

TL-113-58/08

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AVRO AIRCRAFT LIMITED  
INTER-DEPARTMENTAL MEMORANDUM

Ref: 2713/11/J  
Date: 1 August, 1958  
To: See Distribution  
From: E.F. Burnett - Weight Supervisor  
Subject: Arrow 2 Production A/C Weight and C.G. Summary - Report 7-0400-34  
Issue 22

Attached is a copy of Weight and C.G. Summary Report 7-0400-34  
Issue 22 dated August 1st, 1958, for your retention

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

Classification ~~cancelled / changed to~~ <sup>confirmed as</sup> 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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Prod. A/C  
Date : 1 August, 1958

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I N D E X

<u>Sheet</u>	<u>Content</u>
1-1 to 1-7	Introductory notes and explanation of weight changes.
2-1 to 2-3	Weight & 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 22 of July 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 (4,800 lb each, revised weight, excluding Nose Bullet, Input Frame and AVRO installed accessories).
- 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 unit weights quoted herein are as received from R.C.A. in their weight statement dated June 5th, 1958. This includes the Infra Red Tracker system seeker head installed in its Fin pod location.

(Total weight of the installed system is 3336 lb, including Missile actuation and firing systems).

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

Arrow 2 Aircraft 25206 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 tailcone plugs have been introduced to restrict the exhaust area. Provision for carrying these plugs, which are jettisonable, will be made on all Mk 2A/C. The plug may be installed for any mission, but would probably be jettisoned prior to combat. It is only recorded in this report for a ferrying mission.

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<u>1. Structure</u>	<u>Weight lb</u>
a) <u>Wings</u>	
Elevators - allowance for slotting of surface, false rib, steel seal strip, T/Edge shear link etc. added	+ 4.36
<u>Wing Weight Increase</u>	+ 4.36
b) <u>Fin &amp; Rudder</u>	
Rudder - surface slotted, false rib, steel seal strip T/Edge link etc added	+ 2.34
<u>Fin &amp; Rudder Increase</u>	+ 2.34
c) <u>Fuselage Fwd Sta 255 ins</u>	
Canopy Arches - act wts. of seal fillet & jack support fittings	- 1.10
Lower Longeron - brackets added, hinges for circuit breaker panel on R.H. side etc.	+ 0.65
Upper Shear Panel - addn. of equip. Mtg. panel	+ 0.25
Air Intakes - minor prodn. drg. changes - repair scheme was already allowed for, now est. to drgs.	+ 0.13
<u>Front Fuselage Decrease</u>	- 0.07
d) <u>Centre Fuselage Sta 255 - 485 ins</u>	
No weight change	
e) <u>Duct Bay Sta 485 - 591.65 ins</u>	
No weight change	
f) <u>Engine Bay Sta 591.65 - 742.5 ins</u>	
Lower Longerons - Act. wt. of O/B long. & doublers, some hardware changes	- 1.45
Panels at Engine Access Doors - production drawing reissues	+ 0.34
Engine Rails & Attachments - actual wt of rails obtained	+ 0.61
Side Panel Fwd - production drawing reissues	+ 0.03
Top Longerons - actual weight of longerons	+ 0.13
Side Panel aft - actual wt. of 32% of structure obtained	- 0.01
Side Panel Centre - Prodn. drg. reissues and some actual wts	- 0.08
<u>Engine Bay Decrease</u>	- 0.43

