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HELICOPTER TRANSMISSION SYSTEM**Summary

This report presents and describes the data and criteria to be used for the structural stress substantiation of the main parts of the drive system of the ES101 helicopter kit.

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MODIFICATIONS RECORD

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TABLE OF CONTENTS

MODIFICATIONS RECORD	2
TABLE OF CONTENTS	3
1 INTRODUCTION	5
2 REFERENCES	5
2.1 CS-VLR	5
2.2 CS27.....	5
2.3 ORDER 8110.9.....	5
2.4 MANUALE DI IMPIEGO PER IL PILOTA.....	5
2.5 DOT/FAA/AR-MMPDS-01.....	6
2.6 MECHANICAL ENGINEERING DESIGN	6
2.7 PETERSON'S STRESS CONCENTRATION FACTORS	6
2.8 SD 5340D.....	6
2.9 CATALOG 5000 E.....	6
2.10 AGMA 911-A94	6
3 ACRONYMS AND ABBREVIATIONS	7
4 BASIC HELICOPTER DATA (REF. FIG. 1)	7
4.1 GENERAL	7
4.2 MAIN ROTOR	7
4.3 TAIL ROTOR.....	7
4.4 ENGINE	8
4.5 DRIVE SYSTEM.....	8
4.5.1 <i>Engine Transmission</i>	8
4.5.2 <i>Main Transmission</i>	8
4.5.3 <i>Tail Drive System</i>	8
5 FACTORS	9
6 MATERIAL PROPERTIES AND ALLOWABLES	9
6.1 GENERAL	9
6.2 GEAR INDEXES.....	9
6.3 BEARING LIVES.....	10
7 CALCULATION METHODS	10
7.1 ULTIMATE MARGIN OF SAFETY	10
7.2 FATIGUE MARGIN OF SAFETY	11
7.3 SPIRAL BEVEL GEAR FORMULA	11

7.3.1 *Bending Stress*..... 11

7.3.2 *Contact Stress* 12

7.3.3 *Scoring Index* 12

7.3.4 *Crowned Spline Analysis Formula* 13

8 CRITERIA..... 14

8.1 MGB GEAR DESIGN CRITERIA..... 14

8.2 BEARING DESIGN CRITERIA 14

8.3 ENGINE OUTPUT TORQUE 14

8.4 MAIN ROTOR TORQUE 15

8.5 MAIN ROTOR LOADS..... 15

8.6 TAIL ROTOR TORQUE..... 16

8.7 TAIL ROTOR LOADS 17

FIG. 1 – ES101 GENERAL 3 VIEWS DRAWING 18

FIG. 2 – ROTOR LOADS SCHEME..... 19

FIG. 3 - MGB ASSEMBLY WITH MR MAST (P/N E1.63.001.102) 20

FIG. 4 - ENGINE ASSEMBLY WITH CLUTCH (P/N E1.63.002.102) 21

1 Introduction

This report presents the data and criteria for the structural (static and fatigue) substantiation of the main parts of the drive system of the ES101 helicopter kit.

In particular, the CRITICAL parts (whose structural failure can compromise flight safety) shall be considered by the analysis.

The drive system is composed of:

- Engine output module with centrifugal clutch (ref. Fig. 4) P/N E1.63.001.102
- Main Gearbox (MGB) assembly with freewheel unit and mast (ref. Fig 3) P/N E1.63.002.102
- Tai rotor drive system (belt drive)

2 References

2.1 CS-VLR

Certification Specifications for Very Light Rotorcraft CS-VLR
Amendment 1 - 17 November 2008
EASA

2.2 CS27

Certification Specifications for Small Rotorcraft CS27
Amendment 2 - 17 November 2008
EASA

2.3 Order 8110.9

Handbook on Vibration and Fatigue Evaluation of Helicopter and Other Power Transmission System
20 January 1975
FAA

2.4 Manuale di Impiego per il Pilota

25 August 2003
Aviotecnica

2.5 DOT/FAA/AR-MMPDS-01

Metallic Materials Properties Development and Standardization (MMPDS)

