AMERICAN GEAR MANUFACTURERS ASSOCIATION

Design Guidelines for Aerospace Gearing

AGMA 911–A94

AGMA INFORMATION SHEET

(This Information Sheet is NOT an AGMA Standard)

AGMA 911–A94, Design Guidelines for Aerospace Gearing

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ABSTRACT:

This Information Sheet covers current gear design practices as they are applied to air vehicles and spacecraft. The material included goes beyond the design of gear meshes and presents the broad spectrum of factors which combine to produce a working gear system, whether it be a power transmission or special purpose mechanism. Although a variety of gear types, such as wormgears, face gears and various proprietary tooth forms are used in aerospace applications, this document covers only spur, helical, and bevel gears.

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FOREWORD

[The foreword, footnotes, and annexes are provided for informational purposes only and should not be construed as a part of AGMA 911–A94, *Information Sheet – Design Guidelines for Aerospace Gearing.*]

This Information Sheet supersedes AGMA Standard 411.02, *Design Procedure for Aircraft Engine and Power Take–Off Spur and Helical Gears.* Its purpose is to provide guidance to the practicing aerospace gear engineer in the design, manufacture, inspection, and assembly of aerospace gearing. In addition, it addresses the lubrication, environmental, and application conditions which impact the gearbox as a working system of components.

Material in the Information Sheet is supplemental to current AGMA Standards, but does not constitute a Standard itself. By definition, Standards reflect established industry practice. In contrast, some of the practices discussed here have not seen enough usage to be considered standard, but they do provide insight to design techniques used in state–of–the–art aerospace equipment. It is expected that the user of this Information Sheet will have some general experience in gear and machine design, and some knowledge of current shop and inspection practices.

Suggestions for the improvement of this information sheet will be welcome. They should be sent to the American Gear Manufacturers Association, 1500 King Street, Suite 201, Alexandria, Virginia, 22314.

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Design Guidelines for Aerospace Gearing

1 Scope

This Information Sheet covers current gear design practices as they are applied to air vehicles and spacecraft. The material included goes beyond the design of gear meshes per se, and presents, for the consideration of the designer, the broad spectrum of factors which combine to produce a working gear system, whether it be a power transmission or special purpose mechanism. Although a variety of gear types, such as wormgears, face gears and various proprietary tooth forms are used in aerospace applications, this document covers only conventional spur, helical, and bevel gears.

1.1 Application

The working environment of the aerospace gear has become so diverse that a single set of guidelines will no longer suffice. The operating conditions imposed on a high speed, high powered, transmission or actuator are quite different than those experienced by the spacecraft mechanism which must function in a hard vacuum for long periods of time without maintenance. This Information Sheet addresses these differences and provides guidance to the designer for these demanding applications.

1.2 References

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

AGMA 230.01 – 1974, *Surface Temper Inspection Process.*

AGMA 246.02A – 1983, *Practice for Carburized Aerospace Gearing.*

AGMA 390.03a, – 1980, *Gear Handbook – Gear Classification, Materials and Measuring Methods for Bevel, Hypoid, Fine Pitch Wormgearing and Racks Only as Unassembled Gears.*

ANSI/AGMA 110.04 – 1989, *Nomenclature of Gear Tooth Failure Modes.*

ANSI/AGMA 2000–A88, *Gear Classification and Inspection Handbook – Tolerances and Measuring Methods for Unassembled Spur and Helical Gears (Including Metric Equivalents).*

ANSI/AGMA 2001–B88, *Fundamental Rating Factors and Calculation Methods for Involute Spur and Helical Gear Teeth.*

ANSI/AGMA 2003–A86, *Rating the Pitting Resistance and Bending Strength of Generated Straight Bevel, ZEROL® Bevel, and Spiral Bevel Gear Teeth.*

ANSI/AGMA 2004–B89, *Gear Materials and Heat Treatment Manual*

ANSI/AGMA 6023–A88, *Design Manual for Enclosed Epicyclic Gear Drives.*

ANSI/AGMA 6123–A88, *Design Manual for Enclosed Epicyclic Metric Module Gear Drives.*

2 Application

A listing of aerospace geared applications by type of service or function performed is useful in segregating the diverse gearing tasks into mechanism families which experience similar load and environmental spectra.

Applications can be identified by general grouping as follows:

- **Main propulsion systems;**
  - **Propeller gearboxes** reduce engine speed to propeller speed;
  - **Fan gearboxes** allow the use of optimum turbine and fan speeds for maximum efficiency;
  - **Helicopter transmissions.** A system of gearboxes and shafting to drive the helicopter rotors from the engine(s);
  - **Mechanical interconnection between engines** allow for independent engine operation on multi–engine systems;