part 5—CRUISE

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Page numbers in bold face type denote illustrations.

SCOPE.

The charts and tables provided here aid efficient flight planning and permit evaluation and selection of specific methods of operation most suited to assigned missions. Text material following the discussion of the charts provides background information needed to understand cruise control. A drag conversion chart is shown first. Composite cruising charts are discussed and shown next. These allow a rapid survey of the operating weight, speed, and altitude combinations available. The accompanying fuel flow data allow a quick evaluation of any proposed type of operation. Moreover, the composite charts can be used prior to or during flight for any type of cruise control schedule. The specific range charts included next can be used directly in the computation of all types of flight plans. Miles-per-pound data are included for altitudes from sea level to 25,000 feet in 5000-foot increments and for weights from 80,000 to 145,000 pounds. Power settings shown will result in maximum overall operating economy from a standpoint of combined engine and propeller efficiencies. Operating tables and time-and-distance prediction charts are included at the end of this part. They summarize performance for long-range and holding-speed schedules, and are obtained directly from the composite cruising charts.

DRAG CONVERSION CHART.

The drag conversion chart (figure A5-1) is presented which shows the effects on airspeed of cowl flaps, oil flaps, after-cooler (heat exchanger) scoop, and exit door positions. The decrease in speed with change in flap position is dependent upon the speed at the minimum drag position. Approximately 7 1/2 knots calibrated airspeed loss will be experienced by changing the oil flaps from the minimum drag position to the 50 percent open position. Approximately 9 knots calibrated airspeed is lost by varying cowl flap position from the minimum-drag to 40-percent-open position. The lower curve shows the effect of cabin air-conditioning primary and secondary heat exchanger scoops and exit doors on airspeed. Cruise performance is based on operation with flaps in minimum drag position and in primary after-cooler (heat exchanger) scoop and exit door open (3-knot loss).

The following example is provided to illustrate the use of the drag conversion chart.

Conditions.

- Cruising speed—175 knots
- Cowl flaps—30% open
- Oil cooler flaps—40% open
- Primary aftercooler and exit doors—open
- Secondary aftercooler scoop—open

Since the four-engine cruise performance is based on settings other than these, the following adjustments (from figure A5-1) are made to predict a speed for a given power:

a. Cowl flaps, 3 knots CAS loss (difference between 10% and 30%).

b. Oil cooler flaps, 4.5 − 0.5 = 4 knots CAS loss (difference between 25% and 40%).

c. Aftercooler scoop, 5.5 − 3 = 2.5 knots CAS loss (difference in opening the secondary scoop).

Therefore, there is a total speed loss of 3, 4, and 2.5 or 9.5 knots CAS from that expected for a specified power setting.

COMPOSITE CRUISING CHARTS.

Composite cruising charts (figures A5-2 through A5-8), are included, which cover four-, three-, and two-engine operation. Use of these charts permits rapid determination of level flight speeds, power settings, and fuel flows for any given weight and density altitude.

Power settings required for various cruising speed schedules may be determined rapidly by superimposing the desired cruising speed schedule on the center portion of the chart. Required power schedules and resultant fuel flows may be read directly above and below the speed-schedule line opposite the desired flight altitude.

Separate charts are furnished for low and high blower. The low-blower, 10-percent lean charts include an AUTO RICH portion (shaded area) to facilitate high weight and altitude flight planning. High-blower operation is presented with AUTO RICH (shaded area) and lean mixture on one chart. High blower lean mixture power settings and fuel flows are applicable to either 10 or 15 percent lean.

Power settings obtained from these charts apply directly to the inboard engines and include the 50-rpm allowance in full throttle. An allowance of 5 BMEP must be made between inboard and outboard engines in part throttle to account for cabin supercharger power requirements with normal cabin pressurization requirements. An additional allowance of up to 5 BMEP (depending on the electrical power requirements) must be made when the 30 kva generators are operating.

Performance shown on these charts will be obtained if the aircraft is flown in the cruise configurations noted on the miles-per-pound charts.

DETERMINATION OF CRUISING CEILING FROM COMPOSITE CHARTS.

Use figure A5-2 to determine the low blower cruising ceiling with maximum cruise power and 10 percent lean mixture. Enter the chart at the expected gross weight, move horizontally to the desired cruise speed, shown as equivalent airspeed (EAS), then vertically into the power section to the 2500 rpm line in the 10 percent lean area. The altitude is found by moving horizontally to the left. This is indicated by steps marked (A) on the sample chart. Should this altitude be lower than desired, reenter the chart at the desired altitude, move horizontally to the right to the 2500 rpm line, proceed vertically downward to the minimum acceptable cruising speed, and again move horizontally to the right. The gross weight that is read is the maximum weight that may be used for flight planning at the conditions stated (illustrated by steps B on the same chart). Should a higher cruising altitude still be desired, a shift to AUTO RICH mixture or high blower may be necessary. Corresponding cruise ceilings can be determined from figures A5-3 through A5-8 using the procedure described above.

USE OF COMPOSITE CHARTS TO CONSTRUCT CRUISING TABLES.

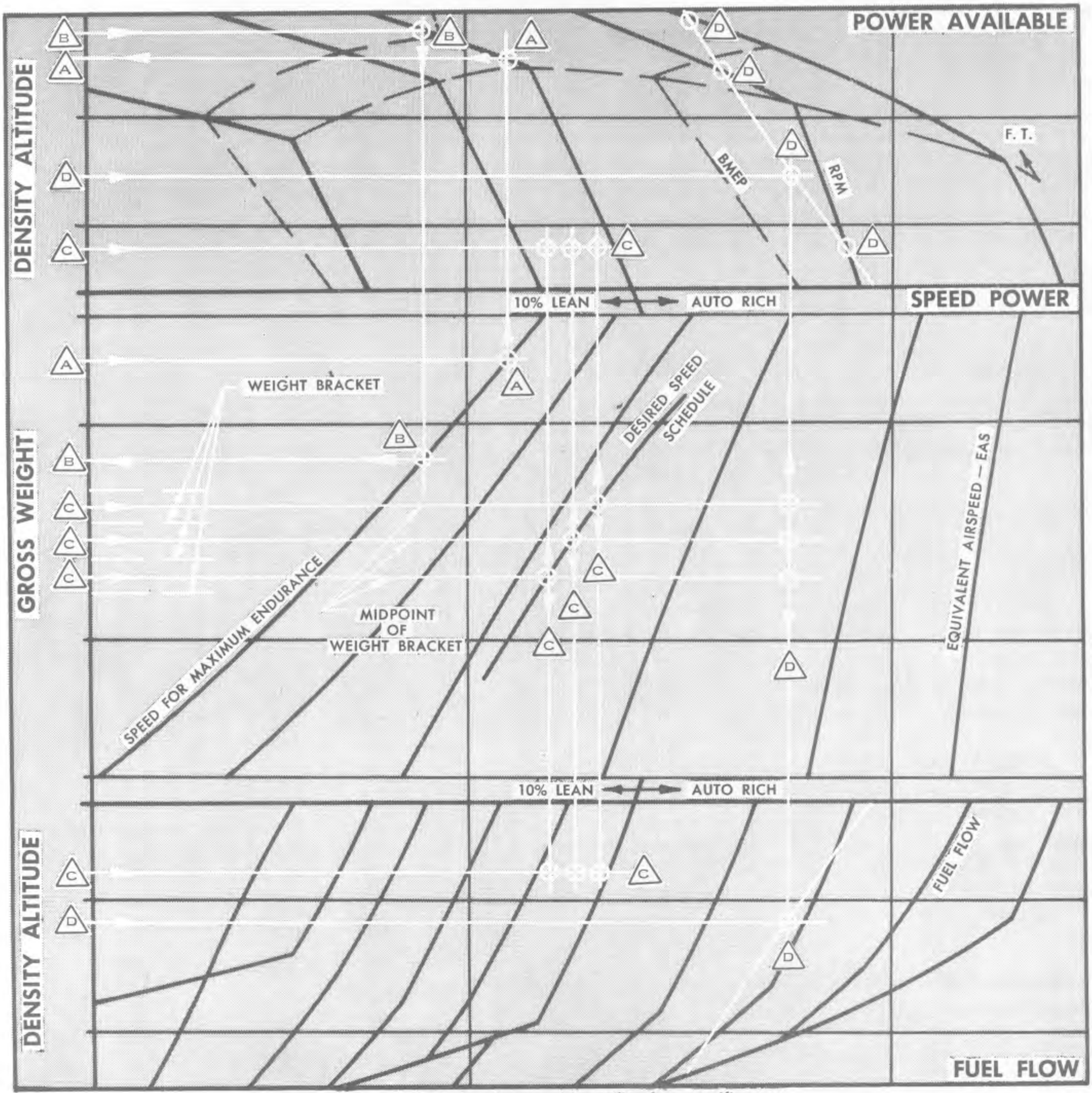
The composite charts may also be used to develop cruising tables for any desired cruise schedule, such as long-range, high-speed, constant-power, etc., or combination schedules, such as long-range and constant-power. For a specified speed schedule, the cruising speed is plotted in the speed-power section (center) in EAS values. The cruising weight is divided into weight brackets of 1000, 2000, 3000, or 4000 pounds, depending on the variation of speed that can be tolerated. Increments of 3000 pounds are recommended. Enter at the midpoint of each weight bracket and move horizontally to the scheduled equivalent airspeed. Draw a vertical line from the speed to the power available and fuel flow sections (upper and lower). The BMEP, rpm and fuel flow values may be read by entering the upper and lower sections at the desired cruise altitude lines and moving horizontally to the intersection with the vertical line. This procedure is outlined by steps (C). BMEP values are read at the lowest whole value. All fractions are dropped so as not to overboost the engine; e.g., the 181.6 BMEP position on the chart would be read as 181.

A constant-power schedule would require a power line superimposed on the upper and lower portions. This is accomplished by calculating the BMEP and rpm values for the BHP in question and plotting them in the power-available section. This is shown as step (D). The extraction of the rpm, BMEP, fuel flow, and speeds for the desired altitudes and weight brackets is the same as previously described. The following example is shown on figure A5-2:

Conditions.

- Four-engine operation
- Low blower, 10% lean mixture
- Speed of 193 knots, EAS
- Weight bracket, 123,500 to 120,500 lb
- Density altitude, 11,000 ft

COMPOSITE CRUISE CONTROL CHART



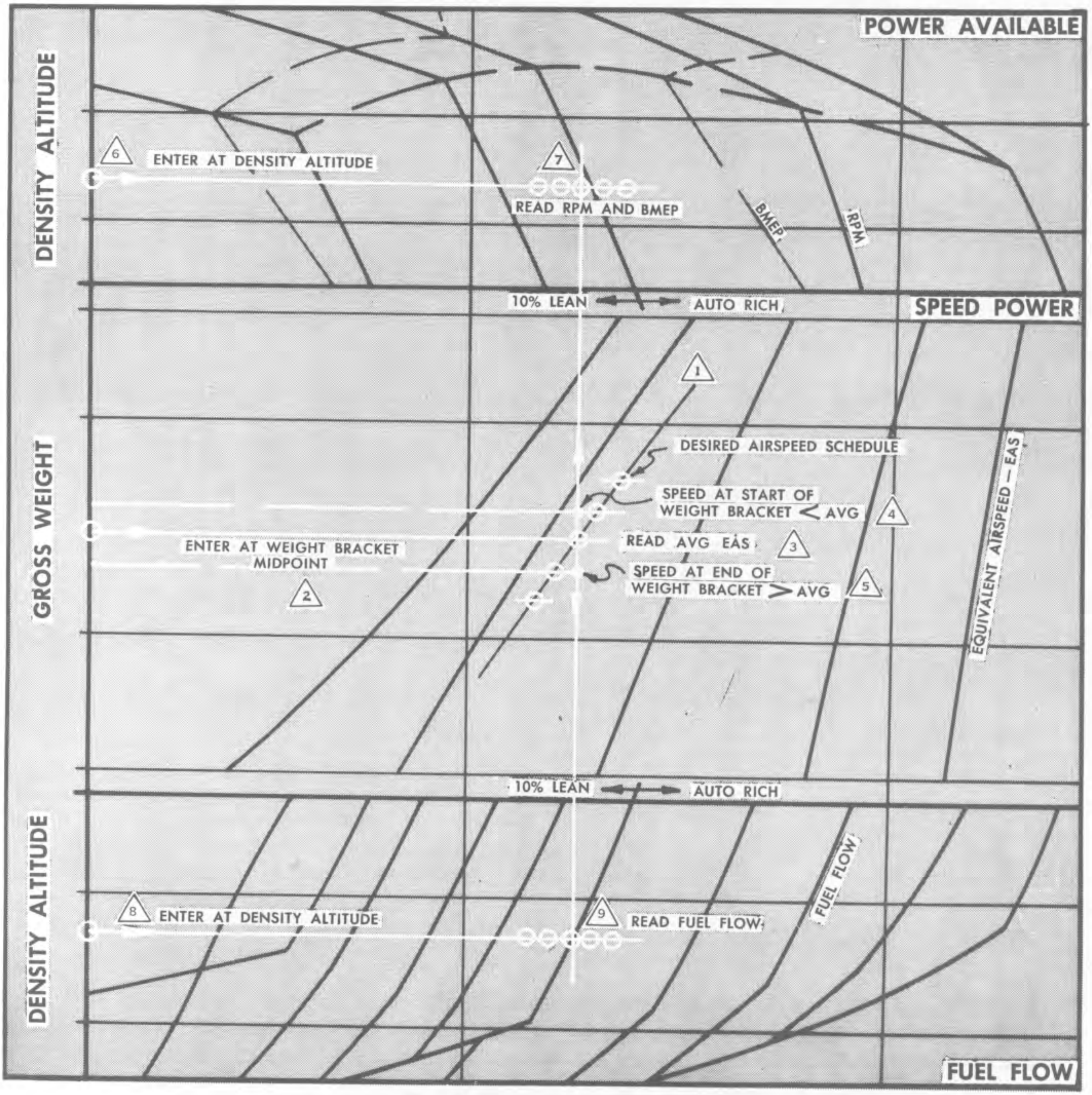
A — A Illustrates maximum cruising ceiling for a specific gross weight and speed with 2500 rpm, 10% lean

B — B Illustrates maximum cruising weight for a specific altitude and speed with 2500 rpm, 10% lean

C — C Illustrates the method of tabulating a specific cruise schedule at given altitudes

D — D Illustrates the method of tabulating a constant power cruise schedule

COMPOSITE CRUISE CONTROL CHART



1. Select desired airspeed schedule versus gross weight — 1
2. Read average airspeeds for weight brackets selected — 2, 3
3. Read power settings corresponding to flight altitude and average airspeeds — 6, 7
4. Read fuel flows corresponding to flight altitude and power settings — 8, 9

The midpoint of the weight bracket is 122,000 pounds. Entering the chart at 122,000 lb gross weight, proceed to 193 knots and then vertically to the power and fuel flow sections. Read the following values at 11,000 ft:

RPM	2200
BMEP	169
BHP (RPM × BMEP/236)	1575
Fuel flow (lb/hr/engine)	640

The average equivalent airspeed is converted to true airspeed by the formula TAS = (EAS × $1/\sqrt{\alpha}$). The time is found by dividing the weight increment by the fuel flow (four engines). The air distance flown is found by multiplying the true airspeed by the time.

Average TAS after adjusting for tip tank installation (193 − 2) × (1.1822)	226
Time: hr, min	1:10 (1.171 hr)
Distance: nautical air miles	265

ADJUSTMENT FOR DRAG EFFECTS.

To find the BHP required to compensate for additional drag effects or speed loss, read the chart using a faster speed than desired by an amount equal to the speed which would otherwise be lost due to the drag.

Example.

A 193-knot EAS long-range cruise speed is desired at 122,000 pounds. Flap settings indicate a 3-knot EAS drag increase (from Drag Conversion Chart, figure A5-1) over conditions stated on the Composite Chart. Enter Composite Chart at 122,000 lb; proceed to 196 knots, and read the power and fuel flow above and below this point.

WIND CORRECTIONS TO RANGE VALUES.

Wind corrections may also be made to the range values calculated from composite chart readings. The distance for the weight bracket is adjusted by the amount equal to the time increment for the bracket multiplied by the true wind component.

Example.

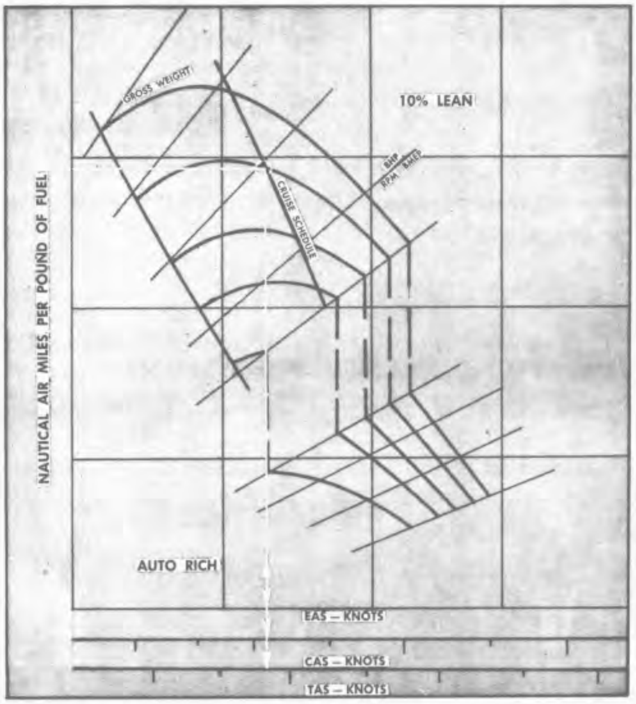
a. Zero-wind conditions, 265 nautical air miles, 1.171 hours, and 226 knots TAS.

b. 40-knot true headwind component

(40) × (1.171) = 47 nautical air miles;
265 − 47 = 218 nautical ground miles.

Or,

(226 − 40) × (1.171) = 218 nautical ground miles.



MILES PER POUND OF FUEL CHARTS.

Miles-per-pound charts are included in this section as figures A5-9 through A5-27. Data are included for four-, three-, and two-engine operation for weights from 80,000 to 145,000 pounds, except where limited by power available, and for density altitudes from sea level to 25,000 feet, in 5000-foot increments.

The use of the specific range curves is straight-forward. The initial entry is determined by the type of schedule desired. For example, from figure A5-11, recommended long range cruise speed schedule is as follows:

Gross Weight	118,000 lb
BHP	1500
EAS	192 knots
TAS	224 knots
Specific Range	0.0910 nmi/lb fuel
INBD BMEP (figure A2-9)	168
RPM (figure A2-9)	2110

To adjust data for tip tank installation or any other drag effect, parallel a constant power line for the decreased speed (2 knots in this case) and read the following:

EAS	190 knots
TAS	222 knots
Specific Range	0.0902 nmi/lb fuel

Gross weight, BHP, inboard BMEP, and RPM are the same as previously read. Thus, with 3000 pounds of fuel, the range would be (3000) × (0.0902) or 271 nautical miles.

TIME-AND-DISTANCE PREDICTION CHARTS.

The time-and-distance charts summarize range available and flight time for operation at holding and long-range cruise speed schedules.

Note

> Allowances are included for cabin pressurization and scoop drag. However, no allowance is included for time, distance, or fuel used during climb.

The time-and-distance charts are used on an incremental basis as illustrated by the following example:

Starting Gross Weight	130,000 lb
Ending Gross Weight	115,000 lb
Cruise Density Altitude	9,000 ft (Low Blower)
Time	16.80 − 10.90 = 5.90 hr (Figure A5-28)
Distance	3050 − 1720 = 1330 nautical air miles (figure A5-29)

Predicted distance for tip tank installation is approximately 99 percent of chart distance, (1330) × (.99) or 1317 nmi.

Time-and-distance prediction charts recommended for long-range operation with three engines operative are given in figures A5-30 and A5-31. While this type of operation represents an abnormal flight condition, ample performance is available as long as high altitude flight is not required. AUTO RICH power settings are required at heavy gross weights. If prolonged flight is necessary, a cruising altitude should be selected which allows use of lean mixture power settings as soon as possible.

Three-engine specific range values are 90 to 95 percent of four-engine range values at lower altitudes and intermediate weights, and approach 100 percent of the four-engine values at light weights.

The time-and-distance prediction charts for long-range operation on two engines are shown in figures A5-32 and A5-33. Only low-blower performance is shown, as two-engine performance is limited to low altitudes. Cabin superchargers are assumed to have been disconnected to utilize all available power for propulsion. Most two-engine operations require AUTO RICH power settings. A study of the fuel economy charts, however, reveals that 10 percent lean power settings may be used instead of AUTO RICH if terrain clearance permits a low flight altitude.

CRUISE OPERATING TABLES.

Figures A5-37, -37, and -39, provide detailed power settings and fuel planning data for operation at long-range cruise speed schedules. They are compatible with the composite cruise control charts and are directly applicable when operating in the configuration shown on the nautical-miles-per-pound-of-fuel charts. Blower shifts schedules are arranged to comply with the current recommended WAD operating procedures. However, a 2000-ft high blower overlap is shown on sheet 5 of figure A5-37 for the 4-engine long range cruise. Tables presented are constructed to include power settings, fuel flow, true and equivalent airspeeds, air miles, and time. Cruising density altitudes from 3000 to 23,000 feet are included. The values are selected for the midpoint of each 3000-pound increment of fuel used. This arrangement allows several rule-of-thumb adjustments to be made in flight or during flight planning.

Correction of air miles to be flown for wind component is made as follows: Convert the hours and minutes to a fraction of an hour. Multiply the true wind velocity component by this time fraction and adjust the air miles entries by the amount obtained. For example, if the true headwind component is 40 knots, air miles for a weight bracket is 345 nmi, and time required is 1 hr and 24 min; wind setback is 1.4 × 40, or 56 nmi, and ground nautical miles traveled is 345 − 56, or 289 nmi.

Should the predicted airspeeds not be realized because of excessive drag or other factors, the distance would be adjusted as follows: if the predicted speed for the previous example is 197 EAS and only 190 knots is attained, the loss is 7/197, or 3.5%. Since 3.5% of 289 is 10 nmi, only 289 − 10, or 279 nmi would be traveled during the 1 hour and 24 minutes. These values are based on using 3000 pounds of fuel in 1 hour and 24 minutes. If the fuel consumption were excessive, this time would be reduced. Should the predicted fuel flow for the previous example be 705 as compared to actual consumption of 725 lb/hr/engine (after flowmeter instrument calibration corrections), the fuel flow increase of 20 lb/hr reduces the time by 20/705, or approximately 3%. The 84-minute period will be reduced by this percentage and becomes 82 minutes. Distance traveled is reduced by the same percentage (if wind and speed corrections are not large) and becomes 270 nautical miles.

BASIS FOR RANGE PREDICTIONS.

The performance which can be obtained with any power schedule is a function of many variables. These include airspeed, gross weight, mixture setting, cowl flap position, power schedule, altitude, temperature, and number of engines operating. Each has an effect on overall performance which can be expressed in terms of distance flown per unit of fuel used, or fuel economy, which is a direct measure of the efficiency with which the aircraft is being operated.

Power schedules presented in Part 2 are shown in terms of engine speed (rpm), inboard engine torque (BMEP), and inboard engine brake horsepower. Use of the tachometers and BMEP gages will allow a uniform type of cruise control to be used based on density altitude. It will be independent of ambient air conditions and differences between individual engines as long as the engines are not operated at limit manifold pressure.

Manifold pressure gage readings should be used as checks to ensure that engine operating limits are not exceeded. Manifold pressure limits must be observed if they are reached before BMEP limits are reached. In addition, no more than 2 in. Hg difference in manifold pressure is allowable among engines set at the same power. A greater difference is indicative of engine or BMEP gage malfunction, and power on the engine with the higher BMEP reading should be reduced until the variation among engines is 2 in. Hg or less.

The effect of using high blower when it is not required for a given power setting is to increase the amount of fuel consumed by the engines and decrease range. This is due to the higher internal horsepower required to drive the blowers at the greater speed. Miles-per-pound charts are shown for both high and low blower operation for some altitudes, and a rapid comparison can be made between the two operating conditions to determine the optimum blower setting.

Auto rich and lean mixture cruise performance is given for airspeeds ranging from holding to maximum continuous power operation. Power schedules are shown on the miles-per-pound charts in terms of inboard engine power. Limit manifold pressures are included.

Power available schedules were derived from the standard-day power available chart and the engine power schedule table. Full-throttle cruising power settings have been adjusted by a 50-rpm allowance to allow for possible decrease in full-throttle power available due to engine wear or operation with air temperature above standard. Fuel consumption values were obtained from the fuel flow charts for operation with AUTO RICH and lean mixture settings (see Part 2). If power required for full-throttle cruise can be obtained at less than charted values, a lower rpm should be used to conserve fuel.

CRUISE CONTROL.

Large aircraft are of such complexity as to demand the application of rigid cruise control techniques if maximum utility of the aircraft is to be realized. The term "cruise control" means intelligent flight planning and operation of an aircraft to accomplish the assigned mission most efficiently. These missions will be of such a variety that it is impractical to present detailed performance data for all types which might be anticipated. Basic information is provided which permits the evaluation of a wide selection of operational techniques. However, before discussing the various types in detail, an understanding of a few basic principles is necessary.

Consideration should be given to the performance of the aircraft-engine-propeller combination. These primary items determine the area of operation within which the aircraft can accomplish a specific mission.

Since most missions can be accomplished in several ways, consideration should also be given to airplane utilization factors which may govern from an overall point of view. These factors include, among others, total flight time per trip and number of trips possible per time period, weight of cargo, fuel expense per trip, and crew relief requirements for long and short haul operations. In many cases, the final selection may be a compromise based on these several requirements. When considering performance only, maximum efficiency of propeller-driven aircraft occurs when the combined efficiencies of the propeller, engine, and aircraft-wing combinations are so perfectly matched that all components maintain maximum efficiency at the same airspeed for each possible flight condition. However, since compromises were made in the selection and design of these components, these compromises must be reflected in the selection of cruise control procedures. Wing efficiency is the primary factor affecting cruising characteristics, although engine performance may govern under some conditions. Properly selected constant-speed-propellers usually maintain near-maximum levels of efficiency if normal engine and aircraft operating procedures are used. Every aircraft has an angle of attack of the wing at which the least amount of drag is created for the lift produced. This is usually expressed as the angle for maximum lift: drag, or L/D ratio, and operation at this angle results in maximum efficiency as far as the wing alone is concerned.

Powered aircraft cannot cruise at a given altitude for long periods at both a constant L/D ratio and constant indicated airspeed. Gross weight changes in flight as fuel is consumed; therefore, airspeed must be progressively reduced to fly level at a constant L/D. The speed reduction schedule can be represented by the equation: $EAS_2 = EAS_1 \times (W_2/W_1)^{1/2}$, where W_1 and W_2 refer to initial cruise and enroute weights, respectively. This speed variation maintains wing lift equal to gross weight at constant angle of attack.

A maximum L/D ratio speed schedule seldom achieves maximum range for modern transport aircraft. From a practical point of view, effects of airspeed variations with turbulence, inaccurate altitude control, etc., are greater and of longer duration at or below the speed for maximum L/D ratio than they are for somewhat higher speeds. In addition, the combined efficiencies of the engine and propeller may be such that maximum overall efficiency is not maintained.

Engine life and brake specific fuel consumption (BSFC) are the measures of engine operating efficiency to be considered. Engine reliability and time between overhauls is self-explanatory. A power plant which continually needs attention and repair does not contribute its full share or serve its intended purpose; however, with proper use, a long and efficient time between removals for overhaul can be obtained.

Cruise power occupies the largest percentage of an engine's total operating time and is the outstanding factor affecting its life, performance, and operating economy. This is substantiated by extended service history over a period of years of similar engines in identical aircraft installations. Lower cruising powers extend engine life and result in better engine performance. The brake horsepower taken from the engine is not the only operating factor that influences engine life. The manner in which this power is taken is of equal importance. It is readily apparent by reference to the engine calibration curves that a pilot or an engineer can obtain a desired power output by an infinite number of rpm and BMEP settings. It has been shown conclusively by endurance tests that of two engines delivering equal powers, the engine which operates at the lower rpm will have the longer life if the allowable BMEP is not exceeded. The engine operating at lower speed will result in more durability, as evidenced by having higher compression and lower oil consumption. The buildup of piston ring miles along the cylinder walls is a major factor in premature engine wear.

While engine wear is important from the overall point of view, BSFC is the item of immediate concern to a crew in flight. This term is defined as the number of pounds of fuel consumed by the engine per hour divided by the brake horsepower delivered. Normal values to be expected vary from 0.4 to 0.5 pounds per BHP per hour, depending on power delivered, rpm, BMEP, altitude and blower setting. Minimum BSFC and greatest efficiency is normally obtained in low blower, between 2000 and 2400 rpm, and with limit BMEP settings and 10 percent lean mixture strength. The BSFC increases rapidly if less than limit BMEP is used to obtain a given power, since this requires a higher rpm. Other items which detract from engine efficiency are improper mixture, poor or incomplete combustion, friction of moving parts, and heat losses through exhaust and cooling systems.

The flight crew has some control over the losses which affect engine performance. Combustion efficiency can be changed with power settings and mixture control.

Manually leaning to 10 percent lean mixture, using the 10 percent BMEP method, gives the best practical mixture for cruise. A 15-percent BMEP method is recommended in high blower. The largest engine losses controllable by the flight crew are those due to friction of the engine's moving parts. The simplest way to reduce friction is to reduce rpm. However, there is a limit to this reduction due to allowable cylinder BMEP, propeller design, possible vibration difficulties, and minimum accessory speeds.

There is one other faction which should be kept in mind—the portion of engine power which is delivered to accessory equipment but not indicated by the BMEP gages. This includes the generator and cabin supercharger power requirements. While the loads imposed by this equipment are normally allowed for, they should not be permitted to become excessive without good reason.

For example, maintaining high cabin differential pressures when not needed can be wasteful of engine power. This is particularly true in hot weather when refrigerating the cabin air. Besides pumping more air into the cabin than is needed, cooling requirements are such that heat exchanger scoops must be set to wider openings. Extra fuel is required to pump more pressurized air, and more drag is created in cooling it for use.

The efficiency of the propellers is the last item to be discussed here which affects performance. Operation outside the region for near-maximum propeller efficiency can penalize aircraft performance severly. For example, if 85 percent efficiency is a normal value attainable in cruise and only 80 percent is realized because of an improper combination of airspeed and power setting, the power wasted is (85-80)/85, or almost 6 percent of the engine power being delivered.

There is an optimum power setting for maximum propeller efficiency at each altitude and airspeed. The reactions of a propeller are much the same as the reactions of a wing. As with a wing, power must be expended to overcome drag as well as to create lift or thrust. For a given propeller, the amount of power lost is largely a function of true airspeed and propeller rpm. Maximum efficiency occurs when the most engine torque is converted to propulsive thrust, or the most horsepower is transmitted to the air as thrust horsepower. (This is something like operating at the point of maximum L/D for a wing.) Efficiency drops off rapidly as the tip speed approaches the speed of sound. Therefore propeller efficiency must be taken into careful consideration and balanced with efficient engine power settings. This has been done in setting up the cruise power schedules. Flight test data have been used wherever possible.

