

MAINTENANCE INSTRUCTION

TESTING ENGINES REBUILT IN THE FIELD AND BRAKE HORSEPOWER STANDARDIZATION

APPLICATION: 567 Series Engines

GENERAL

To insure satisfactory rebuilt engine operation, the engine should be given a regulated preliminary running and inspection before actual service. The following test procedure will serve to check engine performance and workmanship.

The engine should be assembled using the instructions and recommendations on component parts as outlined in the Engine Maintenance Manual. After completion of assembly the engine may be tested on, (1) test stand, (2) in a locomotive, stationary load test or (3) in a locomotive, on the road test, depending on engine application.

To provide for varied conditions affecting the actual determination of engine output, data obtained in the engine test must be compensated to near normal conditions. These factors are outlined following the test procedure, under "Brake Horsepower Standardization."

For instructions governing electrical arrangements on different locomotives or resistance grid bank connection in conjunction with this engine test see Maintenance Instruction 2121. Before starting test make a complete inspection of all equipment involved to ascertain that engine condition is satisfactory for the test.

PROCEDURE

A. Inspection And First Adjustments

1. Water test engine at 50 p.s.i. This must be done before installing en-

gine in the locomotive; or if engine is installed, blank off engine water inlets and outlets to prevent damage to the cooling system components. Disregard pump seal leakage at this pressure. If engine is not water tight, repair leaks and repeat water test.

2. Check fuel system for leaks.
3. Using an external pump, force lubricating oil through the oil lines in the engine to check for bearing leakage and upper deck oil supply. to determine that no restrictions exist in the oil passages. The engine should be barred over at least one revolution during this check. Check function of piston cooling pipes at 20-25 p.s.i.

NOTE: If desired, instructions may be obtained to construct a permanent engine water, fuel and lube oil system checking arrangement by requesting drawing File 294 through the Regional Service office. This drawing shows the schematic piping and pertinent information concerning this pre-test.

4. Provide engine lubricating oil as recommended in Maintenance Instruction 1607.
5. Check on one cylinder of each bank, according to Engine Manual instructions (as a check on completion of engine assembly).
 - a. Valve timing
 - b. Valve lash adjuster setting.
 - c. Injector timing
 - d. Injector rack setting

THIS ISSUE COMPLETELY REVISED AND SUPERSEDES ALL * PREVIOUS ISSUES.

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6. Fill governor with new oil to full mark using oil having specifications similar to Texaco Regal F (R&O) or SAE 40 oil as used in the engine. Lubricate governor linkage.
7. Check generator alignment, see Maintenance Instruction 432 for D12, 433 for D15, and 425 for D4 and D8 generators. Check end thrust. Blow out generator before starting test, using dry air at low pressure.

B. Testing On A Test Stand Or In Locomotive - Stationary Load Test

1. The following data will be required to maintain control over operating characteristics during the test runs: Engine Speed, Engine Brake Horsepower (Generator Volts and Amperes), Power Piston Setting, Water "In" Temperature, Water "In" Pressure, Air "In" Temperature, Main Bearing Oil Pressure, Piston Cooling Oil Pressure (if gauged), Oil "In" Temperature, Fuel Flow Observation, Exhaust Observation.

If testing is performed on a test stand, comprehensive data supplying complete information on lube oil, fuel oil, water and air temperature and pressure characteristics, and specific fuel consumption should be obtained. It is recognized that testing on a locomotive necessarily limits engine characteristics which can be secured, and those enumerated are obtainable without extensive changes in the locomotive.

2. Break-in run

- a. The first three runs of the break-in run should be made with the cylinder head covers removed so that the valve assemblies and camshaft bearings can be observed and checked while operating.

- (1) Run 5 minutes at 275 RPM no load and shutdown for bearing inspection.

- (2) Run 10 minutes at 275 RPM no load and shutdown for bearing inspection.

- (3) Run 15 minutes at 350 RPM and 50 B.H.P. for 6, 8 and 12 cylinder engines and 100 B.H.P. for 16 cylinder engines and shut down for bearing inspection.

NOTE: A - Locomotive engines

1. Run fifteen (15) minutes at horsepower output corresponding to throttle position for speeds given below in items (4), (5) and (6) if testing in a locomotive.
2. If testing other than in a locomotive, operate at speeds and horsepower as given in items (4), (5) and (6).

