

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

**UNCLASSIFIED**

Report # 7-0400-34  
 Sheet # 1-1 Issue 5  
 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 of the figures quoted herein are only of a preliminary nature, particularly in the case of the Rear Fuselage, Engine Installation and some systems which are being extensively redesigned and about which there is as yet very little information available.

Information has been based on the MK 1 Aircraft with relevant changes made sometimes to preliminary scheme drawings and sometimes verbal information. Where no details are available, allowances have been retained as in the MK 1 Aircraft.

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) is currently carried.
- c) The R.C.A. Radar Astra I System is installed -- Weight & C.G. location being to the latest breakdown received from them, dated Jan. 11/57. However, the Sparrow III Auxiliaries included in the above breakdown have been deleted and some AVRO installed Antennae added (Total Weight = 2,679.5 lb.)

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

a) Wing:

WEIGHT (lb)

I/Wing complete - miscellaneous production drawing changes, inclusion of actual weights of some machinings etc.

+ 13

There will be changes to the Inner Wing I/B Ribs, Centre Trailing edge etc., associated with the redesigned engine mounts etc., however, since complete details are as yet unavailable, weight allowances will remain as in MK 1 Aircraft.

It should also be noted that actual weights of MK 1 machined skins have been checked and the estimates currently recorded tally with the actual weight at nominal thicknesses. However, some skins, notably those machined at AVRO are in some cases well above maximum tolerances, excess weight being of the order of 6 lb/panel. Thus with a set of 12 similarly machined skins excess weight could be as much as 70 lb/A/C. It is hoped that machining techniques will have been improved for the MK 2 A/C and nominal thicknesses more strictly adhered to

Weight Change Increase  
Ref. 2-1

+ 13

b) Fin & Rudder:

Fin - redesign elevator jack pick-up, some actual weights etc.

+ 4

Weight Change Increase  
Ref. 2-1

45280 4

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### INTRODUCTION

#### 1. STRUCTURE:

N.B. In the MK 1 Aircraft Structural changes are made to the Wing, Fin and Control Surfaces to accommodate the possible necessity of installing a "Buzz Damping" System. These allowances will not be made on the MK 2 Aircraft until the requirements for Damping are confirmed, pending flight test of MK 1 A/C.

#### c) Fuselage Sta. 255"-485"

WEIGHT (lb)

Miscellaneous Items - all joint items at Stas. 255" & 485"  
now treated separately (see below)

- 13

Equipment Bay Structure and Radar Bay Structure will also change, but estimates are not yet available.

Weight Change Decrease  
Ref. 2-2

- 13

#### d) Duct Bay Sta. 485"-591.65"

Lower Panel - all joint items at Sta. 591.65" treated separately (see below)

- 12

The Floating Duct is being extensively redesigned with an articulated adaptor between floating duct and engine to include gills. No drawings are yet available and it is felt that the weight currently recorded for the duct, together with the adaptor ring (see Engines group) will be adequate. An estimate will be made at the earliest opportunity.

Weight Change Decrease  
Ref. 2-2

- 12

#### e) Engine Bay Sta. 591.65"-742.5"

Longerons - joint straps called up on "Marry-up" drawings treated separately (see below)

- 11

Outer Skins - Aft of Sta. 717.36 gauge decrease to .051 from .064.

- 3

Intermediate Formers - Former 717.36 now intermediate, weight was previously light former

+ 4

Inner Longerons - entirely redesigned - cap from Sta. 591.65-697.28 now steel etc.

+ 28

Engine Access Doors - alterations to surround structure and former tips, fairing added etc.

- 5

Light Formers - miscellaneous minor changes

- 3

Weight Change Increase  
Ref. 2-2

+ 10

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### INTRODUCTION

#### 1. STRUCTURE (continued)

##### f) Rear Fuselage Sta. 742.5 Aft.

WEIGHT (lb)

Fixed R.F. - some changes to MK 1 production drawing estimates  
are applicable here, parabrake release socket  
(6 lb) now with structure (see Equipment Group)

+ 12

Weight Change Increase

+ 12

Ref. 2-3

##### g) Fuselage Joints

This is a new sub-section to include all items of "Marry-up" of  
Fuselage components i.e. items not readily assigned to the above  
structure components. Items of Fin and Wing "Marry-up" are  
already included in the structural weights of these groups.

Fuselage Marry-Up\* - not previously considered separately  
(\* Actual Weight change per A/C = 52-11-12-13 = 16 lb/A/C  
see above structural breakdown).