There are five general rules which should be followed in all types of planning. The first is concerned with gross weight. *Know it*. Know your empty weight, operational weight, loaded weight, takeoff weight, in-flight weight, landing weight, and zero-fuel weight. The performance of the aircraft depends primarily on weight, power, and altitude.

The effect of excess weight on cruise performance must be stressed. It takes more power to fly at an efficient speed when your airplane is heavy than when it is light. The difference in fuel consumed per mile can amount to over 30 percent as shown by the miles-per-pound charts.

Furthermore, don't carry *"pocket"* fuel. The effects of this practice are insidious. The aircraft demonstrates the effect of carrying the extra weight by its performance during takeoff climb, and cruise. If you need the extra fuel, or think you may need it, load it, show it in your weight log, and plan your flight to allow for the additional weight. The cruise charts do not include any allowances for icing, turbulence, navigation tolerances, and items which detract from normal performance. You are in the best position to judge what your needs might be. But, unnecessary reserves increases operating costs due to higher fuel usage and reduced cargo loads.

In all cases, use actual gross weight as the basis for power settings. Keep a log of fuel used in order to determine gross weight variation in flight. The frequency with which power settings should be changed as weight decreases depends on the accuracy with which a cruise control procedure is to be followed. It is recommended that weight increments of no more than 4000 pounds be used. Whenever practical, reduce power for every 3000 pounds reduction in aircraft gross weight. When the weight increments have been selected for a particular operation, set powers at the midpoints of the weight brackets.

The second rule is to operate by *density altitude*. The density of the air is the governing factor. That is what the engines, propellers, and wings are interested in. Air density varies directly with pressure and inversely with temperature. Local barometric pressure and temperature are varying quantities, and the denstiy of the air for a given geometric altitude at any one place will vary from day to day. Cruise control power settings have been established in terms of density altitudes rather than pressure altitudes and air temperatures. If flight plans are prepared in terms of density altitudes, the effects of variation of air temperature from standard is minimized. Do not forget to use an altimeter set to 29.92 in. Hg reference pressure when reading pressure altitude to obtain density altitude.

The aircraft operates most efficiently at density altitudes from 10,000 to 15,000 feet, depending on gross weight. As gross weights decrease, the best operating *density* altitude increases. High blower power setting may be used with good economy in some cases. However, if fuel consumption per nautical mile is of primary concern, operate at the altitude where the required power setting can be obtained with full throttle in low blower without increasing engine speed. The heavy line on the long-range cruising tables show where a blower shift will be necessary. A density altitude just under the altitude for blower shift will be the most efficient for that gross weight.

The effect of wind on cruise range and fuel required is very real and must be considered in flight planning. However, the effect of wind on cruise procedure is another problem. In theory you should speed up in a headwind, and slow down in a tailwind. A headwind decreases the groundspeed and increases the time of flight or the time during which fuel will be consumed. Therefore, for slower type aircraft, it is generally profitable to increase speed and fuel flow in a headwind in order to achieve a saving in trip fuel by reducing flight time. For similar reasons it may be profitable to reduce speed and fuel flow in a tailwind and allow it to give you more help. This aircraft however, flies at relatively high speed and tailwinds are *normally* of little importance when planning speed schedules. In addition, the airspeed schedule recommended for long-range cruise is already above the speed for theoretical maximum range. *Normal* headwinds of up to 40 knots are automatically taken care of. However, an occasion may arise when the absolute maximum miles per pound is necessary. Refer to the miles-per-pound charts (figures A5-9 through A5-27). The following rule of thumb may be used if a wind of greater magnitude exists:

a. Note the true airspeed for maximum air miles per pound of fuel shown on the miles-per-pound charts (figures A5-9 through A5-27) for the appropriate flight weight and altitude conditions.

b. If a headwind exists, add 25 percent of the headwind to this true airspeed schedule, note power settings and calibrated airspeeds to be flown.

c. If a tailwind exists *subtract* 25 percent of the reported tailwind from this true airspeed schedule. Note power settings and calibrated airspeeds to be flown: however, do not schedule speeds slower than those recommended for holding.

d. Compute miles per pound at the modified cruising speed schedule. Miles per pound = (air miles per pound at modified flight speed) × (ground speed/modified true airspeed).

The third rule is to climb no higher than necessary. The fuel saved during a letdown is never equal to the additional fuel used for climb. It is never worthwhile to climb in hopes of regaining the extra fuel expediture in a later descent. Of course, operation at higher levels may be desirable from a standpoint of decreased flight time or to decrease weather turbulence. It may also be desirable to use a step-climb procedure, particularly if operating at heavy initial weights. Start at a relatively low cruising altitude in order to avoid using high power settings, then, as fuel is used and weight decreased, climb to a higher level where the initial power settings provide increased true airspeeds.

The fourth rule is to maintain level flight at the selected cruising altitude. This is the only way in which stabilized speed performance shown in the cruising charts can be realized. The reason is quite simple. Aside from effects of drag items, which can be accounted for, turbulence and small rates of climb are the major factors causing speed loss. The speed loss in climb will be greater, and gain in descent decreased if scoops and flaps are not set to the minimum drag positions. The speed loss will be reduced when operating at higher than long-range cruising speeds. However, speed increase may not be possible at heavy initial cruising weights if maximum cruise power schedules are required for long-range speeds.

The fifth rule is fairly obvious. Use a minimum drag configuration whenever possible to maintain maximum speed. Set cowl and oil cooler flaps to the minimum drag positions noted on figure A5-1 if engine operating temperatures permit it. Small deviations are not serious, but the effect of setting beyond faired positions is large.

Try to maintain comfortable cabin temperatures with the least opening of the air-conditioning system heat exchanger scoops. In particular, avoid full opening of the secondary scoops whenever possible because of their effect on speed. Consider using a slightly higher cabin altitude, and check cabin temperature versus temperature at the flight engineer's station before using full refrigeration.

CRUISE CONTROL SCHEDULES.

The introduction has covered the basic principles involved in cruise control and the general rules which are applicable. The main types of cruise control procedures in use can now be covered.

There are several basic types of cruise control procedures that can be used with considerable success. Some of the most common are listed below. Each has its advantages and disadvantages which depend on airspeed desired, distance to be flown, cargo required, and other consideration. The basic types are:

a. Maximum Range Cruise

b. Long-Range Cruise

c. Modified Long-Range Cruise

d. Constant Power Cruise

e. Constant Airspeed Cruise

f. High-Speed Cruise

g. Holding Speed Cruise, or Maximum Endurance

Maximum Range Cruise.

Maximum range cruise control should be considered first. It forms the general basis for all long distance types of operating schedules. But you should realize at once that it is very seldom used in actual practice, being one of the most difficult cruise-control procedures to apply successfully. Its use requires exact knowledge of aircraft performance as related to wind and weather conditions, precise piloting technique, and fine control of all engines in order to obtain the most miles per pound of fuel used. Maximum range speed and power schedules can be obtained from the peak values shown on the miles-per-pound charts; however, use of such a schedule may not be sufficiently rewarding to justify its use. Effects of turbulence, inaccurate altitude control, etc., are greater and of longer duration at maximum range speeds than at higher speeds. The long-range cruise schedule is approximately 10 percent faster and increases theoretical fuel requirements only about 1 percent.

Long-Range Cruise.

Long-range cruise is the most economical and practical type of cruising procedure for long flights. It requires less trip fuel than any faster schedule, and may be more economical in the long run than a maximum range schedule. Figures A5-28 through A5-33 provide time-and-distance prediction charts for long-range operation.

Data are included for overload weights and AUTO RICH mixture power settings. It is suggested that this schedule be used whenever maximum loads are to be carried over long distance or where fuel consumption must be kept at a minimum.

While the indicated airspeeds for long range schedules are rather low, it will be found that operation at high altitudes will result in relatively high true airspeeds. Fuel economy is not unduly reduced unless rich mixture power settings are used. However, additional climb fuel allowances must be made.

Note

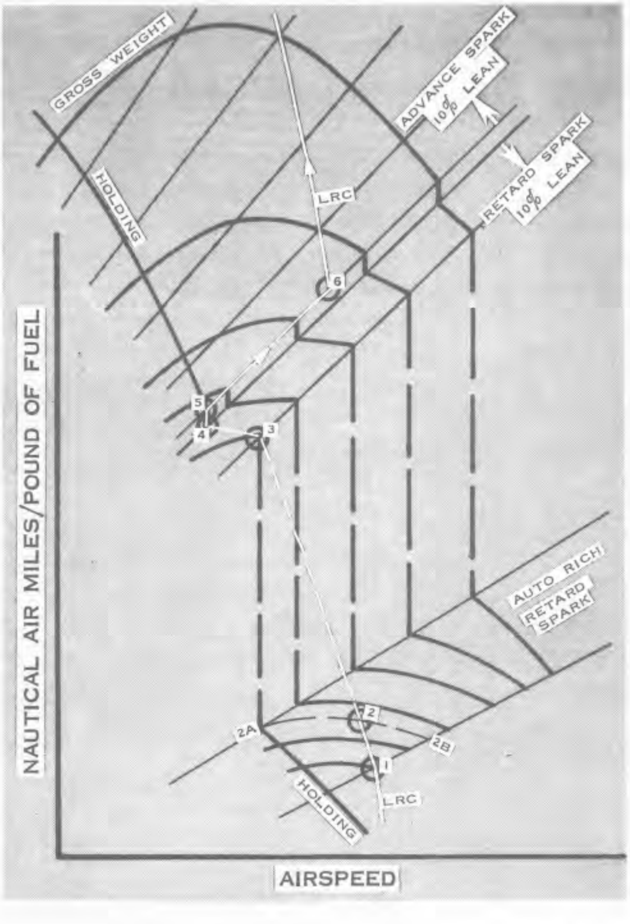
> Refer to the Miles-Per-Pound charts for a comparison of long range schedule specific range and true airspeed values with those for other speed schedules.

While it is true that flying at the optimum IAS for a long time would result in more range, it is impractical to do so. An infinite number of very small power reductions would be required. Long-range cruise is actually a series of constant power cruising segments, or brackets based on aircraft weight. The average airspeed obtained will approximate the optimum IAS for the best practical combination of wing, engine, and propeller efficiencies. The recommended long range cruise schedules are simplified schedules which provide approximately 99 percent maximum miles per pound of fuel used. They are modified to the following basic schedules:

4-engine, low blower:	190 knots EAS @ 116,000 lb ±1/2 knot EAS/1000 lb increase or decrease in weight.
4-engine, high blower:	185 knots EAS @ 116,000 lb ±1/2 knot EAS/1000 lb (except 180 knots EAS minimum average speed).
3-engine, low and high blower:	180 knots EAS @ 116,000 lb ±1/2 knot EAS/1000 lb (except 170 knots EAS minimum average speed).
2-engine	160 knots EAS

These tabulated schedules are shown on the Nautical Miles-Per-Pound of Fuel charts (figures A5-9 through A5-27). However, the schedules are modified for transition from auto rich to 10-percent lean operation.

The sequence followed results in maximum range per pound of fuel used. This is illustrated by the following example:



Starting at point 1 in auto rich, proceed to point 2. This intersection represents a weight (line 2, 2A, 2B) where operation in 10-percent lean is possible at increased range (point 3) with reduced speed. Therefore, set 10-percent lean and follow speed schedule to point 4. At point 4, advance spark (point 5) and fly constant power until the intercept with the long range speed schedule (6). Continue flight with normal long range cruise speeds.

Modified Long-Range Cruise.

Modified long-range cruise procedure is a variation in long range procedure which may be made in flight. Plan the flight in accordance with long-range cruise, then, if the fuel remaining after the equi-time point is reached is sufficient and if there will be no other need for reserve fuel, such as to reach an alternate destination, the cruise power being used at that time may be maintained for the remainder of the flight. This is somewhat similar to operating at an intermediate speed schedule and has many of the advantages of the maximum cruise power schedule. A constant power setting is used for most weight and altitude conditions to minimize cruise control management complexity. Airspeeds are not as high as for the maximum cruise power conditions but are equal to or greater than those for the long range cruising condition in all cases.

Constant Power Cruise.

Constant power cruise is probably the easiest and simplest method of cruise control. One power setting is used continuously for cruise throughout the entire flight. The airspeed increases as the flight progresses, and the average airspeed is usually higher than that recommended for long range. No advantage is taken of the increased range or payload which could be obtained by reducing power as the weight of the aircraft decreases. It is less economical, fuelwise, than some other types of cruise control. Constant power cruise performance data can be obtained from the composite cruise charts (figures A5-2 through A5-8).

Constant Airspeed Cruise.

Constant airspeed cruise is a method whereby power is reduced as gross weight is reduced to maintain constant airspeed. This method simplifies flight planning and in-flight navigation. Power reductions are made at convenient intervals so that the airspeed will average a desired figure for a given distance. The composite cruise charts can be used to advantage in predicting necessary power settings. Although this type of cruising schedule can be more efficient and economical than constant power cruise, it will normally require more fuel per trip than long range cruise.

High-Speed Cruise.

High-speed cruise is a type of cruise control schedule which utilizes the maximum cruising power available with lean mixture. It results in the shortest flight time per trip. It also decreases engine life somewhat due to the engine speeds used. This type of cruise control is usually used for missions where speed is vital.

Use of maximum cruise power allows the aircraft to develop a higher continuous speed with reasonably economical fuel consumption and a minimum of cruise control management complexity. The schedule is particularly effective for operations at moderately short ranges when an increase in the fuel load does not require a flight at overload weights.

The high-speed cruise schedule requires expenditure of more fuel than would be necessary if long range or intermediate speed procedures were followed. The differences in fuel required become greater at lower altitudes.

Holding Endurance.

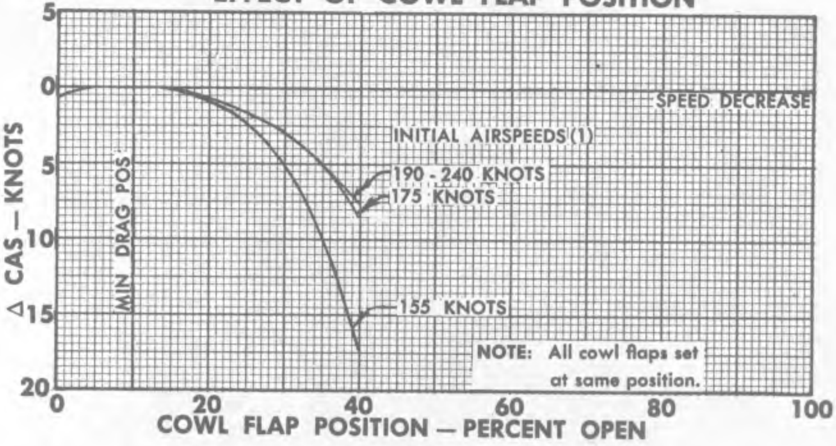
Holding on maximum endurance cruise performance is a function of the same variables as those which affect maximum range performance, except that the time flown per unit of fuel used is the measure of efficiency for this type of operation. In order to obtain maximum endurance, low airspeeds and the lowest practical altitude should be used so that the engine power requirements and fuel flow may be reduced to a minimum. The recommended holding endurance power settings are based on operation at speeds for a lift coefficient (C_L) of 0.7. This speed schedule results in slightly higher than absolute minimum fuel flows, but it represents a practical flight condition which permits operation in mild-to-moderate turbulence. Extension of the wing flaps decreases the speed necessary for level flight. The deck angle is also decreased, which lessens the difficulty of maintaining a low airspeed. However, the extension of the wing flaps increases the minimum power required and decreases the endurance time available.

FOUR ENGINE OPERATION
DRAG CONVERSION
EFFECTS OF COOLING FLAP AND SCOOP POSITIONS ON AIRSPEED

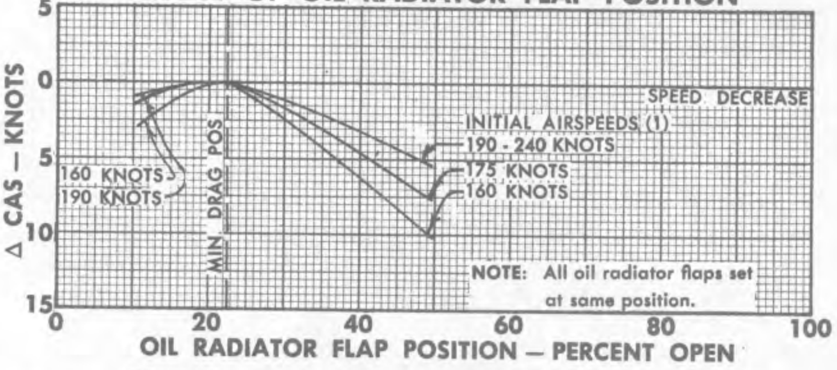
MODEL: EC-121R
DATA AS OF: 31 MARCH 1967
DATA BASIS: FLIGHT TEST

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

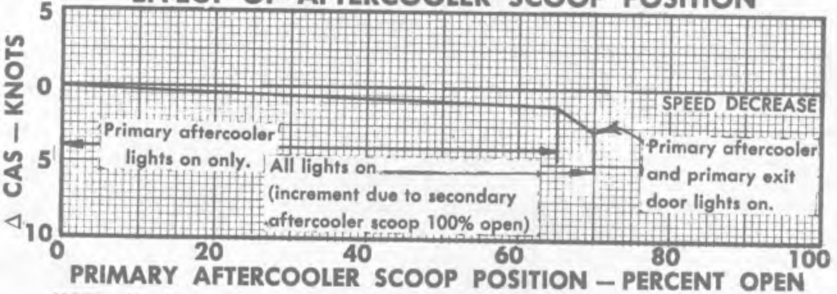
EFFECT OF COWL FLAP POSITION



EFFECT OF OIL RADIATOR FLAP POSITION



EFFECT OF AFTERCOOLER SCOOP POSITION



NOTE: Maximum primary aftercooler opening while in flight equals 70% of full travel.

REMARKS:

1. Change in velocity based on initial airspeed occuring at minimum drag position.
2. Closing the ram air door decreases the CAS approximately 2 knots.
3. Tip tank installation will decrease the CAS 2.0 to 2.5 knots,

Figure A5-1

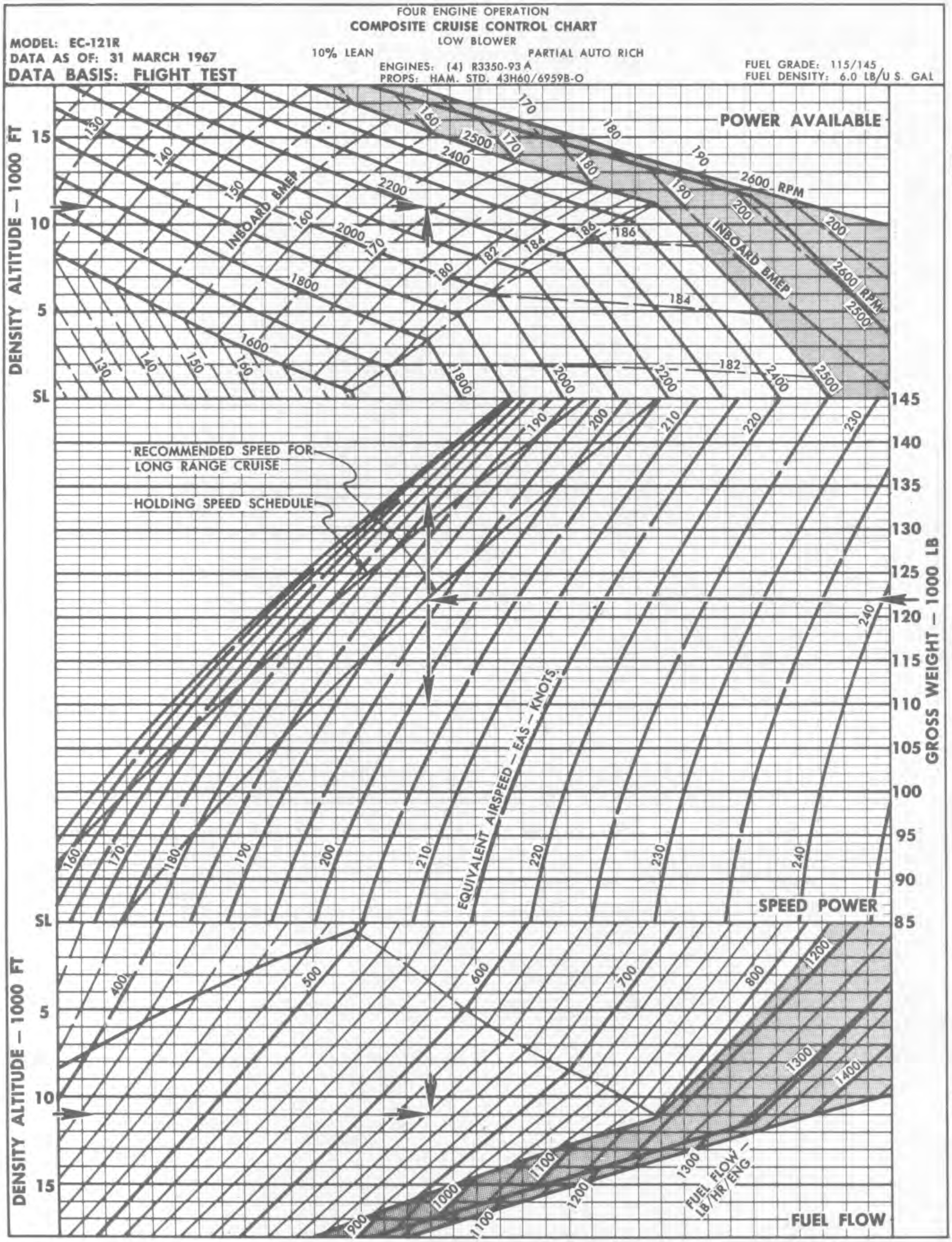

FOUR ENGINE OPERATION
COMPOSITE CRUISE CONTROL CHART
LOW BLOWER
MODEL: EC-121R
DATA AS OF: 31 MARCH 1967
DATA BASIS: FLIGHT TEST
10% LEAN
PARTIAL AUTO RICH
ENGINES: (4) R3350-93 A
PROPS: HAM. STD. 43H60/6959B-O
FUEL GRADE: 115/145
FUEL DENSITY: 6.0 LB/U S. GAL
POWER AVAILABLE
2600 RPM
2500
2400
2200
2000
1800
1600
INBOARD BMEP
130
140
150
160
170
180
182
184
186
190
200
DENSITY ALTITUDE – 1000 FT
SL
5
10
15
RECOMMENDED SPEED FOR LONG RANGE CRUISE
HOLDING SPEED SCHEDULE
EQUIVALENT AIRSPEED – EAS – KNOTS
210
220
230
240
GROSS WEIGHT – 1000 LB
85
90
95
100
105
110
115
120
125
130
135
140
145
SPEED POWER
400
500
600
700
800
900
1000
1100
1200
1300
1400
FUEL FLOW – LB/HR/ENG
FUEL FLOW

Figure A5-2

FOUR ENGINE OPERATION

COMPOSITE CRUISE CONTROL CHART

HIGH BLOWER

10 %/15% LEAN AUTO RICH

MODEL: EC-121R
DATA AS OF: 1 APRIL 1968
DATA BASIS: FLIGHT TESTS

ENGINE: (4) R3350-93A
PROPS: HAM. STD. 43H60/6959B-0
FUEL GRADE: 115/145
FUEL DENSITY: 6.0 LB/US GAL

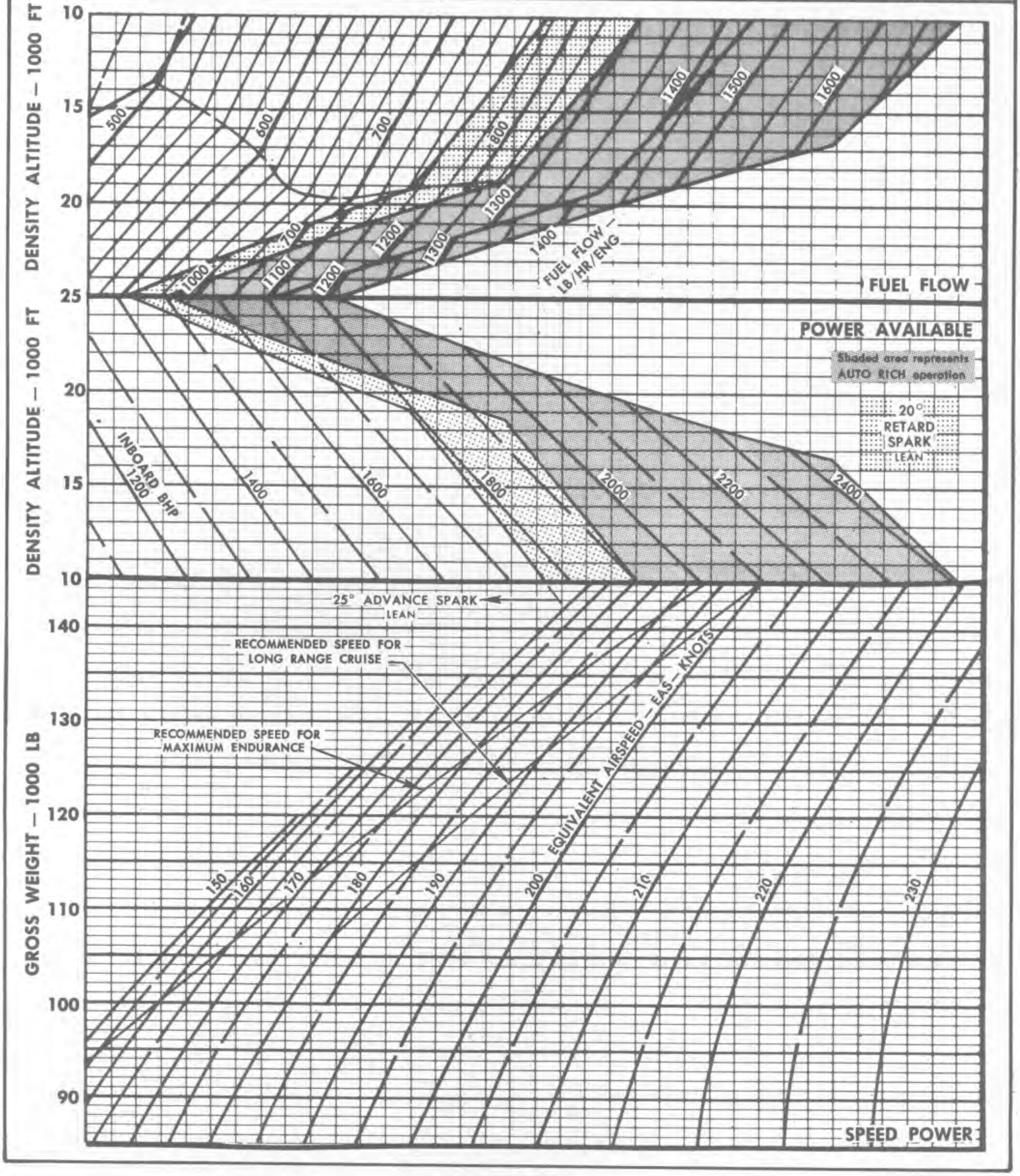
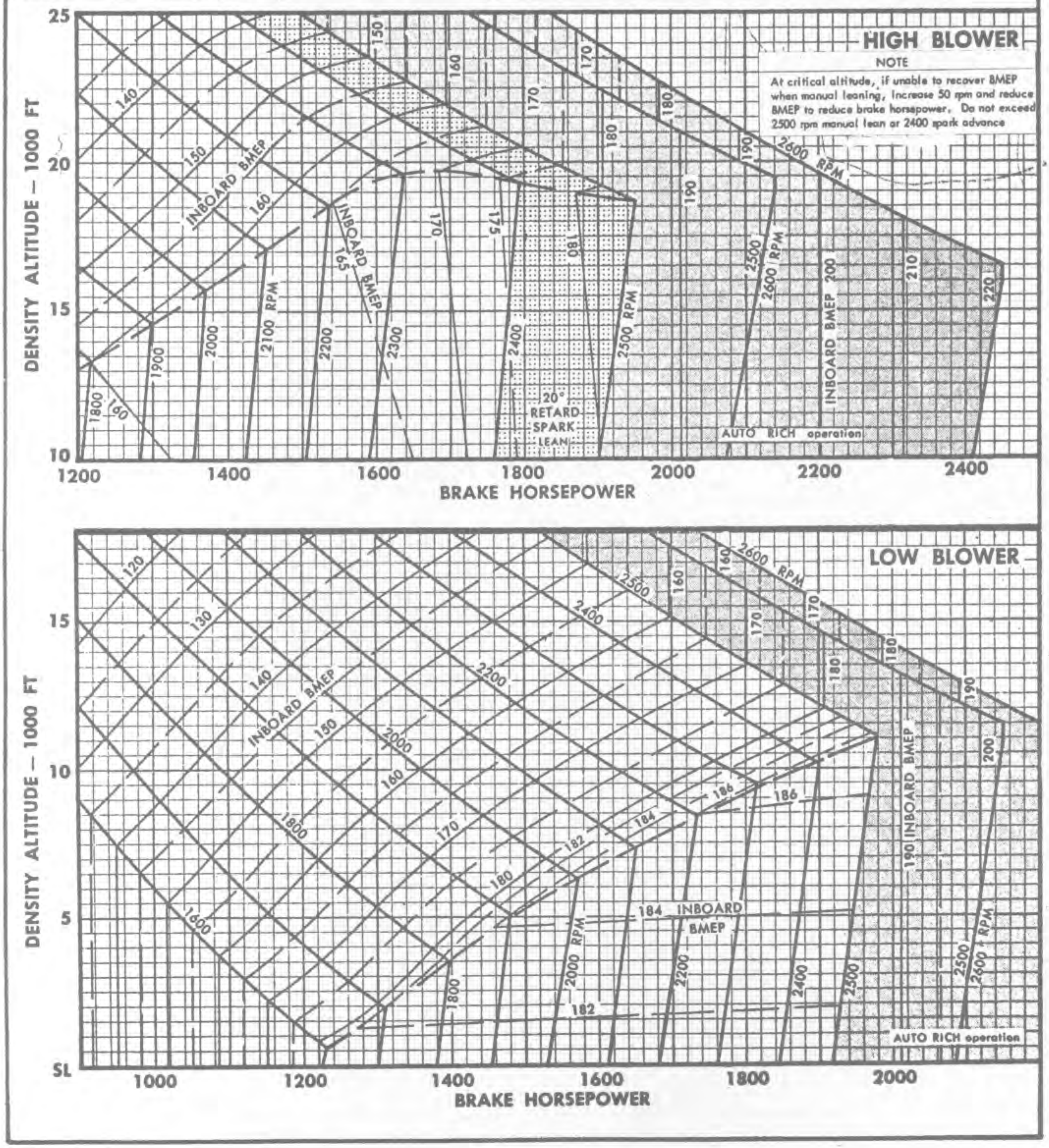


Figure A5-3

POWER AVAILABLE

MODEL: EC-121R
DATA AS OF: 1 APRIL 1968
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

