

UNCLASSIFIED
SECURITY CLASSIFICATIONAVRO AIRCRAFT LIMITED
INTER-DEPARTMENTAL MEMORANDUM

Ref: 1644/11/J
 Date: 1 July, 1958
 To: See Distribution
 From: E.F. Burnett - Weight Supervisor
 Subject: Arrow 2 Production A/C Weight and C.G. Summary - Report 7-0400-43
 Issue 21

Attached is a copy of Weight and C.G. Summary Report 7-0400-34
 Issue 21 dated June 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 5-5/DAS Eng 6-4-5

Date: 5 Nov 1992

Signature: *E. F. Burnett*

Unit / Rank / Appointment: DSIS 3, Secretary CRAD HQ DRP

E. F. Burnett
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EFB/ag

cc: Messrs. J.C. Floyd	J.P. Booth	A.J. Crest
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Issue: 21

Aircraft: Arrow 2
Prod. A/C
Date: 1 July, 1958

I N E D X

<u>Sheet</u>	<u>Content</u>
1-1 to 1-5	Introductory notes and explanation of weight changes
2-1 to 2-3	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 & C.G. of the Arrow 2 Production Aircraft based on the latest weight estimates available.

All weight & C.G. changes are relative to Issue 20 of June 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 PS13 Engines comprise the Power Plant (4,500 lb each, brochure weight, excluding Nose bullet and Input frame. An actual weight of an appropriate PS13 engine should soon be available).
- b) A package containing 4 "semi-submerged" Sparrow II missiles (432 lb each) froms the current Armament.
- c) The R.C.A. Astra I Radar system is installed. The basis of the unit weight and C.G. breakdown is a weight statement received from R.C.A. April 21st, 1958. Some relevant ammendments have been made to this list.

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

(Total weight of the installed system is 3,325 lb. including missile actuation and firing systems).

In addition to the above, Minneapolis-Honeywell MH 64 Damping System is installed.

Arrow 2 Aircraft 25205 to 25208, and some later serial numbers will have the "Astra Minus" system (Navigational and Communication Equipment only).

- 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 the report, immediately preceeding the item title will be found a number varying from 0 to 100. This is the 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.

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1. Structure

Weight lb

a) Wings

I/W Struct F/S to M/Spar - Additional stiffening elements in U/C Bay	+	4.75
Fuselage Hinge Joints - Mk 2 prod. drgs estimated. Actual weights obtained of all available applicable parts	-	9.89
<u>Wing Weight Decrease</u>	-	<u>5.14</u>

b) Fin & Rudder

No weight change

c) Fuselage Fwd Sta 255 ins

Bulkhead Sta. 120 ins - doublers added for additional Air-Conditioning holes	+	0.85
Misc. other equip. bracketry changes etc.	+	0.45
Cockpit Floor - bracketry changes for equip. etc.	+	0.17
Lower Shear Panel - misc. minor prod. drg. changes	+	0.05
<u>Front Fuselage Increase</u>	+	<u>1.52</u>

d) Centre Fuselage Sta. 255 - 485 ins

Skin - minor changes to all wing seal clips	+	0.07
Armament Bay Roof - Additional Services requirements	+	0.14
Electronics Bay - latches replace Camlocs on side access doors	+	2.29
Radar Access Door - misc. bracketry changes	+	0.20
addition of struts to hold door open	+	0.40
Equip. Bay Structure - Max. venting requirements Air Conditioning bay to electronics bay, tray modified	-	0.47
Misc. Items C.F. - addition of nylon guide strips and seal retainers along lower longeron	+	8.42
<u>Centre Fuselage Increase</u>	+	<u>11.05</u>

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.

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h) Fuselage Joints

Weight lb

Joint at Sta 742.5 ins - first estimate to MK 2
Prod. drgs.

+ 0.94

Fuselage Joints Increase

+ 0.94

Total Structural Increase

+ 8.37

2. Landing Gear

Main Landing Gear - proposals for the wheel, tyre, and brake assys are being considered from both Goodrich and Goodyear. Indications are that an assembly will NOT weigh LESS than 170 lb. Previously 165 lb each assy was allowed based on MK 1 A/C. It should be noted that the U/C leg is not stressed for this additional weight and possible changes could occur here also.