+ 52

Weight Change Increase

+ 52

Ref. 2-3

#### TOTAL STRUCTURAL WEIGHT INCREASE

+ 66

#### 2. LANDING GEAR

Main Undercarriage - redesign of shortening mechanism preliminary  
estimate of Weight Saving by Dowty

- 50

#### TOTAL LANDING GEAR DECREASE

- 50

Ref. 2-3

#### 3. POWER PLANT & SERVICES

Engine Controls - based on MK 1 production drawing estimates

+ 1

Fire Extinguishing System - MK 1 production drawing estimates

- 5

Accessory Gear Boxes on Fuselage - Heat Exchangers called up  
here (see also Equipment Group)

+ 21

Some MK 1 production drawing changes, some oil  
lines etc. previously omitted

+ 22

Bendix Fuel Control Unit - deleted, replaced by Lucas Units of  
13 or 14 lb each installed by Orenda

- 120

Starter Shroud - first scheme drawings available

+ 6

Miscellaneous changes

+ 3

#### TOTAL POWER PLANT & SERVICES DECREASE

- 72

Ref. 2-4

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#### 3. POWER PLANT & SERVICES (Continued)

N. B. Although it is fully appreciated that the MK 2 A/C Fuel System will be entirely different from that of the MK 1 A/C Proportioner System, there are currently insufficient details available to evaluate the weight of the MK 2 A/C Selection System which will replace the Proportioners.

#### 4. FLYING CONTROLS GROUP

#### WEIGHT (lb)

Mechanical Controls - redesign of rudder bearings and bellcranks	+ 6
F/C Hydraulics - Spec. weights were recorded for all servos, now some actual weights obtainable	+ 20
Manufacturer's Weights of pumps - allowance too low	+ 28
Filter element retainers now steel	+ 3
Actual Weights of accumulators and compensators target weights were previously recorded	+ 23
Miscellaneous alterations.	+ 1

#### TOTAL FLYING CONTROLS INCREASE

+ 83

Ref. 2-5

#### 5. EQUIPMENT GROUP

Oil & Hydraulic Fluid Cooling - Heat Exchangers now with Accessories Gear Boxes (see Engine Group)	- 22
Utility Hydraulics - re-issues of MK 1 production drawings reduction in compensator target weight etc.	- 10
Emergency Power Pack - Initial allowance too high	- 3
Radio & Radar - latest R.C.A. weights of Jan. 11/57, Sparrow III Auxiliaries not carried	- 2
Brake Parachute - MK 1 production drawing estimates, socket now in structure.	- 7
Electrics - addition of brake parachute solenoid valve	+ 1

#### TOTAL EQUIPMENT GROUP DECREASE

- 43

Ref. 2-6

#### 6. OPERATIONAL LOAD

Engine Oil Trapped - more detailed estimate in piping etc.	+ 4
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#### TOTAL OPERATIONAL LOAD INCREASE

+ 4

Ref. 2-6

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### INTRODUCTION

#### SUMMARY

##### Weight Change - Aircraft Weight Empty

Structure	+ 66 lb.
Landing Gear	- 50 lb.
Power Plant & Services	- 72 lb.
Flying Controls	+ 83 lb.
Equipment	- 43 lb.
	<u>- 16 lb.</u>

##### Weight Change - Operational Load Less Fuel

Trapped Oil	+ 4 lb.
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##### Weight Change - Operational Weight Empty -(A/C less Fuel)

<u>Issue 4</u>	<u>Issue 5</u>	
<u>44,197 lb.</u>	<u>44,185 lb.</u>	= <u>- 12 lb.</u>

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WEIGHT CHANGES TO 7-0400-34 Issue 4  
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WEIGHT CHANGE

WEIGHT (lb)

Wing:

+ 3.84	Centre Line Joints I/W - detailed estimate of hardware from aux. spar to main spar.	
+ 8.40	Ribs I/W - Actual weight of Rib # 4 M/S to C/S fwd. section.	
+ 6.04	F/Spar to M/Spar Struct.- production drawing estimates 2 pt. refuelling door	
	Actual Weights of Fus., Side Rib.Aft.	- 5.54
	Addition bracket transfer pump tank 4	+ 10.29
		+ 1.29
		<hr/>
		+ 6.04
- 9.07	M/Spar to R/Spar Structure - re-estimate of posts based on obtained actual weights	+ 4.02
	Error in previous estimate	- 13.09
		<hr/>
		- 9.07
- 3.86	Wing to Fus. Joint - production drawing estimate seal 359" - 485"	
- 1.46	Strut.Pick-Ups I/W - Minor design changes and error in calcs. of engine mtg. pick-up.	
+ 8.64	Structure for Main U/C - re-estimate of U/C pivot assys. details of rib # 24 L/Edge - allowance previously	+ 2.90
	An actual weight was obtained of the Main U/C pick-up fitting - this was as estimated	+ 5.74
		<hr/>
		+ 8.64

