AGMA EV Town Hall

October 19 • 8:00-10:00 am

What to Expect

Twenty minutes at the beginning of the event is reserved for introductions and some important information. You will hear from and learn about the following:

- AGMA Leadership
- AGMA's efforts in Emerging Technology including the Electric Technology Committee
- AGMA's NEW! EV Education, and
- A special guest or two!

This is a true town hall and the rest of the event is reserved for audience participation.

This discussion is meant to identify some of the areas where AGMA's experience standards development could further benefit the EV sector.

Possible outcomes may include the formation of a group - or multiple groups to revise existing documents or to develop new ones. We also may find the need for more education in this area as another outcome. Regardless, we are here to listen to your feedback and facilitate the next steps in response to industry needs.

Share Your Voice

BEFORE THE EVENT

Read this document. It contains a list of standards and information sheets that are relevant in the discussion of electric vehicle technology.

To help us better prepare for the meeting, please review the list below and email us at **tech@agma.org** the top three areas you believe AGMA should assist with standardization:

- Design, Rating, and Load Calculation
- Metallurgy and Materials
- Accuracy, Tolerance, and Inspection
- Manufacturing and Inspection
- Wear and Failure
- NVH
- Relevant auxiliary components

AT THE EVENT

The EV Town Hall is structured to be a participatory event. It will only be successful with audience participation. Please make sure to get up and provide your comments.

We will be taping the event only for use by AGMA technical team.

We are asking each speaker to keep to two minutes so that we can have the maximum number of participants. You may also submit any comments directly to **tech@agma.org**.

Existing AGMA publications relevant to EV industry

Source: AGMA Publications Catalog-2023 edition, Available on the AGMA website: www.agma.org

Standards have been arranged by the following topics:

- **Most Relevant Top Level Design Documents that may apply to EV**
- **Rating Documents Relevant to Gears Regardless of Application**
- **Relevant NVH Standards**
- **Relevant Gear Material Documents**
- **Relevant Manufacturing and Inspection Documents**
- **Relevant to auxiliary components (windshield wipers, window actuators, seat adjustment)**
- **Other Relevant Design Documents**

Top Level Design Documents that may apply to EV

ANSI/AGMA 6002-D20 Design Guide for Vehicle Spur and Helical Gears and its Metric Version (ANSI/AGMA 6102-D20)

This standard provides information on the design of spur and helical vehicle power transmission gears. Included are considerations for design, material and heat treatment, lubrication, determination of load capacity, mounting features, and typical design problems.

Revision of ANSI/AGMA 6002-C15.

ISBN: 978-1-64353-074-1 Pages: 65

ANSI/AGMA 6123-C16 Design Manual for Enclosed Epicyclic Gear Drives

This is a design manual for drives employing epicyclic gear arrangements. It includes descriptions of epicyclic drives, nomenclature, application information and design guidelines with reference to other AGMA standards.

Replaces ANSI/AGMA 6123-B06. Reaffirmed October 2021.

ISBN: 1-55589-059-9 Pages: 136

AGMA 945-1-B20 Splines - Design and Application and its inch version (AGMA 945-2-B20)

This information sheet covers parallel straight sided and involute splines. It provides information relating to geometry, fit types, materials, manufacturing, rating, inspection, lubrication, and failure of splined elements.

Revision of AGMA 945-A18

ISBN: 978-1-64353-076-5 Pages: 79

Rating Documents Relevant to Gears Regardless of Application

AGMA 908-B89 Geometry Factors for Determining the Pitting Resistance and Bending Strength of Spur, Helical and Herringbone Gear Teeth

Gives the equations for calculating the pitting resistance geometry factor, I, for external and internal spur and helical gears, and the bending strength geometry factor, J, for external spur and helical gears that are generated by rack-type tools (hobs, rack cutters or generating grinding wheels) or pinion-type tools (shaper cutters). Includes charts which provide geometry factors, I and J, for a range of typical gear sets and tooth forms.

Reaffirmed November 11, 2020.

ISBN: 1-55589-525-5 Pages: 78

ANSI/AGMA 2001-D04 Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth

Presents a comprehensive method for rating the pitting resistance and bending strength of spur and helical involute gear pairs. Contains detailed discussions of factors influencing gear survival and calculation methods. Revisions reflected in this version include incorporating the latest AGMA accuracy standard (ANSI/AGMA 2015-1-A01) into the determination of dynamic factor and change to the relationship between service factor and stress cycle factor.

Revision of ANSI/AGMA 2001-C95. Reaffirmed March 2016.

