AUSROC II-2

LOX-KERO ROCKET SYSTEM

WOOMERA TRIAL CAMPAIGN

(19th-26th May 1995)

ASSEMBLY, TEST & LAUNCH

PROCEDURES

Issue: 11th May 1995

CONTENTS

ABBREVIATIONS

AC	Ausroc Cameraman
AOM	Ausroc Operations Manager
ASRI	Australian Space Research Institute
BOC	British Oxygen Company
CON	Range Control Officer (RAAF Personnel)
EC-2	Equipment Center 2 (Launch Blockhouse)
ESM	Electrical Systems Manager
FO	Fuelling Officer
JA-1	Kerosene derivative used as Jet Fuel
IB	Instrumentation Building
LA-2	Woomera Launch Area 2
LCO	Launch Control Officer
LO	Logistics Officer
LOX	Liquid Oxygen
LSC	Launch Sequence Controller
MC	Media Coordinator
MSM	Mechanical Systems Manager
PLC	Pressurised Liquid Container (150 L cryogenic storage)
PRO	Public Relations Officer
QE	Quadrant Elevation
RAAF	Royal Australian Air Force
RSO	Range Safety Officer (RAAF Personnel)
TO	Technical Officer
TS-1	Test Shop 1
TSO	Telemetry Systems Officer

INTRODUCTION

This document provides the procedures for the on-site assembly, test, launch, abort and recovery of the Australian Space Research Institute's (ASRI) Ausroc II-2 rocket system. Ausroc II-2 is a liquid fuelled rocket utilising liquid oxygen and kerosene (JA-1) as propellants and is the improved replacement vehicle for the original Ausroc II-2. The vehicle was designed by a group of university students and ASRI members and is supported by a number of industry and government sponsors. The sponsors include:

Ardebil Pty. Ltd.
Australasian Rocket Engineers.
Australian Aviation Underwriting Pool Pty. Ltd.
Australian Space Office
British Oxygen Company
M.B & J.K. Davidson Pty Ltd
Department of Defence
Defence Science and Technology Organisation
H.I.Fraser Pty. Ltd.
Paradynamics
Pendry Pty. Ltd
Production Machinery Development
RAAF - ARDU

The program objective is to design manufacture and test launch a bi-propellant liquid fuelled rocket system and associated support hardware. Appendix:A 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.

HAZARD LEVEL

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

T-5 DAYS (Friday 19th May 1995)	**LEVEL**
1. Arrival at Woomera	I
2. Unload Kerosene Drums in fuel store.	II
3. Unload Ausroc II-2 Systems and Components (TS-1)	I
4. Unload Ground Electronics (IB)	I

T-4 DAYS (Saturday 20th May 1995)	
1. Motor & Fin Unit Attachment (TS-1)	II
2. Vehicle System Assembly Check (TS-1)	I
3. Pre-Installation Tests of Flight Electronics (TS-1)	II
4. Flight Electronics & Antenna Installation (TS-1)	I
5. Pneumatic Valve Operation Check (TS-1)	II
6. System Pressure Test (TS-1)	II
7. Ground Telemetry System Setup (IB)	I
8. Unload Pyrotechnics in Magazine	II

T-3 DAYS (Sunday 21st May 1995)	
1. Launcher Service Facilities Setup (LA-2, EC-2))	I
3. Post-Installation Flight Electronics Tests (TS-1)	I
4. Pyrotechnics Circuit Trials with Electric Matches (TS-1)	II
5. Installation of Recovery System & Nose Cone	I

T-2 DAYS (Monday 22nd May 1995)	
1. Transport & Install Rocket on Launcher (LA-2)	I
2. Elevate Launcher to 70 deg (LA-2)	I
3. Electronics & Telemetry Tests I (LA-2, EC-2, IB)	I
4. Lower Launcher & Cover Rocket with Tarps (LA-2)	I

T-1 DAYS (Tuesday 23rd May 1995)

1. Uncover Rocket & Elevate to 70 deg (LA-2)	I
2. Electronics & Telemetry Tests II (LA-2, EC-2, IB)	I
3. ARDU / ASRI Launch Sequence Trial Runs (LA-2, EC-2, IB)	II
4. PR Session (LA-2, EC-2, IB)	I
5. Lower Launcher & Secure (LA-2)	I
6. Install Recovery System Pyrotechnics (LA-2)	II
7. Cover Rocket & Launcher with Tarps & Secure (LA-2)	II
8. Transport Propellants to Launcher Area & Cover (LA-2)	II

T-0 DAYS (Wednesday 24th May 1995)

1. Remove Cover Tarps (LA-2)	II
2. ARDU / ASRI Launch Sequence Trial Runs (LA-2, EC-2, IB)	II
3. Final Telemetry & Electronics Tests (LA-2, EC-2, IB)	II
4. Fill Helium Pressure Tank (LA-2)	II
5. Elevate Launcher to 70 deg. QE (LA-2)	II
6. Load and Seal Kerosene Tank (LA-2)	II
7. Install Unconnected Pyrotechnic Igniter (LA-2)	II
8. Activate LA-2 Fixed Video Camera / s	II
9. Load and Seal LOX Tank (LA-2)	II
10. Connect Igniter Leads (LA-2)	II
11. Retreat to Blockhouse (EC-2)	II
12. Commence Launch Sequence (EC-2, IB)	III
13. Launch Rocket (LA-2)	III
14. Recover Rocket	II
15. Post Flight PR Session (IB)	I
16. Pack-up all Gear (IB, EC-2, LA-2, TS-1)	I
17. Leave Rangehead	I

T+1 DAYS (Thursday 25th May 1995)

1. Backup day in case of Delay (Repeat of T-0 Days)

2. AUSROC EQUIPMENT SUMMARY

The following list outlines the items that the Ausroc Group will be transporting to the Woomera Rangehead for use in the Ausroc II-2 Trial Campaign:

1. 6m Raven XI Box with Rocket Hardware (inert)

- Rocket Body / Airframe
- Loose Components Bags (refer Appendix:H)
- 20lt drum hand pump and hose
- Recovery System / Nose Cone
- LOX Fuelling Line
- Rocket Cover Tarps

2. Fin Unit / Engine Transport Box

3. Pyrotechnics Box

- 2 x Pyrotechnic Guillotines (Class 1.4S Explosive)
- 1 x Pyrotechnic Piston (0.3g G-20 powder, Class 1.1)
- 6 x Pyro. Gas Generators (0.2g G-20 powder each, Class 1.1)
- 6 x Ignition Flares (20g pressed powder each, Class ?)
- 5 grams Spare Powder (G20, Class. 1.1)
- 40 x Electric Matches with Leads (Type 'E' and 'K')

4. Two BOC 150 lt LOX PLC's (1 MPa storage pressure)

5. Four BOC EHP Helium Bottles (25 MPa)

6. Two BOC EHP Nitrogen Bottles (25 MPa)

7. Two BOC 'G' Size Nitrogen Bottles (13 MPa)

8. Six 20 lt Drums of AVTUR Jet Fuel (JA-1)

9. Tool Kit

10. Mechanical Test Apparatus

11. Electronics Equipment

Items 3 and 8 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 XI 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. The Tail Unit Assembly Checklist is provided in Appendix:B.

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:C.

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 installed within the rocket body. These tests are to be conducted in Test Shop 1 (TS-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 system assembly checks, the electronics package is inserted into the rocket body from the nose end and secured to the fairing wall. The internal wiring looms are then connected along with the 2 external antennas and associated coaxial cables. At this stage, the electrical break-away connector, which is mounted to the fairing immediately below the electronics module, can be connected to external power & test equipment and the electronics unit retested in Test Shop 1. At the completion of these checks the electronics module will be used throughout the valve and pressurisation tests.

At the completion of mechanical and electrical tests in Test Shop 1, the Raven XI motor trolley, with the Ausroc II-2 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 and 3 support straps.

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 System Assembly Checks, the 3 pneumatic valves are to be tested in Test Shop 1 (TS-1) in flight sequence to validate the flight critical wiring looms, pneumatic circuits and valve sensors. The pneumatics are powered by compressed nitrogen gas at 1.0 MPa supplied and regulated from a standard BOC industrial 'G' size pressure bottle at 13 MPa.

The pneumatic circuit is 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 the pneumatic supply adaptor which is fixed to the rocket support plate on the launcher. When launched, the pneumatic supply line is 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 30 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	22-25 MPa
Pre-Flight Test Pressures	4 Mpa	4.5 MPa	10 MPa
Hydro-Test Pressure	5.2 MPa	5.2 MPa	34 MPa
Relief Valve Setting	4.5 MPa	5.0 MPa	n/a
Theoretical Burst Pressure	>8 MPa	>8 MPa	n/a

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

6. RECOVERY AND PYROTECHNIC INSTALLATIONS

At the completion of the system pressure tests, the recovery system is to be installed without its pyrotechnics in Test Shop 1 in preparation for transport to the launcher rail at LA-2. The procedure for the recovery system installation is given in Appendix:F

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 installation procedure. This involves the removal of the nose cone and nose support ring, insertion and attachment of the drogue cable with 2 pyrotechnic cable cutters, 3 nose release pyro gas generators, the pyrotechnic push rod and, finally, the reattachment of the nose support ring and nose cone. This procedure is given in Appendix:I.

