part 2—ENGINE OPERATING DATA

TABLE OF CONTENTS

Page numbers in bold face type denote illustrations.

SCOPE.

This part provides three types of data, as follows:

1. The engine manufacturer's operating data are given in the Engine Limits and Characteristics charts, figures A2-1 through A2-5. These charts show detailed part-throttle operating limits and the full-throttle calibration characteristics for the zero-ram condition. The effects of mixture variation from best power are included, as are the effects of carburetor air temperature variation from standard.

2. Contractor's flight test data are provided in figures A2-6 and A2-7. These show the inflight power-available characteristics which include installation effects. Charts show the performance with standard air temperatures and ram at appropriate airspeeds for take-off, climb, and cruise power settings. The installed power-available data are also tabulated in figures A2-8, A2-9, and A2-10 for reference in making power settings. The tables are based on the same data as the graphical material, but a 50-rpm allowance has been included in the full throttle 10-percent-lean data with 115/145 grade fuel. This allows uniform power setting schedules to be maintained at nonstandard air temperatures and with variations in engine condition.

3. Fuel flow calibrations are included for engine speeds ranging from low cruise to maximum power settings. The data are based on flight tests and do not include any allowance or operational tolerances.

Note

Instrument calibrations of the BMEP, MAP, and fuel flow gages should be known in order to make valid comparisons of engine performance and to protect the engines against inadvertent operation beyond limit values.

ENGINE LIMITS AND CHARACTERISTICS CHARTS.

Briefly described, each engine limits chart is divided into two major parts, the basic calibration for a reference altitude and the altitude calibration for the noted blower setting. Two subdivisions of the altitude calibration are provided to show engine performance at part and full-throttle conditions. The altitude calibration portions of figures A2-1 through A2-5 give detailed part-throttle power limits for either 115/145 or 100/130 grade fuel. The engine manufacturer's calibration showing full-throttle characteristics is provided for reference. (See figures A2-6 and A2-7 for charts of full throttle power available in flight which include adjustments for installation effects.)

In addition to providing information on operating limits, the limits and characteristics charts form the basis for predicting power output with any combination of control settings within allowable values. The charts are based on operation in AUTO RICH or BEST POWER mixture settings. With the exception of maximum power, they are directly applicable only under conditions of 80 percent relative humidity, with standard-day temperatures and pressures at the carburetor top deck. (Maximum power limits are applicable to zero percent relative humidity.) Corrections for other mixture setting and nonstandard air temperatures are provided on the charts.

Note

Operation with 100/130 grade fuel is limited to low blower with AUTO RICH mixture settings only.

BMEP LIMIT CONSIDERATIONS.

The near-horizontal rpm lines on the altitude calibration curves show the variation of limit brake horsepower altitude at constant engine speed. Corresponding limit BMEP settings are defined by the following relationship:

$$BMEP = 236 \times BHP/RPM$$

Limit power values read from the curves at various part-throttle engine speeds represent the highest power which the engines may be allowed to develop at those altitudes and rpm. However, the BMEP instruments only show that portion of total power developed which is delivered to the propeller shaft. The amount of power absorbed by the accessory drive section can further limit the maximum BMEP which may be set. In addition, limit BMEP cannot be used if conditions of either high temperature or high humidity (or both) result in limit manifold pressure being reached at a lower BMEP setting.

ACCESSORY LOAD CONSIDERATIONS.

Power required to operate cabin pressurization equipment is obtained from the outboard engines and varies with the operating altitude of the aircraft, pressurization desired, and engine speed. It is greatest at low altitude with full cabin differential, and least with no pressurization at lowest engine speeds. A nominal allowance of 5 BMEP has been established as representative of normal operation; that is, with cabin pressurized and in normal cruising flight at altitude, a reduced power setting of 5 BMEP on the outboard engines will account for cabin supercharger power requirements and result in the same total power output by all four engines at the same rpm.

The EC-121 aircraft are equipped with 30-kva ac generators, driven by the outboard engines. With the ac generators connected, the additional shaft horsepower absorbed by the accessory section is assumed to be 3 to 5 BMEP per outboard engine. This value is based on normal electrical requirements at customary cruising powers and altitudes.

The effect of dc generator loading is not normally considered, being small enough in magnitude to be neglected when the total electrical load is symmetrically balanced between generators. However, if the load is particularly high on one or more engines, or if total generator capacity is being used, the allowable limit settings should be reduced 2 BMEP from chart limit values for the engines affected.

MAXIMUM POWER MANIFOLD PRESSURE LIMITS—115/145 FUEL.

The limit manifold pressure is the limiting factor when it is reached before limit power. While it is not allowable to adjust limit manifold pressures because of unusual temperature conditions, it is allowed in the event that humidity is excessive, that is, when existing vapor pressure (P_v) is greater than standard. The engine limits at maximum power are for conditions of zero percent relative humidity at standard temperatures. If conditions of extreme humidity do exist, the maximum power limit manifold pressure may be increased by two times the existing vapor pressure. There is a further limit provision to this: the limit MAP may not be increased more than 1 in. Hg, and 277 BMEP must not be exceeded.

The following example illustrates the procedure for increasing limit MAP.

Conditions.

- Pressure altitude—Sea Level
- Vapor pressure—0.400
- Limit MAP at sea level—59.5 in. Hg

Find: Allowable MAP limit, Maximum Power.

Solution: $2 \times 0.400 = 0.800$ in. Hg;
$59.5 + 0.800 = 60.3$ in. Hg MAP.

The allowable MAP limit is 60.3 in. Hg since the ΔMAP did not exceed 1.0 in. Hg.

Dewpoint is directly related to vapor pressure, as illustrated by the Psychrometric Chart at the end of Part 1, and most meteorological offices provide dewpoint rather than vapor pressure. Therefore, the conversion from vapor pressure to dewpoint has been incorporated in the maximum power prediction charts in Part 3. This allows power available for takeoff to be predicted directly from altitude, temperature, and dewpoint (rather than vapor pressure). Maximum power MAP limits, that may be adjusted for vapor pressure, can also be found on the power prediction charts.

The following vapor pressure data are provided for reference:

Altitude (Feet)	Std Temp (°C)	P_v at 80% RH (in. Hg)	Dewpoint Temp (°C)	P_v at 100% RH (in. Hg)
Sea level	15	0.405	0	0.18
2500	10	0.288	10	0.36
5000	5	0.207	20	0.69
7500	0	0.144	30	1.26
10,000	−5	0.097	40	2.18

CLIMB AND CRUISE POWER MANIFOLD PRESSURE LIMITS, 115/145 FUEL.

The limit manifold pressures vary with altitude for cruise and climb power settings. Use of retard (20°) spark and rich mixtures below 2500 rpm in cruise is permitted but results in increased fuel consumption. Retarded spark decreases engine critical altitude. Note that retard (20°) spark must be used above 2400 rpm in high blower and that advance (25°) spark is normally used for 2400 rpm or less. The relatively high limit manifold pressure does not mean to imply that the full limit can always be used to obtain cruise limit BMEP. If full use of the limit MAP were necessary on an individual engine without some very apparent reason, it should be assumed that an engine or BMEP gage malfunction exists and BMEP reduced. Observe the settings on the other engines as a check. No more than 2 in. Hg difference in MAP is allowable among engines for a given power setting. If a greater spread is observed after accounting for accessory load power requirements, power on the engine(s) with the highest MAP should be reduced until a maximum difference among all engines of 2 in. Hg or less is obtained. An investigation should be made at the earliest opportunity to determine the cause of this discrepancy.

100/130 AND 108/135 FUEL OPERATING CONSIDERATIONS.

Operation is restricted to low blower with AUTO RICH mixture settings when using 100/130 and 108/135 grade fuel. Limits supplied for operation with 100/130 grade fuel are also applicable when using 108/135 grade fuel.

EFFECTS OF RAM ON POWER AVAILABLE.

Each Engine Limits and Characteristics chart is based on a zero ram calibration; that is, the calibration is made with standard ambient static pressure and temperature existing at the carburetor top deck, crankcase breather, and turbine exhaust hoods. Ducting necessary for installation of the engine on the aircraft alters the pressures and temperatures from these conditions during flight operation.

This deviation from the standard calibration condition affects the altitude-power characteristics of the engine. The difference in performance is commonly referred to as ram, since normal flight speed usually results in an increase in carburetor deck pressure over ambient static and thereby increases the altitude at which full throttle occurs for particular rpm settings.

STANDARD-DAY POWER AVAILABLE.

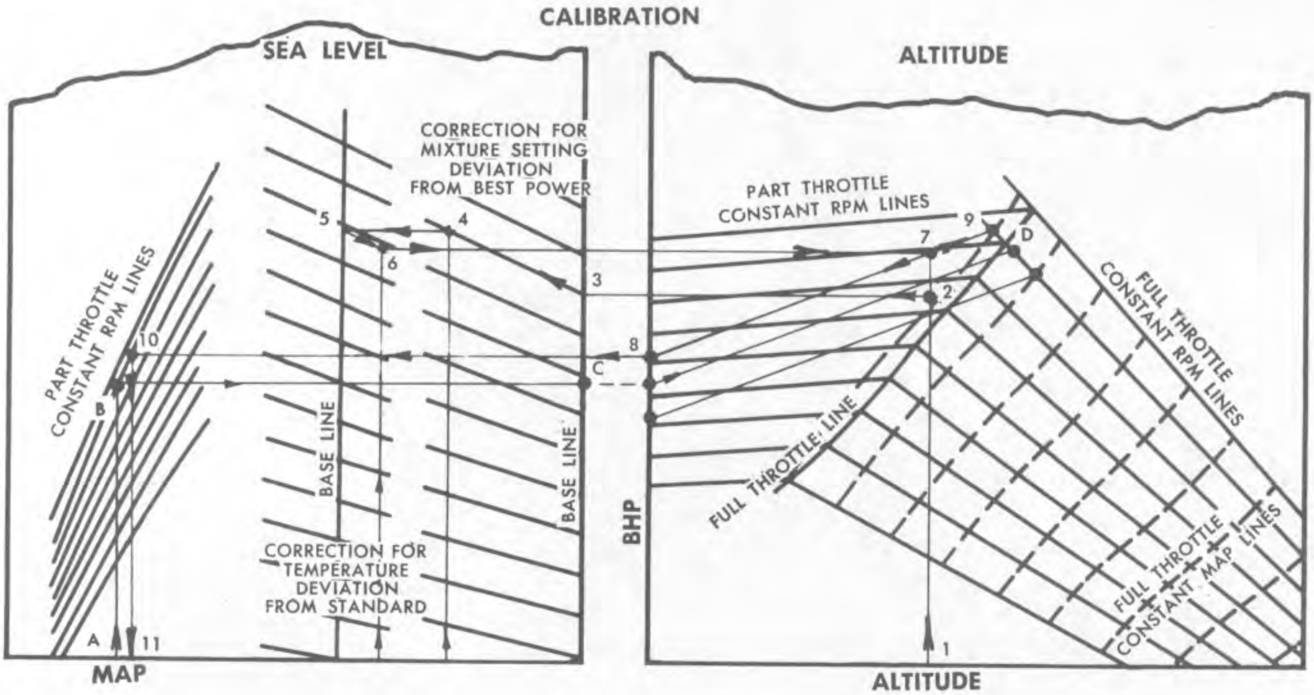
Low- and high-blower standard-day power available for the complete R3350-93A engine installation is shown in figure A2-6. The power available reflects flight test results. This material complies with engine manufacturer's current operating instructions. The power ratings were established at representative flight speeds during the following conditions: climb with Maximum METO, alternate METO, and Alternate Climb (2500 rpm) powers and in level flight with normal cruising powers. Therefore, the full-throttle powers deviate from the zero-ram values. Takeoff, climb, and part-throttle cruise performance shown in this part is based on these powers. Manual-lean, full-throttle cruise performance information includes an allowance which effectively uses a 50-rpm increase in engine speed to develop standard day power. This is called a "50-rpm pad." For example, standard day power available in low blower at 14,000 feet and 2300 rpm is 1575 BHP. With a 50-rpm pad, 2350 rpm would be used to develop 1575 BHP. However, under favorable operating conditions, use the lowest rpm necessary to develop the required power.

