AGMA Responds to Gear Standards Article

The authors of last issue's article comparing AGMA, ISO, and BS methods for Pitting Resistance Ratings are commended. Trying to compare various methods of rating gears is like hitting a moving target in a thick forest. The use of different symbols, presentations, terminology, and definitions in these standards makes it very difficult. But the greatest problem lies with the authors' use of older versions of these documents. ISO drafts and AGMA standards have evolved at the same time their work was accomplished and edited.

This overview is written to convey the current status of these standards. I will clarify where AGMA standards and *ISO drafts differ from what was* presented in the article by Dr. Walton and his colleagues.

In November, 1988, *Gear Technology* allowed AGMA to review the authors' draft of this article. I thank the publishers for that opportunity and the authors for incorporating a few of my suggestions. However, ensuing events have changed the complexion of ISO drafts.

Two parts of the ISO draft for spur and helical rating (ISO/DIS 6336, developed in the 1970s) were balloted in the early 1980s and *disapproved* – not "approved" as stated. Before 1985 the drafts were reworked into five parts for re-balloting. These drafts were apparently used by the authors. To resolve conflicts, the ISO working group responsible for the standards development made a number of changes to ISO/DIS 6336, most significantly in September, 1989, when:

- The application of the standard was limited in helix angle, pressure angle, and addendum modification (a/k/a profile shift or rack shift) range. This was because calculated ratings were inconsistent with experience at some values.
- The life factor curves were modified because some materials do not have known endurance limits.

Due to lack of consensus, the scuffing proposal (ISO/DIS 6336-4) was changed from a standard in October, 1990, to be rewritten as a Draft Technical Report (DTR). The current status of each of the parts of ISO/DIS 6336 is:

Part 1 (common factors, load distribution, dynamic load, etc.) will be balloted this spring (1991).

Part 2 (pitting) was balloted at the end of 1989.

Part 3 (bending) is being balloted as of this writing, Nov. 1990.

Part 4 (scuffing) has been made a DTR.

Part 5 (allowable material stresses) was balloted in the summer of 1990.

The four sets of ballot comments will be formally resolved by ISO's consensus process in June or September of 1991. After ballot resolution, the DIS could become an international standard in 1992 if there are no appeals.

In the meantime, ANSI/AGMA 2001-B88 (1988) was approved to replace AGMA 218.01 (1982). ANSI (American National Standards Institute) and AGMA documents must be revised or reaffirmed every five years. New versions of ANSI/AGMA standards tend to be implemented fairly rapidly in the USA, primarily because they are widely circulated during the consensus approval process. ANSI/AGMA 2001-B88 is significantly different in the application of measurable material quality to allowable stress levels; the introduction of a rim thickness factor; and a clear difference between "application factor" and the old "service factor." The next revision, AGMA 2001-CXX, is being reworked in committee to incorporate the

VIEWPOINT

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latest thinking and experience.

In addition to the differences mentioned above, there are some specific items in the Walton article which should be mentioned:

- The various ISO methods for determining "influence factors" are not "depending on the application and accuracy required." Very little guidance on which method to apply is given. It's simply left to choice. Uninformed users are not made aware of how much accuracy is required. There is little correlation between the complexity of each calculation method and accuracy produced. Experience is lacking to be sure the more complex mathematical methods are capable of predicting gear failures more consistently than the older, more empirical, methods.
- The word "similar" implies similar calculation results between BS 436 and ISO/DIS 6336. But in some cases only the presentation of symbols is "similar," while calculated results can be quite different. The values for Z_N are a good example.
- The authors' statement that "Like the other standards, the new British standard uses modified Lewis and Hertz equations..." glosses over significant differences. Both the ISO Draft International Standard (DIS) and BS 436 (1986) use a 30° inscribed triangle and tooth tip loading to determine the applied point and maximum amount of bending stress. This approach is very different from Lewis' inscribed parabola, particularly for gears with large addendum modification. In the Hertz equations, the methods for spur gears are identical, except for the inclusion of an extraneous factor in the ISO, DIS, and BS 436. This factor increases the calculated capacity of spur gears by Z_{ε}^{2}, or about 25%, compared to ANSI/AGMA ratings.
- To calcuate the ANSI/AGMA geometry factors, one must know the

generating tool configuration. The authors do not express this.

- The statement "...although AGMA and ISO both introduce a service factor..." is incorrect. AGMA 218 and ISO have both introduced an "application factor," which is different in concept from the old AGMA "service factor." The service factor included service life requirements, which the application factor excludes.
- AGMA does not have "...the definition of endurance limits." That concept, as implied by ISO, was deleted with the introduction of the life factor curves in AGMA 218. AGMA standards do not recognize an endurance limit for gears.
- Not only BS, *but also* ANSI/ AGMA standards "allow(s) for the higher permissable stresses to be obtained from using higher quality materials." This was expressed in Sec. 2.5.3 of AGMA 218, and ANSI/ AGMA 2001-B88 gives specific quality requirements for each allowable material stress.
- Standards developers should know the distribution of test or experience points used to develop life factor curves. This distribution, statistically analyzed, is used to determine the life curve and reliability (chance of failure) of a given design. This is a concept which neither BS nor ISO seem to express. ANSI/AGMA life factors are based on a 99% rate of reliability.

The authors have made a significant contribution to the general understanding of different gear rating practices, which are constantly being updated with new developments and experience.

If one wishes to stay up-to-date, involvement in national standard committees is necessary. Participation as a member of a national technical advisory group for ISO is the way to keep up with international standards. If you wish to participate in any way, please contact me at AGMA headquarters.

William A. Bradley,
Manager, Technical Division
AGMA