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AVRO AIRCRAFT LIMITED  
INTER-DEPARTMENTAL MEMORANDUM

Ref: 9354/11/J  
Date: 1 June, 1958  
To: See Distribution  
From: E.F. Burnett - Weight Supervisor  
Subject: ARROW 2 PRODUCTION A/C WEIGHT & C.G. SUMMARY - Report 7-0400-34 Issue 20

Attached is a copy of Weight and C.G. Summary Report 7-0400-34 Issue 20 dated June 1st, 1958, for your retention.

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

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

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## I N D E X

| <u>Sheet</u> | <u>Content</u>  |
|--------------|---|
| 1-1 to 1-5   | Introductory notes and explanation of weight changes  |
| 2-1 to 2-2   | Weight and C.G. Summary   |
| 3            | Horizontal C.G. plot showing basic fixed points on flight envelope. The possible variations of C.G. with fuel used has been omitted until such time as fully approved fuel sequencing is established. |
| 4-1 to 4-15  | I.B.M. Detail sheet of Weight and C.G.s.  |

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### INTRODUCTION & WEIGHT CHANGES

The following is a Weight and C.G. Summary of the Arrow 2 Production Aircraft based on the latest weight estimates available.

All weight and C.G. changes are relative to Issue 19 of May 1st, 1958.

Some early Arrow 2 Aircraft, serial numbers in the group 25206 to 25236, will not be as this summary designates, but will be Flight Test Aircraft with Instrumentation, "Astra Minus", or preproduction Astra I Radar, Missile pack trials and various test installations etc. Appropriate weight statements will be issued at a later date.

#### GENERAL:-

- a) Orenda PSL3 Engines comprise the Power Plant (4,500 lb each, excluding Nose Bullet & Input Frame).
- b) A package containing 4 "semi-submerged" Sparrow II missiles (432 lb each) forms the current Armament.
- c) The R.C.A. Astra I Radar system is installed. The basis of the unit weight & C.G. breakdown is a weight statement received from R.C.A. dated October 4, 1957. No Sparrow III auxiliaries are carried in a production Aircraft. Where later weights have been received from Minneapolis-Honeywell, these have been incorporated.

All installation cables, junction boxes etc not R.C.A. supplied are now AVRO's responsibility weightwise and these have been recently reassessed.

A weight statement has been received from R.C.A. dated April 1, 1958, but this will not be used until several points have been clarified by R.C.A. Some weight increase is to be expected.

The Infra Red tracker system seeker head is installed in its fin pod location.

(Total weight of the installed system is 3,349.4 lb, including missile actuation and firing systems).

In addition to the above Minneapolis-Honeywell MH64 Damping System is installed.

Arrow 2 A/C 25206 to 25208, and some later serial numbers will have the "Astra Minus" system (Navigational and Communication equipment only).

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GENERAL:- (Cont'd)

- d) Where actual weights of Arrow I parts that apply to Arrow 2 Aircraft have been obtained, these weights have been recorded in the Arrow 2 records. Some weights of Arrow 2 parts have also been obtained.

On I.B.M. sheets in this report, immediately preceeding the item title will be found a number varying from 0 to 100. This is percentage actual weight recorded in the relevant item.

- e) To increase the long range capabilities of the Aircraft a tailcone plug has been introduced to restrict the exhaust area. This plug will be used for ferrying missions only and its weight is recorded with the Max. Gross Weight see sheet 2-2.

1. STRUCTURE:-

WEIGHT lb

a) Wings

|   |               |
|---|---------------|
| I/W Centre Line Joints - Mk 2 prod. drg. est of joints  |               |
| Main Spar to Auxiliary Spar   | + 0.14        |
| Elevators - Mk. 2 prod. drgs est, some redesign compared to Mk 1 - no allowance yet made for split control surfaces until design is finalized | - 6.98        |
| <u>Wing Weight Decrease</u>   | <u>- 6.84</u> |

b) Fin & Rudder

No weight change.