OPERATING ALLOWANCES FOR FULL-THROTTLE CRUISE POWER.

Full-throttle cruise powers available are based on fuel-air ratios obtained with 10-percent mixture settings (using the manual leaning method as recommended in Section VII). High blower lean mixture power data are applicable to either 10- or 15-percent lean mixture. Power values shown are directly applicable to the inboard engines, and to the outboard engines if cabin supercharger and generator power is accounted for. The full-throttle lines include the effect of level flight ram at four-engine flight speeds for average gross weights. Since the outboard engines normally operate with the cabin superchargers connected and generator operating, part- and full-throttle cruise powers shown on the chart are not representative of average performance available for four-engine operation. Values read must be reduced by a power increment equivalent to 5 BMEP to obtain average four-engine cruise power available for the EC-121 aircraft.

Note

The average power contribution of each outboard engine is equivalent to 8 to 10 BMEP for cabin supercharger and 30-kva generator operation. (This is a nominal value based on normal cabin differential pressures and electrical requirements at customary cruising powers and altitudes.)



SAMPLE PROBLEM.

The sea level calibration is used together with a portion of the altitude curve to determine constant MAP-RPM lines for varying altitudes.

PROBLEM 1. To find the standard power versus altitude line for 2300 rpm and 34 in. Hg MAP in low blower and best power mixture.

Solution. (See sketch and figure A2-1.)

a. Using the sea level calibration, determine the rpm (2300) and MAP (34 in. Hg) intersection (A-B).

b. Project this point horizontally to the BHP axis and locate (C).

c. Locate (D), defined as the intersection of the full-throttle constant RPM line and the full-throttle constant MAP line corresponding to the given RPM (2300) and MAP (34 in. Hg).

d. Join (C) and (D) with a straight line. This line will define the altitude and power combination which will exist at 2300 rpm and 34 in. Hg MAP on a standard day with best power mixture. For example, at an altitude of 6000 ft the BHP equals 1740 (intersection of line C-D with the 6000-ft altitude).

The use of the correction grids for deviations of temperature from standard and fuel-air mixtures from best power is exemplified next.

PROBLEM 2. To find MAP necessary to produce 1700 BHP at 9000 ft, using 2300 rpm, an 8% lean mixture, and at CAT of −21°C (18° below standard).

Solution. (See sketch and figure A2-1.)

a. Determine the altitude-power intersection (1-2).

b. Move horizontally to zero power drop (2-3) and correct for 8 percent BMEP drop by paralleling the nearest adjustment slope line (3-4).

c. Proceed horizontally to the standard CAT line (4-5). Since the CAT is below standard, parallel the right side of the slope line to −18°C (5-6).

d. Move right horizontally to 9000 feet (6-7).

e. Draw a constant MAP/rpm line near the adjusted power point (7). Use the 34 inch/2300 rpm line from problem 1 (line C-D).

f. Draw a line through the 9000 ft/1790 BHP point (7) parallel to the 34 inch/2300 rpm line (C-D) to sea level and the 2300 rpm full throttle line (8-9). Read the MAP directly at full throttle (9) or move horizontally to the left from sea level to 2300 rpm (10) and read down (11) to 33.7 inches Hg MAP.

To develop a constant MAP/rpm slope for high blower, proceed as above except use the 10,000-foot altitude line rather than sea level.

Note that the CAT correction is solely for part-throttle operation and cannot be used to determine a change in critical altitude with temperature. Such a variation in CAT at full throttle would result in a double correction, the normal change of 2% power per 10°C at constant MAP and a change in MAP and power due to the change in supercharger rise with temperature.

Four-engine cruising performance is based on average power available with the cabin superchargers connected. Three-engine cruising performance is based on average power available with cabin superchargers connected and the 30-kva generators not loaded. Two-engine cruising performance is based on operation with cabin superchargers disconnected and the generators inoperative, the assumption being made that two-engine operating altitudes do not require cabin pressurization and that all available engine power should be utilized for propulsion.

OPERATION WITH RAM DOORS CLOSED.

Takeoff performance shown in this section was determined with the carburetor airscoop open in the RAM position. Operation with these scoops in the ALTERNATE position is permissible.

The altitude at which full throttle will be obtained is reduced approximately 1000 feet at Maximum and 600 feet at METO power settings. Takeoff performance and METO power climb performance will be affected in the full-throttle operating region. In predicting takeoff performance with airscoops in the ALTERNATE position, add approximately 3°C to the runway air temperature. Figures A2-7 and A2-10 provide takeoff, climb, and cruise power settings for use with 110/130 grade fuel.

ENGINE POWER SCHEDULE TABLES.

Engine power settings are tabulated for standard pressure altitudes of sea level to 24,000 feet on figures A2-8 and A2-9. The information applies to AUTO RICH and 10- and 15-percent lean mixture settings with 115/145 grade fuel. The values shown are for inboard engines. The outboard engines should be set 8 to 10 BMEP less in part-throttle at all except Maximum and METO climb powers to allow for cabin supercharger power requirements. Limit MAP and BMEP apply at maximum and climb powers and must be observed when not using the BMEP spread.

Figure A2-10 provides takeoff, climb, and cruise power settings for use with 100/130 grade fuel.

FUEL FLOW CHARTS.

Figures A2-11 through A2-14 show fuel flow in pounds per engine versus inboard engines power for various engine speeds. Figures A2-11 and A2-12 are applicable to low-blower operation with 10 percent lean and AUTO RICH mixture settings, respectively; figures A2-13 and A2-14 are similar charts for high-blower operation. Lean mixture fuel flows, figure A2-13, are applicable to 10- as well as 15-percent lean mixture power settings. The fuel flow charts are based on flight tests. It is again emphasized that valid inflight fuel flow checks can be accomplished only with calibrated BMEP and fuel flow gages.

