TZ.113-57/01

Date: March 1st 1957
Aircraft: C-105 MK 1 with J75 P3 Engines 1st A/C

SECRET

Report # 7-0400-44
Sheet # 1-1 Issue 3
Prepared By: K. Griffin
Checked By: E. Burnett

INTRODUCTION

The following is a Weight & C.G. Summary for the 1st C-105 MK 1 Aircraft with J75 P3 Engines, based on the latest weight estimates available on February 28th, 1957. All Weight & C.G. changes are relative to Issue 2 of February 1st, 1957.

NOTE: This summary does NOT apply for the 2nd and subsequent Mk 1 Aircraft See context below.

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 and subsequent MK 1 Aircraft.
(J75 P3 Engines = 6,175 lb each; J75 P5 Engines = 5,950 lb each)

b) An Instrument Package carrying Flight Test instrumentation will be installed, this also varies between first and subsequent aircraft.

c) An interim Radio & Radar system is installed.

1. STRUCTURE	WEIGHT (lb)
a) Wing:	
I/Wing complete - miscellaneous production drawing changes, inclusion of actual weights of some machinings etc.	+ 13
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	+ 4
c) Fuselage to Sta. 255"	
Radome - production drawing estimates of attachment ring etc.	- 4
Formers - miscellaneous production drawing changes	+ 3
Weight Change Decrease Ref. 2-2	- 1
d) Fuselage Sta. 255" - 485"	
Miscellaneous Items - all joint items at 255" & 485" now treated separately (see below)	- 13
Weight Change Decrease Ref. 2-2	- 13
e) Duct Bay Sta. 485"-591.65"	
Lower Panel - all joint items at 591.65" treated separately (see below)	- 12
Weight Change Decrease Ref. 2-2	- 12

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INTRODUCTION

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	WEIGHT (lb)
1. STRUCTURE (Continued)	
f) Engine Bay Sta. 591.65"-742.5"	
Longerons - joint straps called up on "Marry-up" drawings treated separately (see below)	- 11
Weight Change Decrease Ref. 2-2	- 11
g) Rear Fuselage Sta. 742.5" Aft.	
Fixed R.F. - production drawing estimates of entire structure	- 6
Weight Change Decrease Ref. 2-3	- 6
h) 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 structural sub-divisions. Items of Fin and Wing "Marry-up" are already included in the structure weights of these groups.	
Fuselage Marry-Up* - not previously considered as a separate group	+ 52
(* Actual Weight change per A/C = 52-11-12-13 = + 16 lb/A/C see above Structural breakdown)	
Weight Change Increase Ref. 2-3	+ 52
TOTAL STRUCTURE WEIGHT INCREASE	+ 26

2. LANDING GEAR

No Weight Change.

N. B. A redesigned shortening mechanism is to be introduced on the Main U/C. Dowty estimate that this may save 50 lb in weight. However, it may not be available for the 1st A/C, although it is an interchangeable feature, and the heavier weight will currently be retained here.

3. POWER PLANT & SERVICES

Engine Controls - production drawing estimates	+ 1
Fire Extinguishing System - production drawing estimates	- 5
Accessory Gear Boxes on Fuselage- Heat Exchangers called-up here (see also Equipment Group)	+ 21
Some production drawing changes, some oil lines etc. previously omitted	+ 22

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Continued.

INTRODUCTION

3. POWER PLANT & SERVICES (Cont'd.)

	WEIGHT (lb)
Alternator Drives - Specification Weight decreased from 60 to 55 lb each, checked by actual weight at 55 lb.	- 14
Gear Boxes on Engine - Miscellaneous minor changes	+ 2
TOTAL POWER PLANT & SERVICES INCREASE	+ 27

Ref. 2-4

N.B. J75 P3 Engines on 1st A/C only, 2nd and subsequent A/C have J75 P5 Engines which are 225 lb/engine lighter than the P3 version.