c) Front Fuselage Fwd Sta. 255 ins

|   |               |
|---|---------------|
| Navigator's Canopy* - Sierracin 880 replaces glass for the window   | - 6.26        |
| Windscreen* - addition of rear fairing apron  | + 1.55        |
| addition of shims & alterations to hardware for installation  | + 0.51        |
| Air Intakes - Subsequent to supersonic flight the .04 Mg outer side skins were found to be cracked. Repair scheme instituted, skins now .04 AL, stringer sections changed backing angles added etc. | + 6.42        |
| <u>Front Fuselage Increase</u>  | <u>+ 2.22</u> |

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STRUCTURE (Cont'd)

WEIGHT lb

N.B. \*The use of Sierracin 880 and Sierracete in place of glass and thermapane is being investigated for the windscreen and pilots canopy. If it proves acceptable and NO change in overall thickness is made then there would be weight savings of approx.

- |                           |   |              |
|---------------------------|---|--------------|
| a) 32 lb to Pilots Canopy | ) | Total 70 lb. |
| b) 38 lb to Windscreen    | ) |              |

(Sierracin = .045 lb/cu.in.      Glass = .090 lb/cu.in.)

d) Centre Fuselage Sta. 255 - 485 ins

Duct CF - due to a D.O. error the splice straps at Sta. 257.45 were originally shown as .032 instead of .050 AL.

+ 0.73

Centre Fuselage Increase

+ 0.73

e) Duct Bay Sta 485 - 591.65 ins

No weight change.

f) Engine Bay Sta. 591.65 - 742.5 ins

No weight change.

g) Rear Fuselage Sta. 742.5 ins aft

No weight change.

h) Fuselage "Marry-Up"

Joint Duct Bay to Eng. Bay - Mk. 1 weight was recorded here until Mk 2 drgs were available. The Mk. 1 joint drgs. included some of the heat exchanger area, not applicable to Mk 2 A/C - the weight was left in error. Mk 2 drgs now estimated

- 10.87

Fuselage "Marry-Up"

- 10.87

TOTAL STRUCTURAL DECREASE

- 14.76

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2. LANDING GEAR

WEIGHT lb

Main Landing Gear - increase made to brake weight allowance assuming redesigned Mk 2 brakes to be similar to those for MK 1 A/C.

There are probably further increases to wheels and brakes this is only a preliminary allowance until a definite design proposal is accepted. (Wt of ONE wheel, brake & tyre Assy. was 151.46 lb, now 165 lb allowed)

+ 54.16

TOTAL LANDING GEAR INCREASE

+ 54.16

3. POWER PLANT & SERVICES

Engine Controls - completely re-estimated to Mk. 2 prod. drgs.

- 0.11

Fuel System - completely re-estimated to Mk 2 drgs - previously allowance based on Mk 1 and scheme drgs.

+ 0.81

POWER PLANT & SERVICES DECREASE

+ 0.70

4. FLYING CONTROLS GROUP

No weight change.

5. EQUIPMENT GROUP

Air Conditioning - first complete estimate made to Mk 2 prod. drgs, previously allowances etc based on Mk 1 system were carried. No attempt will be made to analyse the weight change which is relatively small

+ 8.09

Electrics Duct Bay - Further details available on E28 panel - now fully estimated to prod. drgs.

+ 4.39

Radio & Radar Fixed - deletion of 4 Radar Homer antennae complete re-estimate of cables, the weight prediction of which is now AVRO responsibility (see introd. note c)

+ 67.45

Missile Pack Structure - addition of retraction guides misc E.C.N.'s incorporated

+ 6.49

Missile Pack Hydraulics - pressure return lines now Steel were Aluminum, also CS-T-162 pipe replaces CS-T-135 throughout system

+ 5.46

TOTAL EQUIPMENT GROUP INCREASE

+ 83.40

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SUMMARY

Weight Change - Aircraft Basic Weight

|              |                |
|--------------|----------------|
| Structure    | - 14.76        |
| Landing Gear | + 54.16        |
| Power Plant  | - 0.70         |
| Equipment    | + 83.40        |
|              | <u>+123.50</u> |

Weight Change - Operational Weight Empty (A/C Less Fuel)

