

OPERATING INSTRUCTIONS

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# OPERATING INSTRUCTIONS

## SECTION I

### INTRODUCTION

These instructions cover the recommended operating procedures and limits of the Wright Cyclone 704C9GC engine as they apply to the operation of this engine in any commercial airplane. The procedures have been developed from experience and are established as "good practice". The limits have been coordinated with the CAA approved engine specification and where the CAA regulations do not apply, they have been established from experience with a view toward achievement of long periods of reliable operation between engine overhauls and satisfactory part life.

These instructions are intended to cover all the normal routine ground and flight conditions of a commercial operator, as well as certain abnormal or emergency conditions. The Wright Aeronautical Corporation recognizes the following normal engine operating conditions and the instructions given herein should be applied accordingly: Starting, Warm-Up, Ground Operation, Take-Off, Cruise Power Climb, Cruise Power Level Flight and Descent, Low Power Approach, Landing, and Engine Stopping. Abnormal operating conditions are difficult to define because of the varying degree of emergency resulting from different sets of conditions, but the following abnormal conditions are recognized and instructions are given herein for these conditions: operation on minimum number of engines, cruising under icing conditions beyond the normal cruising limits, feathering, cold starting and stopping procedures.

Overhaul and maintenance instructions for this engine are published in separate manuals which may be obtained from the Wright Aeronautical Corporation, Wood-Ridge, New Jersey. Information on fuel consumption and accessory drive limits is provided in the engine specification for this engine (WAC Specification No. 704G).

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## SECTION II

### GENERAL OPERATING INSTRUCTIONS

#### PRE-STARTING

1. See that no tools or equipment are lying loose on or about the engine or airplane and that all fastenings are properly secured.
2. Check the fuel and oil supply for proper grade and quantity. Refer to the Table of Engine Characteristics, Section III.
3. Examine the engine controls for smooth movement and full travel.
4. Set the following controls as indicated:
  - a. Cowl Flaps . . . . . "OPEN"
  - b. Oil Cooler Flaps . . . . . "CLOSED" if manually operated
  - c. Carburetor Air Heater. . . . . "FULL COLD"
  - d. Ignition Switch. . . . . "OFF"
  - e. Mixture. . . . . "CUT-OFF"
  - f. Propeller. . . . . "INCREASE RPM" (low pitch)
  - g. Supercharger Control . . . . . "LOW" and locked
5. Turn the propeller in the normal direction of rotation at least six blades. This may be done either by hand or with the engine starter. If there is unusually high compression, remove the spark plugs from the lower cylinders and drain all liquid as the presence of any quantity of liquid in a combustion chamber is likely to cause serious damage. Never turn the propeller opposite to engine rotation as this may force liquid into an intake pipe from where it is apt to be drawn into the cylinder when the engine is started.

#### STARTING

1. Turn the fuel supply valve "ON" and set the throttle for 1200 rpm.
2. Build up the fuel pressure with the auxiliary fuel pump to the normal operating limits given in Section III, Specific Operating Data Chart.
3. Energize the starter for approximately 10 seconds.
4. Engage the starter and operate the primer simultaneously.
5. After the propeller has made two revolutions, turn the ignition switch to "BOTH".

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6. Operate the booster ignition. Should the engine fail to start within 30 seconds after starter engagement, let the starter cool, and then repeat the starting procedure.

7. When the engine is firing evenly, advance the mixture control to the "AUTO-RICH" position. Operate the primer intermittently as necessary and continue to operate the auxiliary fuel pump until the engine driven fuel pump is supplying sufficient pressure. Do not pump the throttle to obtain smooth operation as this practice causes a wide, rapid variation of the fuel-air ratio and may result in serious backfiring.

8. Observe the oil pressure gage. Stop the engine if the oil pressure does not register within ten seconds or reach 40 lb per sq inch in twenty seconds.

9. Head the airplane into the wind when ground operation for an extended period of time is anticipated.

### WARM-UP

1. Conduct a thorough warm-up at approximately 1200-1400 rpm before making any performance checks or before taxiing to take-off.

2. For all ground operation unless indicated otherwise under "Ground Checks", keep the cowl flaps "OPEN", the propeller control in the full "INCREASE RPM" (low pitch) position, and the mixture control in "AUTO-RICH".