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.

Similarly, the pyros cannot be armed until the electronics unit is activated via the key switch in EC2 and the electrical umbilical connector 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 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 Ausroc Operations Manager (AOM) for evaluation and correction. The ARDU RSO is also to be notified of any failures or problems that occur during the vehicle system testing.

It is planned to have 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 placed at Test Post 1 (Bldg 302) LA-1. The 2 LOX PLC's are also to be loaded onto the back of the recovery truck the afternoon before the flight trial.

7. GROUND EQUIPMENT AND FACILITIES

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

7.1 Telemetry & Data Handling

The receiving and data handling equipment is to be setup in the Instrumentation Building (IB), in the telemetry lab, and, if possible, at R2 on the right flank of the range. These items are:

- 2 x Circularly Polarised Yagi Antennas & Mast Head Amps on roof of IB
- 2 x Coaxial Cables from roof of IB to receivers on first floor
- 1 x Scanner (Telemtry Receiver)
- 2 x Video Recorder (Telemetry / Video Storage)
- 2 x Demodulators
- 3 x IBM-386 Computers for data processing and storage
- 2 x Video monitors displaying on-board video camera

7.2 ASRI Supplied Video & Photographic Coverage

Rocket launch video coverage will be obtained from 2 remote video cameras mounted on tripods around Launcher Area 2. These will be self contained units with battery or mains power 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.

ASRI will also provide its own photographer to document trial activities with both 35mm photographs and slides.

7.3 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 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.

7.4 Personnel Issues

Personnel present for the AUSROC II-2 Trial are divided into 4 groups; Launch Crew, Sponsors, Visitors and Media. Appendix:G lists the names of those involved in each group.

The Logistics Officer (LO) will be reponsible for arranging transportation to and from the rangehead, providing meals for the launch crew and looking after administrative matters. The Public Relations Officer (PRO) will be responsible for coordinating the

activities of the sponsors and visitors. The Media Coordinators (MC) will be responsible for coordinating the activities of the media present for the trial.

7.5 Launcher Services

Electrical and Pneumatic services will be connected to the launcher platform. The pneumatic services consists of a BOC '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 launcher base frame and a 3/8" diameter copper pneumatic tube will transfer the 1MPa nitrogen to the disconnect adaptor on the launcher platform.

The rocket 'sits' on the adaptor to complete the pneumatic circuit. The adaptor provides pneumatic pressure for both the valve 'on' and 'off' capability. 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. Two cables will be used; one for ground power, launch sequencer signals and data transfer and one for the pyrotechnic flare ignition pulse. The first of these will be connected to the break-away connector on the side of the rocket body immediately below the electronics module and the cable itself will be protected by the launcher cable duct and a copper tube leading away from the launcher to the LA-2 cable duct. This connector is disconnected as the rocket leaves the launcher. The second (flare) cable remains attached to the flare which is tethered to the launcher base frame. The flare is ejected from the motor at ignition.

7.6 Range Supplied Equipment & Services

The following Woomera Range facilities will be required for use during the Ausroc II-2 Launch Campaign

1. Test Shop 1
2. Magazine Storage (1.1 G20 powder & Pyrotechnics)
3. Raven XI 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. Launcher Area 2 (LA-2)
9. Equipment Centre 2 (EC2)

10. LA-2 Cable Terminating Hut

11. Adour Radars (R1, R2)

12. Rocket Recovery Trucks (light and heavy)

13. Launcher Area Lights (for early morning work)

14. Fire Extinguishers

7.7 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 ASRI. The hoses and extinguishers are assumed to be provided at the rangehead:

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

8. FUELLING AND LAUNCH PROCEDURES

It is currently planned to conduct the firing at 10.00am 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 6.00am 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 BOC industrial bottles stored on the launcher apron the previous day. The on-board pressure tank is a commercial BOC industrial glass fibre wrapped pressure vessel with a test pressure of 34MPa. The bottle is to be filled to 21-25MPa and should pose no safety problem beyond that encountered with other commercial BOC 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 RSO now holds the launch controller arming 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 RSO passes the arming key to the launch control officer (LCO). The LCO then performs continuity checks of all 4 valve solenoids and firing lines and then initiates the 2 minute firing sequence. At T-0 sec the rocket will leave the launcher rail. Appendix:J 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 safeing procedures. Reasons for aborting the launch include:

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. Adverse weather conditions
6. Tank / Valve leakage during Fuelling
7. Valve Operation failure
8. Misfire
9. Radar Failure

A launch sequence hold which is likely to extend beyond 60 minutes duration from sealing of LOX tank will require the LOX to be dumped to prevent excessive freezing of the LOX components. The kerosene tank and helium tank can remain loaded indefinately. 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 over-ride 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 10 minutes of the flare ignition.

Electric power must be maintained to the Launch Control Sequencer to perform the abort procedures.

Prior to T-10sec 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 20-22 MPa pressure.

After T-10sec 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 20 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 tank bleed plug at the top of the kerosene tank. The helium tank can remain pressurised indefinitely.

The primary abort and propellant dump procedure checklist is given in Appendix:K. 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 effects related to the Ausroc II-2 rocket system as described in ASRI Report 95-1 by Robert Graham (DSTO-WSD).

The flight wind limitations for the Ausroc II-2 campaign follow the procedures outlined in 'Dispersion, Roll and Aerodynamic Loading Predictions for Ausroc II-2', by G. Jepps, April 1991. In this analysis dispersion of the rocket due to steady cross wind, steady tail wind, fin misalignment and thrust misalignment is considered. A user imposed wind limitation is then calculated.

Mr. Jepps' report was based on the initial design for Ausroc II-2. The relevant differences in the Ausroc II-2 variant are increased mass, higher thrust with shorter duration, smaller body diameter, 3 fin tail unit and different CG location. The tail unit uses 3 modified 'AeroHigh' sounding rocket fins which are of stronger construction and sized to provide similar stability to the original Ausroc II-2 rocket. The other differences in design, while small, result in a vehicle slightly more susceptible to dispersion due to cross winds.

In order to determine dispersion characteristics, aerodynamic and mass properties of the vehicle are required. The mass properties are as follows:

Dry Mass	135 kg	(CG = 3.32 m from tip)
LOX Mass	60 kg	(CG = 3.27 m from tip)
Kerosene Mass	30 kg	(CG = 4.58 m from tip)

Xcg (fuelled)	3.47 m from nose tip
Xcg (empty)	3.32 m from nose tip

The USAF Digital Datcom was used to determine the aerodynamic coefficients. Datcom is suitable to the Ausroc II-2 configuration as it easily allows 3 fins to be analysed. The results are listed in the following table. Units are per radian(^{2}). Cd0 is reduced by 0.05 with motor burn due to the increase in base pressure due to thrust.

Mach #	**Cd0**	**Cda2**	**CNa**	**Cma**
0.2	0.424	20.5	19.7	-121.0
0.5	0.399	21.3	20.9	-127.0
0.8	0.391	23.0	22.5	-136.0
0.9	0.468	23.8	23.7	-145.0
1.0	0.643	25.4	26.1	-159.0
1.1	0.759	30.4	30.9	-201.0
1.2	0.760	29.5	29.7	-192.0
1.25	0.744	24.6	25.4	-135.0
1.3	0.688	23.0	24.2	-140.0
1.5	0.651	18.9	20.2	-113.0
2.2	0.511	12.3	13.0	-59.5

An aerodynamic static margin, or measure of stability can now be determined. The following figure shows the static margin for the final Ausroc II-2-1 and Ausroc II-2 for the nominal (empty) configuration:

Ausroc Static Margin vs Mach #

A kinematic computer simulation can be constructed given the thrust value of 11,200 N for 15 seconds, estimates of inertia and the appropriate equations of motion. Ballistic trajectory data is provided in Appendix:A.

To investigate the dispersion, this computer simulation program has been modified to include wind profiles and fin misalignment. The original report calculated dispersion assuming constant parameters throughout flight to burnout. This will provide conservative results if the appropriate parameters are determined. Using a kinematic computer model enhances the accuracy of the results as less assumptions are made.

The fins were accurately assembled and the alignment measured with respect to the fin unit. The alignment was measured at the root, mid-section and tip and then averaged. The worst alignment was 0.028°.