R3350-93 ENGINE LIMITS AND CHARACTERISTICS

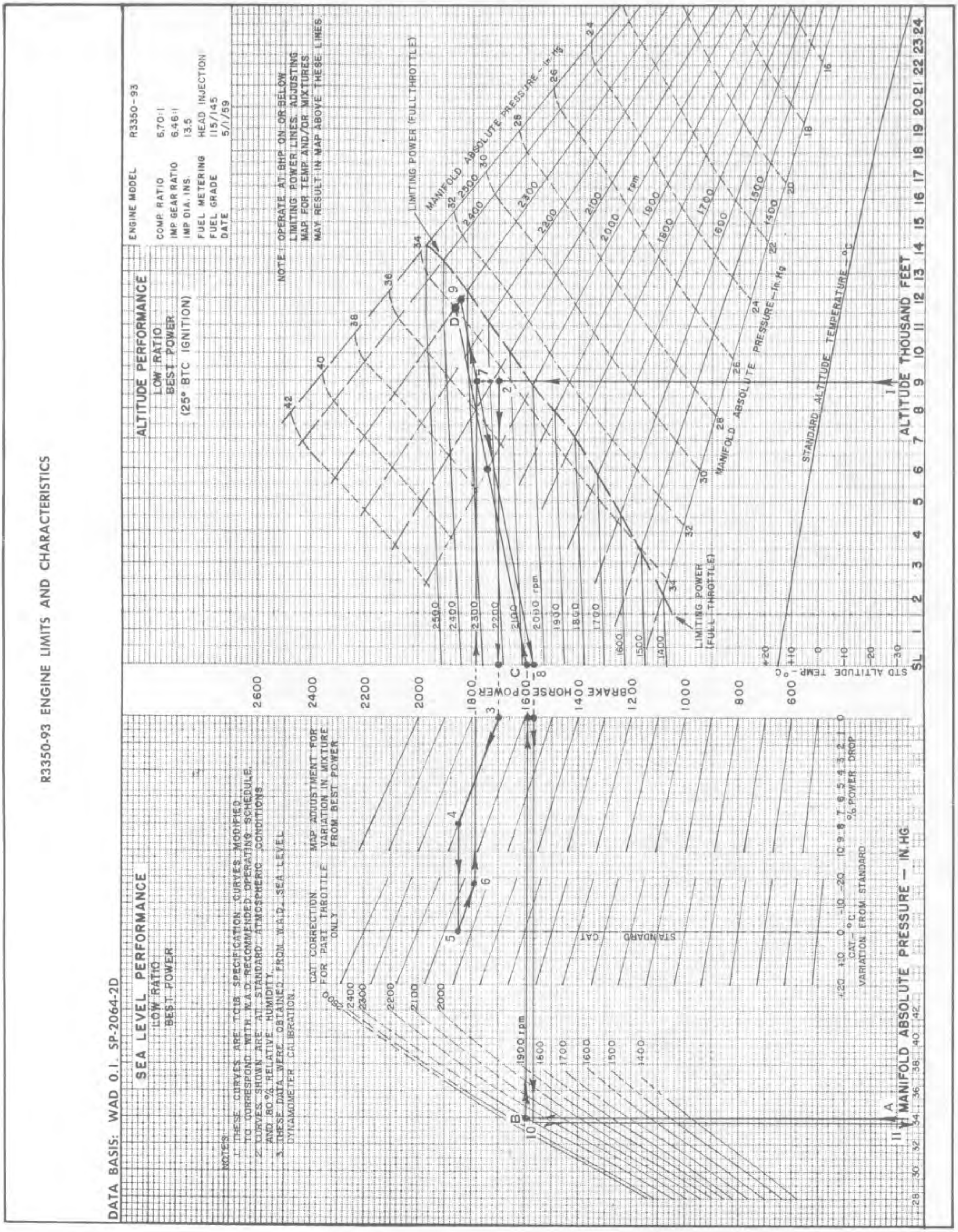


Figure A2-1

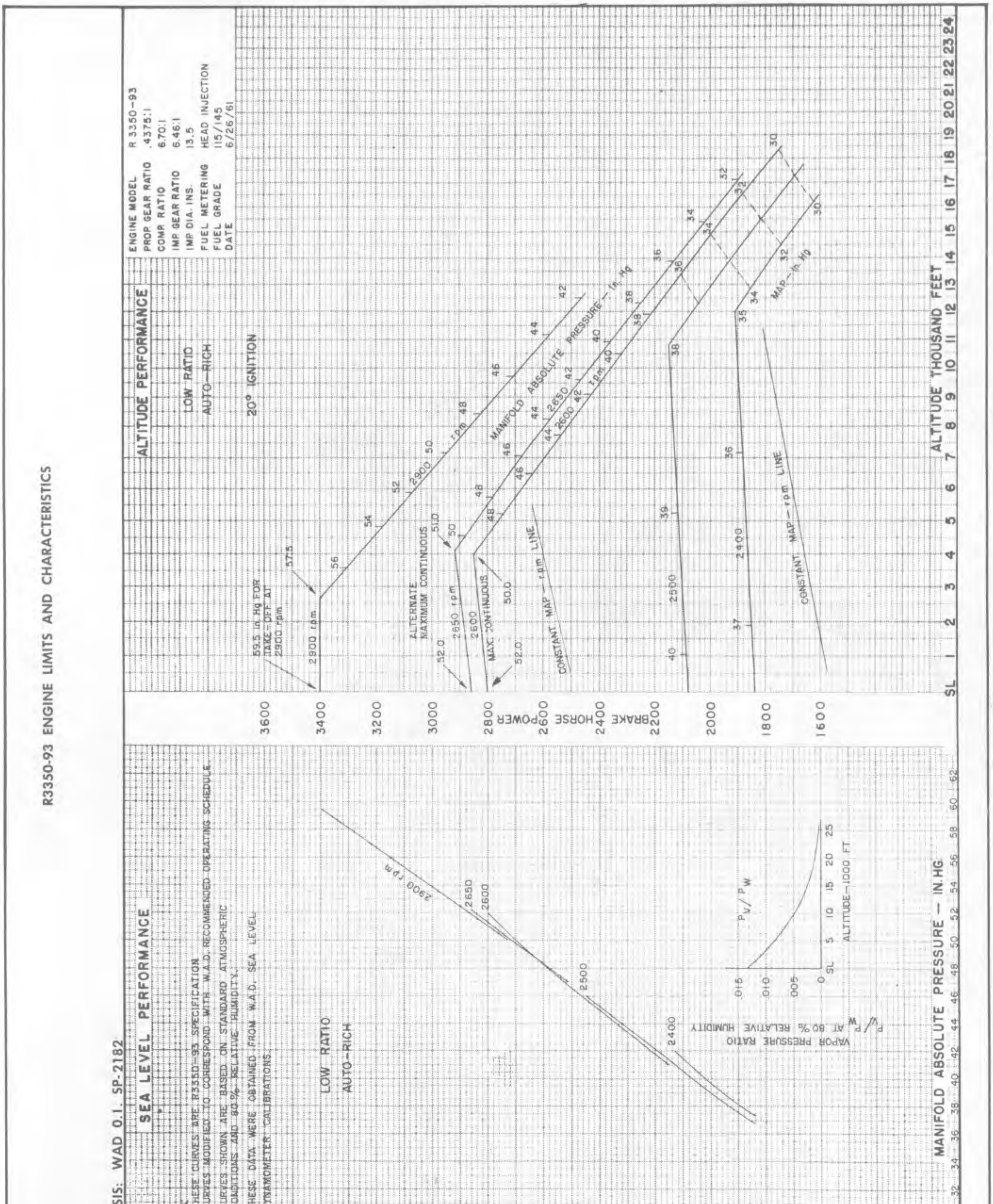

R3350-93 ENGINE LIMITS AND CHARACTERISTICS
DATA BASIS: WAD O.I. SP-2182
SEA LEVEL PERFORMANCE
NOTES:
1. THESE CURVES ARE R3350-93 SPECIFICATION CURVES MODIFIED TO CORRESPOND WITH W.A.D. RECOMMENDED OPERATING SCHEDULE.
2. CURVES SHOWN ARE BASED ON STANDARD ATMOSPHERIC CONDITIONS AND 80% RELATIVE HUMIDITY.
3. THESE DATA WERE OBTAINED FROM W.A.D. SEA LEVEL DYNAMOMETER CALIBRATIONS.
LOW RATIO
AUTO-RICH
2900 rpm
2650
2600
2500
2400
VAPOR PRESSURE RATIO
Pv/Pw AT 80% RELATIVE HUMIDITY
ALTITUDE-1000 FT
MANIFOLD ABSOLUTE PRESSURE — IN. HG
BRAKE HORSE POWER
ALTITUDE PERFORMANCE
LOW RATIO
AUTO-RICH
20° IGNITION
ENGINE MODEL R 3350-93
PROP GEAR RATIO .4375:1
COMP RATIO 6.70:1
IMP GEAR RATIO 6.46:1
IMP DIA. INS. 13.5
FUEL METERING HEAD INJECTION
FUEL GRADE 115/145
DATE 6/26/61
59.5 in. Hg FOR TAKE-OFF AT 2900 rpm
ALTERNATE MAXIMUM CONTINUOUS
MAX. CONTINUOUS
CONSTANT MAP-rpm LINE
MANIFOLD ABSOLUTE PRESSURE — in. Hg
MAP—in. Hg
ALTITUDE THOUSAND FEET

Figure A2-2

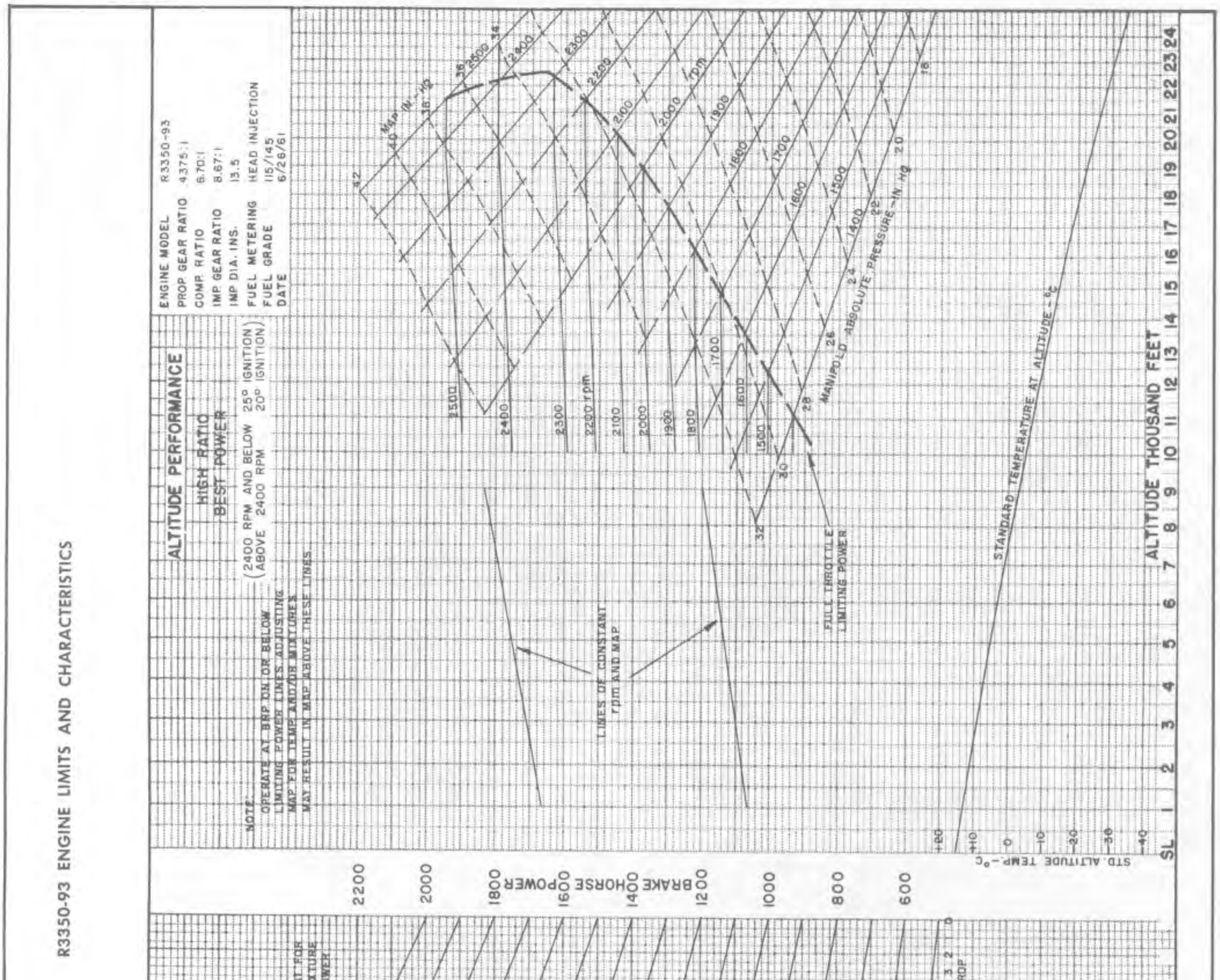

R3350-93 ENGINE LIMITS AND CHARACTERISTICS
DATA BASIS: WAD O.I. SP-2185
10,000 FEET PERFORMANCE
HIGH RATIO
BEST POWER
NOTES:
1. THESE CURVES ARE R3350-93 SPECIFICATION CURVES MODIFIED TO CORRESPOND WITH W.A.D. RECOMMENDED OPERATING SCHEDULE.
2. CURVES ARE SHOWN AT STANDARD ATMOSPHERIC CONDITIONS AND 80% RELATIVE HUMIDITY.
3. THESE DATA WERE OBTAINED FROM W.A.D. SEA LEVEL DYNAMOMETER CALIBRATIONS.
4. NO SEA LEVEL PERFORMANCE IS SHOWN FOR HIGH GEAR RATIO.
CAT CORRECTION FOR PART THROTTLE ONLY
MAP ADJUSTMENT FOR VARIATION IN MIXTURE FROM BEST POWER
STANDARD CAT
CAT-°C VARIATION FROM STD.
% POWER DROP
MANIFOLD ABSOLUTE PRESSURE — IN. HG
BRAKE HORSE POWER
ALTITUDE PERFORMANCE
HIGH RATIO
BEST POWER
2400 RPM AND BELOW 25° IGNITION
ABOVE 2400 RPM 20° IGNITION
ENGINE MODEL R3350-93
PROP GEAR RATIO .4375:1
COMP. RATIO 6.70:1
IMP GEAR RATIO 8.67:1
IMP DIA. INS. 13.5
FUEL METERING HEAD INJECTION
FUEL GRADE 115/145
DATE 6/26/61
NOTE:
OPERATE AT BHP ON OR BELOW LIMITING POWER LINES ADJUSTING MAP FOR TEMP AND/OR MIXTURES. MAP RESULT IN MAP ABOVE THESE LINES.
LINES OF CONSTANT rpm AND MAP
FULL THROTTLE LIMITING POWER
MANIFOLD ABSOLUTE PRESSURE - IN. HG
STANDARD TEMPERATURE AT ALTITUDE - °C
STD. ALTITUDE TEMP. - °C
ALTITUDE THOUSAND FEET

Figure A2-3

R3350-93 ENGINE LIMITS AND CHARACTERISTICS

DATA BASIS: WAD O.I. SP-2184

SEA LEVEL PERFORMANCE

NOTES:

1. THESE CURVES ARE R3350-93,-34 SPECIFICATION CURVES MODIFIED TO CORRESPOND WITH W.A.D. RECOMMENDED OPERATING SCHEDULE.
2. CURVES SHOWN ARE BASED ON STANDARD ATMOSPHERIC CONDITIONS AND 80% RELATIVE HUMIDITY.
3. NO SEA LEVEL PERFORMANCE IS SHOWN FOR HIGH GEAR RATIO.
4. THESE DATA WERE OBTAINED FROM W.A.D. SEA LEVEL DYNAMOMETER CALIBRATIONS.