3. Continue the warm-up until the oil pressure stabilizes. Control the oil cooler flaps to maintain the oil temperature below the maximum operating limit of 104°C.

### GROUND CHECKS

Oil Pressure -- 1. Adjust the oil pressure relief valve to  $70 \pm 5$  lb per sq inch when the oil inlet temperature is 85°C (185°F) and with the engine operating between 1500-1800 rpm.

2. Open the throttle to obtain not more than 30 inches Hg manifold pressure. If the oil pressure drops or fluctuates as engine speed is increased, extend the warm-up period.

Fuel Pressure -- Adjust the fuel pressure relief valve if the fuel pressure is not within the limits specified in the Table of Specific Operating Data, Section III.

Magneto Switch -- At the start of the day's flying it is necessary to check the "OFF" position of the ignition switch to assure connection of the ground wires.

1. Run the engine at approximately 700 rpm.

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2. Turn the ignition switch to "OFF" momentarily to see if the engine stops firing.

3. Return to "BOTH" position.

Magnetos -- 1. Open the throttle to obtain 30 inches Hg manifold pressure or 2400 rpm, whichever occurs first.

2. Note the rpm as the engine operates with the ignition switch in the "BOTH" position.

3. Place the ignition switch in the "LEFT" position and observe the rpm.

4. Return the switch to "BOTH" in order to stabilize speed.

5. Repeat this procedure for the "RIGHT" position.

Atmospheric conditions will influence the readings obtained, however, a drop of 75 rpm or less is considered normal providing no engine roughness is encountered.

Idle Adjustment -- 1. Idle the engine at approximately 500 rpm.

2. Set the throttle stop on the carburetor to maintain this rpm and lock the throttle.

3. Move the cockpit mixture control toward the "CUT-OFF" position, watching the tachometer for any change in rpm during this procedure. Make sure that the mixture control is returned to the "AUTO-RICH" position before the engine stops.

4. Set the mixture adjustment on the carburetor so that the engine speed increases up to 10 rpm before dropping or does not show any increase in speed but delays at least five seconds before dropping. If the engine speed increases more than 10 rpm it indicates a rich idle setting, while an immediate decrease indicates a lean idle setting.

5. Prevent fouling of the spark plugs by opening the throttle to 2000 rpm periodically during this check.

6. Re-set the throttle stop on the carburetor to the desired idle speed.

Propeller -- 1. Run at 1500 rpm, but do not exceed 25 inches Hg manifold pressure during the following check.

2. Note rpm reaction as control is placed in full high pitch "DECREASE RPM" position.

3. Return the control to low pitch position.

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4. Check for reduction and full recovery of rpm

Supercharger Clutch Operation — Note: Grade 100/130 fuel required for supercharger high ratio take-off and recommended for high ratio normal rated power. Supercharger high ratio operation on Grade 91 permitted at 70 percent METO high ratio power and below.

1. Set the engine speed to 1700 rpm with the throttle.
2. Move the supercharger control lever to the "HIGH" position and lock.
3. Open the throttle to obtain 30 inches Hg manifold pressure.
4. Move the supercharger control lever to the "LOW" position and lock. A sudden decrease in manifold pressure indicates that the two speed mechanism is working properly. Do not repeat supercharger clutch shift checks at less than five minute intervals.

### PRE-TAKE-OFF CHECK LIST

1. Cowl Flaps. . . . . "FULL OPEN"
2. Oil Cooler Flaps. . . . . "OPEN"
3. Carburetor Air Heater . . . . . "FULL COLD"
4. Mixture Control . . . . . "AUTO-RICH"
5. Propeller . . . . . "FULL INCREASE RPM" (low pitch)
6. Fuel Boost Pump . . . . . "ON"
7. Magneto Switches. . . . . "BOTH"
8. Supercharger Control. . . . . "LOW" and locked (for normal take-off)
9. Oil Temperature . . . . . No minimum oil-in temperature is specified for take-off. It is necessary, however, to assure proper circulation of the oil before using take-off power. When the oil temperature has risen at least 6°C (10°F) above the pre-starting temperature and the oil pressure has stabilized, it is permissible to take-off. Do not take-off with an oil temperature higher than 104°C.
10. Head Temperature. . . . . No minimum head temperature is specified for take-off.

