

Date: June 1st, 1957
Aircraft: C-105 MK. 2

Report # 7-0400-34 Iss. 8
Prepared By: K. Griffin
Checked By: E. Burnett

UNCLASSIFIED
~~SECRET~~

Classification cancelled / changed to: UNCLASSIFIED

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

Date: 5 Nov 1992

Signature: *E. Burnett*

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

I N D E X

<u>Sheet #</u>	<u>Content</u>
1-1 to 1-4	Introductory notes and brief explanation of Weight Changes to the Aircraft.
2-1 to 2-4	Detailed explanation of Weight Changes to weight reports as listed on I.B.M. Sheets.
3-1 to 3-2	Weight and C.G. Summaries.
4-1	Horizontal C.G. Envelope for Aircraft Flight Conditions using fuel sequencing, C.G. controlled to approximately 31% M.A.C. until Damping System requirements proven. (ref. Avro Spec. E-503).
4-2	Horizontal C.G. Envelope for Aircraft Flight Conditions using fuel sequencing to achieve approximately 34% M.A.C. at Combat Weight (Alternate sequencing Spec. E-503).
5-1 to 5-15	I.B.M. Detail Sheets of Weight's and C.G.'s .



UNCLASSIFIED
~~SECRET~~

Date: June 1st, 1957
Aircraft: C-105 MK 2
Production A/C

~~UNCLASSIFIED~~
NON CLASSIFIE

Report # 7-0400-34 Iss. 8
Sheet # 1-1
Prepared By: K. Griffin
Checked By: E. Burnett

INTRODUCTION

The following is a Weight & C.G. Summary of the C-105 MK 2 Production Aircraft. Of necessity some figures quoted herein are only of a very preliminary nature, due to lack of information e.g. Fuselage aft of Sta. 803, Air-Conditioning system etc, extensive redesign from MK 1 is in progress.

Weight estimates have been made, based on the MK 1 Aircraft with relevant changes made to MK 2 scheme and production drawings. Where no details regarding minor changes are yet available, allowances have been retained as in the MK 1 Aircraft.

All Weight & C.G. changes are relative to Issue 7 of May 1st, 1957.

GENERAL

- a) Orenda PS 13 Engines comprise the Power Plant (4,500 lb each).
- b) A package containing 4 "semi-submerged" Sparrow II Missiles (432 lb each) forms the current armament.
- c) The R.C.A. Radar Astra I System is installed - Weight & C.G. location being to the latest breakdown received from them, dated January 11th, 1957. However, the Sparrow III Auxiliaries and the Infra-red Tracker system, included in the breakdown, have been deleted and some Avro installed antennae added (Total Weight 2,614.5 lb)
- d) A considerable number of MK 1 parts and assemblies have now been weighed. There have only been very insignificant weight deviations between calculated and actual weights of Structural items, however, bought out equipment has been fairly consistantly in the order of 11% above the manufacturers estimates or Avro specification weight requirements. Where these weights apply to the MK 2 Aircraft, they have been incorporated into the MK 2 Aircraft weight records.

On the I.B.M. sheets in this report, immediately preceeding the item title, will be found a number varying from 0 to 100. This is the percentage actual weight recorded in that particular report.

N.B. It should be noted that the first MK 2 Aircraft will probably not be as this summary designates, but will be a Flight Test version with instrumentation replacing the Missile Package etc.

1. STRUCTURE

WEIGHT (lb)

- a) Inner Wing - addition of bumper pads
Miscellaneous re-estimates, actual weights of
MK 1 parts etc. etc.
- | | | |
|------------------------|---|----|
| Weight Change Increase | + | 5 |
| Ref. 2-1 | + | 5 |
| | + | 10 |

b) Fin and Rudder

Rudder - Actual weight of MK 1 Rudder

~~UNCLASSIFIED~~
NON CLASSIFIE

Weight Change Increase	+	3
Ref. 2-1	+	3

Date: June 1st, 1957
Aircraft: C-105 MK 2
Production A/C

UNCLASSIFIED
SECRET
NON CLASSIFIE

Report # 7-0400-34 Iss. 8
Sheet # 1-2
Prepared By: K. Griffin
Checked By: E. Burnett