MANIFOLD ABSOLUTE PRESSURE — IN.HG

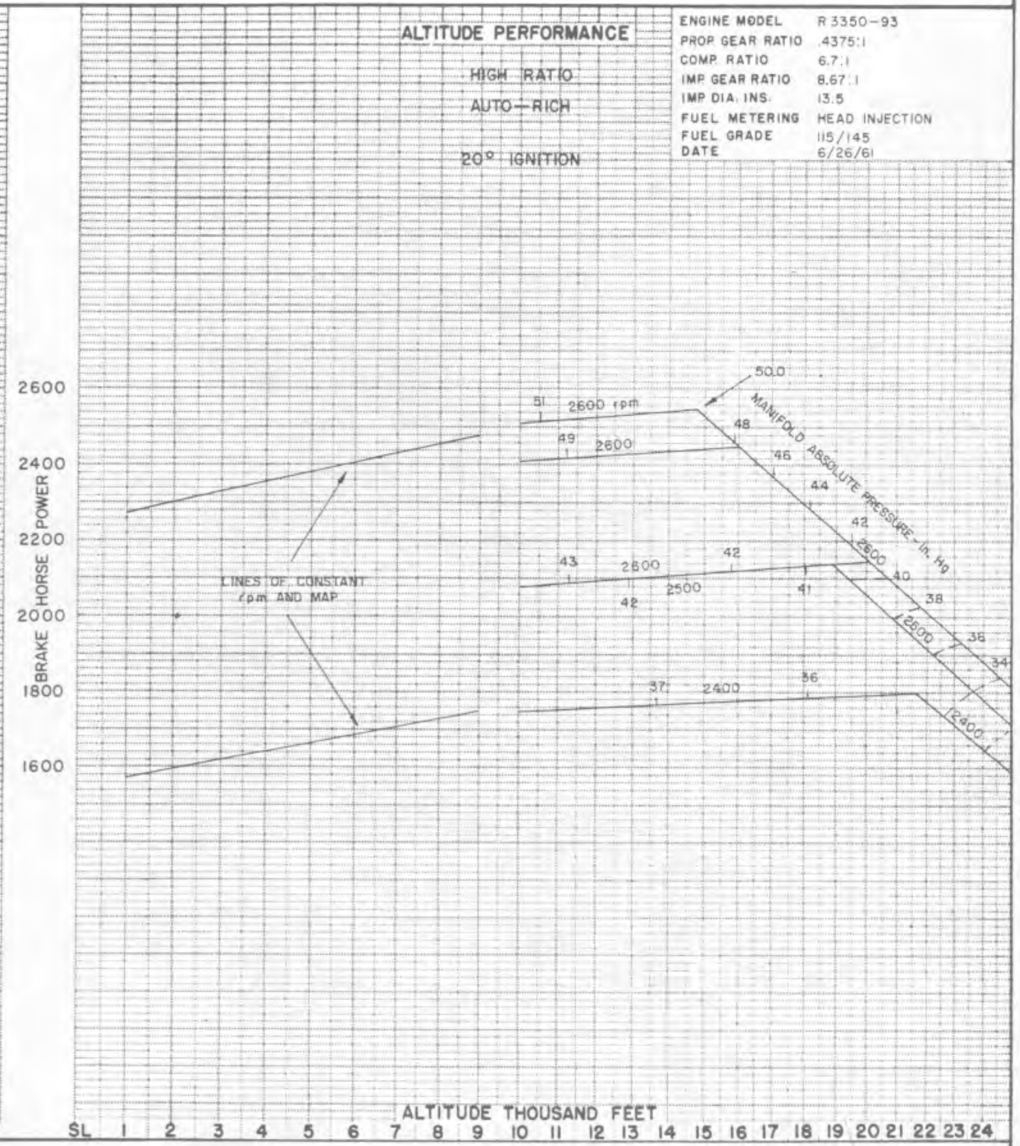


Figure A2-4

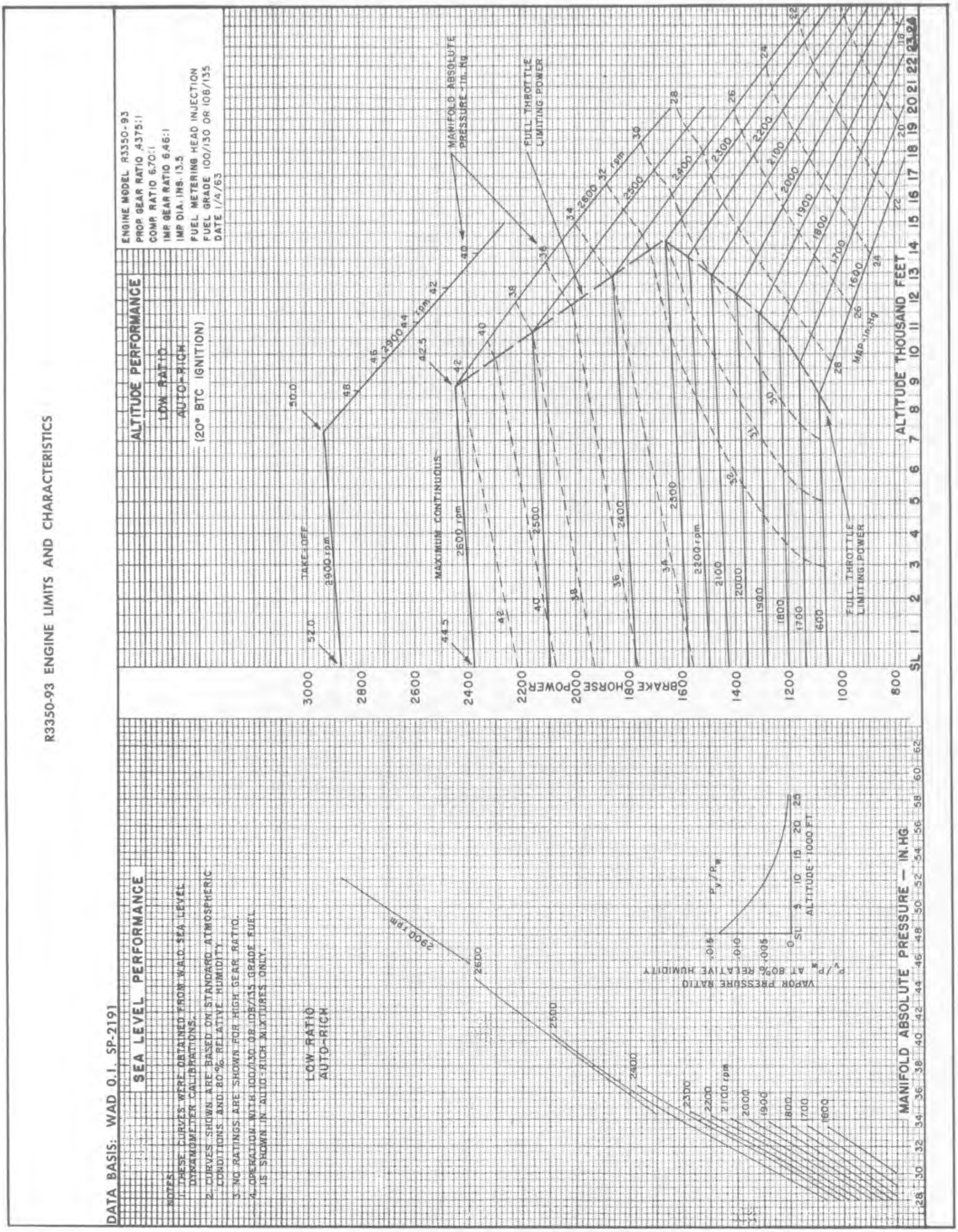
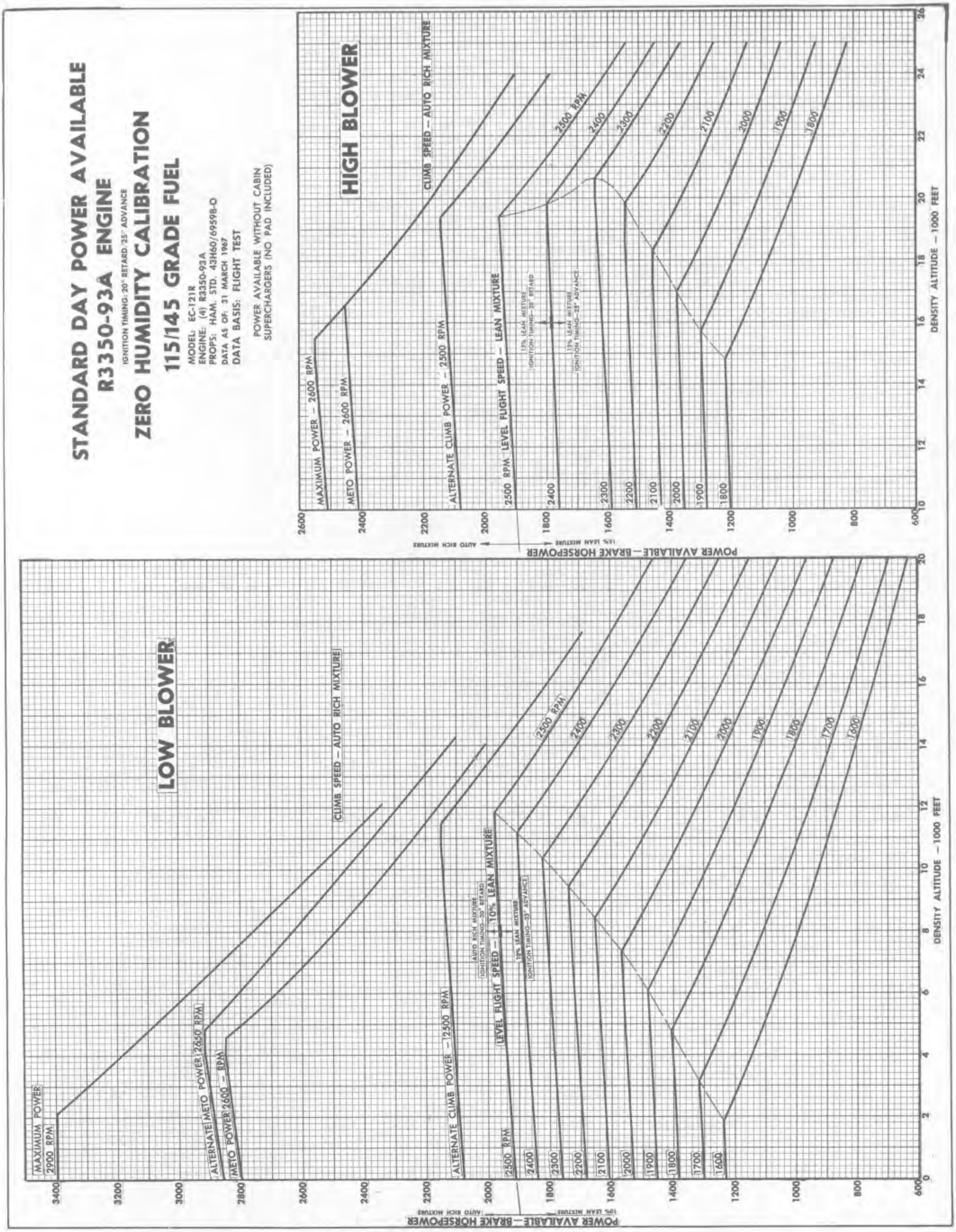