At critical altitude, if unable to recover BMEP when manual leaning, increase 50 rpm and reduce BMEP to reduce brake horsepower. Do not exceed 2500 rpm manual lean or 2400 spark advance

Figure A5-4

THREE ENGINE OPERATION
COMPOSITE CRUISE CONTROL CHART
LOW BLOWER

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

10% LEAN
ENGINES: (4) R3350-93A
PROPS: HAM. STD. 43H60/6959B-O

PARTIAL AUTO RICH

FUEL GRADE: 115/145
FUEL DENSITY: 6.0 LB/U S GAL

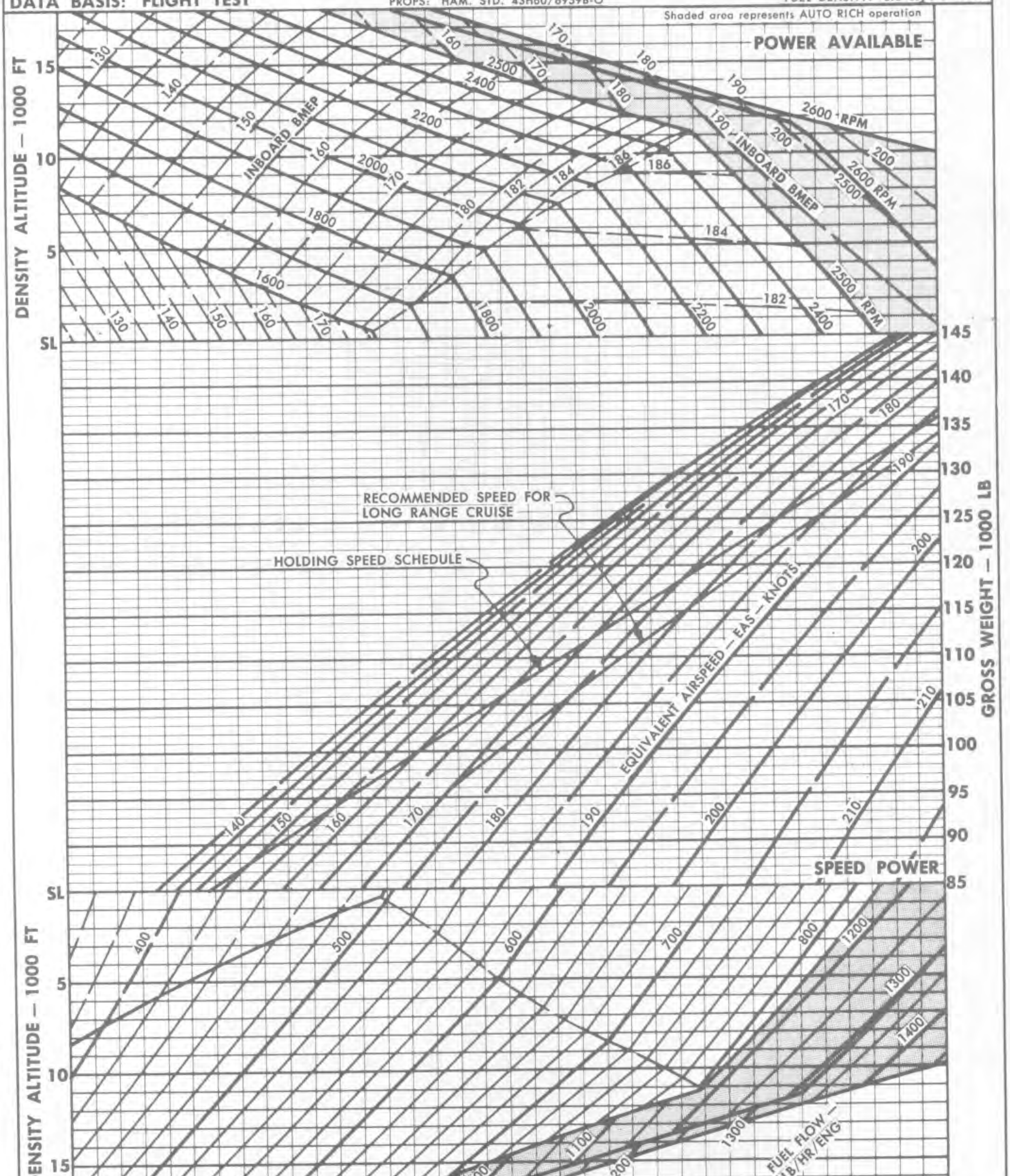


Figure A5-5

THREE ENGINE OPERATION

COMPOSITE CRUISE CONTROL CHART

LOW BLOWER

AUTO RICH

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

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

FUEL GRADE: 115/145
FUEL DENSITY: 6.0 LB/U S GAL

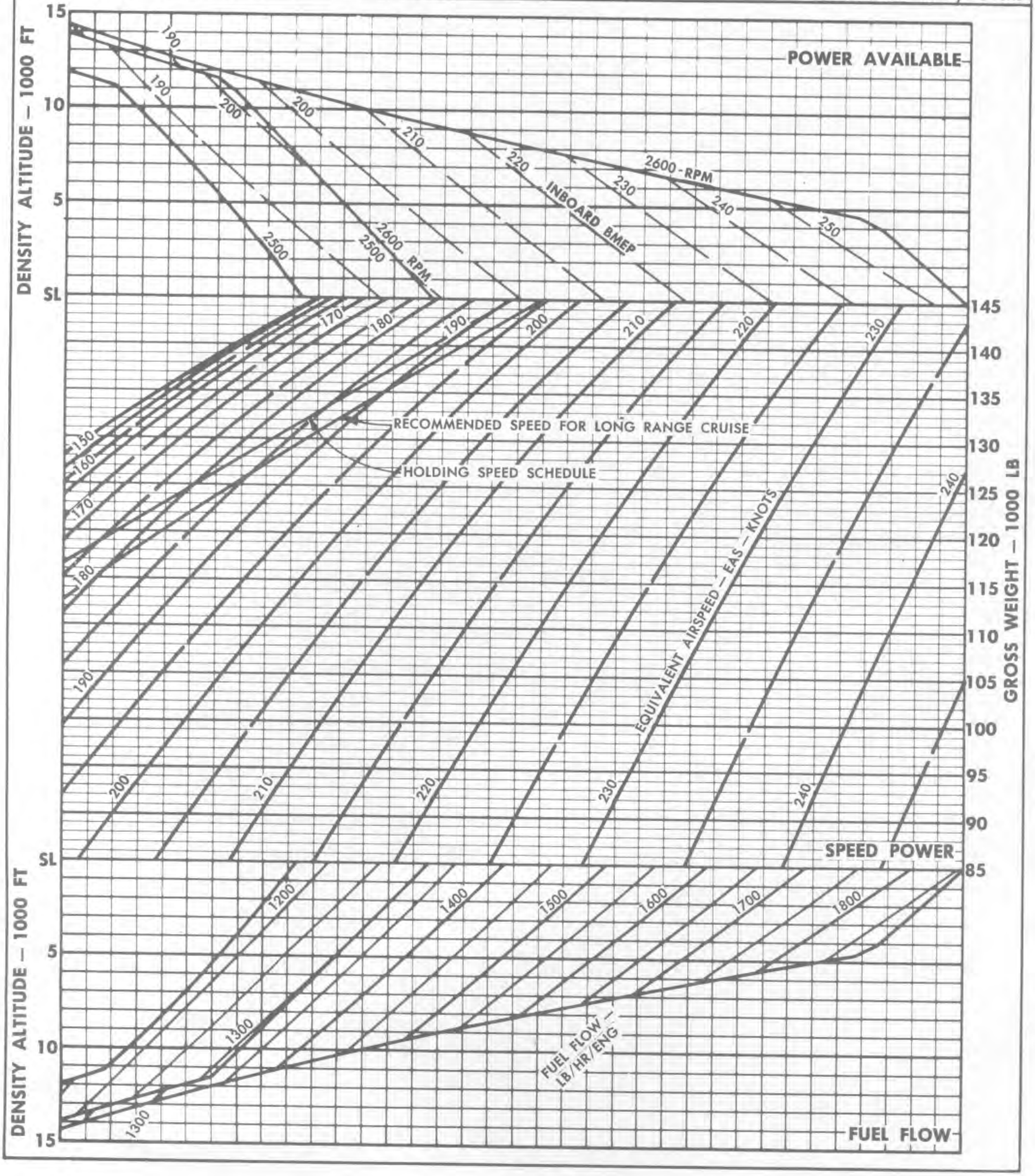


Figure A5-6

THREE ENGINE OPERATION

COMPOSITE CRUISE CONTROL CHART

HIGH BLOWER

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

10%/15% LEAN AUTO RICH

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

FUEL GRADE: 115/145
FUEL DENSITY: 6.0 LB/U S GAL

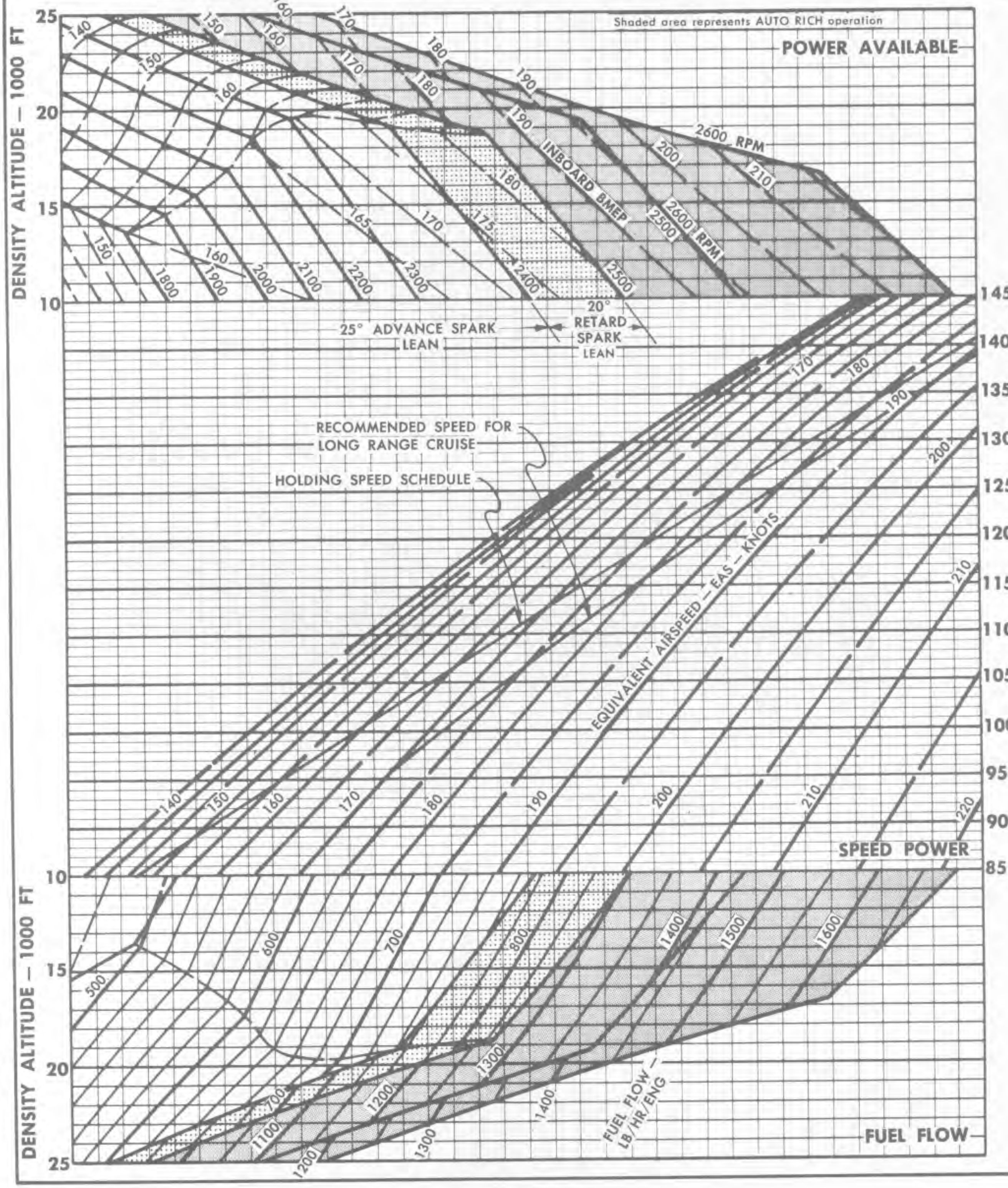


Figure A5-7

TWO ENGINE OPERATION

COMPOSITE CRUISE CONTROL CHART

LOW BLOWER

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

PARTIAL 10% LEAN

AUTO RICH

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

FUEL GRADE: 115/145
FUEL DENSITY: 6.0 LB/U S GAL

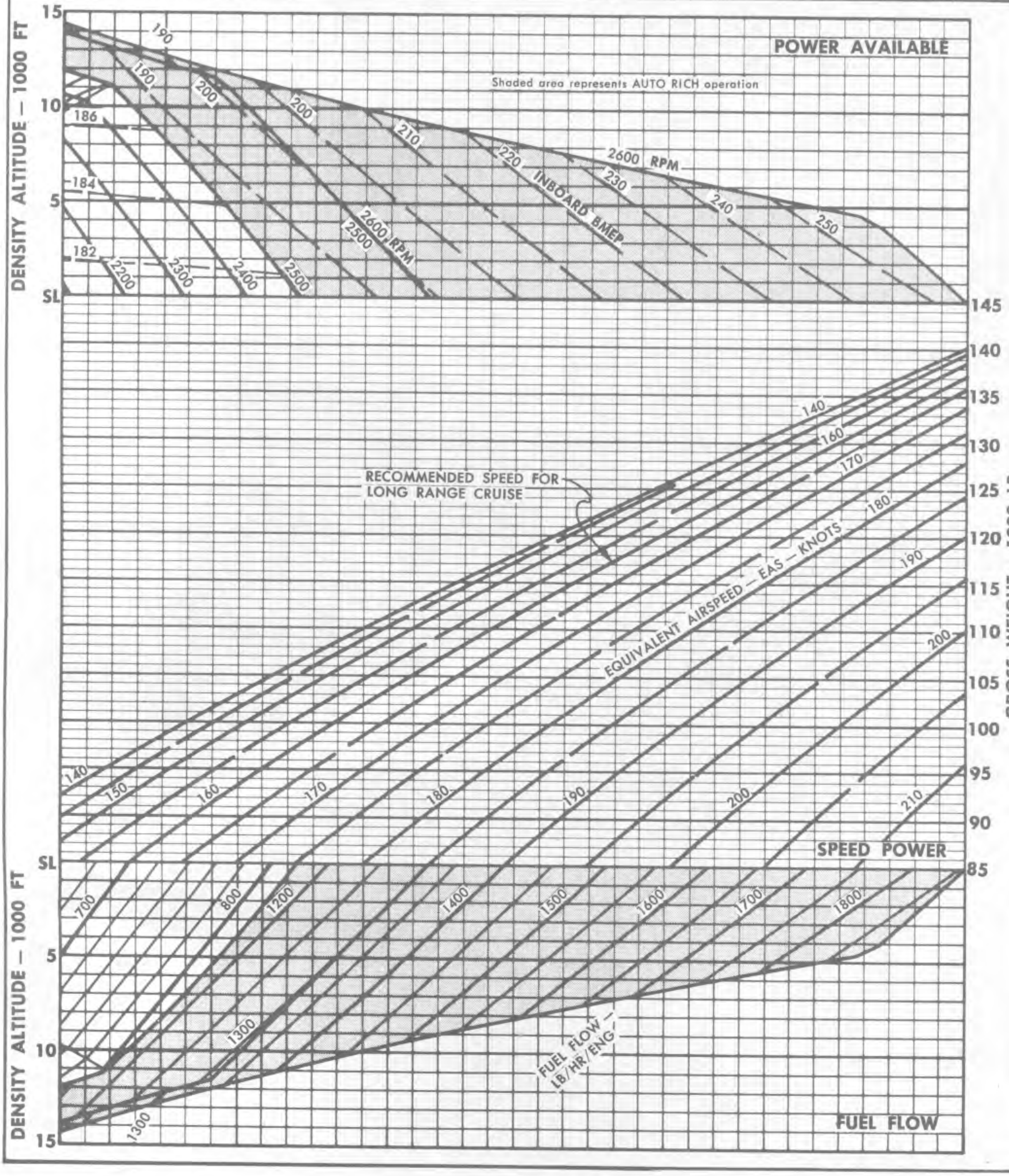


Figure A5-8

FOUR ENGINE OPERATION

NAUTICAL AIR MILES PER POUND OF FUEL

SEA LEVEL DENSITY ALTITUDE $1/\sqrt{\sigma} = 1.0000$

LOW BLOWER

MODEL: EC-121R
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 /U S GAL

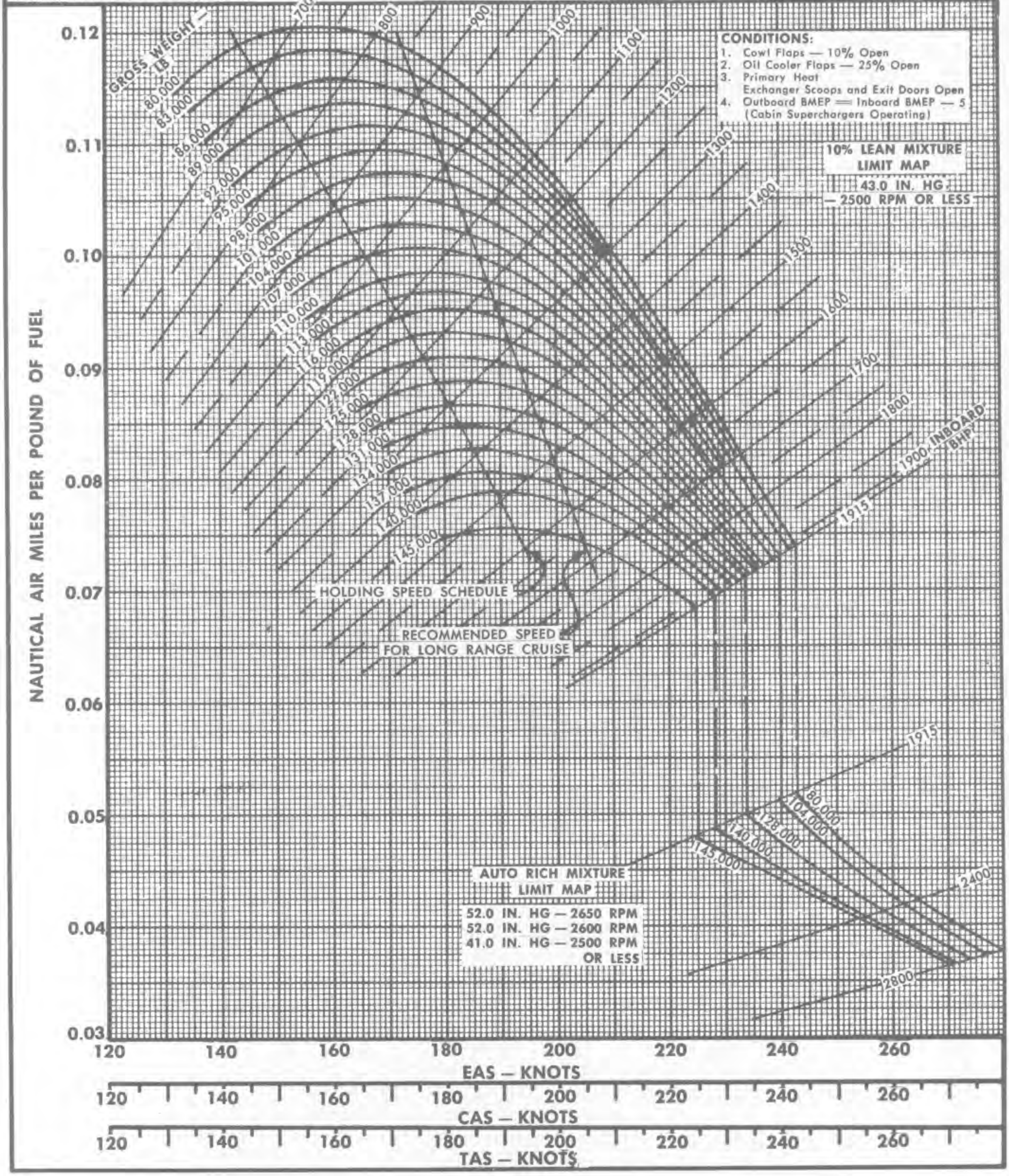


Figure A5-9

FOUR ENGINE OPERATION

NAUTICAL AIR MILES PER POUND OF FUEL

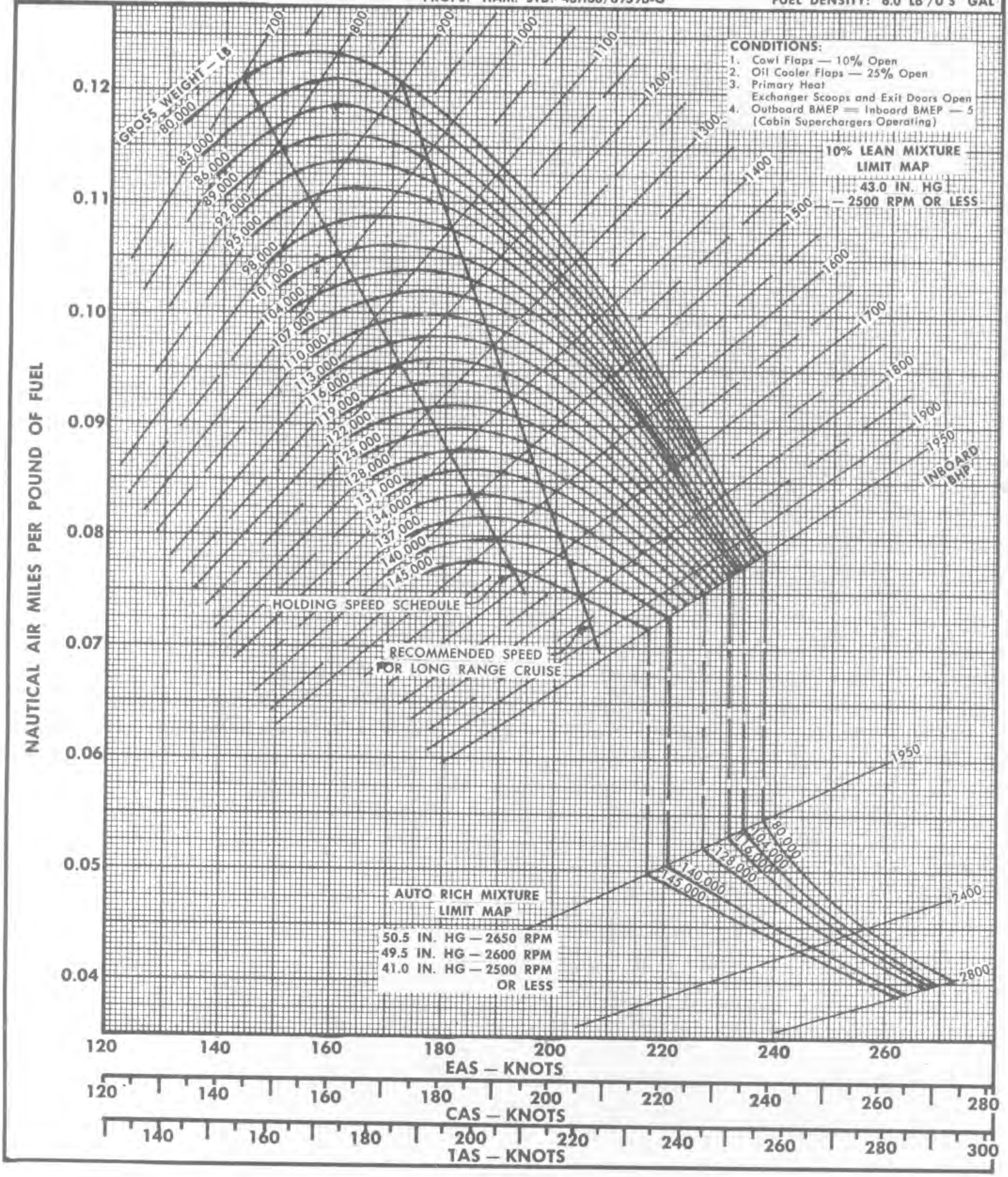
5,000 FT DENSITY ALTITUDE $1/\sqrt{\sigma} = 1.0773$

LOW BLOWER

MODEL: EC-121R
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 /U S GAL



CONDITIONS:
1. Cowl Flaps — 10% Open
2. Oil Cooler Flaps — 25% Open
3. Primary Heat Exchanger Scoops and Exit Doors Open
4. Outboard BMEP = Inboard BMEP — 5 (Cabin Superchargers Operating)

10% LEAN MIXTURE LIMIT MAP
43.0 IN. HG — 2500 RPM OR LESS

AUTO RICH MIXTURE LIMIT MAP
50.5 IN. HG — 2650 RPM
49.5 IN. HG — 2600 RPM
41.0 IN. HG — 2500 RPM OR LESS

Figure A5-10

FOUR ENGINE OPERATION

NAUTICAL AIR MILES PER POUND OF FUEL

10,000 FT DENSITY ALTITUDE $1/\sqrt{\sigma} = 1.1637$

LOW BLOWER

MODEL: EC-121R
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/U S GAL

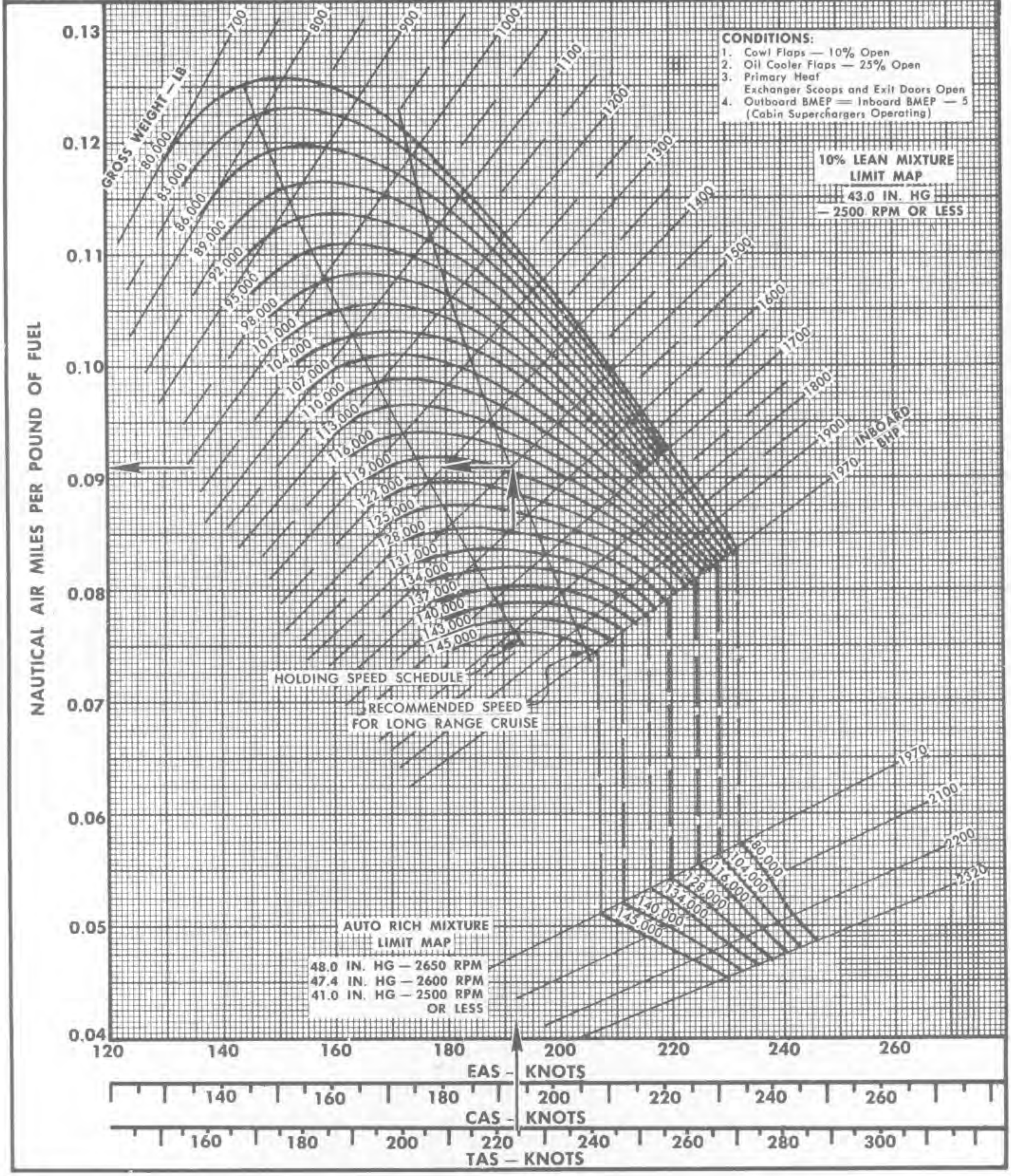


Figure A5-11

FOUR ENGINE OPERATION

NAUTICAL AIR MILES PER POUND OF FUEL

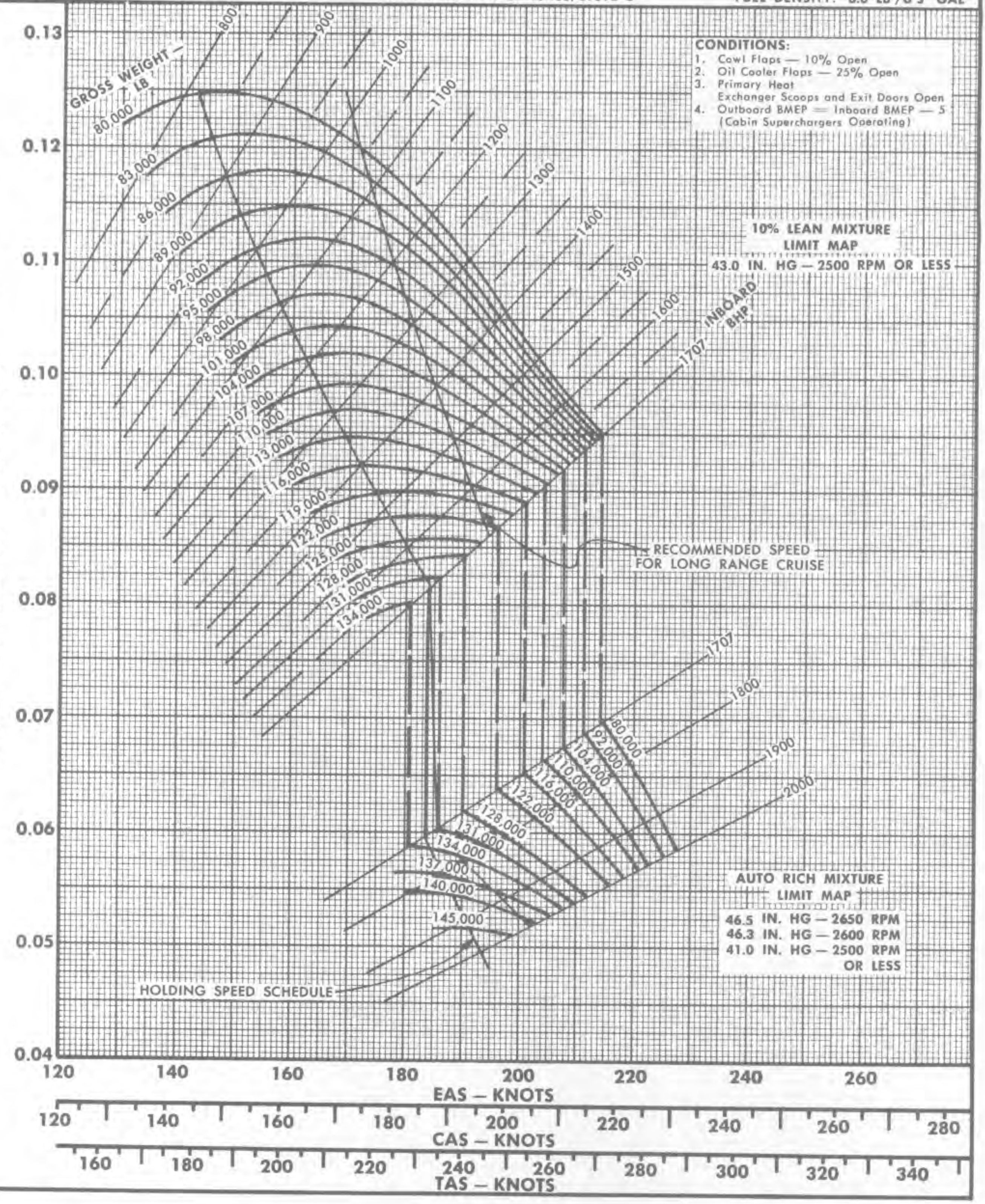
15,000 FT DENSITY ALTITUDE $1/\sqrt{\sigma} = 1.2606$

