AUSROC II

LOX-KERO ROCKET SYSTEM

WOOMERA TRIAL CAMPAIGN

ASSEMBLY, TEST & LAUNCH

PROCEDURES

28th September 1992

AUSROC II

CONTENTS

INTRODUCTION

This document provides the procedures for the assembly, test, launch, abort and recovery of the Ausroc II amateur rocket system. Ausroc II is a liquid fuelled rocket utilising liquid oxygen and kerosene (JA-1) as propellants. The vehicle was designed by a group of university students, graduates and amateurs and is supported by a number of industry and government sponsors. The program objective is to design manufacture and test launch a bi-propellant liquid fuelled rocket system and associated support hardware. Appendix:J provides the system specifications and basic performance data for the vehicle, including a static firing thrust profile, valve and ignition characteristics and a nominal 70 deg. QE trajectory simulation.

1. ACTIVITY SUMMARY

The following is a list of all major assembly and launch area operations along with the hazard status of each. The majority of these points are explained in more detail in later sections of this report.

DANGER LEVEL

I - All personnel are allowed access
II - Only active essential personnel are allowed access
III - No personnel are allowed access to the vehicle

T-5 DAYS (Friday 16th October)	**LEVEL**
1. Arrival at Woomera	I
2. Unload Kerosene Drums in fuel store.	II
3. Unload Pyrotechnics in magazine	II
4. Unload Vehicle and Components in Test Shop 1 (TS-1)	I
5. Unload Ground Electronics at I.B.	I
T-4 DAYS (Saturday 17th October)	
1. Motor & Fin Unit Attachment	I
2. Vehicle System Assembly Check	I
3. Pre-Installation Tests of Flight Electronics	I
4. Pneumatic Valve Operation Check	II
5. System Pressure Test	II
6. Initial IB Ground Electronics Set-Up and Test	I
T-3 DAYS (Sunday 18th October)	
1. Launcher service facilities setup (electrical & pneumatic)	I
2. Flight Electronics Installation	I
3. Post-Installation Flight Electronics Tests	I
4. Pyrotechnics Circuit Trials with Electric Matches	II

T-2 DAYS (Monday 19th October)

1. Transport & Install Rocket on Launcher	I
2. Elevate Launcher to 70 deg	I
3. Flight & Ground Electronics & Telemetry Tests (70 deg)	I
4. Lower Launcher & Cover Rocket with Tarps	I

T-1 DAYS (Tuesday 20th October)

1. Uncover Rocket & Elevate to 70 deg	I
2. Flight & Ground Electronics & Telemetry Tests (70 deg)	I
3. Launch Sequence Trial Runs with RMB Personnel	II
4. PR Session at Launcher (Media, Sponsors etc)	I
5. Lower Launcher & Secure	I
6. Install Pyrotechnics, Recovery & Nose Cone	II
7. Cover Rocket & Launcher with Tarps & Secure	II
8. Transport Propellants to Launcher Area & Cover	II

T-0 DAYS (Wednesday 21st October)

1. Remove Cover Tarps	II
2. Fill Helium Pressure Tank	II
3. Release First Weather Balloon	I
4. Elevate Launcher to 70 deg. QE	II
5. Final Telemetry & Electronics Tests	II
6. Load and Seal Kerosene Tank	II
7. Install Pyrotechnic Igniter (Unconnected)	II
8. Activate all Video Cameras	II
9. Release Second Weather Balloon	I
10. Load and Seal LOX Tank	II
11. Connect Igniter Leads	II
12. Retreat to Blockhouse	II
13. Commence Launch Sequence	III
14. Launch Rocket	III
15. Recover Rocket	II
16. Post Flight PR Session (IB Conf. Rm)	I
17. Pack-up all Gear	I
18. Leave Rangehead	I

2. ITEMS ARRIVING AT WOOMERA

The following list outlines the items that the Ausroc Group will be transporting to the Woomera Rangehead for use in the Ausroc II Trial Campaign:

1. 6m Raven 11 Box with Rocket Hardware (inert)
    - Rocket Body - Airframe
    - Engine / Fin Unit
    - Antenna (x2)
    - Recovery System / Nose Cone
    - Loose Components Bag (refer Appendix:F)
    - 3 x Empty 20lt kerosene drums
    - 20lt and 200lt drum hand pumps and hose
2. Pyrotechnics Box
    - 3 x Pyrotechnic Guillotines (0.2g powder each)
    - 1 x Pyrotechnic Piston (0.3g powder)
    - 6 x Pyro. Gas Generators (0.2g powder each)
    - 6 x Ignition Flares (20g pressed powder each)
    - 5 grams Spare Powder (G20, Class. 1.1)
    - 20 x Electric Matches (Type 'E' and 'K')
3. 2 x CIG 150 lt LOX PLC's (1 MPa)
4. 4 x CIG EHP Helium Bottles (22MPa)
5. 5 x CIG 'G' Size Nitrogen Bottles (13MPa)
6. 1 x 200 lt Drum of JA-1 Jet Fuel
7. Tool Kit
8. Mechanical Test Apparatus
9. Mobile Scaffold Equipment
10. Electronics Equipment (refer section 6)

Items 2 and 6 can be placed in Hazardous Storage until the pyrotechnic installation and flight fuelling operations occurs out at Launcher 2. All other items are used in the pre-flight assembly and test procedures and can be taken to Test Shop 1 where all installation and systems tests will be undertaken.

3. SYSTEM ASSEMBLY & CHECKS

After arrival and unloading at Test Shop 1, the rocket body / airframe is removed from the transport box and placed on the Raven II trolley for assembly and check. The motor and fin unit are attached to the thrust mount and the plumbing and wiring connected in preparation for the system tests. This Tail Unit Assembly Checklist is provided in Appendix:A. The mechanical system assemblies are then checked by 2 independent team members to ensure that no components, plumbing, connectors or sub-assemblies have been damaged during transit from Melbourne and Salisbury. The System Assembly Checklist is provided in Appendix:B. Any problems or discrepancies discovered during this exercise should be reported immediately for correction.

4. FLIGHT ELECTRONICS SYSTEM TESTS

The electronics package arrives at Woomera external to the vehicle and undergoes a test and evaluation procedure prior to being attached to its mounting fixture within the rocket body. These tests are to be conducted in Test Shop 1. The pyrotechnic wiring looms are to be tested, before and after installation of the electronics into the rocket, with live electric matches to verify the circuit continuity.

At the completion of the valve and system pressure tests, the electronics package is inserted into the rocket body from the nose end and secured to a fixed mounting ring. The internal wiring looms are then connected along with the 2 external antennas and associated coaxial cables. At this stage, the 2 electrical umbilical connectors, which are mounted to the base of the fin unit, can be connected to the external power & test plugs and the electronics unit retested, in the rocket, in Test Shop 1. At the completion of mechanical and electrical tests in Test Shop 1, the Raven II motor trolley, with the Ausroc II vehicle on it, is towed from Test Shop 1 to the launcher and then installed on the underside of the rail via the 2 launch lugs.

The telemetry transmitter and electronics are to be tested while elevated at 70 degrees on the launcher on 3 occasions: T-2 days, T-1 day (before the installation of the pyrotechnics and recovery system) and immediately after the launcher is elevated on the launch day prior to propellant fuelling with the pyrotechnics and recovery system installed. The electronics test procedures are given in Appendix:D

5. VALVE OPERATION & PRESSURE TESTS

Following the completion of the 2 System Assembly Checks the 3 pneumatic valves are to be tested in test shop 1 in flight sequence to validate the flight critical wiring looms and pneumatic circuits. The pneumatics are powered by compressed nitrogen gas at 1.0 MPa supplied and regulated from a standard CIG industrial ’G’ size pressure bottle at 13 MPa. The pneumatic valves are such that, until the point when the rocket moves off its launch support plate, they can be turned both ’on’ and ’off’. The ’off’ function is utilised in the event of a failed ignition or a failure of one of the other valves to operate successfully. This function is handled by the ’Launch Sequence Controller’ via the ’Abort’ switch. On the launcher, the rocket sits on 2 pneumatic supply adaptors, one each for ’on’ and ’off’, which are fixed to the rocket support plate. When launched, the pneumatic supply lines are disconnected and the circuit is rendered inoperative.