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+ 12.53

Fin & Rudder

+ 4.33	Fin - redesign of jack pick-up	+ 1.46
	Actual Weights of hinge brackets	+ 0.79
	"Marry-Up" re-estimated	+ 2.08
		<hr/>
		+ 4.33

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+ 4.33

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WEIGHT CHANGE

WEIGHT (lb)

Centre Fuselage Sta. 255"-485"

- 12.50 Miscellaneous Items C.F. - the joints at Sta. 255 & 485  
were included here now see separate  
section on fuselage joints below.

- 12.50

Duct Bay Sta. 485" - 591.65"

- 12.33 Lower Panel - based on MK 1 details - joint to E.B. now  
separated see below.

- 12.33

Engine Bay Sta. 591.65"-742.5

- 11.30 Longerons - Joint straps now included with D.B. to E.B.  
joint - see separate joint section  
below.
- 2.99 Outer Skins - Aft of Sta. 717.36 gauge changed from .064  
to .051
- + 9.89 Intermediate Formers - Former Sta. 717.36 was previously  
considered as a light former - now  
included here since it is consider-  
ably heavier than the average light  
former, although it is not machined.
- 24.75 Light Formers - Former Sta. 717.36 now with Intermediate  
Formers - 6.09  
Light Formers Sta. 596.45-692.45  
terminate at Lower Longerons, frame  
tip box structure now considered  
with access doors (see below) - 16.00  
Lower Formers 7-2.3-725.7 re-estimated - 1.08  
Miscellaneous changes splice plates etc - 1.58  
- 24.75
- + 11.60 Engine Access Doors - deletion of MK 1 type surround  
structure - 24.00  
Former tip structure added + 29.42  
Addition of Fairings + 6.18  
+ 11.60
- + 27.73 Inner Longerons E.B. - From Sta. 697-742.5 structure was  
assumed as MK 1 - redesign now + 5.60  
Sta. 591.65-697.28 - Cap Steel was  
Al. .072 straps on lower cap etc. + 22.13

+ 10.18

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WEIGHT CHANGE

WEIGHT (lb)

Rear Fuselage Sta. 742.5 Aft.

- + 12.54 Fairing under Rudder - estimate to MK 1 production drawings, socket for parachute release now included with structure.
- 5.72 Longerons & Torque Box - based on MK 1 production drawing estimates.
- + 5.13 Formers Fixed R.F. - based on MK 1 production drawing estimates.

+ 11.95

Joints Fuselage:

This is a new sub-section to include all items of "Marry-up" of Fuselage components i.e. items not readily assigned to the above structural components. Items of Fin and Wing Marry-up are already included within the structural weights of those groups. Previously the weight of these Marry-up items was included with one or other of the mating components.

- + 5.00 Joint C.F. to D.B. - new report, an allowance previously in Miscellaneous Structure.
- + 8.14 Joint F.F. to C.F. - new report, an allowance was previously included in Miscellaneous Structure C.F.
- + 9.52 Joint Air Intakes to F.F. - was included with Air Intake Structure. This structure is currently being re-estimated and it is felt that the joint allowances etc. were inadequate, hence the introduction of this further weight.
- + 25.08 Joint D.B. to E.B. - new report, allowances were previously in Lower Panel D.B. and Longerons E.B. (see relevant sections)
- + 4.43 Joint R.F. to E.B. - new report - was included in R.F. Weight

+ 52.17

Undercarriage Group

- 50.00 Main Undercarriage - redesign of shortening mechanism preliminary estimate of weight savings by Dowty.