LOW BLOWER

MODEL: EC-121R
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 /U S GAL



CONDITIONS:
1. Cowl Flaps — 10% Open
2. Oil Cooler Flaps — 25% Open
3. Primary Heat Exchanger Scoops and Exit Doors Open
4. Outboard BMEP = Inboard BMEP — 5 (Cabin Superchargers Operating)

Figure A5-12

FOUR ENGINE OPERATION

NAUTICAL AIR MILES PER POUND OF FUEL

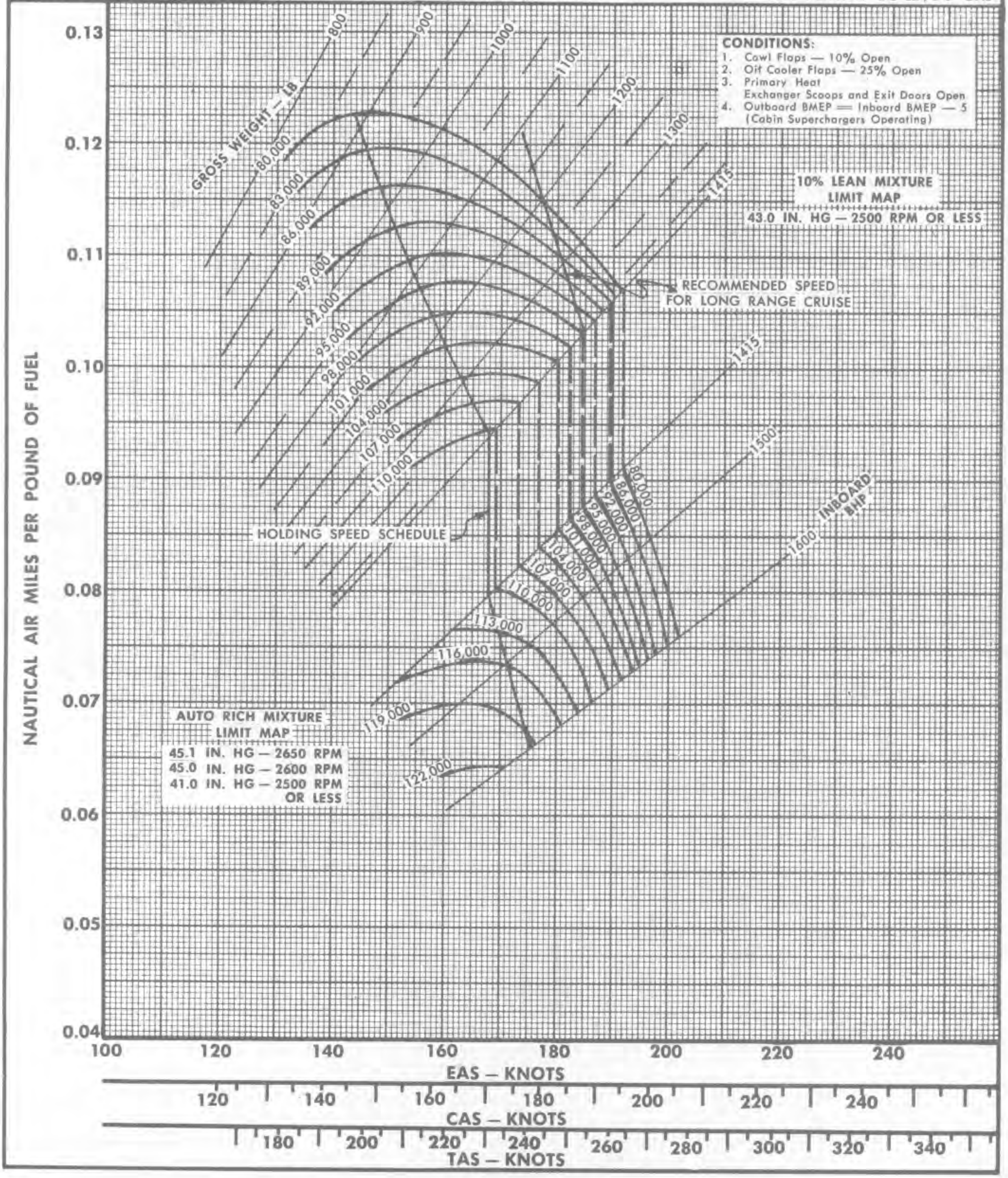
20,000 FT DENSITY ALTITUDE $1/\sqrt{\sigma} = 1.3700$

LOW BLOWER

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

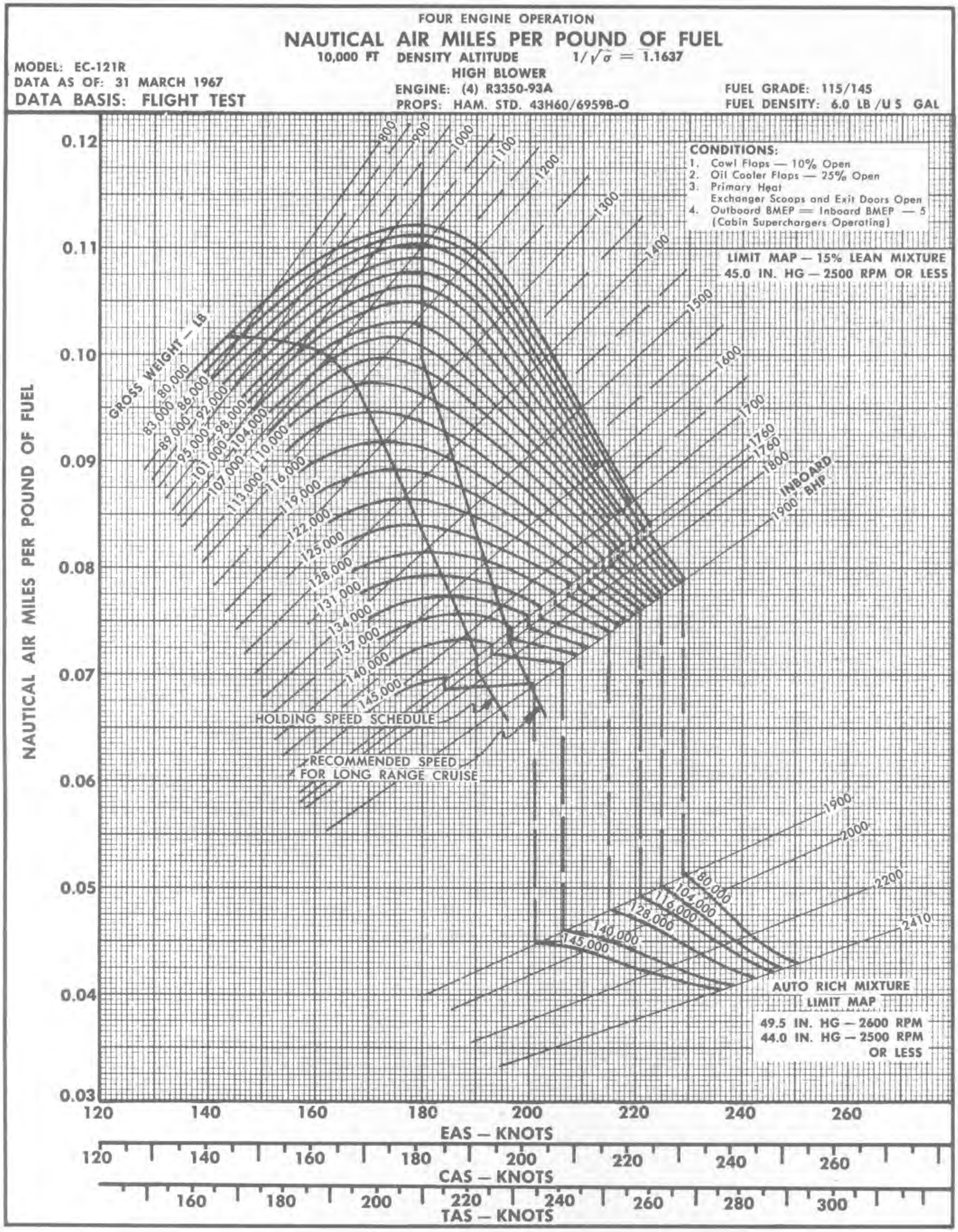
ENGINE: (4) R3350-93A
PROPS: HAM. STD. 43H60/6959B-O

FUEL GRADE: 115/145
FUEL DENSITY: 6.0 LB /U S GAL



CONDITIONS:
1. Cowl Flaps — 10% Open
2. Oil Cooler Flaps — 25% Open
3. Primary Heat Exchanger Scoops and Exit Doors Open
4. Outboard BMEP = Inboard BMEP — 5 (Cabin Superchargers Operating)

Figure A5-13



FOUR ENGINE OPERATION

NAUTICAL AIR MILES PER POUND OF FUEL

10,000 FT DENSITY ALTITUDE $1/\sqrt{\sigma} = 1.1637$

HIGH BLOWER

MODEL: EC-121R

DATA AS OF: 31 MARCH 1967

DATA BASIS: FLIGHT TEST

ENGINE: (4) R3350-93A

PROPS: HAM. STD. 43H60/69598-O

FUEL GRADE: 115/145

FUEL DENSITY: 6.0 LB/U S GAL

CONDITIONS:
1. Cowl Flaps — 10% Open
2. Oil Cooler Flaps — 25% Open
3. Primary Heat Exchanger Scoops and Exit Doors Open
4. Outboard BMEP = Inboard BMEP — 5 (Cabin Superchargers Operating)

LIMIT MAP — 15% LEAN MIXTURE
45.0 IN. HG — 2500 RPM OR LESS

AUTO RICH MIXTURE LIMIT MAP
49.5 IN. HG — 2600 RPM
44.0 IN. HG — 2500 RPM OR LESS

Figure A5-14

FOUR ENGINE OPERATION

NAUTICAL AIR MILES PER POUND OF FUEL

15,000 FT DENSITY ALTITUDE $1/\sqrt{\sigma} = 1.2606$
HIGH BLOWER

MODEL: EC-121R
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/U S GAL

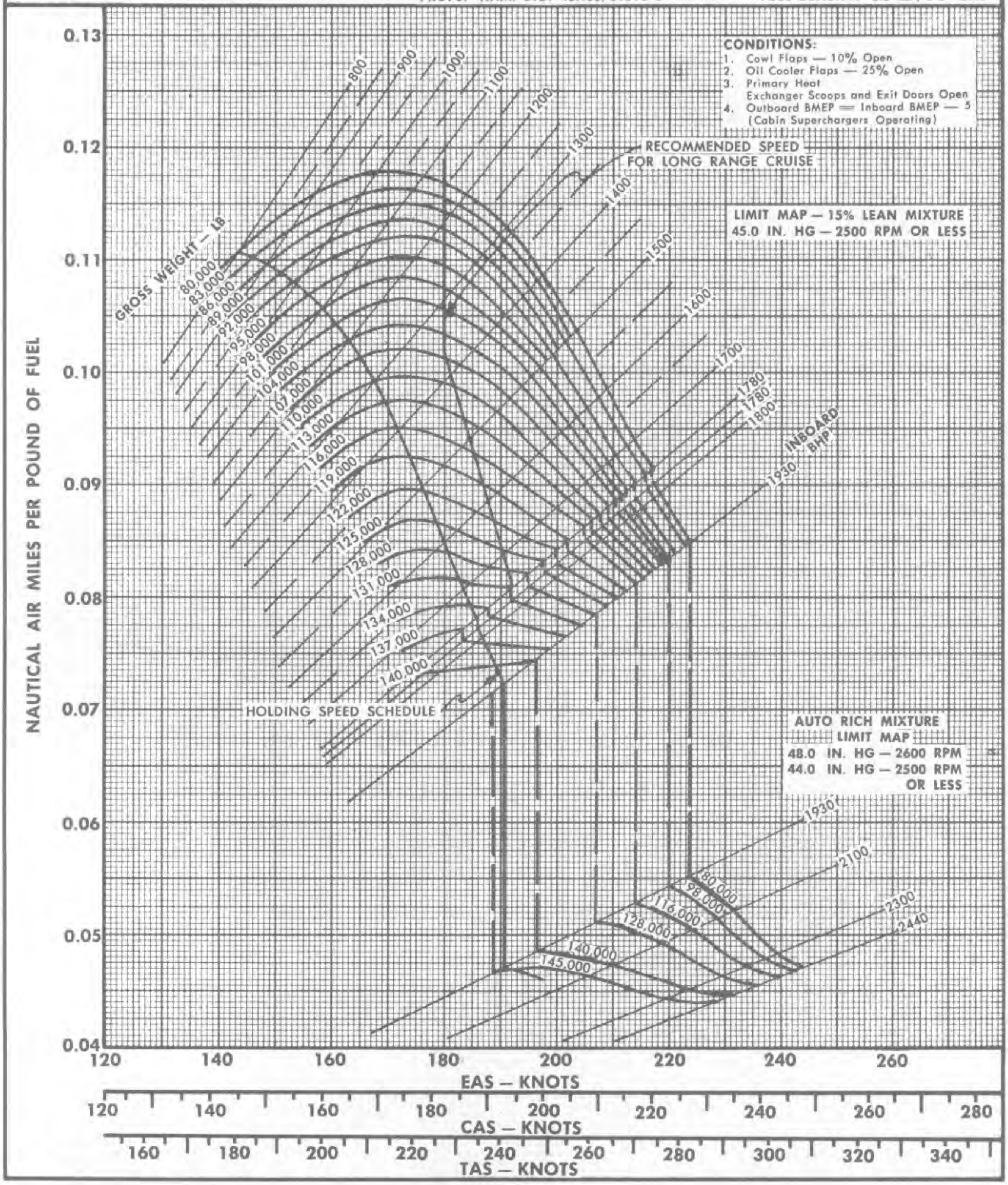


Figure A5-15

FOUR ENGINE OPERATION

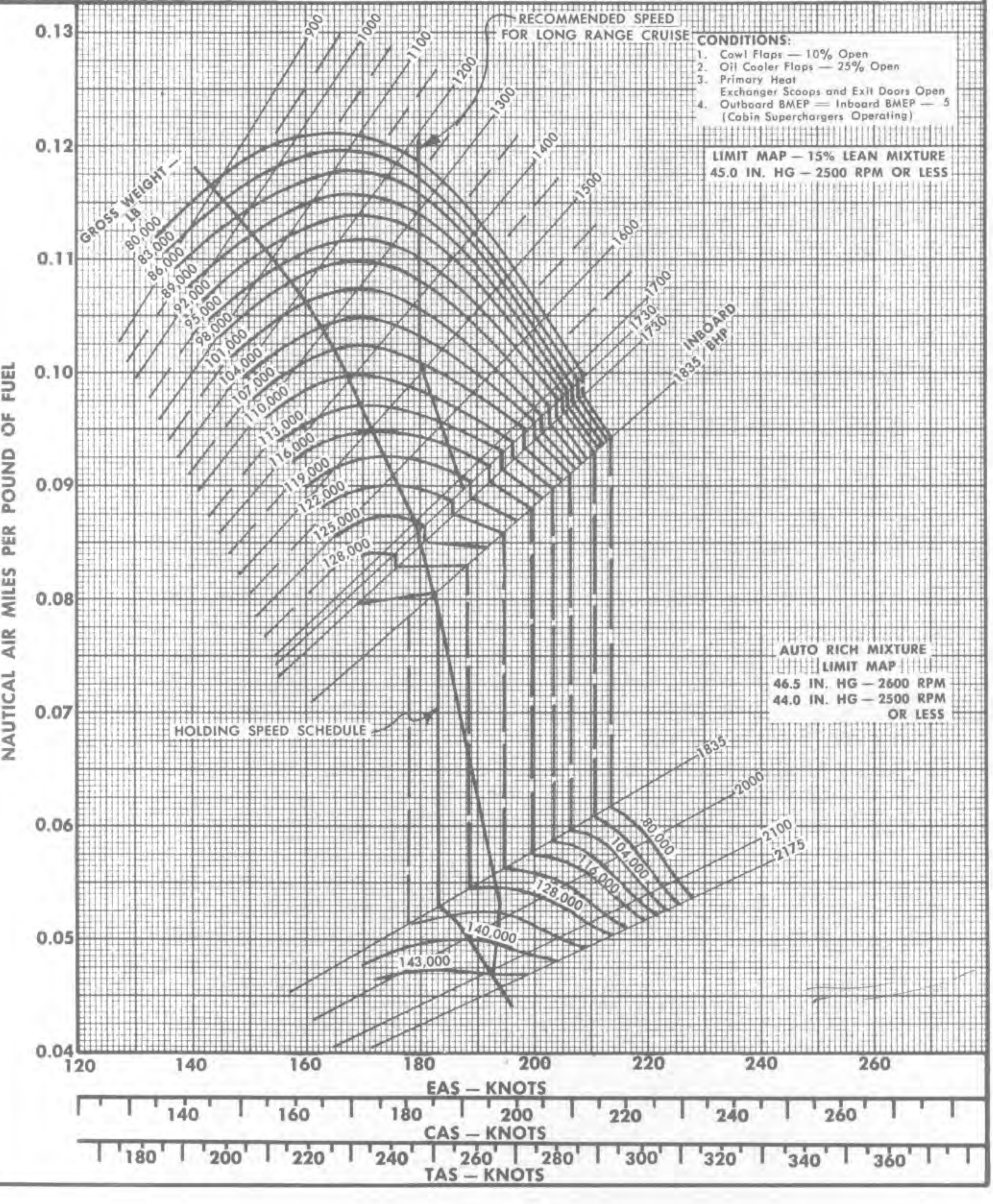
NAUTICAL AIR MILES PER POUND OF FUEL

20,000 FT DENSITY ALTITUDE $1/\sqrt{\sigma}$ — 1.3700

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

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

FUEL GRADE: 115/145
FUEL DENSITY: 6.0 LB/U S GAL



CONDITIONS:
1. Cowl Flaps — 10% Open
2. Oil Cooler Flaps — 25% Open
3. Primary Heat Exchanger Scoops and Exit Doors Open
4. Outboard BMEP = Inboard BMEP — 5 (Cabin Superchargers Operating)

LIMIT MAP — 15% LEAN MIXTURE
45.0 IN. HG — 2500 RPM OR LESS

AUTO RICH MIXTURE LIMIT MAP
46.5 IN. HG — 2600 RPM
44.0 IN. HG — 2500 RPM OR LESS

Figure A5-16

FOUR ENGINE OPERATION

NAUTICAL AIR MILES PER POUND OF FUEL

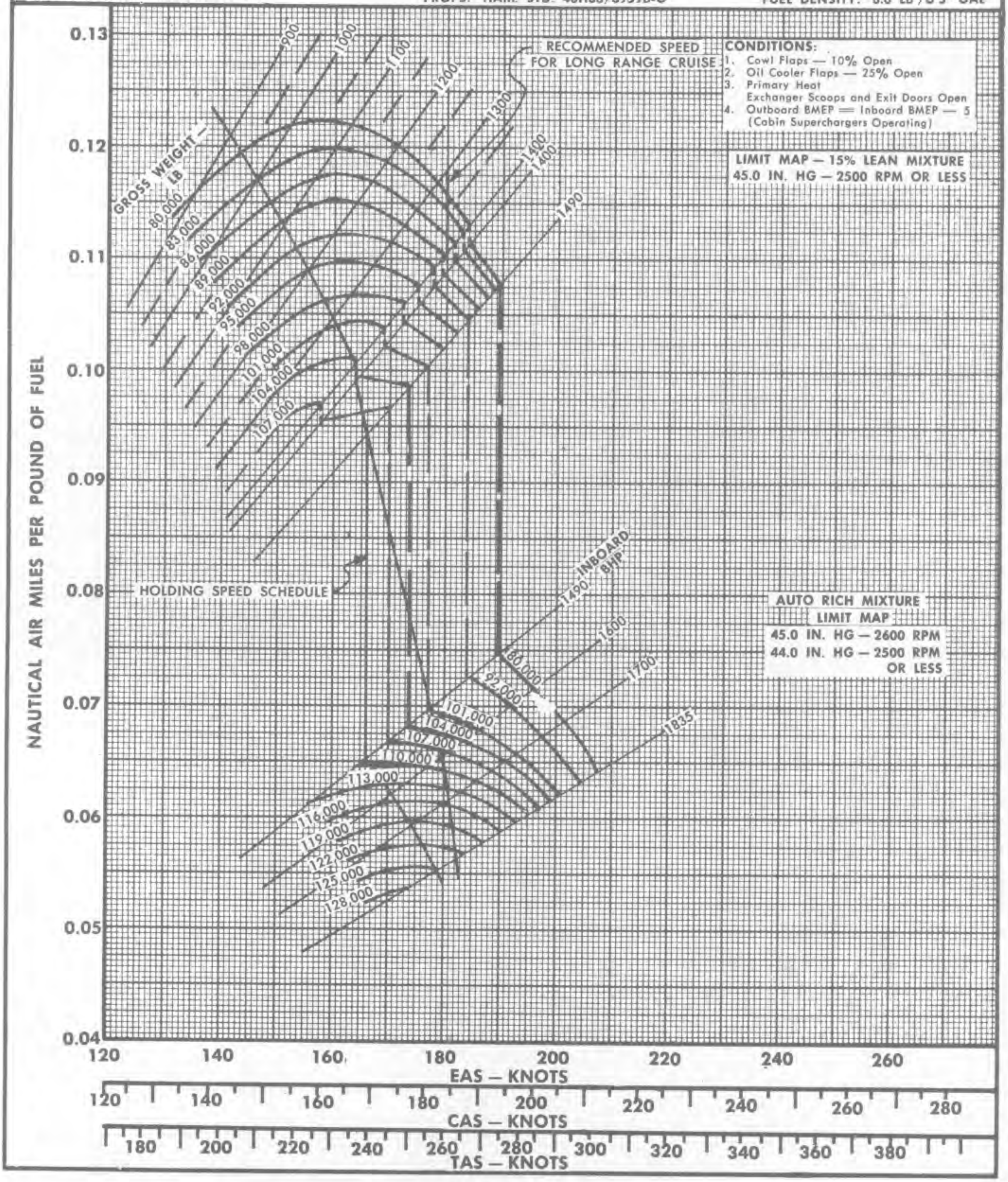
25,000 FT DENSITY ALTITUDE $1/\sqrt{\sigma}$ 1.4938

HIGH BLOWER

MODEL: EC-121R
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/U S GAL



CONDITIONS:

1. Cowl Flaps — 10% Open
2. Oil Cooler Flaps — 25% Open
3. Primary Heat Exchanger Scoops and Exit Doors Open
4. Outboard BMEP == Inboard BMEP — 5 (Cabin Superchargers Operating)

LIMIT MAP — 15% LEAN MIXTURE
45.0 IN. HG — 2500 RPM OR LESS

AUTO RICH MIXTURE LIMIT MAP
45.0 IN. HG — 2600 RPM
44.0 IN. HG — 2500 RPM OR LESS

Figure A5-17

THREE ENGINE OPERATION

NAUTICAL AIR MILES PER POUND OF FUEL

SEA LEVEL DENSITY ALTITUDE $1/\sqrt{\sigma} = 1.0000$
LOW BLOWER

MODEL: EC-121R
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 /U S GAL

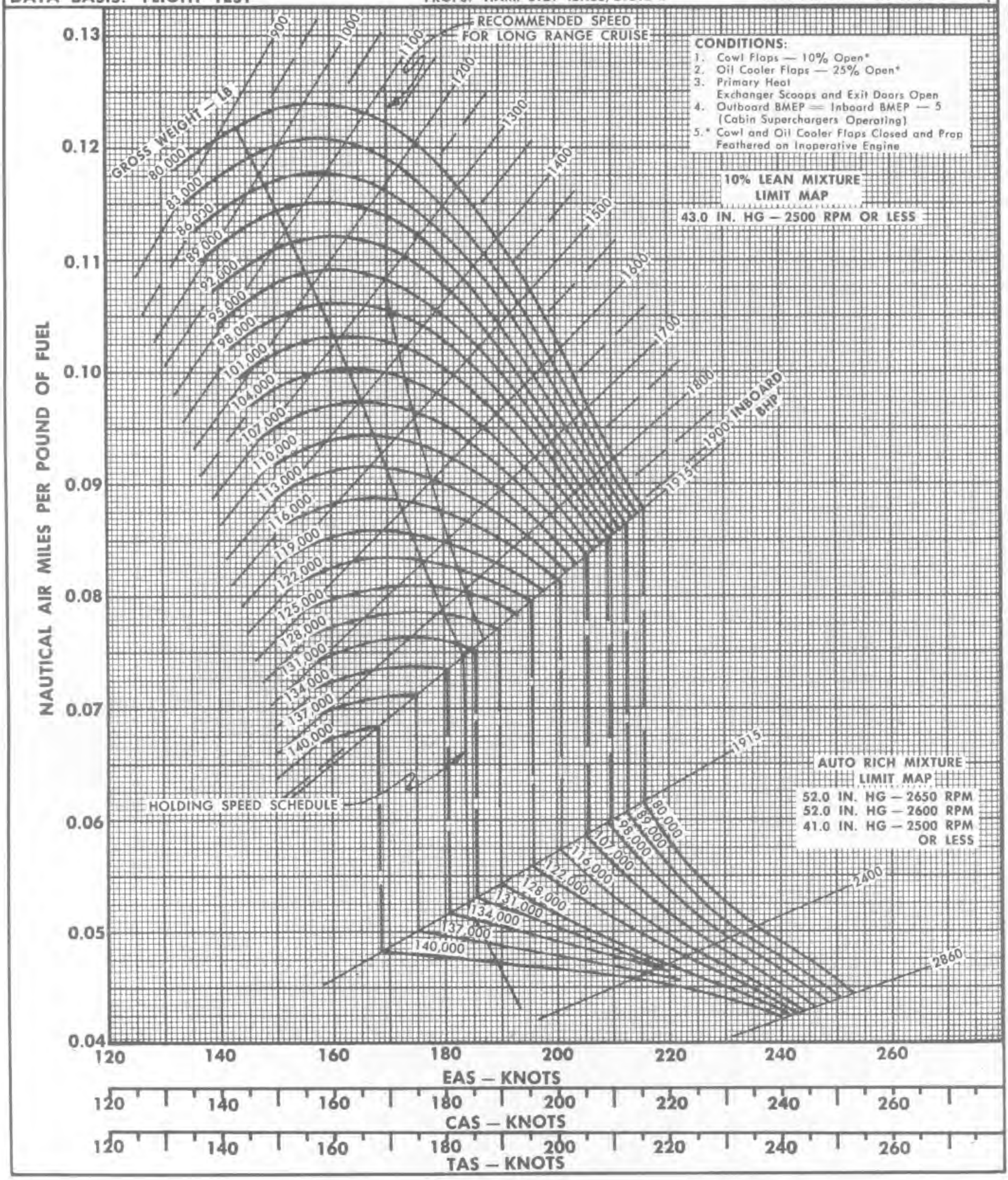


Figure A5-18

THREE ENGINE OPERATION

NAUTICAL AIR MILES PER POUND OF FUEL

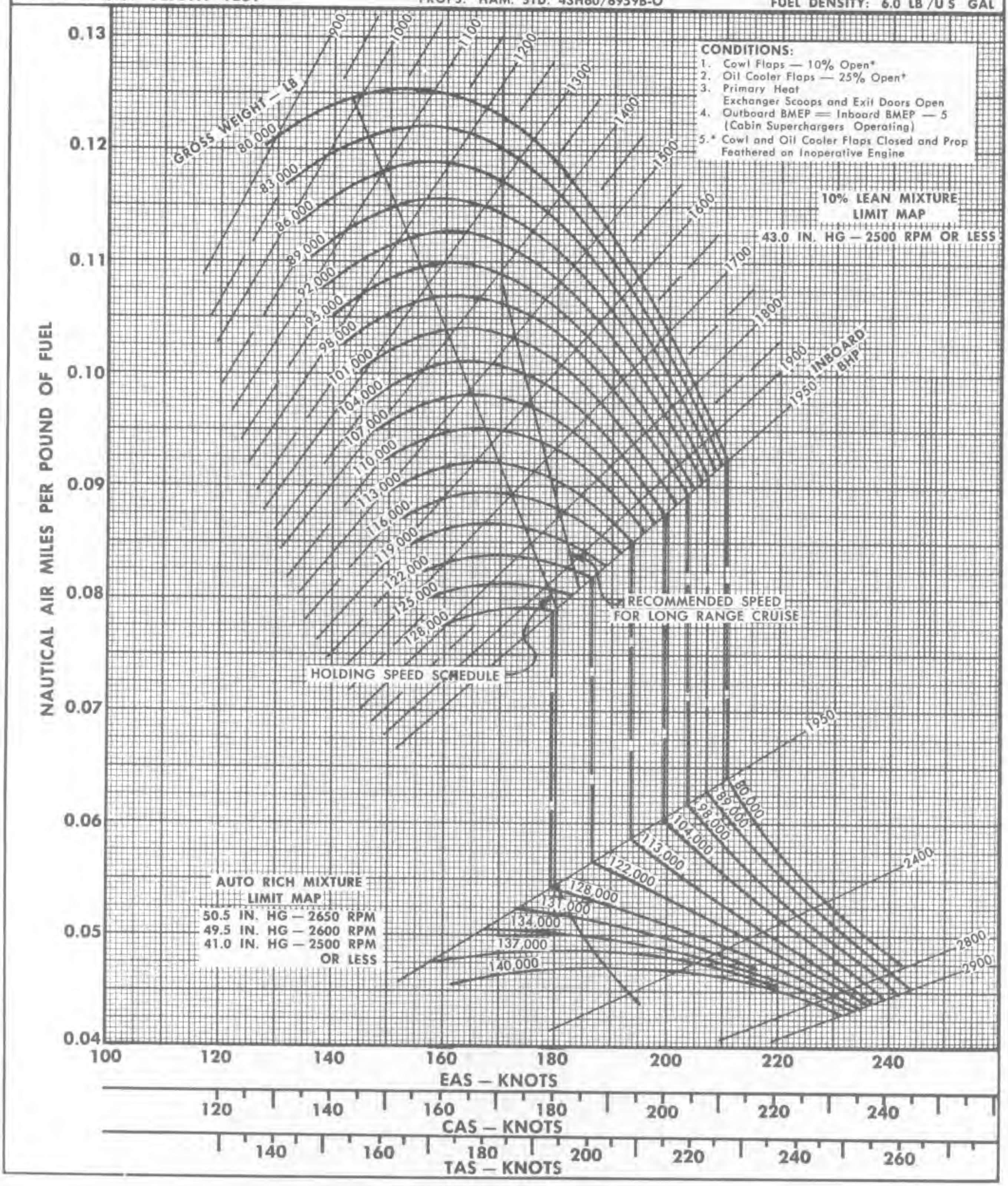
5,000 FT DENSITY ALTITUDE $1/\sqrt{\sigma} = 1.0773$