B - Power unit engines

1. Power unit (mobile, truck trailer or portable) engines complete runs as given in items (4) and (5), (provided speed and load can be varied) but disregard item (6).

Make full load test at horsepower given for these engines in Table I.

2. Engines which can be loaded only at synchronous speed operate at no load at speeds given in items (4) and (5). Follow these runs with 15 minute runs at 1/3 and 2/3 load at synchronous speed.

- (4) Run 15 minutes at 575 - *595 RPM and:

(* = corresponding speed of 835 RPM full speed engine compared to 800 RPM full speed engine.)

Engine Model	BHP	Locomotive engines 900-910 RPM, using a power unit engine 825-840 RPM for 60-cycle; 855-870 RPM for 50-cycle, using a 20 to 30 second speed rise from idle to trip.
6-567	260	
8-567	345	
12-567	530	
16-567	670	

(5) Run 15 minutes at 650 - *675 RPM and:

Engine Model

Engine Model	BHP	Engine	BHP
6-567	370		
8-567	490		
12-567	745	6-567	450
16-567	960	8-567	600
		12-567	900
		16-567	1300

(a) Shut down and set over-speed trip to operate at:

(6) Run 15 minutes at 725 - *755 RPM and:

TABLE I

SERIES ENGINE	LOCO. HP	MINIMUM CORRECTED HP	INJECTOR RACK LENGTH	POWER PISTON GAP	*INJECTOR (BASIC ENGINE)	ENGINE RPM FULL SPEED
6-567	600	612	.83"	5/16"	LO	800
6-567	** 650	705-745	.92"	×	HO	835
8-567	800	825	.83"	5/16"	LO	800
8-567	** 875	950-1000	.92"	×	HO	835
8-567	900	950-1000	.92"	×	HO	835
12-567	1000	1100	1.00"	7/16"	LO	800
12-567	1125	1250	.87"	11/32"	LO	800
12-567	**1125	1250	1.04"	×	HO	835
12-567	1200	1275	.83"	5/16"	LO	800
12-567	**1310	1420-1495	.92"	×	HO	835
16-567	1350	1440	1.00"	7/16"	LO	800
16-567	1500	1650	.87"	11/32"	LO	800
16-567	**1500	1650	1.04"	×	HO	835
16-567	**1600	1715-1750	1.00"	7/16"	HO	835
16-567	1750	1850-1950	.96"	×	HO	835

*HO -- High output injector 5228230

LO -- Low output injector 5227852 (or 5226543)

** -- Export or locomotive conversion engines

MOBILE — POWER UNIT ENGINES

Engine Model	Corrected BHP	Engine RPM
6-567C	540	720
8-567C	720	720
12-567C	1080	720
16-567C	1440	720

- (7) Set engine speed at full speed and idle speed using tachometer or strobotack. Be sure pointer on governor speed scale (inside governor on those equipped) agrees with actual speed, or remark or reset scale to correspond. Check shutdown of engine.
- (8) On engines in locomotives, set pilot valve linkage for type of engine and check load regulator balance point, reset or remark pilot valve scale, if required. See Engine Maintenance Manual.
- (9) Run one (1) hour at full rated speed at full load injector rack length or power piston gap for the particular engine as given in Table I.
- (10) Retighten all cylinder head to liner nuts, including those under the rocker arms to correct value according to the cylinder liner used, 200 foot pounds on all liners using a shim type gasket and 290-300 foot pounds on liners using a sandwich type gasket. Tighten all cylinder head crab nuts to $1800 \pm 5\%$ foot pounds.
- (11) Inspect and repair water leaks. Repair all lubricating and fuel oil leaks that were observed during past running. Inspect cylinder liners for scores or dirt scratches. Check alignment of piston cooling oil "pee" pipe using gauge 8071720 as outlined in the Engine Manual.
- (12) Tighten all external nuts, capscrews and so forth. Make sure engine is oil tight. Before going on two hour full load run, the engine is to be in best possible condition. Leaks of

any sort should be permanently stopped.

- (13) Check lube oil relief valve setting and be sure component parts are in good condition. The valve guide should be $3/4$ " above valve body. Oil pressure should then agree with pressures given in the Engine Manual.

