part 6 landing

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

DISCUSSION OF CHARTS.

LANDING GROUND ROLL CHARTS.

Charts are provided *(figures A6-2 through A6-4)* showing the landing ground roll for three configurations; brakes only, brakes plus two engines with full reverse thrust and brakes plus four engines with full reverse thrust. Allowances are shown for density altitude, gross weight and headwind. Curve distances corrected for wind account for 100 percent of wind values shown. Use 50 percent of reported headwinds and 150 percent of reported tailwinds with the wind correction grid. This is a recommended procedure which may be revised at the discretion of the pilot, dependent upon the source of measurement of the wind data. This allows a safety margin for fluctuation of wind velocity.

EFFECT OF UNUSUAL RUNWAY CONDITIONS ON LANDING GROUND ROLL CHART.

The Effect of Unusual Runway Conditions on Landing Ground Roll chart *(figure A6-5)* is used to determine the effect of various runway conditions on the landing ground roll. Curves are presented to give corrected ground roll distances for landings made on dry turf, wet concrete, snow, and ice covered runways as compared to landing ground roll distances on dry concrete. The coefficient of friction values given on the chart are approximate since other factors such as the condition of the tires or the amount of water on the runway may affect the coefficient of friction. The corrected landing ground roll distance is determined by entering the chart with the landing ground roll obtained from the Landing Ground Roll charts *(figures A6-2 through A6-4)*.

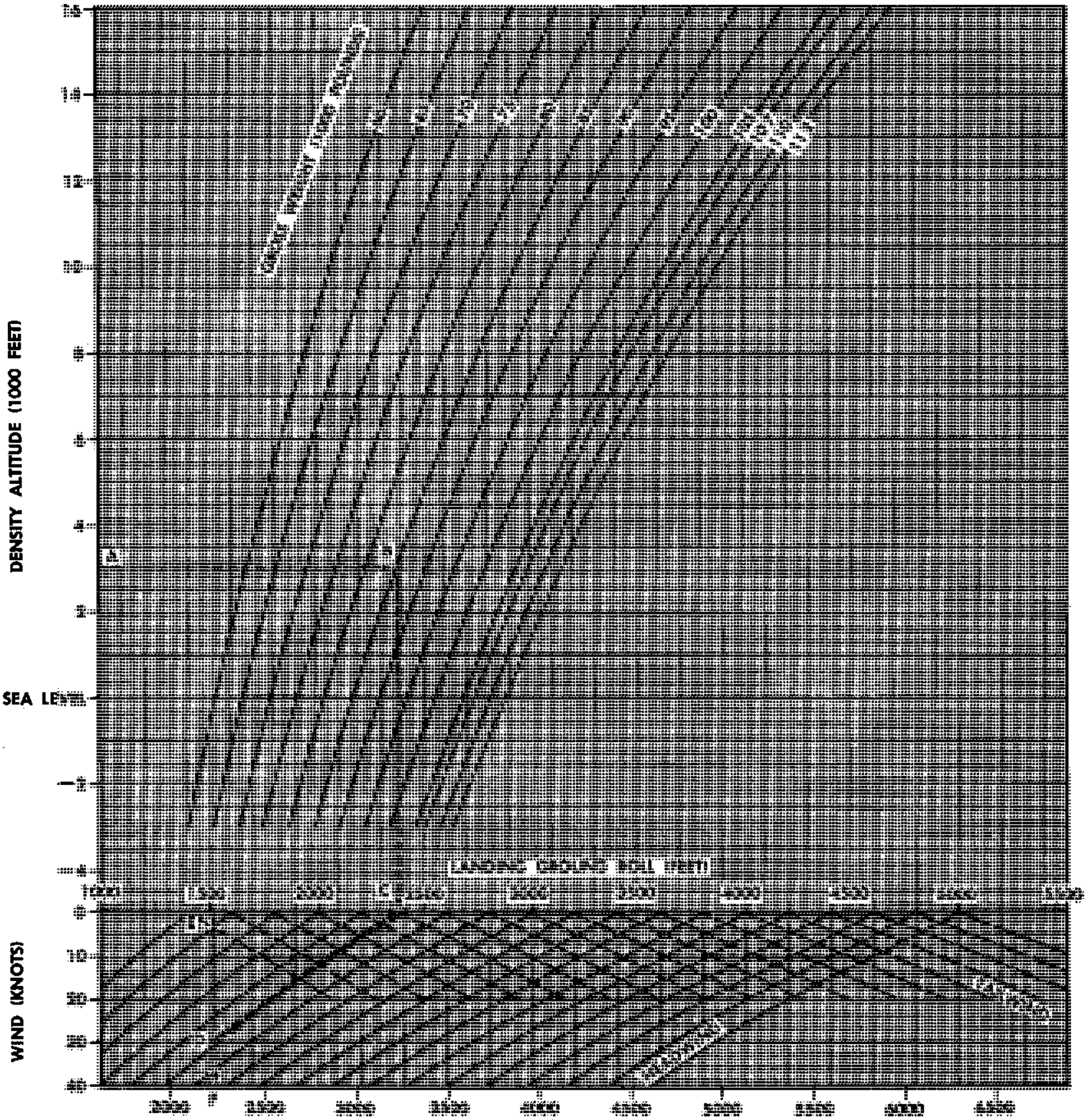
TO BE ADDED WHEN AVAILABLE

Figure A6-1. Takeoff, Landing, and Stall Speeds

LANDING GROUND ROLL — BRAKES ONLY

MODEL: C-118A
DATA AS OF: 6-15-62
DATA BASIS: FLIGHT TEST

ENGINES: (4) R2800-52W
FUEL GRADE: 115/145
ALTERNATE FUEL GRADE: 100/130



NOTES:

1. Based on dry, hard surface runway.
2. Wing flaps full down.
3. Threshold speed = 130 percent of stall speed.
4. Touchdown speed = 120 percent of stall speed.
5. Ground roll for 30 degree flaps is approximately 115 percent of ground roll for flaps full down.

