and next due date.
- Which certifying agency has accredited the lab and their lab code.
- The level of uncertainty of the calibration: in other words, the tolerances of the data.
- The National/International Standard against which the test sample was measured.
- The lab's internal procedure against which the test sample was processed.
- A statement of traceability to NIST (or other standard).
- A serial number identifying the NIST test upon which the calibration house's own standard is based, the date of calibration and calibration due date.
- Reference temperature and humidity under which the calibration was performed.
- Name of the customer; name and address of calibration service. Date of calibration and signature of the technician.
- Test results: i.e., error in the gage, measured at appropriate intervals across its entire range.

If the gage is adjusted subsequent to testing, it must be recalibrated, with results indicated as above. Finally, the report should indicate acceptance or nonacceptance of the test sample as compared to the measuring process and standard.



Elaborate schemes are often employed to eliminate sources of environmental error, including very expensive HVAC units to control temperature and humidity and room-isolation designs to eliminate external vibrations.

tistical norm. If they don't want to show you their results, or if what you see shows them outside the norm, you may want to rethink the lab's viability.

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Another key point is the financial condition of the lab. Have they been around a long time, and are things well kept up? Does it look like they are making money and will be around to support you in the future? You wouldn't want your master ring held up in bankruptcy litigation if the lab went under while they were supposed to be certifying it for you. You may never see your master again, or the documents from previous calibrations. You want a proven supplier with whom you can form a long-term relationship.

Also, do they offer an automatic recall system for your artifacts? Many labs will remind you when your gage-block set is up for calibration. This can take some responsibility off you. In fact, some labs have systems that can be set up to take over your whole calibration process. They can keep all the records on your tools, including when they were calibrated and when they are due again. This capability could become a valuable time-saver for some companies.

Test out the likely candidates among the labs with some work. Do they handle your phone calls in a professional manner? Send them some unannounced work and monitor their turnaround. Is it timely, and do your gages come back well-packed and protected like the standards they are? Customer service is a very important part of the calibration process. Too short a turnaround may signify fast, careless measurements. Too long a time may mean they are overwhelmed or unorganized. It takes time to do a proper calibration, but the time required should be reasonable.

Once you've gotten to the point of selecting the calibration lab that best meets your needs, the last thing to check out is the piece of paper you will receive, the actual calibration certificate. This is the document you will keep on file to demonstrate you're living up to your ISO requirements. You must be comfortable with it, and you should take the time to read and understand the certificate to make sure it meets your needs. There are different levels of certification provided, typically called *Short* or *Long*- form certification. Long-form certifications provide the most comprehensive report.

Once you've found a calibration organization you can live with, you need to nurture that relationship. By keeping communication lines open, you can quickly resolve issues, learn things about your tools that will help you get the most out of them, improve your overall level of measurement control and, ultimately, provide the quality documentation you need on your own parts.■