3. Full Load Run

- a. Blow out generator and wipe off commutator with a clean cloth. Clean engine to aid in determining leaks.
- b. Run two (2) hours at full rated speed at full load injector rack length or power piston gap for the particular engine as given in Table I.
- c. The following conditions should be observed during full load run:
 - (1) General condition of engine.
 - (2) Minimum horsepower (corrected as outlined in this instruction under "Brake Horsepower Standardization."
 - (3) Minimum water inlet temperature 150° F.
 - (4) Check speed of engine each hour. (If speeds are reset, pilot valve must be reset, if used.)
 - (5) Immediately after two hours full load run, bring engine to "idle" and check speed, and with hot oil record water temperature, main bearing oil temperature and pressure.
- d. At the end of the full load run, the complete load should be removed from the engine, simulating sudden loss of load, to check governor overspeed trip control. Overspeed mechanism should not trip.

C. Testing In A Locomotive Without Loading Facilities

If equipment to load engine is not available, it is possible to make a fairly comprehensive check on quality of a rebuilt engine by observing performance in operation. Check overspeed trip at 900-910 RPM. If trip does not operate in this speed range, adjust trip to correct setting.

1. Break-in run.

Same as indicated for testing under load except for running without load. Omit cylinder head to liner and crab nut tightening per part "B" Item 10.

2. Load run.

This test will entail observation under operating conditions. All data recommended under "B" Item 1, should be noted except horsepower. If (a) basic engine adjustments (b) indicated injector rack length or power piston measurement (c) engine speed (d) exhaust observation, all check normal, power output should be within reasonable limits.

Data should be recorded with engine hot, both at idle and full speeds. Overspeed trip and governor action should be checked as per "B" Item 3-d.

D. Final Inspection

Final inspections should be made on engines tested per part "B," immediately after completion of full load run. Final inspection on engines tested per part "C" should be performed as soon after the "on-the-road" test as possible.

1. On engines tested per part "C" only, retighten cylinder head to liner nuts including those under the rocker arms and cylinder head crab nuts as outlined in the Engine Maintenance Manual.

2. Inspect air box, top deck, top of all pistons by visual inspection. If engine is not water tight repair all leaks, run one-half hour at full load and recheck.

3. Check cylinder liners for scuffing, scores and scratches. Remove any scuffed or scored liners. Small scratches will no doubt smooth out in operation.

4. Check alignment of piston cooling tubes using gauge 8071720.

5. Check compression clearances of all cylinders by taking lead readings as outlined in Engine Manual. Maximum clearance to be .068" and minimum .026". Difference between compression clearance at opposite sides of piston should not be more than .005". Check piston compression rings carefully for breaks, worn rings or stuck rings.

6. Check injector rack measurement as outlined in the Maintenance Instruction for the particular engine.

7. Make a visual inspection of all connecting rod bearings for toe and heel wear. Connecting rod capscrews if left unwired at assembly must be torqued to 190-200 foot-pounds and lockwired.

8. Check all capscrews and nuts for wiring such as main bearing nuts, connecting rod capscrews, and so forth.

9. Check camshaft end play. More than .005" increase over original end play of crankshaft should be investigated.

10. If any major replacements are required, such as liners, pistons, connecting rod bearings or main bearings, rerun break-in run for one hour. Shut down and make inspection of new parts.

E. Engines Going To Storage

Prepare engines going to storage as outlined in M.I. 2176.

**BRAKE HORSEPOWER STANDARDIZATION
567 SERIES ENGINES**

To satisfactorily evaluate, for comparison, the horsepower tests on EMD-567 engines under various operating conditions as regards air, fuel and auxiliary load, it is necessary to correct all test data to standard conditions.

I. The following formula may be used in making standardization calculations:

$$\text{Corrected Brake HP} = \frac{\text{*Generator HP} + \text{Auxiliary HP}}{(\text{a}) \times (\text{x}) \times (\text{y})}$$

Where:

Locomotive DC Generators

$$\text{*DC Generator HP} = \frac{\text{Main Generator Volts} \times \text{Main Gen. Amps.}}{\text{Watts to HP Conversion} \times \text{Gen. Eff.}} = \frac{\text{Volts} \times \text{Amps.}}{708}$$

Power Unit Alternators

$$\text{*AC Alternator HP} = \frac{1.732 \times \text{Line Voltage} \times \text{Line Amps.} \times \text{Power Factor}}{723}$$

Auxiliary HP may be determined from Item III.

(Auxiliary HP = 0 when engine is tested on test stand)

Fuel and air factors involved are:

Standard conditions are:

(a) *Correction factor in % for air temp.	60° F.
(x) Correction factor in % for fuel density	.845
(y) Correction factor in % for fuel temp.	60° F.