INTRODUCTION

1. STRUCTURE

WEIGHT (lb)

c) Fuselage Fwd. Sta. 255"

Top Longerons - machined packers Al. replaces Mg.	+	4
Windscreen - actual weight of casting (MK 1 A/C)	+	2
Pilot's Canopy - actual weight of casting and glass (MK 1 A/C)	+	4
Navigator's Canopy - actual weight of casting, window frame and glass (MK 1 A/C)	+	5
Weight Change Increase Ref. 2-1	+	15

d) Centre Fuselage Sta. 255"-485"

No Weight Change

e) Duct Bay Sta. 485"-591.65"

No Weight Change

The Floating Duct is being extensively redesigned with an articulated adaptor between floating duct and Engine, to include gills. No drawings are yet released and it is felt that the weight currently recorded together with the adaptor ring (made obsolete by above, but still recorded for weight purposes) will be adequate. A revised estimate will be made at the earliest opportunity.

f) Engine Bay Sta. 591.65"-742.5"

Engine Rails - estimated to production drawings	+	1
Engine Doors # 1 & 2 - first estimate to scheme drawings	-	11
Weight Change Decrease Ref. 2-2	-	10

g) Rear Fuselage Sta. 742.5" Aft.

Engine Access Doors - web gauges etc. included in some frames	+	5
Weight Change Increase Ref. 2-2	+	5

There is no definite scheme yet for Tailcones and Stringer structure. The weight currently recorded is as for MK 1 in Titanium, allowances having been made for the increased length of the Tailcone, but no other account taken of lines changing or design alterations.

h) Fuselage Joints

No Weight Changes

UNCLASSIFIED
NON SECRET
SECRET

TOTAL STRUCTURAL INCREASE

+ 23

Date: June 1st, 1957
Aircraft: C-105 MK 2
Production A/C

UNCLASSIFIED
NON-CLASSIFIED

Report # 7-0400-34 Iss.8
Sheet # 1-3
Prepared By K. Griffin
Checked By E. Burnett

INTRODUCTION

2. LANDING GEAR

WEIGHT (lb)

No Weight Change

3. POWER PLANT & SERVICES

Engine Mounts & Accessories - some production drawing estimates, early allowances tended to be too high	-	8
Fuel System - first complete estimate of the redesigned system without proportioners	-	64
<u>TOTAL POWER PLANT & SERVICES DECREASE</u>	-	<u>72</u>
<u>Ref. 2-2</u>		

4. FLYING CONTROLS

Mechanical Controls - design O/B Aileron Control Rod etc.	+	4
Hydraulic Controls - miscellaneous design changes	+	4
<u>TOTAL FLYING CONTROL INCREASE</u>	+	<u>8</u>
<u>Ref. 2-2</u>		

5. EQUIPMENT GROUP

Windscreen De-misting - increase in transformer & panel E 40 controls etc. for Navigator's window de-misting	+	12
Ejector Seats - redesign of Martin Baker 80 ft/sec. ejection seat - manufacturer's weight	+	6
Oxygen System - miscellaneous redesign piping etc.	+	76
Low Pressure - piping for waveguide compressor, hydraulic system and armament pack inflatable seal added	+	2
Utility Hydraulics - 200 cu. ins. accumulator replaces 80 cu ins.	+	6
Missile Pack Structure & mechanisms - estimates generally revised to current data, for fuller information see 'weight changes' section, briefly:-	+	12
Structure - increased by	+	45
Telescopic Links	-	27
Launcher Stops deleted	-	35
Drag Links, attachments etc.	-	3
Missile Pack Hydraulics - addition 40 G.P.M filter	+	12
Vendors weights of jacks & valves	-	30
<u>TOTAL EQUIPMENT INCREASE</u>	+	<u>76</u>
<u>Ref. 3-4</u>		

6. OPERATIONAL LOAD

Water - Trapped in Air Conditioning System - no allowance previously +	15
<u>TOTAL OPERATIONAL LOAD INCREASE</u>	<u>15</u>
<u>Ref. 2-4</u>	

