

DOC. N. : **R-101-10-05**Issue : **A**Customer : **/****TITLE : MGB MAIN AND LOWER CASES STRESS  
SUBSTANTIATION**Summary

This report presents the static and fatigue stress substantiation of the main cas P/N E1.63.005.102 and lower case P/N E1.63.008.102 of the MGB of the ES101 helicopter kit.

FILE : **R-101-10-05\_A\_MGB\_main\_case\_001.doc**

LINKS : N.A.

NUMBER OF PAGES : **23**Prepared by :  
Signature:  
Date:Aviotecnica  
October, 16<sup>th</sup> 2010Approved by :  
Signature:  
Date:Aviotecnica  
October, 16<sup>th</sup> 2010**DISTRIBUTION****Customer (PDF file)**

*This document contains proprietary information of AVIOTECNICA and may not be reproduced in any form whatsoever, nor may be used by or its contents disclosed to third parties without written permission from AVIOTECNICA.*

*AVIOTECNICA reserves the rights to undertake legal action to protect its intellectual property.*

**MODIFICATIONS RECORD**

ISSUE	ISSUE DATE	AFFECTED PAGES	REASON OF CHANGE	AUTHOR
A	16/10/2010	ALL	FIRST ISSUE	Aviotecnica

**TABLE OF CONTENTS**

<b>MODIFICATIONS RECORD</b> .....	<b>2</b>
<b>TABLE OF CONTENTS</b> .....	<b>3</b>
<b>1 INTRODUCTION</b> .....	<b>5</b>
<b>2 REFERENCES</b> .....	<b>5</b>
2.1 CS-VLR .....	5
2.2 CS27.....	5
2.3 ORDER 8110.9.....	5
2.4 DOT/FAA/AR-MMPDS-01.....	5
2.5 R-101-10-01 .....	5
2.6 SSM-1 .....	6
2.7 ASTM B93/B93M-09 .....	6
2.8 ASTM B80-09.....	6
2.9 R-101-10-02.....	6
<b>3 ACRONYMS AND ABBREVIATIONS</b> .....	<b>6</b>
<b>4 FACTORS AND ASSUMPTIONS</b> .....	<b>7</b>
<b>5 CALCULATION METHODS</b> .....	<b>7</b>
5.1 ULTIMATE MARGIN OF SAFETY .....	8
5.2 FATIGUE MARGIN OF SAFETY .....	8
<b>6 MGB CASES DESCRIPTION</b> .....	<b>9</b>
<b>7 MAIN AND LOWER CASES ANALYSIS</b> .....	<b>10</b>
7.1 MATERIAL PROPERTIES.....	10
<b>TABLE 1 – AZ91C T4 MATERIAL PROPERTIES (REF. 2.8)</b> .....	<b>10</b>
7.2 LOADS.....	11
<b>TABLE 2 – MGB CASES LOAD CONDITIONS</b> .....	<b>11</b>
7.3 RESULTS .....	11
7.3.1 <i>Static Conditions</i> .....	11
7.3.2 <i>Fatigue Conditions</i> .....	11
<b>8 CRASH CONDITIONS</b> .....	<b>12</b>
<b>9 CONCLUSIONS AND RECOMMENDATIONS</b> .....	<b>14</b>

**FIG. 1 – MGB ASSEMBLY (P/N E1.63.001.102) ..... 15**  
**FIG. 2 – MAIN AND LOWER CASES ASSEMBLY..... 16**  
**FIG. 3 – CASES ASSEMBLY FE MESH..... 16**  
**FIG. 4 – CASES ANALYSIS – APPLIED FORCES..... 17**  
**FIG. 5A – CASES ANALYSIS - VM STRESSES AT STATIC CONDITION..... 17**  
**FIG. 5B – CASES ANALYSIS - VM STRESSES AT STATIC CONDITION ..... 18**  
**FIG. 6A – CASES ANALYSIS - VM STRESSES AT FATIGUE CONDITION ..... 18**  
**FIG. 6B – CASES ANALYSIS - VM STRESSES AT FATIGUE CONDITION..... 19**  
**FIG. 7 – CASES ANALYSIS - VM STRESSES AT CRASH CONDITION ..... 19**

## **1 Introduction**

This report presents the static and fatigue stress substantiation of the main and lower cases of the Main Gearbox (MGB) of the ES101 helicopter kit.

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

## **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 DOT/FAA/AR-MMPDS-01**

Metallic Materials Properties Development and Standardization (MMPDS)  
January 2003  
FAA

### **2.5 R-101-10-01**

BASIC DESIGN CRITERIA FOR THE ES101 HELICOPTER TRANSMISSION SYSTEM  
October 2010  
Aviotecnica

**2.6 SSM-1**

SIKORSKY STRUCTURES MANUAL  
1992  
United Technology Corporation

**2.7 ASTM B93/B93M-09**

Standard Specification for Magnesium Alloys in Ingot Form for Sand Castings, Permanent Mold Castings, and Die Castings  
2009  
ASTM

**2.8 ASTM B80-09**

Standard Specification for Magnesium Alloy Sand Castings  
2009  
ASTM

**2.9 R-101-10-02**

MAIN ROTOR MAST (P/N E1.63.039.202) STRUCTURAL STRESS ANALYSIS  
October 2010  
Aviotechnica

**3 Acronyms and Abbreviations**

CG	Center of Gravity
FEA	Finite Element Analysis
FEM	Finite Element Method
g	gravity acceleration
MCP	Maximum Continuous Power
MGB	Main Gearbox
MR	Main Rotor
Nr	Rotor RPM
RPM	Revolutions Per Minute
TOP	Take-Off Power
TR	Tail Rotor
VM	Von Mises