ISBN: 1-55589-839-4 Pages: 56

ANSI/AGMA 2003-D19 Rating the Pitting Resistance and Bending Strength of Generated Straight Bevel, Zerol Bevel and Spiral Bevel Gear Teeth

This standard specifies a method for rating the pitting resistance and bending strength of generated straight bevel, zerol bevel and spiral bevel gear teeth. A detailed discussion of factors influencing gear survival and a calculation method are provided.

Revision of ANSI/AGMA 2003-C10.

ISBN: 978-1-64353-037-6 Pages: 99

AGMA 932-A05 Rating the Pitting Resistance and Bending Strength of Hypoid Gears

This information sheet provides a method by which different hypoid gear designs can be compared. The formulas are intended to establish a uniformly acceptable method for calculating the pitting resistance and bending strength capacity of both curved and skewed tooth hypoid gears. They apply equally to tapered depth and uniform depth teeth. Annexes contain graphs for geometry factors and a sample calculation to assist the user.

Supplement to ANSI/AGMA 2003-B97. Reaffirmed February 3, 2011.

ISBN: 1-55589-869-6 Pages: 18

NVH Standards

AGMA 914-B04, Gear Sound Manual – Part I: Fundamentals of Sound as Related to Gears; Part II: Sources, Specifications and Levels of Gear Sound; Part III: Gear Noise Control

This information sheet discusses how noise measurement and control depend upon the individual characteristics of the prime mover, gear unit, and driven machine, as well as their combined effects in a particular acoustical environment. It indicates certain areas that might require special attention. This document is a revision of AGMA 299.01 to include updated references and a discussion of Fast Fourier Transform analysis.

Replaces AGMA 299.01. Reaffirmed March 15, 2018.

ISBN: 1-55589-820-3 Pages: 37

ANSI/AGMA 6000-C20 Specification for Measurement of Linear Vibration on Gear Units

This standard presents a method for the measurement of linear vibrations on a gear unit. Instrumentation, measuring methods, test procedures and discrete frequency vibration limits are recommended for acceptance testing to confirm integrity. An annex which lists system effects on gear unit vibration and responsibility is also provided.

Revision of ANSI/AGMA 6000-B96.

ISBN: 1-55589-666-9 Pages: 21

ANSI/AGMA 6025-E19 Sound for Enclosed Helical, Herringbone and Spiral Bevel Gear Drives

Describes a recommended method of acceptance testing and reporting of the sound pressure levels generated by a gear speed reducer or increaser when tested at the manufacturer's facility. The results obtained through the use of this standard should represent only the sound of the gear unit, as other system influences, such as prime mover or driven equipment are minimized. Annexes to the standard present sound power measurement methods for use when required by specific contract provisions between the manufacturer and purchaser.

Revision of ANSI/AGMA 6025-D98.

ISBN: 978-1-64353-033-8 Pages: 32

Gear Materials Documents

AGMA 923-C22 Metallurgical Specifications for Steel and Cast Iron Gearing

This document identifies metallurgical quality characteristics which are important to the performance of steel gearing. The AGMA gear rating standards identify performance levels of gearing by heat treatment method and grade number. For each heat treatment method and AGMA grade number, acceptance criteria are given for various metallurgical characteristics identified in this document.

Revision of AGMA 923-B05.

ISBN: 978-1-64353-119-9 Pages: 56

ANSI/AGMA 2004-C08 Gear Materials, Heat Treatment and Processing Manual

This standard provides information pertaining to ferrous and nonferrous materials used in gearing. Factors in material selection, including material forms, properties, and associated processing and heat treatments are discussed. Manufacturing procedures to prepare materials for machining and final heat treatment are included. Heat treating procedures used for gearing are covered in detail, including process description, product specifications, process controls, and characteristics of heat treated gearing. Post-heat treatment processes to meet gearing requirements are discussed. Product inspection methods and documentation are covered. Term definitions, test methods, distortion and residual stress, sources for additional information and bibliography are included.

Revision of ANSI/AGMA 2004-B89. Reaffirmed February 6, 2020.

ISBN: 1-55589-904-2 Pages: 68

Manufacturing and Inspection Documents

ANSI/AGMA 1010-F14 Appearance of Gear Teeth – Terminology of Wear and Failure

This standard provides nomenclature for general modes of gear tooth wear and failure. It classifies, identifies and describes the most common types of failure and provides information which will, in many cases, enable the user to identify failure modes and evaluate the degree or progression of wear.

Revision of ANSI/AGMA 1010-E95. Reaffirmed February 6, 2020.

ISBN: 1-61481-089-6 Pages: 81

ANSI/AGMA 2008-D11 Assembling Bevel Gears

This Standard was prepared for the assembly man in the factory and for the service man in the field. Each definition, explanation, and instruction is directed toward the physical appearance of the

gears as they are inspected and assembled by these personnel. The definitions are simple. The explanations are thorough. An Annex provides detailed instructions on performing contact pattern checks.