R3350-93 ENGINE LIMITS AND CHARACTERISTICS
DATA BASIS: WAD O.I. SP-2191
SEA LEVEL PERFORMANCE
NOTES:
1. THESE CURVES WERE OBTAINED FROM W.A.D. SEA LEVEL DYNAMOMETER CALIBRATIONS.
2. CURVES SHOWN ARE BASED ON STANDARD ATMOSPHERIC CONDITIONS AND 80% RELATIVE HUMIDITY.
3. NO RATINGS ARE SHOWN FOR HIGH GEAR RATIO.
4. OPERATION WITH 100/130 OR 108/135 GRADE FUEL IS SHOWN IN AUTO-RICH MIXTURES ONLY.
LOW RATIO
AUTO-RICH
VAPOR PRESSURE RATIO
P_v/P_w AT 80% RELATIVE HUMIDITY
ALTITUDE-1000 FT.
MANIFOLD ABSOLUTE PRESSURE — IN.HG.
BRAKE HORSE POWER
ALTITUDE PERFORMANCE
LOW RATIO
AUTO-RICH
(20° BTC IGNITION)
ENGINE MODEL R3350-93
PROP GEAR RATIO .4375:1
COMP RATIO 6.70:1
IMP GEAR RATIO 6.46:1
IMP DIA. INS. 13.5
FUEL METERING HEAD INJECTION
FUEL GRADE 100/130 OR 108/135
DATE 1/4/63
TAKE-OFF
2900 rpm
MAXIMUM CONTINUOUS
2600 rpm
MANIFOLD ABSOLUTE PRESSURE -in. Hg
FULL THROTTLE LIMITING POWER
MAP-in.Hg
ALTITUDE THOUSAND FEET

Figure A2-5



STANDARD DAY POWER AVAILABLE
R3350-93A ENGINE
IGNITION TIMING: 20° RETARD 25° ADVANCE
ZERO HUMIDITY CALIBRATION
115/145 GRADE FUEL
MODEL: EC-121R
ENGINE: (4) R3350-93A
PROPS: HAM. STD. 43H60/6959B-0
DATA AS OF: 31 MARCH 1967
DATA BASIS: FLIGHT TEST
POWER AVAILABLE WITHOUT CABIN SUPERCHARGERS (NO PAD INCLUDED)
HIGH BLOWER
CLIMB SPEED — AUTO RICH MIXTURE
MAXIMUM POWER — 2600 RPM
METO POWER — 2600 RPM
ALTERNATE CLIMB POWER — 2500 RPM
2500 RPM LEVEL FLIGHT SPEED — LEAN MIXTURE
2500 RPM
2400
2300
2200
2100
2000
1900
1800
POWER AVAILABLE — BRAKE HORSEPOWER
DENSITY ALTITUDE — 1000 FEET
LOW BLOWER
CLIMB SPEED — AUTO RICH MIXTURE
MAXIMUM POWER 2900 RPM
ALTERNATE METO POWER 2650 RPM
METO POWER 2600 RPM
ALTERNATE CLIMB POWER — 2500 RPM
LEVEL FLIGHT SPEED — 10% LEAN MIXTURE
2500 RPM
2400
2300
2200
2100
2000
1900
1800
1700
1600
POWER AVAILABLE — BRAKE HORSEPOWER
DENSITY ALTITUDE — 1000 FEET

Figure A2-6

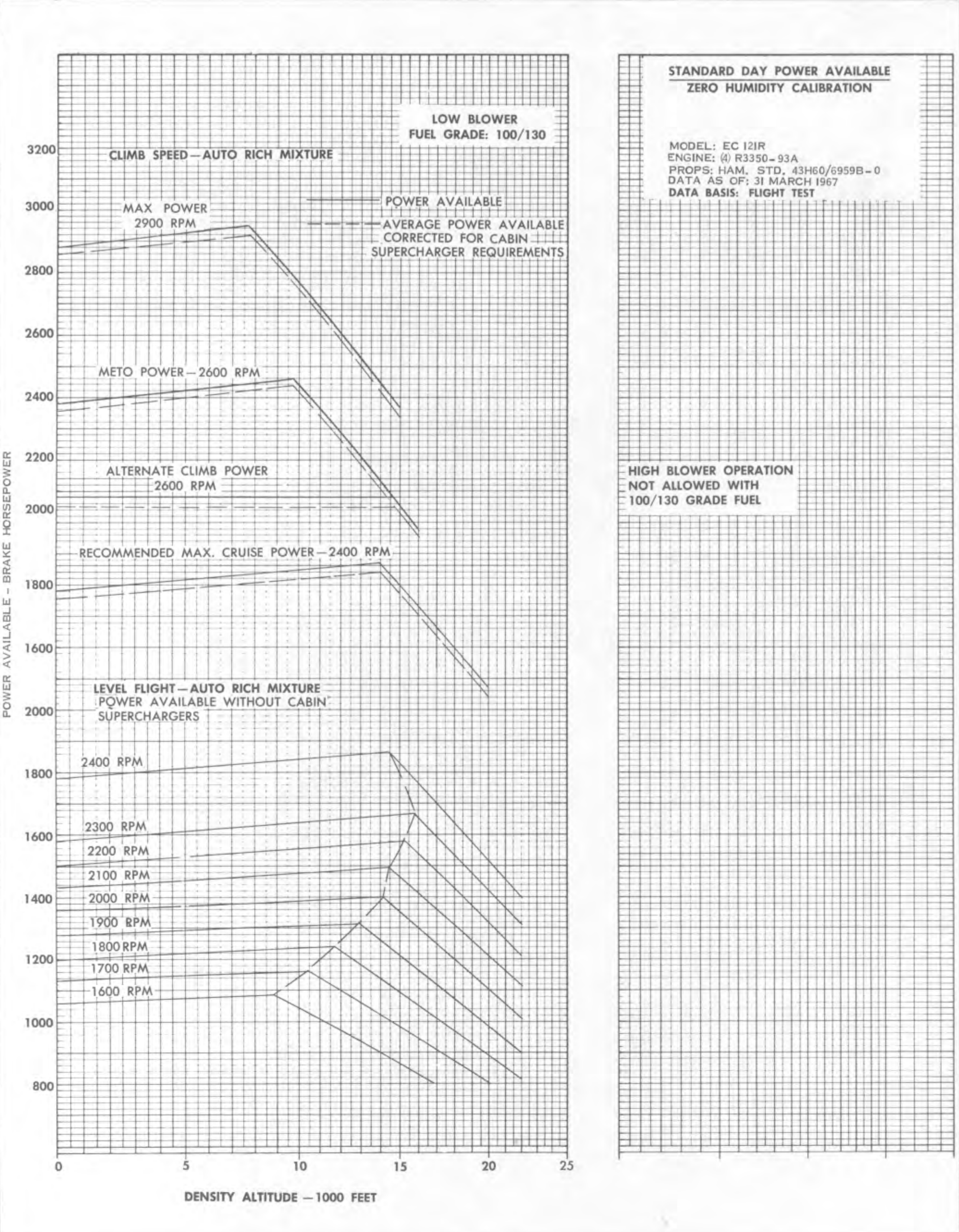

LOW BLOWER
FUEL GRADE: 100/130
CLIMB SPEED—AUTO RICH MIXTURE
MAX POWER
2900 RPM
POWER AVAILABLE
AVERAGE POWER AVAILABLE CORRECTED FOR CABIN SUPERCHARGER REQUIREMENTS
METO POWER—2600 RPM
ALTERNATE CLIMB POWER
2600 RPM
RECOMMENDED MAX. CRUISE POWER—2400 RPM
LEVEL FLIGHT—AUTO RICH MIXTURE
POWER AVAILABLE WITHOUT CABIN SUPERCHARGERS
2400 RPM
2300 RPM
2200 RPM
2100 RPM
2000 RPM
1900 RPM
1800 RPM
1700 RPM
1600 RPM
POWER AVAILABLE - BRAKE HORSEPOWER
3200
3000
2800
2600
2400
2200
2000
1800
1600
2000
1800
1600
1400
1200
1000
800
0
5
10
15
20
25
DENSITY ALTITUDE —1000 FEET
STANDARD DAY POWER AVAILABLE
ZERO HUMIDITY CALIBRATION
MODEL: EC 121R
ENGINE: (4) R3350-93A
PROPS: HAM. STD. 43H60/6959B-0
DATA AS OF: 31 MARCH 1967
DATA BASIS: FLIGHT TEST
HIGH BLOWER OPERATION
NOT ALLOWED WITH
100/130 GRADE FUEL

Figure A2-7

R3350-93 ENGINE POWER SCHEDULE TABLE

AUTO RICH MIXTURE – RETARD SPARK (20°)