Simulating this misalignment in the lateral plane with no roll results in a lateral dispersion of 0.72° off centerline to impact, or 182m. Therefore, this can effectively be ignored.

The effects of thrust misalignment will be effectively negated due to body roll and so have not been evaluated. Ensuring a value at or below 0.5° will have minimal effect as shown by Mr G. Jepps.

A dispersion limit of ±22.5° off centerline has again been used as the range safety criterion. Simulations show that this limit is reached with a 7.8 m/s constant cross wind. This equates to a 2.9° lateral dispersion per m/s of cross wind.

A 20 m/s tail wind with a 70° QE causes the rocket to reach a maximum elevation angle of 89°. Beyond this, the rocket will travel behind the launch pad. This tail wind is more than double the cross wind limit due to the gravity turn being performed by the rocket

after leaving the launch rail. A head wind will only decrease the effective QE and, hence, is not a safety concern.

Conclusion

Range safety requirements limit the maximum cross wind at launch to 8 m/s. Ausroc II-2 has a large static margin, so this limit could be raised if required by shifting the center of gravity forward, without adversely affecting the vehicle pitch stability.

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

Maximum Launch Wind Speed = 5 m/s (18 km/hr) - Any Direction

11. POST FLIGHT RECOVERY

The rocket will reach apogee in approximately 50 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, 15-20 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 and AOM 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, if possible, prior to transport back to the rangehead and packed into the electronics storage box. The rocket 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. Digging implements should be carried.

APPENDIX A

System Specification and Performance Data

Prepared By: _____

M. A. Blair (Ausroc Operations Manager)

Safety Acceptance: _____

B. Henderson (ARDU Range Safety Officer)

Approved By: _____

Commanding Officer Flight Test Squadron

Date:_____

System Specifications & Performance Data

AUSROC II-2 - 2

Rocket Dimensions:

Length	5.94 m (Nose tip to Base of fin unit)
Body Diameter	0.25 m
# Fins	3 at 120 degree spacing
Fin Root Chord	0.465 m
Fin Tip Chord	0.253 m
Fin Span	0.373
Fin L.E. Sweep	30 degrees (L.E. = Leading Edge)
Fin T.E. Sweep	0 degrees (T.E. = Trailing Edge)
Fin Thickness	10 mm
Fin L.E. Half Angle	3.5 degrees
Fin T.E. Half Angle	3.5 degrees
Nose Length (Ogive)	0.536 m

Propulsion System:

Thrust (max)	10,900 N
Burn Time	15.2 sec
Specific Impulse (Measured)	190 sec
Fuel	Kerosene (4.5 MPa Pressure)
Fuel Mass	30 kg
Oxidizer	LOX (4 MPa Pressure)
Oxidizer Mass	60 kg
Combustion Pressure	3 MPa (peak)
Pressurization Gas	Helium
Gas Bottle Volume	16 lt
Gas Bottle Pressure	25 MPa

Rocket Weights:

Dry Weight	135 kg
Fuelled Weight	225 kg
Propellant Weight	90 kg
Mass Ratio (Mp / Mt)	0.4
Center of Gravity from Tip	3.32 m (empty)
	3.47 m (fuelled)

Rocket Telemetry:

Sensors:	3 x Accelerometers (x,y,z axis)
	1 x Pitot Static Tube (on nose cone)
	- 2 x pressure sensors
	4 x Pressure Sensors
	- He / LOX / Kero / Combustion Chamber
	3 x Valve position sensors
	1 x Temperature sensor
	1 x CCD Color Video Camera
Transmitter:	444 MHz (Video / Audio)
	(5 Watt Net Output at Antenna)
Hard Link:	RS-422 Unidirectional
Controller:	8051 uProcessor
	10 bit A/D, 15 Channels
	1 Mbyte Eprom
Power:	1 x 12VDC Sealed Lead Acid Gel Cell
	Voltages: -15, 0, 6.5, 12, 15

Flight Performance:

Launch Rail Length	10 m
Quadrant Elevation (Q.E.)	70 deg
Launch Azimuth	295 deg. magnetic
Calculated Altitude	9600 m
Calculated Range	21,000 m (full ballistic)
Calculated Burnout Vel.	640 m/s
Maximum Q	160 kPa
Launch Wind Limitation	8 m/s (Upper Safety Limit)

Recovery System:

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

Propellant Valve Operation Timing:

	Ausroc II-2	**Ausroc II-2**
Helium Valve	N/A	120 ms
Kerosene Valve	29 ms	25 ms
LOX Valve	87 ms	52 ms

Figure A1: Ausroc II-2 Thrust vs Time Trace

Figure A3: Ausroc II-2 Simulation Altitude vs Range Plot (ballistic flight only)

Figure A4: Ausroc II-2 Simulation Velocity vs Time Plot

Figure A5: Ausroc II-2 Simulation Mach # vs Time Plot

Figure A6: Ausroc II-2 Simulation Acceleration vs Time Plot

Figure A7: Ausroc II-2 Simulation Dynamic Pressure vs Time Plot

APPENDIX B

Motor and Fin Unit Assembly Checklist

Prepared By: _____

M. A. Blair (Ausroc Operations Manager)

Safety Acceptance: _____

B. Henderson (ARDU Range Safety Officer)

Approved By: _____

Commanding Officer Flight Test Squadron

Date:_____

ITEM	TASK TO BE PERFORMED	CHECK
10	Open Ausroc II-2 transport box in Test Shop 1	
15	Remove 3 upper padded rocket saddles and secure to the Raven motor trolley	
20	Lift the rocket body/airframe onto the 3 padded rocket saddles secured to the Raven Motor trolley	
25	Remove all 4 hatch cover plates from the rocket	
30	Unpack the motor from the transport box, remove it from its plastic storage bag and check the item for damage. Ensure that the nozzle protective cover and dessicant satchel remain on the motor until the launch day	
40	Remove the protective cover from the injector face and clean it with an acetone moistened rag	
50	Ensure that all the injector holes are clear of debris with the injector test rods in Bag:A	
60	Remove 2 of the molybdenum di-sulphide coated injector o'rings from Bag:B and place them on the injector	
70	Remove the 3 x M8 caphead bolts connecting the injector to the thrust mount with the allen key from Bag:C	
80	Push the motor onto the injector ensuring that the kerosene hose cutout aligns with that on the injector. Tap lightly with a rubber mallet if required.	
90	Secure the motor with 12 x M8 hi-tensile cap head bolts and allen key from Bag:C.	
100	Remove the protective cap from the end of the kerosene line and the motor kerosene inlet port	
110	Attach and secure the kerosene line to the motor kerosene inlet with the appropriate open ended spanner	
120	Insert the 1/4" copper pnuematic supply tube from Bag:E through the thrust mount to its' swagelok connector in the lower valve fairing and connect with the appropriate open ended spanner.	
130	Slide the lower valve fairing hatch backing plate into position and secure with 10 x M4 hi-tensile countersunk bolts and allen key from Bag:D	
140	Remove the fin unit from the transport box and check it for any damage that may have occurred during transit. The leading and trailing edge protectors are to remain on the fins until the firing day	
150	Heat the mounting end of the fin unit with an oxy/acetylene flame and attach and secure the fin unit to the thrust mount with 20 x M4 hi-tensile countersunk bolts and allen key from Bag:D. Ensure that the body/fin alignment marks are in alignment.	

160	Insert the aft firewall / bulkhead from Bag:F into location between the motor and fin unit wall ensuring that the pneumatic supply tube fitting matches the attachment hole in the bulkhead and the wall mount holes are in alignment.	
170	Secure the bulkhead with 10 x M4 hitensile countersunk bolts and allen key from Bag:D	
180	Attach the retaining nut to the end of the pneumatic supply tube fitting to secure it to the bulkhead	