After the successful completion of the series of valve operation tests, the leak and pressure test is conducted to ensure that the tanks, valves and plumbing circuits are secure and sealed. This check involves pressurising the entire system to the pre-flight test pressures and allowing it to stand for a 10 minute time period to determine if any leaks are present. The following table gives the pressure ratings for the 3 pressure vessels in the rocket:

	Lox Tank	Kero Tank	He Tank
Flight Operating Pressure	4 MPa	4.5 MPa	25 MPa
Pre-Flight Test Pressures	3 MPa	3 MPa	10 MPa
Hydro-Test Pressure	4.5 MPa	5.0 MPa	34 MPa
Relief Valve Setting	4.5 MPa	5.0 MPa	n/a
Theoretical Burst Pressure	7.1 MPa	7.1 MPa	n/a

The procedure and checklist for these test exercises are provided in Appendix:C.

6. GROUND EQUIPMENT AND FACILITIES

The ground equipment involves a wide variety of items being setup at various locations.

6.1 Telemetry & Data Handling

The receiving and data handling equipment is to be setup in the Instrumentation Building (IB) on the right hand end of the first floor. These items are:

- 2 x Circularly Polarised Yaggi Antennas on roof of IB
- 2 x Coaxial Cable from roof of IB to receivers on first floor
- 2 x Telemetry Receivers
- 2 x Demodulators
- 3 x Video recorders
- 3 x IBM-386 Computers for data processing and storage
- 2 x Video monitors displaying on-board video camera
- 1 x Video monitor displaying launch from ground video

6.2 Video & Photographic Coverage

Rocket launch video coverage will be obtained from no fewer than 4 remote cameras mounted on tripods around the launcher area. These will be self contained units with battery power supplies and video cassettes. They will be activated by an Ausroc cameraman immediately prior to the lox fuelling operation and left running for the duration of the firing procedure. There is to be 1 video camera located at post V22 on the right flank of the range and will be powered by mains 240VAC and also activated prior to fuelling. There will also be several remote 35mm cameras on the launcher apron with motor drive assemblies hooked into the launch sequencer.

6.3 Rocket Weather Protection

The rocket is to be installed on the launcher rail 2 days before launch. This is to allow for a variety of electronic, telemetry and dry run firing trials to be undertaken, in flight conditions, prior to launch. The rocket will be left on the launcher, in the horizontal position, overnight. To protect the vehicle from adverse weather conditions that may occur during the day or night, several tarps will be secured over the launcher rail and rocket.

6.4 Personnel Issues

Personnel present for the AUSROC Trial are divided into 4 groups; Launch Crew, Sponsors, Visitors and Media. Appendix:E lists the names of those involved in each group. The Logistics Officer of the Ausroc Launch Crew will be assigned to looking after the sponsors, visitors and media for the duration of the trial period.

6.5 Launcher Services

Electrical and Pneumatic services will be connected to the launcher platform. The pneumatic services consists of a CIG ’G’ size nitrogen gas bottle at 13MPa regulated down to 1MPa for the pneumatic actuators on board the rocket. The bottle and regulator will be fixed to a rear strut on the base frame and a nylon pneumatic hose will transfer the 1MPa nitrogen to a solenoid valve mounted near the launcher platform. Two short nylon hoses extend from the solenoid valve to 2 disconnect adaptors on the launcher platform. The rocket ’sits’ on these adaptors to complete the pneumatic circuit. These adaptors are for valve ’on’ and ’off’ respectively. The pneumatic circuit is broken when the rocket leaves the launcher platform and the nitrogen is then vented to atmosphere until the bottle is empty.

The electrical wiring, both hazardous and non-hazardous, has to be laid out, secured and tested. 3 cables will be used; 1 for ground power to the rocket electronics, 1 for the launch sequencer signals and data transfer and 1 for the pyrotechnic flare ignition pulse. The first 2 of these will be connected to pullout plugs which disconnect from the rocket as it leaves the launcher platform. The flare cable remains attached to the flare which is tethered to the launcher base frame. The flare is ejected from the motor at ignition.