Reaffirmed November 2021.

ISBN: 1-55589-998-1 Pages: 49

ANSI/AGMA ISO 1328-1-B14 Cylindrical gears – ISO system of flank tolerance classification – Part 1: Definitions and allowable values of deviations relevant to flanks of gear teeth

This standard establishes a tolerance classification system relevant to manufacturing and conformity assessment of tooth flanks of individual cylindrical involute gears. It specifies definitions for gear flank tolerance terms, the structure of the flank tolerance class system, and allowable values.

Replaces ANSI/AGMA 2015-1-A01.

ISBN: 1-61481-114-5 Pages: 47

ANSI/AGMA ISO 1328-2-A21 Cylindrical Gears — ISO System of Flank Tolerance Classification — Part 2: Definitions and Allowable Values of Double Flank Radial Composite Deviations

This document establishes a gear tooth classification system relevant to double flank radial composite deviations of individual cylindrical involute gears and sector gears. It provides formulae to calculate tolerances for individual product gears when mated in double flank contact with a master gear.

Identical to ISO 1328-2:2020.

ISBN: 978-1-64353-115-1 Pages: 26

ANSI/AGMA ISO 17485-A08 Bevel Gears – ISO System of Accuracy

This standard establishes a classification system that can be used to communicate geometrical accuracy specifications of unassembled bevel gears, hypoid gears, and gear pairs. It defines tooth accuracy terms, specifies the structure of the gear accuracy grade system, and provides allowable values. The standard provides the gear manufacturer and the gear buyer with a mutually advantageous reference for uniform tolerances. Ten grades are defined, numbered 2 to 11 in order of decreasing precision. Equations for tolerances and their ranges of validity are provided for bevel and hypoid gearing. Identical adoption of ISO 17485:2006.

Replaces ANSI/AGMA 2009-B01. Reaffirmed March 2014.

ISBN: 1-55589-926-4 Pages: 23

Relevant to auxiliary components

AGMA 905-A17 Inspection of Molded Plastic Gears

Due to their specification, design, and manufacture, plastic gears have unique issues that can affect the measurement methods and results obtained. This information sheet describes industry accepted practices to inspect molded plastic gears. It identifies the unique characteristics of molded plastic gears that influence the accuracy and/or repeatability of gear measurements.

ISBN: 1-55589-735-2 Pages: 84

AGMA 909-A06 Specifications for Molded Plastic Gears

The objective of this information sheet is to inform the plastic gear designer of the importance to clearly and thoroughly define the gear specifications to the plastic gear producer. It discusses the specifications for gear tooth geometry, inspection, other gear features and manufacturing considerations for involute external and internal spur and helical gears. Suggested data forms are provided in the annexes.

Reaffirmed April 10, 2018.

ISBN: 1-55589-889-8 Pages: 25

AGMA 946-A21 Test Methods for Plastic Gears

This information sheet describes test methods and recommended documentation practices for determining load carrying capacity and wear performance of plastic gears. It describes test methods for plastic gears related to dynamic testing where two gears rotate against each other

under controlled load and velocity, as well as static testing where a gear is held stationary while a load is applied to one or more of the gear's features, or pulsator testing where the test gear is not rotating, but the load is pulsed repeatedly until fatigue failure occurs.

ISBN: 978-1-64353-091-8

ANSI/AGMA 1006-A97 Tooth Proportions for Plastic Gears and its metric version ANSI/AGMA 1106-A97

Presents a new basic rack, AGMA PT, which, with its full round fillet, may be preferred in many applications of gears made from plastic materials. It contains a description, with equations and sample calculations, of how the proportions of a spur or helical gear may be derived from the design tooth thickness and the basic rack data. In several annexes, there are discussions of possible variations from the basic rack and also a procedure for defining tooth proportions without using the basic rack concept.

Reaffirmed March 2023.

ISBN: 1-55589-684-7 Pages: 47

AGMA 930-A05 Calculated Bending Load Capacity of Powder Metallurgy (P/M) External Spur Gears

This information sheet describes a procedure for calculating the load capacity of a pair of powder metallurgy external spur gears based on tooth bending strength. Two types of loading are considered: 1) repeated loading over many cycles; and 2) occasional peak loading. It also describes an essentially reverse procedure for establishing an initial design from specified applied loads. As part of the load capacity calculations, there is a detailed analysis of the gear teeth geometry, including tooth profiles and various fillets.

Reaffirmed August 2022.