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1. <u>Structure (Cont'd)</u>	<u>Weight lb</u>
g) <u>Rear Fuselage Sta 742.5 aft</u>	
Tailcones - addn. of two splice straps to former Sta 814	+ 0.90
addn. of seal retainers etc.	+ 2.66
Alterations to O/Skin capping to accomodate tailcone plug provisions	+ 0.44
Addition of plug attachment fittings etc	+ 4.32
<u>Rear Fuselage Increase</u>	<u>+ 8.32</u>

h) Fuselage Joints  
 No weight change

Total Structural Increase      + 14.52

2. Landing Gear

Main Landing Gear - Leg assy. as supplied by Dowty for Mk 2 A/C was lighter than the original Mk 1 leg due to the proposed redesigned shortening mechanism. In view of recent developments Dowty inform us that the Mk 2 leg will be no lighter than the Mk 1. Hence the Mk 1 A/C Dowty leg assy. weight will be reverted to (Goodrich 170 lb/assy	+ 23.57
Wheel tyre & brake assys have now been accepted, the weight was recorded in July 1st, 1958, issued of Wt Statement)	
<u>Total Landing Gear Increase</u>	<u>+ 23.57</u>

3. Power Plant & Services

Engines - Orenda have now quoted a weight of 4,800 lb for the PS13 Engine; 4,500 lb was the original brochure weight recorded in all weight statements to date. This wt of 4,800 lb is exclusive of input frame, nose bullet etc	+ 600.00
Engine Accessory Equipment - allowances were made for misc. piping, adaptors, breather lines etc similar to those on J75 P5 Engines - some of these items are no longer necessary on PS13 engines	- 20.98
Accessories Gear Boxes on Fuselage - Air-oil heat exchanges added (see also utility hydraulics D.B.)	+ 7.09
Fire Extinguishing System - D.O. error in piping call-up	+ 0.71
Fuel System - general reissues of Mk 2 prodn. drgs	+ 3.08
Actual wt of air pressure reg. valve 5.13 lb each, Spec. wt was 3.25 lb hence (2 off)	+ 3.76
Modifications to fuel no-air valves, to facilitate recovery of residual fuel*	

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3. Power Plant & Services (Cont'd)

Weight lb

Fuel System - Cont'd

Modification to tank #5, by addition of a sump  
etc to regain presently unusable fuel

+ 24.80

N.B. \* reference note for Residual Fuel in the Operational Load  
Group

Total Power Plant Group Increase

+ 619.76

N.B.  $\phi$  Weight recording of reports in this Group has been changed to  
agree with D.O. drawing "call-Up".

4. Flying Controls Group

No weight change.

5. Equipment Group

Utility Hydraulics D.B. - 2 x 110 cu in. accumulators deleted,  
replaced by one 200 cu. in. accum. in  
E.B. (see below)

- 30.00

Filter inst. & pressure control valve  
redesigned

- 6.05

2 Air-Oil heat exchangers deleted -  
similar exchangers now part of gear  
box system (see Engine Group)

- 5.63

General changes to the system

- 13.75

Utility Hydraulics E.B. - addition of 200 cu in accumulator  
(see above) piping rerouted etc

+ 29.47

U/C Door Sequencing - the main U/C door sequencing system has  
been deleted, partially due to excessive  
weight

- 24.10

Main U/C Door Stops - these are small spring loaded stops,  
2 per door located in the duct bay side  
skins, currently as a T.I.

+ 3.02

Low Pressure Pneumatics - initial estimate to Mk 2 drawings  
deletion of differential pressure  
switch in E.B.

- 2.56

One probe on Fin, not 2 as in Mk 1 A/C

- 2.26

Misc. other changes to weight allowances - 2.04



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5. Equipment Group (Cont'd) Weight lb

Radio & Radar Remov. - Weights quoted herein are to R.C.A.'s latest available wt breakdown of June 5th, 1958.		
1950 I.R. Tracking Unit - deleted	-15.00	
1940 I.R. Servo Amp - Increased	+ 3.00	
1920 I.R. Control Assy - decreased	- 5.00	
1960 Demodulator - increased	+ 5.00	
6130 Target Data Display - increased	+11.00	
6120 Wind Data Display - increased	+ 2.00	
6100 Dead Reckoner - increased	+10.50	
5420 Remote Channel unit-added	+ 8.00	
5451 Rotary switch panel-added	+ 1.50	
Misc. other changes	- 5.52	
<u>Total Change</u>	<u>+15.48</u>	<u>+ 15.48</u>
Radio & Radar Fixed - latest R.C.A. list of Rack weights, previously rack for miniature stable platform was omitted etc. etc.		
Junction Box R2 - estimate based on that for Partial Astra on A/C 25206, but with all necessary ammendments made		+ 16.50
M.H. 64 Damping System - larger rack for G limiter and mach & attitude amps		+ 22.01
Missile Pack Structure - correction in D.O. error in Call-Up of track back-up structure		+ 1.70
D.O. error in omitting shims from G.A.		+ 1.59
Deletion of plug panel		+ 2.30
Misc. minor changes		- 0.24
Addition of fittings & stiffeners where necessary for mounting missile cocoons (see also Op. load)		+ 0.73
Missile Pack Hydraulics - addition of 25 cu in accumulator and CSV103 check valve assy		+ 4.57
Missile Pack Mechanisms - addition of cocoon release mechanism, operated off wing door mech		+ 4.19
Missile Pack Electronics Remov - R.C.A. included a range slaving unit rack in error, now deleted in their latest statement		+ 4.00
		- 3.00
<u>Total Equipment Increase</u>		<u>+ 15.93</u>

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6. Trapped Fuel

Weight lb

Trapped Fuel - the figures established last month were considered unacceptable due to possible inaccuracies in the method of obtaining them. Now detailed estimates, partially supported by test rig results, reveal that the trapped fuel in the system is probably 213.8 lb. Hence a decrease in weight is shown here (372 lb July 1st, 1958). \*

- 158.20

Total Trapped Fuel Decrease

- 158.20

7. Operational Load

Missile Cocoons - it is a requirement on a production pack that a protective covering shall enclose the missile, this is automatically jettisoned on lowering the missile. Two schemes are being considered a metal honeycomb and a moulded plastic structure (probably the heavier). The weight recorded here is preliminary estimate for the metal cocoons

+ 84.00

Residual Fuel - that fuel which is drainable but not usable. On July 1st the weight of this item was quoted from an experimental determination, however, due to possible inaccuracies in the method these figures have not been accepted. A figure of 304 lb has been established by calculation for the present fuel system configuration. However, it is proposed to modify the fuel system (ref Power Plant Group) to recover this fuel, thus at this date no residual fuel will be recorded. Hence the allowance from July 1st will be deleted. \*

- 285.00

Total Operational Load Decrease

- 201.00

\* See also note following the summary on Sheet 2-2.



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Summary

Wt. Change - Aircraft Basic Weight

Structure	+ 14.52
Landing Gear	+ 23.57
Power Plant	+ 619.76
Equipment	+ 15.93
Trapped Fuel	- 158.20
	<u>+ 515.58</u>

Wt. Change - Operational Load

Cocoons	+ 84.00
Residual Fuel	-285.00

Weight Change - Operational Weight Empty (A/C less usable fuel)