UNCLASSIFIED
NON-CLASSIFIED
SECRET

Date: June 1st, 1957
Aircraft: C-105 MK. 2
Production A/C

UNCLASSIFIED
NON-CLASSIFIED

Report # 7-0400-34 Iss. 8
Sheet # 1-4
Prepared By K. Griffin
Checked By: E. Burnett

INTRODUCTION

SUMMARY

Weight Change - Aircraft Basic Weight

Structure	+	23 lb.
Power Plant	-	72 lb.
Flying Controls	+	8 lb.
Equipment	+	76 lb.
	+	<u>35 lb.</u>

Weight Change - Operational Load less Fuel

Water Trapped	+	15 lb.
---------------	---	--------

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

<u>Issue 7</u>	<u>Issue 8</u>	
<u>44,165 lb</u>	<u>44,215 lb</u>	= <u>+ 50 lb.</u>

UNCLASSIFIED
NON-CLASSIFIED
SECRET

Date: June 1st, 1957
Aircraft: C-105 MK 2
Production A/C

UNCLASSIFIED
NON-CLASSIFIED
SECRET

Report # 7-0400-34 Issue 8
Sheet # 2-1
Prepared By: K. Griffin
Checked By: E. Burnett

DETAILED WEIGHT CHANGES TO I.B.M.
TABULATED DETAILS OF May 1st, 1957.

WEIGHT CHANGES

WEIGHT (lb)

Wing:

-	3.93	A/C Centre Line Joints - revisions in accordance with MK 1 Actual weights of parts etc. Machined rib included in Structure F/S to M/S	+	2.09
			-	6.02
			-	3.93
+	17.33	Structure F/S to M/S - Addition of bumper pads C/L rib now included here (see above) Actual weights of MK 1 Skin Panels Miscellaneous minor changes	+	5.48
			+	6.02
			+	5.54
			+	0.29
			+	17.33
+	4.88	Skins M/S to R/S - Actual weight of pump access door calculation was in error.		
-	7.52	Structure for Main U/C - Actual weights of housing and Shaft Fork End.		
-	1.58	Joint O/W to I/W - Incorporation of approximately 25% actual weights		
+	0.94	I/W Structure Aft R/Spar - Actual weight of Beam # 3 Production drawing estimates rear Engine Mount housing	-	0.36
			+	1.30
			-	0.94
+	10.12			

Fin & Rudder

+	3.30	Rudder - Actual weight of MK 1 Rudder
+	3.30	

Fuselage Fwd. Sta. 255"

+	3.75	Top Longeron F.F. - packing which requires machining has been changed from Mg. to Al.		
+	2.49	Windscreen - Actual weight of casting and some hardware alterations		
+	3.56	Pilot's Canopy - Actual weight of glass and machined casting First production drawing estimate of seal.	+	3.06
			+	0.50
			+	3.56
+	5.35	Navigator's Canopy - Actual weight of MK 1 casting, window frame, and glass Detailed estimate made of hardware	+	2.56
			+	2.79
			+	5.35

+ 15.15 | |

UNCLASSIFIED
NON-CLASSIFIED
SECRET

Date: June 1st, 1957
Aircraft: C-105 MK 2

NON CLASSIFIED
SECRET

Report # 7-0400-34 Issue 8
Sheet # 2-2
Prepared By: K. Griffin
Checked By: E. Burnett

DETAILED WEIGHT CHANGES TO I.B.M.
TABULATED DETAILS OF May 1st, 1957.

WEIGHT CHANGES

WEIGHT (lb.)

Engine Bay - Sta. 591.65" to 742.5"

- + 1.43 Engine Rails - estimated to production drawings, increase in web gauge.
- 11.65 Engine Doors # 1 and # 2 - first estimates to scheme drawings, allowances only previously
 - Door # 1
 - Door # 2

- 12.33
+ 0.68
- 11.65

- 10.22

Rear Fuselage Sta. 742.5" Aft.

- + 4.46 Engine Access Doors - Production drawing estimates of most frames, webs etc. increased in gauge compared to MK 1 on which earlier estimates were based.