6.6 Range Supplied Equipment & Services

The following Woomera Range facilities will be required for use during the Ausroc II Launch Campaign

1. Test Shop 1 & O/H Crane
2. Magazine Storage (1.1 G20 powder & Pyrotechnics)
3. Raven II Rocket Motor Trolley
4. IB First floor - Right wing (equipment setup)
5. IB Roof - Telemetry Receiving Antennas
6. IB Conference Room
7. IB Control Room
8. Old Skylark Concrete Launcher Apron
9. Equipment Centre 2 (EC2)
10. Cable Terminating Hut
11. Adour Radar (R2)
12. Rakimos Kinetheodolite
13. Rocket Recovery Truck (no lift equipment required)
14. Transport Trailer
15. Launcher Area Lights (for early morning work)
16. Observation Post V22
17. Fire hoses & Fire Extinguishers

6.7 Safety Equipment

The following list itemises the safety equipment required to perform the hazardous operations during the test shop and launcher activities. The personal safety gear is to be provided by the Ausroc Crew. The hoses and extinguishers are assumed to be provided at the rangehead:

1. 2 x Water hoses at launcher
2. 2 x CO2 Fire Extinguishers at launcher
3. 4 x Safety hard hats and visors
4. 2 Pair of long safety gloves
5. 2 x Fire proof coveralls and safety boots

7. PYRO. & RECOVERY INSTALLATIONS

At the completion of the second set of electronics, telemetry and dummy firing checks at T-1 day, the launcher is lowered into the horizontal position and secured for the pyrotechnic and recovery system installation procedure. This involves the insertion and attachment of the parachute tube and mount plate, canopy straps, 2 pyrotechnic cable cutters, drogue support cable, nose adaptor ring, 3 nose release pyro gas generators and finally the drogue line and nose cone. This procedure is given in Appendix:G.

Prior to installation, all electric match initiators are to be checked for continuity with an approved ohmmeter. Several interlocks prevent premature operation of the pyrotechnics. A latching relay interlock in the electronics module prevents the pyros from being armed until after motor burnout. Similarly, the pyros cannot be armed until the electronics unit is activated via the key switch in EC2 and the electrical umbilical connector at the base of the rocket is disconnected at rocket liftoff, thus preventing operation while the rocket is on the launcher. At the completion of this operation, all vehicle hatches are sealed and the protective tarps are secured over the launcher and rocket for protection overnight.

At this stage all electronic and mechanical systems, both rocket and ground based, are to have emerged from the testing procedures operating successfully. Any failures or problems are to be reported to the design authority for evaluation and correction. It is planned to have one of the lox plc’s, 3 of the 20lt drums of kerosene, 3 of the helium pressure bottles and associated filling lines and 3 of the ’G’ nitrogen bottles out on the launcher apron on the afternoon prior to the launch day. They are to be positioned a minimum of 30m from each other and the launcher and covered with tarps for storage overnight.

8. FUELLING AND LAUNCH PROCEDURES

It is currently planned to conduct the firing at 9.30am in order to avoid the winds which increase in strength as the day progresses. To achieve this launch time, the crew intend to arrive at the range at 5.30am to begin the final tests and fuelling operations. The launch sequence controller is used to perform dummy firing runs with live electric matches and active pneumatic valves. These tests are performed with the vehicle on the launcher in the horizontal position. If these trials are unsuccessful a launch hold is initiated until the problems are rectified.

At the successful completion of these trials, the helium pressurant is loaded into the on-board pressure tank from the 3 CIG industrial bottles stored on the launcher apron the previous day. The on-board pressure tank is a commercial CIG industrial glass wrapped pressure vessel with a test pressure of 34MPa. The bottle is to be filled to its nominal working pressure of 25MPa and should pose no safety problem beyond that encountered with other CIG pressure bottles.

The launcher rail is now raised to the nominal 70 degree launch QE and the rail secured with the support arms and cables. The electronics and telemetry are re-activated for a final operational check in association with the ground equipment and then shut down for the fuelling operation. The RSO now holds the electronics activation key, the launch controller arming key and the override enable key.

