

AVRO AIRCRAFT LIMITED
INTER-DEPARTMENTAL MEMORANDUM

UNCLASSIFIED
NON CLASSIFIED

Ref. 3398/11/J
Date November 1st, 1957
To See Distribution
From Mr. E.F. Burnett
Subject ARROW MK 1 WEIGHT & C.G. SUMMARY - REPORT # 7-0400-44 Issue 11.

Attached is a copy of Weight and C.G. Summary, Report # 7-0400-44 Issue 11, dated November 1st, 1957 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/DARET 5-5/DAS Eng 6-4-5

Date: 5 Nov 1992

Signature: B. Aubrey

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

E. F. Burnett

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Weight Supervisor

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50244

Date: November 1st, 1957
Aircraft: C-105 MK 1 with
J75 P3 Engines

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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 & C.G. Summaries
3-1	Horizontal C.G. Envelopes for Flight conditions with fuel proportioners used.
4-1 to 4-15	I.B.M. Detail Sheets of Weights & C.G.'s.

N.B. The C.G. Envelopes for the 1st Aircraft with fuel
sequencing has been omitted until a fully approved
sequencing is established.

Date: November 1st, 1957
Aircraft: C-105 MK 1 with
J75 P3 Engines
1st Aircraft.

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INTRODUCTION & WEIGHT CHANGES

The following is a Weight & C.G. Summary for the 1st C-105 Aircraft, with J75 P3 Engines, based on the latest information currently available. All weight & C.G. changes are relative to Issue 10 of October 1st, 1957.

- Note: 1) This Summary does not apply for the 2nd and subsequent MK 1 Aircraft see context below.
- 2) The statement herein is for the 1st Aircraft complete to drawings and not necessarily in the condition for first flight. The original design of tailcones and stinger are recorded, the redesigned versions will be recorded at a later date, when they are available for retrofit.

For early flights there may be some shortages in non-essential equipment, some flight test installations will probably be incomplete etc. etc. A statement for first flight will be issued later.

GENERAL:

- a) Pratt & Whitney J75 P3 Engines comprise the Power Plant for the 1st Aircraft. J75 P5 Engines, which are partially redesigned versions of the P3 Engines, are to be installed on the 2nd & subsequent MK 1 Aircraft.
(J75 P3 Engines = 6,175 lb each; J75 P5 Engines = 5,950 lb each.)

- b) An Instrument Package containing Flight Instrumentation is installed, this also varies, the package for A/C's Nos. 1 to 3 differing from those for A/C's No. 4 and 5 (which are to be used for Astra 1 Trial Installations.).

A relatively detailed estimate of other proposed Flight Test Installations throughout the aircraft has been made. These installations amount to 1,398 lb (figure partially confirmed by actual weights of cable assys.)

- c) Emergency lowering for the Undercarriages and additional fire protection, to be installed in the 1st Aircraft, are allowed for in the summary. There is no provision to jettison any or all of the Instrument Package in an emergency.
- d) An Interim Radio & Radar System, with Minneapolis-Honeywell M.H.64 Damping System is installed. Currently there is no Doppler or Tacan installation although provisions for future installation of Doppler, which is not yet available, will be made.
- e) It should be noted that due to material substitutions and concessions introduced by Planning & Production Departments there is a structural weight penalty of 203 lb to-date. 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.
- f) Pending Flight Test requirements a "Buzz Damping" System may be installed on the first Aircraft. Provisions for this installation are already included in the structural group as modifications to the Control Boxes. For the first flight the control surfaces will be unmodified, however, if the need for Dampers is proven, a modified set of Control Surfaces will be made available.

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1st Aircraft.

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INTRODUCTION & WEIGHT CHANGES

GENERAL:

f) (Continued)

The following weight penalties ensue:

Ailerons	+	11.68 lb/A/C
Elevators	+	11.07 lb A/C
Rudder	+	8.78 lb
Equipment	+	123.97 lb
	+	<u>155.50 lb</u>

- g) A considerable number of Actual Weights have now been obtained. Structural weights are checking within 0.5% of estimates on sub-assemblies etc. However, equipment (excluding Engines and Gear Boxes) shows a consistant increase averaging about 11% over manufacturer's quotations or initial specification weights. Preceding the report titles on the I.B.M. Tabulation Sheets, will be found a number varying from 0 to 100, this the percentage of actual weight recorded within the report.

A summary of Actual Weights obtained so far is as follows:

Structure	-	74.91%
Undercarriage	-	97.86%
Power Plant	-	92.71%
Flying Controls	-	47.59%
Equipment	-	23.39%

i.e. 70.11% of the Basic Weight of the 1st Aircraft.

- h) 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.

For first flight the aft restriction is 30% M.A.C., this may be achieved by installing maximum ballast.

C.G. Envelopes showing fuel sequencing have currently been omitted until a fully approved sequencing is established.

1. STRUCTURE

WEIGHT (lb)

a) Wings:

Dorsal Fairing - Actual weight of fibreglass fairing

+ 4.04

Weight Increase Wings

+ 4.04

b) Fin and Rudder:

No Weight Change.

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INTRODUCTION & WEIGHT CHANGES

1. STRUCTURE (Cont'd.)

WEIGHT (lb)

c) Fuselage Fwd. Sta. 255"

Nose Structure Fwd: 120" - delete de-icing tank and filler
radome de-icing no longer a require-
ment - 2.66
Skin F.F. - General production drawing revisions + 1.05
Weight Decrease Front Fuselage - 1.61

d) Centre Fuselage Sta. 255"-485"

Radar Access Door - alterations to removable panel + 0.30
Pack Mounting Structure - modifications to Beam Sta. 292
to accommodate Ram Air Turbine
installation + 0.72
Electronics Bay Structure - delete L.H. Access Door for
Ram Air Turbine - 5.82
delete L.H. cover panel for
Ram Air Turbine - 3.92
Structure for Ram Air Turbine - no allowances were pre-
viously made for the extensive
provisions for the Ram Air Turbine
(Net Structural change = 40.74 - 3.92
- 5.82 + .72 = 31.72 lb) + 40.74
Weight Increase Centre Fuselage + 32.02

e) Duct Bay Sta. 485"-591.65"

No Weight Change

f) Engine Bay Sta. 591.65" to 742.5"

Outer Skins E.B. - Alterations to hardware 'call-up' + 1.52
Heavy Formers - miscellaneous production drawing changes + 1.65
Actual weights of parts + 1.43
Weight Increase Engine Bay + 4.60

g) Rear Fuselage Sta. 742.5 Aft.

Tailcones - Actual weight obtained - considerable steel
packing used on assembly also
tolerances on such low gauges
often account for high percentage
weight deviation + 15.24
Weight Increase Rear Fuselage + 15.24

h) Fuselage 'Marry-Up'

No Weight Change

TOTAL STRUCTURAL INCREASE

+ 54.29

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1st A/C

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INTRODUCTION & WEIGH CHANGES

2. LANDING GEAR

WEIGHT (lb)

Main U/C Doors - Actual weights of Doors
Actual weights of Fairings
TOTAL LANDING GEAR DECREASE

- 10.34
+ 0.80
- 9.54

3. POWER PLANT & SERVICES

No Weight Change

4. FLYING CONTROLS GROUP

No Weight Change

5. EQUIPMENT GROUP

Radome De-icing - this no longer a basic requirement	-	8.88
Electrics F.F. - addition of E49 panel for Ram Air Turbine and capacitor mounting for Air Conditioning	+	3.38
Electrics C.F - addition of E50 Air Conditioning Panel	+	2.37
Utility Hydraulics E.B. - alterations to piping routes etc.	+	1.13
Ram Air Turbine - estimated to installation drawings with manufacturer's weights of equipment, previously only an allowance made	+	15.41
Damping System - production drawing estimates of installations Cable allowance deleted now fully detailed with Radar System below	+	3.09
Interim Radio & Radar - addition of cables for M.H.64 Damping System - see above	-	43.14
Miscellaneous equipment and mounting detail changes	+	81.07
Doppler not available	+	11.56
Flight Test Installations - production drawing estimates of installations on Engines	-	100.00
Addition of Flight Test Damping System wiring etc.	-	6.68
addition of Flight Test Power System wiring etc.	+	57.02
Ejector Seats - The redesigned Martin-Baker seat was weighed and the weight agreed with manufacturer's quotation..	+	24.00
Redesign of installation and emergency O2 System	-	0.36
Crew's personal parachutes are packed in the seat and remain with the seat, consequently they have been removed from Operational Load and included with Equipment Group. Parachute allowance was 20 lb each now actual weight of 27.5 lb each	+	55.00
<u>TOTAL EQUIPMENT GROUP INCREASE</u>	+	<u>94.97</u>

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INTRODUCTION & WEIGHT CHANGES

6. OPERATIONAL LOAD

WEIGHT (lb)

Crew Members - Allowance deleted, parachutes are now included with seat weight - see Equipment Group above	- 40.00
Alcohol - Deleted, radome de-icing no longer a requirement	- 22.00
<u>TOTAL OPERATIONAL LOAD DECREASE</u>	<u>- 62.00</u>

SUMMARY:

Weight Change - Aircraft Basic Weight

Structure	+ 54.29 lb
Landing Gear	- 9.54 lb
Equipment	+ 94.97 lb
	<u>+ 139.72 lb</u>

Weight Change - Operational Load (Less Fuel)

Crew	- 40.00 lb
Alcohol	- 22.00 lb
	<u>- 62.00 lb</u>

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

UNBALLASTED CONDITION

<u>Issue 10</u>	<u>Issue 11</u>	
<u>47,759.29 lb</u>	<u>47,837.01</u>	= <u>+ 77.72 lb</u>

N. B. If A/C Ballasted such that the C.G. in any flight envelope (excluding some suggested fuel sequencings) does not exceed 31% M.A.C., a further 984 lb of ballast are necessary.

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1st A/C

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WEIGHT & C.G. SUMMARY

<u>DESCRIPTION</u>	<u>WEIGHT</u> <u>lb</u>	<u>H . ARM</u> <u>ins.</u>	<u>V. ARM</u> <u>ins.</u>
STRUCTURE	18,585.79	561.67	137.48
Wings	9,963.50	642.82	142.26
Fin & Rudder	1,025.85	754.34	209.31
Fuselage Fwd. Sta. 255"	2,628.42	181.75	128.18
Sta. 255"-485"	1,682.14	377.80	130.20
Sta. 485"-591.65"	998.59	534.01	104.59
Sta. 591.65"-742.5"	1,433.13	661.00	107.31
Sta. 742.5" Aft.	801.58	801.04	129.05
"Marry-Up"	52.58	468.91	103.89
UNDERCARRIAGE - Retracted -	2,600.31	488.39	134.91
Main Undercarriages	1,959.62	539.48	141.00
Main U/C Doors & Fairings	282.34	537.60	138.37
Nose Undercarriage	333.81	170.81	99.70
Nose U/C Door & Fairing	24.54	162.24	88.23
POWER PLANT & SERVICES	14,365.59	652.98	120.35
Engines & accessories J75 P3	12,562.29	664.92	119.78
Gear Box & Drives on Fuselage	275.54	601.39	102.98
Gear Box & Starters on Engines	259.65	591.55	104.52
Engine Controls	32.43	375.76	118.62
Engine Nose Bullets	71.01	562.74	115.07
Fire Extinguishing System	65.46	700.45	134.21
Engine Mountings	206.21	635.04	127.71
Fuel System	893.00	536.67	136.12
FLYING CONTROLS GROUP	1,857.18	686.26	139.66
Mechanical Flying Controls	949.04	687.85	148.43
Hydraulic Flying Controls	908.14	684.60	130.50
EQUIPMENT FIXED AND REMOVABLE	9,507.18	404.46	113.31
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	339.06	204.43	134.10
Oxygen System	223.59	253.72	156.43
Air Conditioning System	812.41	335.87	134.32
Surface Finish	100.00	591.52	140.20
Hydraulics Main System	639.97	504.37	117.71
Cabin Insulation	14.31	187.48	132.00
Brake Parachute	90.78	786.65	143.16
Electrical System	1,118.98	417.54	112.96
Low Pressure Pneumatics	54.39	432.79	129.22
Intake De-icing Boots	51.84	197.02	118.00
Canopy Actuation	64.92	221.99	154.35
Cabin Consoles	17.45	174.76	124.34
MK 64 Damping System	99.08	450.83	140.34
Interim Radio & Radar	635.61	338.85	124.03
Instrument Pack Structure	686.80	385.81	94.68
Pack Instrumentation 1st A/C	3,036.00	395.45	95.00
Flight Test Installations	1,398.43	491.44	129.55
Additional Fire Protection 1st A/C	154.17	425.05	102.89

continued.

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WEIGHT & C.G. SUMMARY

<u>DESCRIPTION</u>	<u>WEIGHT</u> <u>lb</u>	<u>H. ARM</u> <u>ins.</u>	<u>V. ARM</u> <u>ins.</u>	<u>M.A.C.</u> <u>%</u>
Equipment (Fixed & Removable)(Continued)				
Emergency Landing Gear Lowering	12.91	458.83	128.60	
Ram Air Turbine Equipment	90.41	336.64	104.73	
AIRCRAFT BASIC WEIGHT	46,916.05	558.64	127.28	
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	984.00	86.81	116.50	
Operational Weight Empty U/C Up	48,821.07	545.50	127.16	30.25
U/C Down		547.50	123.84	30.80
Maximum Internal Fuel (2,544 gal @ 7.8 lb/gal.)	19,843.00	538.88	144.32	
U/C Up		543.59	132.12	29.72
A.U.W. Maximum Internal Fuel U/C Down	68,664.07	545.02	129.76	30.11

N.B. 1) Aircraft Datum is considered to be 120" 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 does not exceed 31% M.A.C. i.e. 303 lb on Former Sta. 68.5 and 681 lb on the Shear Panel.

BH: Kathleen Griffin

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CLOS ME PA - NORMAL FLIGHT CONDITION

FOR 1ST A/C (1ST FLIGHT DEPARTS)

FUEL SYSTEM PROPORTIONERS USED

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