+ 4.46

Engine Group

- 0.00 Starters & Gear Boxes on Engine - C.G. correction to C.S. Drive
- 64.31 Fuel System - entirely redesigned for MK 2 Aircraft, the proportioners are no longer used.
- 3.86 Engine Mounts - some production drawing estimates including design changes on front I/B Mounting
- 3.83 Engine Mounting Accessories - some production drawing estimates - the locating block front centre mounting was over estimated.

- 72.10

Flying Controls Group

- + 3.56 Mechanical Flying Controls - redesign O/B Aileron Control Rod
 - Addition of stick force transducer
 - Miscellaneous minor changes
- + 3.62 Flying Control Hydraulics I/W - Steel tubes replace Jarry hoses
 - Jack installation hardware
 - Miscellaneous other changes
- + 0.33 Flying Control Hydraulics Rudder - Miscellaneous minor piping changes etc.

+ 2.24
+ 1.00
+ 0.32
+ 3.56

+ 1.66
+ 1.00
+ 0.96
+ 3.62

+ 7.51

UNCLASSIFIED
SECRET
NON CLASSIFIE

Date: June 1st, 1957
Aircraft: C-105 MK 2
Production A/C

UNCLASSIFIED
SECRET
NON CLASSIFIED

Report # 7-0400-34 Iss. 8
Sheet # 2-3
Prepared By: K. Griffin
Checked By: E. Burnett

DETAILED WEIGHT CHANGES TO I.B.M.
TABULATED DETAILS OF May 1st, 1957.

WEIGHT CHANGES

WEIGHT (lb)

Equipment - Fixed & Removable

+ 18.35	Windscreen De-misting - increase in size of transformer	+ 10.00
	redesign of panel E 40	+ 2.00
	Controls etc. added for Navigator's window de-misting	+ 6.35
		+ 18.35
0.00	Electrics D.B. - C.G. correction for alternators	
+ 98.42	Ejector Seats - redesign of Martin Baker 80 ft/sec.	
	Ejection Seat - Manufacturer's weights	+ 76.00
	addition of Emergency Oxygen (called up with seat installation - see below	+ 22.42
		+ 98.42
- 19.85	Oxygen System - Emergency system now called up on Seats	
	see above	- 20.28
	redesign of piping in cockpit	+ 0.43
		- 19.85
+ 6.40	Low Pressure Pneumatics - piping for waveguide compressor, hydraulic system and armament pack	
	inflatable seal added (seal with pack structure.)	
+ 11.60	Utility Hydraulics D.B. - 200 cu. ins. accumulator replaces 80 cu. ins.	
- 18.25	Missile Pack Hydraulics - addition of 40 G.P.M. filter	+ 12.00
	Vendors weights available for majority of equipment.	- 30.25
		- 18.25
+ 20.70	Missile Pack Structure - previous estimates were made prior to issue of scheme drawings, structure now partially re-estimated.	
	Longitudinal beams # 1 to 8	+ 34.64
	Wing doors - largely redesigned	
	production drawing estimates	+ 19.64
	Fin doors - redesigned, production drawing estimates	+ 14.48
	Curtain wall - initial allowance too high	- 3.61
	Forward transverse beam - first drawing estimate	+ 1.42
	Gear Uplock structure - partial re-design	+ 1.48
	Pack and Door Sealing - seals on doors now included with production drawings of doors	- 11.74
	Door actuation mounting frames added	+ 2.60
	Door jack mounting frames added	+ 3.81
	Slings Brackets added	+ 1.00
	Rear Beam, redesign of track 'back up' structure (tracks included)	+ 3.30
	continued.	

UNCLASSIFIED
SECRET
NON CLASSIFIED

Date: June 1st, 1957
Aircraft: C-105 MK 2
Production A/C

UNCLASSIFIED
NON CLASSIFIED

Report # 7-0400-34 Iss. 8
Sheet # 2-4
Prepared By: K. Griffin
Checked By: E. Burnett

DETAILED WEIGHT CHANGES TO I.B.M.
TABULATED DETAILS OF May 1st, 1957.

WEIGHT CHANGES

WEIGHT (lb)

Equipment - Fixed & Removable (Cont'd.)

Missile Pack Structure (cont'd.)