APPENDIX C

System Assembly Checklist

Prepared By: _____

M. A. Blair (Ausroc Operations Manager)

Safety Acceptance: _____

B. Henderson (ARDU Range Safety Officer)

Approved By: _____

Commanding Officer Flight Test Squadron

Date:_____

ITEM	ITEM TO BE CHECKED	CK1	CK2
5	**PROPULSION SYSTEM**		
10	Helium Bottle in Place		
15	Helium Bottle Upper Support in Place		
20	10 x Upper He Bottle Fairing Support Bolts Secure		
25	Helium Bottle Lower Support in Place		
30	10 x Lower He Bottle Fairing Support Bolts Secure		
35	3 x Helium bottle tie rods secure		
40	Helium Pressure Sensor Secure and Connected		
45	Helium Bottle Check Valve Secure		
55	Helium Ball Valve in Place & Secure		
60	Helium Ball Valve Actuator and Sensor in Place		
65	Helium Actuator Mounting Cage Secure		
75	He. Actuator "Abort" Tubes Attached		
80	Helium Solenoid Valve Secure		
85	Helium Solenoid "Open" Tube Attached		
95	Helium Solenoid Power Line Secure		
105	LOX Tank Regulator (4MPa) in correct orientation		
110	Kero Regulator High Pressure Tube Secure		
115	LOX Tank Pressurant Check Valve Secure		
120	LOX Tank Pressure Feed Fitting Secure		
125	LOX Relief Valve Stem in Place		
130	LOX Relief Valve (4.5MPa) Secure		
135	LOX Pressure Tansducer Stem in Place		
140	LOX Pressure Transducer Secure		
145	LOX Tank Bleed Plug in Place		
150	LOX Tank Base Fitting Secure		
155	LOX Tank Check / Fill Valve in Place		
160	LOX Transfer Tube Attached		
165	Kero Tank Reg. (4.5MPa) in Correct Orientation		
170	Kero Tank Pressurant Check Valve Secure		
175	Kero Tank Fill port Fitting Secure		
180	Kero Tank Relief Valve (5MPa) in Place		
185	Kero Tank Fill Port Plug in Place		
190	Kero Tank Bleed Plug in Place		
195	Kero Tank Base Fitting Secure		
200	Kero Ball Valve Secure		
205	Kero Ball Valve Actuator in Place		
210	Kero Actuator Mounting Cage Secure		
215	Kero Actuator Position Sensor Secure		
225	Kero Actuator "Close" Tube Attached		
230	Kero Solenoid Valve Secure		
235	Kero Solenoid "Open" Tube Attached		

245	Kero Solenoid Power Line Connected		
250	Kero / Motor Transfer Hose Attached		
255	LOX Ball Valve in Place and secure		
260	LOX Ball Valve Actuator in Place		
265	LOX Actuator Mounting Bracket Secure		
270	LOX Actuator Position Sensor Secure		
280	LOX Actuator "Close" Teflon Tube Attached		
285	LOX Solenoid Valve Secure		
290	LOX Solenoid "Open" Teflon Tube Attached		
300	LOX Solenoid Power Line Connected		
305	LOX Valve / Injector Adapter Secure		
306	"Abort" Solenoid & wiring in place and secure		
307	"Abort" Solenoid supply tube attached and secure		
308	3 x "Abort" supply tubes attached and secure		
310	Injector in Place		
312	Chamber Pressure Sensor Secure		
315	Motor Attached		
320	Motor Mounting Bolts Secure (12xM8)		
325	2 x Ignition Flare Holders + Retaining cable		
	STRUCTURAL COMPONENTS		
330	LVF Hatch Cover & Backing Plate Present		
335	LVF Hatch Cover Bolts Available (12xM4)		
340	ITF Hatch Cover & Backing Plate Present		
345	ITF Hatch Cover Bolts Available (8xM4)		
350	UVF Hatch Cover & Backing Plate Present		
355	UVF Hatch Cover Bolts Available (12xM4)		
360	Electronics Hatch Cover & Backing Plate Present		
365	Electronics Hatch Cover Bolts Available (8xM4)		
370	Fin Unit in Place & Secure (20xM4)		
380	Aft fire wall / Bulkhead installed		
385	Actuator Pressure Tube Attached to Aft fire wall		
395	Lower Launch Lug Secure (4xM6)		
400	Upper Launch Lug Secure (4xM6)		
405	All 5 bolted structural interfaces secure. Each interface has 20 x M4 contersunk bolts		
	RECOVERY SYSTEM		
410	Recovery System wall adapter secure (10xM4)		
415	Recovery System Mounting Plate Secure		
420	PVC Parachute Canister in Place		
425	24' Canopy & Deployment Bag in Place		
430	3 x Body Mounting Straps Secure		
435	Nose Cone / Body Mount Secure (10xM4)		
440	3 x Gas Gen. Bolts Installed		
445	6 x G.G. Initiator Leads Present		
447	Pyro. Push Rod Installed		

448	2 x Pyro. Push Rod Initiator leads Present		
450	Nose Ring Attached to cone (12xM3)		
460	Nose Tip Attached to cone (6xM6)		
465	Pitot Tube Attached		
466	2 x Silicon Pitot Tube pressure hoses attached		
467	Silicon pressure hose pull-out connector secure		
468	Silicon pressure hose secured to parachute fairing wall with cloth tape 250mm long		
470	Drogue & Pouch in Place and secure		
475	Drogue Extension Line Secure		
480	Drogue Support Cable Secure		
485	2 x Pyro. Guillotines Attached & Secure		
490	4 x Initiator Leads present		
	ACTUATOR NITROGEN SUPPLY		
520	'G' Size BOC Nitrogen Bottle in Place		
530	Nitrogen Regulator Attached (1.0 MPa)		
535	1 MPa Nitrogen 3/8" Copper Tube Secure		
565	1MPa Launcher Pneumatic Fitting in place & secure		
	FUELLING EQUIPMENT		
570	2 x 150lt BOC LOX PLC's		
575	LOX Fuelling Line		
580	2 x Safety Coveralls		
585	2 x Safety Visors		
590	2 Sets Safety Gloves		
595	2 x Spare LOX Tank Bleed Plugs		
597	1 x 200lt Kero drum & hand pump		
600	3 x 20lt Kerosene Drums & hand pump		
610	2 x Spare Kero Tank Bleed Plugs		
615	4 x EHP GIG Helium Bottles		
620	EHP Helium Bottle Fitting		
625	Helium Fill Line		
630	Spanner Set and Shifters		
635	6 x 'G' Nitrogen bottles & regulator		
	The Vehicle is now cleared for the Valve and Pressure Tests		

APPENDIX D

Electronics Systems Test Checklist

Prepared By: _____

A. Cheers (Electrical Systems Manager)

Safety Acceptance: _____

B. Henderson (ARDU Range Safety Officer)

Approved By: _____

Commanding Officer Flight Test Squadron

Date:_____

APPENDIX E

Valve and Pressure Test Checklist

Prepared By: _____

M. A. Blair (Ausroc Operations Manager)

Safety Acceptance: _____

B. Henderson (ARDU Range Safety Officer)

Approved By: _____

Commanding Officer Flight Test Squadron

Date:_____

ITEM	TASK TO BE PERFORMED	CHECK
	VALVE OPERATION TESTS IN TEST SHOP 1 (Electronics must be Installed)	
10	Remove the 1MPa regulator from Bag:G and connect it to one of the BOC 'G' nitrogen bottles (13 MPa)	
20	Attach the ground test pneumatic fitting from Bag:E	
30	Attach one end of the 3/8" copper pneumatic tube in Bag:H to the 3/8" swagelok fitting on the regulator and the other end to the 3/8" swagelok on the ground test pneumatic fitting.	
70	Connect the ground test breakaway connector to the rocket electrical connector, power supply, Launch Sequence Controller (LSC) and ground computer	
110	Using the LSC, in manual mode, operate each of the 4 solenoids to ensure that they are all 'Clicking' then return all solenoids to the 'off' position	
120	Open the BOC 'G' nitrogen bottle. The pneumatic circuit is now active. Check for leaks.	
130	Using the LSC in manual mode again, operate each of the valve actuators 'on' and 'off' 3 times. Ensure that the computer displays the correct valve positions.	
140	Turn all 3 valves to 'on' and depress the 'ABORT' button. All 3 valves MUST close immediately for successful operation.	
150	Ensure that all valves are returned to the 'off' position.	
160	Attach an electric match to the end of the LSC flare ignition lead.	
170	Arm and activate the 2 minute launch sequence countdown via the LSC.	
180	Ensure that all 3 valves have operated successfully from the computer record and that the electric match has been initiated.	
190	Replace the electric match and repeat the launch sequence on 2 more occasions.	
200	Ensure that all valves are returned to the 'off' position.	
210	The vehicle is now cleared for the tank pressurisation tests.	
	TANK PRESSURE TEST IN TEST SHOP 1	
230	Ensure that the rocket is firmly affixed to the trolley and that both are physically restrained from moving in the longitudinal direction.	