Values for these correction factors may be obtained from Charts I and II on pages 9 and 10.

NOTE: It is essential that accurate test instruments be used.

*The most accurate method of obtaining air intake temperature is to measure engine air box temperature. Corresponding blower intake air temperature is shown on the air temperature scale with the correction factor between them. Air box temperature can be obtained by modifying one (1) air box cover, used for test purposes, to include a dial thermometer. This cover then is applied near the center of the engine.

II. EXAMPLE:

A. Test on a 16 cylinder 567-B installed in F-7A locomotive unit.

OBSERVED DATA:

Gen. Volts	831	
Gen. Amps.	1260	
Engine Intake Air Temp.	110° F.	Correction % (a) = .956
Fuel Specific Gravity	.845	Correction % (x) = 1.00
Fuel Temperature	100° F.	Correction % (y) = .98
Cooling Fans Running	3	Auxiliary HP = 30-3/4
F-7A		Auxiliary HP = 54
		Total Auxiliary HP = 84-3/4

SOLUTION:

$$\text{Gen. HP} = \frac{831 \times 1260}{708} = 1480 \text{ HP}$$

$$\begin{aligned} \text{Corrected B.H.P.} &= \frac{\text{Gen. HP} + \text{Aux. HP}}{(a) \times (x) \times (y)} \\ &= \frac{1480 + 84.75}{.956 \times 1.00 \times .98} \end{aligned}$$

$$\text{Corrected B.H.P.} = 1670 \text{ HP}$$

*NOTE: The above example applies to altitudes of 0-2000 ft.

B. Horsepower correction at altitudes above 2000 ft.

If it is necessary to make a horsepower correction above 2000 ft. altitude the following example may be used only if blower intake air temperature is between 85° - 95° F. Insufficient data at this time makes it impossible to correct at any other intake temperature where altitudes in excess of 2000 ft. are encountered.

Values for these correction factors may be obtained from Charts I and II on Pages 9 or 10.

OBSERVED DATA:

1650 HP Altitude 5000 ft.

Correction % = .967

SOLUTION:

$$\begin{aligned} \text{Corrected B.H.P. at 5000 ft.} &= \frac{\text{Correction B.H.P.}}{.967} \\ &= \frac{1650}{.967} \end{aligned}$$

$$\begin{aligned} \text{Corrected B.H.P. at 5000 ft.} &= 1706 \text{ B.H.P.} \end{aligned}$$

- III. A. The total engine horsepower developed in a locomotive is the horsepower input to the generator plus the horsepower required by the direct driven or alternator driven auxiliary equipment, that is, traction motor blower, radiator cooling fans, generator blower, air compressor, auxiliary generator, and so forth.

The auxiliary horsepower for the following locomotives is a fixed value plus the power required to operate the cooling fans. For these values to apply correctly the engine must be operated at full speed and load and the air compressor must be unloaded.

Auxiliary Load Values

800 RPM

Model	Auxiliary Horsepower
F-7A, FP-7A, F-7B GP-7, GP-7B	56 HP plus 10-1/4 HP for each cooling fan in operation. Maximum 97 HP
E-8A, E-8B E-9A, E-9B	57 HP/engine + 10-1/4 HP for each cooling fan in operation on the engine being tested. Maximum 87 HP (per engine)
SD-7	91 HP plus 10-1/4 HP for each cooling fan in operation. Maximum 132 HP
SW-8, TR-6	36 HP
SW-9, TR-5, SW-1200, TR-12	63 HP
SW-600	27 HP

835 RPM

Model	Auxiliary Horsepower
F-9A, FP-9A, F-9B GP-9, GP-9B	64 HP plus 11-1/2 HP for each cooling fan in operation. Maximum 110 HP
SD-9	104HP plus 11-1/2 HP for each cooling fan in operation. Maximum 150 HP
SW-900, TR9	47 HP

- B. The auxiliary horsepower for Export Locomotives are listed separately for each locomotive since the auxiliaries may vary with same model locomotives.