SAMPLE PROBLEM:

A. Density altitude = 3000 feet.
B. Gross weight = 85,000 pounds.
C. Landing ground roll no wind = 2370 feet.
D. Headwind = 30 knots.
E. Landing ground roll with wind = 1520 feet.
F. Landing distance from 50 feet height = 2200 feet.

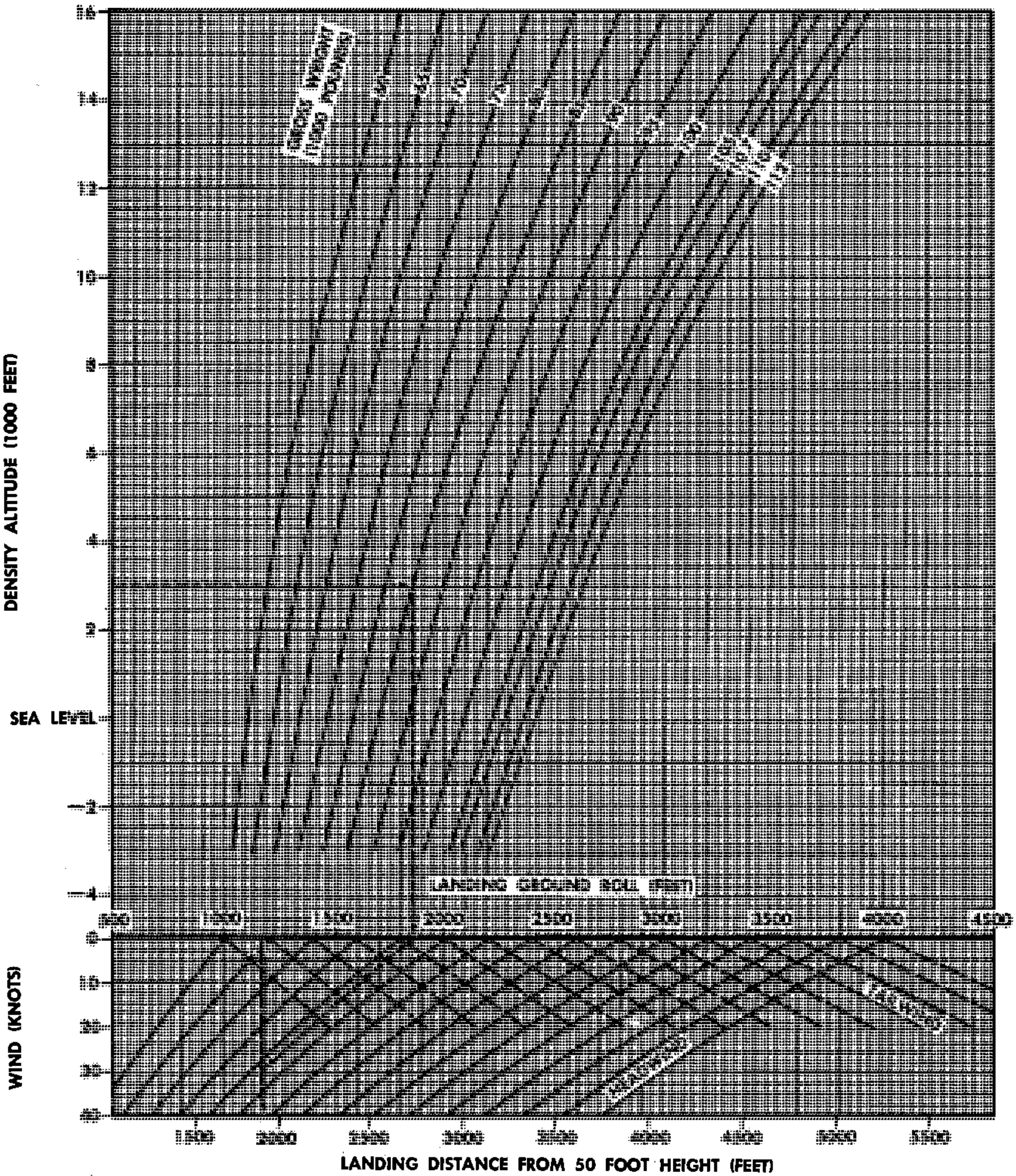
AA1-239

Figure A6-2. Landing Ground Roll — Brakes Only

LANDING GROUND ROLL — BRAKES PLUS TWO-ENGINE REVERSE THRUST

MODEL: C-118A
DATA AS OF: 6-15-62
DATA BASIS: ESTIMATED

ENGINES: (4) R2800-52W
FUEL GRADE: 115/145
ALTERNATE FUEL GRADE: 100/130



NOTES:

1. Based on dry, hard surface runway.
2. Wing flaps full down.
3. Threshold speed = 130 percent of stall speed.
4. Touchdown speed = 120 percent of stall speed.
5. Ground roll for 30 degree flaps is approximately 115 percent of ground roll for flaps full down.

