CHAPTER 8 — WEIGHT AND BALANCE

CONTENTS — MAINTENANCE PROCEDURES

FIGURES

TABLES

WEIGHT AND BALANCE

8-1. PURPOSE

This section gives the procedures that are necessary to find the actual weight empty and the center of gravity (CG) of a helicopter configuration, and to find what changes, if any, are necessary to keep the helicopter within the gross weight flight limits during operation.

8-2. GENERAL

The CG is the balance point of a body and is used when calculating the weight and balance for the helicopter. If a helicopter and pendulum are compared, the suspension point is where the main rotor hub intersects the mast and the pendulum weight is the helicopter. The pendulum weight will stop with its CG directly below the suspension point. For example, a helicopter will fly with its nose up if the CG is aft of the hub/mast intersection. To fly the helicopter in a level manner, the pilot must move the cyclic control stick forward. The more the pilot moves the cyclic control stick forward, the less power there will be for forward speed and the control over the helicopter is decreased. Because this loss of control is unsafe, it is important to keep the helicopter CG within the given gross weight flight limits. This is done in two ways:

1. By changing the location of the helicopter weight empty CG through equipment relocation or by adding or removing ballast, and

2. By deriving the combinations of useful load items which are permitted for each flight.

8-3. TERMINOLOGY

It is necessary to apply weight and balance control, using terms that follow:

Weight Empty - value obtained when adding the weight of the airframe, power plant, required equipment, serviceable and special equipment, fixed ballast, hydraulic fluid, transmission and gearbox oil, fuel that is not usable and engine oil that is not drainable.

Maximum Gross Weight - maximum approved takeoff weight of the helicopter plus its contents.

Useful Load - maximum gross weight minus weight empty. The maximum gross weight includes the pilot, the passengers, the engine oil, fuel, baggage, and cargo.

Center of Gravity (CG) - the point about which all of the moments in all of the axis are exactly equal in magnitude. For balance purposes, think of the weight of an item as being concentrated at the CG of the item.

Weight Empty CG - center of gravity of the helicopter in weight empty condition.

NOTE

When the gross weight flight limits taper, increasing weight empty can cause a previous payload configuration that had been inside limits to have a center of gravity outside limits.

Most Forward Gross Weight - the sum of empty weight, maximum crew weight, engine oil and all useful load items which result in most forward CG.

Most Aft Gross Weight - sum of the empty weight, minimum crew weight, engine oil and all useful load items which result in the most aft CG.

Weight Empty CG Limits - a range of weight empty CG based on the standard fuel and passenger loading. A helicopter that is ballasted within this range will not go outside the gross weight flight limits with standard loading.

Gross Weight Flight Limits - the center of gravity range plotted against gross weight within which helicopter meets requirements of the Federal Aviation Regulations under which it is certified.

Datum - the intersection of the vertical, lateral, and horizontal planes from which all measurements are taken for balance purposes. The distance to the CG of an item is measured from the datum in terms of Fuselage Station (FS), Buttline (BL) and Waterline (WL).

Arm - the distance from the datum to the CG of an item. The longitudinal arm is the fuselage station, the lateral arm is the butt line and the vertical arm is the waterline. The algebraic sign convention is plus (+) for

an object that is aft of the datum, above the datum and to the right of the datum (when looking forward). The minus sign (-) is used when parts are forward of the datum, below the datum and to the left of the datum when looking forward.

Moment - result when you multiply the weight of an item and the arm of the item.

Unusable Fuel - whichever is the greater: the amount of fuel remaining in the system when, in the worst attitude in which flight is maintained, the fuel pump cavitates or when fuel gage reads zero.

Minimum Fuel - for weight and balance purposes, this is the same as unusable fuel.

Undrainable Fuel/Oil - the fuel and oil remaining in their respective system after the draining procedures are completed.

Tare Weight - for mechanical scales, the weight of chocks, blocks, stands, etc. that are used during weighing. This weight is included in the scale readings. For electronic scales, consult scale manufacturers data.

As-Weighed Weight - weight of the helicopter configuration on the scales. This should be as close to Weight Empty as possible.

LEVELING

8-4. LEVELING PROCEDURE

Helicopters 4 through 103 and 584 and subsequent can be leveled using the plumb bob method (paragraph 8-5) or by alternate procedure using a spirit level and target leveling plate mounted on the cabin floor (paragraph 8-6).

Helicopters 104 through 583 are leveled using a spirit level positioned on leveling pads located on aft portion of cabin roof adjacent to pylon support (paragraph 8-7).

8-5. LEVELING PROCEDURE USING PLUMB BOB METHOD

NOTE

It will be necessary to loosen or remove upper upholstery at location of slotted plate (1, Figure 8-1) and a portion of carpeting around leveling plate (3).

NOTE

A slotted plate (3) is located on the cabin roof approximately 14 inches (355.60 mm) inboard from edge of passenger-cargo door at fuselage station 90.00, buttline -11.14 (Approximately 7.00 inches (177.80 mm) forward of aft seat structure). The slotted plate (1) is located directly above leveling plate (3).

1. Hang a plumb bob (2) from slotted plate (1) in cabin roof. Plumb bob should be just above leveling plate (3).

CAUTION

HELICOPTER MUST BE ON HARD LEVEL SURFACE PRIOR TO JACKING HELICOPTER.

2. Place two forward jacks (5) under, but clear of forward jack fittings (4). Place the aft jack (5) under aft jack fitting (6).

3. Adjust the aft jack (5) until the helicopter is almost level.

4. Adjust forward jacks (5) until snug against forward jack fittings (4). Raise all three jacks evenly until skids are clear of surface.

5. Level helicopter fore and aft and laterally by adjusting height of jacks (5) at forward and aft jack fittings (4 and 6) while observing plumb bob (2). Helicopter is level when plumb bob is directly over intersection of lines of leveling plate (3).

8-6. ALTERNATE LEVELING METHOD (HELICOPTERS S/N 4 THROUGH 103 AND 584 AND SUBSEQUENT)

1. Mount large leveling plate (8, Figure 8-1, detail A) on cabin floor approximately 14 inches (355.60 mm) inboard from edge of passenger-cargo door at fuselage station 90.00, and buttline 11.14 (approximately 7.00 inches (177.80 mm) forward of aft seat structure).

NOTE

During this step ensure that forward jacks (5) are clear of forward jack fittings (4) to prevent sideloads to helicopter.

2. Place the two forward jacks (5) under, but clear of the forward jack fittings (4). Place the aft jack (5) under the aft jack fitting (6).

3. Adjust the aft jack (5) until helicopter is almost level.

4. Adjust forward jacks (5) until snug against forward jack fittings (4). Raise all three jacks evenly until skids are clear of surface.

5. Position spirit level (7) on leveling plate (8).

6. Level helicopter fore and aft and laterally by adjusting height of jacks (5) at forward and aft jack fittings (4 and 6) while observing spirit level (7) indication. Helicopter is level when spirit level (bubble) is in center of spirit level both longitudinally and laterally.

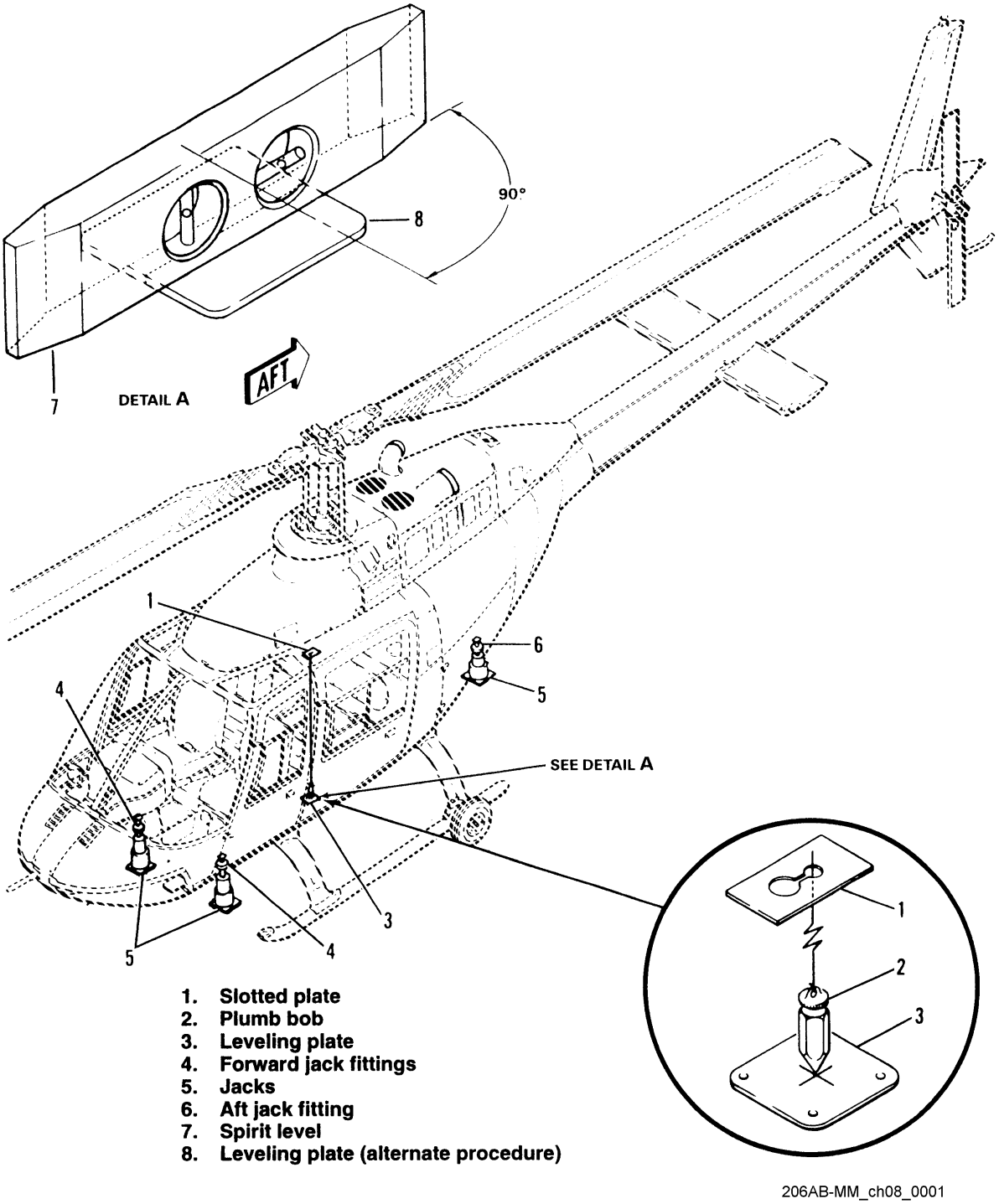


Figure 8-1. Helicopter Leveling

8-7. LEVELING USING LEVELING PAD METHOD (HELICOPTERS 104 THROUGH 583)

NOTE

Helicopters S/N 104 through 583 incorporate four leveling pads located on aft right portion of cabin roof adjacent to pylon support.