STANDARD DAY — 115/145 GRADE FUEL

80 PERCENT RELATIVE HUMIDITY

MODEL: EC-121R
DATA AS OF: 31 MARCH 1967
DATA BASIS: FLIGHT TEST

PROPS: HAM. STD. 43H60/6959B-0

ENGINE SPEED RPM	DENSITY ALTITUDE FT	SL	2,000	4,000	6,000	8,000	10,000	12,000	14,000	10,000	12,000	14,000	16,000	18,000	20,000	22,000	24,000
	BLOWER SETTING	LOW BLOWER								HIGH BLOWER							
	MAXIMUM POWER: MAXIMUM ALLOWABLE CYLINDER HEAD TEMPERATURE 260° C, 5 MIN TIME LIMIT, LIMIT BMEP 277.																
2900	INBOARD BHP	3400	3400	3185 F.T.	2970 F.T.	2760 F.T.	2555 F.T.	2350 F.T.		CAUTION — HIGH BLOWER NOT PERMITTED ABOVE 2600 RPM							
	INBOARD BMEP	277	277	260	245	225	208	191									
	*LIMIT MAP	59.5	58.0	57.0	56.0	55.0	54.5	54.0									
	MAXIMUM POWER: MAXIMUM ALLOWABLE CYLINDER HEAD TEMPERATURE 260° C, 5 MIN TIME LIMIT.																
2600	INBOARD BHP									2510	2525	2540	2500 F.T.	2325 F.T.	2175 F.T.	2035 F.T.	
	INBOARD BMEP									228	229	231	227	211	197	185	
	*LIMIT MAP									51.0	50.5	50.0	49.5	48.5	48.0	47.5	
	METO (NORMAL RATED) POWER: MAXIMUM ALLOWABLE CYLINDER HEAD TEMPERATURE 245° C, NO TIME LIMIT.																
2600	INBOARD BHP	2800	2825	2850	2685 F.T.	2495 F.T.	2320 F.T.	2160 F.T.	2010 F.T.	2410	2425	2440	2450	2325 F.T.	2175 F.T.	2035 F.T.	1900 F.T.
	INBOARD BMEP	254	256	258	244	226	211	196	183	218	219	220	222	211	197	185	173
	LIMIT MAP	52.0	51.0	50.0	49.0	48.5	47.5	47.0	46.5	49.5	49.0	48.5	47.5	47.0	46.5	46.0	45.0
	ALTERNATE METO (NORMAL RATED) POWER: MAXIMUM ALLOWABLE CYLINDER HEAD TEMPERATURE 245° C, NO TIME LIMIT.																
2650	INBOARD BHP	2860	2885	2915	2810 F.T.	2630 F.T.	2460 F.T.	2290 F.T.	2120 F.T.								
	INBOARD BMEP	255	257	259	250	234	219	204	189								
	LIMIT MAP	52.0	51.5	51.0	50.0	49.0	48.5	47.5	47.0								
	ALTERNATE CLIMB POWER: MAXIMUM ALLOWABLE CYLINDER HEAD TEMPERATURE 230° C, NO TIME LIMIT.																
2500	INBOARD BHP	2080	2095	2110	2120	2135	2145	2105 F.T.	1955 F.T.	2080	2090	2105	2120	2135	2090 F.T.	1930 F.T.	1785 F.T.
	INBOARD BMEP	196	198	199	200	201	202	199	184	196	197	199	200	201	197•	182	169
	LIMIT MAP	41.0	41.0	41.0	41.0	41.0	41.0	41.0	41.0	44.0	44.0	44.0	44.0	44.0	44.0	44.0	44.0

*Add 2 x vapor pressure except not to exceed 1 in. Hg. Limit values are for zero percent relative humidity.

NOTES:

1. Set power by RPM and BMEP unless limit MAP is obtained first. Set outboard engines 5 BMEP less than values shown at all except maximum and METO power to allow for cabin supercharger power requirements.
2. Inboard engine BMEP settings are those expected to be available with standard-day temperatures and ram air. Values shown are limits unless full throttle (F.T.) performance is shown.
3. Not more than 2 in. Hg difference in MAP is allowable among engines for a given power setting after accounting for cabin supercharger power requirements. (This corresponds to 12 BMEP spread when at or near full throttle.) If a greater difference is observed, reduce the power on the engine with the higher MAP reading until the variation among engines is 2 in. Hg or less.

Figure A2-8

MODEL: EC-121R/C-121G
DATA AS OF: 31 MARCH 1967
DATA BASIS: FLIGHT TEST

R3350-93A ENGINE POWER SCHEDULE TABLE

10% LEAN LOW BLOWER
10%/15% LEAN HIGH BLOWER
ADVANCE SPARK (25°) †
115/145 GRADE FUEL

PROPS: HAM. STD. 43H60/6959B-O

Maximum Cruise Power: Max allowable CHT 215°C. Limit MAP 43.0 in. Hg (low blower), 44.0 in. Hg (high blower, 10% Lean mixture and 45.0 in. Hg (high blower, 15% Lean mixture). No time limit.

ENGINE RPM	DENSITY ALTITUDE — FT	SL	2,000	4,000	6,000	8,000	10,000	12,000	14,000	16,000	10,000	12,000	14,000	16,000	18,000	20,000	22,000	24,000
		LOW BLOWER									HIGH BLOWER							
2500	INBOARD BHP INBOARD BMEP	1915 181	1930 182	1942 183	1952 184	1960 185	1970 186	1910 F.T. 181	1770 F.T 167	1645 F.T. 155	1900 180	1913 181	1925 182	1935 183	1945 184	1835 F.T. 174	1690 F.T. 159	1555 F.T.
2450	INBOARD BHP INBOARD BMEP	1880 181	1890 182	1900 183	1910 184	1920 185	1930 186	1790 F.T. 172	1670 F.T. 161	1580 152	1825 175	1835 177	1880 178	1860 179	1870 180	1735 F.T. 172	1415 F.T.	1455 F.T.
2400	INBOARD BHP INBOARD BMEP	1840 181	1850 182	1865 183	1880 184	1890 185	1900 186	1785 F.T. 176	1650 F.T. 162	1525 F.T. 150	1755 172	1765 173	1775 174	1780 175	1790 176	1730 F.T. 170	1595 F.T. 157	1465 F.T. 144
2350	INBOARD BHP INBOARD BMEP	1800 181	1815 182	1825 183	1835 184	1845 185	1855 186	F.T. 167	F.T. 154	F.T. 142	1675 168	1685 169	1695 170	1700 171	1710 172	1680 F.T. 169	1540 F.T. 155	1460 F.T. 146
2300	INBOARD BHP INBOARD BMEP	1760 181	1775 182	1785 183	1800 184	1810 185	F.T. 178	F.T. 163	F.T. 150	F.T. 139	1590 163	1600 164	1610 165	1620 166	1630 167	1610 F.T. 165	1480 F.T. 152	1360 F.T. 140
2250	INBOARD BHP INBOARD BMEP	1720 181	1735 182	1745 183	1760 184	1770 185	F.T. 173	F.T. 160	F.T. 148	F.T. 137	1550 162	1555 163	1565 164	1575 165	1585 166	1520 F.T. 159	1410 F.T. 148	1300 F.T. 136
2200	INBOARD BHP INBOARD BMEP	1680 181	1695 182	1705 183	1720 184	1730 185	F.T. 169	F.T. 156	F.T. 145	F.T. 134	1505 162	1510 163	1520 163	1530 164	1535 164	1445 F.T. 154	1340 F.T. 144	1245 F.T. 134
2100	INBOARD BHP INBOARD BMEP	1610 181	1625 182	1635 183	1645 184	F.T. 176	F.T. 162	F.T. 150	F.T. 139	F.T. 128	1425 161	1430 162	1440 162	1450 163	1400 F.T. 158	1300 F.T. 146	1215 F.T. 136	1135 F.T. 127
2000	INBOARD BHP INBOARD BMEP	1530 181	1545 182	1555 183	1570 184	F.T. 168	F.T. 155	F.T. 144	F.T. 132	F.T. 122	1355 159	1360 160	1370 161	1355 F.T. 160	1260 F.T. 149	1175 F.T. 138	1095 F.T. 129	1020 F.T. 120
1900	INBOARD BHP INBOARD BMEP	1455 181	1465 182	1475 183	F.T. 172	F.T. 159	F.T. 147	F.T. 136	F.T. 126	F.T. 117	1285 159	1290 160	1295 161	1230 F.T. 152	1140 F.T. 141	1060 F.T. 131	980 F.T. 121	910 F.T. 113
1800	INBOARD BHP INBOARD BMEP	1380 181	1390 182	F.T. 173	F.T. 160	F.T. 149	F.T. 138	F.T. 128	F.T. 118	F.T. 110	1205 159	1210 160	1195 F.T. 157	1105 F.T. 145	1020 F.T. 134	945 F.T. 124	870 F.T. 114	805 F.T. 106
1700	INBOARD BHP INBOARD BMEP	1300 180*	F.T. 178	F.T. 163	F.T. 150	F.T. 140	F.T. 130	F.T. 121	F.T. 113		1145 150*	1145 150*	1145 150*	1030 135*	915 120*	915 120*	800 105*	
1600	INBOARD BHP INBOARD BMEP	1225 180*	F.T. 166	F.T. 153	F.T. 142	F.T. 132	F.T. 123	F.T. 115			1030 135*	1030 135*	1030 135*	915 120*	800 105*	800 105*		
1600	INBOARD BHP INBOARD BMEP	1155 170*	1085 160*	1015 150*	950 140*	880 130*	815 120*				915 120*	915 120*	915 120*	800 105*				
1600	INBOARD BHP INBOARD BMEP	1085 160*	1015 150*	950 140*	880 130*	815 120*					800 105*	800 105*	800 105*					
1600	INBOARD BHP INBOARD BMEP	1015 150*	950 140*	880 130*	815 120*						725 95*	725 95*						
1600	INBOARD BHP INBOARD BMEP	950 140*	880 130*	815 120*														
1600	INBOARD BHP INBOARD BMEP	880 130*	815 120*															
1600	INBOARD BHP INBOARD BMEP	815 120*																

1800 RPM ONLY

NOTE:
* IF THERE IS ANY ENGINE INSTABILITY AT 15% LEAN, USE 10% THROUGH 15% LEAN

† RETARD SPARK (20°) REQUIRED FOR ENGINE SPEEDS GREATER THAN 2400 RPM IN HIGH BLOWER.

NOTES:

1. Set power by RPM and BMEP unless limit MAP is obtained first. Set outboard engines 5 BMEP less than values shown at all powers to allow for cabin supercharger power requirements. Set outboard engines an additional 3 to 5 BMEP less (total 8 to 10 BMEP less) to allow for generator and cabin supercharger power requirements.
2. Inboard engine BMEP settings are those expected to be available with standard day temperatures and ram air. Values shown are limits unless full throttle performance is shown, noted by (F.T.), or unless settings less than limit values are recommended, noted by (*). An arbitrary allowance of 50 RPM has been included in the full throttle power settings.
3. Not more than 2 in. Hg difference in MAP between engines is allowable for a given power setting after accounting for cabin supercharger and generator power requirements. (This corresponds to 12 BMEP spread when at or near full throttle.) If a greater difference is observed, reduce power on engine with the highest MAP until the difference is 2 in. Hg or less.

Figure A2-9

R3350-93 ENGINE POWER SCHEDULE TABLE

AUTO RICH MIXTURE—20° RETARD SPARK
LOW BLOWER—100/130 GRADE FUEL

MODEL: EC-121R/C-121G
DATA AS OF: 31 MARCH 1967
DATA BASIS: FLIGHT TEST

PROPS: HAM. STD. 43H60/6959B-O

ENGINE RPM	POWER SETTINGS						
	DENSITY ALTITUDE - FT	SL	5000	10000	15000	20000	
2900	INBOARD BHP	2880	2920	2765 F.T.	2365 F.T.		Maximum Power — Max allow. CHT, 260° C; 5 min. time limit; Limit BMEP, 234 to 240.
	INBOARD BMEP	234	238	225	192		
	LIMIT MAP	52.0	50.5				
2600	INBOARD BHP	2380	2420	2440 F.T.	2055 F.T.		METO Power—Max allow. CHT, 245° C; No time limit; Limit BMEP, 216 to 223.
	INBOARD BMEP	216	220	222	187		
	LIMIT MAP	44.5	43.5				
2400	INBOARD BHP	1780	1810	1840	1795 F.T.	1465 F.T.	Max Cruise Power — Max allow. CHT, 230° C; No time limit; Limit BMEP, 175 to 183.
	INBOARD BMEP	175	178	181	177	144	
	LIMIT MAP	36	36	36			
2400	INBOARD BHP	1780	1810	1840	1795 F.T.	1465 F.T.	Cruise Power—Max allow. CHT, 230° C; No time limit.
	INBOARD BMEP	175	178	181	177	144	
2300	INBOARD BHP	1580	1610	1640	1670 F.T.	1425 F.T.	
	INBOARD BMEP	162	165	168	171	146	
2200	INBOARD BHP	1500	1530	1560	1585 F.T.	1320 F.T.	
	INBOARD BMEP	161	164	167	170	142	
2100	INBOARD BHP	1430	1455	1480	1485 F.T.	1215 F.T.	
	INBOARD BMEP	161	163	166	165	137	
2000	INBOARD BHP	1355	1370	1390	1340 F.T.	1100 F.T.	
	INBOARD BMEP	160	162	164	158	130	
1900	INBOARD BHP	1275	1290	1305	1210 F.T.	985 F.T.	
	INBOARD BMEP	158	160	162	150	122	
1800	INBOARD BHP	1200	1215	1235	1095 F.T.	890 F.T.	
	INBOARD BMEP	157	159	162	144	117	
1700	INBOARD BHP	1130	1150	1160 F.T.	980 F.T.	805 F.T.	
	INBOARD BMEP	157	160	161	136	112	
1600	INBOARD BHP	1060	1075	1045 F.T.	865 F.T.		
	INBOARD BMEP	156	158	154	127		
1600	INBOARD BHP	1015	1030	995 F.T.			
	INBOARD BMEP	150	152	147			
1600	INBOARD BHP	950	965	995 F.T.			
	INBOARD BMEP	140	142	147			
1600	INBOARD BHP	880	895				
	INBOARD BMEP	130	132				
1600	INBOARD BHP	815	830				
	INBOARD BMEP	120	122				
1600	INBOARD BHP	745	760				
	INBOARD BMEP	110	112				

NOTE:

Do not use high blower with low grade fuel. Operation in low blower to be in Auto Rich mixture setting only.

NOTES:

1. Set maximum and METO power by RPM and limit BMEP unless MAP is obtained first. If cabin superchargers are connected, at all except maximum and METO powers, set outboard engines 5 BMEP less than limit values.
2. Inboard engine BMEP values are those expected with standard-day temperature and ram air. Values shown are limits unless full throttle (F.T.) performance is shown. No rpm allowance is included in the full-throttle power settings shown above.
3. Not more than 2 in. Hg difference in MAP is allowable among engines for a given power setting after accounting for cabin supercharger requirements. (This corresponds to 12 BMEP spread when at or near full throttle.) If a greater difference is observed, reduce the power on the engine with the higher BMEP reading until the variation among engines is 2 in. Hg or less.