+ 20.0

N.B. For Bendix anti-skid control system - see equip group.

Total Landing Gear Increase

+ 20.0

3. Power Plant & Services

Accessories Gear Boxes on Fus. - expected increase for
seperate oil system for
Constant Speed Drive units

+ 5.00

Fire Extinguishing System - redesigned for MK 2 A/C - Mk 1
A/C weight estimates were
previously recorded - considerable
additional piping in the Duct Bay
around Air-Oil heat exchangers.
Supply unit is similar to that in
MK 1 A/C

+ 7.41

Total Power Plant Increase

+ 12.41

4. Flying Controls Group

Mechanical Flying Controls - Prod. drg reissues, including
redesign of rear aileron quadrant,
installation of rotary actuator
for aileron pitch-trim etc.

+ 5.75

Total Flying Controls Increase

+ 5.75

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5. <u>Equipment Group</u>	<u>Weight lb</u>
Utility Hydraulics C.F. - first est. to Mk 2 prod. drgs	+ 0.90
Utility Hydraulics I/W - Some piping changes etc - first est to Mk 2 prod. drgs	+ 9.30
Sequencing U/C Doors - a mechanically operated system is being introduced on Mk 2 A/C for both the Nose and the Main U/C Doors. N.B. The Nose Door on Mk 1 A/C was electrically operated. It will now be possible to close doors with U/C extended.	+ 51.10
Anti-Skid System - A.T.I. of a Bendix system is to be made on Mk 1 A/C. An anti-skid system is a basic requirement for a Mk 2 A/C and Wt estimates here have been based on the Mk 1 A/C T.I.	+ 37.68
Radio & Radar Remov - estimates quoted to latest R.C.A. Wt. Statement (see General Note d))	- 0.20
Sparrow Pack Electronics Remov - Latest R.C.A. weights of missile auxiliaries	+ 4.30
Sparrow Pack Electronics Fixed - Firing box MPR3 deleted for a prod. aircraft and box MPR2 is increased by approx 20%	- 28.38
<u>Equipment Group Increase</u>	<u>+ 74.70</u>

N.B. Items 6 & 7 Below

Since the tank configuration for Mk 1 and Mk 2 are similar Mk 1 A/C figures quoted below will be considered applicable to MK 2 A/C.

6. Trapped Fuel

Trapped Fuel - Aircraft 25201 was weighed dry and then drained thus establishing a weight of fuel trapped within the system	* + 372.00
<u>Total Trapped Fuel</u>	<u>+ 372.00</u>

7. Operational Load

Residual Fuel - this is the fuel that is drainable, but unusable, the figure has also been established experimentally. Previously this report contained both trapped and residual fuel, which were theoretically underestimated	+ 66.60
<u>Total Operational Load Increase</u>	<u>* + 66.60</u>

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N.B. * This has not influenced the Gross Weight of the Aircraft,
 though it has increased the effective Combat Weight;
 see also note following Wt. and C.G. summaries Shts 2-2 & 2-3.

Summary

Weight Change - Aircraft Basic Weight

Structure	8.37
Landing Gear	20.00
Power Plant	12.41
Flying Controls	5.75
Equipment	74.70
Trapped fuel	+ 372.00
	<u>+ 493.23</u>

Weight Change - Operational Load

Residual Fuel	+ 66.60
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Weight Change - Operational Weight Empty (A/C less usable Fuel)

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46,353.04	46,912.87	<u>+ 559.83</u>

