A. V. ROE CANADA LIMITED
MALTON - ONTARIO

RESEARCH & DEVELOPMENT (AIRFRAME)

PROJECT ARROW I FIRST AIRCRAFT REPORT No. RD. 86

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TITLE:

GROUND TEST DEPARTMENT

SUMMARY OF PRE-FLIGHT TEST

REQUIREMENTS

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FORM 1368

SUMMARY OF PRE-FLIGHT TEST REQUIREMENTS

Operations are numbered to correspond to Ground Test Department Pre-Flight Test Programme.

(1) Utility Hydraulics R.T. 08-611

Fit pressure gauges (4) downstream of Brake Control Valve in brake lines. Attach thermocouples (3) to hydraulic pipes.

Check compensator level, slowly pressurize system, check warning light operation (Utility Hydraulic and Emergency Brake), cut out pressure, changes in compensator level and temperature, return system pressure. Operate wheel brakes and check warning light operation (Utility Hydraulics). Check Emergency Brake light.

Repeat Above Five Times.

Shut off Ground Hydraulic rig Heat Exchanger. Raise pressure until A/C pressure regulator valve opens. Read and tabulate thermocouple readings simultaneously at 1 minute intervals.

Connect ground rig to Armament disconnects, raise pressure until relief valves are fully open. Check all visible lines for leakage. Operate emergency A/C alternator and check lines for leakage.

Landing Gear

With pump flow 5 gallons/minute operate landing gear. With doors up and locked check rigging requirements.

With pump flow 40 gallons/minute or gear operating time 2 seconds, operate landing gear 20 times. Check door jack piston rods, uplocks and sequence valves for damage. Record pressure regulator cut in and cut out pressures.

Carry out Emergency Lowering. Check for leaks and damage. Bleed and prime system.

Speed Brakes

With pump flow 5 gallons/minute operate Speed Brakes as follows: Retract, intermediate "Hold", intermediate "Hold", Extend, intermediate "Hold", Retract.

Repeat Five Times

Check rigging and selector against actual position. Record times for full extension and retraction. Check "creep" over 5 minutes in "Hold" position.

Operate Speed Brakes Twenty Times

Wheel Brakes - Normal System

Check pressures on operating both brakes together. Repeat 5 times.
Check pressures on operating R.H. Brake. Repeat 5 times.
Check pressures on operating L.H. Brake. Repeat 5 times.

Emergency System

Operate brakes from emergency system L.H. and R.H. separately, recharging Utility system accumulator in between.

Operate both brakes simultaneously.

Repeat 3 times.

Check parking brake. Release. Repeat 3 times.

Record number of brake operations available on emergency system.

Repeat 3 times.

(2) Electrics - R.T. 08-604

Check to Report No. P/Systems/34" Production and Pre-Flight-Testing of Electrical Systems", in conjunction with Inspection.

No additional engineering tests required.

(3) Engine Intake Duct Pressure Test R.T. 08-694

Blank off duct at aft ring of Floating Duct forward of Gill Doors Assy. and at duct entry. Pressurize to 10 p.s.i., measure leak rate.

Both Port and Starboard ducts.

(4) Flying Control Hydraulics R.T. 08-613

Attach thermocouples (2) to system piping.

Pressurize system slowly, check changes in return pressure and fluid temperature. Discharge, with same checks.

Repeat Five Times.

Check operation with Utility System unpressurized. Check operation of each system (A and B) separately with other systems unpressurized. Check relief valves by overpressurizing to 4,800 p.s.i.

(5) Engine Control (Stiffness) R.T. 08-614

Before engine installation, lock controls at engine pick up point, load Throttle lever and measure deflection up to 75 lb.

Both Port and Starboard Controls.

(6) Electrics - R.T. 08-604

See Item (2).

(7) Parachute Brake (Mechanism) R.T. 08-651

Static Function

Remove parachute compartment doors.

Operate locking mechanism, checking latch and cockpit indicating time each time.

Repeat 20 times.

Stiffness

Lock release mechanism at (a) Door Latch Pick Up Position and (b) Jettison Latch Pick Up Position. In each case load the control handle up to 150 lb. and measure deflection.

System Self Actuation

Deflect cable run until compartment doors open.

Effectiveness of Solenoid Latch

Load of 150 lb. at cockpit control handle with solenoid latch artifically energised. Measure position of latch roller relative to forward edge of door before, during and after loading.

(8) Engine Controls (Friction) R.T. 08-614

No Mods. to A/C.

With engines installed, controls normal and throttle box friction device release, measure throttle lever break out and friction loads. Both Port and Starboard controls.

(9) Oxygen System R.T. 08-643

No Mods. to A/C.