The kerosene tank is loaded and sealed first. Any residual kero is cleaned up in preparation for lox fuelling. The pyrotechnic ignition flare is inserted into the nozzle, after a continuity check, and taped to the launcher support plate. The flare is also attached to a cable tether which prevents it from causing damage when expelled from the nozzle at ignition. The Lox is then loaded and the intertank hatch replaced and secured. Finally, the ignition flare leads are connected to the firing circuit.

Remaining personnel return to EC2 for the firing sequence. The IB passes power to the launch control sequencer and the RSO passes the arming, override enable and electronics activation keys to the launch control officer (LCO). The LCO then activates the on-board electronics, performs continuity checks of all 4 valve and firing lines and then initiates the 2 minute firing sequence. At T-0 sec the rocket will leave the launcher rail. Appendix:H provides the fuelling and launch procedure checklist

9. LAUNCH ABORT PROCEDURES

Throughout the assembly, test and fuelling phases of the pre-flight activity numerous situations could arise causing time delays and / or abort operations. These can be classified into hazardous and non-hazardous categories. Non-hazardous operations are those undertaken prior to pyrotechnics installation. Problems encountered during these operations will result in time delays. Hazardous operations are those undertaken after the installation of the pyrotechnics, primarily the fuelling, and require special attention to safing procedures. Reasons for aborting the launch are:

1. Direct Order from the Range Safety Officer
2. Direct Order from the Range Manager
3. Electronics and/or Telemetry failure in pre-launch
4. Ignition Flare failure
5. Sudden adverse change in weather conditions
6. Tank leakage during Fuelling
7. Valve Operation failure
8. Misfire and/or Hangfire
9. Radar Failure

A launch sequence hold which is likely to extend beyond 40 minutes duration will require the lox to be dumped to prevent excessive icing of the lox components. The kerosene tank and helium tank can remain loaded. The kero tank, however, must be depressurised for safe storage.

The most serious abort is one initiated during the final 2 minute countdown involving the abort button on the launch sequence controller. The abort button stops the launch sequence. The override enable key switch then enables the 3 valve override switches. Two cases exist depending on the time of abort.

The ignition flare will ignite at T-5sec and burn for 20 sec. No propellant dump operation is allowed to occur within 2 minutes of the flare ignition. During this 2 min. delay the on-board electronics and telemetry are to be deactivated by the LCO with the key switch in EC2. It should be noted that **Electric power must be maintained to the Launch Control Sequencer to perform the abort procedures.**

Prior to T-3sec the helium valve will not have operated and the kerosene tank will not be under pressure. The lox tank will self-pressurise from the time the bleed plug is replaced after fuelling and, thus, will be under pressure. In this case the lox valve is opened via the override switch and the lox is dumped onto the launcher apron, through the injector and motor, where it will vaporise and disperse into the atmosphere. This operation will leave the kerosene tank filled and unpressurised and the helium tank at the nominal 25MPa pressure.

After T-3sec the helium valve will be open and both tanks will be at operating pressure. In this case the helium valve is first closed via its override switch and then the lox valve is opened via its override switch to dump the lox through the injector and motor to the atmosphere where it will vaporise and disperse very readily.

A waiting period of 10 minutes will apply after the lox dump operation before the RSO and FO1 can approach the launcher. The ignition flare is to be disconnected from the firing line and, if still inserted in the motor, removed and stowed in a safe location. The kerosene and helium tanks will be left filled and pressurised after the lox dump operation. The kerosene tank can be depressurised by loosening the fill plug in the intertank fairing. The helium tank can remain pressurised indefinitely.

The primary abort and propellant dump procedure checklist is given in Appendix:I. The launcher area will only be declared safe when the pyrotechnics have been removed and the 2 rocket propellant tanks have been depressurised.

