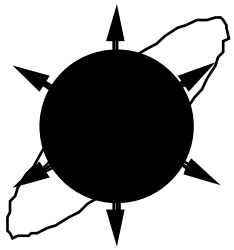

TITLE: AIRFRAME MODAL EVALUATION

TEST SPECIFICATION TS No. 1.0

BRIEF DESCRIPTION: Node and frequency evaluation of the AUSROC II-2 amateur LOX-Kerosene liquid fuelled rocket.

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CONTENTS

SCOPE

1.1 Introduction

The Australian Space Research Institute (ASRI) is undertaking to design, develop, manufacture and flight demonstrate an amateur liquid fuelled rocket designated AUSROC II-2. The vehicle is a single stage liquid oxygen (LOX) and kerosene fuelled rocket weighing 225 kilograms is launched at a quadrant elevation of 70 degrees and achieving a flight apogee of approximately 10 kilometres at a speed of Mach 1.6. The rocket carries a flight validation payload incorporating various sensors. The entire rocket weighing 135 kilograms, all-burnt, is recovered by deployable parachute system.

The AUSROC II-2 program aims to develop and enhance the engineering skills of both students and ASRI members in space launch systems.

1.2 Purpose

The purpose of this test specification is to determine potentially catastropic structural coupling exists between the first and/or second body bending frequencies and fin bending frequency.

1.3 Objectives

1.3.1 To determine the first five body longitudinal frequencies of the flight readied rocket.

1.3.2 To determine the node positions and mode shapes of natural frequencies described in 1.2.1.

1.3.3 To determine fin bending, torsion and hybrid frequencies within the range of the frequencies described in 1.2.1.

1.3.4 To determine the mode shapes described in 1.2.3.

1.3.5 To assess the likelihood of mode coupling critical to flight safety.

2. APPLICABLE DOCUMENTS

3. TEST LOCATION AND DURATION

This series of tests will be conducted at ASRI Integration Facility, Building 5, Salisbury, South Australia, 5108. The expected duration of the tests is 2 hours for setup, 2 hours for test and 4 hours to complete test documentation and provide conclusions and recommendations.

4. DEVICE UNDER TEST

The device-under-test (DUT) shall be the AUSROC II-2 flight readied vehicle minus propellants, pressurant and pyrotechnics. The DUT represents the flight vehicle at the all-burnt stage.

5. TEST EQUIPMENT

The following equipment is to be available for the test;

support frames to hold rocket in the horizontal position (2),
air cushions (2),
shaker (1),
shaker control rack including power supply and signal generator (1),
displacement potentiometer (1),
accelerometer (optional),
power supply (optional),
oscilloscope, 5mV per division sensitivity / 15MHz (1),
frequency meter, to measure 1Hz to 2kHz, signal level TBD, sensitivity 50mV (1),
flight vehicle mounting strap (1),
various moment relief connecting rods,
various fasteners,
laboratory stands (2),
various cabling and connect leads,
dry sand, 5 kg,
35mm still camera, and
video camera.

6. TEST SETUP

Figure 1. details the test setups. The test setups are to be documented by photographs and sketches.

Figure 1. Test Setup Number 1.

Figure 2. Test Setup Number 2.

7. TEST PROCEDURE

Table 1. details the test procedures. In addition photograph and video the test operations on a opportunity basis.

All test shall be conducted at Standard Laboratory Conditions except otherwise stated. Standard Laboratory Conditions are;

- Atmospheric Pressure 860 to 1060 millibars, \
- Relative Density lesss than 70%, and
- Temperature of 20+-5 degrees

Should a failure occur during the test, the test will be stopped and the cause of failure determined and rectified. Failure during a test will constitue a repeat of the test during which failure occurred

Table 1. Test Procedures

Item	Action	Check
10	Commence with Setup 1.	
20	Apply a low amplitude low frequency (near zero) sine wave to the magnetic vibrator.	
30	Adjust the excitation frequency (increase or decrease) until the first body natural frequency is reached. This is determined by either a minimum power excitation state or by observing harmonic acoustics.	
40	Measure and record body node positions and mode shapes. This is determined by moving an accelerometer or pencil along the flight vehicle body to locate nil displacement positions.	
50	Measure and record the excitation frequency.	
60	Increase the excitation frequency until the second and subsequent body frequencies are achieved. Repeat items 30 to 50.	
70	Reduce excitation frequency to near zero.	
80	Increase excitation frequency until the fin first natural frequency is achieved.	
90	Measure and record mode shapes. This is determined by sprinkling dry sand onto the fin; allowing sufficient time for sand separation; and photograph and sketch the result.	
100	Measure and record the excitation frequency.	
110	Increase the excitation frequency until the second and subsequent fin frequencies are achieved exceeding the fifth body frequency. Repeat items 80 to 100.	
120	Arrange DUT as per Setup 2.	
130	Repeat items 20 to 120	

8. SAFETY

The AUSROC II-2 vehicle will not be fitted with pyrotechnic devices during the test. The Test Coordination Officer shall be responsible for safety during the conduct of the tests, involving test personnel and test equipment.

9. DELIVERABLES

A comprehensive test report shall be prepared by the Test Officer in Charge by ED+2 weeks. The report shall include; sketches and photographs of the test setup(s); all test records; and conclusions and recommendations based on test record valuation.

10. APPOINTMENTS

Test Officer in Charge:	Dwight C. Van Roy
Test Coordination Officer:	Mark Blair
Test Officers, Electrical:	John Coleman, Colin Biggs