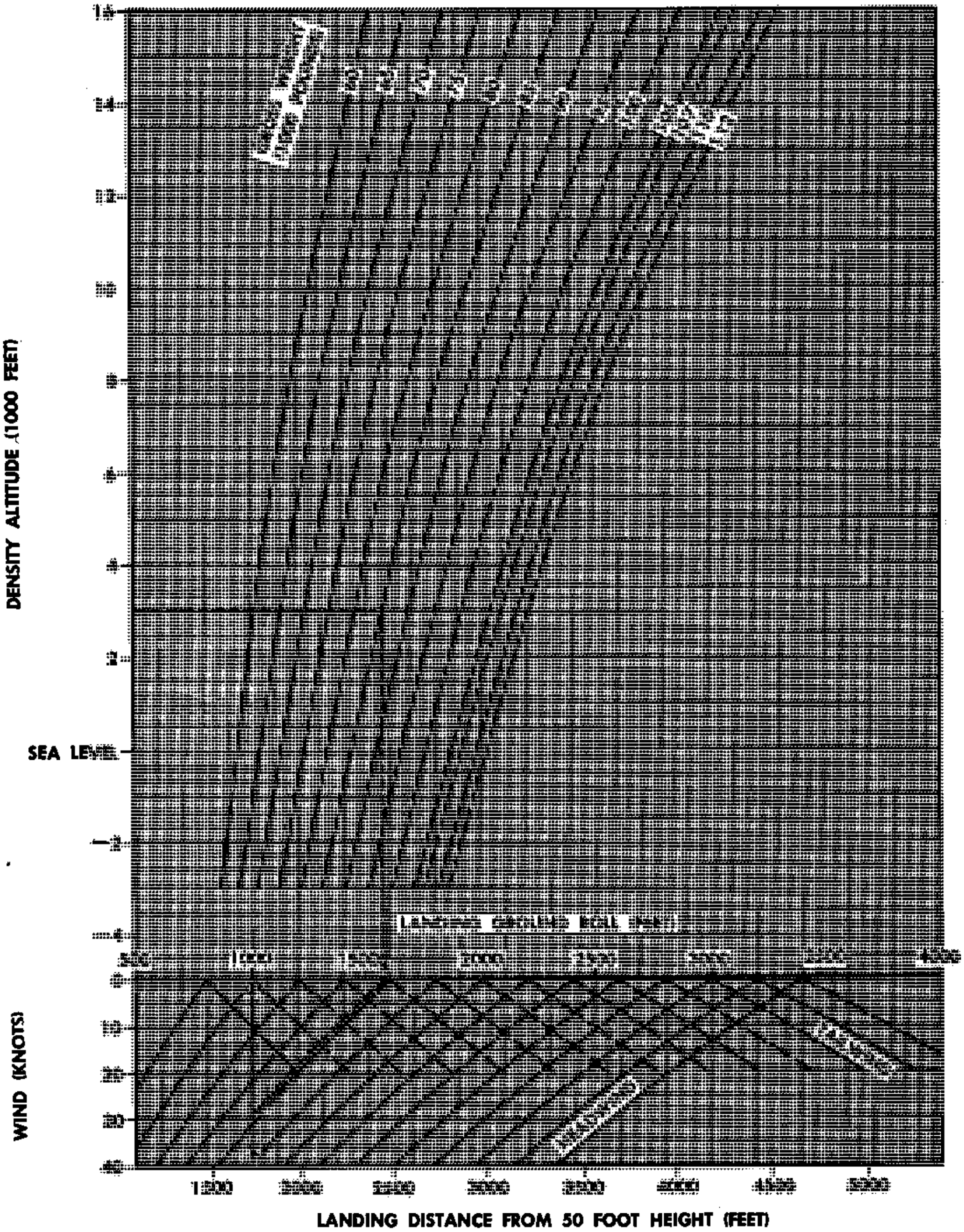
AA1-240

Figure A6-3. Landing Ground Roll—Brakes Plus Two-Engine Reverse Thrust

LANDING GROUND ROLL — BRAKES PLUS FOUR-ENGINE REVERSE THRUST

MODEL: C-118A
DATA AS OF: 6-15-62
DATA BASIS: ESTIMATED

ENGINES: (4) R2800-52W
FUEL GRADE: 115/145
ALTERNATE FUEL GRADE: 100/130



NOTES:

1. Based on dry, hard surface runway.
2. Wing flaps full down.
3. Threshold speed = 130 percent of stall speed.
4. Touchdown speed = 120 percent of stall speed.
5. Ground roll for 30 degree flaps is approximately 115 percent of ground roll for flaps full down.

AA1-23B

Figure A6-4. Landing Ground Roll—Brakes Plus Four-Engine Reverse Thrust

EFFECT OF UNUSUAL RUNWAY CONDITIONS ON LANDING GROUND ROLL

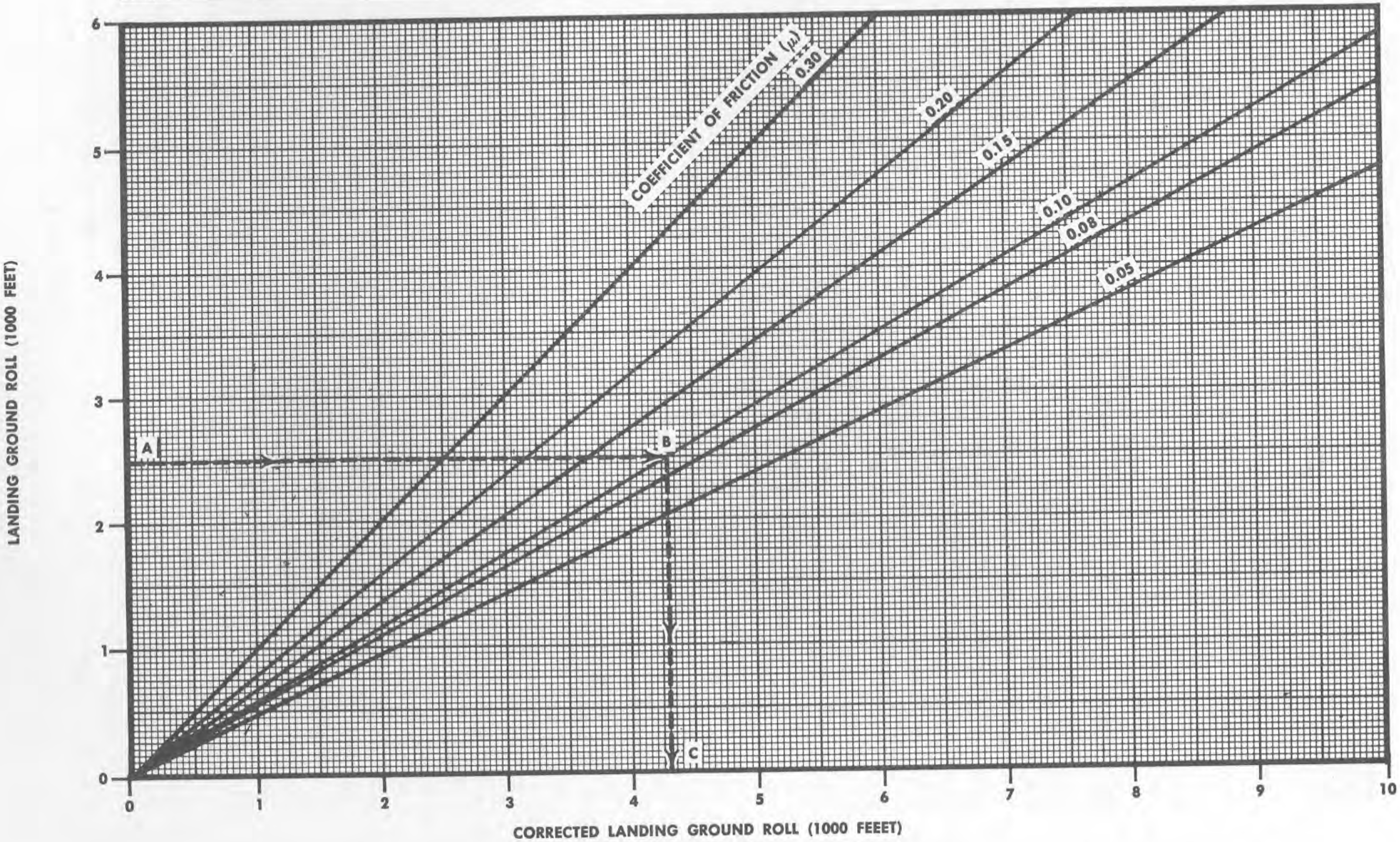
MODEL: C-118A
DATA AS OF: 6-15-62
DATA BASIS: CALCULATED