- 50.00

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WEIGHT CHANGE

WEIGHT (lb)

Power Plant & Services

+ 1.46	Engine Controls - based on production drawing estimates MK 1	
- 5.06	Fire Extinguishing System - based on production drawing estimates MK 1 A/C	
+ 43.08	Accessory Gear Boxes on Fuselage - addition of heat exchangers called up here (see also Equipment Group)	+ 20.98
	Constant Speed drive and engine oil lines etc. based on MK 1 production drawing estimates.	+ 22.10
		+ 43.08
- 267.00	Engine Service Accessories - deletion of Bendix fuel control units, replaced by Lucas units of 13 or 14 lb each installed by Orenda. They state that their engine weight will cover this increase, hence Constant Speed Drive units now with Accessories Gear Boxes	- 120.00
		- 147.00
		- 267.00
+ 155.63	Starters & Gear Boxes on Engine - Constant Speed Drive Unit transferred here (see above)	+ 147.00
	Starter Shroud - scheme estimate	+ 5.66
	Miscellaneous changes	+ 2.97
		+ 155.63
- 71.89		

Flying Controls Group

+ 5.62	Mechanical Controls - redesign of rudder bearings and bellcranks	
+ 60.32	F/Controls Hydraulics - Actual weights of accumulators and compensators - target weights were previously recorded	+ 22.90
	Increase in servos (based on actual weights of elevator servos etc.)	+ 7.00
	Increase in weights of pumps, now manufacturer's quotes, previously only allowances	+ 28.00
	Miscellaneous changes to production etc	+ 2.42
		+ 60.32
+ 6.93	F/C Hydraulics Fin - Servo specification weight increase 4 lb to 9 lb	+ 5.00
	Filter element retainer Steel	+ 1.09
	Miscellaneous changes valves and piping	+ 0.84
		+ 6.93

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WEIGHT CHANGE

WEIGHT (lb)

Flying Controls Group (continued)

+ 5.07	F/C Hydraulics I/W - Servos actual weights were Spec. weights	+ 4.00
	Miscellaneous, minor changes	+ 1.07
		+ 5.07
+ 5.28	F/C Hydraulics O/W - Servos actual weights were Spec. weights	+ 4.00
	Filters element retainers Steel	+ 3.72
	Miscellaneous changes & actual weights piping and couplings etc.	- 2.44
		+ 5.28
+ 83.22		

Equipment Group.

- 22.00	Oil & Hydraulic Fluid Cooling - deleted, remaining heat exchangers now incorporated in Power Plant Group where they will be called up with the Accessories Gear Box in- stallation	
+ 1.36	Electrics R.F. - addition of solenoid valve for brake parachute	
- 7.31	Brake Parachute - based on an estimate to MK 1 drawings, socket now included with structure	
+ 2.05	Utility Hydraulics F.F. - based on MK 1 drawings - actual weights of swivels, addition of valves, piping changes etc.	
- 1.71	Utility Hydraulics C.F. - based on MK 1 drawings - some piping changes, actual weights of pressure switches, couplings etc.	
+ 4.87	Utility Hydraulics D.B. - based on MK 1 drawings - addition of Emergency Power Pack (was included in Electrics see below) Reduction in compensator target weight and fluid Miscellaneous changes piping, coupling etc.	+ 19.01 - 10.03 - 4.11 + 4.87
- 0.88	Utility Hydraulics E.B. - general revisions to MK 1 pro- duction drawings	
+ 4.80	Utility Hydraulics I/W - redesign of swivel assys. addition of flow control valve and restrictor piping re-routed etc. as MK 1	+ 1.70 + 1.80 + 1.30 + 4.80

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WEIGHT (lb)

Equipment Group (Continued)

- 22.00 Electrics D.B. - Emergency Power Pack now in Hydraulics  
see above.
- 3.00 Radio & Radar Fixed - revised R.C.A. figures of Jan 11/57.
- 43.25 Radar Removable - revised R.C.A. figures of Jan. 11/57.  
(Sparrow III auxiliaries not carried)
- + 44.00 Missile Pack Electronics - revised R.C.A. figures of equip-  
ment mounted within the pack -  
(Sparrow III auxiliaries not carried)

Load

- + 3.84 Engine Oil Trapped - more detailed estimate of piping on  
MK 1 A/C - probably similar figures  
apply for MK 2