Development allowance reduced since it is partially absorbed above	-	22.46
Forward attachment - now with mechanisms see below	-	8.86
Aft. Attachment - now mechanisms	-	15.00
	+	20.70
- 40.56 Sparrow Pack Mechanisms - these have mostly been re-estimated largely to production drawings.		
Drag links - production drawing estimates	-	2.08
Uplocks - partially redesigned, production drawing estimates	-	0.56
Ground handling bars added at aft end	+	1.15
Launcher stops deleted	-	34.56
Small upstops added	+	2.56
Fwd pack attachment - now included here see also structure(above)	+	8.07
Aft. pack attachment - now included here	+	11.86
Fwd. & Aft Missile Telescopic Links- fairly extensive redesign	-	27.00
	-	40.56
	+	76.81

Operational Load

+ 15.00 Water Trapped Air Conditioning - no allowance was previously made for that water trapped in Evaporator.

+ 15.00

+ 50.13 TOTAL WEIGHT CHANGES

UNCLASSIFIED
NON CLASSIFIED
SECRET

Date: June 1st, 1957
Aircraft C-105 MK. 2
Production A/C

Report # 7-0400-34 Iss. 8
Sheet # 3-1
Prepared By: K. Griffin

~~UNCLASSIFIED~~
~~WEIGHT & BALANCE~~
~~SECRET~~
~~NON CLASSIFIED~~

DESCRIPTION	WEIGHT lb.	H. ARM ins.	V. ARM ins.
STRUCTURE	18,350.01	564.26	137.68
Wing	9,980.77	642.76	142.21
Fin & Rudder	1,024.00	754.25	209.28
Fuselage Fwd. Sta. 255"	2,481.60	186.85	128.88
Sta. 255"-485"	1,681.78	379.07	129.47
Sta. 485"-591.65"	952.35	533.07	103.64
Sta. 591.65"-742.5"	1,480.48	661.39	109.39
Sta. 742.5" Aft.	696.45	795.40	127.90
'Marry Up'	52.58	468.91	103.89
UNDERCARRIAGE - Retracted	2,551.77	487.22	134.79
Main Undercarriages	1,901.62	539.31	141.00
Main U/C Doors & Fairings	291.80	537.10	138.40
Nose Undercarriage	333.81	170.80	99.70
Nose U/C Door & Fairing	24.54	162.24	88.23
POWER PLANT & SERVICES	10,685.88	674.15	121.33
Engines & Accessories P.S.13	9,090.12	690.98	121.17
Gear Box & Drives on Fuselage	281.84	601.70	102.49
Engine Controls	32.43	375.76	118.61
Gear Box, Starter & Drives on Engine	315.45	615.98	105.24
Engine Nose Bullet (Orenda supplied)	70.00	587.17	116.00
Fire Extinguisher System	70.46	702.44	134.82
Engine Mountings	132.38	666.82	136.52
Fuel System	693.20	530.62	134.87
FLYING CONTROLS GROUP	1,801.45	686.69	140.08
Mechanical Flying Controls	946.48	687.84	148.61
Hydraulic Flying Controls	854.97	685.42	130.63
EQUIPMENT - FIXED AND REMOVABLE	7,974.66	325.77	112.15
Instruments	46.07	163.68	138.70
Probe	18.50	40.00	108.00
Cockpit Pressure Sealing	5.00	186.00	130.00
Oxygen System	23.59	253.72	156.43
Air Conditioning System	897.00	331.77	133.38
Hydraulic Main System	609.09	500.86	117.57
Cabin Insulation	14.31	187.48	132.00
Brake Parachute	62.38	769.41	143.24
Electrical System	1,242.38	426.80	112.53
Low Pressure Pneumatics	55.70	416.79	123.99
Surface Finish	100.00	591.52	140.20
Intake De-icing Boots	51.84	197.02	118.00
Radome Anti-icing	8.88	51.49	125.00
Canopy Actuation	62.05	222.11	154.47
Cabin Consoles	17.45	174.76	124.34
Radar Door Actuation	10.00	268.00	95.00
Ejector Seats	284.42	202.80	136.25
Radio & Radar removable	1,850.50	178.50	104.46
Radio & Radar fixed	621.00	234.04	116.15