LOW BLOWER

MODEL: EC-121R
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 /U S GAL



CONDITIONS:
1. Cowl Flaps — 10% Open*
2. Oil Cooler Flaps — 25% Open*
3. Primary Heat Exchanger Scoops and Exit Doors Open
4. Outboard BMEP = Inboard BMEP — 5 (Cabin Superchargers Operating)
5.* Cowl and Oil Cooler Flaps Closed and Prop Feathered on Inoperative Engine

Figure A5-19

THREE ENGINE OPERATION

NAUTICAL AIR MILES PER POUND OF FUEL

10,000 FT DENSITY ALTITUDE $1/\sqrt{\sigma} = 1.1637$

LOW BLOWER

MODEL: EC-121R
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/U S GAL

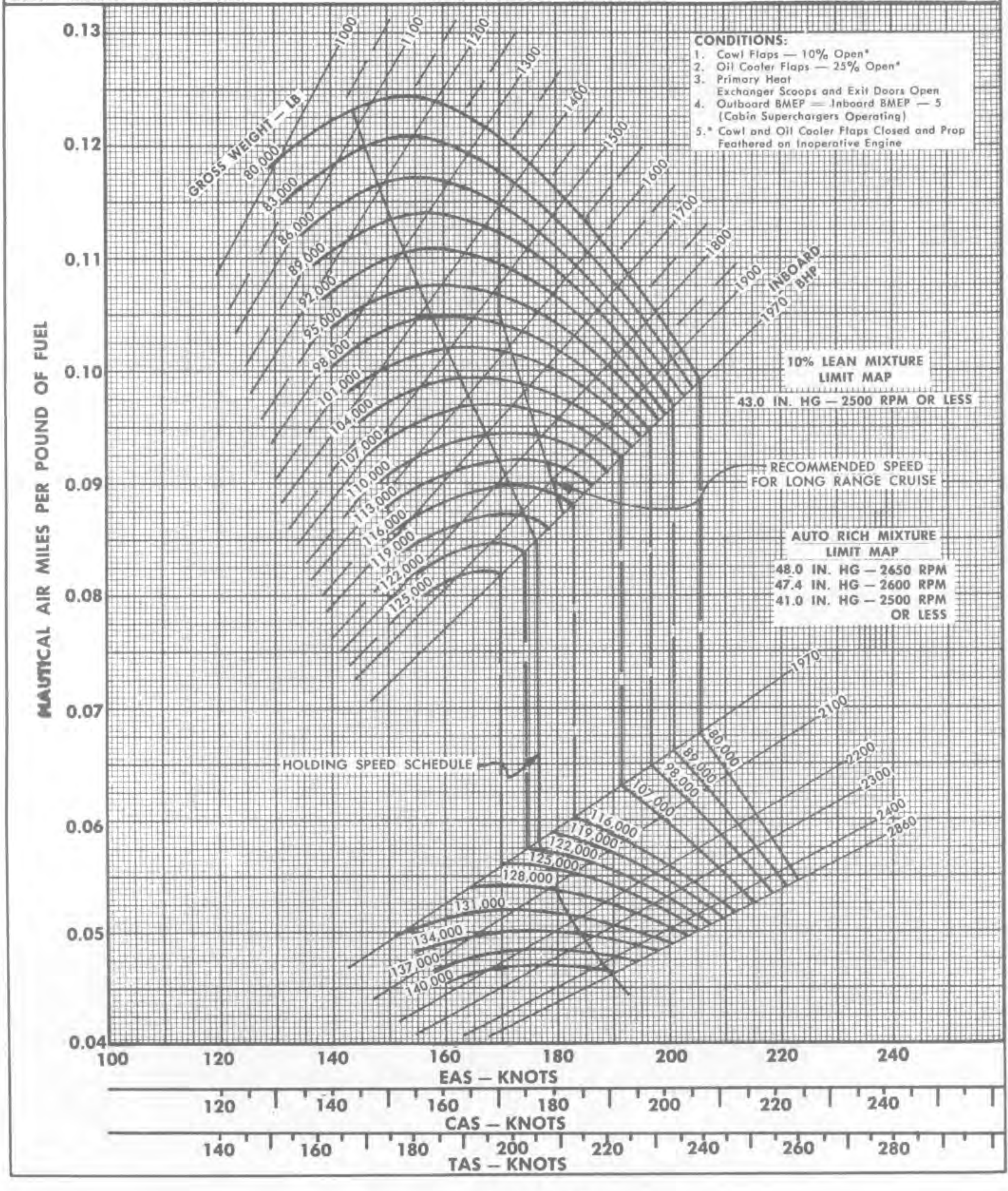


Figure A5-20

THREE ENGINE OPERATION

NAUTICAL AIR MILES PER POUND OF FUEL

15,000 FT DENSITY ALTITUDE $1/\sqrt{\sigma} = 1.2606$
LOW BLOWER

MODEL: EC-121R
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 /U S GAL

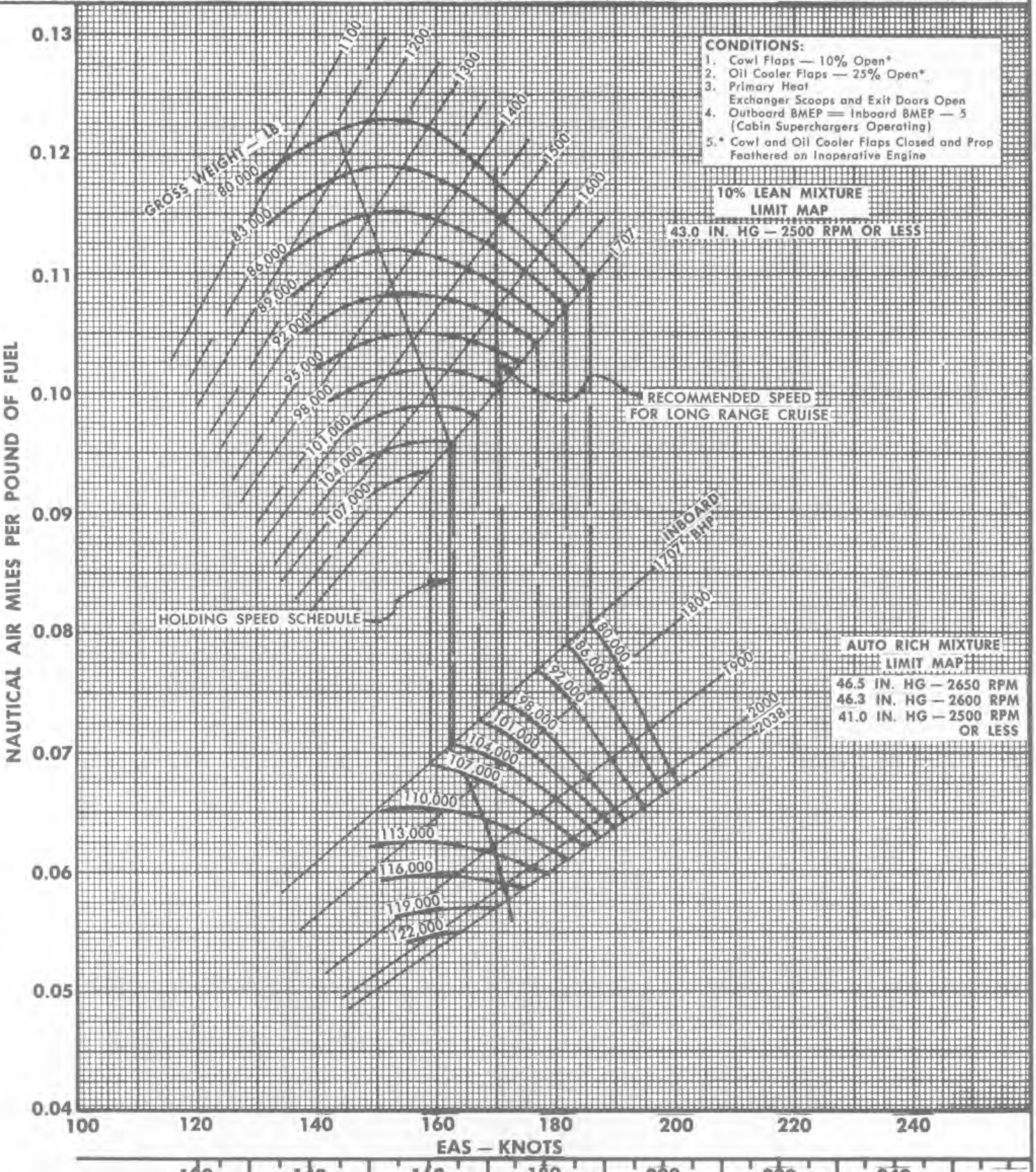


Figure A5-21

THREE ENGINE OPERATION

NAUTICAL AIR MILES PER POUND OF FUEL

10,000 FT DENSITY ALTITUDE $1/\sqrt{\sigma} = 1.1637$

HIGH BLOWER

MODEL: EC-121R
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/U S GAL

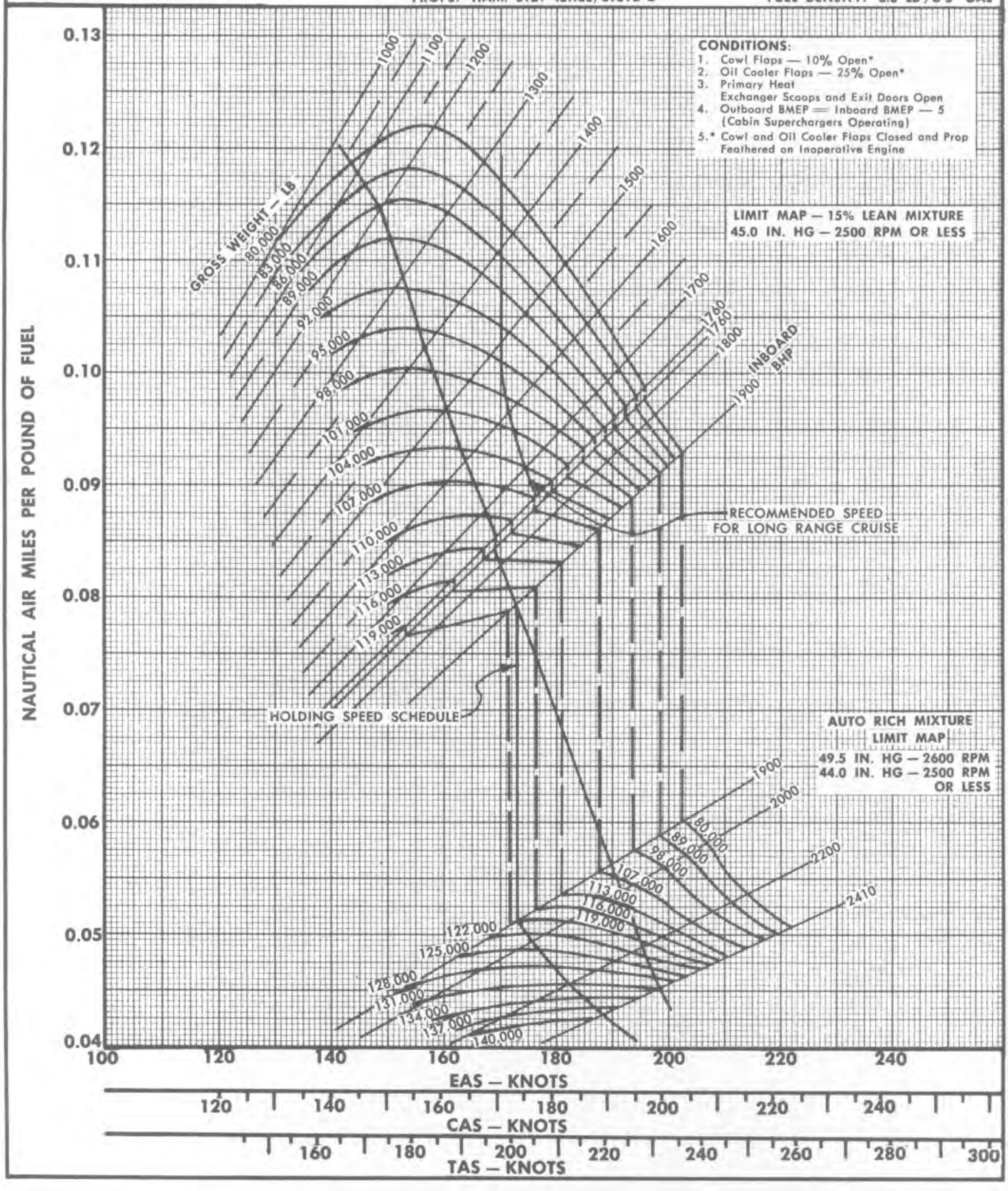


Figure A5-22

THREE ENGINE OPERATION

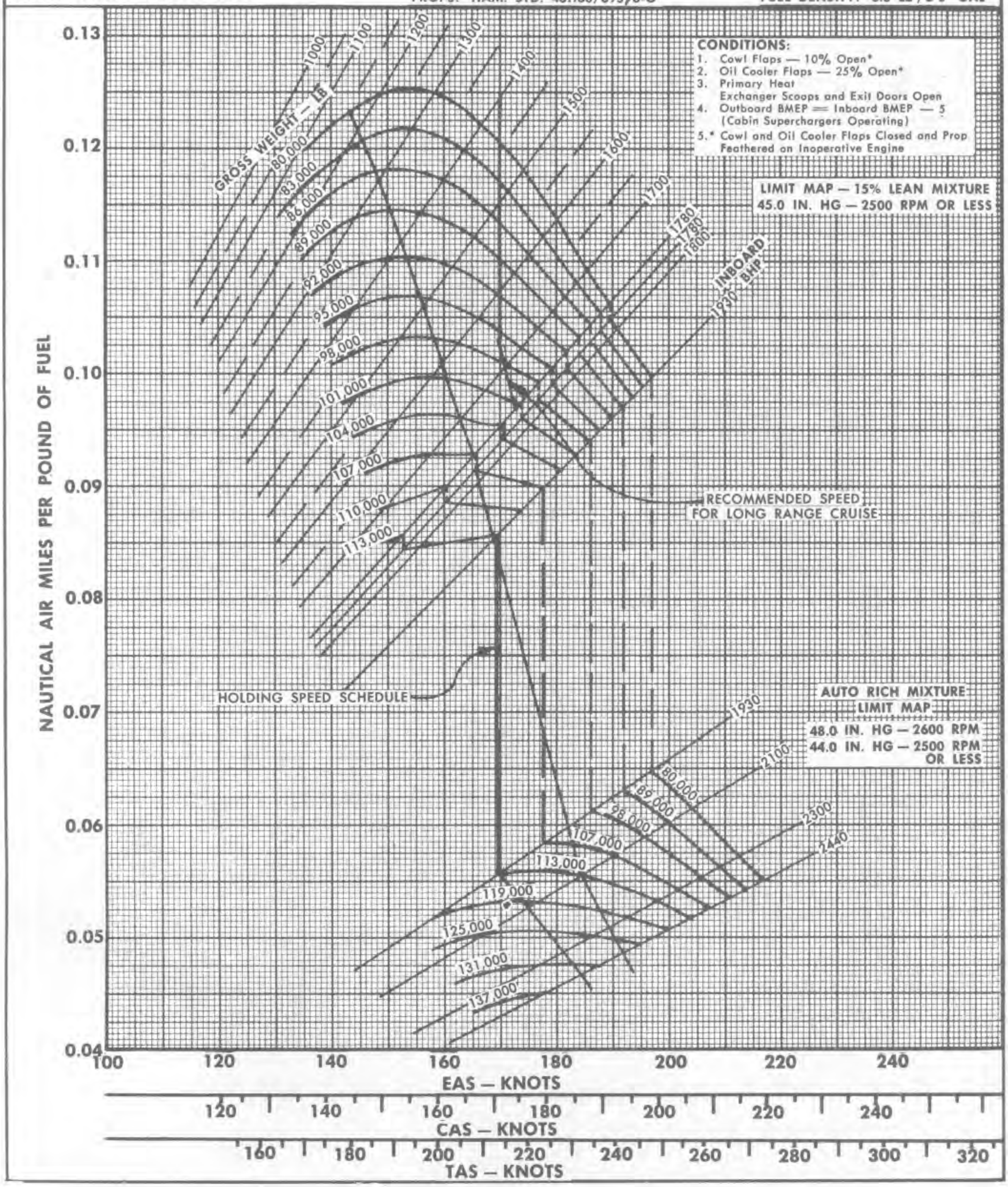
NAUTICAL AIR MILES PER POUND OF FUEL

15,000 FT DENSITY ALTITUDE $1/\sqrt{\sigma} = 1.2606$
HIGH BLOWER

MODEL: EC-121R
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 /U S GAL



CONDITIONS:
1. Cowl Flaps — 10% Open*
2. Oil Cooler Flaps — 25% Open*
3. Primary Heat Exchanger Scoops and Exit Doors Open
4. Outboard BMEP == Inboard BMEP — 5 (Cabin Superchargers Operating)

5.* Cowl and Oil Cooler Flaps Closed and Prop Feathered on Inoperative Engine

LIMIT MAP — 15% LEAN MIXTURE
45.0 IN. HG — 2500 RPM OR LESS

AUTO RICH MIXTURE LIMIT MAP
48.0 IN. HG — 2600 RPM
44.0 IN. HG — 2500 RPM OR LESS

RECOMMENDED SPEED FOR LONG RANGE CRUISE

HOLDING SPEED SCHEDULE

Figure A5-23

THREE ENGINE OPERATION

NAUTICAL AIR MILES PER POUND OF FUEL

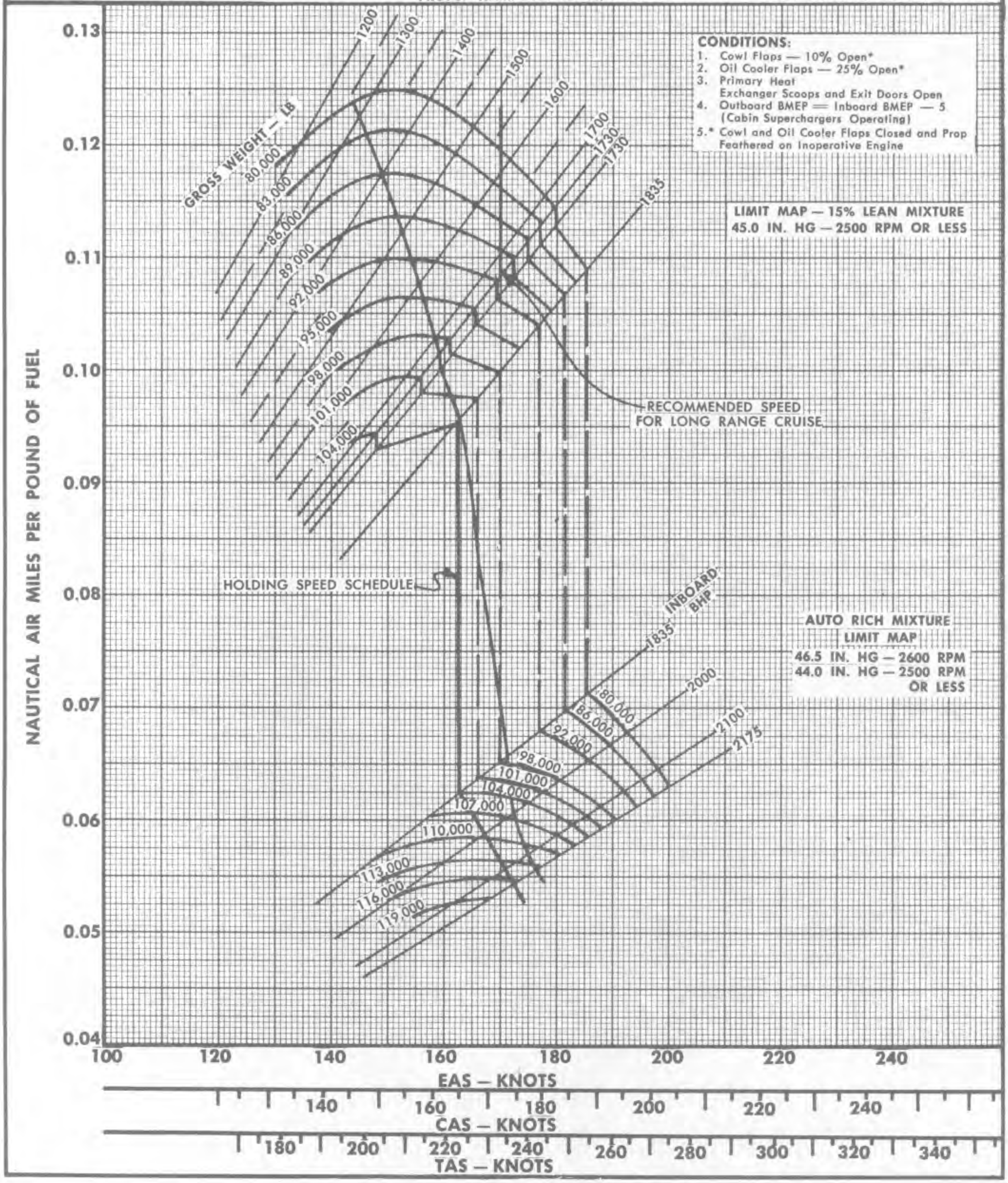
20,000 FT DENSITY ALTITUDE $1/\sqrt{\sigma} = 1.3700$

HIGH BLOWER

MODEL: EC-121R
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 /U S GAL



CONDITIONS:

1. Cowl Flaps — 10% Open*
2. Oil Cooler Flaps — 25% Open*
3. Primary Heat Exchanger Scoops and Exit Doors Open
4. Outboard BMEP = Inboard BMEP — 5 (Cabin Superchargers Operating)
5.* Cowl and Oil Cooler Flaps Closed and Prop Feathered on Inoperative Engine

Figure A5-24

TWO ENGINE OPERATION

NAUTICAL AIR MILES PER POUND OF FUEL

SEA LEVEL DENSITY ALTITUDE $1/\sqrt{\sigma} = 1.0000$

LOW BLOWER

ENGINE: (4) R3350-93A

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

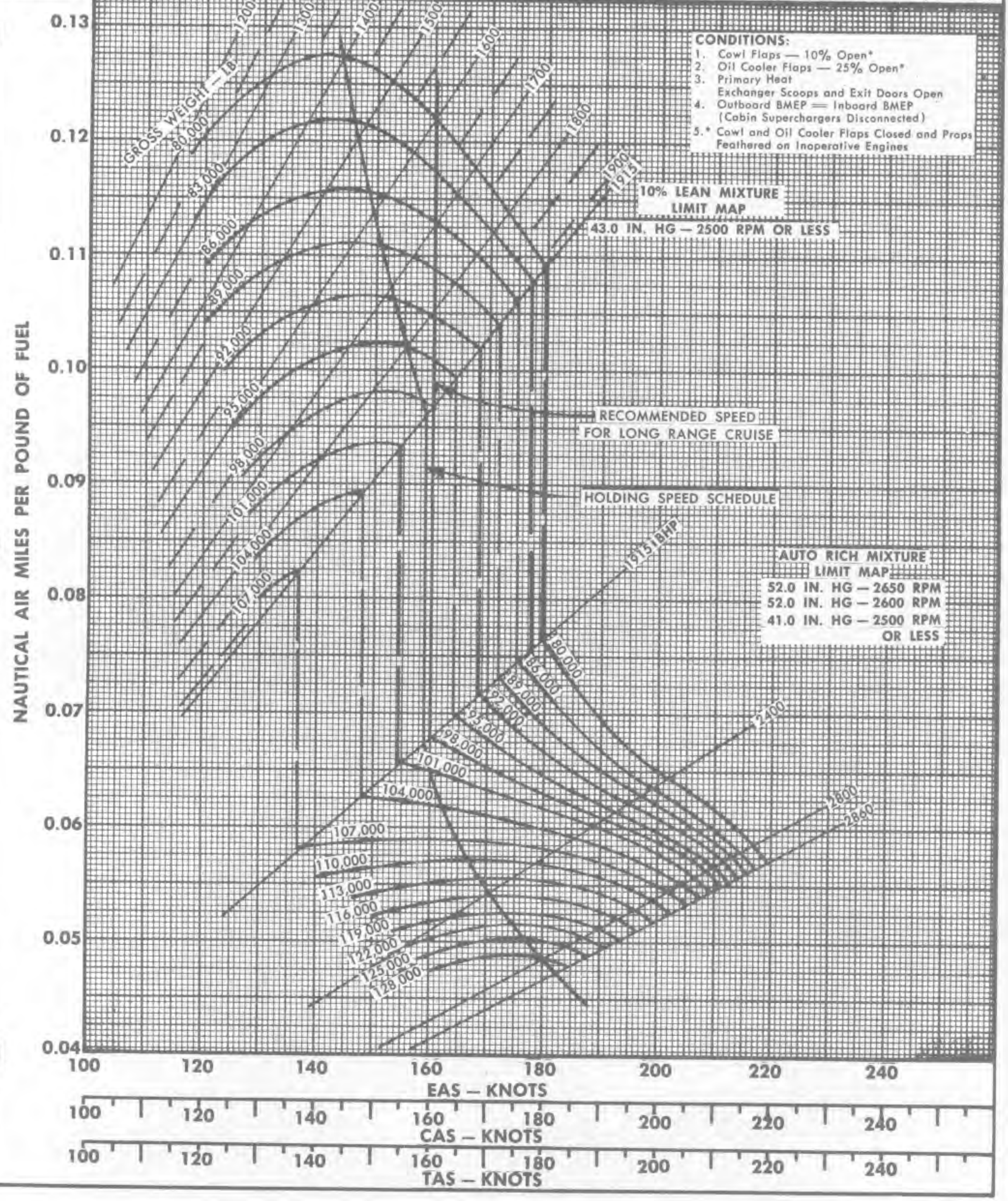
MODEL: EC-121R

DATA AS OF: 31 MARCH 1967

DATA BASIS: FLIGHT TEST

FUEL GRADE: 115/145

FUEL DENSITY: 6.0 LB /U S GAL



CONDITIONS:
1. Cowl Flaps — 10% Open*
2. Oil Cooler Flaps — 25% Open*
3. Primary Heat Exchanger Scoops and Exit Doors Open
4. Outboard BMEP == Inboard BMEP (Cabin Superchargers Disconnected)
5.* Cowl and Oil Cooler Flaps Closed and Props Feathered on Inoperative Engines

Figure A5-25

TWO ENGINE OPERATION

NAUTICAL AIR MILES PER POUND OF FUEL

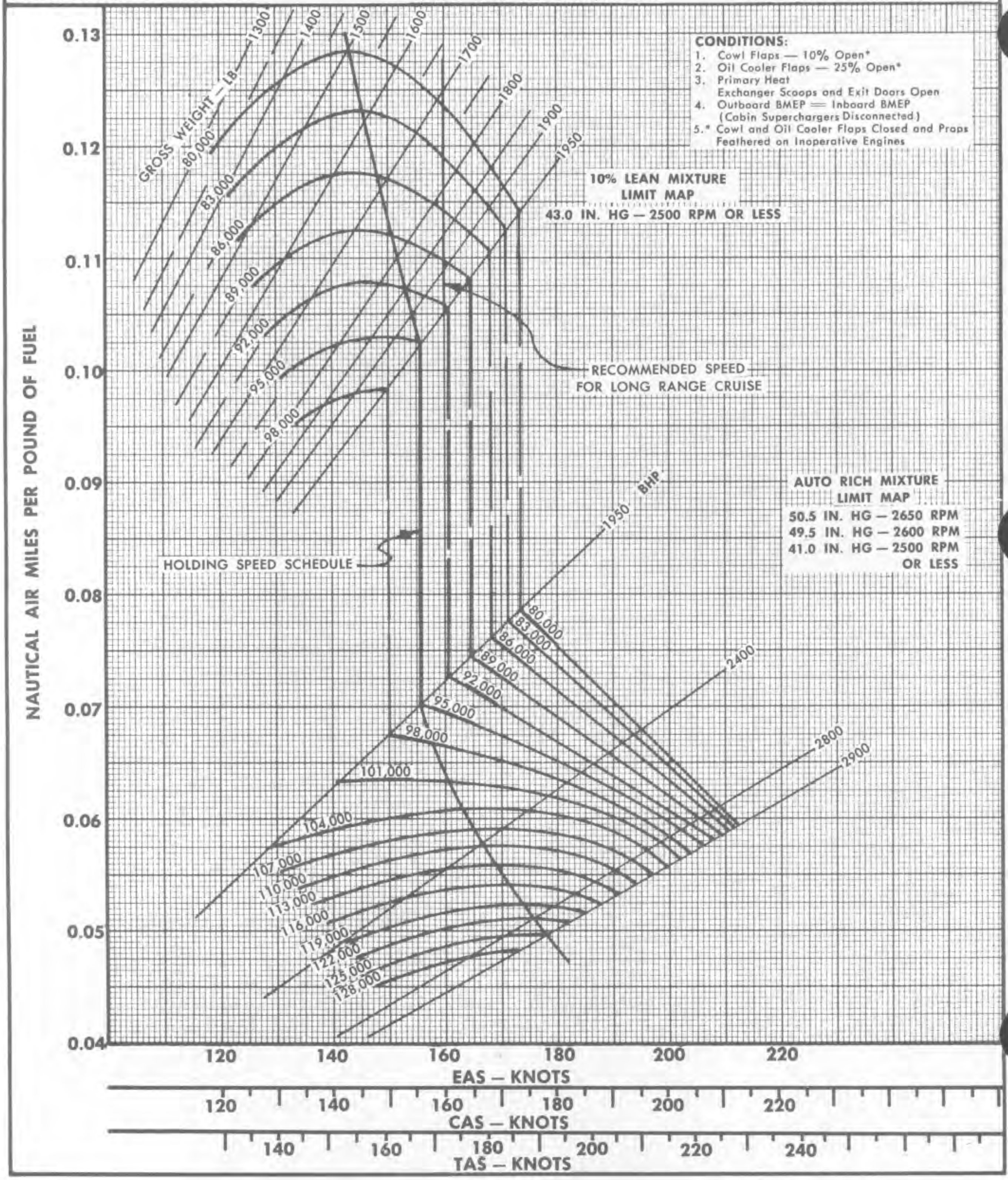
5,000 FT DENSITY ALTITUDE $1/\sqrt{\sigma} = 1.0773$