1. Open access door adjacent to firewall on right side of forward cowling.

2. Place spirit level across two lateral pads.

3. Level helicopter laterally by adjusting height of jacks (5, Figure 8-1) at forward jack fittings (4 and 6) while observing spirit level indication. Helicopter is level when spirit level (bubble) is centered laterally.

4. Place spirit level device across fore and aft leveling pads.

NOTE

No correlation of leveling provision is required between lateral and fore and aft pads.

5. Level helicopter fore and aft and laterally by adjusting height of jacks (5) at forward and aft jack fittings (4 and 6) while observing spirit level indication. Helicopter is level when spirit level (bubble) is centered both longitudinally and laterally.

8-8. WEIGHING PROCEDURE

8-9. PREPARATION OF THE HELICOPTER FOR WEIGHING

Before weighing the helicopter, ensure configuration is as near the Weight Empty as possible. Perform the following:

1. Remove, as much as possible, dirt, grease, moisture, and any equipment not required for weighing from helicopter.

2. Ensure baggage compartment is empty.

3. Place all kits and required equipment for weighing in proper locations.

4. Ensure transmission, gearbox, and hydraulic reservoirs are serviced to proper levels (Chapter 12).

5. Ensure engine oil system is either fully drained or topped up to the full mark.

NOTE

The Weight Empty configuration is the weight of the basic helicopter plus the weight of the kits, special equipment, fixed ballast, transmission and gearbox oil, hydraulic fluid, unusable fuel, and undrainable oil.

6. Drain fuel system (Chapter 12).

8-10. WEIGHING

1. Do not weigh the helicopter outdoors or in an open building because wind, flapping rotors, and body sway may seriously affect the accuracy of scale readings.

NOTE

If electronic platform scales are used, always align the jackpoint on center of the scale. Do not cross scale coax wire on ground or put any weight on cable.

2. If electronic loadcells are used, ensure that loadcells and adapters are tightened to pads of the jacks used to raise the helicopter. Place loadcells in position on jacks. Perform warmup recommended by the scale manufacturer. Refer to instructions supplied by the manufacturer and adjust each loadcell to zero.

3. Ensure each of the scale calibrations have a zero reading before performing each weighing procedure.

CAUTION

ENSURE LANDING GEAR SKIDS DO NOT TOUCH THE WEIGH SCALES OR FLOOR. IF SKIDS TOUCH, THE SCALES WILL NOT BE BALANCED CORRECTLY.

4. Weigh helicopter on portable scales and place scales in position on level ground. Place a scale under each jackpoint. Align jackpoint on center of scale. Use

jacks to make helicopter level in longitudinal and lateral directions (paragraph 8-4).

5. Balance each scale and make a note of the readings. If electronic scales are used, find the weight on each cell from the digital counter. Refer to manufacturer instructions.

6. Remove the helicopter from jacks (Chapter 7). On each scale, weigh the weight tare. This includes the applicable jack, blocks, and any other equipment in position between the helicopter and scale. Subtract this weight tare from the first scale reading to get the net weights.

7. To ensure accurate readings are obtained, rotate loadcells/electric scales one position and reweigh the helicopter. If the difference between the first total weight and second total weight is less than 10.0 pounds (4.54 Kg), and if forward weight and aft weight difference between the first and second weighings (ie. [left+right -aft] - [left+right-aft]) is less than 5.0 pounds (2.268 Kg) the resultant readings can be considered accurate. Refer to Table 8-1 for sample weighing results.

8-11. CALCULATIONS

8-12. CALCULATING AS-WEIGHED CENTER OF GRAVITY

1. The distance from FS 0.00 to the centers of forward jack fittings (4, Figure 8-1) is called forward arm (A, Figure 8-2). The distance from FS 0.00 to the center of the aft jack fitting (6, Figure 8-1) is called the aft arm (B, Figure 8-2). The forward arm is 55.16 inches (1401 mm) long and the aft arm is 179.92 inches (4570 mm) long.

2. Refer to Figures 8-2 and 8-3 for calculation formulas.

3. Multiply the sum of the net weights of the forward scales by the forward arm. The result is called forward moment and is expressed in inch-pounds (millimeter-kilograms).

4. Multiply the net weight of the aft scale by the aft arm. The result is called aft moment and is expressed in inch-pounds (millimeter-kilograms).

5. Add forward and aft moments and divide this sum by the As-Weighed weight. The result is the helicopter As-Weighed Center of Gravity (CG) in inches (millimeters) aft of FS 0.00 (Figure 8-3).

8-13. CALCULATING INITIAL WEIGHT EMPTY AND CENTER OF GRAVITY (CG)

1. Before you find the ballast requirements, you must compute the initial weight empty from the As-Weighed weight. Balance calculations are based on the Weight Empty condition. Start with the As-Weighed weight, the CG, and the moment as determined in paragraph 8-12 above, and perform the following steps:

a. Add the weight of all Weight Empty items that were not on helicopter when it was weighed. Some examples are:

(1) Unusable fuel

(2) Undrainable engine oil

(3) Transmission oil

(4) Gearbox oil.

b. Subtract the weight of all the non Weight Empty items on the helicopter when it was weighed. Some examples are:

(1) Plumb bob

(2) Spirit level

(3) Engine oil

(4) Undrainable fuel.

2. Table 8-2 lists the density weights and quantities that must be used for weight and balance calculations. The fuel quantities are for a standard day. If a helicopter has to be weighed with full tanks (this is **not** recommended), do a specific gravity check to find correct weight of fuel on board.

3. Table 8-3 shows a typical calculation for deriving the Initial Weight Empty and the CG.

8-14. COMPUTING AN ACTUAL WEIGHT RECORD — EXAMPLES

For these examples, the helicopter has battery removed, fuel system drained, engine oil system full, and helicopter leveled with a plumb bob. The helicopter was serviced with JP-5 fuel and MIL-PRF-23699 oil.

NOTE

All changes made to the as-weighed condition must be shown on the Actual Weight Records (Figures 8-4 and 8-5).

Table 8-1. Sample Weighing Results Using Electronic Platform Scales

SCALE LOCATION	SCALE READING		TARE WEIGHT		NET WEIGHT	
POSITION ONE	(LBS)	(KG)	(LBS)	(KG)	(LBS)	(KG)
Fwd Left	402	182.3	1.0	0.5	401	181.9
Fwd Right	430.5	195.3	0.0	0.0	430.5	195.3
Aft	887	402.3	2.0	0.9	885	401.4
As Weighed	1719.5	780.0	3.0	1.4	1716.5	778.6

SCALE LOCATION	SCALE READING		TARE WEIGHT		NET WEIGHT	
POSITION TWO	(LBS)	(KG)	(LBS)	(KG)	(LBS)	(KG)
Fwd Left	409	185.5	2.0	0.9	407	184.6
Fwd Right	429.5	194.8	1.0	0.5	428.5	194.4
Aft	885	401.4	0.0	0.0	885	401.4
As Weighed	1723.5	781.8	3.0	1.4	1720.5	780.4

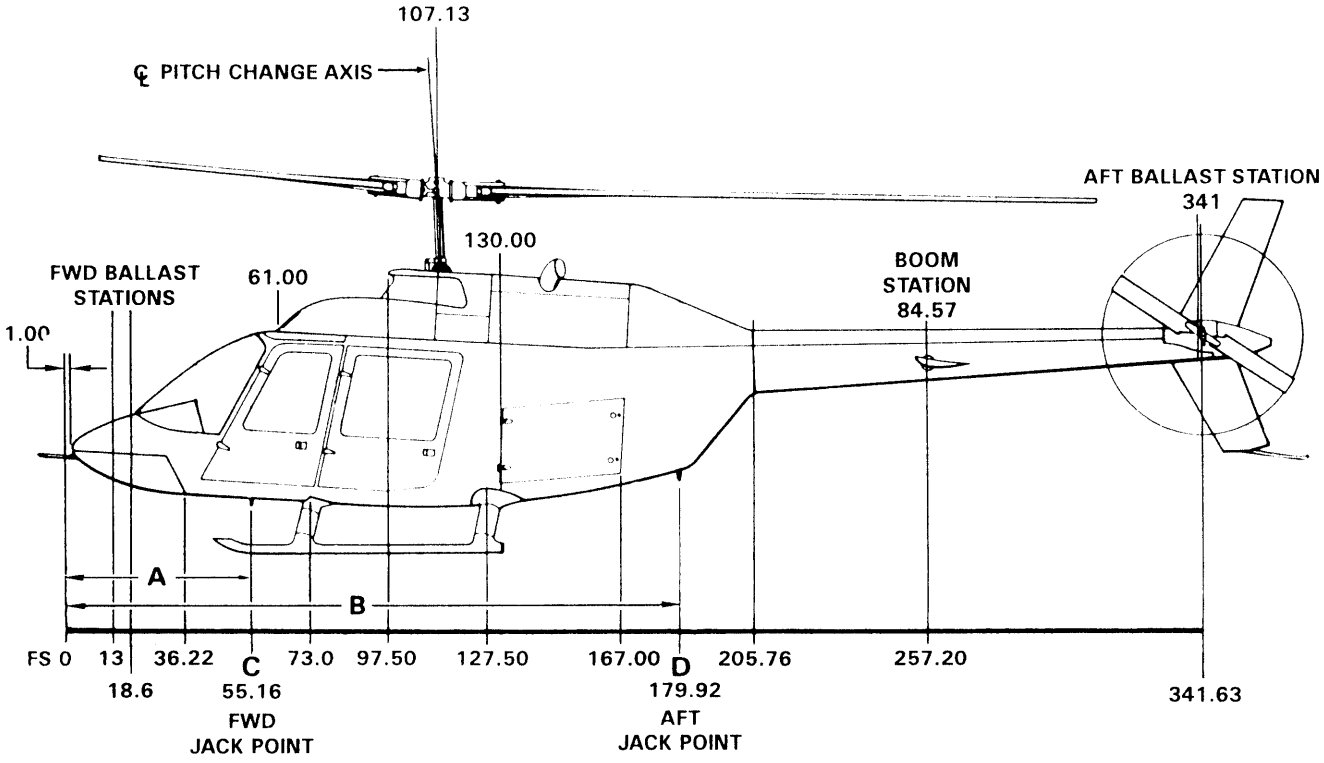
Table 8-2. Weights

VARIOUS FUELS AND OILS		
FUEL OIL	**DENSITY**	
	LBS/GAL	**(KG/L)**
JP-4 (Jet B)	6.5	0.779
JP-5 (Jet A)	6.8	0.815
JP-8	6.8	0.815
DOD-L-85734	8.4	1.007
MIL-PRF-7808	7.7	0.923
MIL-PRF-23699	8.4	1.007