240	Remove the upper valve fairing hatch cover (8 x M4 bolts)	
250	Attach the helium fill hose and from Bag:I to one of the 'full' EHP Nitrogen bottles (25MPa).	
260	Attach the other end of the helium fill line to the helium bottle check valve through the upper valve fairing hatch.	
280	Only the AOM, MSM and RSO are permitted to be around the vehicle during the pressurisation tests.	
290	Remove the motor nozzle cover and the dessicant satchel from within the motor chamber.	
300	Using the LSC operate the helium valve to the 'open' position	
310	Slowly open the nitrogen bottle until the helium tank pressure sensor reads 3MPa then close the nitrogen bottle.	
320	Allow the pressurised tanks to stand for 15 minutes and then take a second reading of the tank pressures from the computer screen.	
330	Search for gas leaks and repair as required until the pressure reading remains constant.	
333	Increase the He tank pressure slowly to 10 MPa and close the BOC nitrogen bottle. The LOX and kero tank pressures should stabilise at 4 and 4.5 MPa repectively. Allow to stand to 15 minutes. **If either of these 2 pressures is exceeded by 0.2 MPa during the pressure rise, the trial is to be stopped immediately and the regulators checked.**	
336	Search for gas leaks and repair as required until the pressure reading remains constant.	
340	Using the LSC 'open' and immediately 'close' the valves (one at a time) to dump the nitrogen pressurant gas out through the injector and motor and test the regulator resupply.	
350	Return all 3 valves to the 'off' position when empty	
360	Replace the dessicant satchel and motor nozzle cover	
370	Disconnect the helium line from the he. check valve	
380	Replace the upper valve fairing hatch (8 x M4 bolts)	
390	Shut off the pneumatics nitrogen bottle	
400	Disconnect the pneumatic supply tube and electric umbilical connector.	

APPENDIX F

Recovery System Installation Procedure

Prepared By: _____

M. A. Blair (Ausroc Operations Manager)

Safety Acceptance: _____

B. Henderson (ARDU Range Safety Officer)

Approved By: _____

Commanding Officer Flight Test Squadron

Date:_____

ITEM	TASK TO BE PERFORMED	CHECK
10	The recovery system installation is to be conducted after the flight electronics have been installed and system pressure tests have been successfully undertaken.	
70	Remove the parachute wall adaptor/base plate from Bag:J and install it through the nose end of the vehicle to the attachment point. Ensure that the electrical and pyrotechnic wiring looms and silicon pitot pressure tubes are fed through the base plate before it is secured	
80	Secure the wall adaptor/base plate to the rocket body with the 8 x M4 countersunk bolts from Bag:D	
90	Remove the main parachute with 3 main parachute support straps and wall mounts attached from Bag:K and secure each one to its corresponding internal wall location with 6 x M4 countersunk mounting bolts from Bag:D	
100	Remove the parachute storage canister from Bag:K and fix it in location on the parachute base plate with 5 minute araldite. Allow 10 minutes for cure.	
110	Insert and secure the nose adaptor ring to the rocket body with 8 x M4 countersunk bolts from Bag:D. Ensure that the alignment markings match.	
120	Remove the safety cardboard from around the first knife edge cutter at the base of the main parachute bag.	
130	Insert the main parachute bag into the parachute support canister with the support strap junction at the base. Care must be taken to ensure that the knife edge does not cut the parachute bag tie prematurely.	
240	Attach the main parachute bag retainer cord, with the second knife edge cutter, from Bag:L to the top of the parachute support canister to hold the parachute bag in place during negative acceleration after burnout.	
280	Attach the nose cone, with drogue installed, to the rocket body with the 3 retaining pins from Bag:M. Ensure that the markings are aligned	
	The Recovery System is now installed and connected in preparation for transport to the launcher. Note: The pyrotechnics still need to be installed.	

APPENDIX G

Personnel Attendance Checklist

(as of March 1995)

Prepared By: _____

M. A. Blair (Ausroc Operations Manager)

Safety Acceptance: _____

B. Henderson (ARDU Range Safety Officer)

Approved By: _____

Commanding Officer Flight Test Squadron

Date:_____

NAME	POST / ASSOCIATION
LAUNCH CREW	
1. Mark Blair	Ausroc Operations Manager (AOM) (FO1)
2. Norbert Leidinger	Mech. Systems Manager (MSM) (FO2)
3. Andrew Cheers	Electrical Systems Manager (ESM)
4. Tzupei Chen	Launch Control Officer (LCO)
5. John Coleman	Telemetry Systems Officer (TSO1)
6. Ian Bryce	Telemetry Systems Officer (TSO2)
7. Darren Laker	Logistics Officer (LO)
8. Rob Graham	Fuelling Officer (FO3)
9. Colin Biggs	Technical Officer (TO1)
10. Grant Waldram	Public Relations Officer (PRO)
11. Warren Williams	Media Coordinator 1 (MC1)
12. Michael O'Donnell	Media Coordinator 2 (MC2)
13. Grahame Coote	Media Coordinator 3 (MC3)
14. Susana White	ASRI Cameraperson (AC)
15. Torsten Blackwood	ASRI Photographer (AP)
SPONSORS	
Roman Byszinski	Aust. Space Office
Warwick Jones	Aust. Space Insurance Group
Neil Watson + Wife	British Oxygen Company
Brian Embleton	COSSA
Erol Yildrim + Friend	
VISITORS	
Phil Pearson	ASRI - Research Committee
Scott Simmonds	DSTO-WSD
Simon Rettalick	DSTO-WSD
Dwight Van-Roy	DSTO-WSD
Alan Lockett	Defence Center Adelaide
Kerrie Dougherty	Powerhouse Museum
Phil Hinds	ASRI
Greg Brown	Adelaide Uni.
Rick Morgans	Adelaide Uni.
Michael Leske	Adelaide Uni.
Nick Estcourt-Hughes	Adelaide Uni.
David Hayter	Adelaide Uni.
Prakash Sabapathy	Adelaide Uni.
Corey Beer	RMIT
Simon Griffiths	RMIT
Steven Pietrobon	Uni of SA
Stephen Greasley	Sydney Uni.
Greg Redden	CSIRO
Gary Luckman	ASRI
Ian French	ASRI

James Hill	ASRI
Dave Emery	BHP
Yu-Wen Chen	
Jim Blair	
Helena Valentine + Ben	
Jack Blair + Wife	
Steve Cooper	
Ian Fritsch	
SIGHTER / ZUNI TRIALS	
Roy Singh	ASRI
Steven Kollias	ASRI
Chris Chapman	ASRI
MEDIA	
Grant Anderson	A Current Affair
Cameraman	A Current Affair
Soundman	A Current Affair
Phillip Willmington	9 News
John Sever	9 News
Soundman	9 News
Peter Ford	Today-Tonight / 11.00 am
Cameraman	Today-Tonight / 11.00 am
Soundman	Today-Tonight / 11.00 am
Reporter	7 News
Cameraman	7 News
Soundman	7 News
Alan Murrell	10 News
Cameraman	10 News
Soundman	10 News
Peter Lewis	ABC 7.30 Report
John Busch	ABC 7.30 Report
Chris Moon	ABC 7.30 Report
Cameraman	Middlemarch Productions (UK)
Soundman	Middlemarch Productions (UK)
Assistant 1	Middlemarch Productions (UK)
Assistant 2	Middlemarch Productions (UK)
Rick Holden	Advertiser
Photographer	Advertiser
John Fairell	Freelance Science Reporter

APPENDIX H

Loose Component Bags Listing

Prepared By: _____

M. A. Blair (Ausroc Operations Manager)

Safety Acceptance: _____

B. Henderson (ARDU Range Safety Officer)

Approved By: _____

Commanding Officer Flight Test Squadron

Date:_____

BAG / BOX	CONTENTS
A	3 x Injector Hole Test Rods
B	4 x Injector O'rings (molybdenum disulphide coated)
C	16 x M8 High Tensile cap head bolts plus 2 allen keys to suit
D	100 x M4 High Tensile countersunk bolts plus 3 Allen keys
E	Ground Test Pneumatic Tube plus adapters
F	Fin Unit Aft Firewall plate
G	2 BOC Regulators + special EHP bottle adapter
H	5m of 3/8" Copper Pneumatic Tube
I	Helium Fill Hose
J	Parachute Module Wall Adapter and Base Plate + screws (10 off)
K	Main Parachute and Storage Canister
L	Main parachute retainer cord and knife edge
M	6 x Nose retaining Pins plus Pin Puller
N	Nose Pin safety band
O	5 x 1/8" NPT Tank Bleed Port Grub Screws
P	Nitrogen Purge Line plus adapters
Q	Tape Bag (cloth / duct / aluminium / masking)
R	Rags (assorted)
S	Acetone (or similar cleaning fluid)
T	Adhesives Bag (super glue / loctite / 5 minute araldite)
U	Taps (1/8" NPT / 1/4" NPT / M4)
V	3 x Graphite powder containers
W	10 x Brass payload screws
X	3 x Parachute wall mounts
Y	Pneumatic line retaining plate
Z	2 x Drogue support bars
27	3/4" NPT kerosene fill plug + allen key
28	2 x Igniter holders
29	Assorted spare seals
30	Copper pneumatic pullout tube
31	Aluminium pads for fin unit remover
32	Fin unit remover
33	EHP bottle spanner
34	Swagelok fittings and spanner
35	M8 Dynabolts + masonry drills
36	Teflon tape + custom cutoff allen keys
37	Pyrotechnic push-rod assembly
38	Sandpaper
39	Gas torch and hose
40	Nose / body connector ring
41	Drogue parachute assembly
42	LOX fill hose
43	2 x 4L can of acrylic matt black launcher paint + brushes
44	Spray paint (4 x appliance white) (2 x Black)
45	2 x Rotary wire brushes