4. FLYING CONTROLS GROUP

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
Manufactured weights of pumps - allowance too low	+ 28
Filter element retainers now steel	+ 5
Actual weights of accumulators & compensators target weights were previously recorded	+ 23
Steel piping replacing Al., actual weights of end fittings and couplings etc. etc.	+ 27
TOTAL FLYING CONTROLS INCREASE	+ 109

Ref. 2-5

Pending Flight Test requirements a "Buzz Damping" system may be installed on the first aircraft. Provisions for this installation are already included in the Structure Group. The "Buzz Damper" system weights are not currently recorded but they incur a weight penalty of 134 lb if necessary.

5. EQUIPMENT GROUP

Oil & Hydraulic Fluid Cooling - heat exchangers now with Acc. Gear Boxes (see Engine Group)	- 22
Emergency Lowering Main & Nose Gear - this is to be installed on the 1st A/C only.	+ 13
Interim Radio & Radar - deletion of RO units and true air speed pressure ratio transducer and amplifier	- 58
Emergency Power Pack - initial allowance too high	- 3
Utility Hydraulics - re-issues of production drawings reduction in comp. target weight and fluid	- 10
Miscellaneous piping changes, actual Wts. etc.	0
Brake Parachute - production drawing estimates, socket now in struct.	- 7
Electrics - Addition of brake parachute solenoid valve	+ 1
TOTAL EQUIPMENT GROUP DECREASE	- 86

Ref. 2-5

6. OPERATIONAL LOAD

	WEIGHT (lb.)
Engine Oil Trapped - More detailed estimate in piping etc.	+ 4
TOTAL OPERATIONAL LOAD INCREASE	+ 4

Ref. 2-6

SUMMARY

Weight Change - Aircraft Weight Empty

Structure	+ 26 lb.
Power Plant & Services	+ 27 lb.
Flying Controls	+ 109 lb.
Equipment	- 86 lb.
	+ 76 lb.

Weight Change - Operational Load Less Fuel

Trapped Oil	+ 4 lb.

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

Issue 2	Issue 3	
45,112 lb.	45,192 lb.	= + 80 lb.

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DETAILED WEIGHT CHANGES TO 7-0400-44/Issue 2

WEIGHT CHANGES

			WEIGHT (lb)	
Wing:				
+	8.40	Ribs I/W - Actual Weight of Rib # 4 M/S to C/S forward section.		
-	1.46	Strut. Pick-Ups I/W - minor design changes and error in calcs. of engine mounting pick-ups.		
+	8.64	Structure for Main U/C - re-estimate of U/C pivot assys.	+	2.90
		details of Rib # 24 allowance prev.	+	5.74
		An actual weight was obtained of the Main U/C pick-up fittings - this was as estimated		-
			+	8.64
+	3.84	Centre Line Joints - detailed estimate of hardware on the C/L joint Aux. Spar to Main Spar		
-	3.86	Wing to Fuselage Joint - production drawing estimates of seal from Sta. 359-485.		
+	6.04	F/Spar to M/Spar Strut. - production drawing estimates 2 pt. refuelling door	-	5.54
		Actual Weights of Fuselage Side Rib Aft.	+	10.29
		Addition bracket transfer pump tank #4	+	1.29
			+	6.04
-	9.07	Main Spar to R/Spar Strut. - re-estimate of posts based on obtained actual weights	+	4.02
		Error in previous estimate	-	13.09
			-	9.07
+	12.53			

I/Wing Skins - Actual weights have been checked and the estimates currently recorded tally with the actual weight at nominal thickness. However, some skins notably those machined at AVRO are considerably above nominal tolerances, excess weight being of the order of 6 lb/panel - Thus with a set of 12 similarly machined AVRO manufactured skins excess weight could be as much as 70 lb/A/C.