UNUSABLE FUEL (INCLUDES UNDRAINABLE)						
FUEL	**WEIGHT**		**CG**		**MOMENT**	
	(LBS)	**(KG)**	**(INCHES)**	**(MM)**	**(IN-LBS)**	**(MM-KG/100)**
JP-4	9.7	4.4	120	3048	1164	134.1
JP-5	10.1	4.6	120	3048	1212	140.2
JP-8	10.1	4.6	120	3048	1212	140.2
TRAPPED/UNDRAINABLE FUEL						
JP-4	3.0	1.4	130.0	3302	390	46.2
JP-5	3.1	1.4	130.0	3302	403	46.2
JP-8	3.1	1.4	130.0	3302	403	46.2
UNDRAINABLE ENGINE OIL						
DOD-L-85734	1.4	0.6	167	4242	234	25.5
MIL-PRF-7808	1.3	0.6	167	4242	217	25.5
MIL-PRF-23699	1.4	0.6	167	4242	234	25.5
USABLE ENGINE OIL						
DOD-L-85734	12.3	5.6	179.0	4547	2202	254.6
MIL-PRF-7808	11.3	5.1	179.0	4547	2023	231.9
MIL-PRF-23699	12.3	5.6	179.0	4547	2202	254.6

Table 8-3. Deriving Initial Weight Empty And Center Of Gravity (Example)

ITEM	**WEIGHT**		**CG**		**MOMENT**	
	(LBS)	**(KG)**	**(INCHES)**	**(MM)**	**(IN-LBS)**	**MM-KG/100)**
As-weighed	1716.5	778.6	119.5	3035	205095	23629.6
Remove:						
Engine oil	-12.3	-5.6	179.0	4547	-2202	-254.6
Plumb Bob	-0.3	-0.1	90.0	2286	-27	-2.3
Undrainable Fuel	-3.1	-1.4	130.0	3302	-403	-46.2
Add:						
Battery	34.6	15.7	14.7	373	509	58.6
Unusable Fuel	10.1	4.6	120.0	3048	1212	140.2
Initial Weight Empty	1745.5	791.8	117.0	2971	204184	23525.3



NOTE

Station 0 (datum) is located 55.16 inches (1.401 m) forward of forward jackpoint centerline.

A = FORWARD ARM

B = AFT ARM

C = FORWARD SCALE READING

D = AFT SCALE READING

AC = FORWARD MOMENT

BD = AFT MOMENT

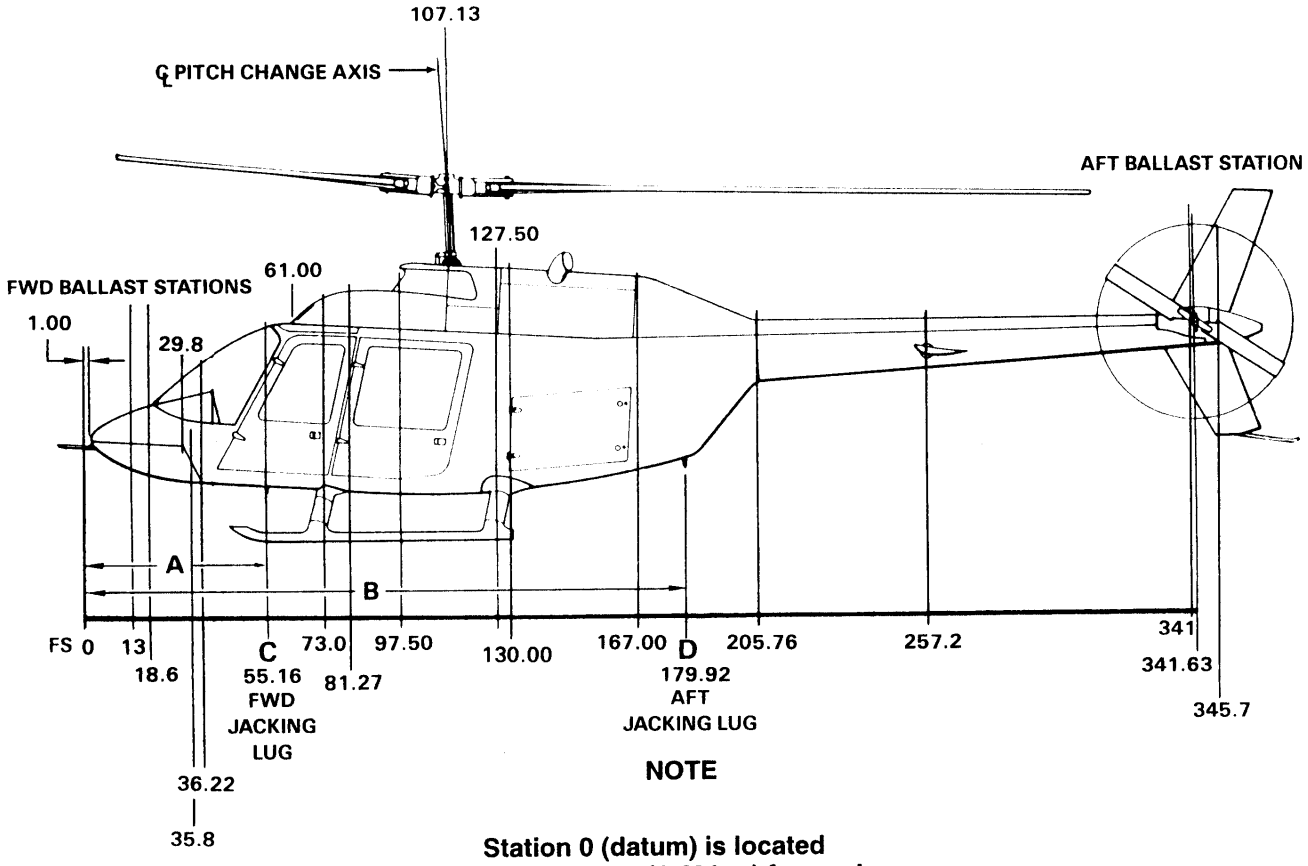
C + D = TOTAL WEIGHT

$$\frac{AC + BD}{C + D} = \text{CG FROM STATION 0}$$

206A/B HELICOPTER

206AB-MM_ch08_0002

Figure 8-2. Weight And Balance Station Diagram (sheet 1 of 2)



A = FORWARD ARM

B = AFT ARM

C = FORWARD SCALE READING

D = AFT SCALE READING

AC = FORWARD MOMENT

BD = AFT MOMENT

C + D = TOTAL WEIGHT

$$\frac{AC + BD}{C + D} = \text{CG FROM STATION 0}$$

206B3 HELICOPTER

206AB-MM_ch08_0003

Figure 8-2. Weight And Balance Station Diagram (sheet 2 of 2)

EXAMPLE

Using pounds

Forward moment = (Net weight fwd left + net weight fwd right) (Arm A)

= (401.0 + 430.5) (55.16) = 45866 IN-LB

Aft moment = (Net weight aft) (Arm B)

= (885.0) (179.92) = 159229 IN-LB

As weighed C.G. = $\frac{\text{(Fwd moment + aft moment)}}{\text{As weighed weight}}$

= $\frac{45866 + 159229}{1716.5}$ = 119.5 IN.

Using kilograms

Forward moment = (Net weight fwd left + net weight fwd right) (Arm A)

= (181.9 + 195.3) (1401) = 528457 mm-kg

Aft moment = (Net weight aft) (Arm B)

= (401.4) (4570) = 1834398 mm-kg

As weighed C.G. = $\frac{\text{(Fwd moment + aft moment)}}{\text{As weighed weight}}$

= $\frac{(528457 + 1834398)}{778.6}$ = 3034.9 mm

Figure 8-3. Calculating As-Weighed Center Of Gravity (Example)

BELL HELICOPTER COMPANY
Model 206A/B Actual Weight Record
Sample (206B)

Date Weighed:_____ Serial Number:_____

WEIGHING RESULTS

Cell Location		Scale	Tare	Net
Forward Jackpoint	(F.S. 55.16, B.L. -17.0)	402.0	1.0	401.0
Forward Jackpoint	(F.S. 55.16, B.L. +16.82)	430.5	0.0	430.5
Aft Jackpoint	(F.S. 179.92, B.L. + 0.0)	887.0	2.0	885.0
	Total	1719.5	3.0	1716.5

Longitudinal CG., As Weighed

$$CG = \frac{55.16 \times (831.5) + 179.92 \times (885.0)}{\text{Total weight}} = \frac{205094.7}{1716.5} = 119.5 \text{ ins}$$

Lateral CG., As Weighed

$$CG = \frac{-17.0 \times (401) + 16.82 \times (430.5)}{\text{Total weight}} = \frac{424.0}{1716.5} = 0.2 \text{ ins}$$

			Longitudinal		Lateral	
Weight Empty Derivation		Weight (lb)	Arm (ins)	Moment (lb.ins)	Arm (ins)	Moment (lb.ins)
A/C as Weighed		1716.5	119.5	205095	0.2	424
Delete:	Trapped Fuel (JP5)	-3.1	130.0	-403	0.0	0
	Usable Oil	-12.3	179.0	-2202	0.0	0
	Plumb Bob	-0.3	90.0	-27	-11.0	3
Add:	Unusable Fuel (JP5)	10.1	120.0	1212	0.0	0
	Battery	34.6	14.7	509	1.0	35
	Nose Ballast	15.0	13.0	195	-2.5	-38
WEIGHT EMPTY		1760.5	116.1	204379	0.2	424
Most Forward C.G.						
Weight Empty		1760.5	116.1	204379	0.2	424
+ Pilot		170.0	65.0	11050	14.0	2380
+ Passenger, Fwd.		170.0	65.0	11050	-11.0	-1870
+ Passenger Aft (3)		510.0	104.0	53040	0.0	0
+ Oil, Engine (MIL-PRF-23699)		12.3	179.0	2202	0.0	0
Total - Most Forward		2622.8	107.4	281720	0.4	934
Most Aft C.G.						
Weight Empty		1760.5	116.1	204379	0.2	424
+ Pilot		170.0	65.0	11050	14.0	2380
+ Passenger Aft (3) △1		510.0	104.0	53040	0.0	0
+ Full Fuel (JP5) △2		618.8	118.0	73018	0.0	0
+ Oil, Engine (MIL-PRF-23699)		12.3	179.0	2202	0.0	0
Total - Most Aft		3071.6	111.9	343689	0.9	2804

Figure 8-4. Weight Record — English Units Sample (sheet 1 of 2)

NOTES:

△1 3 Aft passengers are required for most aft C of G calculation because the aft limit line shown in the Center of Gravity vs Gross Weight chart (Ref: Flight Manual Limitations Section) slopes forward at weights above 2425 pounds.