46	
47	
48	
49	
50	

APPENDIX I

Pyrotechnics Installation Checklist

Prepared By: _____

M. A. Blair (Ausroc Operations Manager)

Safety Acceptance: _____

B. Henderson (ARDU Range Safety Officer)

Approved By: _____

Commanding Officer Flight Test Squadron

Date:_____

ITEM	TASK TO BE PERFORMED	CHECK
10	Prior to the pyrotechnics installation procedure the propellants and gases to be used during the fuelling operation are to be transported to Test Post 1 (Bldg 302) LA-1. Items to be transported are: 3 x 20lt drums of Kerosene, 3 x 'G' Nitrogen Bottles (13 MPa) and 3 x EHP Helium bottles (25 MPa). All items are to be covered for storage overnight.	
20	The pyrotechnic installations are to be performed while the rocket is installed on the launcher rail after the completion of the electronics system tests on the day prior to the firing. Personnel present for this operation are: AOM, MSM, ESM, LCO, and RSO	
30	Ensure that the flight electronics are switched to the 'off' state.	
40	Cut power to the Rocket from the key switch in EC2. The electrical connector, however, is to remain connected to the rocket at all times from now on.	
50	Clear the launcher area of all non-essential personnel.	
60	Transport the pyrotechnics box and work table to the launcher. The launcher area is now restricted to authorised essential personnel only.	
70	Remove the 3 nose cone retaining pins with the pin puller from Bag:M. Remove nose cone	
80	Remove the 10 x M4 bolts holding the nose ring to the fairing and remove the nose ring. Ensure that the PVC parachute tube is adequately supported in the fairing.	
85	Remove the Drogue support cable, with the 2 pyrotechnic guillotines and wall mounts attached, from the pyrotechnics box. Inspect each cutter for signs of damage. Check each for continuity with an approved ohmmeter and short the match wires.	
90	Attach the drogue support cable to the 2 'D' shackles on the unconnected parachute wall mounts.	
100	Bolt the 2 wall mounts to the corresponding locations inside the fairing wall with 6 M4 bolts each from Bag:D	
110	Connect the electric match leads from the cutter cartridges in series and crimp them to the cable pair labelled as 'Cutters' in the wiring loom.	
120	Remove 3 of the pyro gas generator cartridges from the pyrotechnics box and test each for continuity with an approved safety ohmmeter. Short electric match wires after test	
130	Install and secure the 3 gas generator cartridges into the 3 chambers on the nose adaptor ring	

140	Remove the pyrotechnic push-rod unit from the pyrotechnics box and test its gas generator cartridge for continuity with an approved safety ohmmeter. Short the electric match wires after test.	
150	Secure the pyrotechnic push rod unit to the nose adaptor ring with 6xM4 countersunk bolts from Bag:D	
160	Connect the electric match leads from the 3 gas generator cartridges in series and crimp them to the cable pair labelled as 'Nose Pins' in the wiring loom.	
170	Crimp the electric match leads from the pyrotechnic push-rod cartridge to the cable pair labelled as 'Push-Rod' in the wiring loom.	
180	Insert and secure the nose ring to the payload fairing with 10 x M4 countersunk bolts from Bag:D. Ensure that the drogue support cable and pyro. wiring is clear and that the alignment markings match	
190	Connect the drogue support strap, from within the nose cone, to the main parachute pull-out line, which is located on top of the parachute bag, and also to the drogue support cable and the second knife edge cutter with a single 'D' clip and secure.	
195	Connect the 2 silicon pressure hoses from the pitot tube to the press-on connector running along the inside of the parachute fairing.	
200	Attach the nose cone to the rocket body with the 3 retaining pins from Bag:M. Ensure that the markings are aligned and no wiring is crimped.	
210	Attach the nose pin safety retaining retaining band from Bag:N	
210	Transport the pyrotechnics box back to the magazine.	
	The On-Board Pyrotechnics are now all installed and connected in preparation for firing	

APPENDIX J

Fuelling and Launch Procedure Checklist

Prepared By: _____

M. A. Blair (Ausroc Operations Manager)

Safety Acceptance: _____

B. Henderson (ARDU Range Safety Officer)

Approved By: _____

Commanding Officer Flight Test Squadron

Date:_____

ITEM	**Time to Zero**	**TASK TO BE PERFORMED**	**POSTS**
10	**T-5h**	**Depart Woomera Township for Rangehead**	Launch Crew
20	**T-4h20m**	**Launch Crew arrives at Rangehead**	
		Breakfast in Bldg 56	Crew
30	**T-3h50m**	Range Safety Officer to transport pyrotechnic ignition flare box to launcher explosives cabinet from the rangehead magazine	RSO
40		Commence ground electronics tests in IB	ESM TSO's
50		Remove and stow rocket cover tarps	FO3
60	**T-3h30m**	**Perform Dummy Launch Sequence**	
70		Activate observation video cameras on LA-2 and the monitor in EC2 for launcher viewing	OPR
75		Activate EC-2 status computer and ground power supply.	LCO
80		Activate on-board electronics key switch in EC2 **CALL "FLIGHT ELECTRONICS ACTIVATED"**	LCO
85		Confirm operational status of flight electronics and telemetry. **CALL** **"FLIGHT ELECTRONICS OPERATIONAL"**	TSO1
90		Ensure all 3 ball valves are closed **CALL "ALL VALVES CLOSED"**	LCO
100		Connect / Check pneumatic supply line	FO1
110		Open Pneumatics Nitrogen supply bottle. Ensure that bottle pressure is > 10MPa and outlet pressure = 1 MPa **CALL "PNEUMATIC PRESSURE ON. "**	FO1
115		Confirm LSC SAFE / ARM key is safe and key is removed.	RSO LCO
117		Deactivate Electronics for RF Silence **CALL "ELECTRONICS DEACTIVATED"**	LCO
120		Perform a No Volts check on the flare ignition cable and attach electric match ('E' type) to flare ignition cable **CALL "ELECTRIC MATCH CONNECTED"**	RSO
125		Reactivate onboard Electronics **CALL "ELECTRONICS REACTIVATED"**	LCO
127		Confirm Telemetry Status **CALL "TELEMETRY OK"**	TSO1

130		Switch ARDU range control intercept key to 'Armed' **CALL "INTERCEPT IS ARMED"**	CON2
140		Check the continuity of the valve solenoid cables and the ignition flare cable. **CALL "CONTINUITY OK"**	LCO
150		Arm and initiate 2 minute launch sequence **CALL "2 MIN. TEST SEQUENCE ACTIVATED"**	LCO
155		At completion of sequence switch ARDU range control intercept key to 'Safe' **CALL "INTERCEPT IS SAFE"**	CON2
160		Check that the electric match has been fired and that all 3 valves opened in sequence in the required time from the computer records **CALL "TEST SEQUENCE SUCCESSFUL"**	LCO TSO1
165		Close all valves. Switch LSC safe/arm key to 'SAFE' and remove key **CALL "ALL VALVES CLOSED, LSC SAFE/ARM SWITCH IS SAFE AND KEY REMOVED"**	LCO
170		**This sequence must be successful to continue pre-launch test and fuelling operations**	
180		Repeat 115-170 on two more occasions	
190		Deactivate onboard electronics for RF silence **CALL "ELECTRONICS DEACTIVATED"**	LCO
200		Check continuity of the electric match in the ignition flare while in RF silence then short the match leads	RSO
210		Reactivate onboard electronics **CALL "ELECTRONICS REACTIVATED"**	LCO
215		Confirm operational status of telemetry **CALL "TELEMETRY OK"**	TSO1
220		Close pneumatics nitrogen bottle and vent the line pressure. **CALL "PNEUMATICS OFF"**	RSO
225		At this stage the Range Safety Officer will hold the launch sequence controller arming key. The override key will remain with the LCO.	FO1
240	**T-3h**	**Commence Helium Fill**	
250		Essential personnel only are now permitted to be present on the launcher apron. 3 FO's, the RSO + assistants, AP and the AC **CALL "COMMENCING HELIUM FILL OPERATION"**	FO1
260		Remove Upper valve fairing hatch (8xM4 Bolts)	FO2
270		Connect helium fill hose from Bag:I to first helium pressure bottle	FO3
280		Connect fill hose to Helium fill check valve	FO2