Issue 19

46,229.54

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46,353.04

+123.50 lb



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| DESCRIPTION                            | WEIGHT<br>lb | H. ARM<br>ins | V. ARM<br>ins |
|--|--------------|---------------|---------------|
| <b>STRUCTURE</b>                       | 19,154.35    | 566.68        | 137.31        |
| Wings                                  | 10,029.89    | 642.98        | 142.21        |
| Fin & Rudder                           | 1,039.01     | 735.84        | 208.90        |
| Fuselage - Fwd Sta 255 ins             | 2,588.02     | 184.43        | 128.67        |
| Sta 255 - 485 ins                      | 1,700.93     | 376.01        | 130.59        |
| Sta 485 - 591.65 ins                   | 1,161.25     | 538.59        | 105.63        |
| Sta 591.65 - 742.5 ins                 | 1,574.07     | 659.68        | 110.72        |
| Sta 742.5 ins aft                      | 1,019.48     | 806.57        | 127.46        |
| "Marry - Up"                           | 41.70        | 460.70        | 110.60        |
| <b>LANDING GEAR - RETRACTED</b>        | 2,638.41     | 488.35        | 134.95        |
| Main Landing Gear                      | 1,989.10     | 538.89        | 141.00        |
| Main Gear Doors & Fairings             | 287.98       | 538.52        | 138.40        |
| Nose Landing Gear                      | 333.81       | 170.81        | 99.70         |
| Nose Gear Door & Fairing               | 27.52        | 162.22        | 88.66         |
| <b>POWER PLANT &amp; SERVICES</b>      | 10,801.37    | 671.45        | 121.35        |
| Engine & Accessories FS13              | 9,186.78     | 687.95        | 121.16        |
| Engine Nose Bullets (Orenda Supplied)  | 70.00        | 587.17        | 116.00        |
| Engine Controls                        | 32.32        | 379.90        | 117.49        |
| Gear Box & Drives on Fuselage          | 281.84       | 601.70        | 102.49        |
| Gear Box, Starter & Drives on Engines  | 315.45       | 615.98        | 105.24        |
| Fire Extinguishing System              | 65.46        | 700.45        | 134.21        |
| Engine Mountings                       | 132.38       | 666.82        | 136.52        |
| Fuel System                            | 717.14       | 531.46        | 134.96        |
| <b>FLYING CONTROLS GROUP</b>           | 1,926.56     | 650.93        | 138.14        |
| Mechanical Flying Controls             | 952.74       | 676.42        | 147.63        |
| Hydraulic Flying Controls              | 973.82       | 626.00        | 128.86        |
| <b>EQUIPMENT FIXED &amp; REMOVABLE</b> | 9,033.59     | 331.29        | 114.21        |
| Instruments                            | 46.07        | 163.68        | 138.70        |
| Probe                                  | 15.25        | -23.71        | 108.00        |
| Cockpit Pressure Sealing               | 5.00         | 186.00        | 130.00        |
| Oxygen System                          | 26.07        | 240.54        | 156.70        |
| Cockpit Equipment                      | 6.00         | 187.50        | 145.00        |
| Ejector Seats                          | 342.94       | 204.50        | 134.11        |
| Air Conditioning System                | 864.09       | 341.68        | 135.33        |
| Cockpit Insulation                     | 14.31        | 187.48        | 132.00        |
| Hydraulics Utilities system            | 647.33       | 505.17        | 117.69        |
| Drag Chute                             | 91.07        | 786.68        | 143.19        |
| Electrical System                      | 1,268.41     | 434.75        | 112.77        |
| Low Pressure Pneumatics                | 56.94        | 421.96        | 128.47        |
| Surface Finish                         | 100.00       | 591.52        | 140.20        |
| Intake Deicing Boots                   | 88.00        | 195.82        | 118.00        |
| Canopy Actuation                       | 64.92        | 221.99        | 154.35        |
| Cabin Consoles                         | 17.28        | 174.66        | 124.33        |
| Radar Door Actuation                   | 10.00        | 268.00        | 95.00         |
| MH64 Damping System                    | 184.72       | 464.22        | 135.05        |
| Radio & Radar Removable                | 2,095.20     | 209.73        | 108.59        |
| Radio & Radar Fixed                    | 841.53       | 212.59        | 114.94        |
| Sparrow Pack Structure                 | 897.36       | 383.98        | 98.77         |
| Sparrow Pack Mechanisms                | 553.32       | 372.85        | 99.13         |