10. WIND LIMITATIONS

This section provides a summary of the wind effect results of the Ausroc II rocket system as described in a report by G. Jepps. This report was commissioned under a DSTO-WSRL contract No.301481

10.1 Lateral Dispersion

Calculations have been made to estimate lateral flight path dispersion due to cross wind, fin misalignment and thrust misalignment. Lateral displacements from the unperturbed trajectory at all burnt have been calculated for these 3 causes. At all burnt, on the unperturbed trajectory, AUSROC II is at an altitude of 6000m and at a down range horizontal distance of 5000m from the launcher. While the motor is thrusting, a steady cross wind causes a rocket to deviate towards the direction from which the cross wind is coming. Thus for a cross wind blowing from the right, looking down range, a thrusting rocket will veer towards the right. The calculated results for lateral displacement from the unperturbed trajectory at all burnt are as follows:

149m for every m/s of cross wind
389m for every degree of fin misalignment
792m for every degree of thrust misalignment

The last two figures have been calculated on the assumption that the rocket does not roll and hence that the plane in which the motor thrust is offset, due to the misalignment, remains fixed. The results for the lateral angular displacement of the perturbed trajectory from the unperturbed trajectory at motor all burnt are:

1.22 degrees for every m/s of cross wind
3.62 degrees for every degree of fin misalignment
5.71 degrees for every degree of thrust misalignment

These lateral angular deviations for fin and thrust mis-alignments occur in the plane in which the thrust is offset for a non-rolling rocket. For the cross wind, the angular deviation is in the side plane, defined as the plane which contains the tangent to the unperturbed trajectory and which is normal to the vertical plane. Hence the side plane orientation changes as the unperturbed trajectory tangent changes direction along the flight path. At motor all burnt, the unperturbed trajectory tangent makes an angle of 46 degrees with the horizontal. Because range boundaries are defined in the horizontal ground plane, the angular deviations quoted for the side plane need to be projected on to the horizontal plane.

Lateral angular deviation is a maximum when the deviations due to fin and thrust misalignment occur in the same direction as that due to cross wind, which is in the side plane defined above. In this case, the projections of the deviations on to the horizontal plane at motor burn out are:

1.76 degrees for every m/s of cross wind
5.2 degrees for every degree of fin misalignment
8.22 degrees for every degree of thrust misalignment

These results can be used to place a conservative restriction on cross wind speed. Taking the measured fin misalignment angle of 0.5 degree and allowing 0.5 degree for thrust misalignment it is found that for cross wind speeds of less than 9 m/s, AUSROC II will remain within a 45 degree arc down range of the launcher.

10.2 Dispersion due to Tail Wind

The significance of a tail wind is that it tends to increase the effective launch angle of a thrusting rocket. For launch angles close to 90 degrees, lateral dispersion entirely governs the initial direction of flight, so that flight in a backwards direction behind the launcher is a possibility. The calculated result for tail wind dispersion is that the trajectory elevation angle is:

1.15 degrees for every m/s of tail wind

A conservative limit of 10 m/s is suggested for tail wind. This would increase the QE from 70 degrees to an effective 81.5 degrees, leaving some margin for fin and thrust misalignment.

Dispersion is sensitive to the value of rocket speed as the rocket just leaves the launcher. It is important to ensure that AUSROC II develops its full design speed of 30 m/s before leaving the launcher. A loss of speed due to slow thrust build up could greatly increase dispersion.

10.3 User Imposed Wind Limitations

In order to ensure adequate safety margin and in view of favourable fuelling an operating conditions, the Ausroc Team have decided to impose a launch wind limit as follows:

Maximum Launch Wind Speed = 8 m/s (28 km/hr)
(16 knots)

11. POST FLIGHT RECOVERY

The rocket will reach apogee in 55 seconds. The drogue is deployed at apogee and brings the rocket down to 3 km where the main parachute is deployed. The vehicle should impact at approximately 8 m/s, 20-25 km downrange unless high speed winds carry the rocket, under canopy, some further distance down or cross range. The Adour R2 radar will skin track the rocket to its impact point. The range recovery truck will then be sent to the nominal impact area to recover the vehicle.

The RSO, AOM and ATO are to be included in the recovery operation to ensure that all on-board pyrotechnics have been activated and/or disarmed. At the time of recovery, any remaining lox will have vaporised and only trace amounts of kerosene will remain in the kero tank, plumbing lines and motor cooling passage. The helium bottle will be completely empty.