△2 618.8 pounds for full fuel (JP5), shown in sample chart is only applicable for 206B-3 S/N 3567 thru sub with 91 gallon fuel cell. Helicopters S/N 4 thru 3566 with 76 gallon fuel cell are to use 516.8 pounds with an arm of 116.0 and a moment of 59949.

Figure 8-4. Weight Record — English Units Sample (sheet 2 of 2)

BELL HELICOPTER COMPANY
Model 206A/B Actual Weight Record
Sample (206B) Metric

Date Weighed:_____ Serial Number:_____

WEIGHING RESULTS

Cell Location		Scale	Tare	Net
Forward Jackpoint	(F.S. 1401, B.L. -432)	182.3	0.5	181.9
Forward Jackpoint	(F.S. 1401, B.L. +427)	195.3	0.0	195.3
Aft Jackpoint	(F.S. 4570, B.L. 0.0)	402.3	0.9	401.4
	Total	780.0	1.4	778.6

Longitudinal CG., As Weighed

$$CG = \frac{1401 \times (377.2) + 4570 \times (401.4)}{\text{Total weight}} = \frac{2362960}{778.6} = 3034.9 \text{ mm}$$

Lateral CG., As Weighed

$$CG = \frac{-432 \times (181.9) + 427 \times (195.3)}{\text{Total weight}} = \frac{4804}{778.6} = 6.2 \text{ mm}$$

			Longitudinal		Lateral	
Weight Empty Derivation		Weight (kg)	Arm (mm)	Moment (kg•mm)	Arm (mm)	Moment (kg•mm)
A/C as Weighed		778.6	3034.9	2362960	6.2	4804
Delete:	Trapped Fuel (JP5)	-1.4	3302.0	-4623	0.0	0
	Usable Oil	-5.6	4547.0	-25463	0.0	0
	Plumb Bob	-0.1	2286.0	-229	-279.0	28
Add:	Unusable Fuel (JP5)	4.6	3048.0	14021	0.0	0
	Battery	15.7	373.0	5856	25.0	393
	Nose Ballast	6.4	330.0	2112	-64.0	-410
WEIGHT EMPTY		798.2	2949.9	2354634	6.0	4815
Most Forward C.G.						
Weight Empty		798.2	2949.9	2354634	6.0	4815
+ Pilot		77.1	1651.0	127292	356.0	27448
+ Passenger, Fwd.		77.1	1651.0	127292	-279.0	-21511
+ Passenger Aft (3)		231.3	2642.0	611095	0.0	0
+ Oil, Engine (MIL-PRF-23699)		5.6	4547.0	25463	0.0	0
Total - Most Forward		1189.3	2729.2	3245776	9.0	10752
Most Aft C.G.						
Weight Empty		798.2	2949.9	2354634	6.0	4815
+ Pilot		77.1	1651.0	127292	356.0	27448
+ Passenger Aft (3) △1		231.3	2642.0	611095	0.0	0
+ Full Fuel (JP5) △2		280.4	2997.0	840359	0.0	0
+ Oil, Engine (MIL-PRF-23699)		5.6	4547.0	25463	0.0	0
Total - Most Aft		1392.6	2842.8	3958843	23.2	32263

Figure 8-5. Weight Record — Metric Sample (sheet 1 of 2)

NOTES:

⚠1 3 Aft passengers are required for most aft C of G calculation because the aft limit line shown in the Center of Gravity vs Gross Weight chart (Ref: Flight Manual Limitations Section) slopes forward at weights above 1100 kilograms.

⚠2 280.4 kilograms shown in sample chart for full fuel (JP5), is only applicable for 206B-3 S/N 3567 thru sub with 344.4 liter fuel cell. Helicopters S/N 4 thru 3566 with 287.7 liter fuel cell are to use 234.5 kilograms with an arm of 2946 and a moment of 690837.

Figure 8-5. Weight Record — English Units Sample (sheet 2 of 2)

8-15. CALCULATING FINAL WEIGHT EMPTY AND CENTER OF GRAVITY

The final weight empty and CG may be found by two procedures: use weight empty CG limits (Figure 8-6) or use gross weight flight limits. (Refer to Flight Manual Limitations section.)

8-16. USE OF THE WEIGHT EMPTY CENTER OF GRAVITY LIMITS

When a helicopter has a standard fuel system and standard seating arrangement, use appropriate Weight Empty CG limits (Figure 8-6) as a guide to properly ballast the helicopter. Charts which depict a Maximum Gross Takeoff Weight (MGTOW) of 3350 pounds apply to helicopters which have incorporated the Increased Internal Gross Weight kit per STC NO. SR09397RC (Ref: BHT-206-SI-129).

Select the appropriate chart from Figure 8-6 based on the aircraft serial number, modification state and allowable maximum gross weight. The charts were derived using the worst combination of the values in Table 8-4.

1. If the initial weight empty and CG are within the weight empty CG limit lines (Figure 8-6), the initial weight empty is the final weight empty. Write this value down on the Actual Weight Record form included in the flight manual.

Table 8-4. Values Used To Determine Weight Empty Vs Center Of Gravity Charts

FIGURE 8-6	SHEET 1& 2		SHEET 3 & 4		SHEET 5 & 6	
(ALL VALUES IN POUNDS)	FWD	AFT	FWD	AFT	FWD	AFT
Pilot	170	150	170	170	170	170
Copilot/Fwd Passenger	170	-	170	-	170	-
Aft Passengers	510	510	510	510	510	510
Oil	12.3	12.3	12.3	12.3	12.3	12.3
Fuel	-	516.8	-	516.8	-	618.8

2. If computed CG is outside the limits, the required CG is found by moving horizontally to the nearest limit and reading the value at this point. Since limit lines are not vertical, the required CG used should be inside the limit line to allow for increase in weight because of addition of the ballast.

a. If the required CG is aft of the limit line and tailboom ballast is already installed, remove ballast and calculate the initial weight empty and CG again before you calculate the required ballast.

b. If required CG is forward of the limit line and nose ballast is already installed, remove the ballast and calculate Initial Weight Empty and CG again before calculating the required ballast.

NOTE

Never allow ballast to be installed in both nose and tailboom at the same time.

c. If the CG is aft of the limit and the nose ballast is already installed (or if CG is forward of the limit and if tailboom ballast is already installed) calculate additional ballast that will be required.

d. Calculate required ballast using the formula that follows:

NOTE

If weight empty exceeds the maximum shown on the chart (Figure 8-6), or if helicopter fuel system or seating arrangement are non-standard, install alternate cockpit placard and calculate ballast requirement using gross weight flight limits.

NOTE

When a helicopter has a unique loading configuration that is not standard, such as crew and/or passenger weights, baggage compartment loading, or other variations, use gross weight flight limits to calculate ballast.

$$\text{BALLAST} = \frac{(\text{Weight Empty})\,(\text{Required CG} - \text{Calculated CG})}{\text{Ballast CG} - \text{Required CG}}$$

EMPTY WEIGHT CENTER OF GRAVITY LIMITS

MGTOW 3200 lb

S/N 4 to 2211 (see sheet 3 if modified per BHT-206-SI-112)

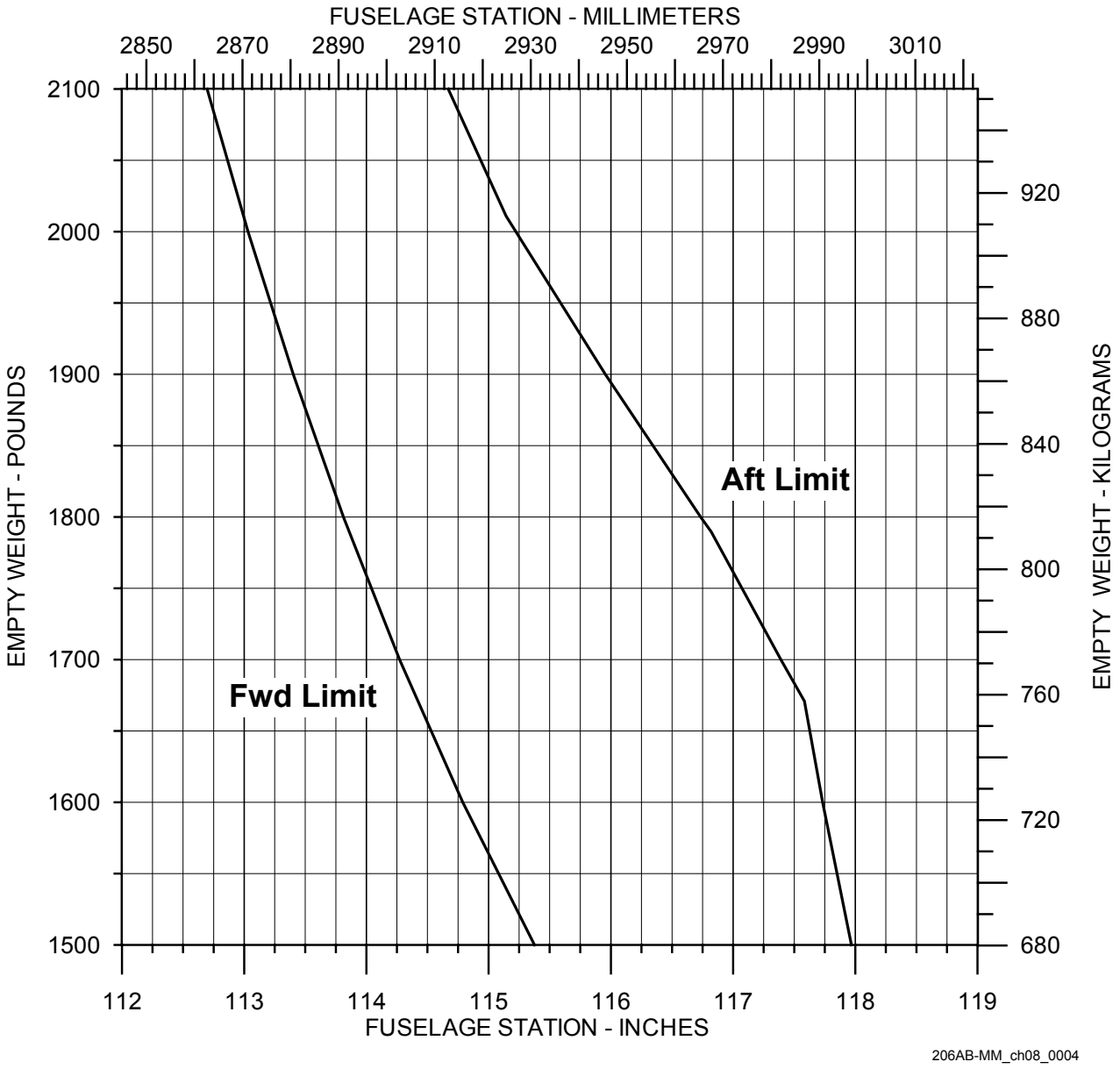


Figure 8-6. WEight Empty Vs Center Of Gravity Chart (sheet 1 of 6)