Fin & Rudder:				
+	4.33	Fin - redesign of jack pick-up	+	1.46
		Actual weight of hinge brackets	+	0.79
		Marry-up - re-estimated.	+	2.08
			+	4.33
+	4.33			

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Checked By: E. Burnett

DETAILED WEIGHT CHANGES TO 7-0400-44 Issue 2

WEIGHT CHANGES

		WEIGHT (lb)
Fuselage Fwd. Sta. 255"		
- 3.85	Radome - Production drawing estimates of attach. ring, brushing etc.	
+ 2.51	Formers F.F. - Miscellaneous amendments to production drawings, equipment bracketry etc. added	
- 1.34		
Centre Fuselage Sta. 255" - 485"		
- 12.50	Miscellaneous Items C.F. - the joints at 255" and 485" were included here - now see separate section on fuselage joints below.	
- 12.50		
Duct Bay Sta. 485"- 591.65"		
- 12.33	Lower Panel D.B. - miscellaneous changes to brackets etc. Joint to E.B. - now separate below	+ 1.52 - 13.85
		- 12.33
- 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	
- 11.30		
Rear Fuselage Sta. 742.5" Aft.		
+ 5.13	Formers Fixed R.F. - Production drawing estimates of Former Sta. 803 and addition of 'U' bolts for latches.	
- 15.99	Tunnel Fixed R.F. - redesign of straps and rails, fwd. seal now with engine tunnel, Fwd. end of tunnel skin Sta. 744.5" was assumed Sta. 742.5".	
+ 12.54	Fairing under Rudder - Production drawing estimates also parabrake socket added (see also equipment group) Upper I/B Longerons also included here.	
- 0.33	Skins Fixed R.F. - Production Drawing estimate	
- 1.06	Engine Access Doors - error in previous calculation of hinge weight .	

continued.

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DETAILED WEIGHT CHANGES TO 7-0400-44 Iss. 2

WEIGHT CHANGES

			WEIGHT (lb.)	
Rear Fuselage Sta. 742.5" Aft. (Cont'd.)				
- 5.72	Longerons & Torque Box - Upper I/B now with centre fairing		-	6.15
	Lower I/B & O/B doubler titanium was Al.		+	3.83
	Upper O/B diaphs. with elevator fillet fairing		-	2.16
	Changes to centre beam		-	0.95
	Miscellaneous changes		-	0.29
			-	5.72
- 5.43				
Joint 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 sub-divisions. Items of Fin and of 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.			
+ 8.14	Joint F.F. to C.F. - new report - an allowance was previously in Miscellaneous Struct. C.F. (see Struct. Sta. 255"-485")			
+ 5.00	Joint C.F. to D.B. - new report - an allowance was previously in Miscellaneous Struct. C.F.			
+ 9.52	Joint Air Intakes to F.F. - was included with air intakes structure. This structure is currently being re-estimated and it is felt that joint allowances etc. were inadequate, hence this new report.			
+ 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 Rear Fuselage Weight.			
+ 52.17				
Power Plant & Services				
+ 1.46	Engine Controls - detailed estimate to production drawings			
- 5.06	Fire Extinguishing System * - first detailed estimate to production drawings.			
+ 43.08	Access Gear Boxes on Fuselage - addition of heat exchangers called up here (see also equipment group)		+	20.98
	Constant speed drive & gear box oil lines on Fuselage omitted.		+	8.56
	Engine Oil Lines, not fixed on engine were erroreously omitted		+	10.35
	Miscellaneous production drawing changes		+	3.19
			+	43.08

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Checked By: E. Burnett

DETAILED WEIGHT CHANGES TO 7-0400-44 Iss. 2

WEIGHT CHANGES			WEIGHT (lb)
Power Plant & Services (Cont'd.)			
- 124.00	Service Accessories	- Alternator Drives now called up with Gear Box installation on Engines	
+ 111.25	Gear Boxes on Engine	- Actual weights of starters	- 1.72
		Addition of Alternator Drives (see above) (Spec. Weight 55 lb was 62 lb)	+ 110.00
		Miscellaneous other changes	+ 2.97
			+ 111.25
+ 26.73			

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N.B. 1) J75 P3 Engines on 1st Aircraft only, 2nd and subsequent A/C have J75 P5 Engines which are 225 lb/engine lighter than the P3 version.

2)* Additional fire protection will be installed on the 1st A/C, the bottles being mounted within the instrument package. For details of weight involved see Equipment Group on Summary Sheets.

