

A NEW STANDARD IN GEAR INSPECTION



AGMA'S NEW 2015 GEAR INSPECTION STANDARD IS QUITE DIFFERENT FROM ITS PREDECESSOR. READ ON TO LEARN ABOUT THE CHANGES, INCLUDING TIPS ON THEIR EASY IMPLEMENTATION.

By Dennis Gimpert

In the June 2005 issue of *Gear Solutions* magazine we presented an article entitled "An Elementary Guide to Gear Inspection." This article will introduce the new AGMA Gear Inspection Standard that will be the base to expand upon the topic of gear inspection.

Some material contained in this paper is extracted from AGMA ISO 10064-2 "Cylindrical Gears—Code of Inspection Related to Radial Composite Deviations, Runout, Tooth Thickness, and Backlash" and ANSI/AGMA Standards 2015-1-A01 "Accuracy Classification System—Tangential Measurements for Cylindrical Gears," with the permission of the publisher, the American Gear Manufacturers Association.

The New AGMA 2015 Gear Inspection Standard

The new AGMA 2015 standard is substantially different from the previous AGMA 2000-A88 standard.

AGMA states that "the user of ANSA/AGMA 2015-1-A01 must be very careful when comparing tolerance values formerly specified using ANSI/AGMA 2000-A88." Several critical areas to be aware of are as follows:

Accuracy grade numbers are reversed—A smaller grade number represents a smaller tolerance value and, as such, a higher quality gear. This is directly opposite of the previous AGMA standard, ANSI/AGMA 2000-A88, but does align with the procedures used by all other world gear standards. The tolerance grades for the new standard are designated A2-A11. Also note that the letter "A" is used to designate the new AGMA standard versus "Q" for the old 2000-A88 standard.

The "K" chart is no longer inferred for profile and lead evaluation—Using the old AGMA gear inspection standard, a "K" chart was established by constructing two lines diagonally across the tolerance band as shown in Figures 1 and 2.

FIGURE 1: "Old" AGMA profile "K" chart

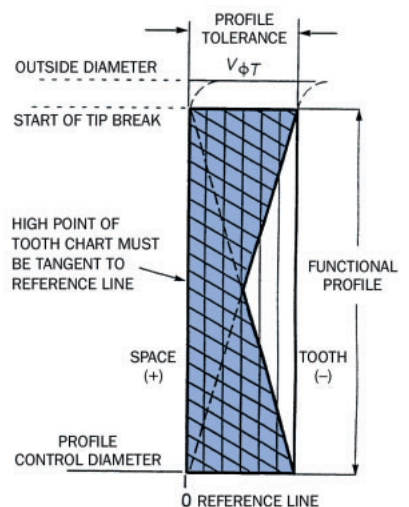


FIGURE 2: "Old" AGMA profile "K" chart

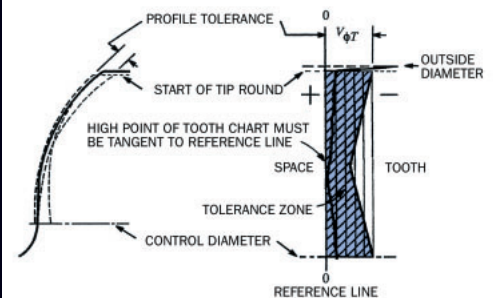
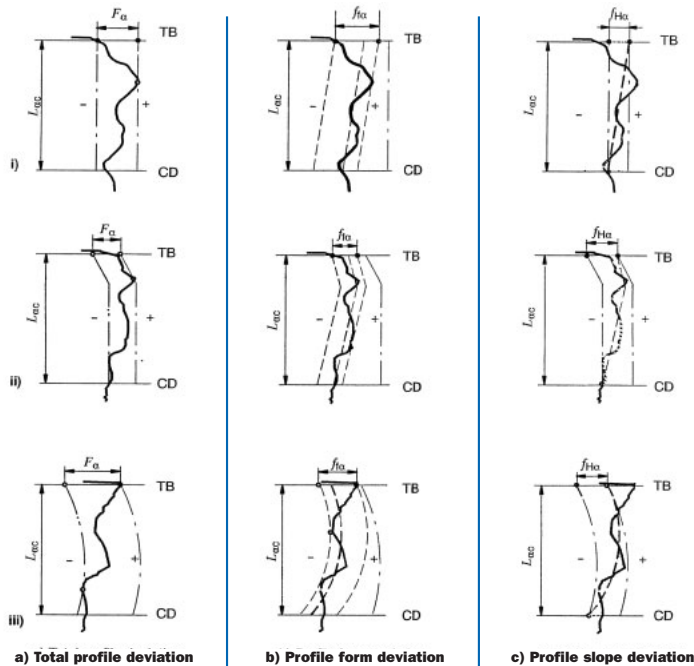


FIGURE 3: New profile and helix deviation includes total, form, and slope errors.



A key problem with the “K” chart is that any profile or lead trace within the defined “K” area would be an acceptable gear. In reality this gear may or may not be a “good” gear. A second problem with the use of a “K” chart is that a nominal value is inferred such that the ideal profile or lead trace is inferred to be in the mean of the “K” area at all points.

Slope and form errors are now included—In addition to total helix and profile errors, slope and form error are included for both profile and helix inspection.

Profile inspection includes total deviation, F_{α} , form deviation, f_{α} , and slope deviation, $f_{H\alpha}$. Helix inspection includes total deviation, F_{β} , form deviation, f_{β} , and slope deviation, $f_{H\beta}$.