EMPTY WEIGHT CENTER OF GRAVITY LIMITS

MGTOW 3350 lb (REF: STC NO. SR09397RC)

S/N 4 to 2211 (see sheet 4 if modified per BHT-206-SI-112)

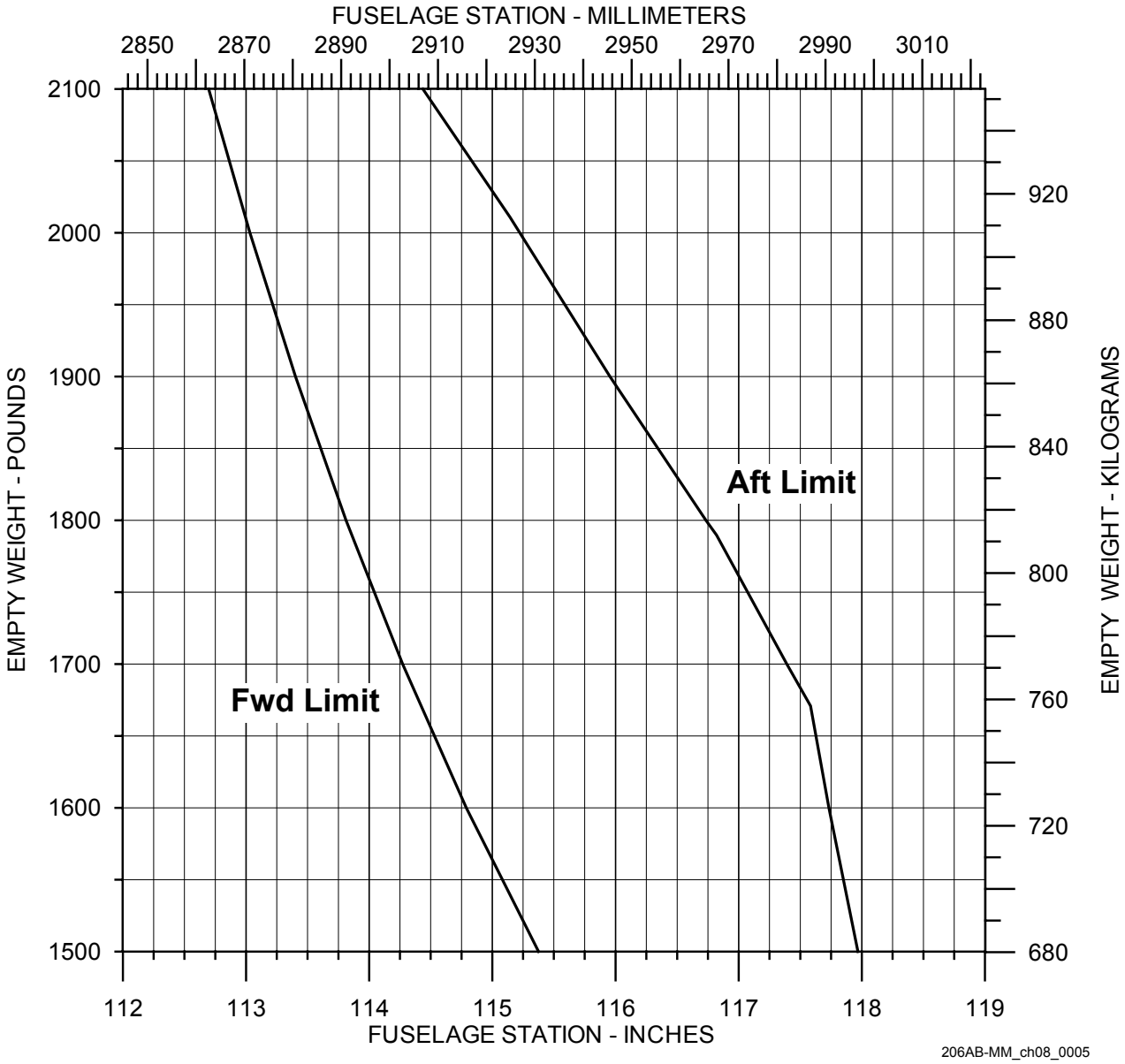


Figure 8-6. Weight Empty Vs Center Of Gravity Chart (sheet 2 of 6)

EMPTY WEIGHT CENTER OF GRAVITY LIMITS

MGTOW 3200 lb
S/N 2212 to 3566
S/N 4 to 2211 (if modified per BHT-206-SI-112)

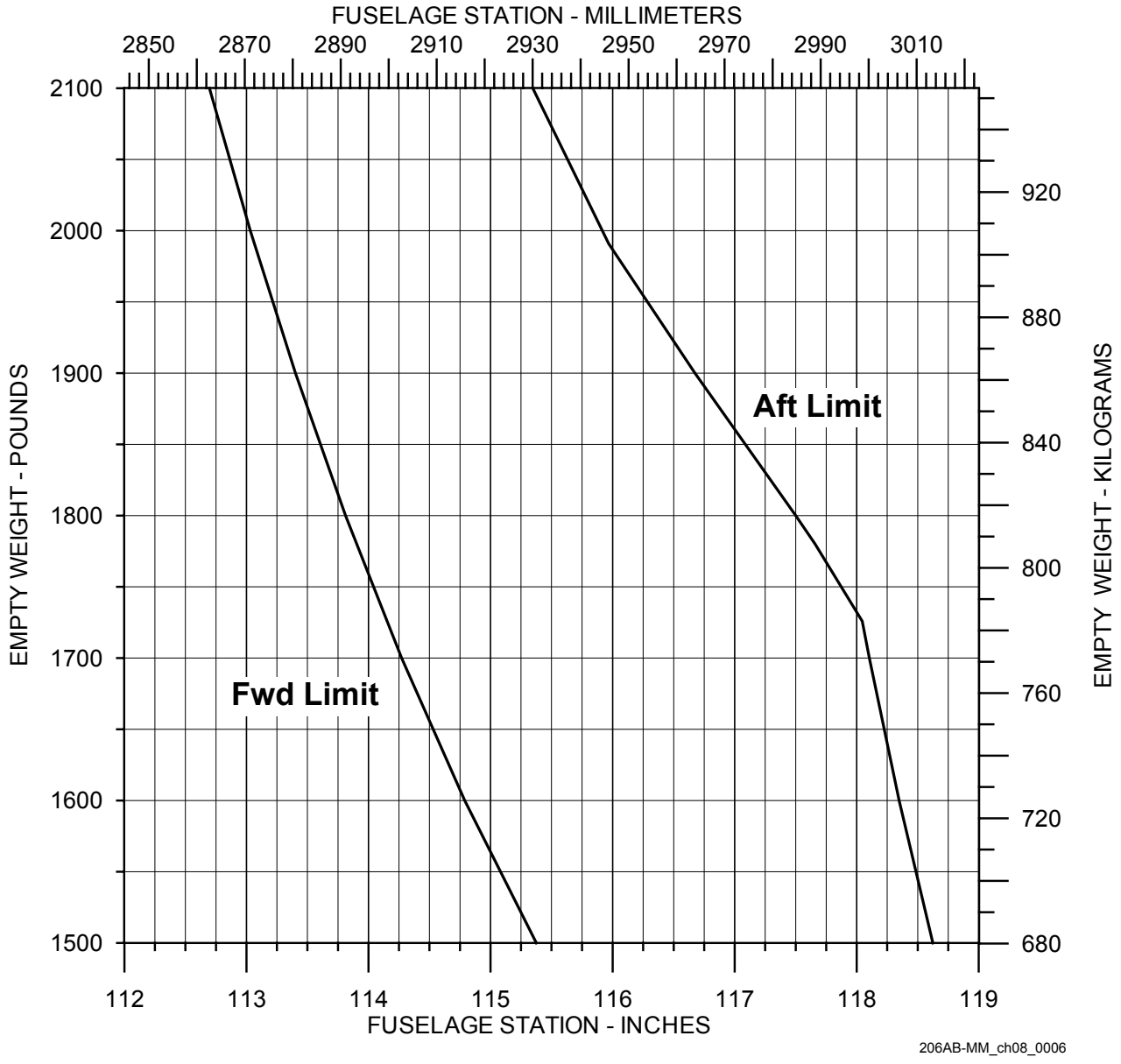


Figure 8-6. Weight Empty Vs Center Of Gravity Chart (sheet 3 of 6)

