UNCLASSIFIED

R. Armstrong

No - comment - rather a comprehensive job

KDJB

AVRO AIRCRAFT

Inter-Departmental Memorandum

Ref: 9341/22/J
Date: May 23, 1958
To: S. E. Harper
From: T. Roberts
Subject: ARROW 1 - FIRST SERIES OF ENGINEERING FLIGHTS

Attached herewith is R.F.T. 5051, which covers the first series of engineering flights on the Arrow 1.

T Roberts

TR*bb

T. Roberts
Technical Design Coordinator
FLIGHT TEST

c.c.
Messrs J. Chamberlin
R. Lindley
F. Brame
C. Lindow
F. Mitchell
P. Martin
D. Scard (6)
J. Ames
D. Ewart
J. Booth
J. Lynch
J. Gale
S. Whiteley
S. Kwiatkowski
A. Thomann
J. Lucas
F. Bradshaw
C. Marshall
D. Rogers
J. Zurakowski

W/C G. Waterman
W/C G. Waterman (2) AVRO T.S.D. RCAF for transmittal to S/L K. Owen, C.E.P.E. Detachment.

Central Files

FORM 1749 A

UNCLASSIFIED

SECRET

AVRO AIRCRAFT LIMITED

MALTON, ONTARIO

REQUISITION FOR FLIGHT TEST

R.F.T. NO. 5051

SHEET NO. 1 OF 9

DATE: May 15, 1958

AIRCRAFT 25201	ASSIGNMENT NO. X73-383	WORK ORDER NO.

ARROW 1 - FIRST SERIES OF ENGINEERING FLIGHT

1. OBJECTIVE OF FLIGHTS

The objective of the first series of engineering flight is to obtain data and investigate the following:-

1.1 Free aircraft stability and control derivatives.

1.2 Check yaw damper as altered on the basis of information obtained to-date.

1.3 Check for control surface buzz, particularly in the transonic region.

1.4 Check engine functioning, particularly during subsonic climb and cruise.

1.5 Obtain brake pressures and undercarriage fore and aft accel. during normal landing.

1.6 Check for intake flow break away at reduced R.P.M.

1.7 Check roll and pitch damper, when available.

1.8 Check C_L vs α with undercarriage down, doors shut.

1.9 To probe further the flight envelope within the revised limits of the design certificate.

1.10 To determine the max. level speed, consistent with the flight envelope limitations, prior to changing to the 45" divergent ejector.

The above sequence does not indicate the order in which tests should be conducted.

R.F.T. PREPARED BY:	APPROVED BY:	AUTHORIZED BY:
DATE FOR COMPLETION	PRIORITY	ESTIMATED COMPLETION DATE:

AVRO AIRCRAFT LIMITED

MALTON, ONTARIO

REQUISITION FOR FLIGHT TEST

R.F.T. NO. 5051

SHEET NO. 2 OF 9

DATE: May 15, 1958

AIRCRAFT 25201	ASSIGNMENT NO. X73-383	WORK ORDER NO.

2. DATA REQUIRED FROM TESTS

2.1 Telemetry

2.1.1 Stability and Control

Angle of Attack.
Angle of sideslip.
Normal acceleration.
Lateral acceleration.
Roll rate. p
Pitch rate. q
Rudder differential servo position.
Rudder angle.
Port elevator angle.

2.1.2 Engine Installation

Fuel temperature at inlet to starboard engine burner.

2.1.3 Structural Integrity

(1) Channel for vibration pick-up accelerometer.
(2) Channel for vibration pick-up accelerometer.

Provision should be made such that any two of the following accelerometers could be chosen for a particular flight. These to be stipulated prior to preparing A/C for flight.

Accelerometers nos. 22, 34, 36, 42, 51, 58, 61, and 67. see CF105 Instrumentation, Issue 7, Fig. 5.

2.2 Oscillograph

2.2.1 Stability and Control

Aircraft static pressure.
Differential pressure.
Port elevator differential servo balance.

R.F.T. PREPARED BY:	APPROVED BY:	AUTHORIZED BY:
DATE FOR COMPLETION	PRIORITY	ESTIMATED COMPLETION DATE:

AVRO AIRCRAFT LIMITED

MALTON, ONTARIO

REQUISITION FOR FLIGHT TEST

UNCLASSIFIED

R.F.T. NO. 5051

SHEET NO. 3 OF 9

DATE: May 15, 1958

AIRCRAFT 25201	ASSIGNMENT NO. X73-383	WORK ORDER NO.

