Writing the Standards

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The AGMA committee experience is second to none in developing technical awareness among its members and technical influence among the standards user community. Having personally worked through the local chair positions of a national manufacturing engineering organization, and having belonged briefly to a national engineering organization serving the steel industry, I can say without hesitation that my years on the AGMA Mill Gearing Committee have been without equal in terms of my learning experience.

When the Mill Gearing Committee convened about eleven years ago under the leadership of Craig Danecki, it was blessed with gear engineers representing original equipment manufacturers in the grinding mill industry, as well as representatives of gear manufacturing companies for both grinding mill and rolling mill products, and consulting engineers for both sets of products; and the membership represented three countries on two continents. The group attempted for the first few meetings to divide time between grinding mill and rolling mill applications. It became evident early on, however, that the majority of the membership was involved solely in the grinding mill and related product application. The committee elected to address the development of that standard first. After withdrawing 6004-F88, the work began in great earnest on creating what would become 6014-A06.

The standard 6014-A06 is now being reconsidered for revision or reaffirmation, which will be required in 2011. I have seen a considerable number of mill builders already calling for gearing to be rated to this standard. That is actually an accomplishment, as engineering companies are traditionally slow to change the standards by which they qualify and quantify the capacities and design life of their products. The ring gear manufacturers still see more gear inquiries which refer to AGMA 321, (replaced by 6004-F88 22 years ago), than any other standard. By all accounts 6004-F88 was a failure, as most of those directly involved with the ball mill gearing industry couldn't accept the more liberal ratings and range of solutions it provided versus 321. In fact, a real surprise to me was the "goal" expressed at the onset of the committee work for the 6014 standard, which was to develop a standard that produced ratings more in line with those of 321.

This, of course, was no easy task, as this standard would have 2001 as the parent standard, which includes a different geometry factor standard than 321, as well having all the complexities of multiple material "grades" and the related metallurgical factors which dictate the choice of allowable design stress numbers. Also, time marches on. Since 321 had been replaced, materials like ductile iron, or sheroidal graphitic iron (SGI) and austempered ductile iron (ADI) had made significant inroads to this application. The committee would need to deal technically with these and other issues for the 21st century.

The committee developed its own specific approach to the dynamic factor for the grinding mill application, because the large diameter, flange mounted and spring mounted, split gear blanks experience considerably different transmission accuracy levels than do smaller shaft mounted non-split gears. Member companies shared with the committee results of their research on how pitch varies as the gear split rolls past the pinion, as well as differences in gear deflections between "T"-style and "Y"-style blanks, and mesh stiffness changes with mesh point varying relative to the position of cross stiffeners (ribs) on the gear blank. A standard of this magnitude takes a long time to digest and produce.

AGMA has always carefully kept commercial influence out of committee produced product, which is not easy to do when committee members are convinced that there ought to be factors that acknowledge what they believe is overwhelming technical evidence to support their product design culture. The perfect example is what went on for years in this committee between parties that believed cast steel structure was superior to forged, as in rolled rings or rectangular forgings, and vice-versa. At the end of the day, untold hours of technical research done by companies in the United States, Canada and France were presented, argued and massaged to yield allowable stress numbers for all three materials involved, and a series of metallurgical factor constraints that equate a well made steel weldment with a good forged rim to a well made, sound cast steel gear. Manufacturing guidelines were provided that encourage the standard user to assure that the "T" or "Y" section gear blank was mechanically sufficient, as were maintenance guidelines to assure proper alignment and lubrication. In this way the "application" standard has gone further than any of its predecessors.

The committe members who contributed to ANSI/AGMA 6014-AO6, *Gear Power Rating for Cylindrical Shell and Trunion Supported Equipment*, were chairman Craig

Danecki and myself, vice-chairman, along with: J.C. Berney-Ficklin of Bechtel Corp., J. Carr of FLSmidth & Co., J.L. Daubert of FLSmidth & Co., M. Dreher of Ferry-Capitain, T.C. Glasener of Xtek Inc., R.W. Hankes of A-C Equipment Services Corp., E.O. Hurtado of FFE Minerals, M.J. Raab of Anderol Inc., V. Svalbonas of Metso Minerals Ltd., Y. Theberge of Metso Minerals Ltd. and F.C. Uherek of Rexnord Industries LLC.

The rolling mill standard 6005.B89 was intended to be reaffirmed with a cautionary note, but it was also withdrawn at the same time as 6004-F88. When 6014-A06 work was concluded, many committee members were compelled to withdraw from active duty as rolling mill gear products were not associated with the product offerings of their company. Chairman Danecki also passed the gavel to me at this time. The remaining members were quite few. Fortunately, additional technical experts whose companies were not involved with grinding mills and ring gear manufacturing joined the activities. The committee continues to grow, and in non-conventional ways. We have had involvement by members representing the lubrication industry, and most recently a member involved in the vibration analysis of rolling mill gear drives. The Mill Gearing Committee has survived a few institutional changes at AGMA as well. We were successful in attaining a grandfathered status when AGMA membership became a requirement for committee membership, and a challenge by the AGMA Technical Division Executive Committee over the need for a rolling mill rating standard separate from the enclosed drive rating standard, 6013-A06 in its present version. The reasons why a rolling mill standard is required are exhaustive and beyond the scope of this column. However, the exercise of fighting for the life of a standard document that essentially defines the nuts and bolts of a good portion of your professional life is a real motivation to do the job correctly. This opinion was shared by the committee and was evident in the passion displayed when responding to the committee's request.

The committee membership undertook the rolling mill standard with a considerably different goal than it did the grinding mill standard. The goal was to make the standard reflect the product requirements in the industry today. Unlike 6004-F88, the rolling mill gearing standard 6005.B89 was readily accepted and applied in the metals rolling industry. However, over the last 20 years the rolling mill gear industry has been dominated by an evolving specification for high quality gearing products, with fatigue capacity calculations requiring AGMA 2001 ratings. Only a few customers today require AGMA 6005.B89 ratings, and that is basically because of the lower allowable root bending stress levels in 6005.B89 in comparison to the basic 2001 rating. However, in the rolling mill gear product industry today, the use of the 2001 gear rating standard also requires the application of stress cycle factors equal to 20 years of continuous cycles, longitudinal flank modifications and exhaustive manufacturing control to meet strict metallurgical factors.

Writing a new standard to replace 6005.B89 would guarantee AGMA 2001.D04 as the parent standard. The operational characteristics of rolling mill gearing required that the committee establish metallurgical controls linked to the allowable Grade 1 and Grade 2 stress numbersthat are sufficiently conservative for coarse pitch, shock loaded gearing. While shock loads are a given, much of the gearing today must be highly accurate so as not to negatively affect the surface of the strip being rolled. In the superseded AGMA accuracy standard 390.03, mill gear set accuracy requirements were listed as Q5. Today, requirements run from Q8 to Q12 in the AGMA 2000-A88 system. It is precisely that range of accuracy requirements, in conjunction with requirements for flank and profile modifications, fine surface finish, shot peening enhancements, etc., that requires the new standard allow for quantitative differences in the calculated capacities to agree with the significant manufacturing differences.

Quantifying enhancements are currently provided for by the presence of certain rating factors in the AGMA 2001.D04 power formulas. Many of these factors are, however, undefined or undefined in the 2001 base standard. Linking the enhancement to the benefit of such enhancements requires the benefit of the theoretical research done by many scholars, and the significant applied experience of the committee members. Nevertheless, the introduction of new values to rating factors requires the committee be not only directionally correct, but also significantly conservative.

One of the most enjoyable and educational facets of committee membership is the review of an application standard with engineers from the target industry, who are not gear engineers by background. The rolling mill gearing committee met with two senior maintenance engineers from an Alabama plant of a major international steel firm to discuss the spectrum of loads in the rolling process. We learned how the steel makers interpret the telemetry charts for their mill stands, and from that the committee determined an approach to dealing with the mean rolling loads, the cyclical peak loads, and the non-cyclical peak loads. While this standard is still under construction, we promise a product worthy of the time taken to produce it.

The current committee members and the hard-working AGMA Staff member who are contributing to AGMA 6015-AXX, *Power Rating of Single and Double Helical Gearing for Rolling Mill Service*, are myself, chairman, and Chris Dale of Xtek Inc., vice-chairman, along with: Dick Calvert of Chalmers & Kubeck, Bob Fern of CHL Systems, Hal Johnson of Lufkin Industries, Tom Shumka of Global Inspections, Frank Uherek of Rexnord Gear Group and Amir Aboutaleb of AGMA.

Sincerely,
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