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AVRO AIRCRAFT LIMITED
INTER-DEPARTMENTAL MEMORANDUM

Ref: 7717/11/J
Date: 1 April, 1958
To: See Distribution
From: E.F. Burnett
Subject: ARROW 1 A/C 25201 WEIGHT & C.G. SUMMARY - Report #7-0400-44 Issue 16

Attached is a copy of Weight and C.G. Summary, Report #7-0400-44 Issue 16, dated April 1, 1958, for your retention.

This report, based on A/C 25201, will be superceded on May 1, 1958 by Report #7-0400-64 Issue 1, which is based on A/C 25202 and 25203.

All future Weight & Balance reporting on A/C 25201 will be done on "Weight Statement for Flight Test", forms and will be issued to those concerned.

Classification cancelled / changed to: UNCLASSIFIED

By authority of: DRDA 7/DARFT 5-8/DAS Eng 6-4-5

Date: 5 Nov 1992

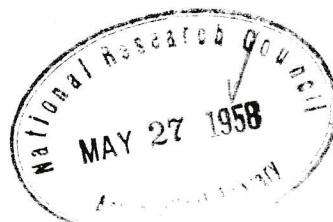
Signature: *B. Aubrey*

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

E.F. Burnett
E.F. Burnett

EFB/ag

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I N D E X

Sheet

Content

1-1 to 1-7

Introductory notes and explanations
of Weight Changes.

2-1 to 2-3

Weight & C.G. Summaries

3

Horizontal C.G. Envelopes for Flight
conditions with fuel proportioners
used.

4-1 to 4-15

I.B.M. Detail Sheets of Weight &
C.G.'s.

N.B. The C.G. Envelope for A/C 25201 with fuel sequencing
has been omitted until a fully approved sequencing
is established.

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INTRODUCTION & WEIGHT CHANGES

The following is a Weight & C.G. Summary for the first Arrow I Aircraft #25201, with J75 P3 Engines based on the latest information available. All Weight & C.G. changes are relative to issue 15 of March 1st, 1958.

NOTE:

- 1) This summary does not apply for A/C 25202 and 25203 which will have J75 P5 Engines, nor for Aircraft 25204 and 25205 which are for full Astra I trial installations etc.
- 2) The summary herein is for the aircraft complete to drawings, not in the condition encountered for first flight.
For first flight there was full Radar Nose ballast as originally designed (1397 lb), 507 lb additional nose ballast, 160 lb ballast & Dummy in Navigators seat, and some shortages in the Pack Instrumentation.
The required c.g. for this flight was 28% M.A.C.

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.

- 3) This is the final summary to be issued on A/C 25201. (see also notes H and K).

GENERAL

- a) Pratt & Whitney J75 P3 Engines comprise the Power Plant for Aircraft #25201. J75 P5 Engines, which are partially redesigned versions of the J75 P3 Engines, are to be installed on A/C 25202 and subsequent Arrow I Aircraft. (J75 P3 Engines = 6,175 lb each, J75 P5 Engines = 5,950 lb each)
- b) The Instrument Package containing Flight Instrumentation is installed, the packages for A/C 25201 to 25203 differing from those for A/C 25204 and 25205. A/C 25203 is also to have a weapon pack trial installation eventually.

The weight recorded here is Flight Test Department's estimate of cable & instruments - for first flight there were shortages to this weight and an actual weight of the pack to be installed was obtained.

A relatively detailed estimate of other proposed Flight Test Installations throughout the Aircraft has been made. These installations amount to 1,457 lb (figure partially confirmed by Actual Weights of some cable assys.).

- c) Emergency lowering for the landing gear and hydraulic actuation to close nose wheel door with landing gear extended also additional Fire Protection, all installed on the first aircraft are allowed for in this summary.
- d) An Interim Radio & Radar System with Minneapolis-Honeywell MH64 Damping System is installed. Currently there is no Doppler or Tacan installation, though provision for future installation of Doppler, which is not yet available, is made.

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INTRODUCTION & WEIGHT CHANGES (Cont'd)

GENERAL (Cont'd)

- e) The original design of tailcones & stinger are recorded (manufactured, however, in St. Steel not titanium as shown on drawings); the redesigned versions will be fitted to the Aircraft at a later date.

