American
Gear Manufacturers
Association

ANSI/AGMA 6123-C16
(Revision of ANSI/AGMA 6123-B06)

NOTE: Please see last page for errata

American National Standard

Design Manual for Enclosed Epicyclic Gear Drives

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[Revision of ANSI/AGMA 6123-B06]

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[Tables or other self-supporting sections may be referenced. Citations should read: See ANSI/AGMA 6123-16, *Design Manual for Enclosed Epicyclic Gear Drives,* published by the American Gear Manufacturers Association, 1001 N. Fairfax Street, Suite 500, Alexandria, Virginia 22314, http://www.agma.org.]

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ABSTRACT

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.

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Foreword

[The foreword, footnotes and annexes, if any, in this document are provided for informational purposes only and are not to be construed as a part of ANSI/AGMA 6123-C16, *Design Manual for Enclosed Epicyclic Gear Drives*.]

This standard presents design information and rating methods for epicyclic enclosed gear drives. This standard supersedes ANSI/AGMA 6023-A88 and ANSI/AGMA 6123-A88.

The initial AGMA publication that addressed epicyclic gearing was a portion of AGMA 420.04, *Practice for Enclosed Speed Reducers or Increasers Using Spur, Helical, Herringbone and Spiral Bevel Gears*. It was published in 1975, but was subsequently superseded by ANSI/AGMA 6123-A88, *Design Manual for Enclosed Epicyclic Gear Drives*, a much more comprehensive epicyclic gear document, published in 1988.

AGMA reactivated the Epicyclic Gear Committee to develop a revision to ANSI/AGMA 6123-A88 that would incorporate additional guidelines, the latest gearing technology as applied to epicyclic gears, and SI units exclusively.

The purpose of this standard is to provide the user of enclosed epicyclic gear drives with a method of specifying and comparing proposed designs to help predict the relative performance of different units. This standard is intended to establish a common base for rating epicyclic gear units and to encourage the maximum practical degree of uniformity and consistency between rating practices in the gear industry. It emphasizes the complexity of epicyclic unit design, and the need to consider the entire system of housings, bearings, gears and shafts in establishing the rating of a drive.

The formulas presented in this standard contain numerous terms whose individual values can vary significantly depending on application, system effects, accuracy, and manufacturing methods. Proper evaluation of these terms is essential for realistic rating. The knowledge and judgment required to evaluate properly the various rating factors comes primarily from years of accumulated experience in designing, testing, manufacturing, and operating similar gear units. The detailed treatment of the general rating formulas for specific product applications is best accomplished by those experienced in the field.

This revision was created to address load sharing between planets in more detail, provide additional guidance for higher speed epicyclic units with the addition of Annex H, and add other clarifications where needed. In regards to load sharing, an analytical method for the calculation of K_γ has been introduced in Clause 9 with additional details and examples given in Annex I. Furthermore, Table 7 has been retained from the previous revision except for the change of K_γ from 1.44 to 1.38 for Application Level 2-6 planets and from 1.60 to 1.52 for Application Levels 1 and 2 with 8 planets. In addition, K_γ for level 2-3 planets is now 1.05 instead of 1.00.

The first draft of ANSI/AGMA 6123-C16 was created in January 2013. It was approved by the membership in July 2016 and as an American National Standard on August 26, 2016.

Suggestions for improvement of this standard will be welcome. They may be submitted to tech@agma.org.

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American National Standard–

Design Manual for Enclosed Epicyclic Gear Drives

1 Scope

This standard is applicable to enclosed epicyclic speed reducers and increasers which use spur and helical gears. It applies to non-aircraft, industrial, vehicular, or machine tool gear units with carrier speeds less than 1800 rpm and pinion absolute speed less than 4500 rpm.

1.1 Limitations

Rating methods and influences identified in this standard are applicable to enclosed drives of single and multiple stage designs, with pitch line velocities not exceeding 35 m/s.

See Clause 4 for additional information, requirements, and limitations pertaining to the design of epicyclic gear drives.

A more detailed engineering study should be undertaken if conditions or requirements extend beyond a company's traditional design and manufacturing expertise in areas such as:

- lighter weight;
- higher power;
- reduced space;
- lubricants other than specified by ANSI/AGMA 9005;
- lower speeds;
- higher torque;
- double helical gearing.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this American National Standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this American National Standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below.

AGMA 925-A03, *Effect of Lubrication on Gear Surface Distress*

AGMA 927-A01, *Load Distribution Factors – Analytical Methods for Cylindrical Gears*

ANSI/AGMA, 1012-G05, *Gear Nomenclature, Definitions of Terms with Symbols*

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*

ANSI/AGMA 2101-D04, *Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth*

ANSI/AGMA/AWEA 6006-A03, *Standard for Design and Specification of Gearboxes for Wind Turbines*

ANSI/AGMA 6001-E08, *Design and Selection of Components for Enclosed Gear Drives*

ANSI/AGMA ISO 6336-6-A08, *Calculation of load capacity of spur and helical gears – Part 6: Calculation of service life under variable load*

ANSI/AGMA 6113-B16, *Standard for Industrial Enclosed Gear Drives (Metric Edition)*

ANSI/AGMA 9005-F16, *Industrial Gear Lubrication*

ISO 281:2007, *Rolling Bearings – Dynamic Load Ratings and Rating Life*

ISO 6336-1:2006, *Calculation of load capacity of spur and helical gears – Part 1: Basic principles, introduction and general influence factors*

ISO 6336-2:2006, *Calculation of load capacity of spur and helical gears – Part 2: Calculation of surface durability (pitting)*

ISO 6336-3:2006, *Calculation of load capacity of spur and helical gears – Part 3: Calculation of tooth bending strength*

ISO 6336-5:2016, *Calculation of load capacity of spur and helical gears – Part 5: Strength and quality of materials*

ISO 9085:2002, *Calculation of load capacity of spur and helical gears – Application for industrial gears*

ISO/TR 13593:1999, *Enclosed drives for industrial applications*

3 Symbols and terminology

3.1 Symbols

The symbols used in this standard are as shown in Table 1.

NOTE: The symbols and terms contained in this document may vary from those used in other AGMA and ISO standards. Users of this standard should assure themselves that they are using these symbols and terms in the manner indicated herein.

3.2 Nomenclature

The terms used, wherever applicable, conform to the following standards:

AGMA 904-C96, *Metric Usage*

ANSI/AGMA 1012-G05, *Gear Nomenclature, Definitions of Terms with Symbols*

Table 1 – Symbols and terms

Symbols	Definition	Units	First used
A_C	Carrier arrangement constant	-	Eq 73
A_F	Surface area exposed to forced convection	m^2	Eq 61
A_s	Stress cross sectional area of fastener	mm^2	Eq 52
A_T	Total surface area exposed to ambient air	m^2	Eq 59
A	Bearing load exponent	-	Eq 78
$a_{1, 2, 3}$	Bearing life calculation factors	-	10.2.6.1
B_A	Altitude modifier	-	Eq 99
B_{AT}	Ambient air temperature modifier	-	Eq 99
B_D	Operation time modifier	-	Eq 99
B_{ST}	Maximum allowable oil sump temperature modifier	-	Eq 99
B_V	Ambient air velocity modifier	-	Eq 99
B	Mean bearing diameter exponent	-	Eq 78
b'	Effective spline length	mm	Eq 39
b_{we}	Engaged sun/planet face width	mm	Eq 87
b_{wi}	Engaged planet/ring face width	mm	Eq 94
b_{WP}	Planet gear face width	mm	Eq 75
b_{WS}	Sun pinion face width	mm	Eq 73