290		Slowly open helium pressure bottle	FO2
300		When pressures have equalised close helium bottle	FO2
310		Disconnect fill hose from pressure bottle	FO3
320		Obtain Helium Tank Pressure reading from EC-2 computer display. **CALL "HELIUM PRESSURE AT _____ MPA"**	LCO
330		Repeat 270-320 with 2nd & 3rd helium bottles	
335		Rocket helium tank pressure sensor should read approximately 20-23 MPa. Allow the tank to settle for 5 min to check for leaks.	
340		Disconnect fill hose from Helium fill check valve	FO2
345		Transport the 3 Helium pressure bottles and fill hose to Test Post 1 (Bld 302) LA1. Replace Hatch Cover (8 x M4 bolts)	FO1 FO3
350		**CALL** **"HELIUM FILL OK. PRESSURE AT ____ MPA"**	LCO
355		**Enable battery and payload launch detect, and test battery operation.**	
360		Switch External Power Off	LCO
362		Switch 'Battery Enable' switch to 'Enabled'	FO1
364		Switch 'Test/Launch' switch to 'Launch'	FO1
366		Attach video camera and electronics hatch	FO1
368		Switch External power on	LCO
370		Confirm operational status of telemetry **CALL "TELEMETRY OK"**	TSO1
372		Confirm payload state is 'Pending Go' **CALL "PAYLOAD STATE PENDING GO"**	TSO1
374		Switch internal battery on	LCO
380		Confirm battery unloaded voltage is acceptable **CALL "BATTERY UNLOADED VOLTAGE OK"**	TSO1
385		Switch external power off. External power should not be off for more than 1 minute.	LCO
386		Confirm operational status of telemetry **CALL "TELEMETRY OK"**	TSO1
387		Confirm battery loaded voltage is acceptable **CALL "BATTERY LOADED VOLTAGE OK"**	TSO1
390		Switch external power on	LCO
395		Remove the motor nozzle cover and dessicant satchel	FO3
400	**T-2h30m**	**Elevate Launcher**	
405		**CALL "PREPARING TO ELEVATE LAUNCHER"**	FO1
410		Clear all personnel to rear of launcher	RSO
415		Remove safety band from around Nose pyro-pins **CALL "SAFETY BAND REMOVED"**	FO1

420		Winch up the launcher rail until the rail support beams align with the 70 degree QE mounting brackets. Assist initial portion of lift (FO2, FO3)	FO1 FO2 FO3
430		Bolt support beams to brackets (2xM12 bolts)	FO2 FO3
440		Connect rear support cables to turnbuckles and tension until the launcher rail is straight at 70 degrees QE	FO2 FO3
450		Move Scaffold fuelling tower into place and lock wheels	FO1 FO3
460		**CALL "LAUNCHER SECURE. SCAFFOLD IN PLACE"**	FO1
470	**T-2h**	**Commence Final Telemetry & Electronics Tests**	
490		Ensure that the telemetry signal is being received and recorded and that the system status is operational **CALL "TELEMETRY RECEIVED"**	TSO1
520		Record ground wind velocity. If greater than 5m/s hold or abort pending forcast.	CON1
530	**T-1h30m**	**Media arrive and setup remote cameras**	Media
540	**T-1h30m**	**Kerosene Fuelling Operation**	
550		**CALL "COMMENCING KEROSENE TANK FILL"**	FO1
560		Move 3x20lt kero drums and hand pump onto scaffold fuelling tower	FO3
570		Remove the lower valve fairing hatch. (8xM6 bolts)	FO2
580		Remove kero tank fuelling port plug	FO3
590		Remove kero tank bleed plug	FO3
600		Attach hand pump to first kero drum and pump kero into tank via the fuelling port	FO3
605		Check for kerosene leaks in the lower valve fairing	FO2
610		Repeat process with remaining 2 kero drums until kero is seen to be flowing out of the bleed port	
620		Replace and tighten bleed port plug	FO1
630		Replace and tighten fuelling port plug	FO1
640		Clean up any kero spills and move empty kero drums and hand pump to Test Post 1 (Bld 302) LA1	FO2 FO3
650		**CALL "KEROSENE TANK FILL COMPLETE"**	FO1
660		Re-Check helium tank pressure. The pressure should be 20-23 MPa **CALL "HELIUM PRESSURE STILL NOMINAL"**	LCO
665		Install intertank hatch backing plate **CALL "BACKING PLATE SECURE"**	FO1 FO3
680	**T-1h**	**Pyrotechnic Ignition Flare Insertion**	

690		Remove ignition flare, with electric match installed, from storage box	RSO
710		Attach the flare tether cable to the flare support bar	FO2
720		Clean flare support bar and the underside of the launcher support plate with a clean dry rag	FO3
730		Insert the ignition flare into the nozzle as far as the support bar will allow	FO1
740		Use cloth tape to secure the support bar to the launcher support plate **CALL "FLARE INSTALLED. LEADS SHORTED"**	FO1 RSO
750	**T-1h**	Sponsors and visitors arrive at the rangehead and go to the Viewing area in the IB	PRO
760	**T-50m**	**LOX Purge and Fuelling Operation**	
763		FO1 and FO2 to be wearing approved cryogenic safety gear	FO1 FO2
765		**CALL "PREPARING TO PURGE LOX SYSTEMS"**	FO1
770		Reverse the truck with the 2 LOX PLC's and N2 purge bottle into position next to the launcher on the opposite side to the scaffold	RSO
775		Attach the LOX fuelling hose to the LOX PLC	FO2
780		Attach LOX fuelling hose to LOX fill check valve	FO1
785		Remove LOX tank bleed port plug	FO1
790		Connect the nitrogen purge line (Bag: P) to one of the 'G' nitrogen bottles (13 MPa) and to the LOX bleed port.	FO1 FO2
800		Using the override key and LSC, open the LOX ball valve	LCO
820		Open the nitrogen bottle to allow a slow flow of the dry nitrogen to purge through the LOX tank, valve and injector. The purge is to last for 2 minutes.	FO2
830		Close the nitrogen bottle	FO2
840		Remove the purge line from the LOX bleed port.	FO1
850		Using the override key and LSC, close the LOX ball valve, check for kerosene leaks and, if none, replace the lower valve fairing hatch. (8xM6 bolts) else rectify leak.	LCO
860		**CALL "NITROGEN PURGE COMPLETE"**	FO1
870		Remove fin edge protectors **CALL "FIN EDGE PROTECTORS REMOVED"**	FO3
880		All remote video cameras on LA-2 are to be activated and checked at this point.	AC
940		**All fuelling officers to be off the scaffold during LOX fill**	

950		Open the PLC liquid transfer valve. Oxygen vapour will exit via the bleed port during the fill operation.	FO2
960		A thick white stream of oxygen vapour will exit the bleed port when the liquid level reaches it.	
970		When full, close the PLC liquid transfer valve	FO2
980		FO1 returns to the scaffold and removes the LOX fuelling line from the check valve and attaches the check valve plug	FO1
985		Tighten LOX pipe nut with spanner while chilled	FO1
990		Drive the truck with the 2 LOX PLC's to a safe location	RSO
1000		Replace intertank hatch (8xM6 bolts)	FO1
1010		Replace LOX bleed port plug. At this point the LOX tank pressure will begin to rise and the tank relief valve will vent at pressures > 4.5MPa **CALL "LOX TANK SEALED"** **Record time of LOX tank closure**	FO1 LCO
1020		Move Scaffold to safe location (>10m from rocket)	FO2 FO3
1030		**CALL "LOX TANK FILL COMPLETE"**	FO1
1040		Open the pneumatics nitrogen bottle. Confirm setting at 1 MPa. **CALL "PNEUMATICS CIRCUIT ACTIVE"**	FO1
1050	**T-15m**	**Final Arm and Launch Procedure**	
1060		**CALL "-15 MINUTES"**	CON2
1065		Deactivate onboard electronics for RF silence **CALL "ELECTRONICS DEACTIVATED"**	LCO
1070		Perform a no volts check on the flare ignition cable and attach the firing leads to the ignition flare igniter leads.	RSO
1075		Reactivate onboard electronics **CALL "ELECTRONICS REACTIVATED"**	LCO
1077		Confirm operational status of Telemetry **CALL "TELEMETRY OK"**	TSO1
1080		RSO and 3 FO's return to EC2 for the firing sequence.	
1090	**T-10m**	RSO passes 'Arming' key to the LCO. **CALL "-10 MINUTES"**	CON2
1110		Confirm telemetry status. **CALL "TELEMETRY RECIEVING OK"**	TSO1
1120		**The on-board electronics and telemetry must be operating successfully to continue at this point.**	
1125		Switch range control intercept key to 'ARM' **CALL "INTERCEPT IS ARMED"**	CON2