On a modern CNC gear inspection machine it is possible to program the desired profile and lead forms. This could include the old “K” chart, cylindrical crowns, or other desired modified profile or helix shapes. An example of free input of helix shape on the Wenzel GearTec inspection machine is shown in Figures 4 and 5.



FIGURE 4: Modern CNC gear inspection machine by Wenzel GearTec

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The new AGMA 2015 gear inspection is a pure metric standard—Only a few notes are included regarding the inch system.

The new AGMA standard is formula based—The AGMA tolerances for the various accuracy groups are calculated from formulas. This has been done for two reasons. First, the formulas can be computer based to provide easy and accurate calculations of the gear tolerances. Second, the

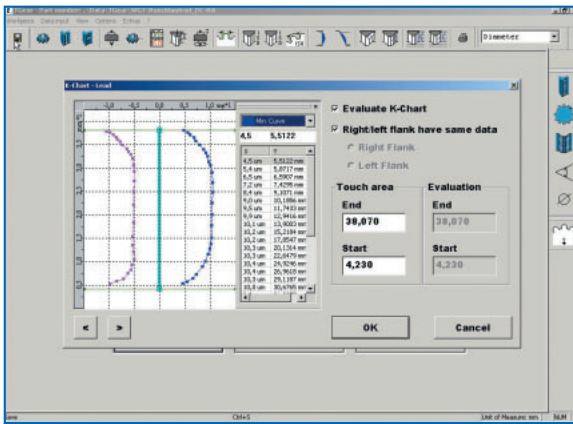


FIGURE 5: Free input of helix inspection shape

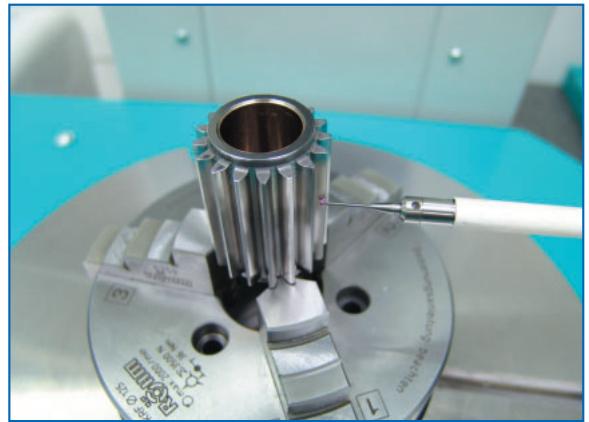


FIGURE 7: Analytical inspection of fine pitch gear, i.e. 0.5 (50.8 DP)

tolerance calculated will reflect the actual gear parameters. Other gear inspection standards use groupings of tolerances that could allow “fudging” of the gear design to place it within a favorable position of the range.

$$F_{\alpha T} = (3.2\sqrt{m_n} + 0.22\sqrt{d_T} + 0.7) \times (\sqrt{2})^{(A-5)}$$

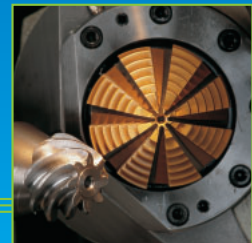
FIGURE 6: Formula to calculate total profile tolerance

An example of the formula to calculate total profile tolerance is shown at left. The variables include module, mn, tolerance diameter, dt, and quality, A.

The new AGMA standard has an extended range—Modules (mn) from 0.5 to 50.0 mn (diametric pitch 50.8 to 0.5 DP) are now included. The new standard includes ranges of diameter (D) of 5 to 10,000mm, teeth (z) of 5 to 1000 (or 10,000/mn, whichever is less), face width (b) of 0.5 to 1000mm, and helix (β) up to 45 degrees.

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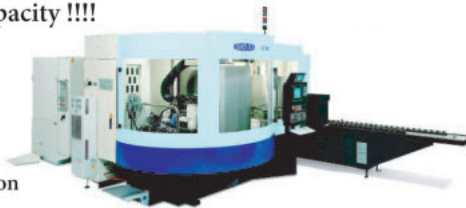
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An important note is that, in the past, gears finer than 20DP were classified and inspected by AGMA for composite testing only and did not require analytical inspection of lead, profile, and spacing. The primary reason for this limitation was the inability of inspection machines to measure gears finer than 20DP. Today, with modern gear inspection machines, it is possible to measure gear teeth finer than 0.5 mn, 50DP. See Figure 7 for an example of fine pitch gear inspection.

Accuracy Grade Groupings

The new AGMA 2015 standard places gears into three accuracy groups. The highest quality gears are placed in the “high accuracy” group and have designations of A2-A5. “Medium accuracy” are designated A6-A9, and “low accuracy” are A10-A11. Again, notice that the quality grade in the new AGMA standard is preceded by the letter “A” to distinguish it from the previous standard.

For the low accuracy gear grouping only “cumulative pitch” and “single pitch” are required. For the medium accuracy gear grouping, cumulative pitch and single pitch, as well as “total profile and lead” are required. For the high accuracy gear grouping, cumulative pitch, single pitch, lead and profile total, slope, and form are required.

In future articles on gear inspection we will continue to explore the new AGMA Gear Inspection Standard. Areas that will be discussed include cumulative pitch, single flank, and composite testing. We will also report on current trends in gear inspection machine development and the increased capabilities that are offered.

ABOUT THE AUTHOR:

Dennis Gimpert is president of North American operations for Jos. Koeper & Sohne GmbH of Furtwangen, Germany. He holds a bachelor's degree from Michigan Technological University and has worked as an application engineer for the machine tool division of Barber Colman and as vice president of marketing for American Pfauter. Gimpert is active with the American Gear Manufacturers Association, a member of the AGMA Board of Directors, and chairman of the Business Management Executive Committee.