3) The fuel system will incorporate both proportioners and a selection system. The weight recorded is to existing production drawings.

Flying Controls Group			
+ 5.62	Mechanical Flying Controls	- redesign of rudder bearings and and bellcranks.	
+ 68.44	F/Controls Hydraulics	- Actual weights of accumulators and conpensators - 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, manufacturer's weight quotes, previously only allowances	+ 28.00
		Miscellaneous changes to piping etc.	+ 10.54
			+ 68.44
+ 16.87	F/C Hydraulics I/W	- Servos actual weights were Spec. weights	+ 4.00
		Piping Steel was Aluminum	+ 11.80
		Miscellaneous minor changes	+ 1.07
			+ 16.87
+ 9.07	F/C Hydraulics O/W	- Servos actual weights were Spec. weights	+ 4.00
		Filters - element retainer now Steel	+ 3.72
		piping etc. - some Steel was Al. but actual weights of end fittings etc. also incorporated.	+ 1.35
			+ 9.07

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DETAILED WEIGHT CHANGES TO 7-0400-44 Iss. 2

WEIGHT CHANGES

			WEIGHT (lb)	
Flying Controls Group (Cont'd.)				
+	8.84	Rudder Hydraulics - Servo weight increased from 4 lb to 9 lb.	+	5.00
		Filter element retainer Steel	+	1.09
		Steel piping replacing Al.	+	1.57
		Miscellaneous changes valves etc.	+	1.18
			+	8.84
+	108.84			
Equipment Group				
+	2.05	Utility Hydraulic F.F. - Actual weights of swivels, addition of valves, piping changes etc.		
-	1.71	Utility Hydraulic C.F. - some piping changes, actual weights of pressure switches, couplings etc.		
+	4.87	Utility Hydraulic D.B. - Addition of Emergency Power Pack (was included in Electrics see below)	+	19.01
		Reduction in compensator target weight and fluid	-	10.03
		Changes to piping, coupling etc. etc.	-	4.11
			+	4.87
-	0.88	Utility Hydraulic E.B. - General revisions to drawing re-issues.		
+	4.80	Utility Hydraulic I/W - Redesign of swivel assys.	+	1.70
		addition of flow control valve and restrictor	+	1.80
		piping rerouted etc.	+	1.30
			+	4.80
+	8.53	Emergency Lowering Main U/C - for 1st A/C only		
+	4.38	Emergency Lowering Nose U/C - for 1st A/C only		
-	22.00	Electrics D.B. - delete emergency power pack, called up with hydraulics-see above		
-	22.00	Oil & Hydraulic Fluid Cooling - deleted, remaining heat exchangers now incorporated in Engines Group where they are called up with accessories Gear Box installation.		
+	1.36	Electrics R.F. - new report - to include solenoid valve for brake parachute.		
-	7.31	Brake Parachute - production drawing estimates, socket (approx. 6 lb) now included with structure, see Rear Fuselage Group.		
-	57.75	Interim Radio & Radar - deletion of RO units and True Air speed pressure ratio transducer and amplifier.		
-	85.66			

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J75 P3 Engines
1st A/C

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DETAILED WEIGHT CHANGES TO 7-0400-44 Iss. 2

WEIGHT CHANGES Operational Load		WEIGHT (lb)
+ 3.84	Engine Oil Trapped - more detailed estimate in piping etc.	
+ 3.84		
+ 79.88	TOTAL WEIGHT CHANGES	