### TAKE-OFF (NORMAL)

1. Advance the throttle to the take-off manifold pressure for the air-port pressure altitude as given in the Engine Performance Curve. Do not exceed take-off manifold pressure or take-off with less than take-off manifold pressure.

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2. Reduce power when clear of immediate take-off obstacles and obtain the desired climb setting by retarding the throttle first and then the propeller control.

### TAKE-OFF SUPERCHARGER "HIGH" RATIO

#### NOTE

The following operating instructions are only applicable when the engine is operated on grade 100/130 fuel.

Take-off in supercharger "HIGH" ratio is permissible when the airport altitude is above 9,200 feet.

1. Supercharger. . . . . "HIGH" and locked
2. Advance the throttle to the high supercharger ratio take-off manifold pressure for the airport pressure altitude as given in the Engine Performance Curve. Do not exceed take-off manifold pressure or hold for longer than five minutes and do not take-off with less than take-off manifold pressure.
3. Reduce power when clear of immediate take-off obstacles and obtain the desired cruise setting by retarding the throttle first and then the propeller control.

### CRUISE POWER CLIMB

1. Cowl Flaps. . . . . Control so as not to exceed 218°C cylinder head temperature.
2. Oil Cooler Flaps. . . . . Control so as not to exceed 104°C oil inlet temperature.
3. Carburetor Air Heater . . . . . "FULL COLD" except when carburetor icing conditions exist. Then control so as not to exceed 38°C (100°F).
4. Mixture Control . . . . . "AUTO-RICH"
5. Supercharger Control. . . . . "LOW" below 16,000 feet  
"HIGH" above 16,000 feet
6. Fuel Boost Pump . . . . . "OFF" except when fuel pressure drops below minimum specified in the Table of Specific Operating Data, Section III.
7. BMEP. . . . . 145 in "LOW" Ratio  
130 in "HIGH" Ratio

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8. Propeller Control . . . . . Set for 2300 rpm
9. Manifold Pressure . . . . . Use manifold pressure required to maintain 700 BHP in "LOW" ratio but do not exceed 32 inches Hg.; in "HIGH" ratio use manifold pressure required to obtain 630 BHP but do not exceed 29.5 inches Hg.
10. Temperature and Pressure Limits . . Do not exceed the maximum limits specified in the Table of Specific Operating Data, Section III.
11. Supercharger Clutch Shift . . . . . Reduce manifold pressure 4 inches Hg with throttle before shifting from "LOW" ratio to "HIGH" ratio. Make all shifts as smoothly and rapidly as possible.

### CRUISE POWER LEVEL FLIGHT AND DESCENT

1. Cowl Flaps. . . . . Control so as not to exceed 205°C cylinder head temperature.
2. Oil Cooler Flaps. . . . . Control so as not to exceed 85°C oil inlet temperature.
3. Carburetor Air Heater . . . . . "FULL COLD" except when carburetor icing conditions exist. Then control so as not to exceed 38°C (100°F).
4. Mixture Control . . . . . "AUTO-LEAN"
5. Fuel Boost Pumps. . . . . "OFF" unless fuel pressure drops below minimum specified in the Table of Specific Operating Data, Section III.
6. Temperature and Pressure Limits . . Do not exceed the maximum limits specified in the Table of Specific Operating Data, Section III.
7. Supercharger Clutch Shift . . . . . Make all shifts as smoothly and rapidly as possible at any RPM in the cruise power range. Reduce the manifold pressure 4 inches Hg. with the throttle before shifting from "LOW" ratio to "HIGH" ratio. Do not shift into the same ratio at less than 5 minute intervals.
8. Selection of Power. . . . . Any cruising power may be used depending on schedule requirements provided that no one of the following limits is exceeded:
  - a. Maximum Cruise Manifold Pressure . . . 32 inches Hg in "LOW" ratio or 29.5 inches Hg. in "HIGH" ratio.

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### b. Maximum Cruise BMEP\*

Low Ratio . . . . . 140 up to propeller load,  
then as allowed by propeller load operation up to 700 BHP.