With converter removed, pressurize system (300 p.s.i.), check for leaks.

Disconnect Pilot's emergency oxygen bottle, blank off outlets to mask and pressure suit on Pilot's composite disconnect. Disconnect normal oxygen supply line from dual check valve. Pressurize emergency system to 1,800 p.s.i. Repeat on Navigator's system.

Check operation of composite leads disconnect and emergency trip valves on pilots and navigators seats by pulling them slowly up ramps.

Check converter loss over 24 hours at 70°F (Off A/C).

Check capacity gauge against weighed weight of oxygen on installation of converter into A/C.

(10) Electrics - R.T. 08-604

See Item 2.

(11) Low Pressure Pneumatics R.T. 08-645

Canopy Seals And Anti-G System

Blank off Anti-G pressure line at Navigators bulkhead, disconnect R.H. - Navigators canopy seal, connect pressure gauge to hose. Connect comp. air supply to drain fitting of hot air filter.

Close and lock both canopies, pressurize system to 50 p.s.i., check gauge reading; check system for leaks. Check press. loss over 15 minutes.

Reconnect Anti-G pressure line, blank off Radome de-icing pressure line, connect pressure gauge to suit outlet port of navigators composite disconnect.

Connect compressed air supply as above, pressurize system to 50 p.s.i., and check Anti-G system for leaks.

Repeat for Pilots Anti-G Valve.

Pitot-Static System

Static lines - Disconnect static lines from all units supplied by both nose boom static sources. Apply air pressure (2 to 5 p.s.i.) to water trap strain plug in primary static system. Check air flow out of lines. Repeat with air supply to secondary system. Reconnect all lines.

Seal off static holes in nose boom with red tape. Attach vacuum source to water trap drain plug in primary system. Check pressure drop with front cockpit altimeter.

Repeat on secondary system.

A similar check is made on the Pitot lines, checking on the front cockpit ASI.

Similar checks are made on the Upper Fin Probe pitot systems.

Radome De-Icing

With alcohol tank empty and air input line disconnected 50 p.s.i. pressure gauge is connected to air input line and system pressurized to 50 p.s.i. Check gauge reading. Reconnect air input line to tank, teeing in 50 p.s.i. gauge. Pressurize system until relief valve opens (14 ± 1 p.s.i.).

Reconnect system, put 1 gallon alcohol in tank, pressurize and operate ice detector relay. Check alcohol spray and air purging.

Repeat 3 times.

(12) Escape System (Ejector Seats) R.T. 08-805

No Mods. to A/C.

Check Bail Out Warning System operation.

Check escape system controls functioning.

Withdraw seats and check for adequate clearance.

Check seat functioning for sequence after ejection including Barostat release and manual separation.

(13) Flying Controls (Stiffness Friction and Frequency Response) R.T. 08-614

Loading rig to be fitted in cockpit for Stiffness tests.

Select Emergency Mode, no hydraulic supply.

Elevator Circuit Stiffness

Disconnect artifical feel unit, lock jack valves, load stick to 200 lb. Measure stick deflection. Load both ways.

Repeat, locked at Rear Quadrant.

Aileron - repeat above, loading to 100 lb.

Rudder - repeat above, loading pedals to 300 lb.

Elevator Circuit Friction

Select emergency mode, hydraulic power on.

Disconnect Feel Unit, measure stick force to overcome friction, in both directions.

Disconnect Feel Unit, parallel servo and jack valve from Rear Quadrant. Measure stick force to overcome friction, in both directions.

With valve linkages disconnected at Rear Quadrant, measure friction in both linkages in both directions.

Measure load required to move surface through entire range of travel with jack disconnected.

Aileron Circuit Friction

Repeat as Elevator.

Rudder Circuit Friction

With Feel Trim unit disconnected, hinge moment limitor disconnected, measure pedal load to overcome friction, in both directions.

Frequency Response

Manual oscillation of stick and rudder pedals with a Trace Recorder measuring stick and pedal forces and positions, parallel servo ram positions, differential servo ram positions, main jack ram positions, control surface positions.

Elevator and Aileron checked both in Manual and Emergency modes.

Rudder checked in Emergency mode.

Elevator Parallel Servo - Pilot's Override

Measure stick forces with servo stationary and servo displacing at maximum rate with external signal supplied to parallel servo.

Aileron Parallel Servo - Pilot's Override

As Elevator.

Measure Elevator, Aileron and Rudder Parallel Servo Authority over range of movement at 5° increments.

Control Force and Trimming

Check Stick and Pedal break out forces. (Emergency Mode)

Check Stick position against Surface position and stick force for 10 different positions of stick, aileron and elevator.

Repeat tests moving in opposite direction.