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WEIGHT AND C.G. SUMMARY

DESCRIPTION	WEIGHT lb	H. ARM ins.	V. ARM ins.
STRUCTURE	18,479.86	563.77	137.62
Wing	10,024.94	643.63	142.11
Fin & Rudder	1,029.70	754.74	209.56
Fuselage Structure: Fwd. Sta. 255"	2,547.84	180.68	128.61
Sta. 255"-485"	1,652.18	379.44	130.02
Sta. 485"-591.65"	1,001.05	533.92	104.67
Sta. 591.65"-742.5"	1,402.24	660.72	107.45
Sta. 742.5 Aft.	769.74	800.41	129.11
Marry-Up	52.17	470.59	103.77
UNDERCARRIAGE - Retracted	2,612.33	488.81	134.66
Main Undercarriage	1,959.62	539.48	141.00
Main U/C Doors & Fairings	294.36	539.29	136.01
Nose Undercarriage	333.81	170.81	99.70
Nose U/C Door & Fairing	24.54	162.24	88.23
POWER PLANT & SERVICES	14,231.21	654.45	120.18
Engines & Accessories	12,557.91	664.92	119.80
Gear Box Installation on Fuselage	280.14	601.46	102.53
Gear Box & Starter on Engine	263.07	591.77	104.40
Engine Controls	32.43	375.76	118.62
Engine De-Icing	70.37	562.80	115.09
Fire Extinguishing System	70.46	702.44	134.83
Engine Mountings	199.32	635.71	128.02
Fuel System	757.51	543.10	135.69
FLYING CONTROLS GROUP	1,819.56	687.03	139.99
Mechanical Flying Controls	942.92	688.24	148.66
Hydraulic Flying Controls	876.64	685.72	130.67
EQUIPMENT FIXED & REMOVABLE	7,080.57	385.28	110.60
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	227.72	142.18
Air Conditioning System	738.02	336.49	134.76
Surface Finish	100.00	591.52	140.20
Hydraulics 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	1,098.71	418.26	112.88
Low Pressure Pneumatics	39.01	478.47	127.28
Intake De-icing Boots	51.84	197.02	118.00
Canopy Actuation	62.05	222.11	154.47
Cabin Consoles	17.45	174.76	124.34
Ejector Seats	186.00	201.10	136.25
Interim Radio & Radar	704.63	322.57	123.34
Instrument Pack Structure	670.61	385.90	94.71
Instrumentation - 1st A/C	2,447.00	389.50	95.00
Additional Fire Protection - 1st A/C	154.17	425.05	102.89
Emergency Landing Gear Lowering	12.91	458.83	128.60
Radome Anti-icing	8.88	51.49	125.00
AIRCRAFT WEIGHT EMPTY	44,223.53	565.02	127.60

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WEIGHT AND C.G. SUMMARY

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DESCRIPTION	WEIGHT lb.	H. ARM ins.	V. ARM* ins.	C.G. Position % M.A.C.
USEFUL LOAD (Less Fuel)	968.02	354.76	132.64	
Crew	430.00	194.00	136.50	
Oil	134.23	608.92	115.68	
Alcohol - Radome de-icing	22.00	93.00	138.00	
Engine Fire Extinguishinge 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	125.00	268.00	132.00	
Operational Weight Empty U/C Up	45,191.55	560.52	127.71	34.39
Operational Weight Empty U/C Down		562.69	124.13	34.99
Maximum Internal Fuel (2,544 gals. @ 7.8 lb/gal.)	19,843.00	538.88	144.32	
A.U.W. Max. Internal Fuel U/C Up	65,034.55	553.92	132.78	32.57
A.U.W. Max. Internal Fuel U/C Down		555.42	130.29	32.98

* A/C datum is considered to be 120" above an arbitrary ground line.

Above figures are for the Aircraft in the unballasted condition.

If the most aft point on the C.G. Envelope is to be ballasted to 31% M.A.C. Then the 1,382 lb of ballast at Sta. 89.16, as currently provided for on Former 68.5 and the Shear Panel, is necessary, plus a further 140 lb. on the Shear Panel (i.e. Total of 1,522 lb.).

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REPORT NO. 7-0420-44-3
BY J. [redacted]
DATE MAR 1/57

HORIZONTAL C.G. ENVELOPE

C105 MK1 1ST A/C FLIGHT CONDITIONS

WITH J75 P3 ENGINES (2ND + SUBSEQUENT A/C HAVE J75 P5 ENGINES)

INTERIM RADIO + RADAR

FUEL SYSTEM PROPORTIONERS

INSTRUMENT PACKAGE (WITH EMERGENCY JETTISON)