

AVRO AIRCRAFT LIMITED  
INTER-DEPARTMENTAL MEMORANDUM

Ref. 5048/11/E  
Date January 1st, 1958  
To See Distribution  
From Mr. E. F. Burnett  
Subject ARROW 1 A/C 25201 WEIGHT & C.G. SUMMARY - Report # 7-0400-44 Iss. 13

Attached is a copy of Weight and C.G. Summary Report # 7-0400-44  
Issue 13, dated January 1st, 1958 for your retention.

This report is revised monthly and is issued complete on the  
1st of each month.

Classification cancelled / changed to: UNCLASSIFIED  
By authority of: DRDA 7/DARFT 5-8/DAS Eng 6-4-5  
Date: 5 Nov 1992  
Signature: *B. Aubrey*  
Unit / Rank / Appointment: DSIS 3, Secretary CRAD HQ DRP

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Date: January 1st, 1958  
Aircraft: ARROW 1, A/C 25201  
with J75 P3 Engines.

I N D E X

| <u>Sheet #</u> | <u>Content</u>  |
|----------------|---|
| 1-1 to 1-5     | Introductory notes and explanations of Weight Changes.  |
| 2-1 to 2-2     | Weight & C.G. Summaries.  |
| 3              | Horizontal C.G. Envelopes for Flight conditions with fuel proportioners used.   |
| 4-1 to 4-15    | I.B.M. Detail Sheets of Weights & C.G.'s  |
| N.B.           | The C.G. Envelope for A/C 25201 with fuel sequencing has been omitted until a fully approved sequencing is established. |

Date: January 1st, 1958  
ARROW 1 A/C 25201 With  
J75 P3 Engines

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### INTRODUCTION & WEIGHT CHANGES

The following is a Weight and C.G. Summary for the first Arrow 1 Aircraft # 25201, with J75 P3 Engines, based on the latest information currently available. All Weight and C.G. changes are relative to Issue 12 of December 1st, 1957.

- Note: 1) This summary does not apply for Aircraft # 25202 and 25203 which will have J75 P5 Engines, nor for Aircraft # 25204 and 25205 which are for full Astra I trial installations etc.
- 2) The statement herein is for the Aircraft complete to drawings and not necessarily in the condition to be encountered for first flight.

For early flights there may be some shortages in non-essential equipment, some flight test installations will probably be incomplete etc. (See also General Note (j)). A statement for first flight will be issued later.

### GENERAL:

- a) Pratt & Whitney J75 P3 Engines comprise the Power Plant for Aircraft # 25201. J75 P5 Engines, which are partially redesigned versions of the P3 Engines, are to be installed on Aircraft # 25202 and subsequent Arrow 1 Aircraft (J75 P3 Engines = 6,175 lb each; J75 P5 Engines = 5,950 lb each).
- b) An Instrument Package containing Flight Instrumentation is installed, this also varies, the package for Aircraft # 25201 to Aircraft # 25203 differing from those for Aircraft # 25204 and 25205 (Astra I Trial Installations.)

A relatively detailed estimate of other proposed Flight Test Installations throughout the aircraft has been made. These installations amount to 1,457 lb (figure partially confirmed by Actual Weights of some cable assemblies.)

- c) Emergency lowering for the Landing Gear and additional Fire Protection to be installed in the first aircraft, are allowed for in the summary.
- d) An Interim Radio & Radar System with Minneapolis-Honeywell M.H.64 Damping System is installed. Currently there is no Doppler or Tacan installation, although provisions for future installation of Doppler, which is not yet available, will be made.
- e) The original design of tailcones and stinger are recorded, the redesigned versions will be recorded at a later date, when they are available for retrofit. The ensuing weight changes will be:

|            |                |
|------------|----------------|
| Tailcones  | + 127.3 lb/A/C |
| Stinger    | = 29.7 lb      |
| Net Change | + 97.6 lb/A/C  |

- f) Pending Flight Test requirements a "Buzz Damping" System may be installed on the first Aircraft. Provisions for this installation are already included in the structural group as modifications to the Control Boxes. For the first flight the control surfaces will be unmodified, however, if the need for Dampers is proven, a modified set of Control Surfaces will be made available.

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## INTRODUCTION & WEIGHT CHANGES

### GENERAL:

#### F) (Continued)

The following weight penalaties ensue:

|           |   |                  |
|-----------|---|------------------|
| Ailerons  | + | 11.68 lb/A/C     |
| Elevators | + | 11.07 lb/A/C     |
| Rudder    | + | 8.78 lb          |
| Equipment | + | 123.97 lb        |
|           | + | <u>155.50 lb</u> |

- g) It should be noted that due to material substitutions and concessions introduced by Planning & Production Departments there is a structural weight penalty of 203 lb to-date. This is all recorded in the structural weight breakdown. No account has been taken of variations on machinings etc. nor of shop repair schemes, since it is impossible to assess these, except where actual weights have been obtained.
- h) A considerable number of Actual Weights have now been obtained. Structural weights are checking within 0.5% of estimates of sub-assemblies etc. However, equipment (excluding Engines and Gear Boxes) shows a consistant increase averaging about 11% over manufacturer's quotations or initial specification weights. Preceeding the report titles on the I.B.M. Tabulation Sheets, will be found a number varying from 0 to 100, this is the percentage of actual weight recorded within the report.

A Summary of Actual Weights obtained so far is as follows:

|                 |        |
|-----------------|--------|
| Structure       | 74.76% |
| Landing Gear    | 97.86% |
| Power Plant     | 92.97% |
| Flying Controls | 59.01% |
| Equipment       | 23.12% |

i.e. 70.42% of the Basic Weight of Aircraft 25201.

- j) The Aircraft is ballasted such that the C.G. on a flight envelope (using fuel proportioners) does not travel aft of 31% M.A.C.

For the first flight the aft restriction is 30% M.A.C., this may be achieved by installing maximum ballast in the Radar Nose, and any further ballast requirements in the Observer's cockpit.

C.G. Envelopes showing fuel sequencing have currently been omitted until a fully approved sequencing is established.

#### 1. STRUCTURE

#### WEIGHT (lb)

##### a) Wings

No Weight Change.

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## INTRODUCTION & WEIGHT CHANGES

### 1. STRUCTURE

WEIGHT (lb)

#### b) Fin and Rudder:

No Weight Change

#### c) Fuselage Fwd. Sta. 255"

|   |   |              |
|---|---|--------------|
| Formers - incorporation of miscellaneous E.C.N's  | + | 1.33         |
| Top Longerons - some actual weights and E. C.N's incorporated                                 | + | 2.17         |
| Crew's Bulkheads - addition of brackets & stiffeners  | + | 1.67         |
| Upper Shear Panel - addition of fillet fairing at rear arch                                   | + | 0.39         |
| Cockpit Floor - addition channel support for uplocks and<br>incorporation of E.C.N's          | + | 0.79         |
| Lower Shear Panel - delete circular door at L band antenna<br>location (duplication of parts) | - | 0.48         |
| Air Intakes - Actual weights of fairings & tip support<br>casting, incorporation of E.C.N's   | + | 3.37         |
| Pilot's Canopy - addition of insulation batting   | + | 0.54         |
| Miscellaneous Items F.F. - small bracketry changes  | + | 0.26         |
| <u>Weight Increase Front Fuselage</u>   | + | <u>10.04</u> |

#### d) Centre Fuselage Sta. 255"-485"

No Weight Change

#### e) Duct Bay Sta. 485"-591.65"

|  |   |             |
|--|---|-------------|
| Formers Side - incorporation of E.C.N's etc.                           | + | 0.34        |
| Formers Lower - production drawing re-issues & E.C.N's<br>incorporated | + | 0.34        |
| Access Panel - minor changes on production drawing re-<br>issues       | + | 0.89        |
| Mounting Brackets - miscellaneous changes & drawing<br>re-issues       | + | 0.30        |
| Skin - addition of small steel doubler & stiffener                     | + | 0.57        |
| Lower Panel Assy. - miscellaneous alterations to<br>brackets etc.      | + | 0.83        |
| <u>Weight Increase Duct Bay</u>  | + | <u>3.27</u> |

#### f) Engine Bay Sta. 591.65"-742.5"

No Weight Change

#### g) Rear Fuselage Sta. 742.5 Aft.

No Weight Change

#### h) Fuselage "Marry-Up"

|   |   |             |
|---|---|-------------|
| Joint D.B to E.B. - miscellaneous hardware changes etc. | + | 0.13        |
| <u>Weight Increase "Marry-up"</u>                       | + | <u>0.13</u> |

TOTAL STRUCTURAL INCREASE

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+

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### INTRODUCTION & WEIGHT CHANGES

|   |   | <u>WEIGHT (lb)</u> |
|---|---|--------------------|
| 2. <u>LANDING GEAR</u>  |   |                    |
| Nose U/C Door & Fairing - addition of seal, indentation plates etc.   | + | <u>0.52</u>        |
| <u>TOTAL LANDING GEAR INCREASE</u>  | + | <u>0.52</u>        |
| N.B. Anti-skid devices are <u>Not</u> yet included, but may be fitted at a later date if pilot requests same. |   |                    |
| 3. <u>POWER PLANT &amp; SERVICES</u>  |   |                    |
| No Weight Change  |   |                    |
| 4. <u>FLYING CONTROLS GROUP</u>   |   |                    |
| Flying Control Hydraulics I/Wing - addition of dampers to elevator jack control valves                        | + | 1.50               |
| Flying Control Hydraulics O/Wing - addition of dampers to aileron jack control valves                         | + | 1.50               |
| Flying Control Hydraulics Fin - addition of damper to rudder jack control valve                               | + | <u>0.75</u>        |
| <u>TOTAL FLYING CONTROLS INCREASE</u>   | + | <u>3.75</u>        |
| 5. <u>EQUIPMENT GROUP</u>   |   |                    |
| Utilities Hydraulics I/Wing - Dowty increase in Weight of Main U/C door Jacks.                                | + | 2.00               |
| Flight Test Installations - addition of telemetry blade type antenna - Engine Bay                             | + | 14.00              |
| Wiring for power supplies & control circuits estimated.   | + | 24.47              |
| αβ sub-system added   | + | <u>3.40</u>        |
| <u>TOTAL EQUIPMENT INCREASE</u>   | + | <u>43.87</u>       |

### SUMMARY

#### Weight Change - Aircraft Basic Weight

|                 |   |              |
|-----------------|---|--------------|
| Structure       | + | 13.44        |
| Landing Gear    | + | 0.52         |
| Flying Controls | + | 3.75         |
| Equipment       | + | <u>43.87</u> |
|                 | + | <u>61.58</u> |

#### Weight Change - Operational Weight Empty (A/C less Fuel)

##### UNBALLASTED CONDITION

Issue 12

47,938.10 lb

Issue 13

47,999.68 lb

+ 61.58 lb

CONTINUED.

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INTRODUCTION & WEIGHT CHANGES.

N.B. If Aircraft Ballasted such that the C.G. in the flight envelope, using correctly functioning fuel system proportioners, does not exceed 31% M.A.C., further 905 lb of ballast are necessary.

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Date: January 1st, 1958  
Aircraft ARROW 1, with  
J75 P3 Engines  
A/C 25201

WEIGHT & C.G. SUMMARY

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| DESCRIPTION                      | WEIGHT<br>lb | H. ARM<br>ins. | V. ARM<br>ins. |
|----------------------------------|--------------|----------------|----------------|
| STRUCTURE                        | 18,605.97    | 561.31         | 137.47         |
| Wings                            | 9,963.50     | 642.82         | 142.26         |
| Fin & Rudder                     | 1,025.85     | 754.34         | 209.31         |
| Fuselage Fwd. Sta. 255"          | 2,644.99     | 181.59         | 128.16         |
| Sta. 255"-485"                   | 1,682.14     | 377.80         | 130.20         |
| Sta. 485"-591.65"                | 1,001.86     | 533.99         | 104.61         |
| Sta. 591.65" - 742.5"            | 1,433.13     | 661.00         | 107.31         |
| Sta. 742.5 Aft.                  | 801.79       | 801.03         | 129.06         |
| "Marry-Up"                       | 52.71        | 469.18         | 103.86         |
| LANDING GEAR - RETRACTED         | 2,600.83     | 488.32         | 134.91         |
| Main Landing Gear                | 1,959.62     | 539.48         | 141.00         |
| Main Gear Doors & Fairings       | 282.34       | 537.60         | 138.37         |
| Nose Landing Gear                | 333.81       | 170.81         | 99.70          |
| Nose Gear Door & Fairing         | 25.06        | 161.94         | 88.24          |
| POWER PLANT & SERVICES           | 14,391.81    | 652.82         | 120.34         |
| Engine & Accessories J75 P3      | 12,562.29    | 664.92         | 119.78         |
| Gear Box & Drives on Fuselage    | 275.54       | 601.39         | 102.98         |
| Gear Box & Starters on Engine    | 286.30       | 589.08         | 105.59         |
| Engine Control                   | 32.43        | 375.76         | 118.62         |
| Engine Nose Bullets              | 70.58        | 562.75         | 115.07         |
| Fire Extinguishing System        | 65.46        | 700.45         | 134.21         |
| Engine Mountings                 | 206.21       | 635.04         | 127.71         |
| Fuel System                      | 893.00       | 536.67         | 136.12         |
| FLYING CONTROLS GROUP            | 1,853.01     | 685.49         | 139.59         |
| Mechanical Flying Controls       | 941.12       | 686.14         | 148.31         |
| Hydraulic Flying Controls        | 911.89       | 684.81         | 130.60         |
| EQUIPMENT FIXED & REMOVABLE      | 9,627.10     | 403.43         | 113.45         |
| Instruments                      | 46.07        | 1163.68        | 138.70         |
| Probe                            | 15.00        | -38.14         | 108.00         |
| Cockpit Pressure Sealing         | 5.00         | 186.00         | 130.00         |
| Ejector Seats                    | 339.06       | 204.43         | 134.10         |
| Oxygen System                    | 26.07        | 240.54         | 156.70         |
| Air Conditioning System          | 812.41       | 335.87         | 134.32         |
| Surface Finish                   | 100.00       | 591.52         | 140.20         |
| Hydraulics Main System           | 641.97       | 504.41         | 117.78         |
| Cockpit Insulation               | 14.31        | 187.48         | 132.00         |
| Drag Chute                       | 90.78        | 786.65         | 143.16         |
| Electrical System                | 1,118.98     | 417.54         | 112.96         |
| Low Pressure Pneumatics          | 54.65        | 433.30         | 129.37         |
| Intake De-icing Boots            | 88.00        | 195.82         | 118.00         |
| Canopy Actuation                 | 64.92        | 221.99         | 154.35         |
| Console Panels                   | 17.45        | 174.76         | 124.34         |
| MH 64 Damping System             | 99.08        | 450.83         | 140.34         |
| Interim Radio & Radar            | 631.89       | 340.18         | 124.23         |
| Instrument Pack Structure        | 686.80       | 385.81         | 94.68          |
| Pack Instrumentation (A/C 25201) | 3,036.00     | 395.45         | 95.00          |
| Flight Test Installations        | 1,456.73     | 488.48         | 128.90         |
| Additional Fire Protection       | 177.67       | 402.00         | 109.57         |
| Emergency Landing Gear Lowering  | 12.91        | 458.83         | 128.60         |
| Ram Air Turbine Equipment        | 91.35        | 336.08         | 104.74         |

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Aircraft: ARROW 1 with  
J75 P3 Engines  
A/C 25201

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WEIGHT & C.G. SUMMARY

| <u>DESCRIPTION</u>                                | <u>WEIGHT</u><br><u>lb</u> | <u>H. ARM</u><br><u>ins.</u> | <u>V. ARM</u><br><u>ins.</u> | <u>M.A.C.</u><br><u>%</u> |
|---|----------------------------|------------------------------|------------------------------|---------------------------|
| AIRCRAFT BASIC WEIGHT                             | 47,078.72                  | 557.85                       | 127.26                       |                           |
| USEFUL LOAD (less Fuel)                           | 921.02                     | 366.58                       | 132.34                       |                           |
| Crew  | 390.00                     | 194.00                       | 136.50                       |                           |
| Engine Fire Extinguisher Fluid                    | 25.00                      | 730.00                       | 129.00                       |                           |
| Residual Fuel                                     | 218.40                     | 553.98                       | 134.04                       |                           |
| Oxygen Charge                                     | 13.39                      | 259.69                       | 159.91                       |                           |
| Water for Air Conditioning                        | 140.00                     | 268.00                       | 132.00                       |                           |
| Oil   | 134.23                     | 608.92                       | 115.68                       |                           |
| BALLAST   | 905.00                     | 86.10                        | 116.50                       |                           |
| Operational Weight Empty                          | 48,904.74                  | 545.52                       | 127.16                       | 30.25                     |
| Maximum Internal Fuel (2,544 gals. @ 7.8 lb/gal.) | 19,843.00                  | 538.88                       | 144.32                       |                           |
| A.U.W. Max. Internal Fuel                         | 68,747.74                  | 543.60                       | 132.11                       | 29.72                     |
|   |                            | 545.02                       | 129.75                       | 30.11                     |

N.B. 1) Aircraft Datum is considered to be 120" above an arbitrarily chosen ground line.

2) The above figures are for the Aircraft in the BALLASTED Condition such that the Aft C.G. on the horizontal C.G. Envelope does not exceed 31% M.A.C. i.e. 303 lb on Former Sta. 68.5 and 602 lb on the Shear Panel.

REPORT No: 7-0400-44-13

DATE: Jan 1st 1954

BY: Kathleen Lyggett

SHEET: 3

HORIZONTAL C.G. ENVELOPE

ARROW 2 - 1/2 23201

NORMAL FLIGHT CONDITIONS

FUEL SYSTEM PROPORTIONERS USED

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