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| DESCRIPTION   | WEIGHT<br>lb | H. ARM<br>ins | V. ARM<br>ins | % M.A.C. |
|---|--------------|---------------|---------------|----------|
| Sparrow Pack Hydraulics   | 365.51       | 378.03        | 103.89        |          |
| Sparrow Pack Electronics Remov.                                       | 185.50       | 331.91        | 100.00        |          |
| Sparrow Pack Electrics & Electronics<br>Fixed                         | 217.11       | 335.24        | 110.00        |          |
| Sparrow Pack Air Conditioning   | 5.21         | 305.50        | 102.50        |          |
| Sparrow Pack L.P. Pneumatics  | 24.45        | 386.92        | 103.50        |          |
| Aircraft Basic Weight U/C Up  | 43,554.28    | 542.82        | 128.45        |          |
| U/C Down  |              | 545.13        | 124.64        |          |
| USEFUL LOAD (less fuel)   | 2,798.76     | 377.29        | 104.80        |          |
| Crew  | 390.00       | 194.00        | 136.50        |          |
| Oil   | 138.97       | 636.92        | 110.57        |          |
| Engine Fire Ext. Fluid  | 25.00        | 730.00        | 129.00        |          |
| Residual Fuel   | 218.40       | 553.98        | 134.04        |          |
| Missiles  | 1,728.00     | 389.29        | 88.30         |          |
| Oxygen Charge   | 13.39        | 259.68        | 159.91        |          |
| Water for Air Conditioning  | 285.00       | 267.91        | 131.56        |          |
| Operational Weight Empty U/C Up                                       | 46,353.04    | 532.83        | 127.02        | 26.75    |
| U/C Down  |              | 535.00        | 123.44        | 27.35    |
| Op. Wt. Empty less Missiles U/C Up                                    | 44,625.04    | 538.39        | 128.52        | 28.29    |
| U/C Down  |              | 540.64        | 124.80        | 28.91    |
| Normal Combat Mission Fuel*<br>(200 N. Mile = 2,254 gal at 7.8lb/gal) | 17,580.00    | -             | -             |          |
| Normal Gross Weight   | 63,933.04    | -             | -             |          |
| Half Combat Mission Fuel<br>(1,127 gals at 7.8 lb/gal)                | 8,790.00     | -             | -             |          |
| Combat weight (half mission fuel)                                     | 55,143.04    | -             | -             |          |
| Max. Internal Fuel<br>(2492 gals at 7.8 lb/gal)                       | 19,438.00    | 541.85        | 114.16        |          |
| Gross Weight (Max. int. Fuel) U/C Up                                  | 65,791.04    | 535.49        | 132.08        | 27.49    |
| U/C Down  |              | 537.02        | 129.56        | 27.91    |
| Max External Fuel (500 gal<br>at 7.8lb/gal + Drop Tank)               | 4,242.36     | 520.32        | 60.79         |          |
| Tailcone Plugs  | 252.00       | 857.07        | 128.60        |          |
| Max. Gross Weight (Int & Ext fuel) U/C Up                             | 70,285.40    | 535.73        | 127.76        | 27.55    |
| U/C Down  |              | 537.16        | 125.41        | 27.95    |

N.B. 1) Aircraft Datum = 120 ins above an arbitrarily chosen ground line

2) \* Fuel weights in accordance with latest data issued by Performance Group dated November 19th, 1957. Centres of gravity have temporarily been omitted until a fuel sequencing system is finally established.

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HORIZONTAL C.G. PLOT OF  
FIXED POINTS ON ARROW 2  
FLIGHT ENVELOPE

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BY : Kathleen Lyall

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