ENGINES: (4) R2800-52W
FUEL GRADE: 115/145
ALTERNATE FUEL GRADE: 100/130

RUNWAY SURFACE CONDITION	AVERAGE COEFFICIENT OF FRICTION (μ)
DRY CONCRETE OR MACADAM	0.3
DRY TURF	0.2
WET CONCRETE OR MACADAM	0.15
SNOW OR WET GRASS	0.10
ICE	0.08

SAMPLE PROBLEM:

A. Landing ground roll = 2500 feet.
B. Coefficient of friction = 0.10.
C. Corrected landing ground roll = 4300 feet.



AA1-539

Figure A6-5. Effect of Unusual Runway Conditions on Landing Ground Roll

LIFTOFF, LANDING, AND STALL SPEEDS
PILOT'S INDICATED AIRSPEED — KNOTS (IAS)

	Dump Time	Liftoff Speed	V_s for Zero Angle of Bank				Threshold Airspeeds 130% V_{so}				
Wing Flap Setting		20°	0°	20°	30°	Full Down	0°	20°	30°	Full Down	Wing Flap Setting
Gross Weight Pounds		115% V_s									Gross Weight Pounds
112,000	9.0	120	118	105	97	92	153	136	127	120	112,000
110,000	8.2	118	116	103	96	91	151	134	125	119	110,000
107,000	7.0	117	114	102	95	90	148	133	124	117	107,000
105,000	6.2	116	113	101	94	89	147	131	122	116	105,000
100,000	4.2	113	111	99	92	87	144	129	120	113	100,000
95,000	2.5	110	108	96	90	85	140	125	117	111	95,000
92,610	1.7	109	107	95	89	84	139	124	116	109	92,610
90,000	.6	107	105	94	88	83	137	122	114	108	90,000
88,200	0	106	104	93	87	82*	135	121	113	107	88,200
85,000	0	104	102	91	85	81*	133	118	111	105	85,000
80,000	0	101	99	89	83	78*	129	116	108	101	80,000
75,000	0	98	96	86	80*	76*	125	112	104	99	75,000
70,000	0	95	93	83	78*	73*	121	108	101	95	70,000
65,000	0	92	90	80*	75*	71*	117	104	98	92	65,000
60,000	0	91**	86	77*	72*	68*	112	100	94	88	60,000

Note: Stall speed at zero thrust (V_s).

*Less than minimum control speed (V_{mc}) with one engine out in the air (83 knots IAS).

**110 percent of minimum control speed (91 knots IAS).

BASED ON: FLIGHT TEST DATA

DATA AS OF 2-15-59

Figure A6-6

part 7 mission planning

TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

INTRODUCTION.

Sample problems have been included on the charts in this Appendix to illustrate the use of each type of chart. In addition, two mission planning sample problems are included herein to illustrate how several of the charts are used to plan typical missions.

Sample Problem 1 illustrates a typical medium range mission which does not require the use of capacity fuel. For this type of mission it is necessary to carry adequate reserve fuel to meet certain adverse conditions. (In Sample Problems 1 and 2 the reserve fuel allowance is based on holding for three hours at 10,000 feet altitude at long range cruise speed. However, the various commands may require reserve fuel to be determined differently, depending upon the availability of alternate airfields.) Another important consideration is that large amounts of excess fuel should not be carried without a reason. This is because the fuel consumption increases when the gross weight increases. For the conditions described in Sample Problem 1, the fuel consumed in completing the mission would increase by approximately 200 pounds for each 1,000 pounds of additional fuel carried.

Sample Problem 2 illustrates a long range mission which cannot be completed with capacity payload. For this type of mission it is important that the fuel requirement be determined carefully, because each pound of additional fuel carried means that one pound less payload may be carried.

FUEL DUMP TIME.

The following shows the time required to dump fuel from any given gross weight down to the design landing weight for normal operation of 88,200 pounds.