High Ratio . . . . . 130 up to 2100 Cruise RPM  
Maximum.

c. Maximum Cruise Power . . . . . 700 BHP in "LOW" ratio  
630 BHP in "HIGH" ratio

d. Maximum Cruise RPM . . . . . 2100

9. Power Changes . . . . . Any increase in power should be made by increasing the RPM first and then increasing the manifold pressure. Any decrease in power should be made by decreasing the manifold pressure first and then decreasing the RPM.

### ONE ENGINE OUT OPERATION

One engine out operation is considered emergency operation and as such the area of permissible operation may be extended into the "Emergency Operation" crosshatched area of the Recommended Operating Schedule. Temperature, pressure, and manifold pressure limits as shown on the Table of Specific Operating Data and Normal Engine Performance Curve shall not be exceeded.

### PROPELLER FEATHERING IN FLIGHT

The following procedure is recommended for feathering the propeller in flight, but the sequence may be altered to suit specific installation requirements.

1. Throttle . . . . . "CLOSED"
2. Mixture Control . . . . . "CUT-OFF"
3. Feathering Switch . . . . . "CLOSED"
4. Fuel Shut-Off Valve . . . . . "OFF"
5. Cowl Flaps . . . . . "CLOSED"
6. Oil Cooler Flaps . . . . . "CLOSED"
7. Ignition Switch . . . . . "OFF" after engine stops

\* Refer to Recommended Operating Schedule Curve, Section III.

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### UNFEATHERING

The following procedure is recommended for unfeathering the propeller in flight, but the sequence may be altered to suit specific installation requirements.

1. Propeller Control . . . . . "FULL DECREASE RPM" (high pitch)
2. Ignition Switch . . . . . "ON"
3. Throttle. . . . . Set for maximum of 1200 rpm
4. Feathering Switch . . . . . Press and keep engaged
5. Fuel Supply . . . . . "ON" after propeller has turned approximately three revolutions. Hold the feathering switch "ON" until the engine speed reaches 800 rpm and then release.
6. Mixture Control . . . . . "AUTO-RICH"

Operate the engine at as near 1000 rpm as possible until satisfactory cylinder head and oil temperatures are obtained.

7. Cowl Flaps. . . . . Control so as not to exceed the limits specified in the Table of Specific Operating Data, Section III.
8. Oil Cooler Flaps. . . . . Control so as not to exceed the limits specified in the Table of Specific Operating Data, Section III.

### PRE-LANDING CHECK

1. Cowl Flaps. . . . . Control so as not to exceed 205°C cylinder head temperature.
2. Oil Cooler Flaps. . . . . "OPEN"
3. Carburetor Air Heater . . . . . "FULL COLD"
4. Mixture Control . . . . . "AUTO-RICH"
5. Propeller . . . . . Set for 2300 rpm
6. Fuel Boost Pump . . . . . "ON"
7. Supercharger Control. . . . . "LOW" and locked (for normal take-off)

Immediately after landing, place the propeller control in the "FULL INCREASE RPM" (low pitch) position and cowl flaps "FULL OPEN".

### NOTE

Landing in supercharger "HIGH" ratio is permissible when the airport altitude is above 9200 feet and the engine is operated on grade 100/130 fuel. Under these conditions, item 7 should be "Supercharger Control . . . "HIGH" and locked".

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### EMERGENCY "GO-AROUND"

On a "go-around", open the throttle to obtain rated manifold pressure and then, if necessary, advance the propeller control to give take-off rpm and the throttle to give take-off manifold pressure for the pressure altitude of flight. Maintain take-off manifold pressure until a safe air-speed is reached.

### STOPPING

1. Cowl Flaps. . . . . "FULL OPEN"
2. Oil Cooler Flaps. . . . . "OPEN"
3. Carburetor Air Heater. . . . . "FULL COLD"
4. Propeller Control . . . . . "FULL INCREASE RPM" (low pitch)
5. Throttle. . . . . Set for 1000 rpm

If the engine has been warmed by taxiing, idle until the cylinder head temperatures drop to a maximum of 150°C (300°F) or to a value consistent with existing atmospheric temperature.

6. Mixture Control . . . . . "CUT-OFF"
7. Ignition Switch . . . . . "OFF" after engine stops
8. Cover all openings if the engine is to be idle for an extended period of time or if dusty conditions exist.