When Mk. 1A Tailcones are fitting the ensuing weight changes will be:

Tailcones	+ 139.84 lb/A/C
Stonger	- 29.72
Net change	+ 110.12 lb/A/C

- f) Pending further flight testing it may be necessary to install a "Buzz Damping" system on the first aircraft. Provisions for this installation are already included in the Structural weight as modifications to the Control boxes. For the first flight the control surfaces were unmodified, if the need for Dampers is proven, a modified set of control surfaces will be made available.

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
	+ 155.50 lb

- g) Note exactly as March 1st
- h) Several weighings of A/C 25201 have been made and the results obtained show good agreement with the estimated weights as recorded in this report. 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 have, however, been obtained. Structural weights have checked within 0.5% of estimates of subassemblies etc. Equipment (most of which is now actual weight) has shown a consistent increase averaging about 11% over manufacturer's quotations or initial specification weights (excluding Engines & Gear Boxes). Preceding 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	75.12 %
Landing Gear	98.75 %
Power Plant	92.97 %
Flying Controls	83.85 %
Equipment	24.83 %

70.00
i.e. % of the Basic Weight of A/C 25201.

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INTRODUCTION & WEIGHT CHANGES

GENERAL (Cont'd)

- j) The aircraft is ballasted such that the c.g. on a flight envelope (using fuel proportions) does not travel aft of 31% M.A.C.

For first flight a c.g., with landing gear retracted, of 28.15% M.A.C. was obtained as required (see also introductory note #2).

- k) All outstanding drawings, reissues, trial installations etc pertaining to A/C 25201 have now been estimated. Some of the weight changes appear trivial, but all recorded here.

This issue of report 7-0400-44 now closes the monthly weight reports on A/C 25201. In future this aircraft will be covered by Weight Statements for Flight Testing.

On May 1, 1958, a statement will be issued for A/C 25202 & 25203. This will be report No. 7-0400-64 Issue 1.

1. STRUCTURE

WEIGHT lb

a) Wing

Aileron - due to failure of trailing edge on test, the aileron has been split at rib #4A, an additional rib introduced and the space between packed with sponge rubber strips. + 6.12

Wing to Fus. Joint - Addition of small flexible hoses and some hardware changes + 0.78

Wing Weight Increase + 6.90

b) Fin & Rudder

No weight change

c) Fuselage Fwd Sta. 255"

Structure fwd Sta 120 ins - addition of coupling to joint at Sta 120 ins + 0.19

Winscreen - addition of shims for installation + 0.54

Lower Longeron - addition of .072" Al channels to shear web from Sta 214 - 255, etc. + 1.23

Bulkhead Sta. 255 - addition of packing, rubbing strip etc. + 0.44

Cockpit Floor - Prod. drg. reissues, bracketry added to accomodate F/cont. hydraulic changes + 1.77

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INTRODUCTION & WEIGHT CHANGES

1. STRUCTURE (Cont'd)

WEIGHT (lb)

c) Fuselage Fwd Sta. 255" (Cont'd)

Canopy Arches - Misc. changes on ECNs etc	+	1.98
Air Intakes - Misc. E.C.N.s incorporated	+	0.21
Crew's Bulkheads - Stiffener 7/16" Al added on Pilot's bulkh'd,	+	0.57
equipment bracketry added etc.	+	1.28
Formers FF. - addition of attachment for elevator feel and trim unit	+	0.53
Misc. Items - alterations & additions to systems bracketry	+	1.39
Lower Shear Panel - addition of small electrical brackets	+	0.12
<u>Front Fuselage Increase</u>	+	<u>10.25</u>

d) Centre Fuselage Sta 255 - 485"