Gross Weight (pounds)	*Dump Time (minutes)*
107,000	7.0
106,000	6.5
104,600	6.0
103,300	5.5
101,900	5.0
100,500	4.5
99,200	4.0
97,800	3.5
96,400	3.0
95,000	2.5
93,700	2.0
92,300	1.5
91,000	1.0
89,600	0.5

SAMPLE PROBLEM 1—MEDIUM RANGE MISSION.

Object of Mission:

To transport 18,500 pounds of cargo a distance of 1600 nautical miles.

GIVEN:

1. Miscellaneous conditions:

   Operating weight empty = 59,000 pounds.

   Fuel grade = standard (115/145), with water injection (ADI) used for takeoff.

   Oil carried = 1050 pounds (140 gallons).

   Fuel allowance for warm-up, taxi and takeoff = 625 pounds.

   Reserve fuel requirement = fuel for 3 hours holding at long range cruise speed at 10,000 feet altitude.

2. Takeoff conditions:

   Runway length = 8,000 feet.

   Runway slope = — 0.015 (downhill).

   Pressure altitude = 1500 feet.

   Temperature = 22°C.

   Dew point = 60°F.

   Wind = 20 knots headwind (runway component).

3. Cruise conditions:

   Cruise altitude = 14,000 feet pressure altitude.

   Temperature = — 6°C.

   Cruise at long range cruise speed.

   Wind = 40 knots headwind.

4. Landing conditions:

   Runway length = 7500 feet.

   Pressure altitude = 2000 feet.

   Temperature = 20°C.

   Wind = 30 knots headwind (runway component).

Estimate of Fuel Required.

For this type of mission the easiest way to determine the minimum fuel requirement is to first establish the landing weight and then the initial cruise weight, the initial climb weight and, finally, the takeoff weight. The fuel required is found by subtracting the zero fuel weight and the oil weight from the takeoff weight.

1. Add the payload to the operating weight empty to determine the zero fuel weight, 18,500 + 59,000 = 77,500 pounds.

2. Add the oil weight to the zero fuel weight to determine the zero fuel plus oil weight, 1050 +77,500 = 78,550 pounds.

3. The reserve fuel allowance may now be determined from the Four-Engine Range Prediction —Time chart (*figure A5-23*). Enter the gross weight scale at the zero fuel plus oil weight of 78,550 pounds and read up to the 10,000 foot altitude line and across to the time scale at 23.6 hours. Subtract the holding time of 3 hours (23.6 − 3 = 20.6 hours). Re-enter the time scale at 20.6 hours and read across to the 10,000 foot curve and down to find the gross weight at start of holding of 82,700 pounds. The reserve fuel allowance is equal to the weight at the start of hold minus the weight at the end of hold (zero fuel plus oil weight), 82,700 − 78,550 = 4,150 pounds. (The weight at the start of hold is the same as the final cruise weight, and may also be considered as the landing weight since the fuel saved during the descent to the airfield is approximately offset by the fuel used during the landing and taxiing.)

4. The next step is to establish the cruising density altitude. This may be done with the aid of the Density Altitude Chart (*figure A1-11*). Enter the temperature scale at the expected cruise temperature, −6°C, and proceed vertically upward to cruising pressure altitude, 14,000 feet. The density altitude may then be read at the left hand scale, 14,800 feet. Use 15,000 feet for planning cruise data since the 200 foot difference is negligible.

5. The cruise fuel may now be determined from the Four-Engine Range Prediction — Distance chart (*figure A5-22*). Enter the gross weight scale at the final cruise weight of 82,700 pounds and read up to the 15,000 foot curve and across to the distance scale at 4340 nautical miles for the range at final cruise weight. To determine the cruise fuel accurately it is necessary to know the climb distance. Then the climb distance may be subtracted from the mission distance to establish the cruise distance. Since the climb distance will be small compared to the cruise distance an approximation will suffice. To obtain this approximation subtract the mission distance from the range at final cruise weight (4340 − 1600 = 2740 nautical miles). Re-enter the range scale at 2740 nautical miles and read across to the 15,000 foot curve and down to find approximate initial cruise weight of 95,600 pounds. To correct the initial cruise weight for headwind enter the Range Prediction — Time chart (*figure A5-23*) at the initial and final gross weights of 95,600 and 82,700 pounds. Read up to the 15,000 foot curve and across to the time scale to read the times of 10.2 and 17.2 hours. The difference between these times, 7.2 hours, is the cruise time. Multiply the cruise time by the average predicted headwind of 40 knots to determine the decrease in range due to headwind in nautical miles (7.2 × 40 = 288 nautical miles). Correct for this decrease in range by subtracting 288 nautical miles from the range at initial cruise weight (2740 − 288 = 2452 nautical miles). Re-enter the range scale of the Distance chart (*figure A5-22*) and read across to 15,000 foot and down to obtain the approximate initial cruise weight, corrected for headwind of 98,200 pounds. Assume that this is the initial climb weight and determine the approximate distance to climb from the Time, Distance and Fuel to Climb Chart (*figure A4-1*, assuming 1400 BHP/eng.). Since this is only an approximation it is not necessary to correct for temperature or headwind. Enter the gross weight scale at 98,200 pounds and proceed vertically upwards to 1500 feet altitude and note the distance (read at the left hand scale), 7 nautical miles. Now follow the contour upwards to 14,000 feet and also note the distance, 78 nautical miles. The approximate climb distance is the difference between the two, 78 − 7 = 71 nautical miles. The cruise distance is the mission distance, minus the climb distance, plus headwind correction (1600 − 71 + 288 = 1817 nautical miles). Subtract this cruise distance from the range at end of cruise determined above (4340 − 1817 = 2523 nautical miles). Re-enter the range scale on the Range Prediction — Distance chart (*figure A5-22*) at 2523 nautical miles and proceed horizontally to the 15,000 foot curve. The initial cruise weight may be read at the gross weight scale directly below, 97,500 pounds. The cruise fuel is equal to the initial cruise weight minus the final cruise weight, 97,500 − 82,700 = 14,800 pounds.

6. The time, distance and fuel to climb may now be estimated more accurately. First, determine the average number of degrees above standard for the climbing altitudes. Standard temperature at the initial climb altitude, 1500 feet, is 12°C (from the ICAO Standard Atmosphere Table, figure A1-12, sheet one). Subtract this from the ambient temperature to obtain the number of degrees above standard at the initial climb altitude, 22 − 12 = 10°C. Similarly, standard temperature at the final cruise altitude, 14,000 feet, is − 13°C. The ambient temperature of − 6°C is thus 7°C above standard. The average between these two is (10 + 7)/2, or 8.5°C, which may be rounded off to 9°C. In using the Time, Distance and Fuel to Climb Chart (*fig-*

ure A4-1) the altitude correction for temperature will be 9°C times 0.7% of the altitude per °C, or 6.3% of the altitude. For the initial climb altitude this correction is 6.3% of 1500 feet, or 90 feet. At the final climb altitude it is 6.3% of 14,000 feet, or 880 feet. Enter the gross weight scale at the final climb weight of 97,500 pounds and proceed vertically upwards to 14,000 feet pressure altitude plus 880 feet correction for temperature, or 14,880 feet. At this point read the nautical miles travelled, 88, and the time, 29 minutes. Now follow down the contour to 1500 feet pressure altitude plus 88 feet correction for temperature, or 1590 feet. At this point read the nautical miles travelled, 7, the time, 3 minutes, and the gross weight at start of climb, 99,200 pounds. The difference between these two sets of values will be the distance to climb (88 − 7 = 81 nautical miles), the time to climb (29 − 3 = 26 minutes) and the fuel required (99,200 − 97,500 = 1,700 pounds). If necessary, the effect of wind on the distance to climb may be determined by multiplying the effective wind times the time to climb. Assuming that the average headwind during the climb is 75% of the headwind at the cruising altitude, this wind effect is 75% of 40 knots times 26/60 hour, or 13 nautical miles. Thus the distance to climb is 81 − 13, or 68 nautical miles.

7. The takeoff gross weight may now be determined by adding the fuel allowance for warm-up, taxi and takeoff to the initial climb weight, 625 + 99,200 = 99,825 pounds.

8. The fuel requirement is equal to the takeoff weight minus the zero fuel weight minus the oil weight, 99,825 − 77,500 − 1050 = 21,275 pounds. This is also the sum of the reserve fuel, cruise fuel, climb fuel and warm-up, taxi and takeoff fuel, 4,150 + 14,800 + 1,700 + 625 = 21,275 pounds.

Filling out the Takeoff Data Card.

Now that the takeoff gross weight has been estimated, data may be entered on the takeoff data card. The first step is to find out what power will be available for takeoff. Then the takeoff performance may be determined based on this power.

1. Turn to the applicable Brake Horsepower Available for Takeoff Chart for standard fuel grade, wet *(figure A2-4)*. Enter the pressure altitude scale at 1500 feet and proceed vertically upwards to 27°C CAT (22°C OAT plus 5°C ram rise). At this point note that the brake horsepower, read at the left hand scale, is 2425. Proceed horizontally to the right to the base line and draw a contour parallel to the guide lines. Enter the dew point scale below at 60°F, follow the guide lines to 1500 feet pressure altitude and then go vertically upwards to the contour line just drawn. At this point the power is approximately 2365 BHP. Since the first pressure altitude-CAT point indicates that the power will be obtained with part throttle setting, it is permissible to regain some of this power loss due to humidity by increasing the manifold pressure above the standard day limits (shown on figure A2-1). Enter the dew point scale on the auxiliary graph at 60°F and read the allowable increase in manifold pressure, 0.5 inches Hg. Re-enter the main graph where we left off (2365 BHP), continue to the right to the next base line and follow the guide lines as far as 0.5 inches Hg. Continue horizontally to the right hand scale and read the predicted brake horsepower, 2385. From the intersection of the 95% of predicted BMEP curve and 2385 BHP, drop straight down to the scale below and read 95% of the predicted BMEP, 229 PSI. Use this power for determining takeoff performance.

2. The next step is to find out if the estimated takeoff weight will meet all takeoff requirements. Turn to the Takeoff Gross Weight Limited by Three-Engine Climb Performance Chart *(figure A3-2)*. Enter the chart at a density altitude of 2600 feet, as determined from the Density Altitude chart *(figure A1-11)* at 22°C and 1500 feet pressure altitude, and proceed vertically to 229 BMEP. Proceed horizontally to the right to the first bold line which shows the maximum allowable takeoff gross weight for normal operation, 107,000 pounds. This is well in excess of the estimated takeoff gross weight of 99,825 pounds. By continuing to the right to the next bold line it may be seen that the maximum allowable takeoff gross weight for an emergency is 112,000 pounds. By continuing even farther it may be seen that the 50 feet per minute rate of climb requirement for the configuration noted on the chart is met at approximately 124,500 pounds.)

3. Determine the takeoff factor by entering the Takeoff Performance — Takeoff Factor chart *figure A3-1)* at an OAT of 22°C and proceeding vertically to a pressure altitude of 1500 feet. Read across to a BMEP of 229 psi and down to find a takeoff factor of 4.3.

4. The critical field length may be determined from the Critical Field Length — Brakes Only chart *(figure A3-6)*. Enter the chart with a take-

off factor of 4.3 and read across to a gross weight of 99,825 pounds. Read down to find zero wind/zero slope critical field length of 5070 feet. Correct for a 10 knot headwind (50 percent of reported headwind) by following the guide line to 10 knots and reading down to find corrected field length of 4400 feet. To correct for slope enter the Effect of Runway Slope on Ground Run chart *(figure A3-4)* with a distance without runway slope of 4400 feet. Read up to the −0.015 (downhill) slope correction curve and across to find corrected critical field length of 3980 feet.

5. The refusal speed may be determined from the Takeoff Performance—Refusal Speed—Brakes Only chart *(figure A3-8)*. Enter the chart with a takeoff factor of 4.3 and proceed horizontally to the available runway length of 8000 feet. Read down to a gross weight of 99,825 pounds and across to find the zero wind/zero slope refusal speed of 104.2 knots IAS. Correcting for runway slope of 0.015 downhill and for 10 knots headwind results in a corrected refusal speed of 106.5 knots IAS.

6. The ground run is determined from the Takeoff Performance—Ground Run chart *(figure A3-3)*. Follow the same method described for the other takeoff performance charts using a takeoff factor of 4.3 and the takeoff gross weight of 99,825 pounds. For the given conditions the ground run without wind or slope correction is 3980 feet. Correct for headwind by following the guide lines to 10 knots and reading down for corrected ground run of 3380 feet. Correct for runway slope by entering the Effect of Runway Slope on Ground Run chart *(figure A3-4)* with a distance without runway slope of 3380 feet. Read up to the slope correction curve for −0.015 downhill and across to find corrected distance of 3090 feet. The takeoff speed corresponding to the ground run is read from the gross weight curves on the ground run chart as 112 knots IAS.

7. The acceleration check point and speed may now be determined from the Takeoff Performance — Distance and Time Versus Speed chart *(figure A3-10)*. Enter the scale at the top of the chart with the takeoff speed of 112 knots IAS. Follow the headwind guide lines to 10 knots for a corrected takeoff speed of 102 knots IAS. Read down to the ground run (corrected for wind and slope) of 3090 feet and establish a contour line by following the guide lines. Enter the chart with the refusal speed, corrected for wind and slope of 106.5 knots IAS and correct for a 10 knot headwind to obtain a corrected speed of 96.5 knots IAS. Read down to the previously established contour line and across to find the refusal distance of 2700 feet. Follow the contour line to the first thousand foot marker below refusal distance or 2000 feet. This marker represents the acceleration check point. At the intersection of the checkpoint distance and the contour line read the acceleration check speed, minus wind correction, of 85 knots. Correct the check speed for wind by reading up to the wind correction grid to 10 knots and following the headwind guide line to zero wind for a corrected acceleration check speed of 95 knots IAS.

8. An acceleration increment time check may be preferred to the acceleration speed and distance check. To determine the acceleration increment time check enter the Takeoff Performance — Acceleration Increment Time Check chart *(figure A3-11)* with the takeoff ground run for zero wind but corrected for slope of 3610 feet. Read across to a gross weight of 99,825 pounds and down to the Sea Level altitude line. Follow the guide lines to a density altitude of 2600 feet and read down to the 100 knot line, read the time of 27.5 seconds at the time scale at the bottom of the chart. Follow the guide lines from 100 knots to 60 knots and read the time of 14 seconds. The difference between the two times (27.5 − 14 = 13.5 seconds) is the time required to accelerate from 60 to 100 knots IAS.

The values obtained above for 95% of predicted BMEP critical field length, refusal speed, accleration check point, acceleration check speed, and liftoff speed may be entered in the appropriate places on the Takeoff and Landing Data Card under the Takeoff Data column labeled "Wet" (meaning all four ADI units operative). In a similar manner takeoff data for standard fuel grade, dry, may be obtained and entered on the card. The liftoff speed and dump time are the same for either wet or dry power. The charts used in determining takeoff data for the dry power are the same as those used for the wet power except for 95% of the predicted BMEP which is obtained from figure A2-5. It will be seen when determining the dry power takeoff data that the takeoff requirements are still met at 99,825 pounds gross weight.

1. The items under "LANDING DATA (TAKEOFF WEIGHT)" are for landing shortly after takeoff, if some emergency demands it. The atmospheric and runway conditions are the same as those listed under "TAKEOFF CONDITIONS." The threshold speed may be obtained from the Liftoff, Landing, and Stalling Speeds chart (*figure 2-5* in Section II). For 99,825 pounds gross weight the threshold speed is approximately 112 knots IAS (130% of stalling speed with flaps full down). The landing distance from a 50 foot height may be determined

from the Landing Ground Roll — Brakes Only chart (*figure A6-7*). Enter the chart with a density altitude of 2600 feet and read across to a gross weight of 99,825 pounds. On the scale directly below read the landing ground roll with no wind, 2750 feet. Follow parallel to the guide lines to a 10 knot headwind. On the scale directly above read the ground roll corrected for wind, 2420 feet. Obtain the total landing distance from a 50 foot height on the scale directly below of 3470 feet.

Filling out the Landing Data Card.

The information on the Landing Data Card is for landing at the intended destination at the predicted landing gross weight. The threshold speed may be obtained from the Takeoff, Landing and Stalling Speeds Chart (*figure* 2-7 in Section II). At 82,700 pounds gross weight this is approximately 103 knots (130% of the stalling speed with flaps full down). The landing distance from a 50 foot height may be determined from the Landing Ground Roll — Brakes Only Chart (*figure A6-2*). Determine the density altitude at destination for 2000 feet pressure altitude and 20°C from the Density Altitude chart (*figure A1-11*) as 3000 feet. Enter the Landing Ground Roll — Brakes Only chart at a density altitude of 3000 feet and read across to the gross weight at destination of 82,700 pounds. Read down to find the landing ground roll of 2310 without wind correction. Correct for a 15 knot headwind (50 percent of reported wind) by following the guide line to 15 knots and reading up for a corrected ground roll of 1860 feet. Obtain the total landing distance from a height of 50 feet from the scale directly below, of 2620 feet.

SAMPLE PROBLEM 2 — LONG RANGE MISSION.

Object of Mission:

To transport as much cargo as possible a distance of 3100 nautical miles.