### OIL DILUTION

When a cold weather start is anticipated, dilute the oil before stopping as follows:

1. Idle until the oil temperature falls to 40°C (104°F).
2. Dilute at 1000 to 1200 rpm. Accelerate for 10 seconds at the end of the dilution period.
3. Maintain the oil temperature below 50°C (122°F) and the oil pressure above 15 lb per sq inch during this procedure.
4. Hold the dilution switches "ON" in accordance with instructions found in the "Airplane Pilot's Manual", or if these are absent, use the following table:

ANTICIPATED TEMPERATURE	TIME IN MINUTES
4°C to -12°C	4
-12°C to -29°C	6
-29°C and below	9

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During the dilution process, the propeller governor control and feathering system should be operated several times to insure that properly diluted oil is left in the propeller dome, governor system, and feathering lines. Make sure that the engine rpm is above the minimum governing speed when operating the governor control. When operating the feathering system, pull out the feathering switch after a 300 to 400 rpm drop is obtained, wait for recovery of rpm, and then repeat this procedure.

Precaution -- The oil supply of an engine in which the oil has been diluted should be checked after a thorough warm-up.

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SECTION III

ENGINE CHARACTERISTICS AND SPECIFIC OPERATING DATA

TABLE OF ENGINE CHARACTERISTICS

Series . . . . .	Cyclone 9GC
Model. . . . .	704C9GC
Type . . . . .	Single row static radial, air cooled
Type Certificate Number. . . . .	219
Number of Cylinders. . . . .	9
Bore . . . . .	6.125 in.
Stroke . . . . .	6.875 in.
Piston Displacement. . . . .	1823 cu in.
Compression Ratio. . . . .	6.70:1
Supercharger Ratio . . . . .	7.14 & 10.4:1
Impeller Diameter. . . . .	11 in.
Rotation of Crankshaft (from rear) . . . . .	Clockwise
Rotation of Propeller Shaft (from rear). . . . .	Clockwise
Propeller Reduction Gear Ratio	
Models 704C9GC1, 2, 3, and 4. . . . .	0.666:1
Model 704C9GC5 . . . . .	0.5625:1
Propeller Shaft Spline Size. . . . .	50
Fuel Grade . . . . .	91/96 W.A.C. Spec. No. 5804 100/130 W.A.C. Spec. No. 5806
Oil Grade. . . . .	120 Second W.A.C. Spec. No. 5815

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Type of Carburetor

Models 704C9GC1 and 3 . . . . . Stromberg PD12H3  
Models 704C9GC2 and 4 . . . . . Holley 1375F  
Model 704C9GC5. . . . . Stromberg PD12K10

Carburetor Setting

Models 704C9GC1 and 3 . . . . . W.A.C. No. 68973N35A  
Models 704C9GC2 and 4 . . . . . W.A.C. No. 69276N30A  
Model 704C9GC5. . . . . W.A.C. No. 68973N39A

Type of Magneto. . . . . Scintilla SF9LN4

TABLE OF SPECIFIC OPERATING DATA

704C9GC-1-3-5

Operating Condition	RPM	BHP	Critical Altitude Ft.	Clutch Control Position	Mixture Control Position	Maximum Cyl. Head Temp. °C	Oil-Tn Temp. °C		Fuel * Pressure		Oil Pressure	
							De-sired	Max.	Min.	Max.	Min.	Max.
Take-Off	2500	1200	Sea Level	Low	"Auto-Rich"	232	85	104	15	19	65	75
	2500	1000	14200	High	"Auto-Rich"	232	85	104	15	19	65	75
Rated Power (MFTO)	2300	1000	6900	Low	"Auto-Rich"	218	85	104	15	19	65	75
	2300	900	15200	High	"Auto-Rich"	218	85	104	15	19	65	75
Cruise Power Climb	2100	700	12500	Low	"Auto-Rich"	218	85	104	15	19	65	75
	2100	630	21500	High	"Auto-Rich"	218	85	104	15	19	65	75
Cruise Power Level Flight and Descent (Recommended Maximum)	2100	700	12500	Low	"Auto-Lean"	205	—	85	15	19	65	75
	2100	630	21500	High	"Auto-Lean"	205	—	85	15	19	65	75
Ground Operation (60% rated speed)	—	—	—	Low	"Auto-Rich"	232	85	104	15	19	65	75