Skin CF - addition of brackets fittings	+	0.81
Bulkhead Sta 485 - addition of brackets	+	0.09
Sealing Missile Bay - addition of brackets & doublers to fwd seal	+	0.46
Armament Bay Roof - addition of systems bracketry	+	1.10
Equipment Bay Structure - equip. mtg bracketry changes	+	0.61
Radar Access Door - brackets for micro-switch mountings added etc	+	0.22
Longerons - actual weight obtained - some redesign since last estimate was made	+	5.87
Integral Fuel Tanks - addition of union & cap on doors insulation "Bestobel" added on bulkhead 317 etc	+	1.73
all other estimates revised, E.C.N.'s incorporated etc, many minor changes	+	5.99
Duct CF - Outer plates fwd .04 were .032 Al rolled section & one .02 top hat superceded by a .032 channel	+	1.07
<u>Centre Fuselage Increase</u>	+	<u>18.32</u>

e) Duct Bay Sta 485 -591.105 ins

Lower Panel - addition of .07 steal strap from Sta 486 to Sta 538	+	1.86
misc. other hardware changes etc	+	0.25
Access Doors - minor prod. drg. changes	+	0.10
Duct - misc. E.C.N.s incorporated since time of actual weighing of this component	+	0.30
<u>Duct Bay Increase</u>	+	<u>2.51</u>

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INTRODUCTION & WEIGHT CHANGES

1. <u>STRUCTURE</u> (Cont'd)	<u>WEIGHT (lb)</u>
f) <u>Engine Bay Sta 591.65 - 742.5 ins</u>	
Engine Access Doors - addition of seal around No. 2 door	+ 0.80
Torsion Box - minor changes to brackets etc	+ 0.04
Misc Items - mtg. bracket air duct changed	- 0.04
Engine Tunnel - addition of Al bar stiffeners & associated changes, tube elbow added to air duct, assy	+ 3.13
<u>Engine Bay Increase</u>	<u>+ 3.93</u>
g) <u>Rear Fuselage Sta. 742.5 ins. Aft</u>	
Now weight change	
h) <u>Fuselage Joints</u>	
Joint Air Intakes to F.F. - shims added	+ 1.40
Joint C.F. to D.B. - hardware changes	+ 0.20
<u>Fuselage Joints Increase</u>	<u>+ 1.60</u>
<u>TOTAL STRUCTURAL INCREASE</u>	<u>+ 43.51</u>
2. <u>LANDING GEAR</u>	
Main Landing Gear - Most items for joints are Dowty supplied, however, some bolts etc for joints to Wing are AVRO supplied & these have been previously omitted in error	+ 2.67
<u>TOTAL LANDING GEAR INCREASE</u>	<u>+ 2.67</u>

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INTRODUCTION & WEIGHT CHANGES

3. <u>POWER PLANT & SERVICES</u>	<u>WEIGHT (lb)</u>
Accessories Gear Boxes on Fws. - act. Wt. of oil tank	
de-aerater (2 off)	- 1.50
additional gauges	+ 1.00
Misc. hardware alterations etc.	+ 1.66
Accessories Gear Boxes on Eng - Oil waste drain altered & other minor piping changes	+ 0.82
Fire Extinguishing System - minor changes to clamps & hardware	+ 0.07
Fuel System - actual weight of differential pressure valves	+ 2.50
gate valve mechanism - manual operation	+ 3.52
Steel pipes for power plant waste fuel	
drain added etc.	+ 10.22
Misc. other changes & act. wts. of equip	+ 3.41
<u>TOTAL POWER PLANT GROUP INCREASE</u>	<u>+ 21.70</u>
4. <u>FLYING CONTROLS GROUP</u>	
Mechanical Flying Controls - rudder cable tension regulator added, elevator feel & trim unit redesigned and moved to fwd quadrant from aft quadrant. Alterations also made to nose wheel steering cables & brackets There is an appreciable C.G. shift fwd of approx. 8" for the whole system	+ 8.50
F/Cont. Hydraulics Fus - full production drawing ests. made of booster installation in fwd fuselage (Initial allowance of 77 lb was too light). Production drawings also estimated for installation of surge damping accumulators. Elevator serves moved fwd etc.	+ 59.17
<u>FLYING CONTROLS INCREASE</u>	<u>+ 67.67</u>

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INTRODUCTION & WEIGHT CHANGES