January 2003

FAA

2.6 Mechanical Engineering Design

By J.E. Shigley / L.D. Mitchell

1983

Mc Graw-Hill

2.7 Peterson's Stress Concentration Factors

By W.D. Pilkey

1997 2nd Edition

John Wiley & Sons

2.8 SD 5340D

Allowable Stress Values for Bevel and Hypoid Gears

1982

Gleason Works

2.9 Catalog 5000 E

General Catalogue

June 2003

SKF

2.10 AGMA 911-A94

Design Guideline for Aerospace Gearing

1994

American Gear Manufacturers Association

3 Acronyms and Abbreviations

FEA	Finite Element Analysis
FEM	Finite Element Method
g	gravity acceleration
MCP	Maximum Continuous Power
MGB	Main Gearbox
MR	Main Rotor
RPM	Revolutions Per Minute
TOP	Take-Off Power
TR	Tail Rotor

4 Basic Helicopter Data (Ref. Fig. 1)

4.1 General

Max. gross weight.....	: 640 Kg
Maximum positive load factor.....	: 2.5 g (Ref. 2.1)
Minimum negative load factor.....	: -0.5 g (Ref. 2.1)
Maximum yaw angular velocity.....	: 2 rad/s (Ref. 2.4)
Maximum speed (VNE).....	: 220 km/h
Cruise speed.....	: 190 km/h
Distance from MR to TR (H_{MR-TR}).....	: 4.415 m

4.2 Main Rotor

Type.....	: teetering (see-saw)
Number of blades.....	: 2 (Ref. 2.4)
Sense of rotation.....	: counter clock-wise seen from above
Diameter.....	: 7630 mm (Ref. 2.4)
Nominal rotational speed.....	: 535 RPM (100%)
Rotational speed range (power on).....	: 98 % – 102 % (Ref. 2.4)
Rotational speed range (power off).....	: 90 % – 110 % (Ref. 2.4)
Flapping angle.....	: +/- 8°
Mass of hub and blades.....	: 40 Kg

4.3 Tail Rotor

Type.....	: teetering (see-saw)
Number of blades.....	: 2 (Ref. 2.4)
Sense of rotation.....	: bottom blade rearward

Diameter.....: 1279 mm (Ref. 2.4)
Nominal rotational speed.....: 2680 RPM (100%) (Ref. 2.4)
Rotational speed range (power on).....: 98 % – 102 % (Ref. 2.4)
Rotational speed range (power off).....: 90 % – 110 % (Ref. 2.4)
Flapping angle.....: +/-15°

4.4 Engine

Type.....: gas turbine
Model.....: AvioTecnica T-61A
Nominal rotational speed.....: 6000 RPM (100%)
Take off power rating (TOP).....: 140 hp @ 6000 RPM 117% Torque
Max. continuous power rating (MCP).....: 120 hp @ 6000 RPM 100% Torque

4.5 Drive System

4.5.1 ENGINE TRANSMISSION

Type.....: multiple V belts
Ratio.....: 2.514 / 1 (reducer)
Input rotational speed.....: 6000 RPM (100%)
Output rotational speed.....: 2387 RPM (100%)
Clutch.....: centrifugal type
Engagement rotational speed.....: 3000 RPM (50%)

4.5.2 MAIN TRANSMISSION

Type.....: spiral bevel gears
Ratio.....: 4.4615 / 1 (reducer)
Pinion number of teeth.....: 13
Gear number of teeth.....: 58
Input rotational speed.....: 2387 RPM (100%)
Output rotational speed.....: 535 RPM (100%)
Freewheel.....: sprag type

4.5.3 TAIL DRIVE SYSTEM

Type.....: 2 stages V belt
First stage ratio.....: X / 1 (X.XXX)
Second stage ratio.....: X / 1 (X.XXX)
Input rotational speed.....: XXX RPM (100%)
First stage output rotational speed.....: XXX RPM (100%)
Second stage output rotational speed.....: XXX RPM (100%)

NOTE: X means not available at the time of issue of this report.