Note: Minimum oil pressure at idle speed 15 lb per sq inch

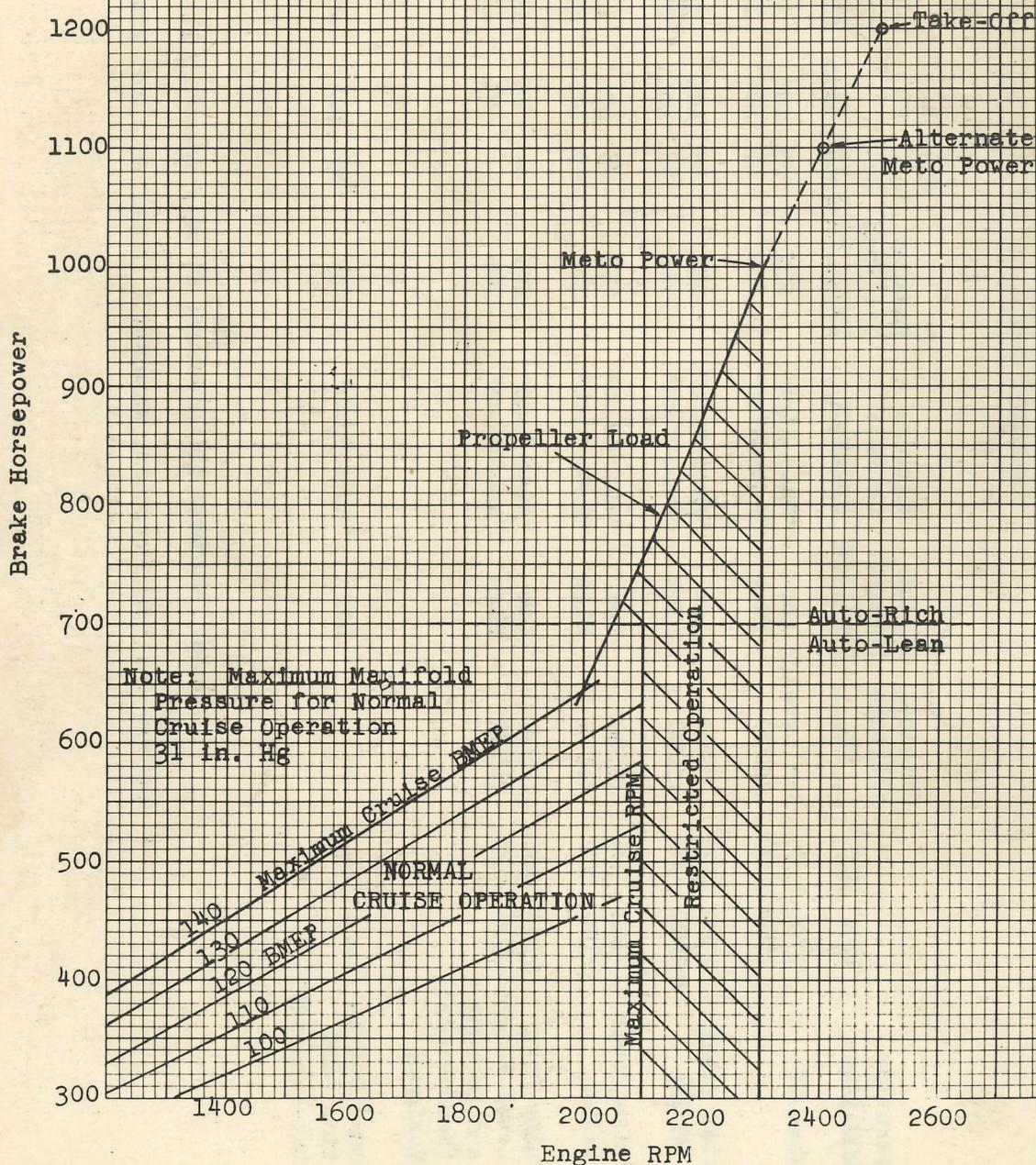
\* 704C9GC-2-4 Fuel Pressure, Maximum 7 lb per sq inch, Minimum 6 lb per sq inch

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RECOMMENDED OPERATING SCHEDULE

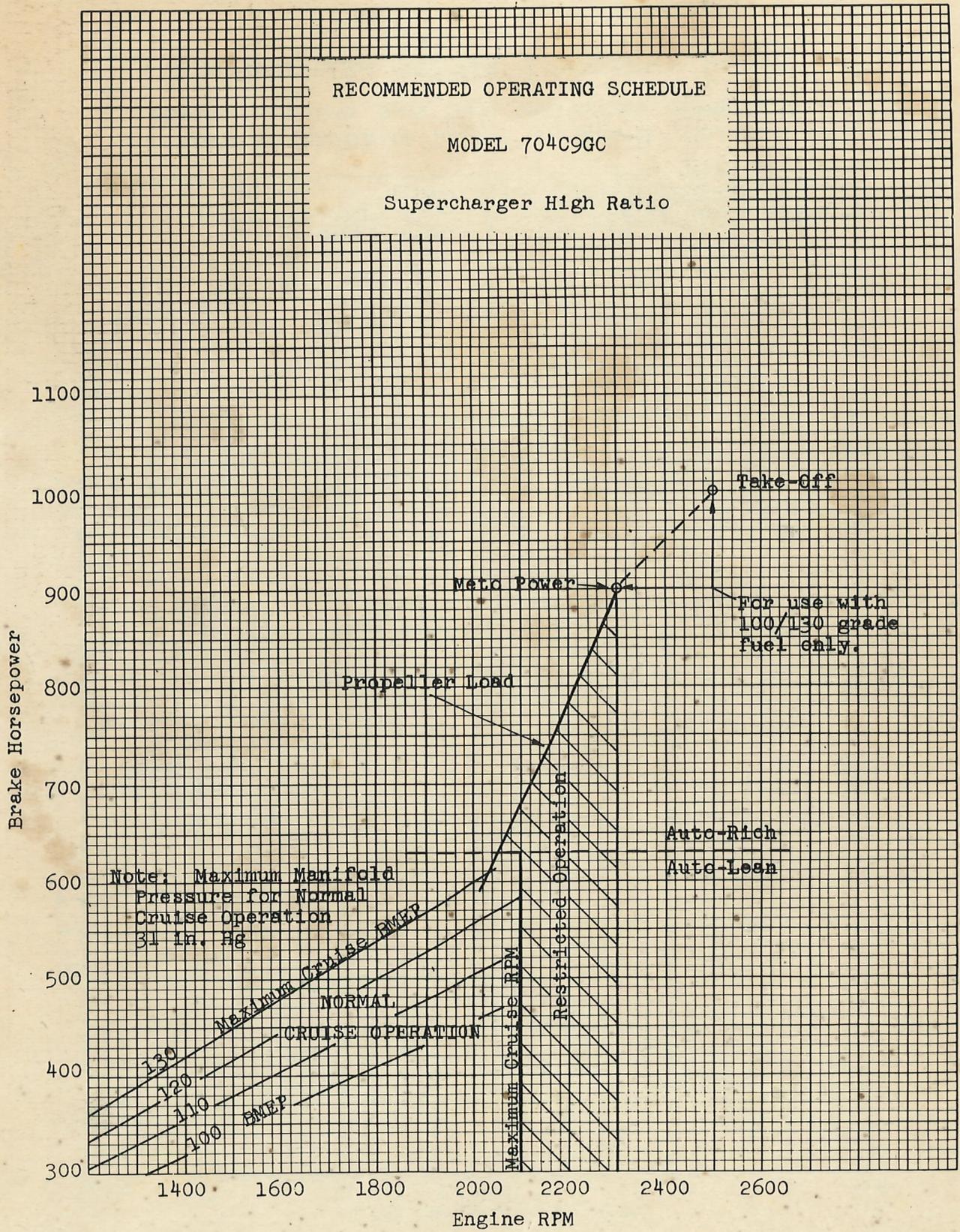
MODEL 704C9GC

Supercharger Low Ratio



Note: Maximum Manifold Pressure for Normal Cruise Operation 31 in. Hg

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WRIGHT AIRCRAFT ENGINE PERFORMANCE

AT STANDARD ATMOSPHERIC CONDITIONS WITH BEST POWER MIXTURE STRENGTHS UNLESS OTHERWISE SPECIFIED