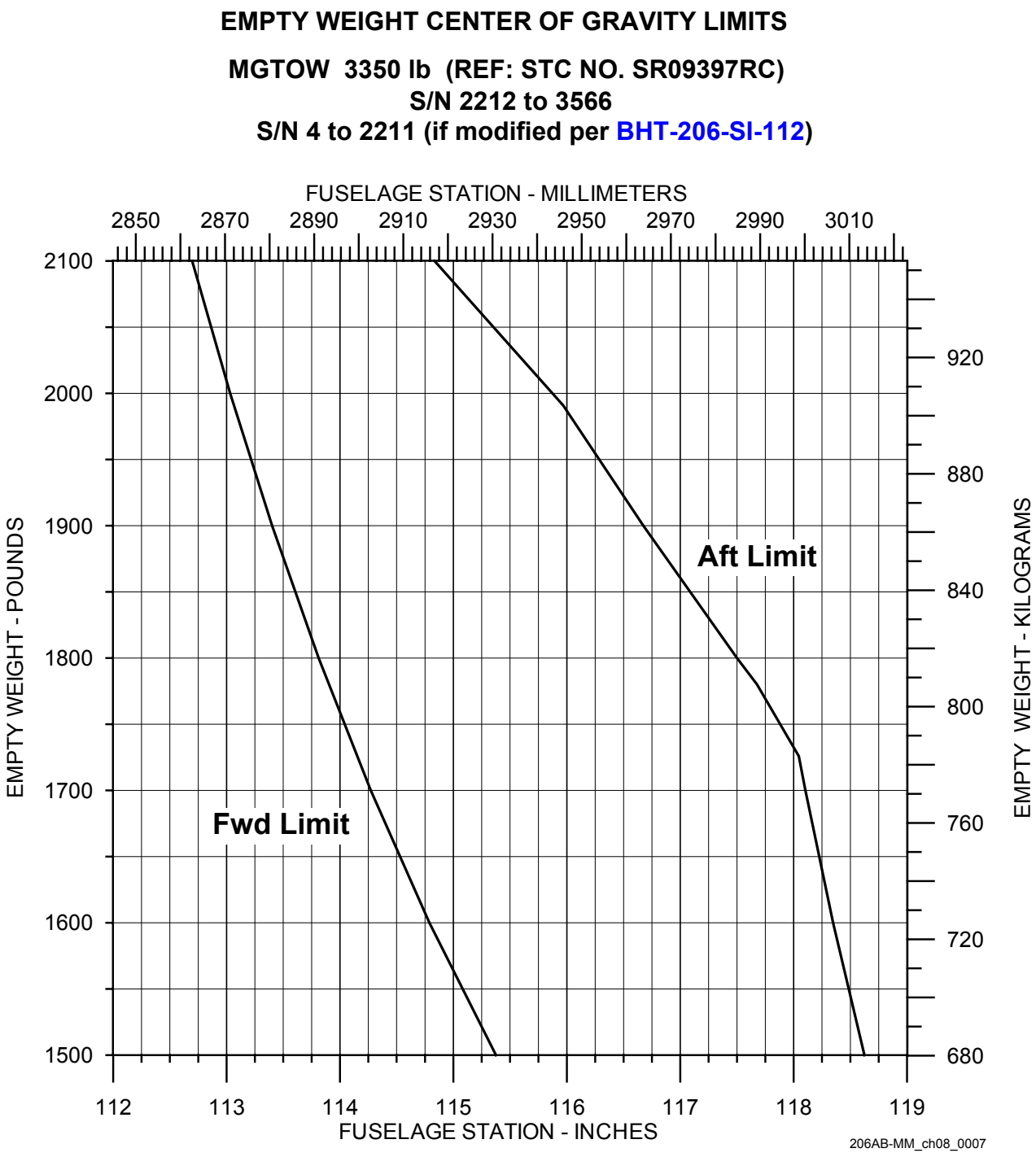


Figure 8-6. Weight Empty Vs Center Of Gravity Chart (sheet 4 of 6)

EMPTY WEIGHT CENTER OF GRAVITY LIMITS

MGTOW 3200 lb

S/N 3567 & Sub.

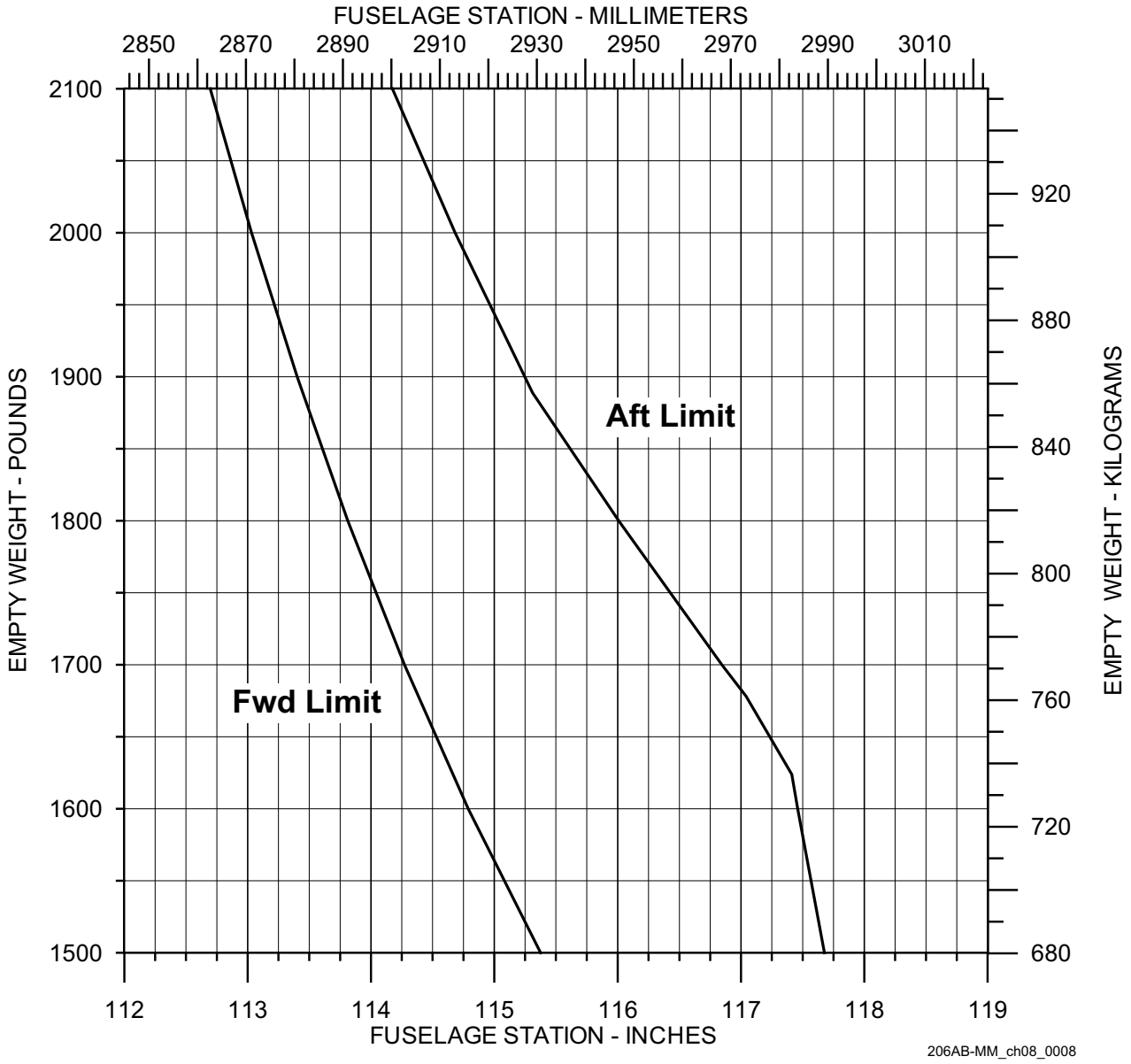


Figure 8-6. Weight Empty Vs Center Of Gravity Chart (Sheet 5 of 6)

EMPTY WEIGHT CENTER OF GRAVITY LIMITS

MGTOW 3350 lb (REF: STC NO. SR09397RC)

S/N 3567 & Sub.

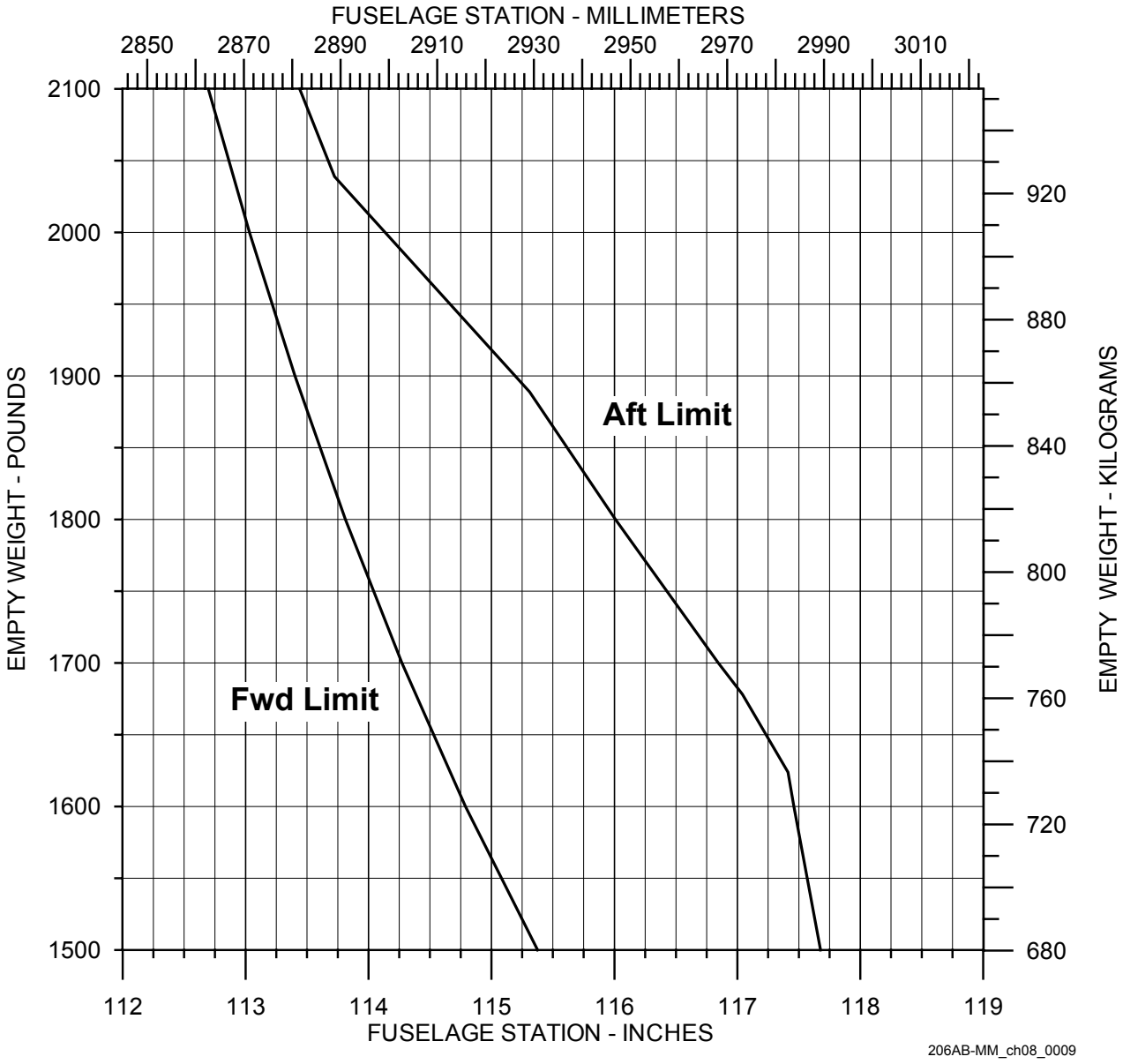


Figure 8-6. Weight Empty Vs Center Of Gravity Chart (sheet 6 of 6)

CALCULATING THE BALLAST REQUIRED

EXAMPLE

$$\text{Required Ballast} = \frac{(1745.5)\,(116.2 - 117.0)}{(13.0 - 116.2)}$$

$$= 13.5 \text{ lbs}$$

In this example the ballast required is less than the total capacity of the forward ballast location, therefore no further calculations are necessary. If this had not been the case then another iteration would be required after having revised the initial weight empty to include the maximum ballast for the forward ballast location.