Figure A2-10

FUEL FLOW
10% LEAN — LOW BLOWER
IGNITION TIMING: 25° ADVANCE

MODEL: EC-121R/C-121G
DATA AS OF: 31 MARCH 1967
DATA BASIS: FLIGHT TEST

ENGINE: (4) R3350-93A
PROPS: HAM. STD. 43H60/6959B-O

FUEL GRADE: 115/145
FUEL DENSITY: 6.0 LB/US GAL

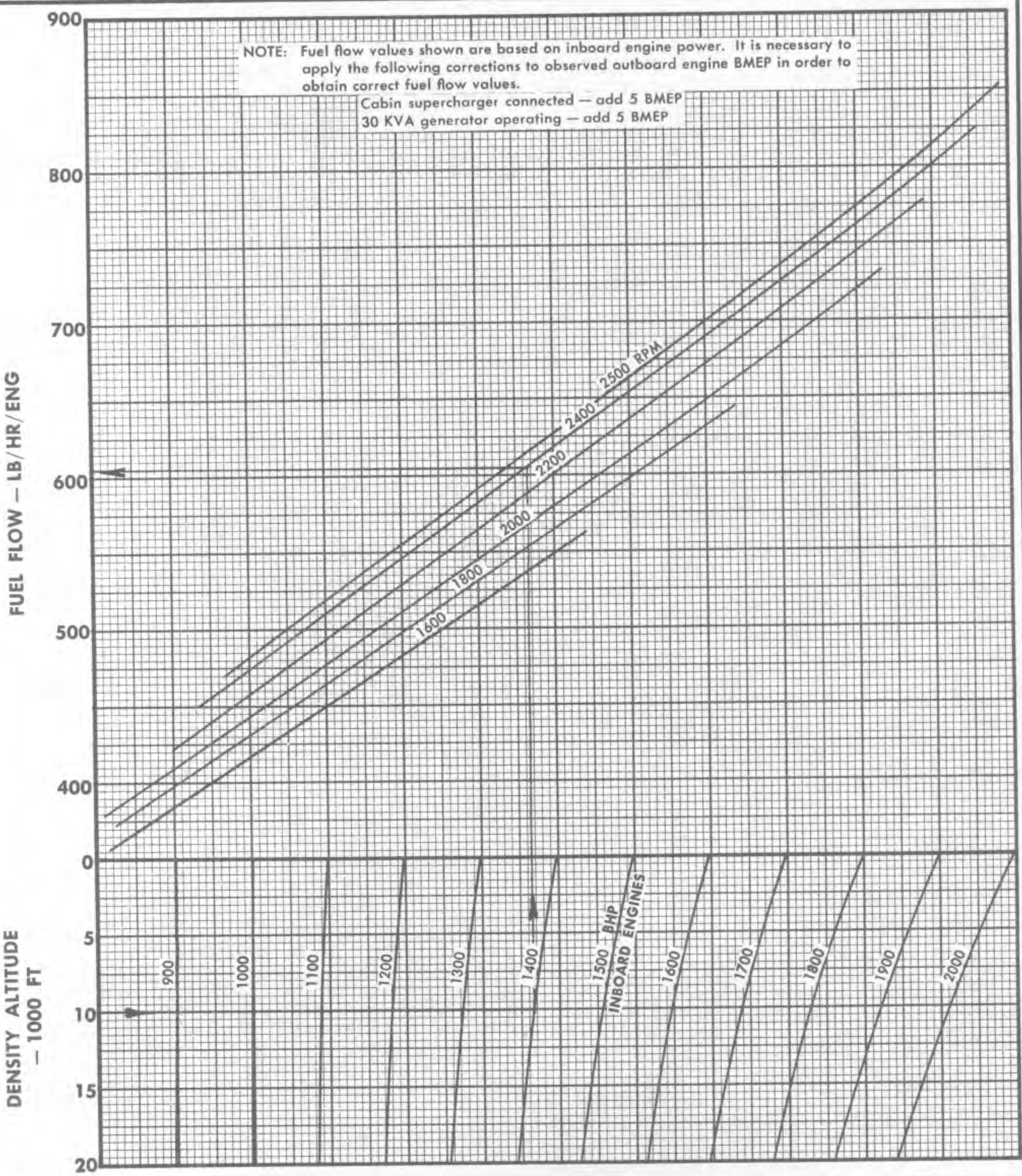


Figure A2-11

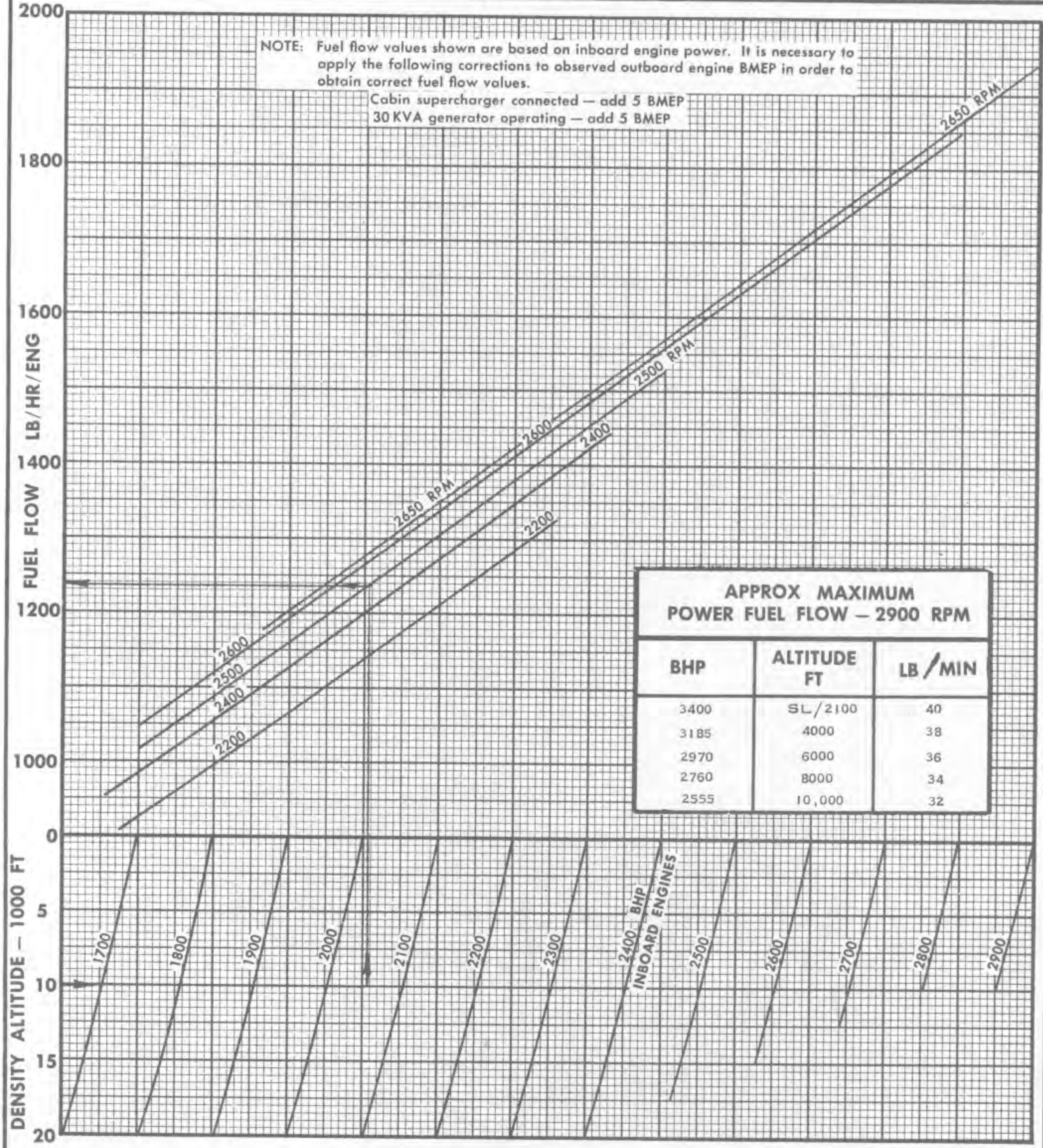
FUEL FLOW
AUTO RICH — LOW BLOWER
IGNITION TIMING: 20° RETARD

MODEL: EC-121R/C-121G
DATA AS OF: 31 MARCH 1967
DATA BASIS: FLIGHT TEST

ENGINE: (4) R3350-93A
PROPS: HAM. STD. 43H60/6959B-O

FUEL GRADE: 115/145
FUEL DENSITY: 6.0 LB/US GAL

NOTE: Fuel flow values shown are based on inboard engine power. It is necessary to apply the following corrections to observed outboard engine BMEP in order to obtain correct fuel flow values.
Cabin supercharger connected — add 5 BMEP
30 KVA generator operating — add 5 BMEP



APPROX MAXIMUM POWER FUEL FLOW — 2900 RPM

BHP	ALTITUDE FT	LB/MIN
3400	SL/2100	40
3185	4000	38
2970	6000	36
2760	8000	34
2555	10,000	32

Figure A2-12

FUEL FLOW

10% / 15% LEAN HIGH BLOWER
IGNITION TIMING: 20° RETARD/25° ADVANCE

MODEL: EC-121R/C-121G
DATA AS OF: 31 MARCH 1967
DATA BASIS: FLIGHT TEST

ENGINE: (4) R3350-93A
PROPS: HAM. STD. 43H60/6959B-O

FUEL GRADE: 115/145
FUEL DENSITY: 6.0 LB/US GAL

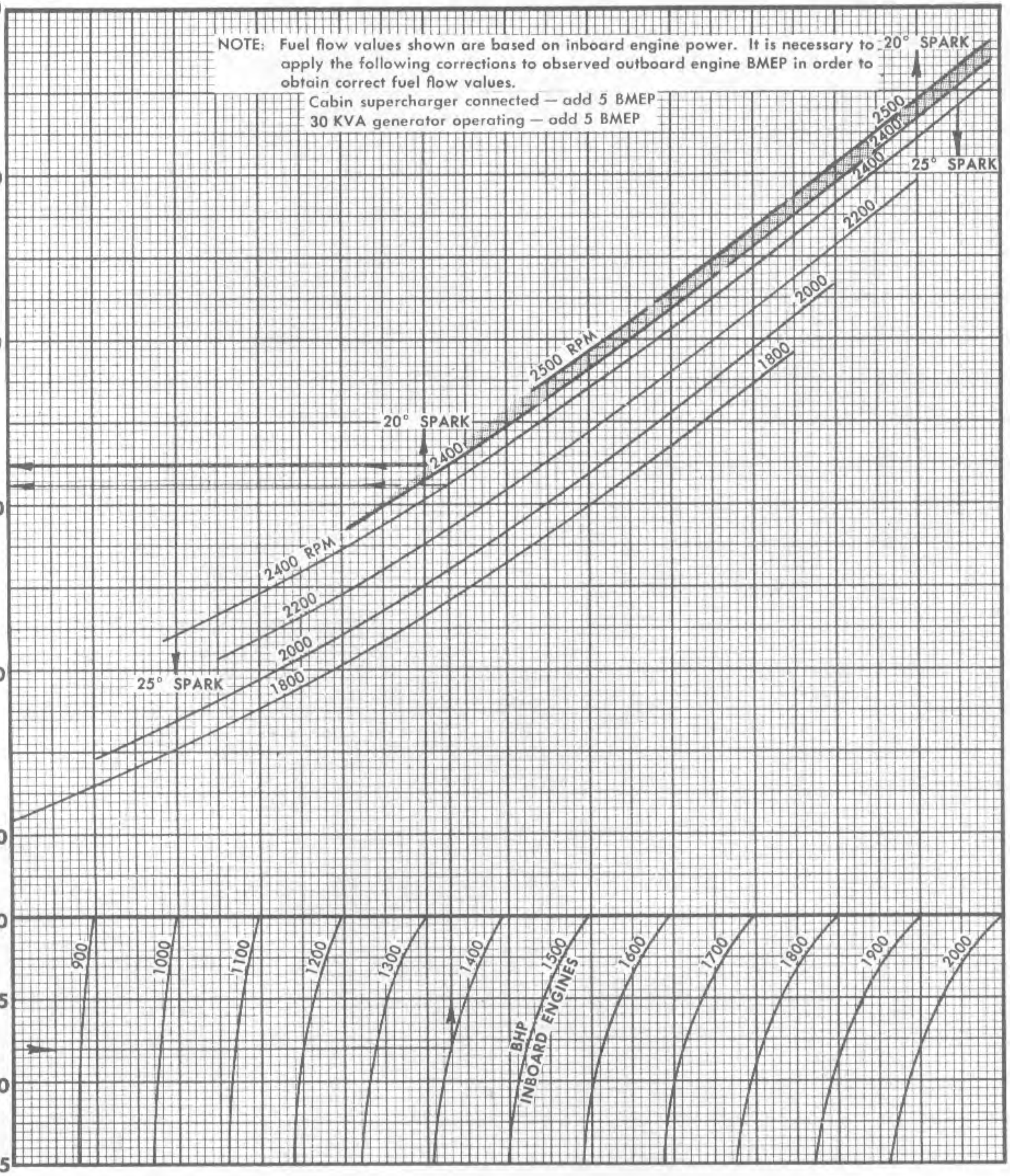


Figure A2-13

FUEL FLOW
AUTO RICH — HIGH BLOWER
IGNITION TIMING: 20° RETARD

MODEL: EC-121R/C-121G
DATA AS OF: 31 MARCH 1967
DATA BASIS: FLIGHT TEST

ENGINE: (4) R3350-93A
PROPS: HAM. STD. 43H60/6959B-C

FUEL GRADE: 115/145
FUEL DENSITY: 6.0 LB/US GAL

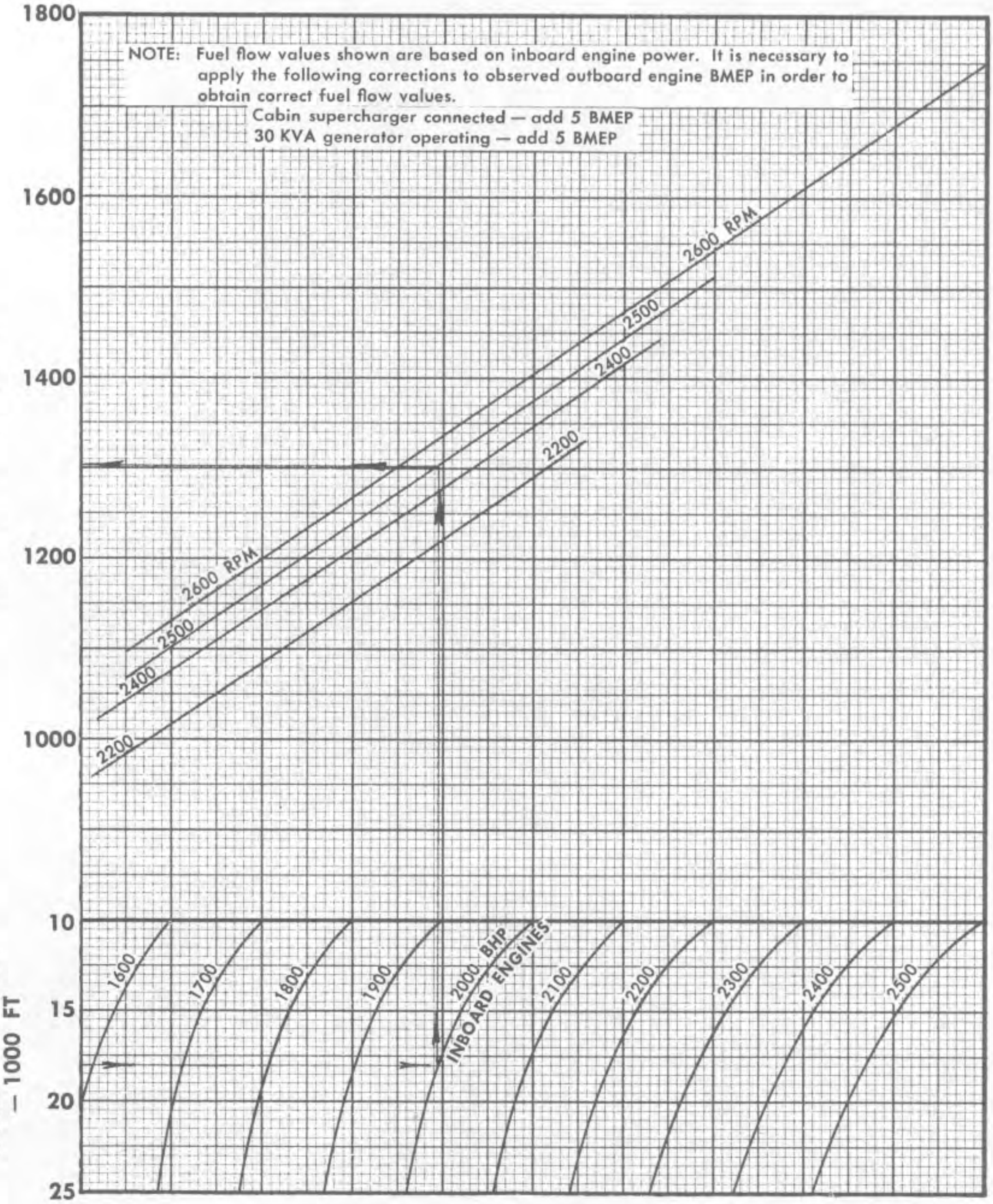


Figure A2-14