~~UNCLASSIFIED~~
~~NON CLASSIFIED~~

continued

Date: June 1st, 1957
Aircraft: C-105 MK 2
Production Aircraft

~~SECRET~~
~~NON CLASSIFIED~~
WEIGHT & C.G. SUMMARY

Report # 7-0400-34 Iss. 8
Sheet # 3-2
Prepared By: K. Griffin

DESCRIPTION	WEIGHT lb.	H.ARM ins.	V.ARM ins.	M.A.C. %
<u>Equipment (Fixed & Removable) (Cont'd.)</u>				
Sparrow Pack Structure	870.70	389.60	96.00	
Sparrow Pack Mechanisms	584.76	377.66	98.93	
Sparrow Pack Hydraulics	331.94	373.52	99.00	
Sparrow Pack Electronics	143.00	332.00	100.00	
Sparrow Pack Electrics	64.10	362.29	95.00	
AIRCRAFT BASIC WEIGHT	41,363.77	547.25	128.46	
USEFUL LOAD (Normal Combat)	18,650.76	516.20	136.66	
Crew	430.00	194.00	136.50	
Oil	138.97	636.92	110.57	
Alcohol	22.00	93.00	138.00	
Engine Fire Extinguisher Fluid	25.00	730.00	129.00	
Residual Fuel	218.40	553.98	134.04	
Missiles	1,728.00	389.29	88.30	
Oxygen Charge	13.39	259.68	159.91	
Water for Air Conditioning	275.00	268.00	131.75	
Fuel for Combat Mission	15,800.00	542.05	142.30	
Normal Combat Mission U/C Up	60,014.53	537.60	131.01	28.07
U/C Down		539.19	128.37	28.51
Half Combat Mission Fuel (1,013 gals. @ 7.8 lb/gal.)	7,900.00	543.20	139.55	
Combat Weight (Half Combat Mission Fuel) U/C Up	52,114.53	537.10	128.88	27.93
U/C Down		538.94	125.84	28.44
Operational Weight Empty U/C Up	44,214.53	536.01	126.97	27.63
U/C Down		538.17	123.39	28.23
Operational Weight Empty U/C Up	42,486.53	541.98	128.54	29.28
Less Missiles U/C Down		544.23	124.82	29.90
Max. Internal Fuel (2,492 gals. @ 7.8 lb/gal.)	19,438.00	541.85	144.16	
A.U.W. Max. Internal Fuel U/C Up	63,652.53	537.79	132.22	28.12
U/C Down		539.29	129.73	28.53
Max. External Fuel (500 gal. @ 7.8 lb/gal. + Drop Tank)	4,248.20	521.84	60.67	
A.U.W. Max. Internal and External Fuel U/C Up	67,900.73	536.79	127.74	27.85
U/C Down		538.20	125.41	28.23

N.B. 1) Aircraft Datum = 120" above arbitrarily chosen ground line.

2) Drop Tank Weight has increased by 22 lb due to introduction of air bottle etc. in tank for transfer purposes.

