

UNCLASSIFIED
NON CLASSIFIEAVRO AIRCRAFT LIMITED
INTER-DEPARTMENTAL MEMORANDUM

Ref: 9600/11/J
 Date: 1 June, 1958
 To: See Distribution
 From: E.F. Burnett
 Subject: ARROW 1 A/Cs 25202 and 25203 - Weight and Balance

Attached is a copy of Weight and C.G. Summary, Report 7-0400-64
 Issue 2, dated June 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
 E.F. Burnett
 Weight Supervisor

EFB/ag

cc: Messrs. J.C. Floyd	J.P. Booth	J. Zurakowski
R.N. Lindley	F. Brame	A. Crust
R. Marshall	W. Czerwinski	(6 copies for
C.V. Lindow	J. Lucas	R.C.A.F.)
J.W. Ames	S. Kwiatkowski	D. Inglis
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D. Wade	T. Roberts	R. Cairns
D.N. Scard	C. Marshall	R. Brownridge



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

Report: 7-0400-64
Issue : 2

I N D E X

<u>Sheet</u>	<u>Content</u>
1-1 to 1-4	Introductory notes and explanations of Weight changes.
2-1 to 2-2	Weight 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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Sheet: 1-1

INTRODUCTION & WEIGHT CHANGES

The following is a weight & C.G. summary for the second and third Arrow 1 Aircraft Nos. 25202 & 25203, with J75P5 Engines, based on the latest information available. All weight and C.G. changes are quoted relative to 7-0400-64 Issue 1 of May 1st, 1956.

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 and Whitney J75 P5 Engines comprise the Power Plant for A/C's 25202 and 25203. (5850 lb each, Pratt and Whitneys 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/C's 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.

For early flights the package will not have complete instrumentation, but ballast will be installed to exactly simulate the completed weight and C.G.

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/C's 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.

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GENERAL: Cont'd

- e) The Mk 1A Tailcones and Stinger are fitted. Actually it is doubtful if these will be available for the initial flights of A/C 25202, however, they will be retrofit as soon as available.
- 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
	- 31.53 lb

When the split control surfaces are introduced this will entail a further weight increase, however, details of these amendments 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. Major repair schemes e.g. cracked outer skin on Air Intakes have been assessed and recorded.
- h) Several weighings of A/C 25201 have been made and the results obtained show good agreement with the estimated weights for the 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 constant increase averaging about 11% over manufacturer's quotations or initial specification weights (excluding Engines and Gear Boxes). Proceeding 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	72.32 %	Power Plant	5.06 %	Equipment	26.89%
Landing Gear	99.00 %	Flying Controls	53.85 %		

i.e. 44.01 % of the Basic Weight of A/C 25202.

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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 in 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

No weight changes

b) Fin & Rudder

No weight changes

c) Fuselage Fwd Sta 255 ins

Air Intakes - outer side skin was in .04 Mg, subsequent to supersonic flight this was found to be cracked. Repair scheme instituted, skin now .04Al, stringer sections changed, backing angles added etc

+ 6.42

Crew's Bulkheads - jack retraction bracket now steel was aluminium self aligning bearing

+ 1.98

Front Fuselage Increase

+ 8.40

d) Centre Fuselage Sta 255 - 485 ins

No weight changes.

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 Joints

No weight change.

TOTAL STRUCTURAL INCREASE + 8.40

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2.	<u>LANDING GEAR</u>	<u>WEIGHT lb</u>
	Main Landing Gear - it has become necessary to fit modified brakes with 1" thick discs.	+ <u>52.16</u>
	<u>TOTAL LANDING GEAR INCREASE</u>	+ <u>52.16</u>
3.	<u>POWER PLANT & SERVICES</u>	
	No weight change.	
4.	<u>FLYING CONTROLS GROUP</u>	
	No weight change.	
5.	<u>EQUIPMENT GROUP</u>	
	Interim Radio & Radar - Incorporation of actual weights of approx. 30% of complete system	+ <u>1.34</u>
	<u>TOTAL EQUIPMENT GROUP INCREASE</u>	+ <u>1.34</u>

SUMMARY

Weight Change - Aircraft Basic Weight

Structure	+ 8.40
Landing Gear	+ 52.16
Equipment	+ <u>1.34</u>
	+ <u>61.90</u>

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

UNBALLASTED CONDITION

Issue 1

Issue 2

47,529.78

47,591.68

+ 61.90

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DESCRIPTION	WEIGHT lb	H. ARM ins	V. ARM ins
STRUCTURE	18,972.71	563.30	137.46
Wings	10,003.01	643.11	142.25
Fin & Rudder	1,034.63	754.84	209.36
Fuselage Fwd Sta 255 ins	2,669.92	181.78	128.17
Sta 255 - 485 ins	1,670.36	380.23	130.70
Sta 485 - 591.65 ins	1,010.63	533.81	104.49
Sta 591.65 - 742.5 ins	1,437.47	660.98	107.30
Sta 742.5 aft	912.38	807.53	128.96
Fuselage Joints	54.31	462.81	104.25
LANDING GEAR - RETRACTED	2,661.39	488.88	135.01
Main Landing Gear	2,018.57	538.99	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	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 & Starters 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 & REMOVABLE	9,438.73	402.97	113.54
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	54.65	433.30	129.37
Electrical System	1,126.18	415.86	112.91
Intake Deicing Boots	88.00	195.82	118.00
Canopy Actuation	65.86	222.01	154.36
Console Panels	17.45	174.76	124.34
MH 64 Damping	99.08	450.83	140.34
Interim Radio & Radar	648.68	342.30	124.04
Hydraulics Utility 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 U/C Up	46,670.66	556.76	127.42	
U/C Down		558.93	123.83	
USEFUL LOAD (less fuel)	921.02	366.58	132.34	
Crew	390.00	194.00	136.00	
Eng. 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	792.00	84.84	116.50	
Operational Wt. Empty U/C Up	48,383.68	545.41	127.33	30.22
U/C Down		547.51	123.87	30.80
Max. Internal Fuel (2508 gals at 7.8 lb/gal)	19,562.00	540.99	144.09	
Gross Weight (Max. Int. Fuel) U/C Up	67,945.68	544.14	132.16	29.87
U/C Down		545.63	129.69	30.28

N.B. 1) A/C Datum = 120 ins above an arbitrarily chosen ground line.