Check Pedal position, rudder angle and pedal force for 6 positions of pedals. Repeat moving in opposite direction.

Record Elevator, Aileron angles, stick position at trim limits.

Repeat preceding relative movement test at trim limits.

Measure time to trim between limits.

Measure time lag between selection of trim and response.

Measure time lag between release of trim selector and cessation of movement.

Record Rudder angle/Pedal position at trim limits.

Check Rudder Angle, pedal positions and force for 6 positions in each direction at trim limits.

Record Rudder angle, Pedal position with 150 lb. Pedal force and Rudder limitation unit servicing valves of q_c between 0 and 3,000 lb./ft.^{2} in increments.

Check in reverse direction.

Check trim time lag as Elevator.

(14) Nosewheel Steering (Stiffness and Friction) R.T. 08-625

Disconnect Rudder control cables at front quadrant and lock steering motor valve. Measure rudder pedal deflections up to 150 lb. load. Repeat in opposite direction.

Disconnect Rudder control cable and Steering motor valve. Measure load at pedal required to overcome friction in each direction.

(15) Fuel System (Air Pressurization System) R.T. 08-608

Connect 25 p.s.i. gauges downstream of Absolute and Differential Pressure regulators. Connect Ground Elect. Supply. Apply 85 p.s.i.g. air pressure to inlet of H.P. line to system.

Check electrical Actuation and Override, pressure regulation, pressure build up rate, relief valve actuation, electrical overrides and pressure relief adequacy. Check Fuel System air leakage, A/C structure and external pipe leakage.

(16) Fire Protection System R.T. 08-637

Electrical check; leakage-check on connections.

(17) ARA 25 - D/F)
) Flight Test Radio Checks
(18) APX 6 - IFF)
(19) R/C Antenna EH. H4.)

(20) Instrumentation Installation)
) Flight Test
(21) Instrumentation Calibration)

(22) Fuel System (Flow and Calibration) R.T. 08-608

Check on Undrainable and Unusable Fuel, Flow Proportioners, Fuel Transfer Pumps, Refuelling equipment, fuel refuelling, partial refuelling, de-fuelling, condensate drain valves. Fuel system leakage tests.

Transfer system functioning tests, flow rates, cross feed functioning, flow proportioner transfer pump by-pass, air admission valves, low level warning system. Check on Net and Gross capacity, unavailable fuel. Fuel contents system calibration test.

(23) Fuel Tank Pressurization

The system will have to be broken down to blank off tanks having different pressure requirements. Pressurize fuel tanks as follows:-

Numbers 1 and 2 ----- 10 p.s.i.g.
Numbers 3,4,6,7,8 --- 24 p.s.i.g.
Number 5 ---------- 22 p.s.i.g.

Measure deflection of structure.

(24) Air Conditioning R.T. 08-692

Measure by simple means the delivery of air to each compartment, and adjust as necessary, by fitting restrictors or flattening ducts, until system is sufficiently satisfactory for first flight. This will have to be repeated in greater detail at a later stage.

(25) Cockpit Pressure Test: R.T. 08-

Pressurise cockpit to 5¾ p.s.i.g. after blocking the relief valve.

Check cockpit flow deflection, canopy distortion and deflection between top longerons.

(26) Escape System R.T. 08-805

Using air pressure to operate the emergency canopy jacks, demonstrate that canopy emergency mechanism functions correctly.

(27) Fuel System
(28) L/P Pneumatics
(29) F/C Hydraulics
(30) Utility Hydraulics
(31) Radio
(32) Interphone
(33) Nacelle Cooling
(34) Intake Pressure Distribution
(35) Duct Bay Explosive Vapor Check

Carried out in conjunction with Flight Test during Engine running.

(36) Ground Resonance Test R.T. 08-720

Carried out with A/C mounted on low frequency supports. Determine natural frequencies and mode shapes of aircraft and control surfaces.

Also observe natural frequencies of F/C circuits, engine control circuits, nose wheel steering controls steering tests.

(37) Damping System R.T. 08-614

Checkout Damping System using Minneapolis Honeywell Ground Test equipment UG6004 A-1 and MB1 Pitot Static Tests.

Check accelerometers by shaking aircraft.

Check gyros by rocking or rotating aircraft.

(38) Flight Test Instrumentation Calibration

(39) Parachute Brake (Static Load) 08-651

Remove fuselage rear (Stinger) fairing and fit loading rig to aircraft picking up stinger attachment points.

Measure pilots effort required to operate jettison mechanism with load of 10,000 lb. applied at parachute strap.

(40) Parachute Brake
(41) Utility Hydraulics (Wheel Brakes)
(42) Nosewheel Steering

Carried out by Flight Test Dept. in Taxi trials.