GIVEN:

1. Miscellaneous conditions:
   - Operating weight empty = 60,000 pounds.
   - Fuel grade = standard (115/145), with water injection (ADI) used for takeoff.
   - Oil carried = 1050 pounds (140 gallons).
   - Fuel allowance for warm-up, taxi and takeoff = 625 pounds.
   - Reserve fuel requirement = fuel for 3 hours holding at long range cruise speed at 10,000 feet altitude.
2. Takeoff conditions:
   - Runway length = 9,000 feet.
   - Runway slope = none.
   - Pressure altitude = 500 feet.
   - Temperature = 14°C.
   - Dew point = 10°F.
   - Wind = none.
3. Cruise conditions:
   - Cruise altitude = 10,000 feet pressure altitude.
   - Temperature = −5°C.
   - Cruise at long range cruise speed.
   - Wind = none.
4. Landing conditions:
   - Runway length = 7,000 feet.
   - Pressure altitude = 1,000 feet.
   - Temperature = 5°C.
   - Wind = none.

This type of mission differs from that discussed in sample problem 1. For long range missions it is very likely that it will not be possible to load the aircraft with capacity payload and still carry enough fuel to reach the destination without exceeding the maximum permissible takeoff gross weight. For this reason the maximum permissible takeoff gross weight is determined first, then the fuel required for the mission is estimated, and, finally, the maximum payload is solved for.

1. An examination of the takeoff conditions indicates that a takeoff is permitted at the maximum structural limit for normal operation, 107,000 pounds gross weight.
2. The initial climb weight is obtained by subtracting the fuel allowance for warm-up, taxi and takeoff from the takeoff gross weight, 107,000 − 625 = 106,375 pounds.
3. The initial cruise weight may be determined from the Time, Distance and Fuel to Climb Chart (*figure A4-2*, assuming 1500 BHP/eng). Since the temperature conditions are standard there will be no altitude correction for temperature. Enter the gross weight scale at 106,375 pounds and proceed vertically upwards to 500 feet pressure altitude and note the distance, 2 nautical miles. Continue upwards, following parallel to the guide lines, to 10,000 feet pressure altitude and note the distance, 53 nautical miles. The difference between these two values is the distance travelled during the climb, 53

− 2 = 51 nautical miles. From this last point drop straight down to the scale below and read the final climb weight, 105,000 pounds. This is also the initial cruise gross weight.

4. The final cruise weight may be determined from the Four-Engine Range Prediction — Distance chart *(figure A5-22)*. The cruise distance is equal to 3100 nautical miles minus the climb distance of 51 nautical miles, or 3049 nautical miles. The pressure altitude at 10,000 feet with a temperature of −5°C is approximately equal to a density altitude of 10,000 feet so no correction for density altitude is necessary. Enter the gross weight scale at 105,000 pounds and proceed vertically upwards to 10,000 feet density altitude and across to the range scale at 2500 nautical miles. Add 2500 to the desired cruise distance (3049 + 2500 = 5549 nautical miles) and re-enter the range scale at 5549 nautical miles. Read across to an altitude of 10,000 feet and down for a final cruise gross weight of 80,700 pounds. This is also the estimated landing gross weight.

5. Determine the reserve fuel from the Four-Engine Range Prediction — Time chart *(figure A5-23)*. Enter the gross weight scale at the final cruise weight of 80,700 pounds and read up to the density altitude of 10,000 feet. Read across to the time scale at 22.0 hours. Add the holding time of 3 hours (22.0 + 3.0 = 25.0 hours) and re-enter the time scale at 25.0 hours. Read across to the 10,000 feet altitude curve and down for a gross weight at end of hold of 76,800 pounds. This is also the zero fuel plus oil weight.

6. To obtain the zero fuel weight subtract the oil weight from the zero fuel plus oil weight, 76,800 − 1050 = 75,750 pounds.

7. To determine the allowable payload subtract the operating weight empty from the zero fuel weight, 75,750 − 60,000 = 15,750 pounds.

Information for the Takeoff and Landing Data Card may be determined in the same manner as described in detail in Sample Problem 1.

C-118A AND VC-118A TAKEOFF AND LANDING DATA CARD

TAKEOFF CONDITIONS

DENSITY ALT 2600 FT.

PRESSURE ALT 1500 FT DEW PT 60 °F

OAT 22 °C + 5°C = 27 °C CAT

WIND COMP 20 (headwind) KTS GROSS WT 99.825 LBS

RUNWAY LENGTH 8000 FT SLOPE 0.015 (downhill)

SIGNIFICANT OBSTACLE HEIGHT 0

DIST FROM END OF RUNWAY —

GROSS WT. LIMITED BY CLIMBOUT OVER OBSTACLE —

GROSS WT LIMITED BY 3-ENG. RATE OF CLIMB 124,500

TAKEOFF DATA

	WET	DRY
95% PREDICTED BMEP	229	
TAKEOFF FACTOR	4.3	
CRITICAL FLD LENGTH	3980 FT	FT
GROUND RUN	3090 FT	FT
REFUSAL SPEED	106.5 KTS	KTS
ACCELERATION CHECK POINT DISTANCE/TIME	2000 ft.	
ACCELERATION CHECK SPEED	95 KTS	KTS

LIFTOFF SPEED 112 KTS

DUMP TIME 4.25 MIN

LANDING DATA (TAKEOFF WEIGHT)

LANDING GROUND ROLL 2420

THRESHOLD SPEED (130% V_{so}) 112 KTS

LANDING DISTANCE FROM 50 FT HEIGHT 3470 FT

Figure A7-1. Takeoff and Landing Data Card

C-118A AND VC-118A LANDING DATA CARD

LANDING CONDITIONS

PRESSURE ALT 2000 FT

OAT 20 °C

WIND COMP 30 (headwind) KTS GROSS WT 82,700 LBS

RUNWAY LENGTH 7500 FT SLOPE 0

DENSITY ALT 3000 FT

LANDING DATA

THRESHOLD SPEED (130% V_{so}) 103 KTS

LANDING DISTANCE FROM 50 FT HEIGHT 2620 FT

LANDING GROUND ROLL 1860

Figure A7-2. Landing Data Card

ALPHABETICAL INDEX

Italics indicates illustrations.

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Section and Page No.

G (Cont'd)

H

I

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