+ 3.84

- 11.57 TOTAL WEIGHT CHANGES

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WEIGHT AND 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>
<b>STRUCTURE</b>	<b>18,277.80</b>	<b>565.94</b>	<b>137.70</b>
Wing	9,962.04	643.15	142.16
Fin & Rudder	1,020.70	754.06	209.27
Fuselage Fwd. Sta. 255"	2,415.63	186.17	129.37
Sta. 255"-485"	1,672.59	379.71	129.51
Sta. 485"-591.65"	949.54	533.12	103.76
Sta. 591.65"-742.5"	1,513.14	661.62	109.24
Sta. 742.5" Aft.	691.99	795.69	128.15
Marry-up	52.17	470.59	103.77
<b>UNDERCARRIAGE - Retracted</b>	<b>2,554.33</b>	<b>487.53</b>	<b>134.52</b>
Main Undercarriage	1,901.62	539.31	141.00
Main U/C Doors & Fairings	294.36	539.29	136.01
Nose Undercarriage	333.81	170.80	99.70
Nose U/C Door & Fairing	24.54	162.24	88.23
<b>POWER PLANT &amp; SERVICES</b>	<b>10,774.34</b>	<b>673.94</b>	<b>121.51</b>
Engines & Accessories PS 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 & Drive on Engine	315.45	609.12	105.24
Engine Nose Bullet	70.00	587.17	116.00
Fire Extinguishing System	70.46	702.44	134.83
Engine Mountings	156.53	666.00	136.69
Fuel System	757.51	543.10	135.69
<b>FLYING CONTROLS GROUP</b>	<b>1,793.94</b>	<b>686.84</b>	<b>140.05</b>
Mechanical Flying Controls	942.92	688.24	148.66
Hydraulic Flying Controls	851.02	685.29	130.52
<b>EQUIPMENT FIXED &amp; REMOVABLE</b>	<b>7,948.78</b>	<b>325.31</b>	<b>111.61</b>
Instruments	46.07	163.68	138.70
Probe	23.00	9.74	108.00
Cockpit Pressure Sealing	5.00	186.00	130.00
Oxygen System	43.44	227.71	142.18
Air Conditioning System	897.00	331.77	133.38
Hydraulic Main System	597.49	498.76	116.66
Cabin Insulation	11.91	179.24	130.00
Brake Parachute	62.38	769.41	143.24
Electrical System	1,216.85	427.55	112.61
Low Pressure Pneumatics	39.01	478.47	127.28
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	186.00	201.10	136.25
Radio & Radar removable	906.80	178.38	104.17
Radio & Radar fixed	41.00	234.67	115.71
Sparrow Pack Structure	850.00	390.84	96.00
Sparrow Pack Mechanisms	625.32	376.67	99.22

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WEIGHT & C.G. SUMMARY

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DESCRIPTION	WEIGHT lb.	H. ARM ins.	V. ARM ins.	M.A.C. %
<u>Equipment (Fixed &amp; Remov.) (Cont'd.)</u>				
Sparrow Pack Hydraulics	350.19	368.83	99.00	
Sparrow Pack Electronics	143.00	332.00	100.00	
Sparrow Pack Electrics	64.10	362.29	95.00	
AIRCRAFT WEIGHT EMPTY	41,349.19	548.23	128.37	
USEFUL LOAD	18,625.76	516.38	136.67	
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	259.69	159.91	
Water for Air Conditioning	260.00	268.00	132.00	
Fuel for Combat Mission	15,790.00	542.05	142.30	
Normal Combat Mission	U/C Up	538.34	130.95	28.27
	U/C Down	539.94	128.31	28.71
Half Combat Mission Fuel (1,012 gals. @ 7.8 lb/gal.)	7,895.00	543.20	139.55	
Combat Weight (Half Combat Mission Fuel)	U/C Up	537.95	128.81	28.17
	U/C Down	539.79	125.77	28.67
Operational Weight Empty	U/C Up	537.01	126.89	27.91
	U/C Down	539.18	123.31	28.50
Operational Weight Empty Less Missiles	U/C Up	543.02	128.46	29.56
	U/C Down	545.28	124.74	30.19
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	538.49	132.16	28.31
	U/C Down	540.00	129.67	28.73
Max. External Fuel (500 gal. @ 7.8 lb/gal. + Drop Tank)	4,226.00	522.34	60.64	
A.U.W. Max. Internal & External Fuel	U/C Up	537.48	127.71	28.04
	U/C Down	538.89	125.38	28.42

- N.B. 1) Aircraft Datum = 120" above arbitrarily chosen ground line.  
2) Revised fuel tank capacities in Centre Fuselage Tanks for MK 2 A/C are now incorporated.  
3) Normal Mission Fuel requirements have been increased in the order of 600 lb by Aerodynamics Dept.