The ballast plates are approximately 3.0 pounds each. Therefore the 13.5 pounds is rounded up to 15.0 pounds.

METRIC EXAMPLE

$$\text{Required Ballast} = \frac{(791.8)\,(2951 - 2971)}{(330 - 2951)}$$

$$= 6.0 \text{ kg}$$

Figure 8-7. How To Find The Correct Ballast Weight

3. To find the exact ballast, more than one calculation may have to be done because the ballast weight is limited at each location. To find the correct ballast weight refer to Figure 8-7.

4. Once the correct ballast is found, calculate the final empty weight shown in Table 8-5.

5. Write ballast weight requirements on the helicopter Actual Weight Record (Figures 8-4 and 8-5). When ballast is removed from as-weighed weight (step 2.a. or b., above), it must be shown on the Actual Weight Record. If part of removed ballast is added again, add entries together to show total weight removed from each location.

6. Install and secure required ballast (paragraph 8-19).

Table 8-5. Deriving Final Weight Empty From Initial Weight Empty (Example)

ITEM	WEIGHT		CG		MOMENT	
	(LBS)	(KG)	(INCHES)	(MM)	(IN-LBS)	(MM-KG/100)
Initial Weight Empty (from Table 8-3)	1745.5	791.8	117.0	2971	204223.5	23524.4
Add:						
Ballast @ FS 13.0 (330.20)	15.0	6.4	13.0	330	195	21.1
Final Weight Empty	1760.5	798.2	116.1	2950	204394	23546.9

8-17. SAMPLE WEIGHING PROCEDURE (NON-STANDARD CONFIGURATION)

For this example the pilot seat is not installed; fuel system is drained and engine oil system is full. The helicopter is configured for a single litter to be permanently installed together with an aft right side attendant seat (Table 8-6 and Figures 8-8 and 8-9).

8-18. CALCULATING THE LATERAL CENTER OF GRAVITY

1. The centerline of the helicopter is Butt line 0.00. The moment arms to the left side (when looking forward) are negative (-) and the moment arms to the right side are positive (+).

2. On each forward scale, multiply net weight by its arm to get left and right moments for the helicopter. Do not calculate the lateral moment for the aft scale because lateral moment for the aft scale is always zero.

3. Add the left side and right side moments together. Divide this total by the As-Weighed weight. The result is the As-Weighed helicopter lateral CG in inches (millimeters) to the left side or right side of Butt line 0.00.

4. Write down these calculations on the Actual Weight Record Form (Figures 8-4 and 8-5).

5. As the empty weight is calculated (paragraph 8-14 and paragraph 8-16), write down the lateral arms and moments on the Actual Weight Record.

6. Do not ballast for lateral CG. Refer to applicable JetRanger Flight Manual for seating limitations to maintain helicopter within lateral gross weight flight limits.

8-19. INSTALLATION OF BALLAST

Ballast weights are manufactured from lead sheets and vary in thickness from 0.0625 inch (1.58 mm) to 0.25 inch (6.35 mm). Each ballast weight has the value of its weight stamped on it. Ballast weights may require special support assemblies, brackets, or hardware to be installed. Refer to Figures 8-10 and 8-11 for the ballast installation. Ballast weights may be modified to meet the ballast requirements without excess weight as shown on Figures 8-10 and 8-11.

1. Find the amount of ballast to be added or removed at each location (Figure 8-7).

NOTE

Do not install ballast in both nose and mid tailboom locations at the same time.

2. Find the number of each size of ballast weight required to get the correct weight at each location.

3. Determine the amount of ballast currently installed at either forward or aft ballast stations.

4. When adding forward ballast to helicopters (S/N 4 through 4128), FS 13.0 location should be used first since less ballast will be required. If the amount required exceeds maximum allowable, additional ballast should be installed at FS 18.6 location. This will require a recomputation due to the difference in arms for the two locations. If more ballast is required, add ballast at FS 35.8. Refer to paragraph 8-11 for calculation.

5. When adding forward ballast to helicopters (S/N 4129 and subsequent), FS 13.0 should be used first since less ballast will be required. If amount required exceeds maximum allowable, then additional ballast should be installed at FS 18.6. This will require a weight and balance recomputation due to the difference in arms for the two locations. If more ballast is required, FS 29.8 should be used first and FS 35.8 second to achieve desired center of gravity. Ballast to be distributed evenly on both sides of console to within 5 pounds (2.268 kg). Refer to paragraph 8-10 for maximum ballast allowable for a certain fuselage station.

Table 8-6. Sample Weight Procedure Non-Standard Seating

ITEM	WEIGHT (LB)	CG (INS)	MOMENT (LB.INS)
A/C As Weighed	1757.5	118.1	207543
Remove:			
Plumb Bob	-0.3	90.0	-27
Trapped Fuel	-3.1	130.0	-403
Engine Oil	-12.3	179.0	-2202
Add:			
Unusable Fuel	10.1	120.0	1212
Pilots Seat	7.7	71.0	547
Initial Weight Empty	1759.6	117.5	206670
Calculate the Most Forward Useful Load			
Pilot	170	65.0	11050
Patient	170	84.0	14280
Attendant	170	104.0	17680
Oil, Engine	12.3	179.0	2202
Most Fwd Useful Load	522.3	86.6	45212
Calculate the Most Aft Useful Load			
Pilot	170	65.0	11050
Attendant	170	104.0	17680
Full Fuel (JP5) △1	618.8	118.0	73018
Oil, Engine	12.3	179.0	2202
Most Aft Useful Load	971.1	107.0	103950
Calculate the Most Fwd Gross Weight and Most Aft Gross Weight			
Initial Weight Empty	1759.6	117.5	206670.44
Most Fwd Useful Load	522.3	86.6	45211.7
Most Fwd Gross Weight	2281.9	110.4	251882.14
Initial Weight Empty	1759.6	117.5	206670.44
Most Aft Useful Load	971.1	107.0	103950.1
Most Aft Gross Weight	2730.7	113.8	310620.54

NOTE:

△1 618.8 pounds shown is only applicable for 206B-3 S/N 3567 thru subsequent with 91 gallon fuel cell. Helicopters S/N 4 thru 3566 with 76 gallon fuel cell are to use 516.8 pounds with an arm of 116.0 and a moment of 59949.

BELL HELICOPTER COMPANY
Model 206A/B Actual Weight Record
Sample (206B)
NON STANDARD SEATING

Date Weighed:_____ Serial Number:_____

WEIGHING RESULTS

Cell Location		Scale	Tare	Net
Forward Jackpoint	(F.S. 55.16, B.L. -17.0)	438.0	0.0	438.0
Forward Jackpoint	(F.S. 55.16, B.L. +16.82)	435.0	2.0	433.0
Aft Jackpoint	(F.S. 179.92, B.L. 0.0)	886.5	0.0	886.5
	Total	1759.5	2.0	1757.5

Longitudinal CG., As Weighed

$$CG = \frac{55.16 \times (871) + 179.92 \times (886.5)}{\text{Total weight}} = \frac{207543.4}{1757.5} = 118.1 \text{ ins}$$

Lateral CG., As Weighed

$$CG = \frac{-17.0 \times (438) + 16.82 \times (433.0)}{\text{Total weight}} = \frac{-162.9}{1757.5} = -0.1 \text{ ins}$$

			Longitudinal			Lateral	
Weight Empty Derivation		Weight (lb)	Arm (ins)	Moment (lb.ins)		Arm (ins)	Moment (lb.ins)
A/C as Weighed		1757.5	118.1	207543		-0.1	-163
Delete:	Plumb Bob	-0.3	90.0	-27		-11.0	3
	Trapped Fuel (JP5)	-3.1	130.0	-403		0.0	0
	Usable Oil	-12.3	179.0	-2202		0.0	0
Add:	Unusable Fuel (JP5)	10.1	120.0	1212		0.0	0
	Pilots Seat	7.7	71.0	547		14.0	108
	Nose Ballast	21.0	13.0	273		-2.5	-53
WEIGHT EMPTY		1780.6	116.2	206943		-0.1	-104
Most Forward C.G.							
Weight Empty		1780.6	116.2	206943		-0.1	-104
+ Pilot		170.0	65.0	11050		14.0	2380
+ Patient on Litter		170.0	84.0	14280		-14.0	-2380
+ Attendant Aft - RH		170.0	104.0	17680		15.0	2550
+ Oil, Engine (MIL-PRF-23699)		12.3	179.0	2202		0.0	0
Total - Most Forward		2302.9	109.5	252155		1.1	2446
Most Aft C.G.							
Weight Empty		1780.6	116.2	206943		-0.1	-104
+ Pilot		170.0	65.0	11050		14.0	2380
+ Attendant Aft - RH		170.0	104.0	17680		15.0	2550
+ Full Fuel (JP5) △1		618.8	118.0	73018		0.0	0
+ Oil, Engine (MIL-PRF-23699)		12.3	179.0	2202		0.0	0
Total - Most Aft		2751.7	113.0	310894		1.8	4826

NOTE:

△1 618.8 pounds shown in sample chart for full fuel (JP5), is only applicable for 206B-3 S/N 3567 thru sub with 91 gallon fuel cell. Helicopters S/N 4 thru 3566 with 76 gallon fuel cell are to use 516.8 pounds with an arm of 116.0 and a moment of 59949.