<u>5. EQUIPMENT GROUP</u>	<u>WEIGHT (lb)</u>
Oxygen System - actual wt. of O ₂ converter obtained	- 3.67
Utility Hydraulics FF - addition of shock mount at air charging valve	+ 0.76
Flow control valve added	+ 0.54
check valve added	+ 0.53
Piping changes etc associated with flow regulator in nose gear circuit	+ 2.65
Utility Hydraulics CF - misc. changes to 1st A/C only.	
No account is taken of the Ram Air Turbine piping	+ 3.06
Utility Hydraulics EB - Actual wt. of pressure regulator valve 10.22 lb target wt. was 55lb.	+ 4.72
redesign of p.r. valve mtg.	+ 0.41
misc. other changes	+ 0.26
Canopy Actuation - actual wt. obtained of Idler lever	+ 0.94
Ejector Seats - gas generator on seat was previously omitted - this was not installed on seat at time of weighing of seat	+ 3.88
Emergency Fire Protection - no allowance was previously made for associated electrics	+ 2.78
hoses replace rigid tubing, some rerouting etc.	+ 11.12
<u>TOTAL EQUIPMENT INCREASE</u>	<u>+ 28.01</u>

SUMMARY

Weight Change - Aircraft Basic Weight

Structure	+ 43.51
Landing Gear	+ 2.67
Power Plant	+ 21.70
Flying Controls	+ 67.67
Equipment	+ 28.01
	<u>+ 163.56</u>

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

UNBALLASTED CONDITION

Issue 15

48,061.59

Issue 16

48,225.15

+ 163.56 lb

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WEIGHT & C.G. SUMMARY

DESCRIPTION	WEIGHT LB	H. ARM ins.	V. ARM ins
STRUCTURE	18,642.16	561.38	137.48
Wings	9,980.26	642.83	142.26
Fin & Rudder	1,025.85	754.34	209.31
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 591.56 - 742.5"	1,437.06	660.97	107.30
Sta 742.5" aft	802.17	802.05	129.06
"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	14,413.51	652.74	120.33
Engine Accessories J75 P3	12,562.29	664.92	119.78
Gear Box & Drives on Fuselage	276.70	603.71	103.24
Gear Box & Starter on Engine	287.12	589.12	105.57
Engine Controls	32.43	375.76	118.62
Engine Nose Bullets	70.58	562.75	115.07
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	2,014.15	653.56	137.19
Mechanical Flying Controls	952.63	679.03	147.59
Hydraulic Flying Controls	1,061.52	630.70	127.85
EQUIPMENT FIXED & REMOVABLE	9,625.08	403.28	113.47
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

Cont'd

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WEIGHT & C.G. SUMMARY

DESCRIPTION (Cont'd)		WEIGHT lb	H. ARM ins	V. ARM ins
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
MH64 Damping		99.08	450.83	140.34
Interim Radio & Radar		647.34	341.86	124.39
Hydraulics Utility System		654.93	503.19	117.65
Emergency Landing Gear Lowering		12.91	458.83	128.60
Nose U/C Door Actuation		33.59	202.56	97.89
Instrument Pack Structure		686.80	385.81	94.68
Pack Instrumentation (A/C 25201)		3,048.00	394.00	95.00
Flight Test Installation		1,456.73	488.48	128.90
Additional Fire Protection		174.78	417.06	107.61
AIRCRAFT BASIC WEIGHT				
U/C Up		47,304.13	556.94	127.21
U/C Down			559.01	123.79
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
DESCRIPTION	WEIGHT LB	H. ARM	V. ARM	% M.A.C.
BALLAST	815.00	85.12	116.50	
Operational Wt. Empty		545.52	127.13	30.25
U/C Up	49,040.15	547.52	123.83	30.81
U/C Down				
Max. Int. Fuel (2,508 gals at 7.8lb/gal)	19,562.00	540.99	144.09	
A.U.W. Max. Int. Fuel	68,602.15	544.23	131.97	29.90
U/C Up		545.66	129.61	30.29
U/C Down				

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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, using fuel proportioners, does not exceed 31% M.A.C. i.e. 303 lb on Former Sta. 68.5 and 512 lb on the Shear Panel.

These figures are theoretical only and are not to be confused with that ballast which is actually installed on A/C 25201 (reference Introductory note 2).