LOW BLOWER

MODEL: EC-121R
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/U S GAL



CONDITIONS:

1. Cowl Flaps — 10% Open*
2. Oil Cooler Flaps — 25% Open*
3. Primary Heat Exchanger Scoops and Exit Doors Open
4. Outboard BMEP = Inboard BMEP (Cabin Superchargers Disconnected)
5.* Cowl and Oil Cooler Flaps Closed and Props Feathered on Inoperative Engines

Figure A5-26

TWO ENGINE OPERATION

NAUTICAL AIR MILES PER POUND OF FUEL

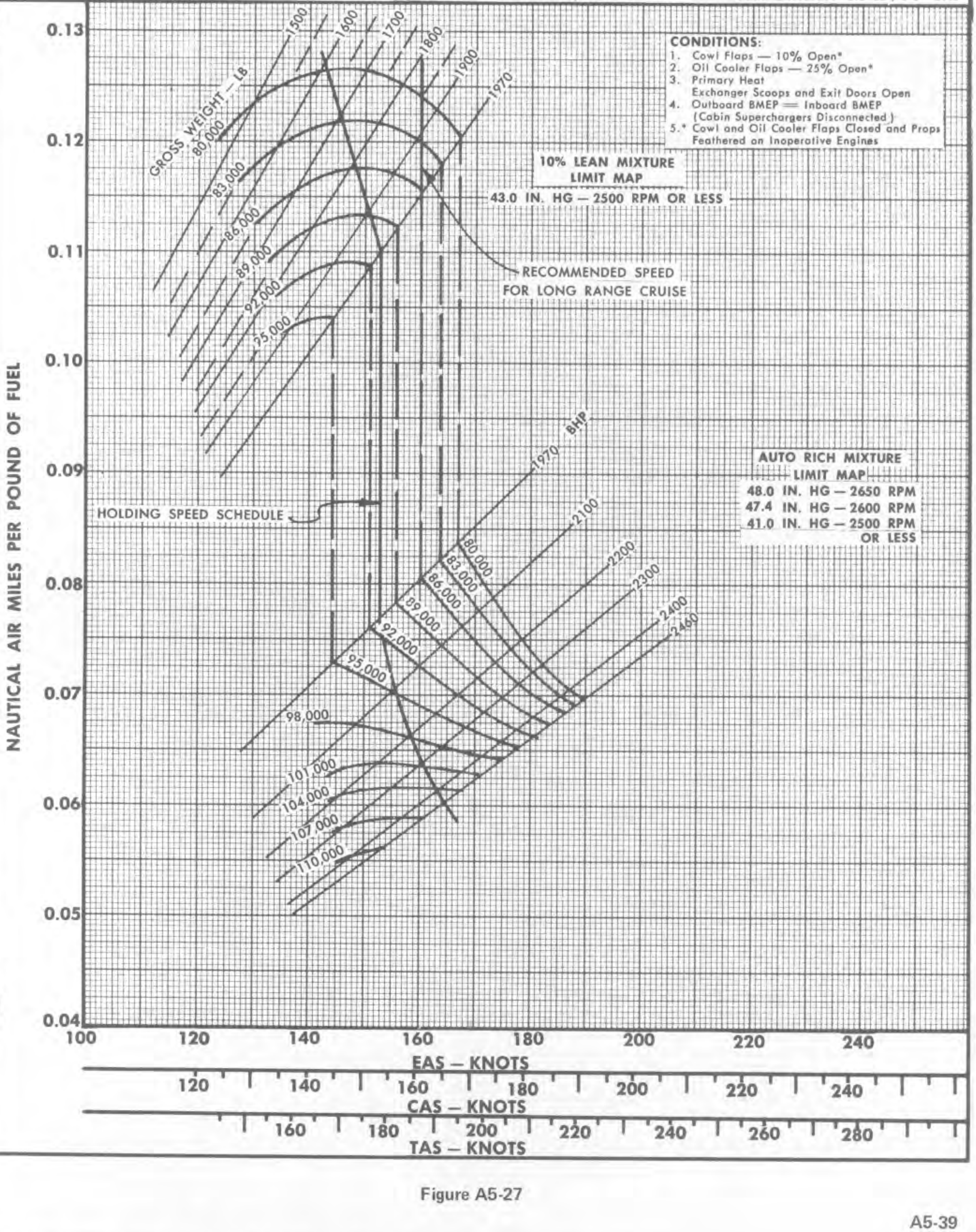
10,000 FT DENSITY ALTITUDE $1/\sqrt{\sigma} = 1.1637$

LOW BLOWER

MODEL: EC-121R
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 /U S GAL



CONDITIONS:
1. Cowl Flaps — 10% Open*
2. Oil Cooler Flaps — 25% Open*
3. Primary Heat Exchanger Scoops and Exit Doors Open
4. Outboard BMEP = Inboard BMEP (Cabin Superchargers Disconnected)
5.* Cowl and Oil Cooler Flaps Closed and Props Feathered on Inoperative Engines