~~SECRET~~
~~NON CLASSIFIED~~
UNCLASSIFIED

REPORT NO: 7-0400-34-8

BY: Karlsson Ruffin

DATE: June 18, 1954

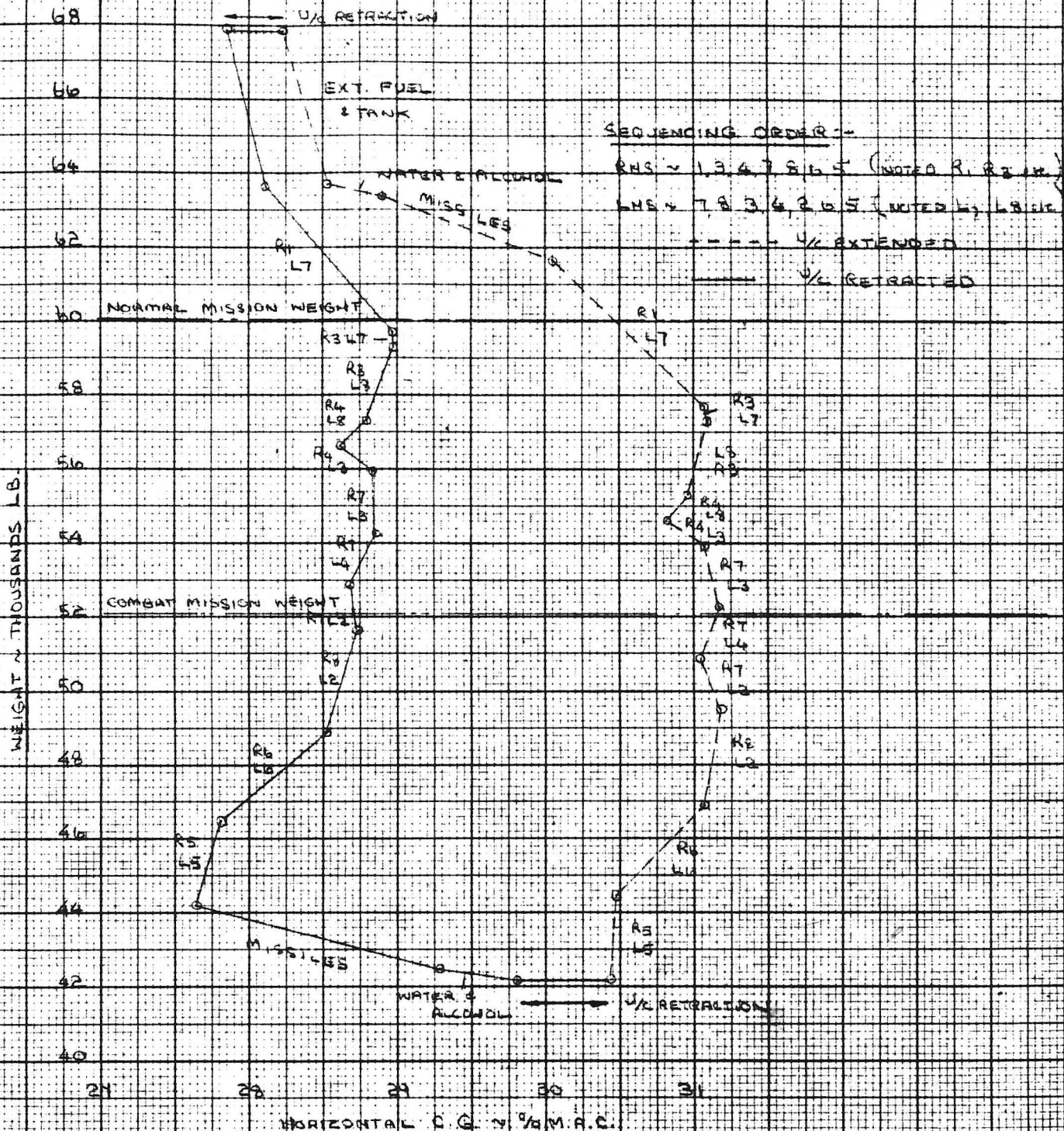
SHEET: 4-

2105 MK2 PRO
HORIZONTAL C.G. **UNCLASSIFIED**
NON CLASSIFIED
FLIGHT CONDITIONS

USING FUEL SEQUENCING ORDER AS SUPPLIED

TO MINNEAPOLIS HONKOWELL (WY AYRD Spec 503)

FOR USE UNTIL NECESSITY OF DAMPING SYSTEM PROVEN



UNCLASSIFIED
NON CLASSIFIED

SECRET

DISTRIBUTED BY RADIO BLUE PRINTING CO., NEW YORK, N.Y.