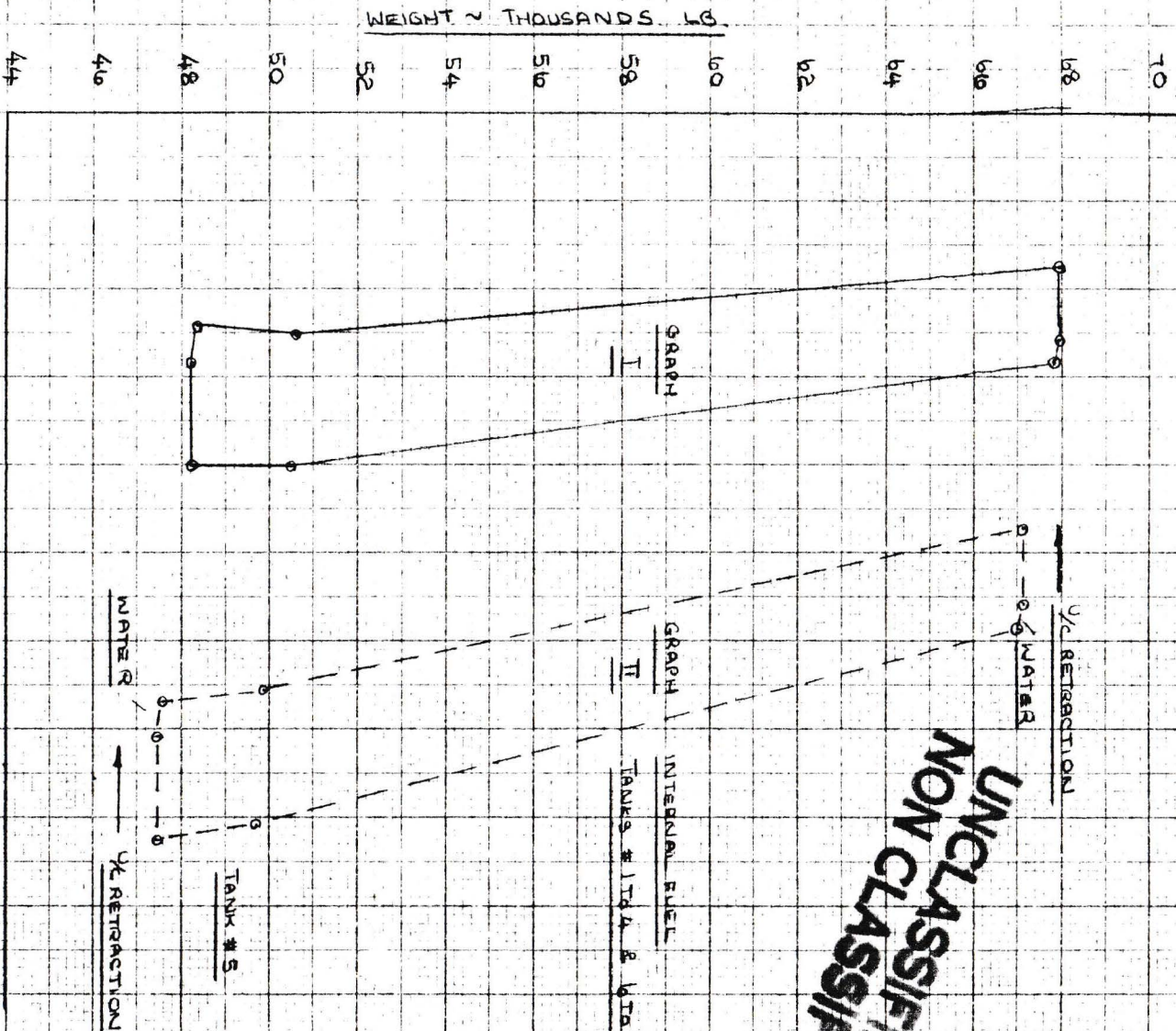
- 2) The above figures are for the aircraft in the BALLASTED condition such that the aft. C.G. on the horizontal C.G. envelope, using fuel proportioners, does not exceed 31% M.A.C. i.e. 303 lb on Former Sta. 68.5 and 489 lb on the Shear Panel.

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

HORIZONTAL C.G. ENVELOPE
ARROW I ~ 1/4 25202 & 25203
NORMAL FLIGHT CONDITIONS
FUEL PROPORTIONERS USED

REPORT No. 7-0400-104 ISSUE 2
DATE: June 1st 1958
SHEET: 3
BY: Kuffel & Fesser

GRAPH I ~ 1/4 BALLASTED SUB. THAT AFT. C.G. DOES NOT EXCEED 31% M.A.C.
GRAPH II ~ NO BALLAST



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HORIZONTAL C.G. POSITION ~ %M.A.C.