INVOLUTE ARTIFACT CALIBRATION BEGINS AT Y-12

Rebuilding a Metrology Infrastructure

The American Society of Mechanical Engineers (ASME) announced at Gear Expo '95 that a national service for the calibration of involute artifacts is now available at the Department of Energy's Y-12 Plant in Oak Ridge, TN.

The service is part of a national program for gear metrology that is backed by a $3 million grant from the Department of Defense's Technology Reinvestment Program (TRP) and $4.8 million in matching funds, mostly from the Department of Energy and the Department of Commerce. The program is a result of a collaboration among ASME, Y-12, the National Institute of Standards and Technology (NIST), AGMA and Penn State University.

The service is the program's first step in reestablishing a national infrastructure for gear metrology that has been sorely missed by many in the industry. In 1986, the National Bureau of Standards (NIST's predecessor) stopped calibrating gear artifacts because the agency's equipment was becoming outdated and unreliable.

With no official calibration service for almost a decade, U.S. gear manufacturers have had no affordable, reliable way to prove that their measurements were accurate. One time-consuming and expensive option has been to send artifacts overseas to the German or British national laboratories for calibration. The other option has been to have artifacts calibrated by a private service in the United States whose measurements are traceable either to one of the overseas laboratories or to the 1986 or earlier measurements performed at the National Bureau of Standards.

Who needs Artifacts?

Artifacts are used by gear manufacturers to calibrate their gear measuring equipment. Often, a statement of the level of uncertainty in those measurements must accompany orders, especially when the customer is a government agency or has ISO 9000 or other strict quality documentation requirements. In addition, the measurements must be traceable to a nationally or internationally recognized standard.

Traceability means that an artifact or end product has been compared, either directly or indirectly, with an artifact whose measurement uncertainty is known. When an involute artifact is calibrated by NIST or Y-12, the owner is provided a chart showing how the artifact differs from a theoretically perfect involute, along with a level of uncertainty for those measurements. If that artifact is then used as a master to create additional artifacts, the manufacturer will have to add the uncertainty of his own equipment and methods to that of the original artifact.

Fellows Corporation, Springfield, VT, is generally recognized as the premier U.S. manufacturer of gear artifacts. In addition, Fellows offers an artifact calibration service. However, all of the artifacts the company has manufactured since 1986 and all of those it has calibrated since 1986 are traceable to the measurements made at the national laboratory almost 10 years ago.

"Our most important need was to have one source nationally that everyone is traceable to. Everybody is asking us to be traceable to NIST, but all we can do is be traceable to our last check at NBS," says Gerry Gagnier, quality control manager for Fellows.

According to Gagnier, gear artifacts should be recalibrated at least every 5 years, under the best of conditions. When calibration service companies have to rely on old measurements of their master artifacts, questions are raised in the minds of their customers. What if the master artifact has been dropped? What if it got scratched or dented? A lot can happen in 10 years.

These concerns are important to companies like M & M Precision Systems, manufacturers of dedicated gear measuring equipment. M & M buys gear artifacts to ship with its machines so that the end user can calibrate the machines. According to Mark Cowan, quality control manager for M & M, master artifacts should be recalibrated on a yearly basis. But with no national laboratory capable of performing these calibrations, this was practically impossible.

Building a Team

The lack of a national calibration service left a lot of people feeling—well, uncertain—about the measurement uncertainty levels being attributed to gears made in the United States. "If you can't measure it, you don't know if you've made it," says Bill Rasnick, development engineer at Y-12.

Gear industry concerns about the lack of a calibration service were first voiced to NIST at a 1992 workshop on precision tolerance manufacturing. This concern led NIST to invite gear industry participants to a workshop focusing on

gear metrology in 1993. Here, the initial plans for the national gear metrology program were born. The partnership between NIST, Y-12, ASME, AGMA and Penn State University was formed. In September 1994, funding from the $3 million TRP grant began.

The steering force behind the project is ASME. The project is headed by Howard Clark, director of research for ASME's Center for Research and Technology. In addition, ASME's Committee on Gear Metrology, which is headed by AGMA's Bill Bradley, acts as an advisory body for the program.

The first priority of the gear metrology program was to reestablish a calibration service for gear artifacts. Because the national laboratory at NIST did not have the facilities for an ongoing gear calibration service, the Y-12 plant was selected as the best location for the Center for Gear Metrology. Y-12, which began as a nuclear weapons manufacturing plant, has one of the best environmentally controlled laboratories in the world, along with the right equipment to perform measurements on complex forms.

"Because of Y-12's experience and expertise in metrology, they are going to be the point of delivery for the gear artifact calibration service," says Howard Harary, a NIST physicist who manages NIST activities in the program.

Although Y-12 would normally be considered one step removed from NIST in the traceability chain, the uncertainty statement that accompanies calibrations done at Y-12 was prepared jointly by NIST and the staff at Y-12. Therefore, the actual level of uncertainty for these calibrations is not necessarily higher at Y-12 than it would be at NIST.

With the involute calibration service under way, the next step will be lead and index calibration services, which should be available in 1996 or 1997, Harary says. Eventually, the lab at Y-12 will perform other types of gear measurement as well, including bevel and spiral bevel gears.

Another objective of the national gear metrology program is to develop and implement gear metrology training and education programs. The TRP partners plan to have training programs in place at the gear metrology center in Oak Ridge by April 1997. Penn State will have university courses in gear metrology by October 1997.

The program partners also are working to establish new and improved gear metrology standards. AGMA's Calibration, Handbook, Inspection and Wormgearing committees are actively working on metrology standards, according to the July/August AGMA *News Digest*.

The Involute Calibration Service

The Y-12 Plant began performing involute calibrations of Fellows 4.5" base circle involute masters in October 1995. The statement of uncertainty says, in effect, that the measurements will be within .9 microns, or about 36 millionths of an inch, 95% of the time, says Bill Rasnick of Y-12. The service for a "standard" calibration costs around $2600 and takes about six weeks.

The National Metrology Center at Y-12 is capable of performing calibrations for involute masters other than the Fellows 4.5", but prices and lead times will vary.

The level of uncertainty for calibrations performed at Y-12 is "essentially equivalent" to calibrations performed by overseas laboratories, Rasnick says.

Because of government regulations, the calibration service is not allowed to compete with U.S. private industry. Therefore, when an artifact comes in for calibration, the owner has to sign a document stating that the services are unavailable elsewhere. Because of this, many will have to rely on calibration through private companies, unless they require a level of precision that only the lab at Y-12 can provide.

"We're hoping that the net effect of the calibration service will be an increase in our business," says Gerry Gagnier of Fellows. "We are now going to have a more up-to-date calibration that our customers can rely on." In addition, Fellows offers calibration of the same artifact for about $600, with a higher level of uncertainty, Gagnier says.

M & M Precision Systems also sees the calibration service as a potential boon to business. "It will allow us to ultimately obtain lower measurement uncertainty for our machines," says Mark Cowan.

The organizers of the national gear metrology program hope that enough interest is generated in the industry for the program to continue after the TRP grant runs out in 1997. "We are trying to set up a service that will be self-supporting," says ASME's Howard Clark. ✪

Anyone interested in sending an involute artifact to Y-12 for calibration can call the Department of Energy's Technology Transfer hotline at 1-800-356-4USA.

"BECAUSE OF Y-12'S EXPERIENCE AND EXPERTISE IN METROLOGY, THEY ARE GOING TO BE THE POINT OF DELIVERY FOR THE GEAR ARTIFACT CALIBRATION SERVICE," SAYS HOWARD HARARY, NIST PHYSICIST.

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