REPORT No: T-0400-34-8

BY: Kathleen Zynoff

DATE: June 15, 1957

SHEET: 4-2

C-105 MIKE PRODUCTION AIRCRAFT

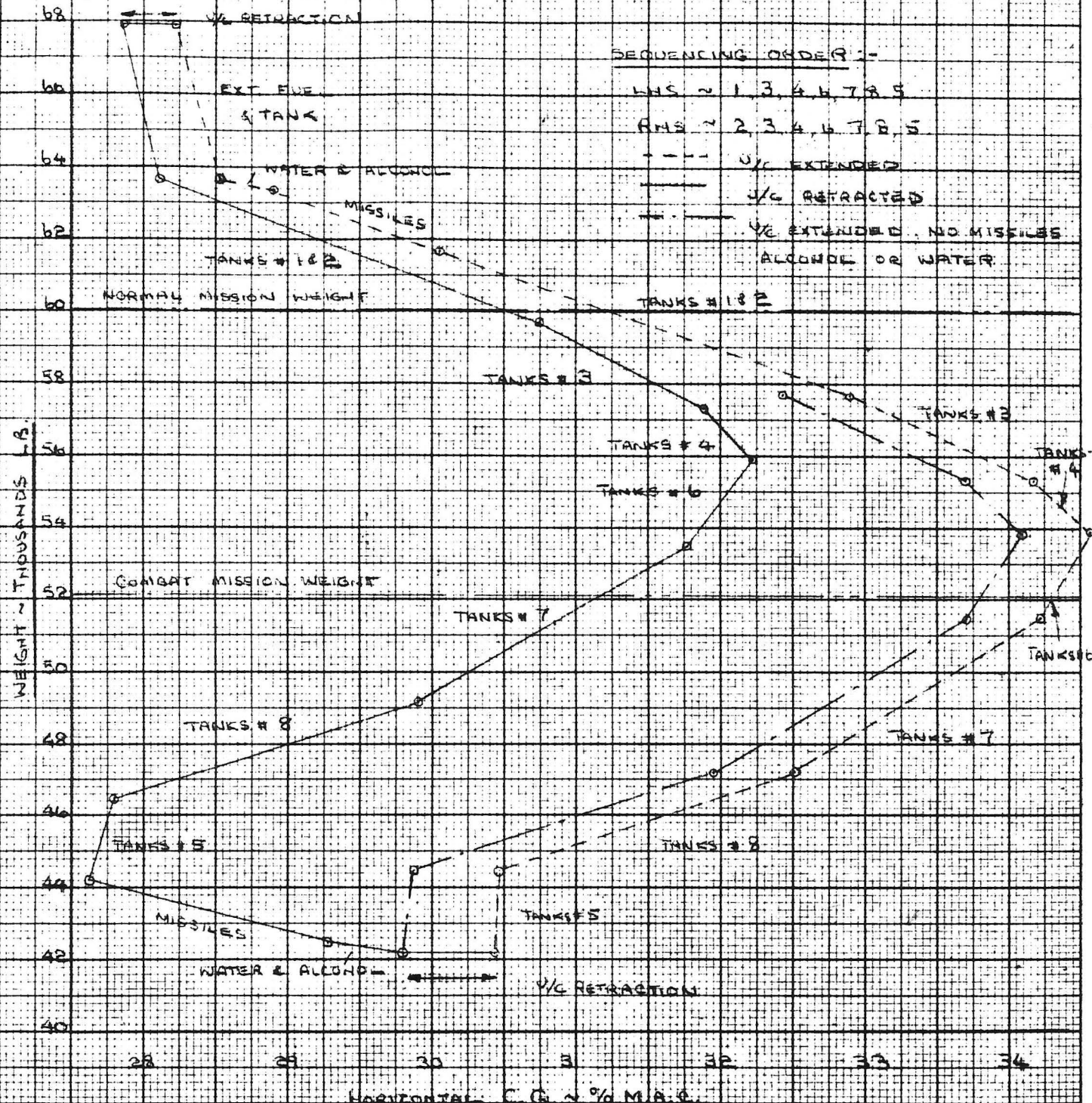
HORIZONTAL C.G. ENVELOPE FOR

AT FLIGHT CONDITIONS

USING ALTERNATE FUEL SEQUENCING

AS SUPPLIED TO MINNEAPOLIS NONETWELL (W/ AVUGO spec 503)

TO ACHIEVE REQUIRED 34% M.A.C. AT COMBAT



G9-12
 10 X 10 TO THE 15 INCH
 MADE IN CANADA

SECRET