1130		The 4 solenoid valve operating cables and the flare igniter cable are re-checked for continuity **CALL "ALL FIRING LINES OK"**	LCO
1135		Switch range control intercept key to 'SAFE' **CALL "INTERCEPT IS SAFE"**	CON2
1140	**T-5m**	Record final ground wind velocity. If greater than 5m/s hold firing sequence for up to 60 min. from time of LOX tank closure then abort.	CON1
1150		**CALL "-5 MINUTES"**	CON2
1160		**CALL "ALL SYSTEMS GO FOR LAUNCH"**	AOM
1170		**CALL "AUSROC II-2 CLEARED FOR LAUNCH"**	CON1
1180	**T-4m**	**CALL "-4 MINUTES"**	CON2
1185		Start recorders on all media video cameras	FO3
1190	**T-3m**	Arm Launch control sequencer **CALL "SEQUENCER ARMED"**	LCO
1200	**T-2m**	Fire button is pressed. 2 minute firing sequence is activated. The abort button can cancel the sequence at any time during the 2 min. countdown. **CALL "SEQUENCE ACTIVATED"**	LCO
1210	**T-1m**	**CALL "-1 MINUTE"**	CON2
1220		Activate all data recorders **CALL "DATA RECORDERS OPERATIONAL"**	TSO1
1240	**T-15s**	**CALL "-15 SECONDS"**	CON2
1245		Switch range control intercept key to 'ARM' **CALL "INTERCEPT IS ARMED"**	CON2
1255	**T-10s**	Helium Valve opens and the 2 propellant tanks are pressurised. Check Tank Pressures. If incorrect: **CALL "ABORT"**	LCO
1260	**T-5s**	Ignition flare ignites	
1270		Confirm flare ignition. If no ignition: **CALL "ABORT"**	
1280		The remote still cameras are activated.	
1290	**T-0.25s**	Kerosene valve opens	
1300	**T-0.00s**	LOX valve opens. Ignition occurs. Rocket liftoff. The ignition flare is expelled from the motor nozzle. The Pneumatic and electrical connectors pull out.	
1310		The pneumatics nitrogen bottle will exhaust to atmosphere through the pullout connector until the bottle is empty	
1320	**T+30s**	**CALL "+30 SECONDS"**	CON2
1330	**T+50s (approx)**	Rocket reaches 9600 m Apogee. Telemetry will indicate that drogue deployment is initiated. **CALL "DROGUE SEQUENCE ACTIVATED"**	TSO1

1340	**T+2m (approx)**	Telemetry will indicate that main canopy deployment is initiated at 3000m **CALL"DEPLOYMENT SEQUENCE ACTIVATED"**	TSO1
1350	**T+4m**	Remove the arming key and disable power to the launch control sequencer. **CALL "SEQUENCER DISABLED"**	LCO
1355		Switch range control intercept key to 'SAFE'	CON2
1360	**T+5m (approx)**	Nominal impact approx. 25km downrange **CALL "AUSROC II-2 CONFIRMED LANDING"**	TSO1
1370	**T+10m**	RSO and FO1 return to launcher apron. **CALL "SITE CLEAR"**	RSO FO1
1380	**T+20m**	Stop remote video cameras	AC
1390	**T+30m**	Recovery truck departs for rocket pickup. At least 4 persons required for recovery.	RSO

APPENDIX K

Abort Procedure Checklist

Prepared By: _____

M. A. Blair (Ausroc Operations Manager)

Safety Acceptance: _____

B. Henderson (ARDU Range Safety Officer)

Approved By: _____

Commanding Officer Flight Test Squadron

Date:_____

ITEM	TASK TO BE PERFORMED	POST
10	The abort procedure can be initiated for any of the reasons listed in Section 9 of this report.	
20	Prior to -2mins Call for a hold in the sequence From -2mins down Call "Stop. Stop. Stop."	Problem Post
30	Prior to -2mins CON2 will stop the IPU From 2mins down LCO will press the abort button and **CALL "STOP. STOP. STOP."**	LCO CON2
50	Power **MUST** be maintained to the LSC to enable the manual operation of the ball valves for propellant dump	
	Abort Prior to Flare Ignition (Before T-5sec)	
60	Determine the cause of the abort.	Problem Post
70	If the abort problem relates to ground equipment: ie radars, telemetry, data recording etc and does not involve personnel returning to the vehicle, a maximum hold period of 60 minutes from time of LOX tank closure can be initiated to provide time to fix the problem at hand	
80	If the solution to the abort problem exceeds the 60 minute duration from LOX tank closure, the propellant dump operation is to be initiated	LCO
100	If all problems are rectified in the 60 min period from LOX tank closure, the LCO is to reset the LSC and **CALL "READY TO RE-ENTER SEQUENCE"** and continue at the -2min 30 sec point in the firing sequence	LCO
	Abort After Flare Ignition (After T-5 seconds)	
120	The ignition flare will burn for approximately 20 seconds	
130	After a 2 minute wait period, remove and short the ignition flare leads from the LSC	LCO
140	Determine the cause of the abort.	Problem Post
150	A maximum 60 minute hold period from LOX tank closure can be initiated to provide time to fix the problem at hand.	
170	If the solution to the abort is less than 60 min then perform 180-240 else if the solution to the abort problem exceeds 60 minutes duration from LOX tank closure, the propellant dump operation is to be initiated	
180	RSO is to take possession of the ARM keys	RSO
190	After a 10 minute wait period FO1 and RSO return to the launcher apron	RSO

200	Disconnect the ignition flare leads from the spent flare in the rocket motor.	FO1
210	Remove the spent flare and retaining tape from the rocket motor and disconnect the tether cable **CALL "SPENT FLARE REMOVED"**	FO1
220	Repeat the pyrotechnic flare insertion procedure given in the Trials Instruction at T-1 hour (appendix J)	FO1
230	Reconnect the ignition flare firing lines. Repeat steps 1065-1075 (appendix J) **CALL "IGNITION FLARE LEADS ATTACHED"**	RSO
240	RSO and FO1 return to EC2	
250	If all problems have been rectified within the 60 minute hold period from LOX tank closure, resume the countdown procedure from T-10 minutes otherwise proceed with the propellant dump operation	
	LOX Dump Operation (After 60 minute hold from LOX tank closure)	
255	Ensure CON2 has switched the range intercept key to 'SAFE'	LCO
260	Remove and short the ignition flare firing lines from the rear of the LSC **CALL "IGNITION FLARE SHORTED"**	LCO
270	Activate the valve override enable key switch **CALL "OVERRIDE ENABLED"**	LCO
280	Close the helium ball valve **CALL "HELIUM VALVE SHUT"**	LCO
290	Open the LOX ball valve with the LOX override switch **CALL "LOX DUMP INITIATED"**	LCO
300	• The LOX will be dumped through the ball valve, injector and motor to the atmosphere and vaporise immediately	
310	The ignition flare will be expelled from the motor during the LOX dump and remain on the ground, attached via a tether to the launcher frame	
320	After a 30 minute wait period the RSO and the 3 FO's return to the launcher apron	
330	Disconnect the ignition flare leads and the cable tether and move the flare to a safe location.	RSO
340	Move Scaffold fuelling tower into place and lock wheels	FO2 FO3
350	Remove intertank hatch (8xM4 bolts)	FO1
360	Slowly loosen the kerosene tank fill plug. The kerosene tank pressure will be released during this operation	FO1
370	Once the helium pressure in the kerosene tank reaches ambient, re-secure the kerosene tank fill plug to seal the kerosene tank	FO1

380	The rocket is now inert with the LOX tank empty, the kerosene tank fuelled at ambient pressure and the helium tank empty. The launcher rail can now be lowered to fix any problems that may have arisen causing the abort	FO1 FO2 FO3
390	Once the rail is lowered to the horizontal position, replace the nose pins safety retention band	FO2
	Pyrotechnics Disarming Procedure	
395	Ensure that the electronics module is disabled	LCO
400	Remove the nose pins safety retention band	FO2
410	Remove the 3 nose support pins with the pin remover in Bag 'Q'	FO2
420	Remove the nose cone and disconnect the 2 pitot tube pressure transfer hoses	FO2
430	Unbolt the nose-body adapter ring and remove. Place a spacer under the main parachute canister to support it once the adapter ring is removed	FO3
440	Cut the 6 crimped firing lines leading to the 3 pyrotechnic gas generators in the nose adapter ring	FO1
450	Cut the 2 firing lines leading to the pyrotechnic push rod assembly	FO1
460	Unbolt the 2 drogue wall mounts and remove from the rocket body	FO3
470	Cut the 4 crimped firing lines leading to the 2 pyrotechnic cable cutters	FO1
480	Remove the 3 gas generators from the nose adapter ring and place in the pyrotechnics storage box	FO2
490	Remove the gas generator from the pyrotechnic push rod assembly and place in the pyrotechnics storage box	FO2
500	Place the cable cutters, complete with cable, in the pyrotechnics storage box	FO3
510	Transport the pyrotechnics storage box to the magazine for safe storage	RSO
	The pyrotechnics are now disarmed and removed from the vehicle. The remainder of the recovery system dissassembly procedure is classed non-hazardous and can follow the reverse of appendix:G	