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**UNCLASSIFIED**  
**NON SECRET**

Report No: 7-0400-34-5

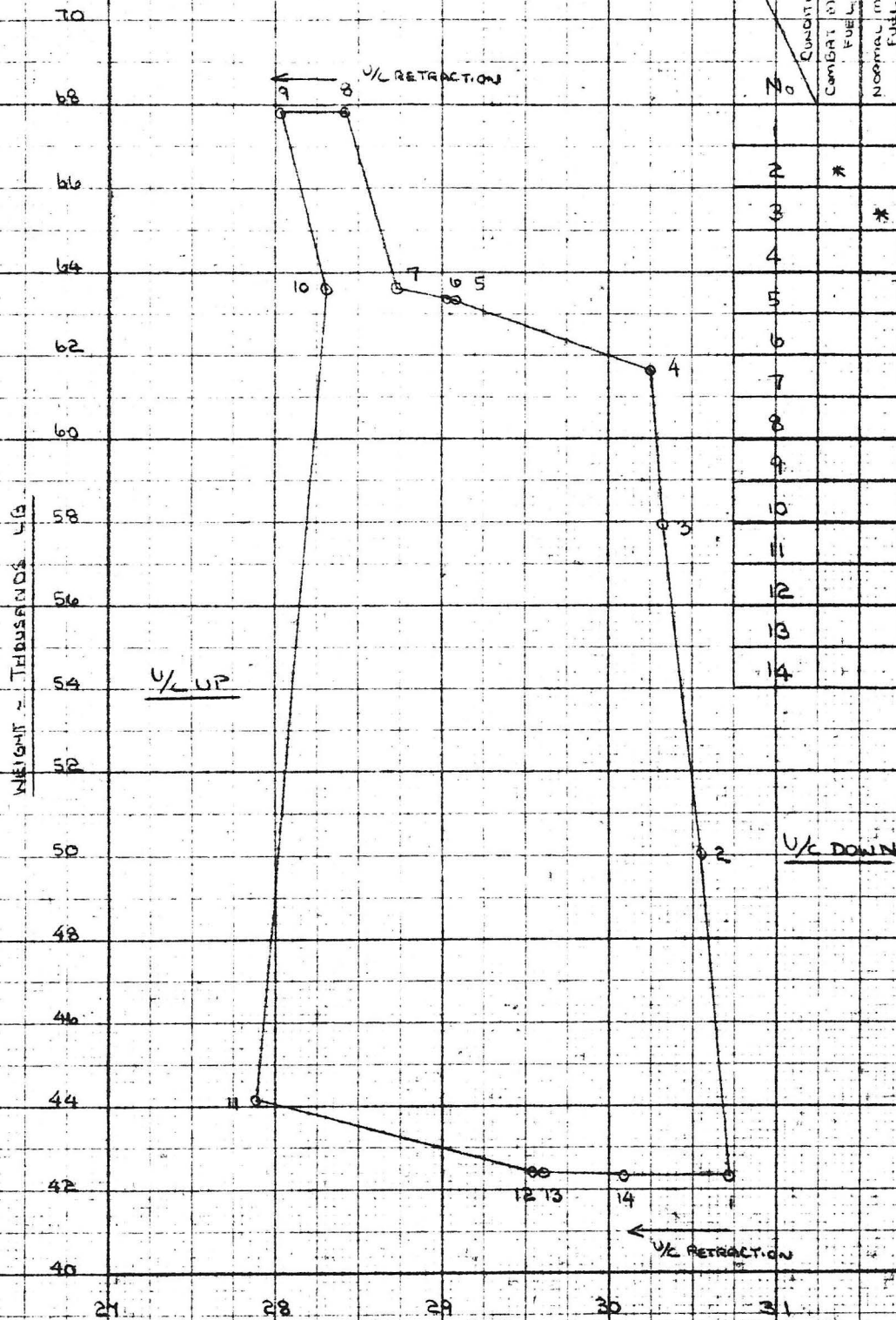
C105 MK2 PRODUCTION AIRCRAFT  
HORIZONTAL C.G. ENVELOPE

By Karlsson, Guy

DATE: March 1954

AT FLIGHT CONDITIONS

(FUEL SYSTEM PROPORTIONING ASSUMED  
UNTIL DETAILS OF SEQUENCING AVAILABLE)



CONDITION	COMBAT MISSION	NO. 1	NO. 2	NO. 3	NO. 4	NO. 5	NO. 6	NO. 7	NO. 8	NO. 9	NO. 10	NO. 11	NO. 12	NO. 13	NO. 14
FUEL															
NO. 1															
NO. 2	*														
NO. 3		*													
NO. 4			*												
NO. 5				*											
NO. 6					*										
NO. 7						*									
NO. 8							*								
NO. 9								*							
NO. 10									*						
NO. 11										*					
NO. 12											*				
NO. 13												*			
NO. 14													*		

HORIZONTAL C.G. ~ 0% MAC

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**NON SECRET**