

SECRET

AVRO AIRCRAFT LIMITED  
INTER-DEPARTMENTAL MEMORANDUM

Ref: 8541/11/J  
Date: 1 May, 1958  
To: See Distribution  
From: E.F. Burnett - Weight Supervisor  
Subject: ARROW 1 A/C 25202 and 25203 - Weight and Balance

Attached is a copy of Weight and C.G. Summary, Report 7-0400-64 Issue 1 dated May 1, 1958, for your retention.

This report supercedes Report 7-0400-44 Weight and C.G. Summary ARROW 1 "25201 which is now covered by "Weight Statements for Flight Test".

Classification 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

E.F. Burnett

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Aircraft: ARROW 1  
A/C 25202 & 25203  
Date: 1 May, 1958

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## I N D E X

<u>Sheet</u>	<u>Content</u>
1-1 to 1-5	Introductory notes & explanations of Weight changes
2-1 to 2-2	Wt and C.G. Summary
3	Horizontal C.G. Envelopes for Flight conditions with fuel proportioners used.
4-1 to 4-15	I.B.M. Detail sheets of Weight and C.G.s

N.B.

Work has been cancelled on the fuel C.G. management system for Arrow 1 aircraft due to the satisfactory functioning of the proportioners.

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### INTRODUCTION & WEIGHT CHANGES

The following is a weight & C.G. summary for the second and third Arrow I Aircraft Nos. 25202 and 25203, with J75 P5 Engines, based on the latest information available. All weight and C.G. changes are quoted relative to 7-0400-44 Issue 16 of April 1st, 1958, which was the last similar summary issued for A/C 25201.

#### NOTE:

- 1) This summary will not apply for A/C 25204 and 25205 which are to be used for full Astra I Trial installations.
- 2) After Phase I of the flight test programme A/C 25203 will be fitted with a weapons pack trial installation, in lieu of the instrument package installed here.
- 3) In this summary the Aircraft is ballasted such that the aft C.G. shall not exceed 31% M.A.C. - which is the theoretical aft limit.

#### GENERAL:

- a) Pratt & Whitney J75 P5 Engines comprise the Power Plant for A/C's 25202 and 25203. (5850 lb each, Pratt & Whitney's latest brochure weight with their installation kit, confirmed by P & W actual weight recorded in engine inspection records).
- b) The Instrument Package containing Flight Instrumentation is installed. The Packages for A/C's 25201 to 25203 differ from those for A/Cs 25204 and 25205.

The weight recorded here is Flight Test Department's estimate of cable and instruments. An actual weight will be obtained as soon as a complete pack is available.

A relatively detailed estimate of other proposed Flight Test Installations throughout the Aircraft has been made. These installations amount to 1457 lb (figure partially confirmed by actual weights of some cable assys).

- c) In A/C 25201 Emergency Fire Protection, landing gear lowering etc were installed. These are no longer necessary in A/Cs 25202 and 25203 and have been deleted from the weight records.
- d) An Interim Radio & Radar System with Minneapolis-Honeywell MH64 Damping System is installed. Currently there is no Doppler or Tacan installation, though space provision for future installation of Doppler, which is not yet available, is made.
- e) The Mk 1A Tailcones and Stinger are fitted.

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GENERAL: (Cont'd)

- f) On A/C 25202, the set of control surfaces modified structurally for "buzz damper" installation are fitted. The control boxes are already modified for all Mk. 1 A/C. If it is decided to fit a trial installation of the "buzz damper" system there will be the following additional wt to A/C 25202....

Buzz Damping Equipment + 124 lb

This weight report incorporates the modified surfaces as on A/C 25202, however, if A/C 25203 does not have a "buzz damper" installation then the following changes ensue:-

Elevators	- 11.07 lb/ A/C
Ailerons	- 11.68 lb/A/C
Rudder	- 8.78 lb
	<u>- 31.53 lb</u>

When the split control surfaces are introduced this will entail a further weight increase, however, details of these ammendments to the design are not yet available.

- g) Due to material substitutions and concessions introduced by Planning and Production Departments, there is a structural weight penalty of 72 lb approx. 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) Several weighings of A/C 25201 have been made and the results obtained show good agreement with the estimated weights for that aircraft. However, at no time has it yet been possible to obtain a dry weight of the complete aircraft.