ISBN: 1-55589-845-9 Pages: 78

ANSI/AGMA 6008-A98 Specifications for Powder Metallurgy Gears

Defines the minimum detailed information to be included in the powder metallurgy gear specifications submitted by the gear purchaser to the gear producer. Specifications on gear tooth geometry are described in detail for external spur and helical gears and for straight bevel gears. In addition, there are discussions on specifications for gear drawings and gear material data. The standard applies to gears made by the conventional P/M process consisting of compaction followed by sintering and, in some cases, by post sintering treatments.

Reaffirmed December 14, 2017.

ISBN: 1-55589-713-4 Pages: 17

ANSI/AGMA 6022-D19 Standard for Design Manual for Cylindrical Wormgearing

Covers the design of fine and coarse pitch cylindrical wormgearing operating at right angles and primarily made as gear sets to be incorporated into other machines and mechanisms. Many of the design procedures are also incorporated in enclosed drives.

ISBN: 1-55589-041-5 Pages: 44

ANSI/AGMA 6034-C21 Practice for Enclosed Cylindrical Wormgear Speed Reducers and Gearmotors

This standard gives a method for rating and design of specific enclosed cylindrical wormgear reducers and gear motors at speeds not greater than 3600 rpm or mesh sliding velocities not more than 6000 ft/min. It contains power, torque and efficiency equations with guidance on component design, thermal capacity, service factor selection, lubrication, and self-locking features of wormgears. Annexes are supplied on service factors, user recommendations.

Replaces ANSI/AGMA 6034-B92.

ISBN: 978-1-64353-092-5 Pages: 43

ANSI/AGMA 6035-A02 Design, Rating and Application of Industrial Globoidal Wormgearing

This standard provides guidelines for the design, rating and application of globoidal wormgearing mounted at a 90-degree angle. Specific definitions for globoidal wormgearing terms are presented, along with formulas for determining the geometric sizes of the major features for the worm and

gear. Design considerations, design procedures, gear blanks and self-locking conditions are also discussed. Procedures for rating the load capacity of globoidal wormgearing are included. Replaces ANSI/AGMA 6017-E86 and ANSI/AGMA 6030-C87.

Reaffirmed May 2019.

ISBN: 1-55589-792-4

Other Relevant Design Documents

ANSI/AGMA 1012-H23 Gear Nomenclature, Definitions of Terms with Symbols

This standard lists terms and their definitions with symbols for gear nomenclature.

Revision of ANSI/AGMA 1012-G05.

ISBN: 978-1-61481-401-6 Pages: 72

AGMA 933-B03 Basic Gear Geometry

This information sheet illustrates important geometrical relationships which provide a sound basis for a thoroughly logical and comprehensive system of gear geometry.

Replaces AGMA 115.01. Reaffirmed February 2022.

ISBN: 1-55589-814-9 Pages: 18

ANSI/AGMA ISO 23509-B17 Bevel and Hypoid Gear Geometry

This standard specifies the geometry of bevel gears. The term 'bevel gears' is used to mean straight, spiral, zerol bevel and hypoid gear designs. If the text pertains to one or more, but not all, of these, the specific forms are identified. This standard is intended for use by an experienced gear designer capable of selecting reasonable values for the factors based on his/her knowledge and background. It is not intended for use by the engineering public at large.

Replaces ANSI/AGMA ISO 23509-A08.

ISBN: 978-1-64353-002-4 Pages: 143

AGMA ISO 22849-A12 Design Recommendations for Bevel Gears

This information sheet provides information for the application of bevel and hypoid gears using the geometry in ANSI/AGMA ISO 23509, the capacity as determined by ISO 10300 (all parts), or ANSI/AGMA 2003-C10 and AGMA 932-A05, and the tolerances in ANSI/AGMA ISO 17485. This information sheet provides additional information on the application, manufacturing, strength and efficiency of bevel gears for consideration in the design stage of a new bevel gear set.

Replaces ANSI/AGMA 2005-D03.

ISBN: 1-61481-029-2 Pages: 40

ANSI/AGMA 2002-D19, Tooth Thickness and Backlash Measurement of Cylindrical Involute Gearing

Establishes the procedures for determining the specification limits for tooth thickness of external and internal cylindrical involute gearing. Includes equations and calculation procedures for the commonly used measuring methods. A specific tooth thickness specification limit can be established from the design thickness or from another tooth thickness measurement. The procedures can be used with an established design tooth thickness, or with actual tooth thickness dimensions. The effect of tooth geometric quality variations on tooth thickness dimensions is discussed. Calculations for backlash are included, and are based on the specified tooth thickness, center distance, and tolerances.

Revision of ANSI/AGMA 2002-B88.

ISBN: 978-1-64353-068-0 Pages: 145