Model B-8 and G-8 locomotive

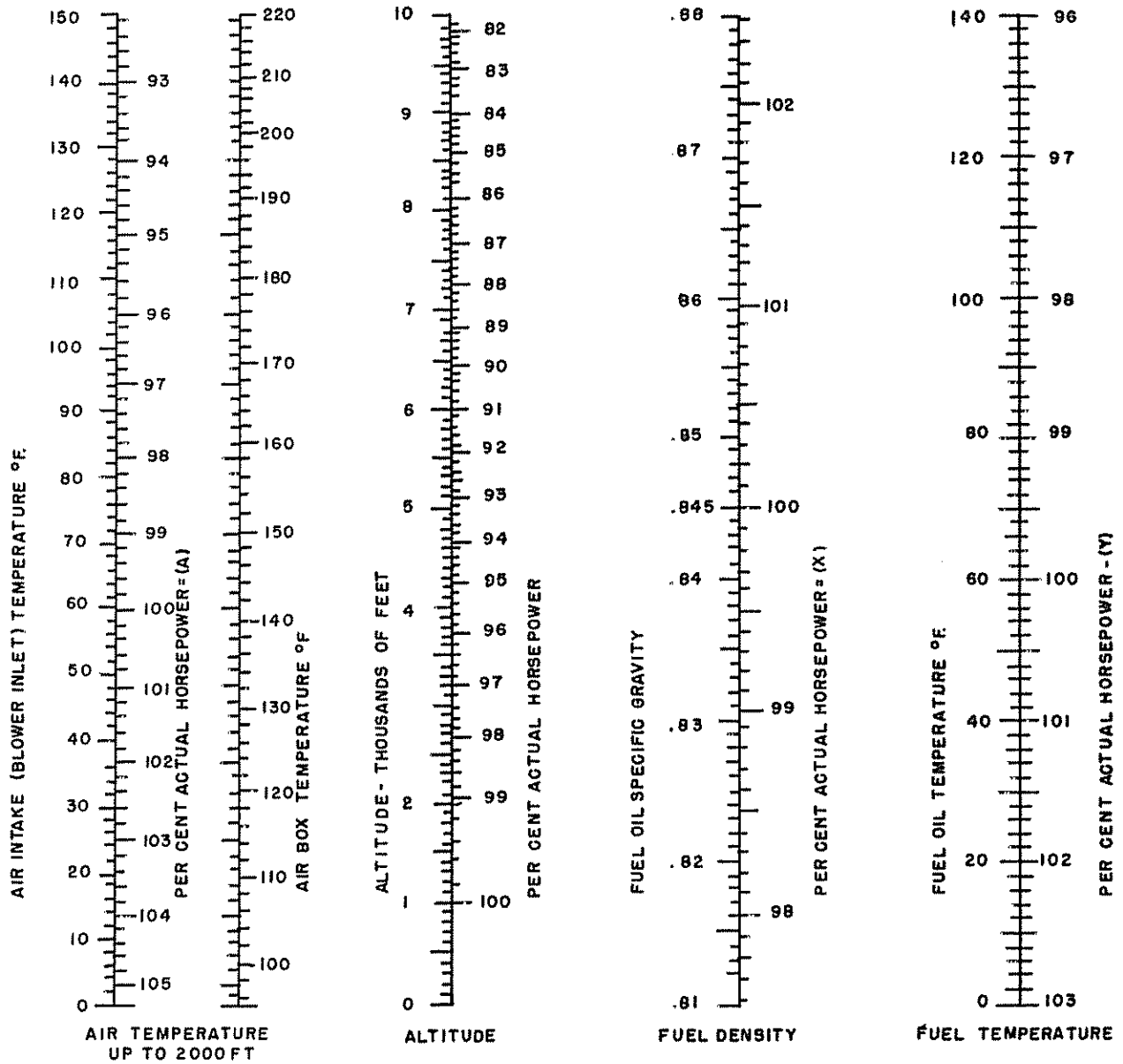
Speed Increaser Cooling Fan (50") and one Traction Motor Blower	42 HP
Auxiliary Generator	9
Traction Motor Blower	14
Main Generator Fan	10.5
Compressor (WXE-unloaded)	8.0
Compressor (unloaded) and Exhauster	33.0

Model B-12 and G-12 locomotive.