10% LEAN MIXTURE LIMIT MAP
43.0 IN. HG — 2500 RPM OR LESS

AUTO RICH MIXTURE LIMIT MAP
48.0 IN. HG — 2650 RPM
47.4 IN. HG — 2600 RPM
41.0 IN. HG — 2500 RPM OR LESS

Figure A5-27

FOUR ENGINE OPERATION

LONG RANGE CRUISE PERFORMANCE

TIME PREDICTION

MODEL: EC-121R
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/U S Gal

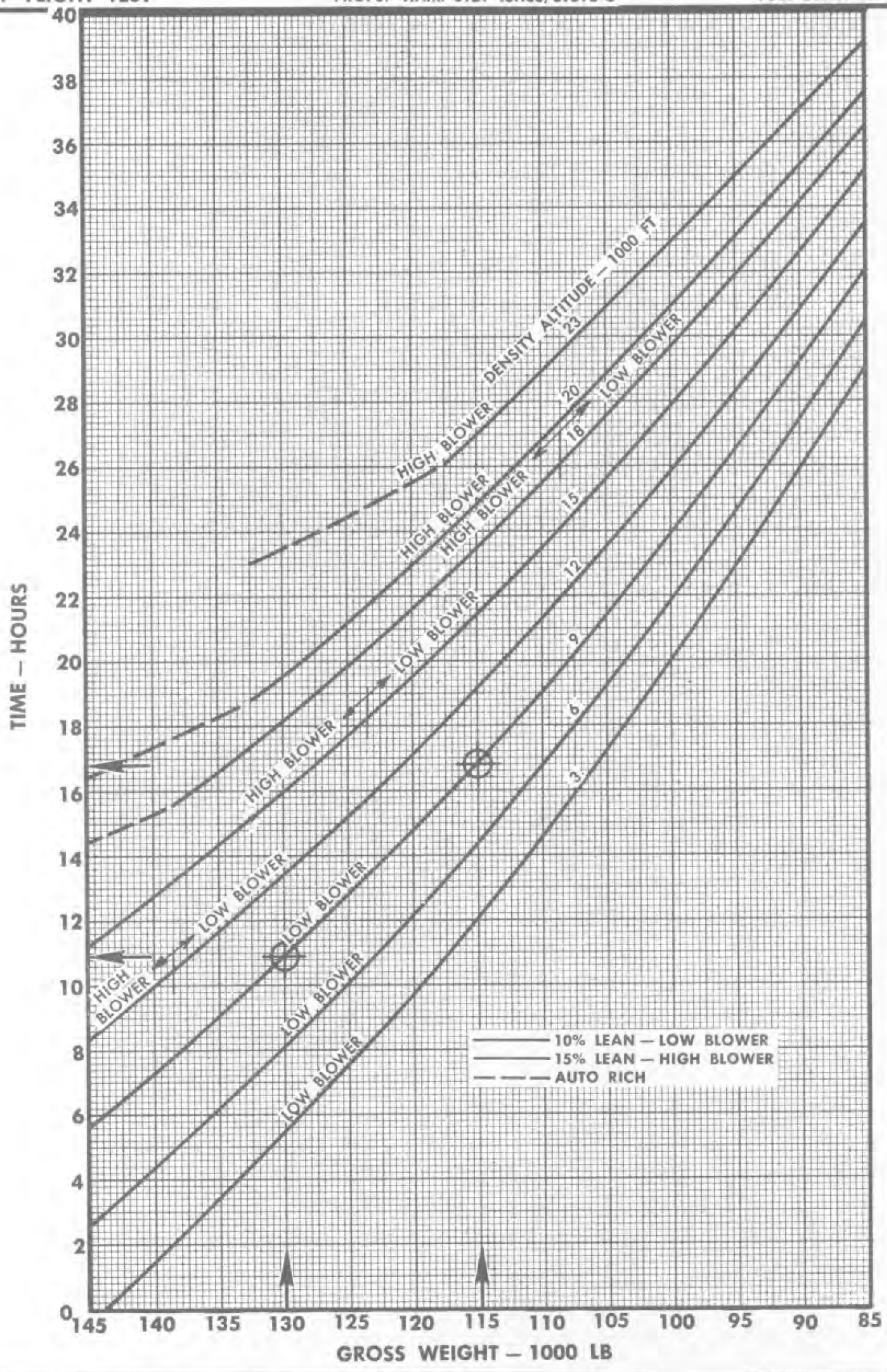


Figure A5-28

FOUR ENGINE OPERATION
LONG RANGE CRUISE PERFORMANCE
DISTANCE PREDICTION

MODEL: EC-121R
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/U S Gal

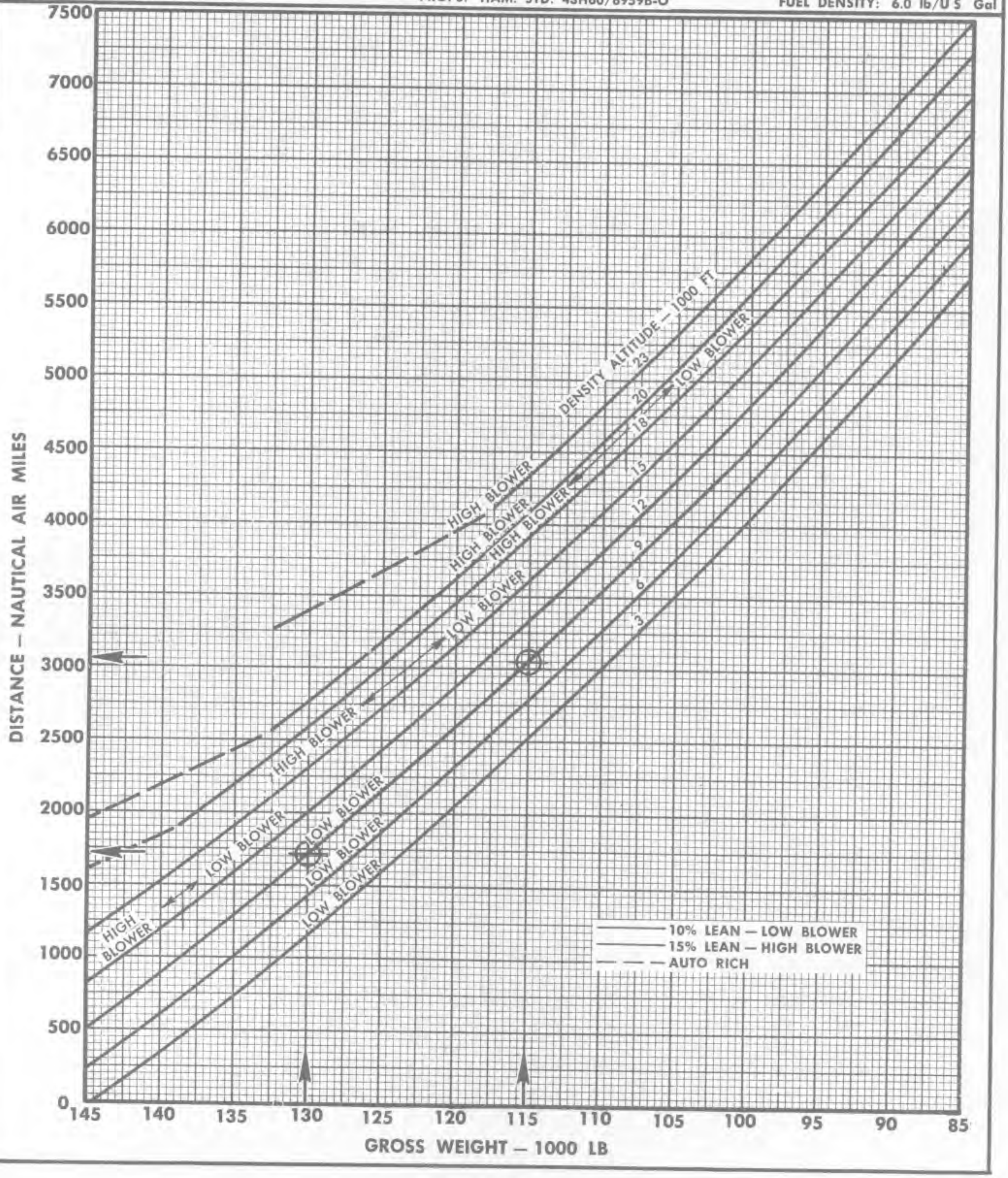


Figure A5-29

THREE ENGINE OPERATION
LONG RANGE CRUISE PERFORMANCE
TIME PREDICTION

MODEL: EC-121R
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/U S Gal

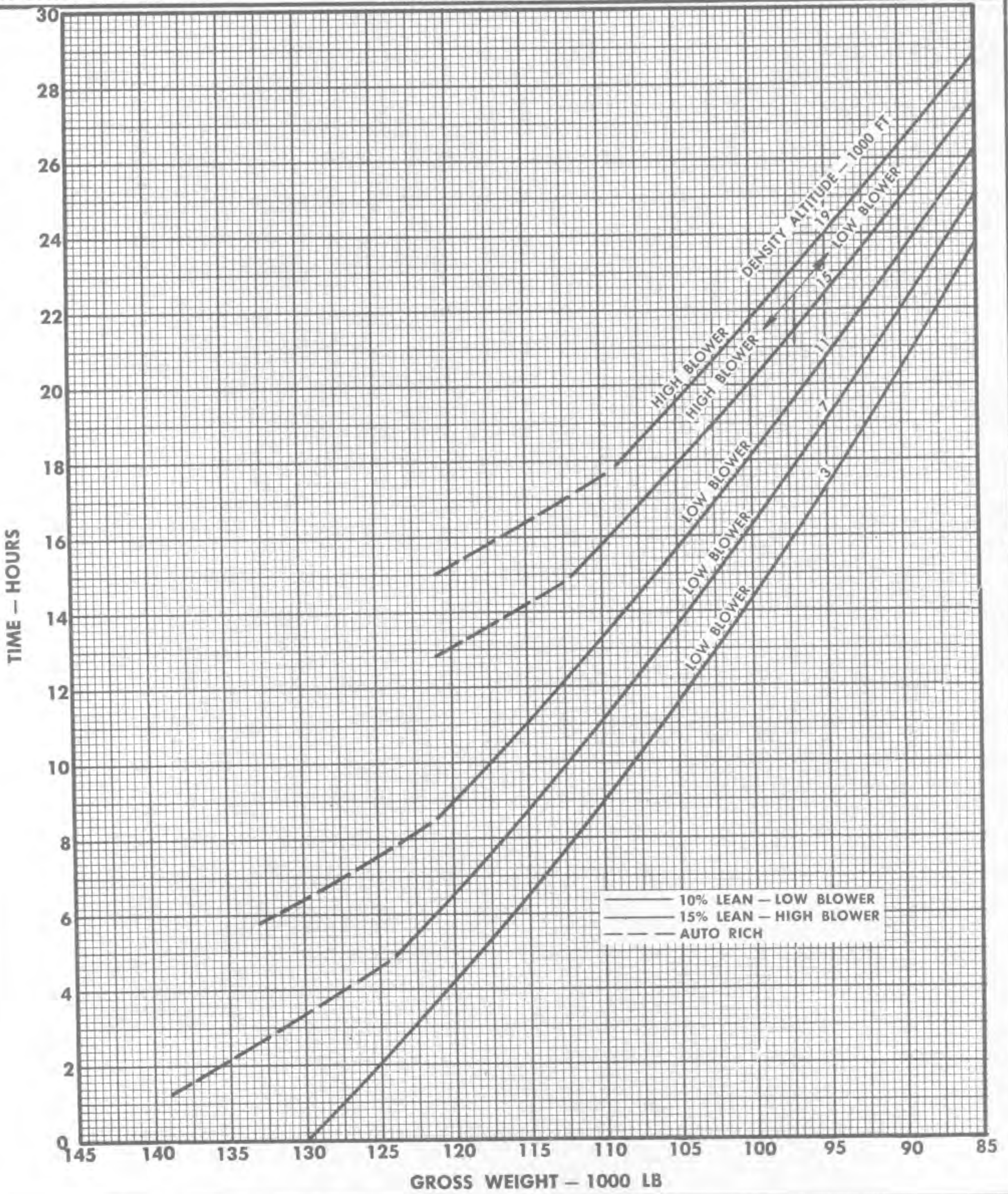


Figure A5-30

THREE ENGINE OPERATION
LONG RANGE CRUISE PERFORMANCE
DISTANCE PREDICTION

MODEL: EC-121R
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/U S Gal

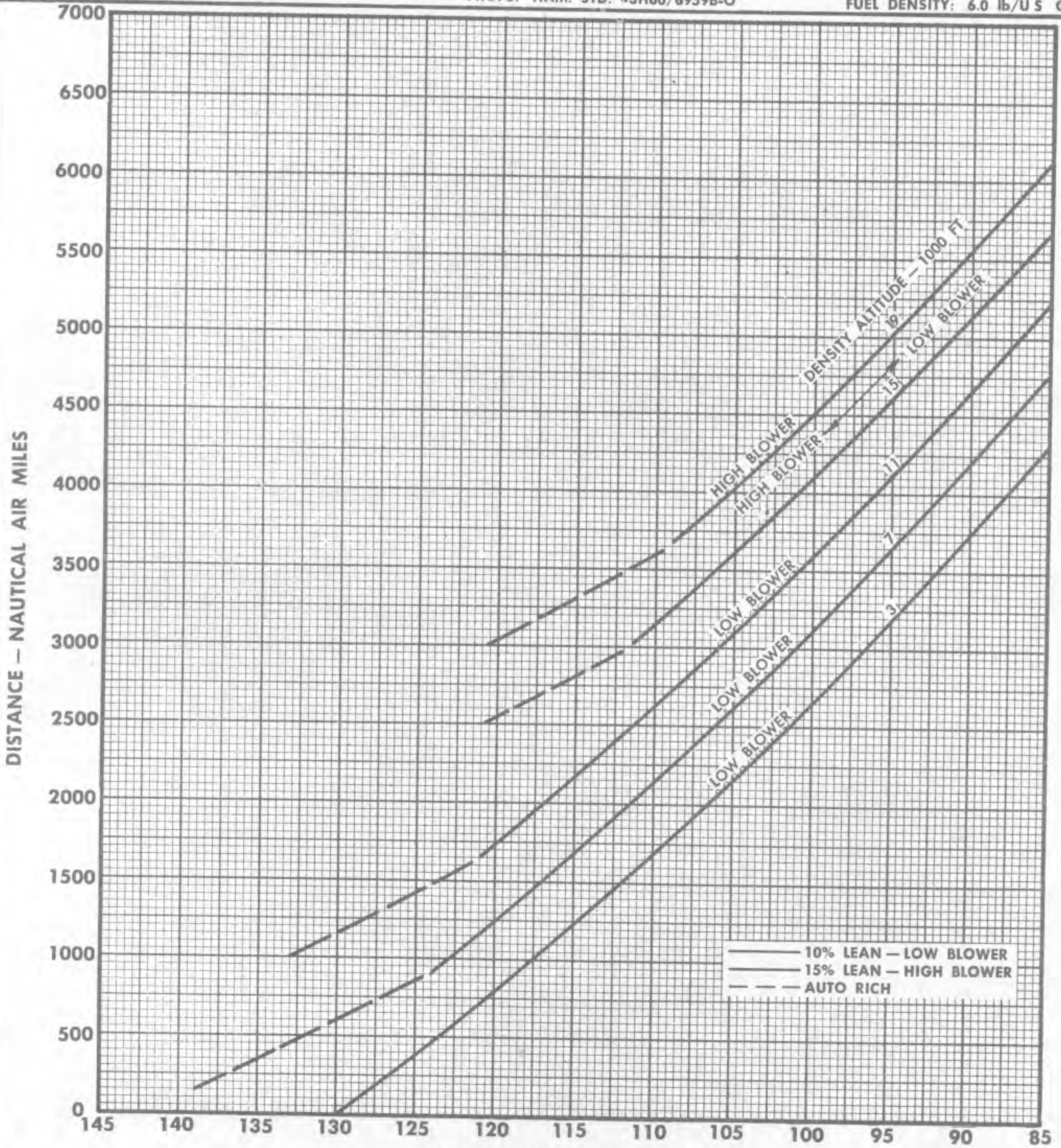


Figure A5-31

TWO ENGINE OPERATION
LONG RANGE CRUISE PERFORMANCE
TIME PREDICTION

MODEL: EC-121R
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/U S Gal

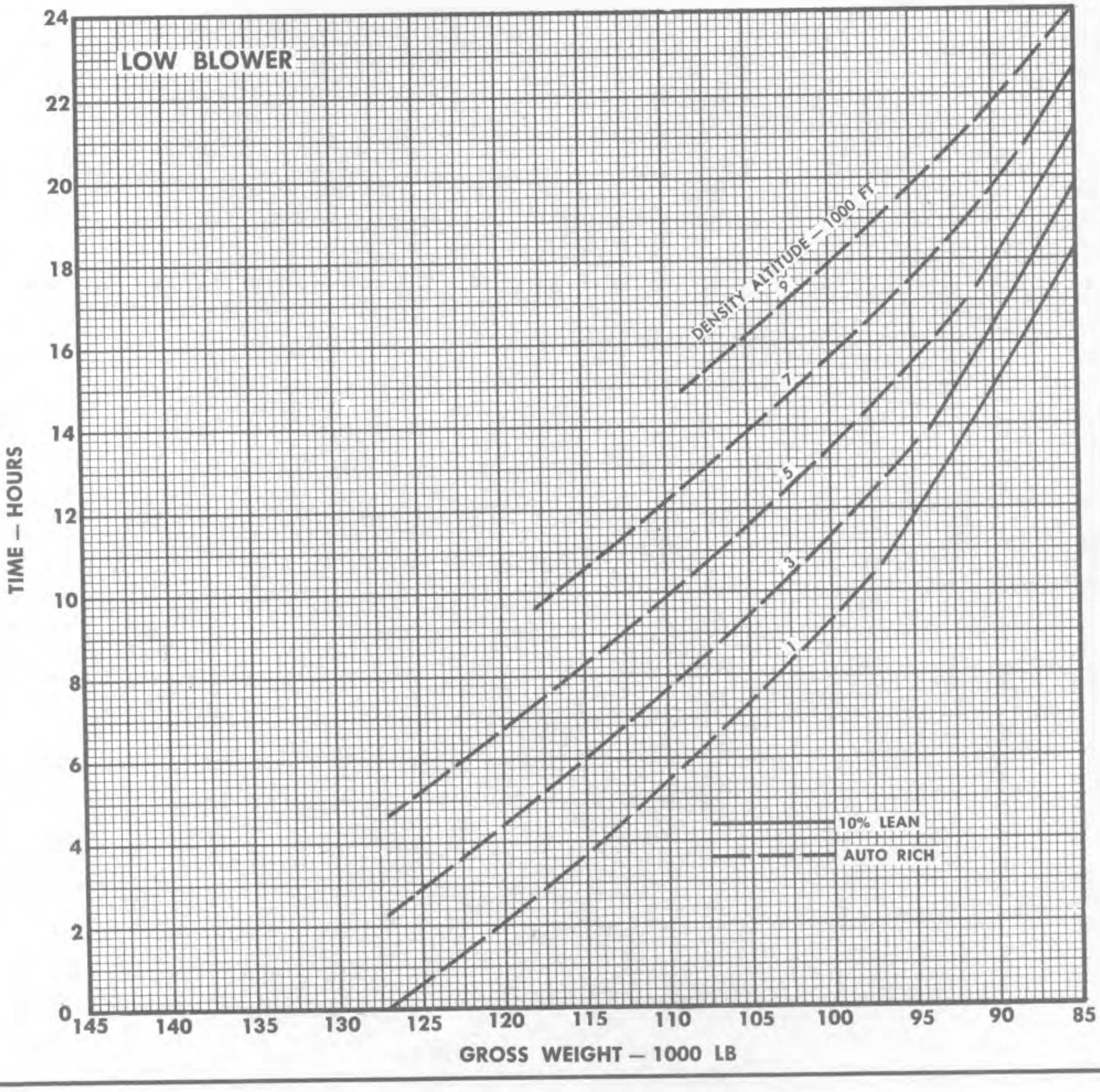


Figure A5-32

TWO ENGINE OPERATION
LONG RANGE CRUISE PERFORMANCE
DISTANCE PREDICTION

MODEL: EC-121R
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/U S Gal

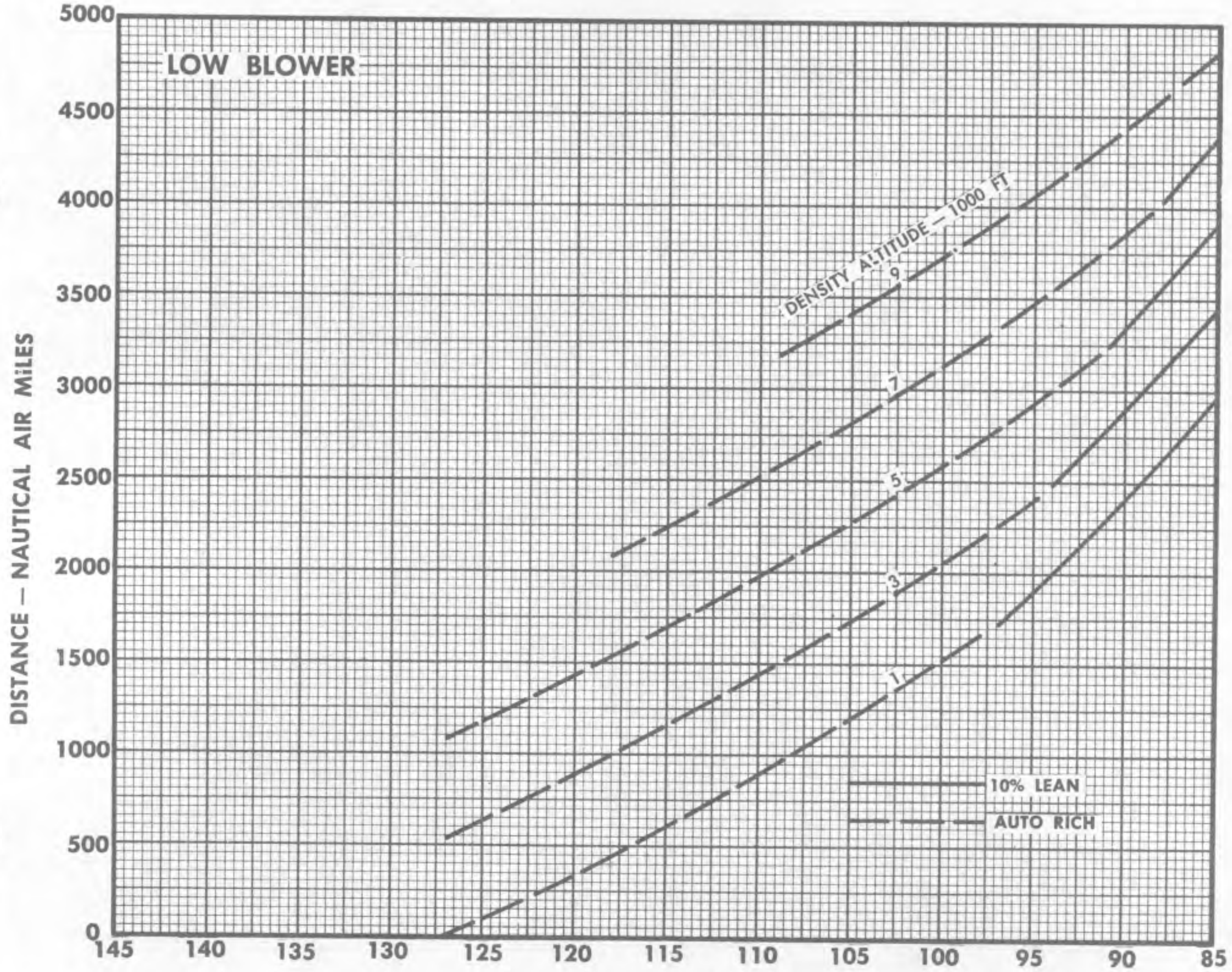


Figure A5-33

FOUR ENGINE OPERATION
HOLDING CRUISE PERFORMANCE
TIME PREDICTION

MODEL: EC-121R
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/U S Gal

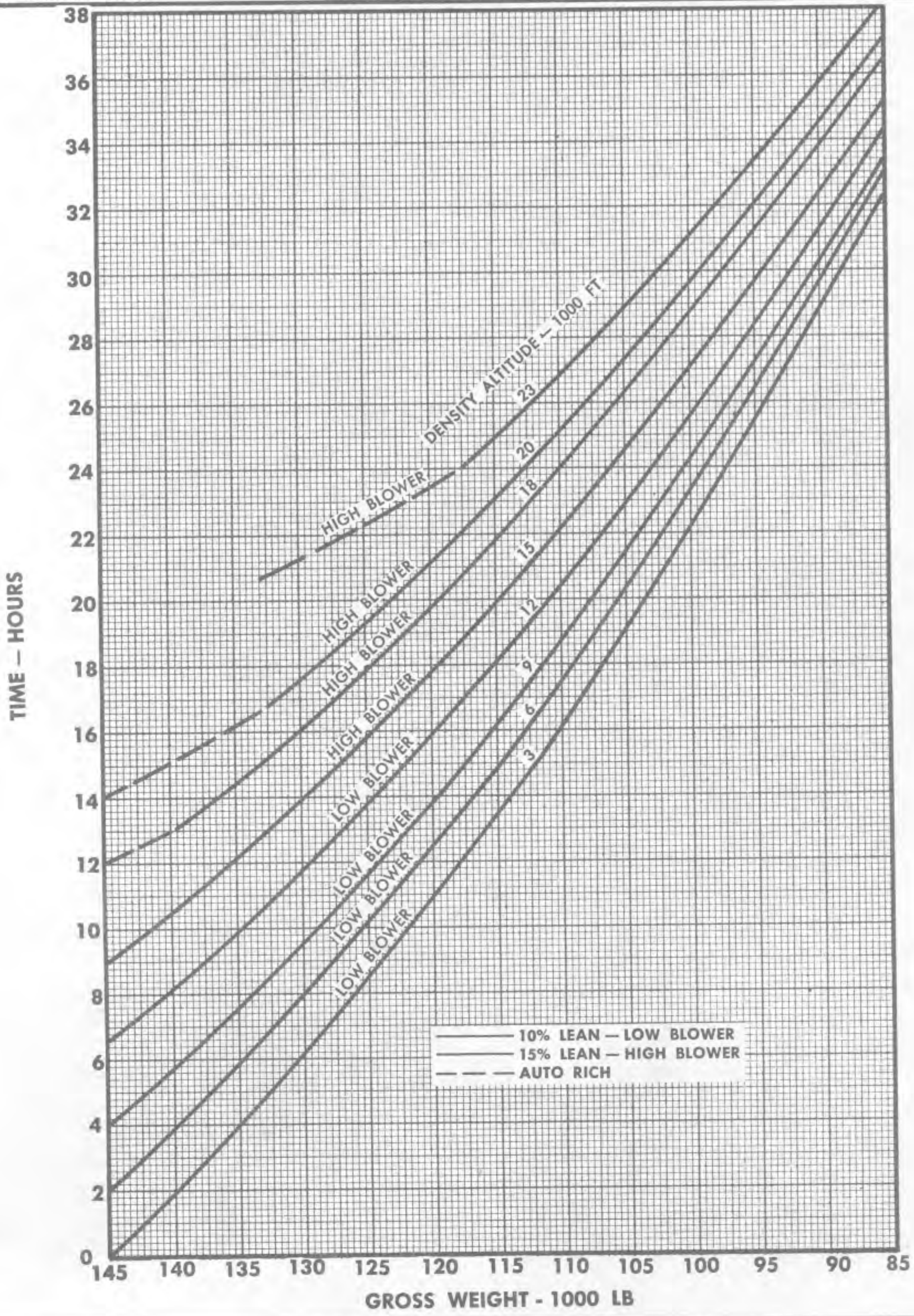


Figure A5-34

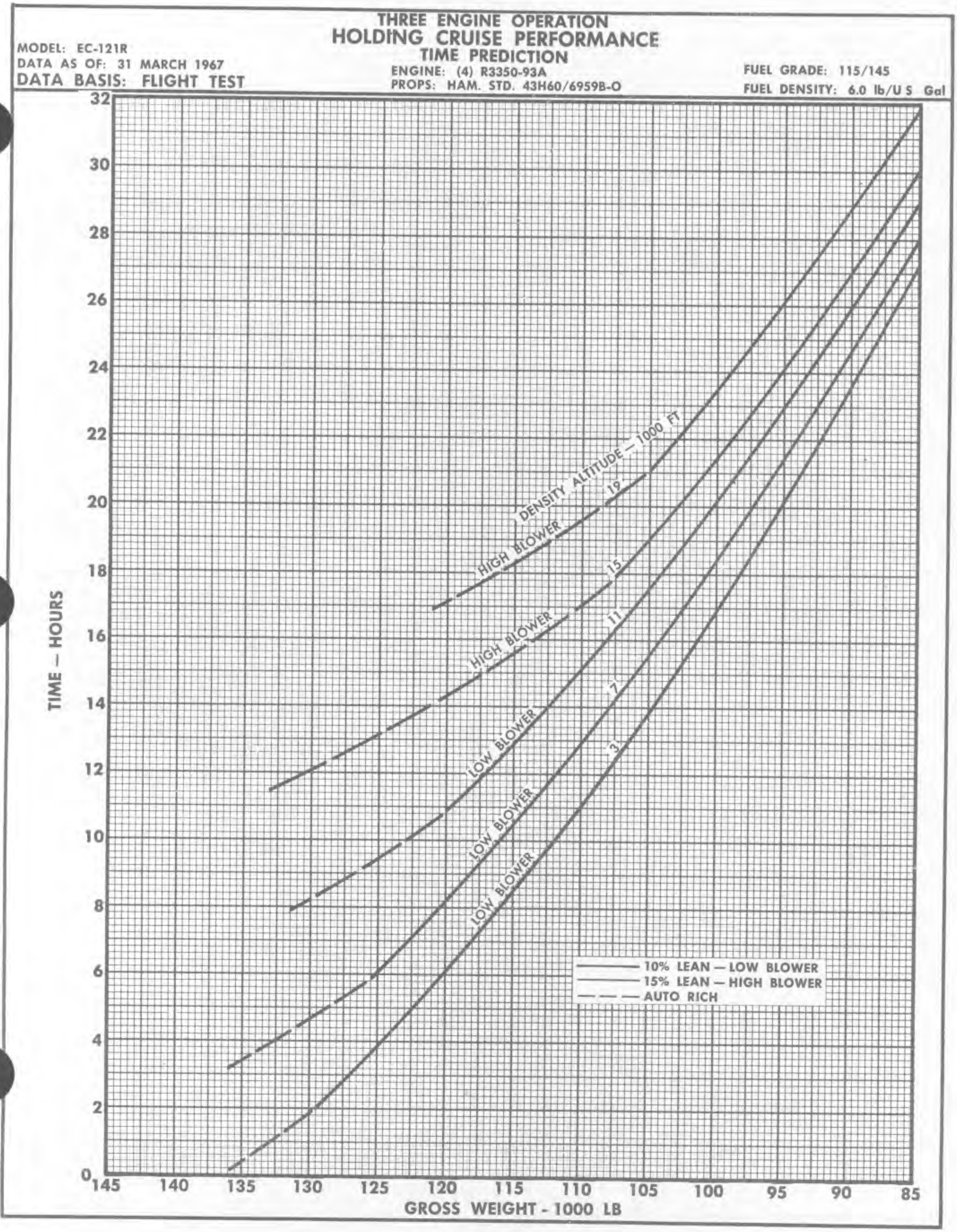

THREE ENGINE OPERATION
HOLDING CRUISE PERFORMANCE
TIME PREDICTION
MODEL: EC-121R
DATA AS OF: 31 MARCH 1967
DATA BASIS: FLIGHT TEST
ENGINE: (4) R3350-93A
PROPS: HAM. STD. 43H60/6959B-O
FUEL GRADE: 115/145
FUEL DENSITY: 6.0 lb/U S Gal
TIME – HOURS
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
32
GROSS WEIGHT - 1000 LB
145
140
135
130
125
120
115
110
105
100
95
90
85
DENSITY ALTITUDE – 1000 FT
19
15
11
7
3
HIGH BLOWER
HIGH BLOWER
LOW BLOWER
LOW BLOWER
LOW BLOWER
10% LEAN – LOW BLOWER
15% LEAN – HIGH BLOWER
AUTO RICH

Figure A5-35

TWO ENGINE OPERATION
HOLDING CRUISE PERFORMANCE
TIME PREDICTION

MODEL: EC-121R
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/U S Gal

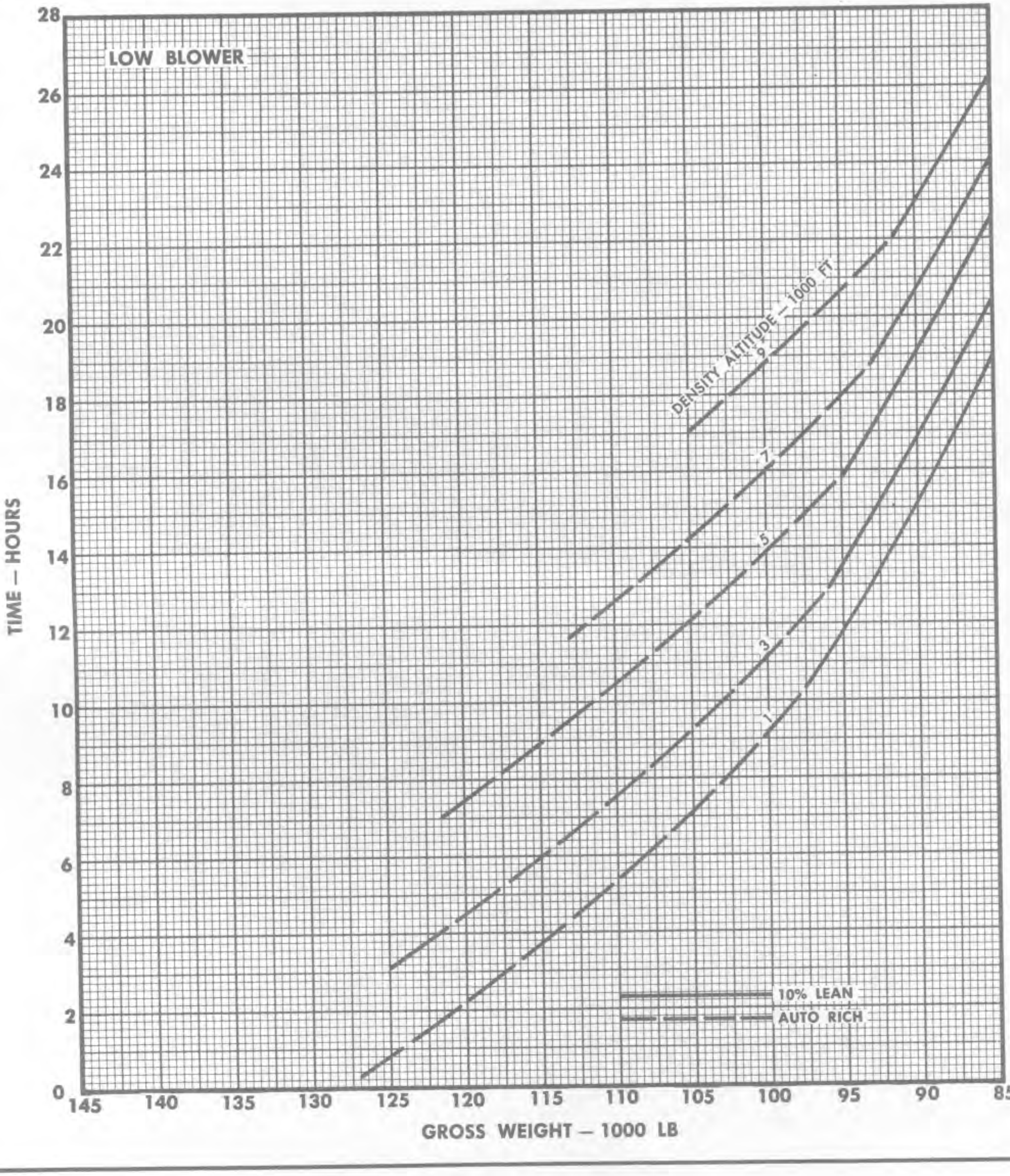


Figure A5-36

FOUR ENGINE OPERATION

LONG RANGE CRUISE – OPERATING TABLES

MODEL: EC-121R
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

GROSS WEIGHT – LB –	H_d 1000 FT	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	BLOWER	LOW BLOWER									HIGH BLOWER											
	BHP	1704	1730	1756	1783	1810	1838	1867	1897	1927	1901	1932	1963	1995	2028	2062	2096	2131	2169			
144,500	RPM	2205	2225	2255	2280	2310	2335	2365	2400	2450	2500	2500	2500	2500	2500	2500	2500	2500	2600			
	BMEP	183	183	184	184	185	185	186	186	186	179	182	185	188	191	194	198	201	197			
	F. F.	700	710	720	730	740	750	760	775	785	835	1300	1310	1330	1345	1350	1370	1395	1430			
TO	EAS	203	203	203	203	203	203	203	203	203	198	198	198	198	198	198	198	198	198			
	TAS	212	216	219	222	226	229	232	236	240	238	242	246	250	254	258	262	267	271			
141,500	Δ TIME	1:04	1:03	1:03	1:02	1:01	1:00	:59	:58	:57	:54	:34	:34	:34	:33	:33	:33	:32	:32			
	Δ DIST	227	228	228	228	229	229	229	229	229	214	140	141	141	143	143	143	143	142			
	BHP	1660	1685	1711	1740	1764	1791	1819	1848	1877	1850	1880	1910	1941	1973	2006	2040	2074	2109	2061		
141,500	RPM	2140	2170	2195	2230	2250	2280	2300	2350	2405	2460	2480	2495	2500	2500	2500	2500	2500	2600	2600		
	BMEP	183	183	184	184	185	185	186	186	184	177	179	181	184	187	190	192	195	192	187		
	F. F.	675	685	695	705	715	725	735	750	765	810	820	830	1280	1300	1320	1330	1350	1395	1360		
TO	EAS	202	202	202	202	202	202	202	202	202	197	197	197	197	197	197	197	197	197	189		
	TAS	211	214	218	221	224	228	231	235	239	236	241	244	248	252	257	261	265	270	264		
138,500	Δ TIME	1:07	1:06	1:05	1:04	1:03	1:02	1:01	1:00	:59	:55	:55	:54	:35	:35	:34	:34	:33	:32	:33		
	Δ DIST	234	234	234	235	235	236	236	235	234	218	220	220	145	145	146	147	147	145	145		
	BHP	1615	1639	1664	1690	1716	1743	1770	1798	1826	1856	1823	1853	1883	1915	1946	1979	2012	2047	2082	2027	
138,500	RPM	2090	2105	2135	2160	2190	2220	2255	2310	2375	2450	2430	2450	2470	2490	2500	2500	2500	2500	2600	2600	
	BMEP	183	183	184	184	185	185	185	184	182	179	177	178	180	181	184	187	190	193	189	184	
	F. F.	660	665	675	685	695	705	715	730	745	760	790	800	810	820	1275	1295	1315	1330	1370	1335	
TO	EAS	200	200	200	200	200	200	200	200	200	200	195	195	195	195	195	195	195	195	195	187	
	TAS	209	212	216	219	222	226	229	233	236	240	238	242	246	250	254	259	262	267	272	265	
135,500	Δ TIME	1:08	1:08	1:07	1:06	1:05	1:04	1:03	1:02	1:00	:59	:57	:56	:56	:55	:35	:35	:34	:34	:33	:34	
	Δ DIST	237	239	240	240	240	240	240	239	238	236	226	227	227	227	149	150	150	150	149	149	
	BHP	1568	1592	1616	1641	1665	1692	1718	1746	1773	1802	1831	1805	1834	1865	1896	1927	1960	1993	2028	1963	
135,500	RPM	2025	2045	2070	2100	2120	2150	2210	2280	2340	2410	2480	2420	2440	2455	2475	2490	2500	2500	2500	2600	
	BMEP	182	183	184	184	185	185	183	181	179	177	173	176	177	179	181	182	185	188	191	178	
	F. F.	635	645	650	660	670	680	690	705	720	735	750	770	780	795	805	820	1280	1295	1310	1300	
TO	EAS	199	199	199	199	199	199	199	199	199	199	199	194	194	194	194	194	194	194	194	185	
	TAS	208	211	214	218	221	224	228	232	235	239	243	240	244	249	253	257	262	266	271	262	
132,500	Δ TIME	1:11	1:10	1:09	1:08	1:07	1:06	1:05	1:04	1:03	1:01	1:00	:58	:57	:57	:56	:55	:35	:35	:34	:35	
	Δ DIST	246	246	247	248	248	248	248	247	244	244	243	234	235	235	235	235	154	154	155	151	
	BHP	1523	1546	1570	1594	1618	1643	1669	1696	1722	1750	1778	1755	1784	1813	1843	1874	1906	1938	1972	2005	1933
132,500	RPM	1970	1990	2010	2035	2070	2115	2175	2240	2310	2375	2445	2390	2405	2420	2440	2455	2490	2500	2500	2600	2600
	BMEP	182	183	184	184	184	183	181	179	176	174	172	173	175	177	178	180	181	183	186	182	175
	F. F.	615	625	630	640	650	660	670	685	700	715	730	745	760	770	780	795	805	1250	1270	1320	1270
TO	EAS	197	197	197	197	197	197	197	197	197	197	197	193	193	193	193	193	193	193	193	193	184
	TAS	206	209	212	216	219	222	226	230	233	236	240	235	244	247	251	256	260	264	269	274	266
129,500	Δ TIME	1:13	1:12	1:12	1:10	1:09	1:08	1:07	1:06	1:04	1:03	1:02	1:00	:59	:59	:58	:57	:56	:36	:35	:34	:35
	Δ DIST	251	251	252	253	253	254	253	252	250	248	247	241	241	241	241	241	241	158	159	156	157

NOTES:
1. Low blower lean data are 10-percent. High blower lean data are 15-percent.
2. Values shown are for weight bracket midpoints.
3. Blower shift indicated by heavy line. ▨ Shaded areas are for AUTO RICH operation.
4. Power settings are for inboard engines and include primary heat-exchanger scoop and exit door drag allowance.
5. Tip tank installation reduces EAS approximately 2 knots.
6. Slashed area represents high blower operation, lean mixture , and retard spark.

Figure A5-37 (Sheet 1 of 5)

FOUR ENGINE OPERATION

LONG RANGE CRUISE — OPERATING TABLES

MODEL: EC-121R
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

GROSS WEIGHT – LB –	H_d 1000 FT	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	BLOWER	LOW BLOWER												HIGH BLOWER								
129,500 TO 126,500	BHP	1483	1506	1528	1552	1576	1600	1626	1652	1678	1704	1732	1759	1731	1759	1789	1818	1849	1881	1913	1946	1875
	RPM	1910	1940	1960	1985	2035	2100	2150	2220	2280	2340	2415	2490	2370	2380	2400	2420	2450	2500	2500	2500	2500
	BMEP	182	183	184	184	183	180	179	176	174	172	169	167	173	174	176	177	178	177	181	183	177
	F. F.	600	610	615	625	635	645	660	670	680	700	710	730	730	740	750	760	775	1225	1240	1250	1205
	EAS	196	196	196	196	196	196	196	196	196	196	196	196	192	192	192	192	192	192	192	192	182
	TAS	205	208	211	214	218	221	224	228	232	235	239	243	242	246	250	254	258	264	268	272	262
	Δ TIME	1:15	1:14	1:13	1:12	1:11	1:10	1:08	1:07	1:06	1:04	1:03	1:02	1:02	1:01	1:00	:59	:58	:37	:36	:36	:37
	Δ DIST	256	256	257	257	258	257	256	256	256	253	253	250	249	250	250	250	250	162	162	163	163
126,500 TO 123,500	BHP	1435	1457	1479	1502	1525	1549	1573	1598	1623	1649	1660	1703	1677	1704	1733	1762	1792	1822	1853	1885	1918
	RPM	1855	1875	1905	1950	2000	2055	2115	2180	2240	2305	2360	2445	2340	2350	2360	2375	2400	2475	2500	2500	2600
	BMEP	182	183	183	182	180	178	176	173	171	169	166	164	169	171	173	175	176	174	175	178	174
	F. F.	575	585	595	605	615	625	635	650	660	670	690	700	705	710	720	730	740	760	1200	1210	1260
	EAS	194	194	194	194	194	194	194	194	194	194	194	194	190	190	190	190	190	190	190	190	190
	TAS	203	206	209	212	216	219	222	226	230	233	237	241	240	244	248	252	256	260	265	269	274
	Δ TIME	1:18	1:17	1:16	1:14	1:13	1:12	1:11	1:09	1:08	1:07	1:05	1:04	1:04	1:03	1:03	1:02	1:01	:59	:38	:37	:36
	Δ DIST	265	264	264	263	263	263	262	261	261	261	258	258	256	258	259	259	259	257	166	167	163
123,500 TO 120,500	BHP	1390	1411	1433	1455	1477	1500	1524	1548	1572	1597	1623	1650	1676	1651	1678	1706	1735	1765	1795	1826	1858
	RPM	1795	1830	1875	1920	1970	2025	2090	2150	2200	2265	2330	2400	2470	2320	2330	2340	2360	2425	2500	2500	2500
	BMEP	183	182	181	179	177	175	172	170	169	167	164	162	160	168	170	172	173	172	169	172	175
	F. F.	555	565	580	590	600	610	620	630	640	655	670	680	700	690	695	705	715	735	1160	1170	1200
	EAS	193	193	193	193	193	193	193	193	193	193	193	193	193	188	188	188	188	188	188	188	188
	TAS	202	205	208	211	214	217	221	225	228	232	236	239	243	241	245	249	253	258	262	266	271
	Δ TIME	1:21	1:20	1:18	1:16	1:15	1:14	1:13	1:12	1:10	1:09	1:07	1:06	1:04	1:05	1:04	1:04	1:03	1:04	:39	:38	:38
	Δ DIST	273	272	269	268	267	267	267	267	267	266	264	264	259	262	264	265	265	264	169	170	169
120,500 TO 117,500	BHP	1345	1366	1386	1408	1429	1452	1474	1498	1521	1546	1571	1596	1622	1596	1622	1675	1705	1730	1740	1765	1796
	RPM	1755	1800	1845	1895	1940	1995	2045	2105	2160	2220	2290	2350	2420	2290	2300	2325	2340	2400	2490	2500	2500
	BMEP	181	179	177	175	174	172	170	168	166	164	162	160	158	165	167	170	172	170	165	167	170
	F. F.	540	550	560	570	580	590	600	610	620	635	650	660	675	665	670	680	690	700	725	1140	1155
	EAS	192	192	192	192	192	192	192	192	192	192	192	192	192	187	187	187	187	187	187	187	187
	TAS	201	204	207	210	213	216	220	224	227	231	234	238	242	240	244	248	252	256	261	265	270
	Δ TIME	1:23	1:21	1:20	1:19	1:18	1:16	1:15	1:14	1:13	1:11	1:09	1:08	1:07	1:08	1:07	1:06	1:05	1:04	1:02	:39	:39
	Δ DIST	279	278	277	276	276	275	275	275	274	273	270	270	269	271	273	274	274	274	270	174	175
117,500 TO 114,500	BHP	1305	1324	1344	1365	1386	1408	1430	1453	1475	1499	1523	1548	1573	1599	1570	1596	1623	1651	1679	1708	1738
	RPM	1730	1770	1815	1865	1910	1960	2020	2070	2125	2190	2250	2315	2385	2450	2250	2275	2300	2330	2410	2500	2500
	BMEP	178	176	175	173	171	169	167	166	164	162	160	158	156	154	165	166	167	168	164	161	164
	F. F.	525	530	540	550	560	570	580	590	605	615	625	640	650	665	650	655	660	675	690	1095	1115
	EAS	190	190	190	190	190	190	190	190	190	190	190	190	190	190	185	185	185	185	185	185	185
	TAS	199	202	204	208	211	214	218	222	224	228	232	236	240	244	241	246	249	254	258	262	267
	Δ TIME	1:26	1:25	1:23	1:21	1:20	1:19	1:18	1:16	1:14	1:13	1:12	1:10	1:09	1:08	1:09	1:09	1:08	1:07	1:04	:41	:40
	Δ DIST	286	286	284	284	282	282	282	282	278	278	278	277	277	275	278	282	283	282	280	179	180

NOTES:
1. Low blower lean data are 10-percent. High blower lean data are 15-percent.
2. Values shown are for weight bracket midpoints.
3. Blower shift indicated by heavy line. ▨ Shaded areas are for AUTO RICH operation.
4. Power settings are for inboard engines and include primary heat-exchanger scoop and exit door drag allowance.
5. Tip tank installation reduces EAS approximately 2 knots.
6. Slashed area represents high blower operation, lean mixture , and retard spark.

Figure A5-37 (Sheet 2 of 5)

FOUR ENGINE OPERATION

LONG RANGE CRUISE — OPERATING TABLES

MODEL: EC-121R
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

GROSS WEIGHT	H_p 1000 FT	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
— LB —	BLOWER	LOW BLOWER															HIGH BLOWER					
	BHP	1265	1284	1303	1323	1344	1365	1386	1408	1430	1453	1477	1500	1525	1551	1576	1542	1568	1595	1622	1650	1679
114,500	RPM	1705	1745	1790	1840	1890	1930	1985	2040	2100	2155	2210	2275	2345	2415	2495	2210	2235	2300	2365	2445	2500
	BMEP	175	173	172	170	168	167	165	163	161	159	157	155	153	152	149	164	166	164	162	159	158
TO	F. F.	510	520	525	535	545	555	565	575	585	600	610	620	630	650	660	630	640	650	665	695	1080
	EAS	188	188	188	188	188	188	188	188	188	188	188	188	188	188	188	183	183	183	183	183	183
	TAS	197	200	202	206	209	212	215	219	222	226	230	233	237	241	245	243	246	250	255	260	264
111,500	Δ TIME	1:28	1:27	1:26	1:24	1:23	1:21	1:20	1:18	1:17	1:15	1:14	1:13	1:12	1:09	1:08	1:11	1:10	1:09	1:08	1:05	:42
	Δ DIST	290	289	289	289	288	286	285	285	284	283	283	282	282	278	278	289	288	288	288	280	183
	BHP	1223	1242	1260	1280	1300	1320	1340	1362	1383	1405	1428	1451	1475	1499	1524	1494	1519	1545	1572	1599	1627
111,500	RPM	1675	1720	1765	1805	1855	1905	1950	2005	2060	2120	2170	2235	2300	2375	2440	2160	2210	2260	2330	2400	2495
	BMEP	172	170	168	167	165	163	162	160	158	156	155	153	151	149	147	163	162	161	159	157	154
TO	F. F.	495	500	510	520	530	540	550	560	570	580	590	600	615	630	640	610	620	630	645	675	685
	EAS	187	187	187	187	187	187	187	187	187	187	187	187	187	187	187	182	182	182	182	182	182
	TAS	196	198	201	205	208	211	214	218	221	224	228	232	236	240	244	242	245	249	254	258	263
108,500	Δ TIME	1:31	1:30	1:28	1:27	1:25	1:23	1:21	1:20	1:19	1:18	1:16	1:15	1:13	1:12	1:10	1:14	1:13	1:12	1:10	1:07	1:06
	Δ DIST	297	297	297	296	294	293	292	292	291	290	290	290	288	285	272	298	296	296	296	287	287
	BHP	1177	1195	1214	1233	1252	1271	1291	1310	1332	1354	1376	1398	1421	1444	1468	1493	1472	1497	1523	1549	1576
108,500	RPM	1645	1690	1730	1775	1820	1865	1915	1965	2020	2075	2135	2200	2250	2325	2400	2460	2180	2235	2295	2355	2440
	BMEP	169	167	165	164	162	161	159	158	156	154	152	150	149	147	144	143	159	158	157	155	152
TO	F. F.	480	485	495	505	510	520	530	540	550	560	570	585	595	610	620	630	605	615	630	640	665
	EAS	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185	185	181	181	181	181	181
	TAS	194	196	199	203	206	208	212	216	219	222	226	229	233	237	241	245	244	248	253	256	261
105,500	Δ TIME	1:34	1:33	1:31	1:29	1:28	1:27	1:25	1:23	1:21	1:20	1:19	1:17	1:16	1:14	1:13	1:12	1:14	1:13	1:12	1:10	1:08
	Δ DIST	303	303	302	302	302	300	300	300	299	297	297	294	294	292	292	292	302	302	302	300	294
	BHP	1143	1160	1177	1196	1214	1233	1252	1272	1292	1313	1334	1356	1378	1400	1424	1448	1431	1455	1480	1505	1532
105,500	RPM	1625	1660	1705	1750	1795	1840	1885	1940	1990	2045	2100	2160	2220	2290	2360	2430	2160	2205	2255	2320	2395
	BMEP	166	165	163	161	160	158	157	155	153	152	150	148	147	144	142	140	157	156	155	153	151
TO	F. F.	465	470	480	490	495	505	515	525	535	545	555	570	580	590	600	615	585	600	610	620	635
	EAS	184	184	184	184	184	184	184	184	184	184	184	184	184	184	184	184	180	180	180	180	180
	TAS	193	195	198	202	204	207	211	214	217	221	225	228	232	236	242	244	242	246	251	255	260
102,500	Δ TIME	1:37	1:36	1:34	1:32	1:31	1:29	1:28	1:26	1:24	1:23	1:21	1:19	1:18	1:16	1:15	1:13	1:17	1:15	1:14	1:13	1:11
	Δ DIST	311	311	310	310	309	308	307	306	304	304	304	300	300	300	300	298	310	309	309	308	307
	BHP	1108	1125	1142	1159	1177	1196	1214	1234	1253	1273	1294	1315	1336	1358	1381	1404	1400	1423	1448	1473	1498
102,500	RPM	1600	1635	1680	1725	1765	1805	1860	1910	1960	2015	2065	2125	2180	2250	2315	2390	2135	2185	2240	2295	2365
	BMEP	163	162	160	158	157	156	154	152	151	149	148	146	144	142	141	139	155	154	153	151	149
TO	F. F.	450	460	470	475	480	490	500	510	520	530	540	550	560	575	585	600	575	585	600	610	625
	EAS	182	182	182	182	182	182	182	182	182	182	182	182	182	182	182	182	180	180	180	180	180
	TAS	190	193	196	199	202	205	208	212	215	218	222	226	229	233	237	241	242	246	251	255	260
99,500	Δ TIME	1:40	1:38	1:36	1:35	1:34	1:32	1:30	1:28	1:27	1:25	1:23	1:21	1:20	1:18	1:17	1:15	1:18	1:16	1:15	1:14	1:12
	Δ DIST	317	315	313	313	313	313	312	312	310	308	308	308	307	304	304	301	316	315	314	313	312

NOTES:
1. Values shown are for weight bracket midpoints.
2. Blower shift indicated by heavy line. ▇ Shaded areas are for AUTO RICH operation.
3. Power settings are for inboard engines and include primary heat-exchanger scoop and exit door drag allowance.
4. Tip tank installation reduces EAS approximately 2 knots.
5. Slashed area represents high blower operation, lean mixture , and retard spark.