Figure 8-8. Weight Record — English Unit Sample

BELL HELICOPTER COMPANY
Model 206A/B Actual Weight Record
Sample (206B) Metric
NON STANDARD SEATING

Date Weighed:_____ Serial Number:_____

WEIGHING RESULTS

Cell Location		Scale	Tare	Net
Forward Jackpoint	(F.S. 1401, B.L. -432)	198.7	0.0	198.7
Forward Jackpoint	(F.S. 1401, B.L. +427)	197.3	0.9	196.4
Aft Jackpoint	(F.S. 4570, B.L. 0.0)	402.1	0.0	402.1
	Total	798.1	0.9	797.2

Longitudinal CG., As Weighed

$$CG = \frac{1401 \times (395.1) + 4570 \times (402.1)}{\text{Total weight}} = \frac{2391171}{797.2} = 2999.5 \text{ mm}$$

Lateral CG., As Weighed

$$CG = \frac{-432 \times (198.7) + 427 \times (196.4)}{\text{Total weight}} = \frac{-1962}{797.2} = -2.5 \text{ mm}$$

			Longitudinal			Lateral	
Weight Empty Derivation		Weight (kg)	Arm (mm)	Moment (kg•mm)		Arm (mm)	Moment (kg•mm)
A/C as Weighed		797.2	2999.5	2391171		-2.5	-1962
Delete:	Trapped Fuel (JP5)	-1.4	3302.0	-4623		0.0	0
	Usable Oil	-5.6	4547.0	-25463		0.0	0
	Plumb Bob	-0.1	2286.0	-229		-279.0	28
Add:	Unusable Fuel (JP5)	4.6	3048.0	14021		0.0	0
	Pilot Seats	3.5	1803.0	6297		356.0	1243
	Nose Ballast	9.5	330.0	3143		-64.0	-610
WEIGHT EMPTY		807.7	2951.9	2384318		-1.6	-1300
Most Forward C.G.							
Weight Empty		807.7	2951.9	2384318		-1.6	-1300
+ Pilot		77.1	1651.0	127292		356.0	27448
+ Patient on Litter		77.1	2134.0	164531		-356.0	-27448
+ Attendant Aft - RH		77.1	2642.0	203698		381.0	29375
+ Oil, Engine (MIL-PRF-23699)		5.6	4547.0	25463		0.0	0
Total - Most Forward		1044.6	2781.2	2905303		26.9	28075
Most Aft C.G.							
Weight Empty		807.7	2951.9	2384318		-1.6	-1300
+ Pilot		77.1	1651.0	127292		356.0	27448
+ Attendant Aft - RH		77.1	2642.0	203698		381.0	29375
+ Full Fuel (JP5) △1		280.4	2997.0	840359		0.0	0
+ Oil, Engine (MIL-PRF-23699)		5.6	4547.0	25463		0.0	0
Total - Most Aft		1247.9	2869.7	3581130		44.5	55523

NOTES:

△1 280.4 kilograms shown in sample chart for full fuel (JP5), is only applicable for 206B-3 S/N 3567 thru sub with 344.4 liter fuel cell. Helicopters S/N 4 thru 3566 with 287.7 liter fuel cell are to use 234.5 kilograms with an arm of 2946 and a moment of 690837.

Figure 8-9. Weight Record — Metric Sample

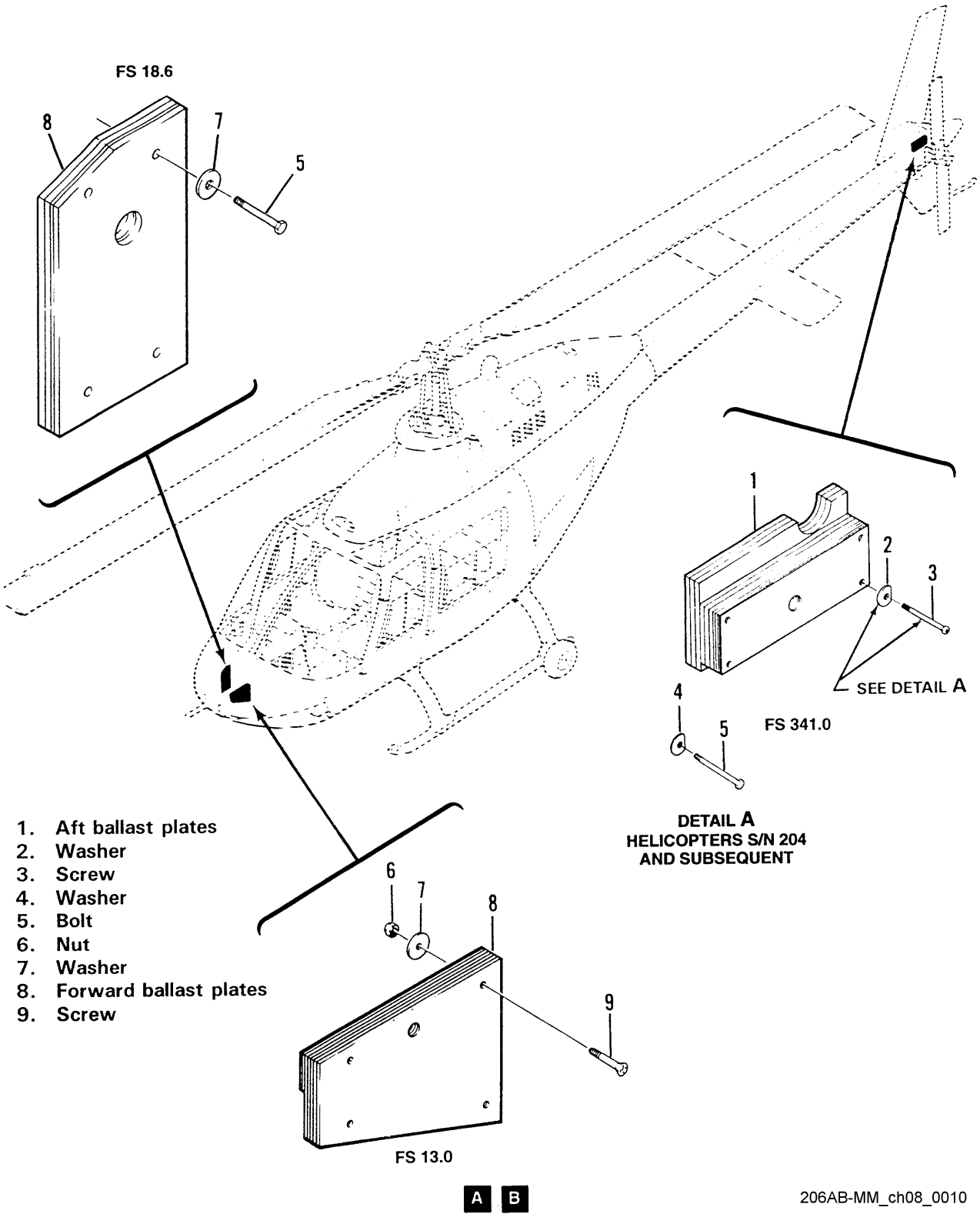


Figure 8-10. 206A/B Ballast Installation

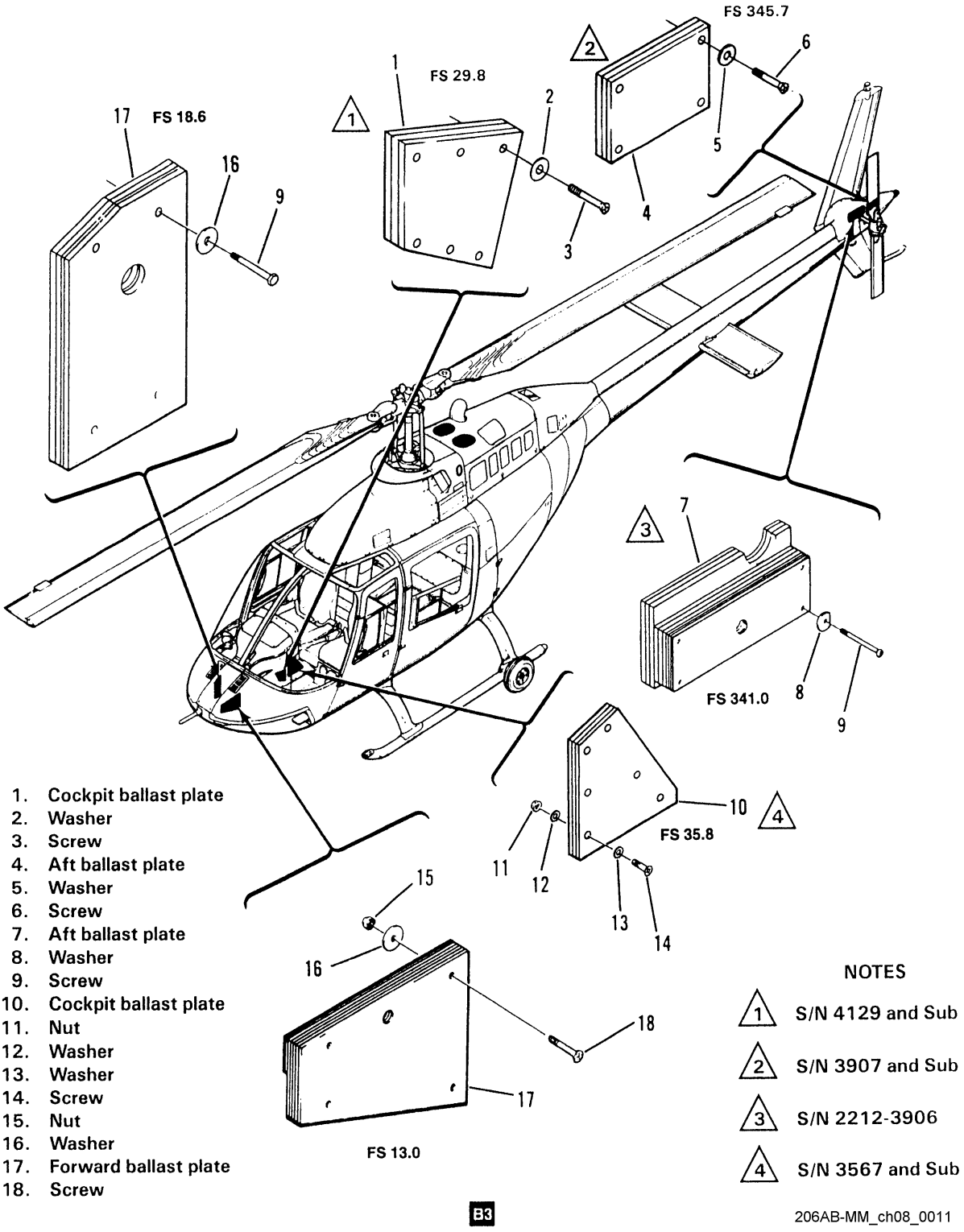


Figure 8-11. 206B3 Ballast Installation

6. Determine lateral center of gravity of helicopter. Lateral CG limits are -3 to +4 inches.

NOTE

Distances from centerline of helicopter to forward jack points are lateral arms. (+) is right and (-) is left. Aft jack point is on the centerline.

a. Multiply net weight of forward left scale by its lateral arm.

b. Add product of net weight of forward right scale and its lateral arm to product in step a.

c. The lateral moment for aft scale will be "0" inch-pounds.

d. Divide moment derived in step b. by total net weight to get lateral center of gravity.

(-17.00) (382.5) + (16.82) (380.0) = – 111

$$\frac{-111}{1557.2} = -0.07 \text{ in.}$$

e. Do not ballast for lateral CG.

7. Enter results of these operations on the actual weight record for the permanent helicopter records. (See Figures 8-4 and 8-5 for same Actual Weight Record Form.)

Table 8-7. Ballast Station vs Maximum Weight

FS	MAXIMUM BALLAST
13.0	28 lb.
18.6	22 lb. △1
29.8	20 lb.
35.8	30 lb.
341	18 lb. △2
345.7	9 lb . △3

NOTES:

△1 Maximum ballast this location restricted to 18 lbs. with 17 or 19 AMP battery installed.

△2 For use with sheetmetal tailrotor gearbox housing.

△3 For use with cast tailrotor gearbox housing.