2.2.1 Stability and Control Cont'd

Port aileron differential servo balance. ‡

‡ These items are not required until roll and pitch damper is available.

2.2.2 Damper System

Normal acceleration.	(normal axis)
Lateral acceleration.	(normal axis)
Roll rate.	(normal axis)
Yaw rate.	(normal axis)
Rudder differential servo balance	(normal axis)
Aileron angle.	(normal axis)
Aileron position X pitch rate.	(normal axis)
Yaw emergency differential servo solenoid	(D.C. Signal)

2.2.3 Flying Control Hydraulics

Filter box outlet pressure.	System B*
Port engine pump inlet temperature	System B

* This may not be available for the first series of flights and is being investigated by Flight Test Department.

2.2.4 Engine Installation

Oil temperature at starboard engine inlet.
Fuel mass flow to starboard engine.
Starboard engine L.P. compressor R.P.M.
Starboard turbine discharge pressure.

2.2.5 Fuel System

Fuel temperature at inlet to starboard engine fuel pump.

R.F.T. PREPARED BY:	APPROVED BY:	AUTHORIZED BY:
DATE FOR COMPLETION	PRIORITY	ESTIMATED COMPLETION DATE:

AVRO AIRCRAFT LIMITED

UNCLASSIFIED

MALTON, ONTARIO

R.F.T. NO. 5051

SHEET NO. 4 OF 9

DATE: May 15, 1958

REQUISITION FOR FLIGHT TEST

AIRCRAFT 25201	ASSIGNMENT NO. X73-383	WORK ORDER NO.

2.2.6 Undercarriage and Brakes

Normal brake pressure (port)
Normal brake pressure (starboard)
Fore and aft leg acceleration (port)
Fore and aft leg acceleration (starboard)

2.2.7 Control Mechanism

Aileron stick force
Aileron stick position

These should be available to be recorded during certain flights in exchange for brake pressures.

2.3 Data Tape

2.3.1 Intake

Massa M141 Microphone on intake outer skin.

The exact location and calibration of item 2.3.1. to be decided by Flight Test Dept. and Stress Office.

2.3.2 Pilot's Voice

The following information is required during engine tests.

Starboard engine H.P. Compressor R.P.M.
Starboard engine J.P.T.
Starboard engine pressure ratio.

2.4 Tufting

Tufting is required on one intake to obtain flow data during engine deceleration at altitude. This should be photographed from the CF100 chase aircraft. The exact location of the tuft to be decided by Flight Test and Technical Design.

R.F.T. PREPARED BY:	APPROVED BY:	AUTHORIZED BY:
DATE FOR COMPLETION	PRIORITY	ESTIMATED COMPLETION DATE:

AVRO AIRCRAFT LIMITED

MALTON, ONTARIO

REQUISITION FOR FLIGHT TEST

~~SECRET~~ UNCLASSIFIED

R.F.T. NO. 5051

SHEET NO. 5 OF 9

DATE: May 15, 1958

AIRCRAFT 25201	ASSIGNMENT NO. X73-383	WORK ORDER NO.

3. TEST PROCEDURE

3.1 Yaw Damper - and ~~free aircraft damping in pitch to be~~ checked up to 450 kts. EAS at 10,000 ft., this is a repeat of tests performed during the first series of flights, and must be performed on the first flight.

3.2 Engine Behaviour - should be investigated on the first flight of this next series. This should include a fixed throttle climb at 400 Kts. EAS until 0.9 M.N. is attained, and then continued at 0.9 M.N. to 36,000 ft., items 2.3.2. being obtained in addition to recorded data. At least one stabilized level speed run should be made at 36,000 ft. at M = 0.9 for 2 or 3 minutes duration.

Tests should be carried out on a flight, possibly about half way through the series, to investigate the intake vibration to low engine R.P.M. This should consist of obtaining photographs of the intake tufts when the engine is throttled back to idling for a series of M.N.'s at approx. 30,000 to 36,000 ft. as discussed with Flight Test. For the same tests, recordings are required from the Massa M141 microphone. This should be in a form suitable for playing through a frequency analyzer.

3.3 Control Surface Taps - should be carried out as in previous tests with particular attention being given to the transonic range. Acceleration to supersonic speeds should start at high altitude, lower altitudes being investigated progressively.