Figure A5-37 (Sheet 3 of 5)

FOUR ENGINE OPERATION

LONG RANGE CRUISE — OPERATING TABLES

MODEL: EC-121R
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

GROSS WEIGHT – LB –	H_d 1000 FT	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
	BLOWER	LOW BLOWER																HIGH BLOWER				
99,500 TO 96,500	BHP	1070	1086	1103	1120	1137	1155	1173	1192	1211	1230	1250	1270	1291	1312	1334	1356	1374	1397	1421	1446	1471
	RPM	1600	1610	1650	1690	1740	1775	1825	1875	1930	1970	2035	2090	2150	2210	2275	2340	2120	2170	2215	2275	2340
	BMEP	158	159	158	156	154	153	151	150	148	147	145	143	142	140	138	137	153	152	151	150	148
	F. F.	440	450	455	460	470	475	485	495	505	515	525	535	550	560	570	580	570	580	590	600	615
	EAS	181	181	181	181	181	181	181	181	181	181	181	181	181	181	181	181	180	180	180	180	180
	TAS	189	192	195	198	201	204	207	211	214	217	221	224	228	232	236	240	242	246	251	255	260
	Δ TIME	1:42	1:40	1:39	1:38	1:36	1:35	1:33	1:31	1:29	1:28	1:26	1:24	1:21	1:20	1:19	1:18	1:19	1:18	1:16	1:15	1:13
	Δ DIST	322	322	322	322	322	322	320	320	318	316	316	314	311	311	311	310	320	319	319	319	317
96,500 TO 93,500	BHP	1035	1050	1067	1083	1099	1116	1134	1152	1170	1189	1208	1228	1248	1268	1289	1311	1343	1366	1389	1413	1438
	RPM	1600	1600	1620	1665	1710	1755	1800	1850	1895	1940	2000	2055	2110	2165	2235	2300	2100	2145	2195	2250	2310
	BMEP	153	155	155	153	152	150	148	147	146	144	142	141	139	138	136	134	151	150	149	148	147
	F. F.	430	435	440	450	455	460	470	480	490	500	510	520	530	545	555	565	560	565	575	590	600
	EAS	179	179	179	179	179	179	179	179	179	179	179	179	179	179	179	179	180	180	180	180	180
	TAS	187	190	193	196	199	202	205	209	212	215	219	222	226	229	233	237	242	246	251	255	260
	Δ TIME	1:45	1:43	1:42	1:40	1:39	1:38	1:36	1:34	1:32	1:30	1:28	1:27	1:25	1:23	1:21	1:20	1:20	1:20	1:18	1:16	1:15
	Δ DIST	326	328	329	327	328	329	327	327	325	322	322	320	320	315	315	315	325	326	326	325	325
93,500 TO 90,500	BHP	1004	1018	1034	1050	1066	1083	1099	1117	1135	1153	1172	1191	1210	1230	1251	1272	1320	1343	1366	1389	1413
	RPM	1600	1600	1600	1635	1680	1720	1770	1810	1860	1910	1965	2020	2075	2145	2200	2250	2085	2135	2185	2230	2300
	BMEP	148	150	152	151	149	148	146	145	144	142	141	139	137	135	134	133	150	148	148	147	145
	F. F.	415	425	430	435	445	450	460	465	475	485	495	505	515	530	540	550	550	560	570	580	595
	EAS	178	178	178	178	178	178	178	178	178	178	178	178	178	178	178	178	180	180	180	180	180
	TAS	186	189	192	195	198	200	204	207	210	214	217	221	224	228	232	236	242	246	251	255	260
	Δ TIME	1:49	1:46	1:45	1:43	1:41	1:40	1:38	1:37	1:35	1:33	1:31	1:29	1:28	1:25	1:23	1:21	1:21	1:20	1:19	1:18	1:16
	Δ DIST	336	334	335	336	334	333	333	334	332	331	329	328	326	323	322	319	327	330	330	330	328
90,500 TO 87,500	BHP	971	986	1000	1016	1032	1048	1064	1081	1098	1116	1134	1152	1171	1191	1210	1231	1299	1321	1343	1366	1390
	RPM	1600	1600	1600	1615	1665	1695	1740	1785	1830	1885	1935	1990	2050	2105	2160	2225	2065	2120	2160	2215	2280
	BMEP	143	146	148	149	147	146	144	143	142	140	138	137	135	133	132	130	148	147	147	146	144
	F. F.	405	410	420	425	430	440	445	455	460	470	480	490	500	515	525	535	540	550	560	570	585
	EAS	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	177	180	180	180	180	180
	TAS	185	187	190	194	197	199	203	206	209	213	216	220	223	227	230	234	242	246	251	255	260
	Δ TIME	1:51	1:50	1:47	1:46	1:45	1:42	1:41	1:39	1:38	1:36	1:34	1:32	1:30	1:28	1:26	1:24	1:23	1:21	1:20	1:19	1:17
	Δ DIST	342	342	339	342	344	339	341	340	340	340	338	337	334	330	329	328	333	332	336	336	334
87,500 TO 84,500	BHP	941	955	970	984	999	1015	1031	1047	1064	1081	1098	1116	1135	1153	1172	1192	1274	1296	1318	1341	1365
	RPM	1600	1600	1600	1600	1630	1665	1720	1755	1800	1850	1900	1950	2015	2070	2130	2190	2045	2100	2145	2200	2255
	BMEP	139	141	143	145	145	144	142	141	140	138	136	135	133	131	130	128	147	146	145	144	143
	F. F.	395	400	405	410	420	425	435	440	450	460	465	475	490	500	510	520	530	545	555	565	570
	EAS	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	175	180	180	180	180	180
	TAS	183	186	188	192	195	197	200	204	207	210	214	217	221	224	228	232	242	246	251	255	260
	Δ TIME	1:53	1:53	1:51	1:50	1:47	1:46	1:43	1:42	1:40	1:38	1:37	1:35	1:32	1:30	1:28	1:27	1:25	1:23	1:21	1:20	1:19
	Δ DIST	345	349	348	352	348	348	345	348	345	341	345	344	338	336	335	335	344	338	339	338	342

NOTES:
1. Values shown are for weight bracket midpoints.
2. Blower shift indicated by heavy line. ■ Shaded areas are for AUTO RICH operation.
3. Power settings are for inboard engines and include primary heat-exchanger scoop and exit door drag allowance.
4. Tip tank installation reduces EAS approximately 2 knots.
5. Slashed area represents high blower operation, lean mixture and retard spark.

Figure A5-37 (Sheet 4 of 5)

FOUR ENGINE HIGH BLOWER OPERATION

LONG RANGE CRUISE – OPERATING TABLES

HIGH BLOWER OVERLAP

MODEL: EC-121R

DATA AS OF: 31 MARCH 1967

DATA BASIS: FLIGHT TEST

ENGINE: (4) R3350-93A

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

FUEL GRADE: 115/145

FUEL DENSITY: 6.0 lb/US Gal

138,500 TO 135,500 LB		
ALT	12,000	
BHP	1795	
RPM	2420	
BMEP	175	
F.F.	785	
EAS	195	
TAS	234	
ΔTIME	0.57	
ΔDIST	224	

126,500 TO 123,500 LB		
ALT	13,000	14,000
BHP	1625	1655
RPM	2310	2325
BMEP	166	168
F.F.	690	700
EAS	190	190
TAS	232	236
ΔTIME	1:05	1:04
ΔDIST	252	252

114,500 TO 111,500 LB		
ALT	16,000	17,000
BHP	1495	1530
RPM	2160	2190
BMEP	164	165
F.F.	615	620
EAS	183	183
TAS	235	239
ΔTIME	1:13	1:13
ΔDIST	286	289

102,500 TO 99,500 LB		
ALT	17,000	18,000
BHP	1355	1385
RPM	2040	2095
BMEP	157	156
F.F.	555	565
EAS	180	180
TAS	234	238
ΔTIME	1:21	1:20
ΔDIST	316	316

90,500 TO 87,500 LB		
ALT	17,000	18,000
BHP	1255	1280
RPM	1960	2015
BMEP	151	150
F.F.	520	530
EAS	180	180
TAS	234	238
ΔTIME	1:26	1:25
ΔDIST	337	337

135,500 TO 132,500 LB		
ALT	12,000	13,000
BHP	1740	1770
RPM	2385	2400
BMEP	172	174
F.F.	755	765
EAS	194	194
TAS	233	237
ΔTIME	1:00	0:59
ΔDIST	232	232

123,500 TO 120,500 LB		
ALT	14,000	15,000
BHP	1600	1625
RPM	2290	2300
BMEP	165	167
F.F.	675	680
EAS	188	188
TAS	233	237
ΔTIME	1:07	1:06
ΔDIST	259	261

111,500 TO 108,500 LB		
ALT	16,000	17,000
BHP	1450	1475
RPM	2100	2125
BMEP	164	164
F.F.	590	600
EAS	182	182
TAS	233	237
ΔTIME	1:16	1:15
ΔDIST	296	296

99,500 TO 96,500 LB		
ALT	17,000	18,000
BHP	1325	1345
RPM	2020	2070
BMEP	155	154
F.F.	545	555
EAS	180	180
TAS	234	238
ΔTIME	1:23	1:21
ΔDIST	322	322

87,500 TO 84,500 LB		
ALT	17,000	18,000
BHP	1235	1255
RPM	1940	2000
BMEP	150	148
F.F.	510	520
EAS	180	180
TAS	234	238
ΔTIME	1:28	1:26
ΔDIST	344	343

132,500 TO 129,500 LB		
ALT	12,000	13,000
BHP	1960	1720
RPM	2360	2370
BMEP	169	171
F.F.	730	740
EAS	193	193
TAS	232	235
ΔTIME	1:02	1:01
ΔDIST	238	238

120,500 TO 117,500 LB		
ALT	14,000	15,000
BHP	1555	1580
RPM	2235	2260
BMEP	164	165
F.F.	650	660
EAS	187	187
TAS	232	236
ΔTIME	1:09	1:08
ΔDIST	268	268

108,500 TO 105,500 LB		
ALT	17,000	18,000
BHP	1425	1450
RPM	2090	2140
BMEP	161	160
F.F.	580	590
EAS	181	181
TAS	236	240
ΔTIME	1:18	1:16
ΔDIST	305	305

96,500 TO 93,500 LB		
ALT	17,000	18,000
BHP	1305	1320
RPM	2000	2050
BMEP	154	152
F.F.	535	545
EAS	180	180
TAS	234	238
ΔTIME	1:24	1:23
ΔDIST	328	328

129,500 TO 126,500 LB		
ALT	13,000	14,000
BHP	1670	1695
RPM	2345	2355
BMEP	167	170
F.F.	715	725
EAS	192	192
TAS	234	238
ΔTIME	1:03	1:02
ΔDIST	246	246

117,500 TO 114,500 LB		
ALT	15,000	16,000
BHP	1530	1550
RPM	2200	2220
BMEP	164	165
F.F.	630	640
EAS	185	185
TAS	233	237
ΔTIME	1:11	1:10
ΔDIST	278	278

105,500 TO 102,500 LB		
ALT	17,000	18,000
BHP	1390	1415
RPM	2060	2115
BMEP	159	158
F.F.	565	575
EAS	180	180
TAS	234	238
ΔTIME	1:20	1:18
ΔDIST	310	310

93,500 TO 90,500 LB		
ALT	17,000	18,000
BHP	1275	1300
RPM	1980	2030
BMEP	152	151
F.F.	525	535
EAS	180	180
TAS	234	238
ΔTIME	1:26	1:24
ΔDIST	334	334

NOTES:
1. Values shown are for weight bracket midpoints.
2. Power settings are for inboard engines and include primary heat-exchanger scoop and exit door drag allowance.
3. Tip tank installation reduces EAS approximately 2 knots.
4. Slashed brackets represent high blower, lean mixture , retard spark (20°) data.

Figure A5-37 (Sheet 5 of 5)

THREE ENGINE OPERATION

LONG RANGE CRUISE — OPERATING TABLES

MODEL: EC-121R
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

GROSS WEIGHT – LB –	H_d 1000 FT	1	3	5	7	9	11	13	15	17	19	21	23
	BLOWER	LOW BLOWER											
139,000 TO 136,000	BHP	2200	2266	2336	2408	2484							
	RPM	2600	2600	2600	2600	2600							
	BMEP	200	206	212	219	226							
	F. F.	1310	1370	1415	1450	1500							
	EAS	191	191	191	191	191							
	TAS	195	199	206	212	219							
	Δ TIME	0:46	0:44	0:42	0:42	0:40							
	Δ DIST	149	146	146	146	146							
136,000 TO 133,000	BHP	2040	2101	2165	2233	2303							
	RPM	2500	2500	2600	2600	2600							
	BMEP	192	198	197	203	209							
	F. F.	1255	1290	1355	1405	1450							
	EAS	189	189	189	189	189							
	TAS	193	197	204	210	218							
	Δ TIME	0:48	0:47	0:44	0:43	0:41							
	Δ DIST	153	153	150	150	150							
133,000 TO 130,000	BHP	1979	2039	2100	2166	2234	2305						
	RPM	2500	2500	2500	2600	2600	2600						
	BMEP	187	193	198	197	203	209						
	F. F.	1240	1265	1300	1380	1405	1405						
	EAS	188	188	188	188	188	183						
	TAS	191	197	203	209	216	216						
	Δ TIME	0:48	0:47	0:46	0:44	0:43	0:43						
	Δ DIST	154	156	156	151	153	153						
130,000 TO 127,000	BHP	1918	1976	2036	2099	2165	2234						
	RPM	2495	2500	2500	2500	2600	2600						
	BMEP	182	187	192	199	204	211						
	F. F.	820	1210	1250	1285	1350	1400						
	EAS	186	186	186	186	186	186						
	TAS	189	195	200	206	212	220						
	Δ TIME	1:13	0:49	0:48	0:47	0:44	0:43						
	Δ DIST	231	161	160	160	157	157						
127,000 TO 124,000	BHP	1867	1924	1982	2043	2108	2175						
	RPM	2430	2475	2500	2500	2500	2600						
	BMEP	181	184	187	192	199	198						
	F. F.	790	810	1205	1250	1290	1350						
	EAS	185	185	185	185	185	185						
	TAS	188	193	200	206	212	216						
	Δ TIME	1:16	1:14	0:50	0:48	0:46	0:44						
	Δ DIST	238	236	166	165	164	160						
124,000 TO 121,000	BHP	1806	1861	1918	1977	2039	2104						
	RPM	2345	2395	2450	2500	2500	2500						
	BMEP	182	184	185	187	192	198						
	F. F.	755	775	800	1195	1240	1285						
	EAS	183	183	183	183	183	183						
	TAS	186	191	197	203	210	216						
	Δ TIME	1:20	1:17	1:15	0:50	0:48	0:47						
	Δ DIST	246	246	246	170	170	168						

NOTES:
1. Values shown are for weight bracket midpoints.
2. Blower shift indicated by heavy line. ▨ Shaded areas are for AUTO RICH operation.
3. Power settings are for inboard engines and include primary heat-exchanger scoop and exit door drag allowance.
4. Prop feathered and all flaps closed on inoperative engine.
5. Tip tank installation decreases EAS approximately 2 knots.

Figure A5-38 (Sheet 1 of 3)

THREE ENGINE OPERATION

LONG RANGE CRUISE — OPERATING TABLES

MODEL: EC-121R
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

GROSS WEIGHT – LB –	H_p 1000 FT	1	3	5	7	9	11	13	15	17	19	21	23
	BLOWER	LOW BLOWER						HIGH BLOWER					
121,000 TO 118,000	BHP	1747	1800	1855	1913	1973	2036	2105	2187	2245	2218		
	RPM	2275	2320	2370	2430	2500	2500	2500	2600	2600	2600		
	BMEP	182	183	185	186	186	192	199	197	204	201		
	F. F.	725	745	770	790	1190	1225	1415	1475	1510	1480		
	EAS	182	182	182	182	182	182	182	182	182	174		
	TAS	185	190	196	202	208	215	222	230	237	234		
	Δ TIME	1:23	1:21	1:18	1:16	0:50	0:48	:42	:41	:40	:41		
	Δ DIST	256	255	255	255	175	175	157	157	157	158		
118,000 TO 115,000	BHP	1695	1746	1799	1855	1913	1974	2038	2105	2176	2249		
	RPM	2205	2250	2300	2350	2410	2500	2500	2500	2600	2600		
	BMEP	181	183	185	187	188	186	193	199	198	204		
	F. F.	700	720	740	760	780	1185	1370	1400	1465	1490		
	EAS	180	180	180	180	180	180	180	180	180	180		
	TAS	183	188	194	200	206	213	220	227	234	242		
	Δ TIME	1:26	1:23	1:21	1:19	1:17	0:51	:44	:43	:41	:40		
	Δ DIST	261	261	261	263	264	180	161	162	162	164		
115,000 TO 112,000	BHP	1643	1693	1744	1798	1855	1914	1976	2041	2109	2181		
	RPM	2130	2180	2230	2285	2350	2445	2500	2500	2500	2500		
	BMEP	182	183	185	186	186	185	186	193	199	198		
	F. F.	675	690	710	730	755	780	1325	1350	1380	1440		
	EAS	178	178	178	178	178	178	178	178	178	178		
	TAS	181	186	192	198	204	210	218	224	232	240		
	Δ TIME	1:24	1:27	1:25	1:22	1:20	1:17	0:45	:45	:44	:42		
	Δ DIST	268	270	271	271	270	269	164	167	167	167		
112,000 TO 109,000	BHP	1593	1641	1691	1744	1799	1856	1810	1979	2045	2115	2059	
	RPM	2060	2110	2165	2215	2280	2400	2490	2500	2500	2500	2600	
	BMEP	183	183	184	186	186	183	182	187	193	200	187	
	F. F.	650	665	685	700	705	755	880	1310	1340	1370	1360	
	EAS	177	177	177	177	177	177	177	177	177	177	168	
	TAS	180	185	191	197	203	209	216	224	230	238	227	
	Δ TIME	1:32	1:31	1:28	1:26	1:25	1:20	1:08	0:46	0:45	:44	:44	
	Δ DIST	277	279	279	281	287	277	246	171	172	174	168	
109,000 TO 106,000	BHP	1539	1586	1634	1685	1738	1795	1851	1905	1976	2043	2114	
	RPM	2000	2040	2085	2135	2230	2360	2450	2490	2500	2500	2600	
	BMEP	182	183	185	188	184	180	178	180	186	193	192	
	F. F.	625	640	660	680	700	725	800	820	1290	1325	1385	
	EAS	175	175	175	175	175	175	175	175	175	175	175	
	TAS	178	183	188	194	200	207	214	220	228	236	244	
	Δ TIME	1:36	1:34	1:31	1:28	1:26	1:23	1:15	1:13	0:46	0:45	:43	
	Δ DIST	284	285	285	285	285	285	268	268	177	178	176	
106,000 TO 103,000	BHP	1485	1529	1576	1625	1676	1730	1786	1840	1910	1971	2039	1950
	RPM	1930	1970	2015	2065	2195	2315	2450	2440	2480	2500	2600	2600
	BMEP	182	183	185	186	181	177	172	178	181	186	185	177
	F. F.	600	620	635	650	675	700	730	790	815	1290	1350	1290
	EAS	174	174	174	174	174	174	174	174	174	174	174	164
	TAS	177	182	187	193	199	206	212	219	227	234	243	237
	Δ TIME	1:40	1:39	1:35	1:32	1:29	1:26	1:22	1:16	1:14	0:46	:45	:43
	Δ DIST	294	298	294	297	295	294	290	277	278	181	181	171

NOTES:
1. Low blower lean data are 10-percent. High blower lean data are 15-percent.
2. Values shown are for weight bracket midpoints.
3. Blower shift indicated by heavy line. ▮ Shaded areas are for AUTO RICH operation.
4. Power settings are for inboard engines and include primary heat-exchanger scoop and exit door drag allowance.
5. Prop feathered and all flaps closed on inoperative engine.
6. Tip tank installation decreases EAS approximately 2 knots.
7. Slashed area represents high blower operation, lean mixture and retard spark.

Figure A5-38 (Sheet 2 of 3)

THREE ENGINE OPERATION

LONG RANGE CRUISE — OPERATING TABLES

MODEL: EC-121R
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

GROSS WEIGHT – LB –	H_d 1000 FT	1	3	5	7	9	11	13	15	17	19	21	23
	BLOWER	LOW BLOWER							HIGH BLOWER				
103,000 TO 100,000	BHP	1437	1480	1525	1573	1620	1674	1728	1785	1840	1902	1973	1878
	RPM	1865	1910	1950	2030	2150	2280	2400	2400	2435	2495	2500	2600
	BMEP	182	183	185	183	178	173	170	176	178	180	186	171
	F. F.	580	595	610	630	655	680	710	755	780	810	1280	1240
	EAS	173	173	173	173	173	173	173	173	173	173	173	160
	TAS	176	181	186	192	198	204	211	218	225	238	241	231
	Δ TIME	1:44	1:41	1:38	1:35	1:32	1:28	1:25	1:19	1:17	1:15	:47	:48
	Δ DIST	305	305	305	304	302	300	298	289	288	288	288	186
100,000 TO 97,000	BHP	1385	1427	1471	1516	1564	1614	1666	1721	1785	1845	1902	1969
	RPM	1795	1830	1900	2000	2110	2230	2360	2370	2395	2455	2500	2600
	BMEP	182	184	183	179	175	171	167	171	176	177	180	179
	F. F.	555	570	590	610	630	655	680	710	745	770	1230	1300
	EAS	172	172	172	172	172	172	172	172	172	172	172	172
	TAS	175	180	185	191	197	203	210	217	224	232	240	248
	Δ TIME	1:47	1:45	1:42	1:38	1:35	1:32	1:28	1:22	1:21	1:18	0:49	0:46
	Δ DIST	316	316	314	314	312	310	309	305	301	301	195	191
97,000 TO 94,000	BHP	1339	1379	1421	1465	1511	1559	1610	1663	1718	1778	1838	1903
	RPM	1735	1770	1865	1965	2075	2195	2310	2450	2360	2390	2500	2600
	BMEP	182	184	180	176	172	170	165	160	172	176	173	173
	F. F.	535	550	570	590	610	635	660	690	720	735	1180	1255
	EAS	170	170	170	170	170	170	170	170	170	170	170	170
	TAS	173	178	183	189	195	201	207	214	222	229	237	245
	Δ TIME	1:52	1:49	1:45	1:42	1:38	1:35	1:31	1:27	1:23	1:23	0.51	:48
	Δ DIST	324	324	321	320	320	317	314	310	309	311	201	195
94,000 TO 91,000	BHP	1302	1341	1382	1425	1470	1517	1566	1617	1671	1735	1788	1851
	RPM	1690	1750	1840	1935	2050	2160	2285	2410	2330	2350	2500	2500
	BMEP	182	181	177	174	169	166	162	158	170	173	169	174
	F. F.	520	540	555	575	600	620	645	670	695	710	1150	1190
	EAS	170	170	170	170	170	170	170	170	170	170	170	170
	TAS	173	178	183	189	195	201	207	214	222	229	237	245
	Δ TIME	1:56	1:51	1:47	1:44	1:40	1:39	1:33	1:27	1:26	1:25	0:52	:50
	Δ DIST	333	329	330	329	325	330	321	312	319	323	206	206
91,000 TO 88,000	BHP	1269	1307	1347	1388	1432	1478	1526	1576	1623	1683	1742	1803
	RPM	1650	1730	1820	1915	2020	2130	2245	2390	2305	2315	2485	2500
	BMEP	182	178	175	171	167	164	160	156	166	172	165	170
	F. F.	510	525	540	560	580	605	630	655	675	695	730	1170
	EAS	170	170	170	170	170	170	170	170	170	170	170	170
	TAS	173	178	183	189	195	201	207	214	222	229	237	246
	Δ TIME	1:58	1:54	1:51	1:47	1:43	1:39	1:35	1:32	1:29	1:26	1:22	0.51
	Δ DIST	340	339	338	337	336	332	328	326	329	330	325	210
88,000 TO 85,000	BHP	1236	1273	1312	1353	1395	1440	1487	1535	1587	1641	1697	1757
	RPM	1620	1705	1795	1895	1995	2100	2215	2340	2495	2300	2435	2500
	BMEP	180	176	173	169	165	162	159	155	150	168	165	166
	F. F.	495	510	530	545	570	590	610	635	665	670	710	1130
	EAS	170	170	170	170	170	170	170	170	170	170	170	170
	TAS	173	178	183	189	195	201	207	214	220	229	237	246
	Δ TIME	2:01	1:58	1:53	1:50	1:45	1:42	1:38	1:35	1:31	1:27	1:25	0:53
	Δ DIST	350	349	347	347	342	341	340	337	332	334	335	218

NOTES:
1.
2. Values shown are for weight bracket midpoints.
3. Blower shift indicated by heavy line Shaded areas are for AUTO RICH operation.
4. Power settings are for inboard engines and include primary heat-exchanger scoop and exit door drag allowance.
5. Prop feathered and all flaps closed on inoperative engine.
6. Tip tank installation decreases EAS approximately 2 knots.
7. Slashed area represents high blower operation, lean mixture , and retard spark.

Figure A5-38 (Sheet 3 of 3)

TWO ENGINE OPERATION

LONG RANGE CRUISE — OPERATING TABLES

LOW BLOWER

MODEL: EC-121R
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

GROSS WEIGHT LB	H_d 1000 FT	1	3	5	7	9	11
	BLOWER	LOW BLOWER					
	BHP	2600	2690	2768			
127,000	RPM	2600	2600	2600			
	BMEP	236	244	251			
TO	F. F.	1710	1755	1815			
	EAS	160	160	160			
	TAS	162	167	172			
124,000	Δ TIME	:53	:51	:50			
	Δ DIST	143	143	143			
	BHP	2480	2545	2642			
124,000	RPM	2600	2600	2600			
	BMEP	225	231	240			
TO	F. F.	1615	1665	1720			
	EAS	160	160	160			
	TAS	162	167	172			
121,000	Δ TIME	:56	:54	:52			
	Δ DIST	152	150	149			
	BHP	2412	2495	2567			
121,000	RPM	2600	2600	2600			
	BMEP	219	226	233			
TO	F. F.	1565	1610	1665			
	EAS	160	160	160			
	TAS	162	167	172			
118,000	Δ TIME	:58	:56	:54			
	Δ DIST	157	156	155			
	BHP	2345	2415	2495	2567		
118,000	RPM	2600	2600	2600	2600		
	BMEP	213	219	226	233		
TO	F. F.	1515	1560	1605	1660		
	EAS	160	160	160	160		
	TAS	162	167	172	178		
115,000	Δ TIME	:59	:58	:56	:54		
	Δ DIST	160	160	160	160		
	BHP	2280	2345	2422	2495		
115,000	RPM	2600	2600	2600	2600		
	BMEP	207	213	220	226		
TO	F. F.	1465	1505	1550	1600		
	EAS	160	160	160	160		
	TAS	162	167	172	178		
112,000	Δ TIME	1:01	1:00	:58	:56		
	Δ DIST	165	167	167	167		

NOTES:
1. Values shown are for weight bracket midpoints.
2. Shaded areas are for AUTO RICH operation.
3. Primary and Secondary Heat Exchanger Scoops and Exit Doors Closed.
4. Props feathered and all flaps closed on inoperative engines.

Figure A5-39 (Sheet 1 of 3)

TWO ENGINE OPERATION

LONG RANGE CRUISE — OPERATING TABLES

LOW BLOWER

MODEL: EC-121R
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

GROSS WEIGHT LB	H_p 1000 FT	1	3	5	7	9	11
	BLOWER	LOW BLOWER					
112,000 TO 109,000	BHP	2218	2280	2345	2422		
	RPM	2600	2600	2600	2600		
	BMEP	201	207	213	220		
	F. F.	1415	1455	1500	1550		
	EAS	160	160	160	160		
	TAS	162	167	172	178		
	Δ TIME	1:04	1:02	1:00	:58		
	Δ DIST	174	173	172	172		
109,000 TO 106,000	BHP	2148	2218	2280	2345	2400	
	RPM	2600	2600	2600	2600	2600	
	BMEP	195	201	207	213	218	
	F. F.	1365	1410	1450	1490	1535	
	EAS	160	160	160	160	160	
	TAS	162	167	172	178	183	
	Δ TIME	1:06	1:04	1:02	1:00	:58	
	Δ DIST	178	178	178	178	178	
106,000 TO 103,000	BHP	2098	2140	2203	2270	2339	
	RPM	2500	2600	2600	2600	2600	
	BMEP	198	194	200	206	212	
	F. F.	1290	1350	1395	1435	1485	
	EAS	160	160	160	160	160	
	TAS	162	167	172	178	183	
	Δ TIME	1:10	1:07	1:05	1:03	1:01	
	Δ DIST	190	187	186	186	186	
103,000 TO 100,000	BHP	2020	2083	2140	2218	2280	
	RPM	2500	2500	2600	2600	2600	
	BMEP	191	197	194	201	207	
	F. F.	1245	1285	1340	1390	1435	
	EAS	160	160	160	160	160	
	TAS	162	167	172	178	183	
	Δ TIME	1:12	1:10	1:07	1:05	1:03	
	Δ DIST	195	195	193	193	192	
100,000 TO 97,000	BHP	1960	2020	2083	2128	2218	
	RPM	2500	2500	2500	2600	2600	
	BMEP	185	191	197	193	201	
	F. F.	1200	1240	1275	1325	1385	
	EAS	160	160	160	160	160	
	TAS	162	167	172	178	183	
	Δ TIME	1:15	1:13	1:11	1:08	1:05	
	Δ DIST	202	202	202	202	198	

NOTES:
1. Values shown are for weight bracket midpoints.
2. **Shaded areas are for AUTO RICH operation.**
3. Primary and Secondary Heat Exchanger Scoops and Exit Doors Closed.
4. Props feathered and all flaps closed on inoperative engines.

Figure A5-39 (Sheet 2 of 3)

TWO ENGINE OPERATION

LONG RANGE CRUISE — OPERATING TABLES

LOW BLOWER

MODEL: EC-121R
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

GROSS WEIGHT LB	H_p 1000 FT	1	3	5	7	9	11
	BLOWER	LOW BLOWER					
97,000 TO 94,000	BHP	1904	1960	2020	2074	2140	2218
	RPM	2470	2500	2500	2500	2600	2600
	BMEP	182	185	191	196	194	201
	F. F.	815	1180	1230	1270	1320	1380
	EAS	160	160	160	160	160	160
	TAS	162	167	172	178	183	189
	Δ TIME	1:50	1:16	1:13	1:11	1:08	1:05
	Δ DIST	298	212	210	210	206	205
94,000 TO 91,000	BHP	1850	1897	1970	2020	2074	2148
	RPM	2400	2450	2500	2500	2500	2600
	BMEP	182	183	186	191	196	195
	F. F.	775	800	1175	1225	1270	1325
	EAS	160	160	160	160	160	160
	TAS	162	167	172	178	183	189
	Δ TIME	1:56	1:52	1:16	1:14	1:11	1:08
	Δ DIST	312	312	220	220	217	214
91,000 TO 88,000	BHP	1796	1841	1893	1970	2020	2074
	RPM	2330	2375	2430	2500	2500	2500
	BMEP	182	183	184	186	191	196
	F. F.	750	770	790	1175	1225	1270
	EAS	160	160	160	160	160	160
	TAS	162	167	172	178	183	189
	Δ TIME	2:00	1:57	1:54	1:16	1:14	1:11
	Δ DIST	324	325	326	227	226	224
88,000 TO 85,000	BHP	1750	1792	1840	1897	1970	2020
	RPM	2270	2310	2360	2420	2500	2500
	BMEP	182	183	184	185	186	191
	F. F.	720	740	760	785	1175	1225
	EAS	160	160	160	160	160	160
	TAS	162	167	172	178	183	189
	Δ TIME	2:05	2:01	1:59	1:55	1:16	1:14
	Δ DIST	337	338	340	342	234	233

NOTES:
1. Values shown are for weight bracket midpoints.
2. Shaded areas are for AUTO RICH operation.
3. Primary and Secondary Heat Exchanger Scoops and Exit Doors Closed.
4. Props feathered and all flaps closed on inoperative engines.

Figure A5-39 (Sheet 3 of 3)