A considerable number of actual weights of parts and components have been obtained. Structural weights have checked within 0.5% of estimates of sub-assemblies etc. Equipment (most of which is now actual weight) has shown a consistant increase averaging about 11% over manufacturer's quotations or initial specification weights (excluding Engines and Gear Boxes). Preceeding the report titles on the I.B.M. Tabulation sheets, will be found a number varying form 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	72.33%
Landing Gear	98.75%
Power Plant	5.06%
Flying Controls	53.85%
Equipment	24.90%

i.e. 43.54% of the Basic Weight of A/C 25201

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GENERAL: (Cont'd)

- 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.
- k) No further work is being proceeded with on the fuel management system for Arrow I Aircraft. The fuel proportioners are functioning satisfactorily and it is not considered necessary to fit the fuel sequencing system.

1. STRUCTURE

WEIGHT (lb)

a) Wings

Elevator - the control surfaces modified structurally for fitment of buzz dampers are installed  
The elevators are to be split in the near future, but as details are not yet known, no weight allowance has yet been made.

+ 11.07

Ailerons - modified for 'buzz damper' as elevators

+ 11.68

\*

Wing Weight Change

+ 22.75

b) Fin & Rudder

Rudder - the rudder modified for "buzz damper" installations is fitted

+ 8.78

Fin Group Weight Increase \*

+ 8.78

\* These weight changes will not apply to A/C 25203, see General note (f) in the introduction.

c) Fuselage Fwd Sta 255"

No weight change

d) Centre Fuselage Sta 255" - 485"

No weight change

e) Duct Bay Sta 485" - 591.65"

No weight change

f) Engine Bay Sta 591.65" - 742.5"

Engine Tunnel - redesign of rear engine mtg access door

+ 0.41

Engine Bay Increase

+ 0.41

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1. STRUCTURE (Cont'd)

WEIGHT (lb)

g) Rear Fuselage aft Sta 742.5"

Tailcones - Mk. 1A tailcones in N155 fitted, these  
replace the shorter tailcones on A/C 25201  
(originally designed in titanium now steel)

+ 139.84

Centre Structure & Stinger - Mk. 1A design fitted

- 29.63

Rear Fuselage Increase

+ 110.21

Total Structural Increase

+ 142.15

2. LANDING GEAR

No weight change

3. POWER PLANT & SERVICES

Engines - J75 P5 engines replace the P3 engines that  
were installed in A/C 25201 (5850 lb each whereas  
P3 Engines were 6,175 lb each)

- 650.00

Act. wt. of engine can, etc.

- 1.29

Engine Nose Bullet - actual weights of P5 bullets obtained  
- these are partially redesigned

+ 5.03

Engine Service Accessories - minor changes to oil  
breather pipes, engine oil  
fillet etc.

+ 2.81

Engine Controls - Misc. minor changes to tension  
regulator mtgs. etc.

+ 0.92

Engine Gear Boxes & Starters - Production drawing ests.  
made for constant speed  
drive can

- 0.32

Total power Plant Group Decrease

- 642.85

4. FLYING CONTROLS GROUP

Flying Control Hydraulics - all production drawings for  
Arrow 1 now estimated various  
design changes etc contributor  
to the weight change  
(which also applies to A/C 25201)

- 6.98

Total Flying Controls Decrease

- 6.98

5. EQUIPMENT GROUP

Emergency Fire Protection - not required for A/C 25202 etc.

- 174.78

Emergency Lowering Main Landing Gear - not required

- 8.53

Emergency Lowering Nose Landing Gear - not required

- 4.38

Total Equipment Decrease

- 187.69

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SUMMARY

Weight Change - Aircraft Basic Weight

Structure	+ 142.15
Power Plant	= 642.85
Flying Controls	= 6.98
Equipment	= 187.69
	<u>= 695.37</u>

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

UNBALLASTED CONDITION

<u>7-0400-44-16</u>	<u>7-0400-64-1</u>	
48,225.15	47,529.78	<u>= 695.37 lb</u>

N.B.

There is also a reduction in the theoretical ballast required. A/C 25201 (ref. report 7-0400-44-16), required 815 lb ballast to limit the calculated aft C.G. to 31% M.A.C.

A/C 25202 requires only 794 lb. Hence there is a further reduction in the ballasted Operational Wt. empty of 815 - 794 lb = 21 lb.

°. Ballasted O.W.E. of A/C 25202 is 716.37 lb. lighter than ballasted O.W.E. of A/C 25201.

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Aircraft: ARROW 1  
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DESCRIPTION	WEIGHT lb	H. ARM ins	V. ARM ins
STRUCTURE	18,784.31	563.47	137.46
Wings	10,003.01	643.11	142.25
Fin & Rudder	1,034.63	754.84	209.36
Fuselage Fwd Sta 255"	2,661.52	181.74	128.18
Sta 255" - 485"	1,670.36	380.23	130.70
Sta 485" - 591.65"	1,010.63	533.81	104.49
Sta 591.65" - 742.5"	1,437.47	660.98	107.30
Sta 742.5" aft	912.38	807.53	128.96
"Marry-Up"	54.31	462.81	104.25
LANDING GEAR -RETRACTED	2,609.23	488.30	134.90
Main Landing Gear	1,966.41	539.55	141.01
Main Gear Doors & Fairings	282.34	537.60	138.37
Nose Landing Gear	333.81	170.81	99.70
Nose Gear Door & Fairing	26.67	161.77	88.25
POWER PLANT & SERVICES	13,770.66	652.46	120.35
Engines & Accessories J75 P5	11,913.81	665.32	119.78
Gear Box & Drives on Fuselage	276.70	603.71	103.24
Gear Box & Starter on Engine	286.80	589.18	105.54
Engine Controls	33.35	375.79	118.49
Engine Nose Bullets	75.61	562.69	115.11
Fire Extinguishing System	65.53	700.45	134.21
Engine Mountings	206.21	635.04	127.71
Fuel System	912.65	537.27	135.48
FLYING CONTROLS GROUP	2,007.17	652.13	137.12
Mechanical Flying Controls	952.63	675.92	147.59
Hydraulic Flying Controls	1,054.54	630.64	127.67
EQUIPMENT FIXED & REMOVALBE	9,437.39	402.95	113.56
Instruments	46.07	163.68	138.70
Probe	15.00	-38.14	108.00
Cockpit Pressure Sealing	5.00	186.00	130.00
Ejector Seats	342.94	204.50	134.11
Oxygen System	22.40	252.82	156.03
Air Conditioning System	822.07	339.45	134.46
Surface Finish	100.00	591.52	140.20
Cockpit Insulation	14.31	187.48	132.00
Drag Chute	90.99	786.18	143.17
Low Pressure Pneumatics	54.66	433.30	129.37
Electrical System	1,126.18	415.86	112.91
Intake De-Icing Boots	88.00	195.82	118.00
Canopy Actuation	65.86	222.01	154.36
Console Panels	17.45	174.76	124.34
MH64 Damping	99.08	450.83	140.34
Interim Radio & Radar	647.34	341.86	124.39
Hydraulics Utilities System	654.93	503.19	117.65
Nose U/C Door Actuation (wheel extended)	33.59	202.56	97.89
Instrument Pack Structure	686.80	385.81	94.68
Pack Instrumentation	3,048.00	394.00	95.00
Flight Test Installations	1,456.73	488.48	128.90

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DESCRIPTION	WEIGHT lb	H. ARM ins	V. ARM ins	M.A.C. %
Aircraft Basic Weight	46,608.76	556.87	127.41	
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	794.00	84.86	116.50	
Operationsl Wt Empty	48,323.78	545.49	127.32	30.24
Max. Internal Fuel (2508 gals at 7.8 lb/gal)	19,562.00	540.99	114.09	
Gross Weight (Max. int. fuel)	67,885.78	544.19	132.15	29.89
		545.63	129.77	30.28

N.B.

- 1) Aircraft Datum = 120 ins 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, using fuel proportioners, does not exceed 31% M.A.C. ie 303 lb on Former, Sta. 68.5 and 491 lb on the Shear Panel.

These figures are theoretical requirements only and are not to be confused with full nose ballast normally installed (1,397 lb total).

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DATE: MAY 1st 1958

SHEET: 3

BY: Kathleen Goffin

HORIZONTAL C.G. ENVELOPE

ARROW I - A/C 25202 & 25203

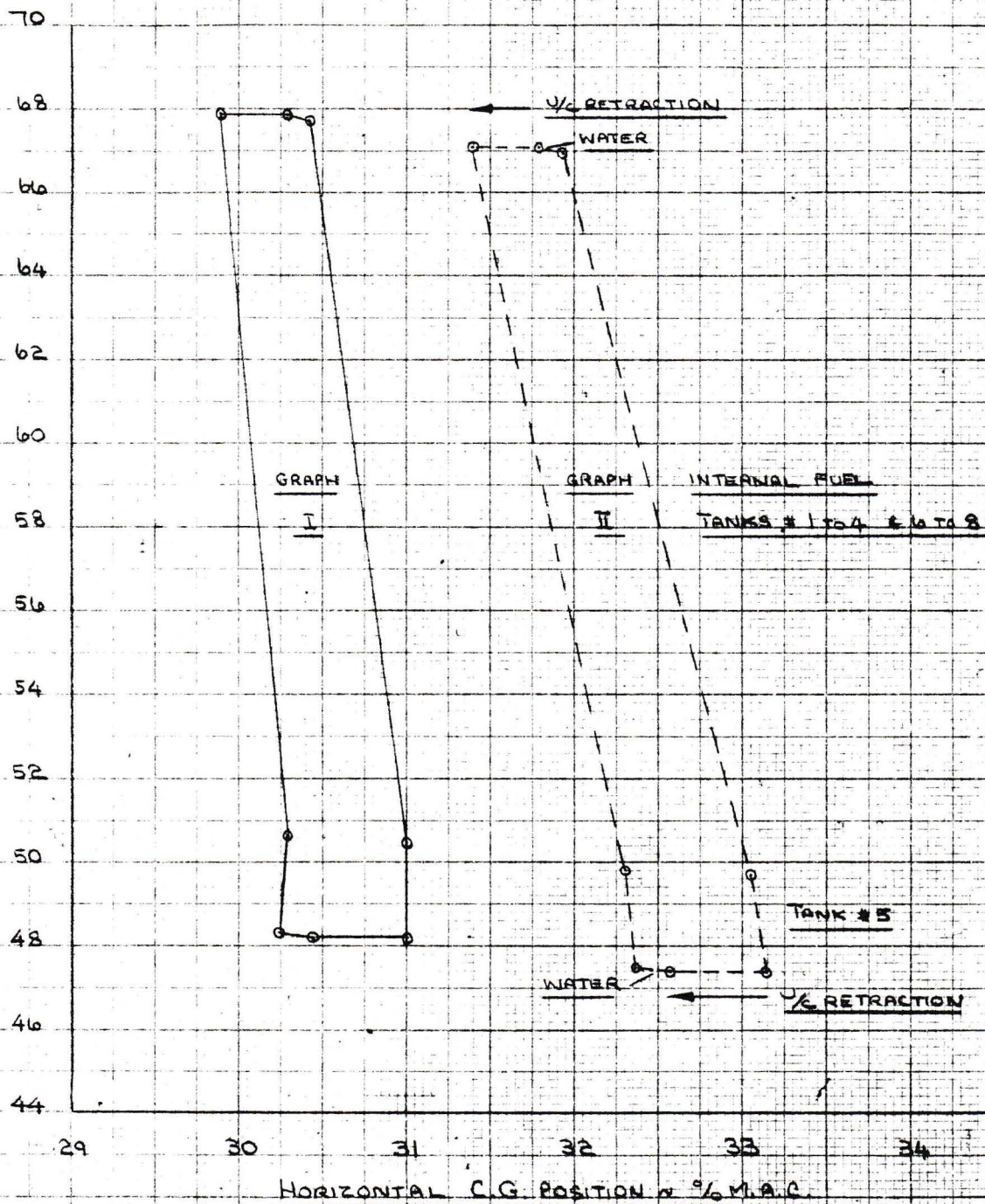
NORMAL FLIGHT CONDITIONS

FUEL PROPORTIONERS USED

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GRAPH I ~ A/C BALLASTED SUCH THAT AFT C.G. DOES NOT EXCEED 31% M.A.C.

GRAPH II ~ NO BALLAST



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