R.F.T. PREPARED BY:	APPROVED BY:	AUTHORIZED BY:
DATE FOR COMPLETION	PRIORITY	ESTIMATED COMPLETION DATE:

3.4 Stability & Control

Manoeuvres shown should be performed at the following flight condition. The actual points to be tested in any particular flight will depend largely on the results of the previous flight. Flight Test will be informed of this by Technical Desigh prior to their preparation of the Flight Briefing.

ALTITUDE (FT)	MACH NO.	MANOEUVRES			
40,000	0.60	3.4.1.1. & 2; 3.4.2.2;			
40,000	0.70	3.4.1.1. & 2; 3.4.2.2; 3.4.3;			
40,000	0.80	3.4.1.1. & 2; 3.4.2; 3.4.3;			
40,000	1.00	3.4.1.1. & 2; 3.4.2; 3.4.3;	3.4.4.1. to 3; 3.4.5.1. & 2;		
40,000	1.15	3.4.1.1. & 2; 3.4.2; 3.4.3;	3.4.4.1. to 3; 3.4.5.1. & 2;	3.4.4.4; 3.4.5.3;	
40,000	1.30	3.4.2.1; 3.4.1.1;			
40,000	1.40	3.4.1.1. & 2; 3.4.2; 3.4.3;	3.4.4.1. to 3; 3.4.5.1. & 2;	3.4.4.4; 3.4.5.3;	
40,000	1.50	3.4.2.1; 3.4.1.1;			
40,000	1.60	3.4.1.1. & 2; 3.4.2; 3.4.3;	3.4.4.1. to 3; 3.4.5.1. & 2;	3.4.4.4; 3.4.5.3;	
50,000	1.40	3.4.1.1. & 2; 3.4.2; 3.4.3;	3.4.4.1. to 3; 3.4.5.1. & 2;	3.4.4.4; 3.4.5.3;	3.4.6;
50,000	1.60	3.4.1.1. & 2; 3.4.2; 3.4.3;	3.4.4.1. to 3; 3.4.5.1. & 2;	3.4.4.4; 3.4.5.3;	3.4.6;
50,000	1.15	3.4.1.1. & 2; 3.4.2; 3.4.3;			3.4.6;
50,000	1.00	3.4.1.1. & 2; 3.4.2; 3.4.3;			3.4.6;
50,000	0.80	3.4.1.1. & 2; 3.4.2.2; 3.4.3;			
30,000	0.95	3.4.1. to 3.4.3;	3.4.4.1. to 3; 3.4.5.1. & 2;	3.4.4.4; 3.4.5.3;	
30,000	0.80	3.4.1.1. & 2; 3.4.2; 3.4.3;	3.4.4.1. to 3; 3.4.5.1. & 2;		3.4.6;
30,000	0.60	3.4.1.1. & 2; 3.4.2; 3.4.3;	3.4.4.1. to 3; 3.4.5.1. & 2;		
30,000	0.45	3.4.1.1. & 2; 3.4.2.2;			3.4.6;
20,000	0.40	3.4.1. to 3.4.3;			
20,000	0.70	3.4.1. to 3.4.3;	3.4.4.1. to 3; 3.4.5.1. & 2;	3.4.4.4; 3.4.5.3;	
20,000	0.90	3.4.1.1. & 2; 3.4.2; 3.4.3;	3.4.4.1. to 3; 3.4.5.1. & 2;	3.4.4.4; 3.4.5.3;	
10,000	0.40	3.4.1. to 3.4.3;			3.4.6; (includes part of 3.1)
10,000	0.70	3.4.1.1. & 2; 3.4.2; 3.4.3;	3.4.4.1. to 3; 3.4.5.1. & 2;	3.4.4.4; 3.4.5.3;	3.4.6; (includes part of 3.1)
10,000	0.80	3.4.2.1; 3.4.1.1;			

NOTE:- Pilot should depress calibrate switch at start and finish of each set of manoeuvres; viz. at start and finish of 3.4.1., of 3.4.2. etc. at each flight condition.

AVRO AIRCRAFT LIMITED

MALTON, ONTARIO

REQUISITION FOR FLIGHT TEST

UNCLASSIFIED

R.F.T. NO. 5051

SHEET NO. 7 OF 9

DATE: May 15, 1958

AIRCRAFT 25201	ASSIGNMENT NO. X73-383	WORK ORDER NO.

3.4.1 Dampers Off - Level Flight

3.4.1.1 Apply steady sideslip up to 20% of limit sideslip (values of limit sideslip to be supplied) and hold wings level. Release rudder and aileron, allow oscillations to subside.