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46,912.87

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47,227.45

+314.58 lb

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Description	Weight lb	H. Arm ins	V. Arm ins
Structure	19,177.24	566.68	137.23
Wings	10,029.11	642.94	142.20
Fin & Rudder	1,041.35	753.96	208.83
Fuselage Fwd Sta 255 ins	2,589.47	184.57	128.60
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	1,573.64	659.68	110.73
Sta 742.5 ins aft	1,027.80	806.84	127.47
"Marry-Up"	42.64	466.91	109.85
Landing Gear - Retracted	2,681.98	489.14	135.04
Main Landing Gear	2,032.67	538.85	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	11,433.54	672.15	121.38
Engines Bare PS13	9,600.00	689.94	121.25
Engine Accessories (inlet frame etc)	303.04	607.92	119.29
Engine Controls	32.32	379.90	117.49
Gear Box & Drives on Fuselage	293.93	602.67	102.24
Gear Box Starter & Drives on Engine	305.20	614.82	105.66
Fire Extinguisher System	73.58	686.35	131.21
Engine Mountings	75.39	671.91	141.52
Fuel System	750.08	532.21	134.96
Flying Controls Group	1,932.21	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	9,124.22	331.09	114.20
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	631.57	503.07	118.31
Sequencing of Nose U/C Door	27.00	200.00	115.00
Mechanical Door Stops Main U/C Doors	3.02	516.00	120.00
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	50.08	394.63	126.02
Surface Finish	100.00	591.52	140.20
Intake De-icing Boots	88.00	195.82	118.00
Canopy Actuation	64.92	221.99	154.32
Cabin Consoles	17.28	174.66	124.33
Radar Door Actuation	10.00	268.00	95.00
MH64 Damping System	186.42	462.33	134.70
Radio & Radar Removable	2,110.48	212.15	108.80

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Description	Weight lb	H. Arm ins	V. Arm ins	M.A.C. %
Radio & Radar Fixed	880.04	216.54	111.59	
Sparrow Pack Structure	906.31	383.90	98.72	
Sparrow Pack Mechanisms	557.32	372.64	99.11	
Sparrow Pack Hydraulics	369.70	378.00	104.00	
Sparrow Pack Electronics Remov.	186.80	326.19	100.00	
Sparrow Pack Electric & Electronic 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	213.80	548.26	141.79	
Aircraft Basic Weight U/C Up	44,563.09	544.43	128.38	
U/C Down		546.71	124.59	
Useful Load (Less usable fuel)	2,664.36	363.22	101.81	
Crew	390.00	194.00	136.50	
Engine Fire Ext. Fluid	25.00	730.00	129.00	
Oil	138.97	636.92	110.57	
Oxygen Charge	13.39	259.68	159.91	
Water for Air Conditioning	285.00	267.91	131.56	
Missiles	1,728.00	389.29	88.30	
Missile Cocoons	84.00	390.40	85.80	
Operational Weight Empty U/C Up	47,227.45	534.21	126.88	27.13
U/C Down		536.38	123.30	27.73
Normal Combat Mission Fuel $\Phi$ (200 Nav. miles - 2290 gals at 7.8 lb/gal)	17,860.00	-	-	
Normal Gross Weight	65,087.45			
Half Combat Mission Fuel (1145 gals at 7.8 lb/gal)	8,930.00			
Combat Weight ( $\frac{1}{2}$ mission fuel)	56,157.45	-	-	
Max. Internal Fuel * (2491 gals at 7.8 lb/gal)	19,433.00	541.85	114.16	
Gross Weight (Max. Int. fuel) U/C Up	66,660.45	536.44	131.92	27.75
U/C Down		537.97	129.38	28.17
Max External Fuel (500 gal @ 7.8 lb/gal + drop tank Tailcone plugs	4,242.36	520.32	60.79	
	252.00	857.07	128.60	
Max. Gross Weight (Int + Ext Fuel) U/C Up	71,154.81	536.61	127.67	27.80
U/C Down		538.05	125.29	28.19



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N.B.

- 1) Aircraft datum = 120 ins above an arbitrarily chosen ground line.
- 2)  $\phi$  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.
- 3) \* The trapped and residual fuel figures have now been calculated in detail (see notes section 6 & 7 of Wt. change summary).

Previous figure trapped + residual	= 657 lb
Current est. for trapped fuel *	= <u>214 lb</u>
Decrease in unusable fuel	= <u>-433 lb</u>

(\* Residual fuel is now considered recoverable)

Hence since the trapped + residual fuel have decreased by approx. 433 lb, the usable fuel has increased by a similar amount, it being assumed that the total volume within the aircraft remains constant.

It is hoped, in the near future, to make an accurate check on the total volumes contained in each tank, currently only calculations are available.

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

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SHEET: 3

BY: Kathleen Gaffney