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DATE: April 1st 1958

BY: Kathleen Lyffe

SHEET: 3

HORIZONTAL C.G. ENVELOPE

ARROW I - $\frac{1}{2}$ 25201

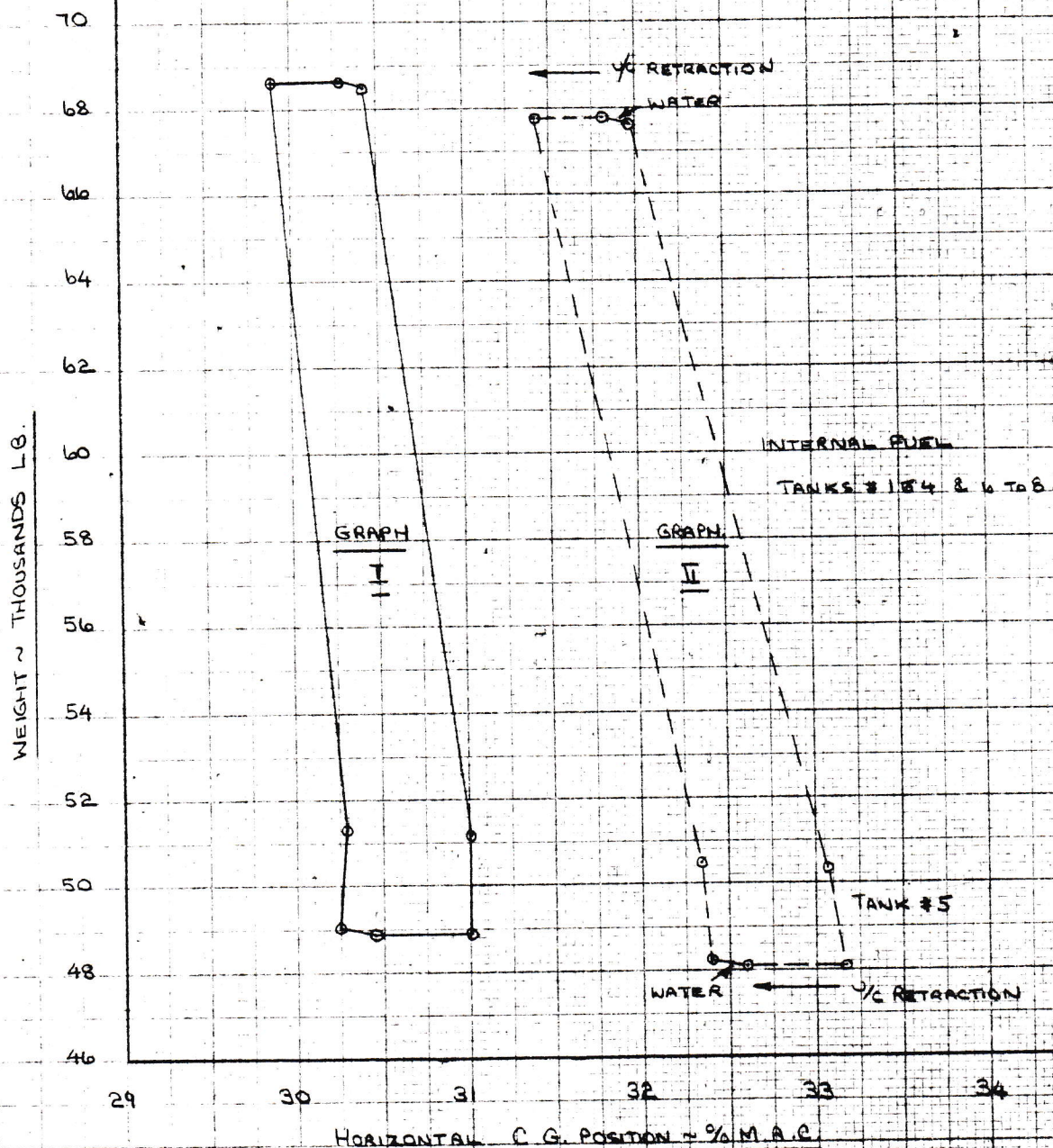
NORMAL FLIGHT CONDITIONS

FUEL SYSTEM PROPORTIONERS USE **UNCLASSIFIED / NON CLASSIFIED**

GRAPH I ~ $\frac{1}{2}$ BALLASTED SUCH THAT AFT CG DOES NOT EXCEED $31\frac{1}{2}\%$ MAC

GRAPH II ~ NO BALLAST

N.B. THE CONDITION REQUESTED & FULFILLED FOR FIRST FLIGHT IS NOT COVERED BY THESE GRAPHS.



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