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Description	Weight lb	H. Arm ins	V. Arm ins
Structure	19,162.72	566.47	137.23
Wings	10,024.75	642.89	142.20
Fin & Rudder	1,039.01	753.84	208.90
Fuselage Fwd Sta 255 ins	2,589.54	184.40	128.66
Sta 255 - 485 ins	1,711.98	375.85	129.94
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"	42.64	466.91	109.85
Landing Gear - Retracted	2,658.41	488.57	134.99
Main Landing Gear	2,009.10	538.68	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
Power Plant & Services	10,813.78	671.38	121.33
Engines & Accessories PS13	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	286.84	603.28	102.50
Gear Box, Starter & Drives on Engines	315.45	615.98	105.24
Fire Extinguisher System	72.87	686.42	131.67
Engine Mountings	132.38	666.82	136.52
Fuel System	717.14	531.46	134.96
Flying Controls Group	1,932.31	651.62	138.20
Mechanical Flying Controls	958.49	677.65	147.69
Hydraulic Flying Controls	973.82	626.00	128.86
Equipment Fixed & Removable	9,108.29	332.60	113.91
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
Hydraulic Utilities System	657.53	505.29	118.04
Sequencing of U/C Doors	51.10	346.00	116.00
Anti-skid Control System	37.68	480.00	113.97
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	2,095.00	212.03	107.09
Radio & Radar Fixed	841.53	212.03	107.09

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Description	Weight lb	H. Arm ins	V. Arm ins	% M.A.C.
Sparrow Pack Structure	897.36	372.85	99.77	
Sparrow Pack Mechanisms	553.32	372.85	99.13	
Sparrow Pack Hydraulics	365.51	378.03	103.89	
Sparrow Pack Electronics Remov.	189.80	326.10	100.00	
Sparrow Pack Electronics & Elecrics Fixed	188.73	336.09	110.00	
Sparrow Pack Air Conditioning	5.21	305.50	102.50	
Sparrow Pack L.P. Pneumatics	24.45	386.92	103.50	
Trapped Fuel	372.00	560.00	136.00	
Aircraft Basic Weight U/C Up	44,047.51	542.84	128.40	
U/C Down		545.15	124.58	
Useful Load (Less usable Fuel)	2,865.36	381.78	105.68	
Crew	390.00	194.00	136.50	
Engine Fire Ext. Fluid	25.00	730.00	129.00	
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	
Oil	138.97	636.92	110.57	
Residual Fuel	285.00	557.84	136.07	
Operational Weight Empty U/C Up	46,912.87	533.00	127.01	26.80
U/C Down		535.17	123.43	27.40
Op Wt. Empty Less Missiles U/C Up	45,184.87	538.50	128.49	28.31
U/C Down		540.75	124.77	27.94
Normal Combat Mission Fuel Φ (200 Naut Miles - 2276 gal at 7.8 lb/gal)	17,750.00	-	-	
Normal Gross Weight	64,662.87	-	-	
Half Combat Mission Fuel (1138 gals at 7.8 lb/gal)	8,875.00	-	-	
Combat Weight (Half mission fuel)	55,787.87	-	-	
Max Internal Fuel *	19,000.00	541.85	114.16	
Gross Weight (Max Int. Fuel) U/C Up	65,912.87	535.55	131.95	27.50
U/C Down		537.09	129.40	27.93
Max. External Fuel (500 gal @ 7.8 lb/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	70,407.23	535.78	127.65	27.57
U/C Down		537.22	125.26	27.96

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N.B.

- 1) Aircraft Datum = 120 ins above an arbitrarily chosen ground line
- 2) Φ Fuel weights in accordance with latest data issued by Performance group dated Nov. 19th, 1957. Centres of gravity have temporarily been omitted until a fuel sequencing system is finally established.
- 3) * The trapped and residual fuel within the Aircraft was determined experimentally by actual weighings in the dry and drained conditions etc for A/C 25201.

Since MK 1 and MK 2 A/C tank configurations are similar Mk 1 figures are considered applicable to Mk 2 A/C until such time as an experimental check can be made on a MK 2 A/C.

The figures obtained on A/C 25201 were considerably in excess of those originally calculated.

Experimentally determined figure	= 657 lb
Calculated figure	= <u>218 lb</u>

Increase in trapped + residual fuel = +439 lb

Now actual weighings of MK 1 A/C in a fully fuelled condition have indicated that it would not be desirable to alter the total estimated fuel within the Aircraft. Hence since the unusable fuel has been increased by 439 lb, the usable fuel has been decreased by a similar amount.

An experimental determination of the tank volumes is expected in the near future.

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

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BY: Kathleen Goffman

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