Speed Increaser Cooling Fan (54") and one Traction Motor Blower	61.0 HP
Auxiliary Generator	9.0
Traction Motor Blower	14.0
Main Generator Blower	16.0
Compressor (WXE-unloaded)	8.0
Compressor (unloaded) and Exhauster	33.0

CHART I

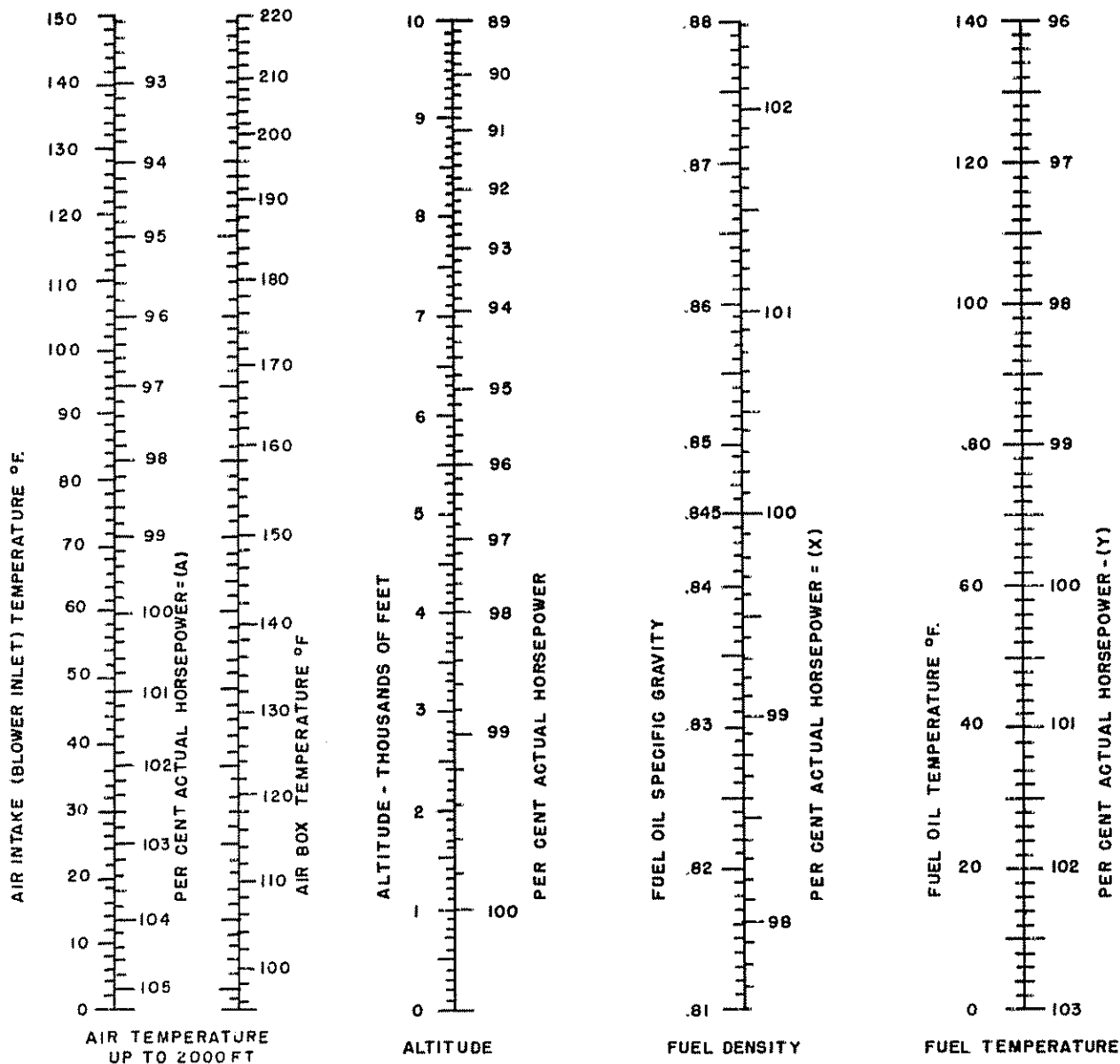
ALL 567 ENGINES DEVELOPING 110 OR MORE TOTAL CORRECTED HORSEPOWER PER CYLINDER



ALTITUDE CHART
 APPLIES TO INTAKE
 AIR TEMPERATURE RANGE
 OF 85-95 ° F. ONLY

CHART II

ALL 567 ENGINES DEVELOPING LESS THAN 110 TOTAL CORRECTED HORSEPOWER PER CYLINDER



ALTITUDE CHART
APPLIED TO INTAKE
AIR TEMPERATURE RANGE
OF 85-95° F ONLY

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