



MINIMUM INSTRUMENTATION FOR PART 1 TESTING

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AN APPRAISAL OF A MINIMISED AIRCRAFT
AND PROGRAM FOR THE 1st. ARROW 1.

Memo Ref: 9576/01/J

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INTRODUCTION

In order to meet the required first flight date and to complete a basic flight test program on the 1st Arrow 1 aircraft at the earliest time, it is necessary to consider what time saving could be achieved by reducing the requirements for systems installation, pre-flight test and flight test instrumentation.

OBJECTIVES

A preliminary program of approximately five flights is proposed, in which to achieve medium supersonic speeds and heights approaching the operational altitude.

No measures will be taken which preclude the possibility of the aircraft achieving the following flight envelope..

- (1) 1.5 M.N.
- (2) 400 kts E.A.S.
- (3) 7.33 'g'
- (4) 45,000'

PRE-FLIGHT TESTING

Most time saving can be achieved by substituting qualitative testing for quantitative testing wherever possible, with the proviso that quantitative testing will be carried out at a later stage in the program.

1. Damper System
Very little attempt should be made to reduce this program since correct functioning of the damping system is vital for flights proceeding into the transonic and supersonic regions.
2. Flying Control Hydraulics
It is possible that some reduction can be made using functional checks only. Resonance tests should be made and some checks on authority. Accelerometers in the controls will be required.
3. Structural Resonance
This appears to be a necessity before first flight. Instrumentation need not be connected to the pack since flight measurement is not essential.
4. Fuel System
Calibration and flow checks are required. No time saving can be achieved here since flight recording is necessary for C.G. and weight and pilot indication.

5. Engines

The possibility of deleting intake survey tests should be investigated. Some cooling measurements need to be made. A reduction in the required transducers is possible with a limited flight envelope. Static pressure measurements are essential.

6. Taxying

All performance testing may be eliminated. Functional checks on parachute brake, wheel brakes, nose wheel steering is required. An indication of brake temperature is necessary, otherwise qualitative analysis is sufficient.

7. Radio and Navigation Aid

This testing may be reduced to functional checks only.

Flight Test Instrumentation.

It has been assumed that in order to carry out a basic flight test program only those instruments required to check stability and control and damper systems need be installed together with certain safety monitoring items.

Some flight test instrumentation will be required for pre-flight tests as already mentioned.

All transducers should be installed but only those mentioned needed to hooked up to the pack and calibrated.

Telemetry must be functional for safety of flight monitoring.

The following instrumentation should be functional and calibrated. Item numbers refer to FAR/C105/1, Issue 7 et subs.

The list is given with reference to first and second priorities.

PART 1 STABILITY AND CONTROL

(a) Priority 1

ITEM

- | | | |
|----|---|-------------------|
| 1. | Aircraft static Pressure | 0-2160 lb/sq.ft. |
| 2. | Aircraft Differential Pressure
Limited Range | 0-1440 lb/sq. ft. |
| 3. | Free air total temperature | |
| 5. | $\dot{\theta}$ | |
| 7. | Rate of yaw $\dot{\psi}$ | |
| 8. | $\ddot{\psi}$ | |

PART 1 STABILITY AND CONTROL cont'd

10. ϕ
11. Angle of attack α
12. Angle sideslip β
13. Longitudinal acceleration \ddot{X}
14. Lateral Acceleration \ddot{Y}
15. Normal acceleration \ddot{Z}
16. Port Elevator Angle δ_e (full range only)
19. Port Aileron Angle δ_a (full range only)
20. Port Aileron Angular acceleration $\ddot{\delta}_a$
22. Angle of Rudder δ_r (full range only)
38. Port Elevator Damper Servo Position
39. Stbd. Elevator Damper Servo Position
40. Port Aileron Damper Servo Position
41. Stbd. Aileron Damper Servo Position
42. Rudder Damper Servo

(b) PRIORITY 2

1. Aircraft Static Pressure

Limited Range	0-720 lb/sq. ft.
Limited Range	0-288 lb/sq. ft.
2. Differential Pressure

(total head - aircraft static)	0-2880 lb/sq. ft.
Limited Range	0-720 lb/sq. ft.
4. Angle of pitch θ (full range only)
6. Azimuth angle ψ (full range only)
9. Angle of bank ϕ (full range only)
18. Stbd. Elevator Angle δ_e (full range only)
21. Stbd. Aileron Angle δ_a (full range only)

PART 1 STABILITY AND CONTROL cont'd

(b) Priority 2 cont'd

26. Elevator Stick Force (full range only)
27. Aileron Stick Force
28. Rudder Pedal Force
32. Elevator Parallel Servo Position
33. Aileron Parallel Servo Position
43. Elevator Trimmer Position
44. Aileron Trimmer Position
45. Rudder Trimmer Position

PART 2 FLYING CONTROL HYDRAULICS

(a) Priority 1

1. Port Engine Pump inlet temp

(b) Priority 2

NIL

PART 3 ENGINE INSTRUMENTATION

(a) Priority 1

4. Oil temp at Stbd. engine inlet
13. Port engine intake static pressure (P_{s2})
14. Stbd. engine intake static pressure (P_{s2})
31. Centre rear mount, station 711
36. Top of titanium former (shroud) at Stn. 803
38. Top of shroud inner flange at Stn. 803
39. Top of shroud inner flange at kink, Stn. 803
40. Inner surface of splitter on splitter at Stn. 855
41. Inboard, shroud (on outer surface, on engine side) Stn. 836
50. Top flange of I-beam of Σ through heat exchangers Stn. 592*

PART 3 ENGINE INSTRUMENTATION cont'd

Priority 1

- 51. Top flange of former directly below firewall, Stn. 663
- 54. Lower longeron engine bay, Stn. 591 (not shown in fig.)
- 57. Gills shut indication lights, port, 2 per engine.
- 58. Gills shut indication lights, stbd., 2 per engine.
- 58a. Air Temperature, Alternator Exhaust
- 59. Top centre compressor, differential between zone 1 and 2
- 60. Zone 2, top rear compressor

1 additional pressure in ejector (Ref. 8910/02A/J)

Priority 2

- 29. Fuel temp. at inlet to port engine burner
- 30. Fuel temp. at inlet to stbd. engine burner

NOTE: The necessity of engine instrumentation for Pratt and Whitney not included (Items 1 to 26a) should be investigated

PART 4 FUEL SYSTEM

(a) Priority 1

All fuel tanks contents (14)

T₁₂ and P₅

(b) Priority 2

NIL

PART 5 UTILITY HYDRAULICS

(a) Priority 1

4. Pump inlet temperature (one pump)

(b) Priority 2

NIL

PART 6 AIR CONDITIONING

(a) Priority 1

Turbine R.P.M.

T₄

P₄

T₅

(b) Priority 2

T₁₂

T_{7B}

P₉

P₁₀

PART 7 ELECTRICS

(a) Priority 1

18. Exhaust temp of T.R.U.S. (One unit only)

(b) Priority 2

NIL

PART 8 STRUCTURAL INTEGRITY

Accelerometers to be operable for ground test only.

SYSTEM EQUIPMENT

On the basis that the flight envelope as given is not to be exceeded, initial Arrow I flights may be undertaken without the following equipment.

1. FLYING CONTROL SYSTEM

- 1.1. "g" limiter
- * 1.2. Vane
- 1.3. roll rate limiter
- 1.4. damper system low pressure switch
- * 1.5. hinge moment limiter
- * 1.6. stick force transducer
- * 1.7. parallel servos
- * 1.8. parallel servo position pots
- * 1.9. auto trim mechanism
- * Effects of deletion to be further investigated.

2. ELECTRICAL SYSTEM

- 2.1. all de-icing equipment
- 2.2. radome de-icing
- 2.3. skin temp. sensor and indicator
- 2.4. navigation lights and flares

3. AIR CONDITIONING SYSTEM

- 3.1. automatic temp. control might be temporarily substituted for by a manual system.
- 3.2. rain repellent system
- 3.3. high temp. ducts leak detection and shut off equipment

4. HYDRAULIC AND ASSOCIATED SYSTEMS

- 4.1. anti - g valve

5. ELECTRONIC SYSTEMS

5.1 air to ground I.F.F.

5.2 U.H.F. homer

5.3 some of the direction indicator provisions - to be established.