The on-board electronics are to be removed from the rocket prior to transport back to the rangehead and packed into the electronics storage box. The fin unit can be unbolted and removed from the rest of the airframe. The rocket, fin unit and electronics box can then be lifted onto the recovery truck and transported back to the rangehead. 3-4 persons can lift the empty rocket without the need for specialised lifting equipment.

APPENDIX A

"Motor and Fin Unit Assembly Checklist"

Prepared By: M. A. Blair ______________________
Ausroc Operations Manager

Checked By: C. R. Gosden ______________________
Trials Control Officer

Safety Acceptance: B. Henderson ______________________
Safety Officer

Approved By: P. Anderson ______________________
ROPS FLTCDR
ARDU

Date:______________________

APPENDIX B

"System Assembly Checklist"

Prepared By: M. A. Blair ________________________
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Checked By: C. R. Gosden ________________________
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Safety Acceptance: B. Henderson ________________________
Safety Officer

Approved By: P. Anderson ________________________
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APPENDIX C

"Valve and Pressure Test Checklist"

Prepared By: M. A. Blair ______________________
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Checked By: C. R. Gosden ______________________
Trials Control Officer

Safety Acceptance: B. Henderson ______________________
Safety Officer

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APPENDIX D

"Electronics Test Checklist"

Prepared By: M. A. Blair ______________________
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APPENDIX E

"Personnel Attendance List"

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Trials Control Officer

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APPENDIX F

"Loose Components Bag List"

Prepared By: M. A. Blair ______________________
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Checked By: C. R. Gosden ______________________
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APPENDIX G

"Pyro and Recovery Installation Checklist"

Prepared By: M. A. Blair ______________________
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Trials Control Officer

Safety Acceptance: B. Henderson ______________________
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APPENDIX H

"Fuelling and Launch Procedure Checklist"

Prepared By: M. A. Blair ______________________
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APPENDIX I

"Abort Procedure Checklist"

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PROJECT AUSROC II

APPENDIX J

"System Specifications & Performance Data"

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Safety Acceptance: B. Henderson ______________________
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ROPS FLTCDR
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PROJECT AUSROC II

System Specifications & Performance Data

AUSROC II - System Specifications

Rocket Dimensions:

Length	6.2m
Body Diameter	0.258m
Diameter across Fins (4 off)	0.858m
Fin Length	0.5m
Fin Width	0.3m
Fin LE Sweep	45 deg
Nose Length (2:1 Ogive)	0.5m

Propulsion System:

Thrust (max)	11,500 N
Burn Time	20 sec
Specific Impulse (Measured)	190 sec
Fuel	Kerosene
Fuel Mass	33 kg
Oxidizer	LOX
Oxidizer Mass	66 kg
Combustion Pressure	3 MPa (peak)
Pressurization Gas	Helium
Gas Bottle Volume	16 lt
Gas Bottle Pressure	25 MPa

Rocket Weights:

Dry Weight	125 kg
Fuelled Weight	224 kg
Propellant Weight	99 kg
Mass Ratio (Mp/Mt)	0.44

Rocket Telemetry:

Sensors:	2 x Accelerometers
	1 x Pitot Tube
	3 x Pressure Sensors
	1 x Temperature Sensor
	1 x CCD Color Video Camera
Transmitter:	Type: Video / Audio
	Frequency: 444 MHz
Power:	10 Watt

Controller:	8051 uProcessor
	8 Channel I/O
	10 bit A/D
	1 Mbyte Eprom
Power:	2 x Dry Lithium Packs
	Voltages: -5,0,5,12,15

Flight Performance:

Launch Rail Length	10 m
Quadrant Elevation (Q.E.)	70 deg
Launch Azimuth	300 deg. magnetic
Calculated Altitude	11,500 m
Calculated Range	24,000 m
Calculated Burnout Vel.	540m/s (Mach 1.6)
Maximum Q	98 kPa
Launch Wind Limitation	8 m/s (all directions)

Recovery:

Stage #1:	1m dia. Ballute Drogue
	(deployed at Apogee)
Stage #2:	24 ft dia. Conical Main
	(Deployed 3000m)

Ausroc II Program Sponsors

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