3.4.1.2 Without touching stick after trimming, apply a moderately sudden sideslip (see below) with rudder only, and release. Allow oscillations to subside.

(a) Up to 20% limit sideslip.
(b) Up to 40% limit sideslip.

3.4.1.3 Where damper steady oscillation of 1 cps has been noticed, apply a sideslip at the low speed condition, increasing from $\beta = 0^\circ$ to $\beta = +4^\circ$ and back through $\beta = 0^\circ$ back to $\beta = -4^\circ$. Hold wings level with aileron.

3.4.2 Normal Yaw Damper Engaged - Level Flight.

3.4.2.1 Start from trimmed flight. Deflect stick back to produce + 1g to +1.5g incremental, then return to neutral and release. Allow oscillations to subside.

3.4.2.2 Apply step input to produce the following and return.

(a) 20% limit β
(b) 40% limit β

3.4.3 Roll - Yaw Damper Engaged

3.4.3.1 Roll from $\phi = -45^\circ$ to $\phi = +45^\circ$ and back at a rate not exceeding 50°/sec.

Note In 3.4.3.1. attempt to achieve steady rate of roll as soon as possible, and hold ailerons steady at this roll rate for as long as possible.

R.F.T. PREPARED BY:	APPROVED BY:	AUTHORIZED BY:
DATE FOR COMPLETION	PRIORITY	ESTIMATED COMPLETION DATE:

UNCLASSIFIED ~~SECRET~~

AVRO AIRCRAFT LIMITED

MALTON, ONTARIO

REQUISITION FOR FLIGHT TEST

R.F.T. NO. 5051

SHEET NO. 8 OF. 9

DATE: May 15, 1958

AIRCRAFT 25201	ASSIGNMENT NO. X73-383	WORK ORDER NO.

3.4.4. Normal Yaw - Damper Engaged

3.4.4.1 Trim into turn pulling 2g at const. M.

3.4.4.2 Repeat 3.4.2.1. but limit Δn to 1g.

3.4.4.3. Apply rudder step input.

(a) to 20% limit β
(b) to 40% limit β

3.4.4.4 Trim into 3g turn and repeat 3.4.4.3. (a).

3.4.5. Dampers Off - Accelerated Flight

3.4.5.1 Trim into turn pulling 2g, const. Mach No.

3.4.5.2(a)Without touching stick, deflect rudder to produce 20% limit β and release.

(b)If resultant roll was not excessive, repeat with 30% limit β.

3.4.5.3 Repeat 3.4.5.2(a)pulling 3g.

3.4.6. Dampers Off Trimmability (at a limited number of conditions)

3.4.6.1 Apply rudder steadily up to 40% limit β with trim at a steady rate, holding wings level with aileron. Return with trim to $\beta = 0^o$, holding wings level.

3.4.6.2 Apply aileron trim holding wings level with rudder, up to 40% limit β, and return trim to zero taking off sideslip with rudder.

3.4.6.3 Apply elevator trim to produce $\Delta n = 1g$ and remove trim, at a steady rate.

R.F.T. PREPARED BY:	APPROVED BY:	AUTHORIZED BY:
DATE FOR COMPLETION	PRIORITY	ESTIMATED COMPLETION DATE:

AVRO AIRCRAFT LIMITED

UNCLASSIFIED

MALTON, ONTARIO

R.F.T. NO. 5051

SHEET NO. 9 OF 9

DATE: May 15, 1958

REQUISITION FOR FLIGHT TEST

AIRCRAFT 25201	ASSIGNMENT NO. X73-383	WORK ORDER NO.

3.4.7 Investigation of the three axes normal damper (if available).

3.4.7.1 In a specified flight condition engage pitch axis and assess handling.

3.4.7.2 Repeat of 3.4.7.1 for roll axis.

3.4.7.3 Engage all 3 axes and assess handling.

3.4.8 At least one landing at the Pilot's discretion should be made with damper off during this series of flights.

3.5 Photographs of the aircraft against the horizon should be obtained over a range of speeds such that C_L vs α can be determined. This is required with the undercarriage down but with the doors shut. This means the undercarriage can not be retracted during these flights. The final approach and landing should be photographed as usual. The object of this test is to determine the change in C_L vs α with the undercarriage doors shut.

R.F.T. PREPARED BY:	APPROVED BY:	AUTHORIZED BY:
DATE FOR COMPLETION	PRIORITY	ESTIMATED COMPLETION DATE: