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Report on Calibration of Pratt and Whitney R-2800-32W Engine - Project TED No. NAM-PP-215.

(None)

Taylor, W. V.; Dotsey, M. J.
Naval Air Material Center, Aeronautical Engine Lab., Philadelphia, Pa.
(Same)

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A calibration was made to determine the sea-level and altitude characteristics of the P&W R-2800-32W engine. This engine is an aircooled, 18-cyl, double-row, radial power plant with a two-stage supercharger having a fixed-ratio main stage and a variable-ratio auxiliary stage. The dry weight of the engine is 2690 lb and the maximum specific outputs, based on 2300 bhp take-off rating, are 0.855 bhp/lb and 0.82 bhp/cu in. The specified fuel is Grade 115/145 AN-F-48 fuel. The calibration results, compiled in graphical form, indicate that the combinations of rpm and manifold pressures, as well as CAT and SFC, are well within the manufacturer's contract guarantees. Based on dynamemter results, combinations are also given additionally for high-altitude cruise operation.

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AERONAUTICAL ENGINE LABORATORY
REPORT ON

MCREXP74

CALIBRATION OF
PRATT AND WHITNEY R-2800-32W ENGINE

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REPORT

ON

CALIBRATION OF
PRATT AND WHITNEY R-2800-32W ENGINE

BY
NAVAL AIR MATERIAL CENTER
NAVAL AIR EXPERIMENTAL STATION
AERONAUTICAL ENGINE LABORATORY
PHILADELPHIA

Project TED No. NAM-PP-215.

Authority - Bureau of Aeronautics Restricted Letter Aer-PP-23 67758 of 25 August 1947.

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Reported by W. V. Taylor — W. V. TAYLOR, Aeronautical Engineer, GS-9, Project Engineer.

M. J. Dotsey — M. J. DOTSEY, Aeronautical Engineer, GS-9, Test Engineer.

Approved by K. E. Wright — K. E. WRIGHT, Commander, U.S.N., Superintendent.

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OBJECT

1. The primary object of this test was to determine the sea-level and altitude characteristics of the Pratt and Whitney (P&W) R-2800-32W engine.

CONCLUSIONS

2. Calibration results indicate that the engine satisfactorily meets the manufacturer's contract guarantees and is capable of the following ratings:

Rating	RPM	BHP	Super. Gear	CAT (°F)	ASRP (In.HG.)	Guar. SFC*	Altitude - Feet P&W Guar.*	Altitude - Feet AEL Dynamometer
Take-off	2800	2300	Partial Aux. Low	89	62.7	.80	Sea Level	Sea Level
Normal Rated Sea Level	2600	1900	Partial Aux. Low	88	51.5	.74	Sea Level	Sea Level
Military Rated Sea Level	2800	2300	Partial Aux. Low	89	62.7	.80	Sea Level	Sea Level
Normal Rated Critical Altitude	2600	1500	Min. Slip High Gear	88	48.6	.81	30,000	34,100
Military Rated Critical Altitude	2800	1800	Min. Slip High Gear	93	60.6	.90	30,000	32,200

* As guaranteed in reference (b)

These runs were made without the automatic manifold pressure regulator. Critical altitude performance would not be affected by the use of the Stromberg CO-3F Automatic Manifold Pressure Regulator, but sea-level manifold pressure requirements at normal and military rated powers would be somewhat increased because of a controlled throttle drop which is built into the regulator. Approximately 51.9 in. Hg ASRP would be required at normal rated, sea-level, and 63.1 in. Hg ASRP at take-off and military rated, sea-level, using the guaranteed SFC's.

3. Overpower runs at sea-level and high gear critical altitude, using Specification AN-F-48 grade 115/145 fuel, indicate that the engine is detonation limited at the following powers and operation is restricted to limited periods:

RPM	BHP	Super. Gear	Altitude (Ft)	Mixture Position	ASRP In. Hg.	CAT °F	F/A
2800	2540	Partial Aux. Low	Sea-Level *	Rich	72.5	98	.098
2800	2110	Min. Slip High Gear	26,600	Rich	72.2	95	.10

* These runs made with 4.0 in. Hg carburetor throttle drop as incorporated in the automatic Manifold Pressure Regulator.

4. The Stromberg PR-64B2 carburetor (No. 728821), metering according to the P.L. No. 390940-10 setting, produced satisfactory normal operation, starting, idling and acceleration characteristics. Mixture control runs, including instability checks, and detonation-limited mixture response runs indicated that the carburetor "normal" setting could be leaner throughout the range, with an attendent saving in fuel consumption. After approximately 100 hours of operating time, a variation in carburetor metering characteristics was noted, particularly in altitude compensation, and it was necessary to manually adjust the fuel flow for the remainder of the calibration to agree with the established limits.

5. Fuel conforming to the minimum requirements of Specification AN-F-48 (115/145) is satisfactory for use at the conditions shown in paragraphs 2 and 3. In addition, this fuel provides detonation-free operation at the powers shown in paragraph 2 at sea-level, with 100°F carburetor air temperature, and at the critical altitude with 125°F carburetor air temperature. Grade (100/130) fuel is not satisfactory for use with this engine except at reduced ratings (see Plates 37 and 38).

6. Operation of the Stromberg CO-3F Automatic Manifold Pressure Regulator (No. B-10077, P.L. No. 3909433) was satisfactory throughout the entire calibration.

7. Engine operation including starting, smoothness, and acceleration was satisfactory. The calibration was started using P&WA YR-2800-32W engine, No. P-28015, (a semi-production model) but a failure of the main accessory drive-shaft after 24 hours of operating time (see Plate 54) necessitated its removal from the dynamometer stand. A production model P&WA R-2800-32W engine, No. P-28802, was installed in the dynamometer room and the entire calibration was conducted on this engine (253 hours of operating time). Following is a list of failures which occurred during the tests:

(a) No. 8 piston failure at 40 hours (see Plate 55), probably due to pre-ignition.

(b) A number of the cap screws holding the right distributor cover failed during the calibration. These screws sheared off and allowed the distributor cover to loosen. Failures occurred at 100, 143 and 145 hours of operation.

(c) At 147 hours of operating time, a broken distributor finger was found in the left distributor.

(d) No. 8 piston and rings failed (scuffing) at 165 hours of operating time.

8. Operation of the BG RB19R spark plugs for most of the calibration was generally satisfactory; however, several instances of faulty plug operation were noted. The failure of No. 8 piston (see paragraph 7(a)) which occurred after approximately 40 hours engine and spark plug time, indicated pre-ignition (see Plate 55), and it was found that the center electrode was missing from one of the spark plugs in this cylinder. A complete set of new spark plugs was installed and after completing 60 hours of high power running (including approximately 6 hours of detonation-limited runs) the following failures were noted:

(a) Three plugs with the ceramic core surrounding the center electrode broken, with pieces missing.

(b) One plug with ceramic core broken and center electrode missing.

(c) One plug with ceramic core cracked.

Spark plug operation was satisfactory for the remainder of the calibration.

9. Considerable trouble was experienced with auxiliary stage impeller stalling at high altitude cruise conditions even with an auxiliary stage "bleed-off" valve installed. Stalling was encountered at low rpm and manifold pressures during high altitude operation, and was first noted by a violent surge or pulsation in the airflow, followed by complete stalling of one of the dual impellers (right hand impeller usually stalled). This condition could be quite serious in an airplane installation since a violent power surge or loss of power occurs and the auxiliary stage inlet temperature of the stalled impeller increases rapidly (temperatures in excess of 240°F have been measured on the inlet screen). A further discussion of this subject may be found in paragraphs 38 and 39.

10. Using "normal" mixtures produced by the P.L. No. 390940-10 setting of the PR-64B2 carburetor, the cooling air baffle pressure drop necessary to maintain the maximum cylinder head and/or flange temperatures specified in reference (b) was as follows:

Condition	RPM	BHP	Super. Gear	Cooling Air Temp. - °F	Baffle Pressure Drop - In. H_2O
Take-off	2800	2300	Partial Aux. Low	85	8.4
Normal Rated Sea Level	2600	1900	Partial Aux. Low	84	5.0
Military Rated Sea Level	2800	2300	Partial Aux. Low	85	8.4
Normal Rated Critical Altitude	2600	1500	Min. Slip High Gear	78	5.0
Military Rated Critical Altitude	2800	1800	Min. Slip High Gear	77	9.2

11. The torquemeter functioned satisfactorily throughout the test. A constant of 158.3 checked dynamomet-r determined power within the specified ± 2 per cent.

RECOMMENDATIONS

12. It is recommended that the Aeronautical Engine Laboratory determined altitude ratings shown in paragraph 2, rather than the values indicated in the Pratt and Whitney engine specification (reference (b)), be accepted as the actual operating characteristics of the engine.

13. The Stromberg PR-64B2 carburetor, metering in accordance with the "normal" and "rich" mixture positions of the P.L. No. 390940-10 setting, is recommended for use with this engine. It is also suggested that an investigation be conducted as to the possibility of leaning out the "normal" setting, particularly in the cruise range, and extending the cruise range to a higher airflow, in an effort to attain lower fuel consumption values over a broader range.

14. Operation with fuel conforming to the minimum requirements of Specification AN-F-48 (115/145) using either P&W guaranteed or "normal" mixture (see Plate 39) fuel consumptions is recommended as satisfactory. Because of detonation limitations (see Plates 37 and 38), fuel of grade (100/130) is not recommended for use with this engine except at reduced ratings.

15. The Stromberg CO-3F Automatic Manifold Pressure Regulator, P.L. No. 3909433, is recommended as satisfactory with this type engine.

16. BG RB19R spark plugs are not recommended as satisfactory for use with this type engine. If it is found necessary to use these type plugs, inspections should be more frequent and the overhaul time period should be decreased.

17. It is recommended that a complete investigation be made in regards to auxiliary stage impeller stalling, and corrective measures applicable. This program should be directed toward establishing values at which stalling is encountered in flight installations (F4U-5 airplane) and further evaluating the auxiliary stage "bleed-off" valve. It is believed that possibly an investigation of entrance ducting or vaneing would help prevent stall. The auxiliary stage "bleed-off" system is considered a wasteful process as it tends to increase high altitude cruise fuel consumption values and somewhat lowers the cruise speed critical altitudes. Based on dynamometer results, it is recommended that for high altitude cruise operation the following combinations of rpm and manifold pressures be used:

(a) 2300 rpm, 36 in. Hg ASRP and above.
(b) 2200 rpm, 37 in. Hg ASRP and above.
(c) 2100 rpm, 38 in. Hg ASRP and above.
(d) 2000 rpm, 39 in. Hg ASRP and above.
(e) No high gear operation below 2000 rpm.

18. A torquemeter constant of 158.3 is recommended for Naval aircraft service use.

DESCRIPTION OF SUBJECT

19. The following is a brief summary of the characteristics of the subject engine. Photographs of general views of the engine are shown on Plates 59 to 61, inclusive.

(a) Manufacturer:

Name	Pratt and Whitney Aircraft, Division of United Aircraft Corporation
Location	East Hartford, Connecticut

(b) Model, Numbers, and Ratings:

Model	R-2800-32W
Type	Aircooled, 18 cylinders, double-row radial, two-stage supercharger with fixed ratio, main stage; variable ratio, auxiliary stage.
Engine Numbers	P-28015 and P-28802
Normal and Military Ratings	See Paragraph 2
Maximum Dive Speeds	3120 rpm

(c) General Data:

Bore and Stroke	5.75 x 6.00 in.
Cylinder Arrangement	Two-row staggered radial, 9 cylinders in each row.
Total Displacement	2804 cu. in.
Master Rod Locations	8 and 9
Compression Volume Ratio	6.75 to 1
Reduction Gear Ratio	.45 to 1
Propeller Shaft Spline	SAE No. 60A
Propeller and Crankshaft Rotation	Clockwise from rear.
Crankshaft Dampers	One 4-1/2 order torsional on rear crank cheek. One 2nd order torsional on front crank cheek.
Crankshaft Balancers	Two 2nd order linear.
Overall Dimensions	53 in. in diameter. 94.75 in. long.
Dry Weight of Engine Including Carburetor, Spark Plugs, etc.	2690 pounds
Maximum Specific Outputs (Based on 2300 BHP Take-off Rating)	.855 bhp per pound .82 bhp per cu. in.
Fuel Spec. AN-F-48	Grade (115/145)
Oil Spec. AN-O-8	Grade 1100

(d) Supercharging:

Number of Stages	Two; main stage (fixed ratio) and dual auxiliary stage (variable ratio.)
Type	Centrifugal. Main stage-gear driven. Auxiliary stage-two-speed gear driven through hydraulic couplings with variable ratio through each coupling.

Impeller Gear Ratios	Main Stage: 6.70 to 1 Auxiliary stage: minimum slip low 7.78 to 1; minimum slip high 9.65 to 1.
Impeller Diameter	Main Stage 11.00 in. Right and left dual auxiliary stage 13.00 in.

(e) Carburetor:

Manufacturer	Bendix-Stromberg
Model	PR-64B2 (No. 728821)
Setting	Parts List No. 390940-10
Fuel Pressure Desired	25 ± 1 psi
Nozzle Pressure Desired	10 ± 1 psi
Injector Location	Spinner-type, located at impeller entrance.

(f) Ignition:

Magneto	Scintilla DF18LN (Nose-mounted)
Distributors	Two (nose mounted)
Ignition Timing	20° BTC
Spark Plugs	BG RB19R
Firing Order	1, 12, 5, 16, 9, 2, 13, 6, 17, 10, 3, 14, 7, 18, 11, 4, 15, 8.
Harness - high tension	Pratt and Whitney Assembly 92408 (cast manifold, shielded unit with detachable leads).

(g) Valve Timing:

Inlet Valve Opens Before Top Center	36°
Inlet Valve Closes After Bottom Center	60°
Exhaust Valve Opens Before Bottom Center	70°
Exhaust Valve Closes After Top Center	26°
Overlap	62°
Valve Adjusting Clearance (Cold)	.060 in.
Valve Timing Clearances (Hot)	

Front Intake .102 in., Exhaust .127 in
Rear Intake .125 in., Exhaust .143 in

(h) Accessory Drives:

Accessory Drive	Ratio to Crankshaft	Permissible Torque Inch - Pounds Continuous	Static	Direction of Rotation*
Starter (1)(Type 1A)	3.000:1	-	13,000	C.
Generator (1)(Type 1A)	3.000:1	500	2,200	C.
Fuel Pumps (2)	.886:1	25	450	C.C.
Vac. Pump (2)				
on PTO Pad (Type II)	1.256:1	125	1,400	C.
on Rear Case (Type II)	1.400:1	250	1,650	C.C.
Tachometer (1)(Type II)	.500:1	7	50	C.C.
Governor (1)	.964:1	125	825	C.C.

* Direction of rotation indicated by C. - Clockwise
C.C. - Counterclockwise
when viewed from rear of engine.

(i) The important basic improvements and design changes made on this engine with reference to the R-2800-18W ("C"-model, two-stage, two-speed) engine previously calibrated (reference (c)) are as follows:

(1) Dual auxiliary stage impellers, driven at variable speed through hydraulic couplings.

(2) Stromberg CO-3F Automatic Manifold Pressure Regulator controlling both carburetor throttles and oil to auxiliary stage supercharger couplings.

(3) Stromberg PR-64B2 carburetor (updraft).

(4) No provisions for automatic spark advance.

(5) Accessory section completely redesigned. Starter drive now geared 3 to 1 compared to 1 to 1 for "C" models. Generator now located on top of rear case between dual auxiliary stage impellers.

(6) Longer connecting rods.

(7) Lighter cylinder heads with longer barrels.

(8) Redesigned pistons with piston pin bosses higher, flat head, curved inside dome.

(9) Provisions for double-acting propeller governor.

(10) Strengthened propeller shaft.

(11) Planetary gear arrangement (3 to 1) for accessory drive shaft.

(12) Rear counterweight made lighter with more movement to cut down loads.

(13) Use of higher main oil pressures (115 to 140 psi at normal rated speed).

METHOD OF TEST

20. Engines No. P-28015 and P-28802 were installed in No. 1W dynamometer room for conduct of a sea-level and altitude calibration as requested by reference (a). The engine was attached to the dynamometer by means of a gear-type coupling and extension shaft. A large rubber coupling was used to attach the extension shaft to the dynamometer and a flywheel was installed on the engine end of the shaft to improve the vibration characteristics. The first engine (P-28015) installed was a semi-production model, and was removed from the dynamometer room after 24 hours of operation when a failure of the main accessory drive shaft occurred (see Plate 54). A production model -32W engine was then installed and all calibration results shown in this report were obtained in this engine (253 hours of operating time). The auxiliary stage inlet and cylinder exhaust pressures (at the outlets of the F-47N airplane type exhaust collector) were maintained at the required altitudes unless otherwise noted. The oil and breathing systems were maintained at or near sea-level conditions, and the fuel system was vented to carburetor entrance pressure. A standard complement of instruments as is normally used by this laboratory was employed to measure fuel, air, and oil flows, temperatures and pressures.

21. Fuel conforming to the requirements of Specification AN-F-48 (115/145) and oil of specification AN-O-8, Grade 1100 were used during these tests. The oil-in temperature and oil-out pressure were maintained at approximately 165°F and 15 psi gage, respectively.

22. F4U-5 airplane ducts, intercoolers and bleed-off valve (Part No. 128891) were installed (see Plates 53, 57, and 58) and suitable ducting was fabricated so that the intercooler outlets were connected to the plant exhaust system and the inlets were connected to the cooling air blower drum. A set of auxiliary intercoolers was placed in the cold air stream of the adjacent dynamometer room, and by suitable piping, water was cooled in these intercoolers and sprayed on the

face of the engine intercoolers. With this arrangement it was possible to attain the desired carburetor air temperatures except at very cold conditions. F4U-5 flight data were used to determine the intercooler effectiveness ratios which is used to calculate the required carburetor air temperatures. The following table shows the intercooler effectiveness ratios used during calibration:

Altitude (Feet)	Military Speed Eff. Ratio %	Normal Speed Eff. Ratio %	Below Normal Eff. Ratio %
0 to 20,000	68	70	70
20,000 to 30,000	64	68	70
30,000 to 38,000	61	65	70

These ratios were calculated by the following formula:

$$\text{Effectiveness Ratio} = \frac{\text{Aux. Exit Temp. - Carb. Air Temp.}}{\text{Aux. Exit Temp. - Std. Altitude Temp.}}$$

The carburetor air temperature used was the average of five thermocouples on the carburetor screen and one in the carburetor scoop.

23. A manual mixture control unit was attached to the carburetor (air pressure to the metering chambers) to obtain desired fuel flows for mixture control and detonation-limited runs.

24. Sperry detonation detecting units were adapted to the intake rocker boxes on each of the 18 cylinders. Detonation was limited to "incipient" conditions-defined as "one or more cylinders indicating detonation at irregular intervals, none indicating a definite frequency".

RESULTS AND DISCUSSION

25. The location of the various plots and photographs in this report are as follows:

Title	Plate Nos.
Altitude Characteristics - Normal Mixtures	1 to 6
Sea-Level Characteristics - Normal Mixtures	7 to 10
Altitude Characteristics - Rich Mixtures	11 to 16
Sea-Level Characteristics - Rich Mixtures	17 to 20
Cruise Altitude Characteristics - Normal Mixtures	21 to 26
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Photographs of No. 8 Piston Failure and Cylinder on Engine, No. P-28802	55 and 56
Photographs of Engine Set-up in Dynamometer Room	57 and 58
General Views of Engine	59 to 61

Additional information on engine operation may be found in references (d), (e), (f), and (g).

26. Plates 1 to 20 inclusive show the sea-level and altitude basic calibration curves. The altitudes, SFC's, manifold pressures, etc., plotted therein for the various speeds and powers are indicative of the values that are obtained in "rich" and "normal" mixture positions of the PR-64B2 carburetor incorporating the P.L. No. 390940-10 setting (see Plates 39 and 40). Temperatures at the auxiliary stage entrance ducts were maintained at standard altitude conditions, as were the exhaust pressures at the outlets of the F-47N airplane-type exhaust collector. Carburetor air temperatures (average of 5 thermocouples on the carburetor screen and one in carburetor scoop) were maintained (by use of the F4U-5 intercoolers) at the desired values depending upon F4U-5 intercooler effectiveness ratios (see Paragraph 22). The Stromberg CO-3F Automatic Manifold Pressure Regulator was set at sea level to obtain approximately military and normal powers at the critical altitude for 2800 and 2600 rpm respectively, the altitude then being raised in successive steps, without touching the regulator, until a full throttle power line was established. At 2400, 2200, and 2000 rpm, the regulator was similarly set to obtain 165 bmep at the critical altitude. At the lower speeds however, auxiliary stage supercharger stalling was encountered at critical altitudes, and it was decided to set the regulator to obtain 165 bmep at sea-level. The auxiliary stage "bleed-off" valve was installed and connected to operate as it does in the airplane installation. All data included in this report were obtained using a production Model R-2800-32W engine, No. P-28802, and using AN-F-48 (115/145) fuel unless otherwise noted. The following table shows the manifold pressures, airflows, fuel/air ratios, SFC's, carburetor air temperatures, using normal and rich mixture strengths, at normal, military, take-off and overpower conditions.

Condition	Gear	RPM	BHP	Mixture	Altitude (Ft.)	ASRP In.Hg.	F/A	SFC	Carb. Air Temp°F	Air Flow Lb/Hr
Take-off	Part.Low	2800	2300	Rich	Sea Level	64.7	.105	.90	83	19700
Take-off	Part.Low	2800	2300	Normal	Sea Level	64.3	.103	.88	83	19700
Normal Rated	Part.Low	2600	1900	Rich	Sea Level	53.6	.106	.88	75	15600
Normal Rated	Part.Low	2600	1900	Normal	Sea Level	53.4	.103	.83	72	15400
Military Rated	Part.Low	2800	2300	Rich	Sea Level	64.7	.105	.90	83	19700
Military Rated	Part.Low	2800	2300	Normal	Sea Level	64.3	.103	.88	83	19700
Normal Rated	Min. Slip High	2600	1500	Rich	32,500	49	.102	.99	58	14600
Normal Rated	Min. Slip High	2600	1500	Normal	32,800	50	.10	.97	57	14700
Military Rated	Min. Slip High	2800	1800	Rich	30,600	63.5	.103	1.09	89	19200
Military Rated	Min. Slip High	2800	1800	Normal	30,900	63.5	.102	1.06	90	19100
OVERPOWER CONDITIONS										
Take-off	Part.Low	2800	2540	Rich	Sea Level	72.5	.098	.86	98	22300
Military	Min. Slip High	2800	2110	Rich	26,600	72.2	.10	1.06	96	22400

27. Plates 21 to 26, inclusive, show the cruise power altitude characteristics of the engine, at various power conditions and at 2200 and 1800 rpm. "Normal" mixture strengths were used throughout, and the same procedure of operation outlined in the preceding paragraph was employed. These runs were made to determine the operating conditions of maximum economy at these two cruise speeds. Data indicates that at 2200 rpm, with the present carburetor setting (P.L.No. 390940-10), maximum economy was obtained at approximately 33.5 in. Hg. manifold pressure. This coincides with the air flow at which carburetor enrichment begins at this speed. However, at approximately 26,000 feet it is necessary to operate at 37 in. Hg ASRP or higher to prevent auxiliary stage stalling. At 1800 rpm stalling was encountered at approximately 18,000 feet, regardless of the manifold pressure employed. Best overall economy was obtained at approximately 34 in. Hg ASRP at this speed. See reference (h) for additional information on altitude cruise conditions.

28. Critical altitude mixture control runs, made at normal and military powers, and at sea-level and high gear minimum slip conditions, are shown on Plate 27. Standard altitude conditions were maintained at the F4U-5 airplane auxiliary stage entrance ducts, and carburetor air temperatures were controlled by the F4U-5 intercoolers to approximately 90°F. Standard altitude exhaust pressure was maintained at the outlets of the F-47N type exhaust collector and approximately 480°F cylinder head temperatures were employed. The engine was operated without the manifold pressure regulator. Manifold pressure requirements at take-off and normal rated powers at sea-level will be slightly higher (see Paragraph 2) with the Stromberg CO-3F regulator installed because the engine would be operating with a controlled throttle drop; however, critical altitude runs will be the same because full throttle and minimum slip high gear is attained in both cases. These data indicate that, at guaranteed SFC's given in reference (b), the engine exceeds its guaranteed critical altitudes by 4100 feet at normal rated power and 2200 feet at military power, minimum slip high gear.

29. Sea-level and altitude overpower runs are shown on Plates 28 to 30, inclusive. Runs were made with "Rich" mixtures as produced by the P.L. No. 390940-10 setting of the PR-64B2 carburetor except at higher air flows, where manual control was necessary (air pressure to carburetor diaphram) to prevent excessive leaning. Standard altitude temperature was maintained at the auxiliary stage entrance ducts and carburetor air temperatures were regulated through the F4U-5 airplane type intercoolers to give intercooler effectiveness ratios of 68 per cent at sea-level, 64 per cent from 20 to 30,000 feet, and 61 per cent from 30 to 40,000 feet. AN-F-48 (115/145) grade fuel was used throughout, and manifold pressures at sea-level and critical altitude were increased until limited by incipient detonation. Also plotted on these plates are data from an overspeed run (2900 rpm) at take-off power, sea-level, which indicates the effects of increased engine rpm on manifold pressure, air flow, etc., requirements.

30. Plates 31 to 34, inclusive, show altitude characteristics and hysteresis checks of the Stromberg CO-3F Automatic Manifold Pressure Regulator (No. B-10077, P.L. No. 3909433) at normal rated and military speeds. These runs were made with the Stromberg PR-64B2 carburetor in the "Normal" mixture position (P.L. No. 390940-10), with standard altitude temperatures at the auxiliary stage entrance ducts, and standard altitude pressures at the outlets of the F-47N airplane-type exhaust collector. Carburetor air temperatures were controlled by the F4U-5 airplane intercoolers to agree with intercooler effectiveness ratios shown on curves. A constant setting of the manifold pressure regulator (set at sea-level) was maintained throughout these runs and the altitude was varied in successive steps from sea-level to above the critical altitude and then returned to sea-level. Operation of the control was satisfactory and the regulation of manifold pressure was within ±1 in. Hg for the two runs made. Considerable surging was encountered when the control shifts the couplings from low to high (and reverse) and at the point just below the critical where the carburetor throttles are fully opened. However, this surging may not be encountered in the airplane installation (F4U-5) to as great a degree since a constant inlet pressure is maintained at the auxiliary stage entrance ducts. In the dynamometer installation, auxiliary stage altitude was controlled by a butterfly-type throttling valve. As the altitude was increased by throttling the air-flow to the entrance ducts, the point was reached where the control supplied oil to the high coupling, (momentarily changing the impeller speed) which in turn varied the air flow. This variation changed the entrance pressure, and before the butterfly altitude valve could be changed (automatic or manual), a surging condition was encountered.

31. Minimum mixture characteristics of the engine in neutral, low and high gears at sea-level and altitude are presented on Plates 35 and 36. Plate 35 shows sea-level mixture control runs at cruise speeds using neutral and partial auxiliary low ratios (near maximum slip) and includes various check points with colder carburetor air and cylinder head temperatures. Plate 36 shows runs with varying carburetor air and cylinder head temperatures for minimum slip operation in low and high auxiliary blower using the automatic manifold pressure regulator. These runs were made at higher airflows and speeds than would normally be required for high altitude operation because auxiliary stage supercharger stalling was encountered at lower cruise conditions. Spotted on the curves are the "Normal" mixture limits of the P.L. No. 390940-10 setting of the PR-64B2 carburetor. These data indicate that, throughout the range tested, satisfactory engine operation can be obtained at mixtures considerably below the carburetor setting when using BG-RB19R spark plugs, and a considerable saving in fuel could be obtained if the "Normal" mixture setting was made leaner.

32. Plates 37 and 38 show detonation-limited mixture response curves using AN-F-48 (100/130) and (115/145) grade fuels. Following is a table showing detonation-limited powers at normal and military speeds, sea-level and critical altitudes with the two grade fuels tested:

Fuel Grade	RPM	Alt. Ft.	CAT: °F	Mixture Position	Super Position	Cyl.Hd. Temp.°F	F/A	ASRP In.Hg	Detonation Limited - BHP
100/130	2800	Sea Level	97	Rich	Part Low	477	.105	62.5	2200
100/130	2600	Sea Level	98	Normal Minus	Part Low	475	.081	50.5	1900*
100/130	2800	30,000 to 34,000	125	Rich	Full High	485	.106	60.5	1590
100/130	2600	30,000 to 34,000	122	Normal Minus	Full High	480	.078	50	1500*
115/145	2800	Sea Level	97	Normal Minus	Part Low	477	.078	61	2300*
115/145	2600	Sea Level	98	Normal Minus	Part Low	475	.066	50	1900*
115/145	2800	30,000 to 34,000	125	Normal Minus	Full High	485	.083	62	1800*
115/145	2600	30,000 to 34,000	122	Normal Minus	Full High	480	.063	52	1500*

* Guaranteed Ratings

These data indicate that operation with grade (115/145) fuel is satisfactory throughout the engine operating range. AN-F-48 (100/130) grade fuel is not recommended for use with this engine at military speed unless the power is lowered to a value below 2200 bhp at sea-level and below 1590 bhp at the critical altitude. An unusual occurrence was noted with this engine at military speed at both sea-level and the critical altitude; namely, an increase in mixture strength above certain values resulted in a decrease in detonation-limited brake horsepower. This may be attributed to the fact that as the fuel-air ratio is increased (above maximum power) more auxiliary stage supercharging is necessary to compensate for the power lost by richened mixtures, and this in turn increases the friction horsepower and indicated mean effective pressures. A point is evidently reached where the anti-knock tendency afforded by the increased mixture strength is counterbalanced and overcome by the increased IMEP, resulting in a decreased detonation-limited brake horsepower. Cruising power runs at sea-level and altitude are also shown on these plates. These data indicate that operation would be satisfactory throughout with (115/145) grade fuel as no detonation could be obtained at these cruise conditions. AN-F-48 (100/130) grade fuel also provided satisfactory detonation-free operation at cruise speed and power loading conditions.

33. Engine and air box carburetor characteristics are shown on Plates 39 and 40. The Stromberg PR-64B2 carburetor, No. 728821 incorporating the P.L. No. 390940-10 setting, was used for these checks, and this carburetor was used throughout the entire calibration. Pratt and Whitney acceptance limits are also plotted on Plate 39, and show that the carburetor metering was well within these limits. These data also show that altitude compensation of the carburetor was satisfactory. Mixture control runs and detonation-limited mixture response runs, discussed in the preceding paragraphs and plotted on Plates 35 to 38, inclusive, indicate that satisfactory cruise operation was obtained at leaner mixtures, and the cruise range could be extended to a higher airflow before enrichment was necessary. It is therefore suggested that the possibility of lowering the cruise normal mixture limits to values nearer best economy and increasing the cruise operating airflow range be considered.

34. Plate 41 is a correction curve for carburetor air temperature deviation from standard temperature and a correction curve for mixture temperature deviation from the plotted calibration values. These curves are derived from various runs at different powers made with constant manifold pressure, fuel-air ratio, and cylinder head temperatures (for each run) and combined to give a percentage power correction.

35. Auxiliary stage inlet temperature correction curves at sea-level and the critical altitude are plotted on Plate 42. Various speeds were run and combined to obtain these curves and all inlet conditions to the cylinders were maintained constant; that is, constant fuel-air ratio, mixture temperature, manifold pressure and cylinder head temperature for each run. The data show that for critical altitude operation with minimum slip, high blower, where cold auxiliary stage inlet temperatures prevail, there is no power correction necessary for temperature variation through the auxiliary stage. For auxiliary stage operation at sea-level however, there should be a slight correction for temperature effects on auxiliary stage power requirements as indicated on the curve. It is believed that this increase in power requirements with hotter air at the auxiliary stage inlet ducts may be due to efficiency considerations of the dual auxiliary superchargers, or to higher supercharging requirements for the same mass airflow with the hotter air thereby increasing the auxiliary supercharger friction and pumping horsepower.

36. Plates 43 and 44 show the exhaust back pressure correction curves in neutral gear, sea-level, and at minimum slip, high blower conditions, critical altitude. For each run, the inlet conditions, to the cylinders (manifold pressure and temperature and fuel-air ratio) were maintained constant and the exhaust pressure varied to change the Pe/Pm ratio (exhaust pressure to manifold pressure). At minimum slip, high gear conditions, speeds below 2000 rpm could not be run because of auxiliary stage impeller stalling. It is interesting to note that at these high gear conditions, the percentage power correction for speeds from 2000 to 2800 rpm is the same, based on Pe/Pm ratios.

37. Plate 45 shows the effect of cylinder head temperature on bhp at low gear military, normal, and two cruise speeds. Inlet conditions to the cylinders were maintained constant throughout each run (fuel-air ratio, manifold pressure and temperature).

38. Cruise stability operating limits of the engine with and without the auxiliary stage "bleed-off" valve are shown on Plate 46. Plate 47 is an additional plot showing the approximate altitudes at which stalling was encountered. The Stromberg CO-3F Automatic Manifold Pressure Regulator was set at sea-level and the engine speed held constant. The altitude was then raised gradually to above the critical altitude and returned to sea-level, noting any stalling tendencies of the auxiliary impellers. A surging condition was generally encountered before stall, and was accompanied by a high amplitude, low frequency vibration. Complete stall was readily ascertained by a sudden rise in temperature at the auxiliary stage entrance screen of the stalled impeller. Temperatures in excess of 240°F have been measured on this screen. The greatest tendency toward supercharger stalling was noted while descending in altitude near the critical altitude when the supercharger slows down in shifting from minimum to maximum slip high gear and also from maximum slip high to minimum slip low gear. In practically all cases, the right hand impeller was the one that stalled. The auxiliary stage "bleed-off" valve prevented supercharger stalling at certain conditions, but high gear operation is still restricted. The following table lists rpm and manifold pressure combinations that should be used for high altitude cruise operation with the "bleed-off" valve:

Altitude	Recommended ASRP at Given RPM					
(Ft.)	2300	2200	2100	2000	1900	1800
0- 3,000	24 to 42	24 to 42	24 to 42	24 to 42	24 to 42	24 to 42
3-16,000	24 to 42	24 to 42	*	*	*	*
16-20,000	24 to 42	24 to 42	*	*	Unsatisfactory Throughout	Unsatisfactory Throughout
20-24,000	24 to 42	24 to 42	*	39 in. & above	Unsatisfactory Throughout	Unsatisfactory Throughout
24-40,000	36 in. & above	37 in. & above	38 in. & above	39 in. & above	Unsatisfactory Throughout	Unsatisfactory Throughout

* Stalling occasionally encountered, particularly when decreasing altitude at near coupling change conditions. Also encountered at low manifold pressures when going into Aux. Low.

It was found that the best method for getting out of stall was to rapidly increase rpm and manifold pressure. However, a serious power and speed surge was encountered in the dynamometer installation when this method was employed and the stalled impeller suddenly returned to full pumping capacity. It is believed the surge would be considerably less in the airplane (F4U-5) because of the faster action of the propeller speed regulation. Verbal contact with a representative of Squadron VX-3 NAS, Atlantic City, in regards to high altitude auxiliary stage supercharger pulsation in the F4U-5 airplane, indicated trouble was encountered at similar operating conditions as the dynamometer engine, and the best method to get out of stall was to increase engine rpm. References (i) and (j) present additional information on this subject.

39. Plate 48 shows auxiliary stage overall performance characteristics of the R-2800-32W engine, No. P-28802. These runs were made with both auxiliary superchargers exhausting to atmosphere. Each of the dual superchargers was tested separately; airflow through the test supercharger was controlled by a butterfly-type altitude regulating valve, the other auxiliary supercharger being open to atmosphere. The engine was run at the speeds shown using the full high ratio (minimum slip) of the auxiliary stage (9.65 to 1). Data plotted show pressure ratio (across each auxiliary supercharger) vs. Qo/1000. Following is a list of symbols and definitions used.

Q_o = Equivalent inlet volume airflow, $Q/\sqrt{\theta}$

Q = Inlet airflow, cu. ft./min. = $\frac{0.0126\ WT_1}{P_{1T}}$

θ = Temperature correction factor = $T_1/518.6$

W = Weight airflow = $K\sqrt{\frac{Pa}{T}}$, Lb./Hr.

T_1 = Inlet temperature, °R.

P_{1T} = Inlet pressure, total

Similar data from Pratt and Whitney supercharger performance curves (see reference (i)) indicated auxiliary impeller stall points were in good agreement between the two sets of data. Corrected airflow curves of the engine, when spotted on these curves, indicate that the auxiliary superchargers are operating at near stall conditions at high altitude, low speeds, and manifold pressures. However, the purpose of the auxiliary stage bleed-off valve is to dump a portion of the air (approximately 3%) overboard after it has been compressed by the dual auxiliary impellers (a wasteful process because of the higher SFC's encountered), and thus keep the dual stages operating at a higher capacity and above the stall limit line. The auxiliary impellers are therefore pumping slightly more air than is being used by the engine (values plotted on calibration curves). The performance curves plotted indicate that the two dual superchargers were not equally matched and the left hand supercharger developed a higher pressure ratio, for a given impeller speed, than the right supercharger. Therefore, as the outlets operate at the same pressure (carburetor top deck) and inlets are at airplane altitude, there is an unbalance between the two superchargers and it is doubtful whether they will divide the load equally. It is believed the supercharger operating at the lower pressure ratio will tend to reduce airflow in an effort to balance exit pressures, and as the curves are relatively flat in this operating range, will go into stall. In nearly all cases where unstable operation occurred during the calibration, stalling was noted at the low output (right) impeller.

40. Plates 49 and 50 show the altitude friction characteristics of the engine at the same operating conditions as the "normal" altitude calibration. Because of horsepower limitations of the dynamometer (approximately 620 bhp) it was necessary to estimate normal and military rpm friction at powers above this value. Since operation was in auxiliary stage at these conditions, estimations were based on additional power requirements of the auxiliary stage (on a temperature rise and weight airflow basis) and oil heat rejection characteristics. Friction horsepower (difference between indicated horsepower and brake horsepower) is considered the sum of the horsepower absorbed by both superchargers, the mechanical friction of the engine, and the pumping action of the pistons. Since the engine was not operating at the same temperature at which it would operate when firing, there was probably some error in simulating both the mechanical friction (effect of temperature upon bearing clearances, oil viscosity, etc.) and the pumping horsepower (improper valve timing and incorrect temperature of the air flowing through the cylinders). However, since the horsepower absorbed by the superchargers of this type engine constitutes the greatest portion of the friction horsepower, the values plotted should be a close approximation. Friction losses at high gear, auxiliary stage were extremely high and accounts for the high specific fuel consumptions encountered at these conditions. As an example, at high gear military power critical, the engine was actually developing over 2900 bhp but only 1800 bhp was being delivered to the propeller shaft for useful output.

41. Plate 51 is a plot of oil flow and heat rejection characteristics of the engine at propeller load powers, sea-level. These data show that the engine exceeds the guaranteed oil flow limits (see reference (b)) at military speed, and that oil flow and heat rejection at normal rated speed are marginal. Oil flow and heat rejection of the engine with the CO-3F Automatic Manifold Pressure Regulator in operation are somewhat higher than without it because a controlled throttle drop is maintained for all altitudes below the critical.

42. Plate 52 is a comparison of brake horsepower output of the engine as determined by the engine torquemeter and by the dynamometer. The constant of 158.3 checked dynamometer determined power well within ± 2 per cent.

43. Plate 53 shows a sketch of the induction system used for the calibration. Plate 54 is a photograph of the main accessory drive shaft failure on the first calibration engine, YR-2800-32W, No. P-28015. Plates 55 and 56 show photographs of No. 8 piston failure and the mating cylinder of Pratt and Whitney R-2800-32W engine, No. P-28802. Plates 57 and 58 are photographs of the engine installed in the dynamometer room, and Plates 59 to 61, inclusive, show general views of the engine.

REFERENCES

(a) Project Authorization - Bureau of Aeronautics Restricted Letter Aer-PP-23 67758 of 25 August 1947.

(b) Specification - Pratt and Whitney Aircraft R-2800-32W Engine Specification No. N-8119-B of 20 December 1949.

(c) Description of R-2800-"C" Engine - Aeronautical Engine Laboratory Report Serial No. AEL-909 - Calibration of Pratt and Whitney R-2800-18 Engine.

(d) Carburetion and Critical Altitude Checks - Naval Air Experimental Station Restricted Letter XE-1-WVT:jmc F21-1(2)(2800) of 22 July 1948 - Including Preliminary Report No. 1 on Project TED No. NAM-PP-215.

(e) Altitude Checks of Power Control & Bleed-off Valve - Naval Air Experimental Station Restricted Letter XE-1-WVT:frs F21-1(2)(2800) of 17 November 1948 - Including Preliminary Report No. 2 on Project TED No. NAM-PP-215.

(f) Mixture Control Checks & Sea Level Calibration - Naval Air Experimental Station Restricted Letter XE-1-WVT:mr F21-1(2)(2800) of 20 December 1948 - Including Preliminary Report No. 3 on Project TED No. NAM-PP-215.

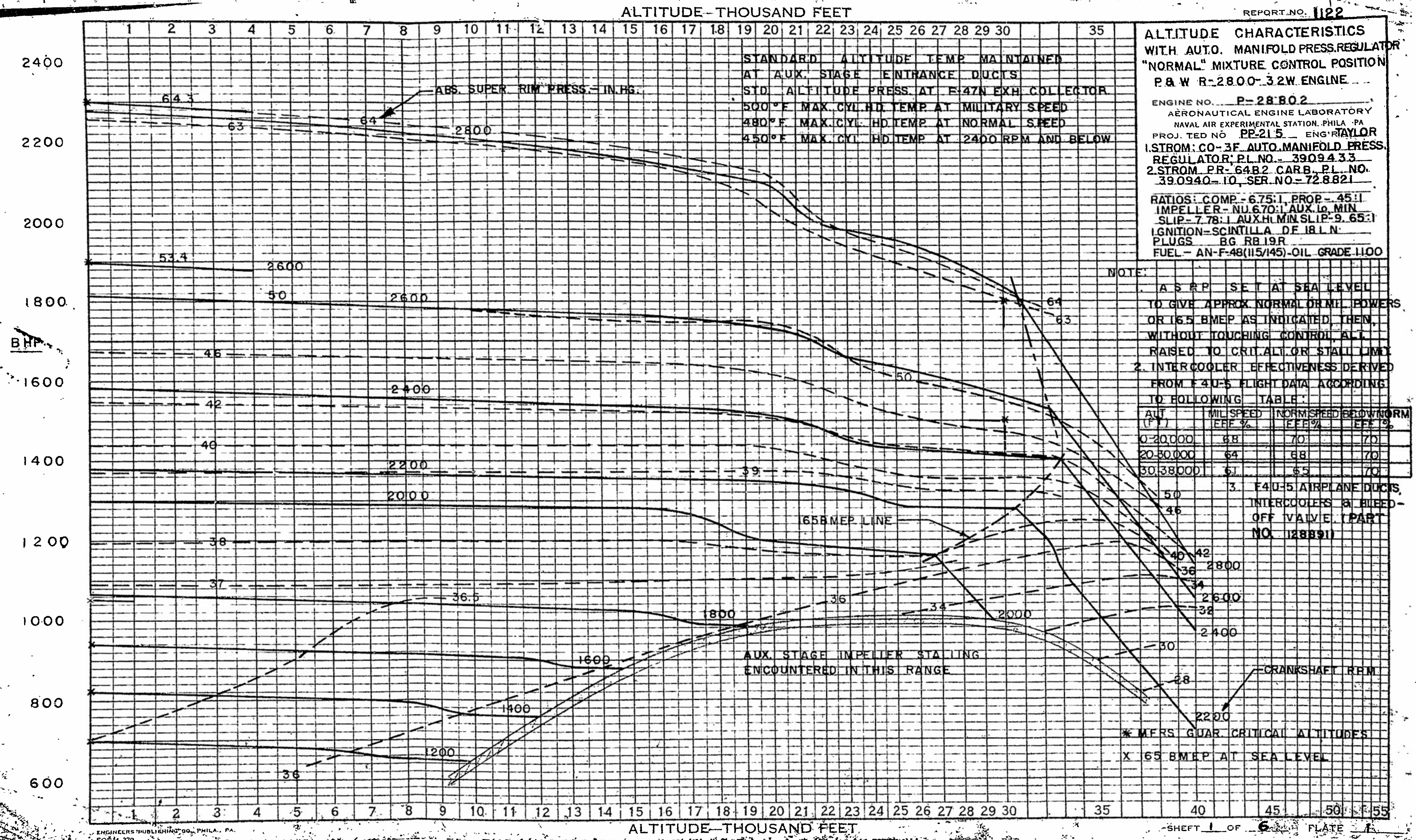
(g) Altitude Calibration - Naval Air Experimental Station Restricted Letter XE-1-WVT:jmc F21-1(2)(2800) of 24 March 1949 - Including Preliminary Report No. 4 on Project TED No. NAM-PP-215.

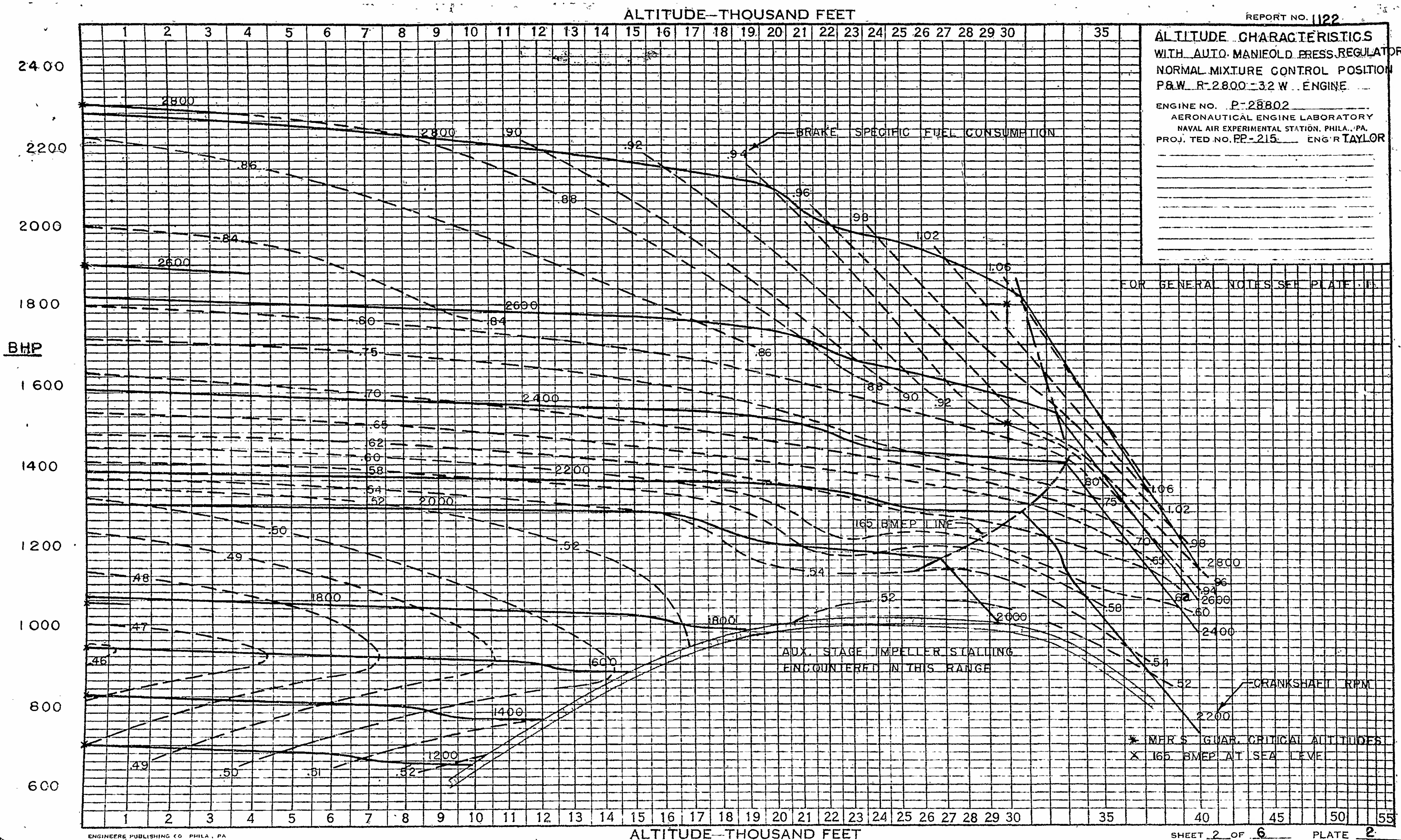
(h) Stalling Characteristics - Naval Air Experimental Station Restricted Letter XE-1-WVT:hmd F21-1(2)(2800) of 25 January 1949.

(i) Stalling Characteristics - Naval Air Experimental Station Restricted Letter XE-1-WVT:JAT:mr F21-1(2)(2800)(5) of 28 June 1949.

(j) Stalling & Combat Power Checks - Naval Air Experimental Station Restricted Letter XE-1-WVT:fsf F21-1(2)(2800)(254) of 14 November 1949.

LEGIBILITY POOR





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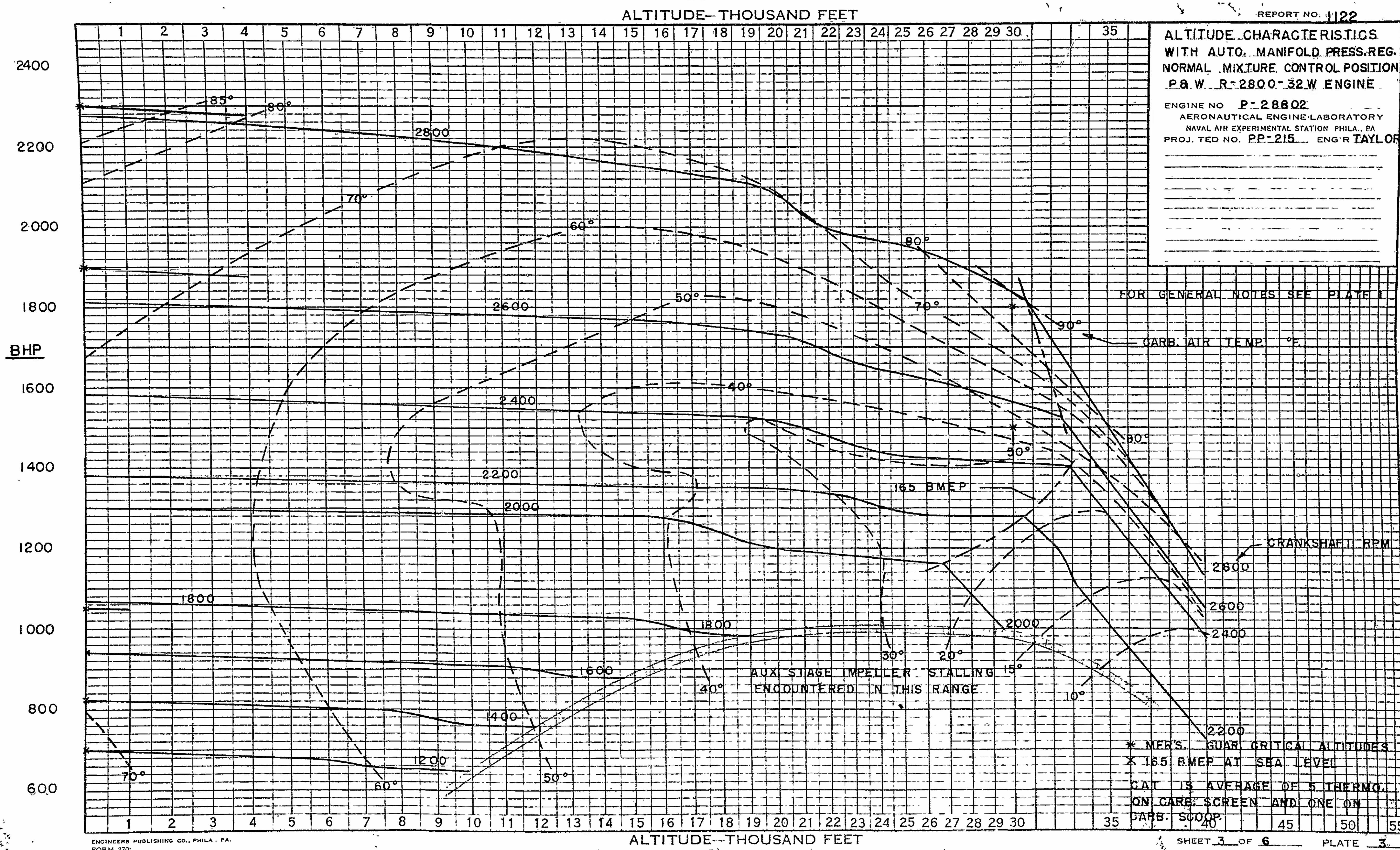
FORM 270

SHEET 2 OF 6 PLATE 2


REPORT NO. 1122
ALTITUDE CHARACTERISTICS
WITH AUTO. MANIFOLD PRESS. REG.
NORMAL MIXTURE CONTROL POSITION
P & W R-2800-32W ENGINE
ENGINE NO P-28802
AERONAUTICAL ENGINE LABORATORY
NAVAL AIR EXPERIMENTAL STATION PHILA., PA
PROJ. TED NO. PP-215 ENG'R TAYLOR
ALTITUDE—THOUSAND FEET
BHP
FOR GENERAL NOTES SEE PLATE 1
CARB. AIR TEMP. °F.
CRANKSHAFT RPM
165 BMEP
AUX. STAGE IMPELLER STALLING ENCOUNTERED IN THIS RANGE
* MFR'S. GUAR. CRITICAL ALTITUDES
X 165 BMEP AT SEA LEVEL
CAT IS AVERAGE OF 5 THERMO. ON CARB. SCREEN AND ONE ON CARB. SCOOP.
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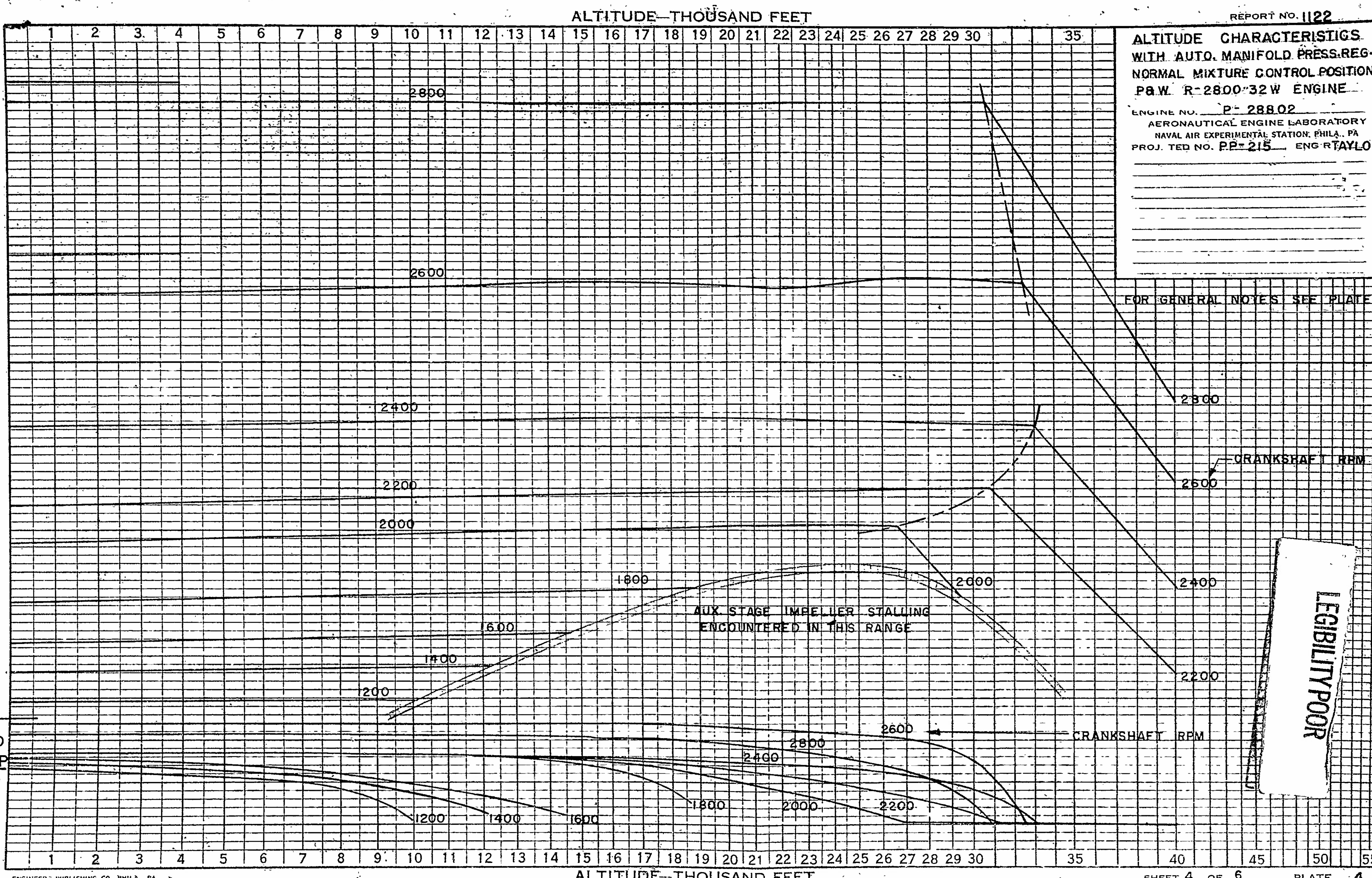
FORM 270
SHEET 3 OF 6
PLATE 3



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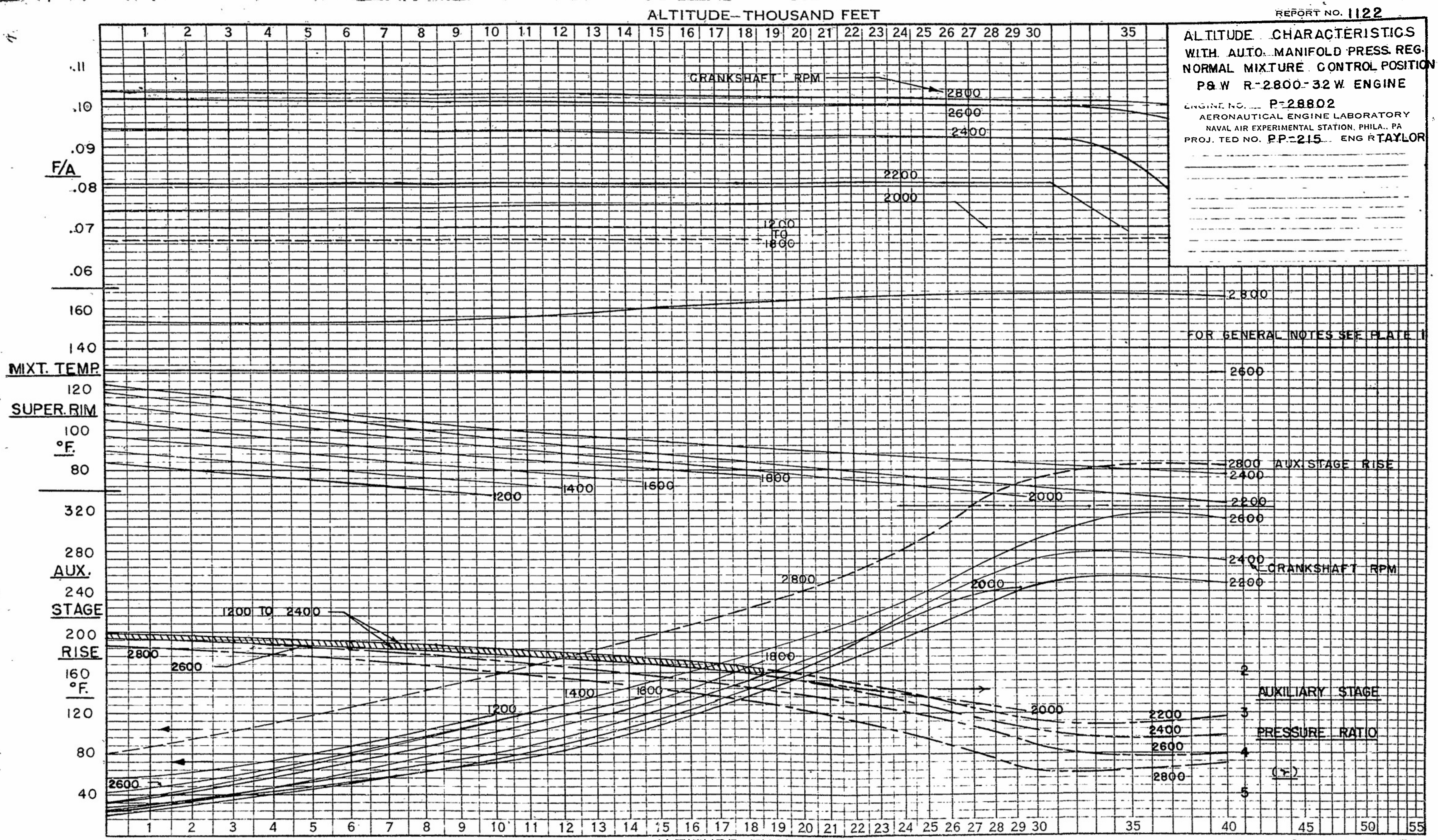
FORM 270



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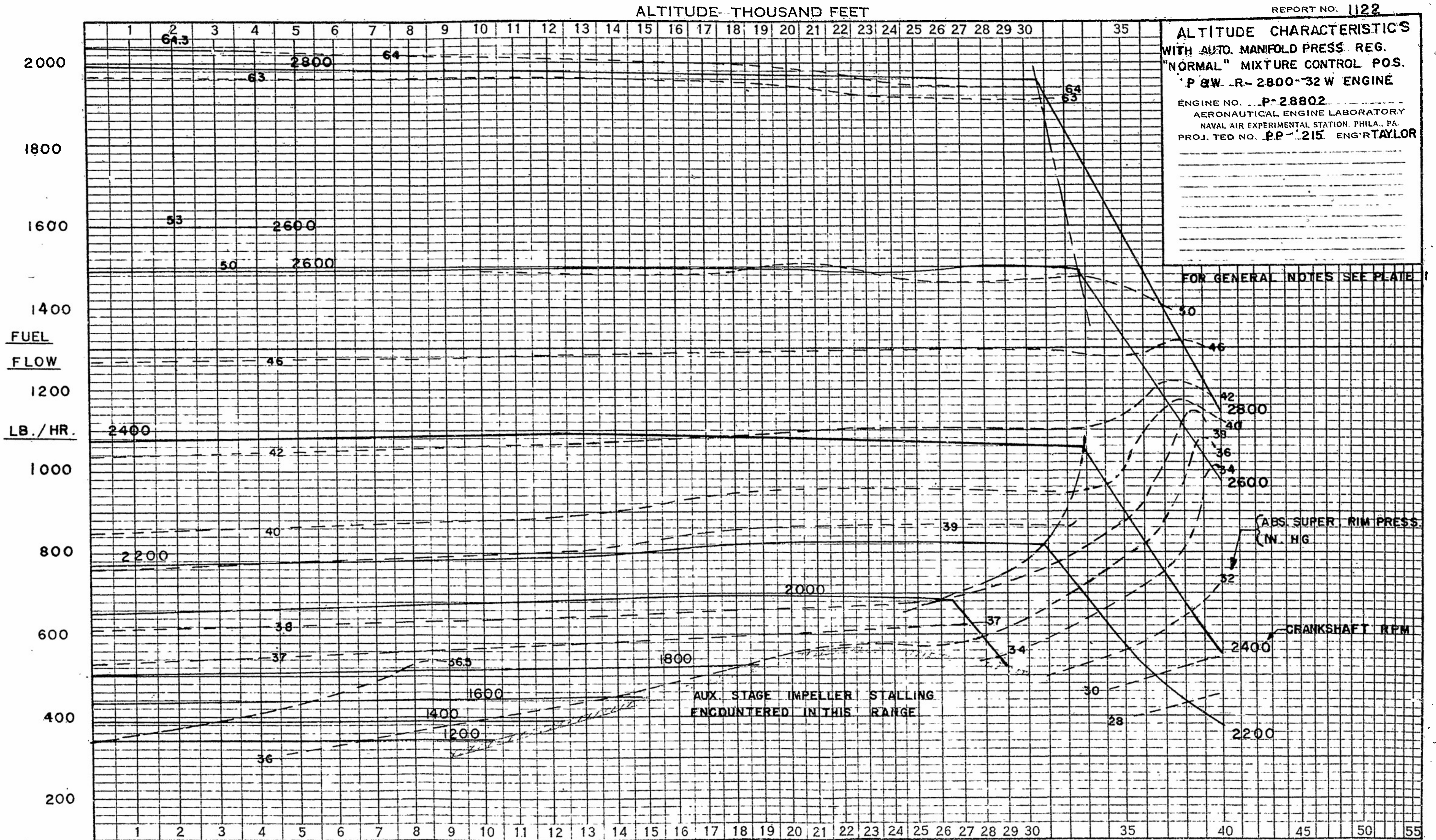
FORM 270

SHEET 5 OF 6 PLATE 5



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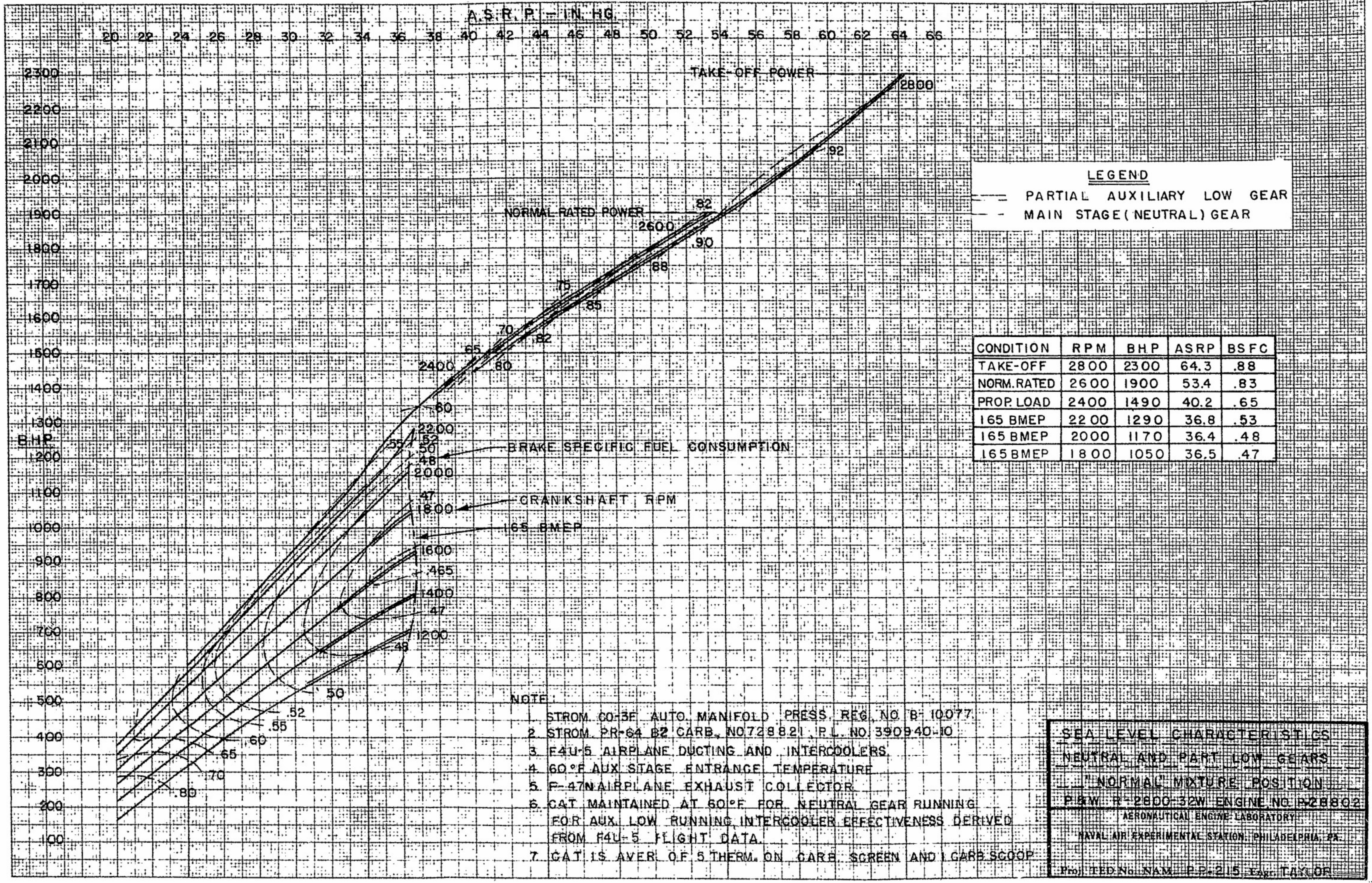
SHEET 6 OF 6 PLATE 5



CONDITION	RPM	BHP	ASRP	BSFC
TAKE-OFF	2800	2300	64.3	.88
NORM. RATED	2600	1900	53.4	.83
PROP. LOAD	2400	1490	40.2	.65
165 BMEP	2200	1290	36.8	.53
165 BMEP	2000	1170	36.4	.48
165 BMEP	1800	1050	36.5	.47

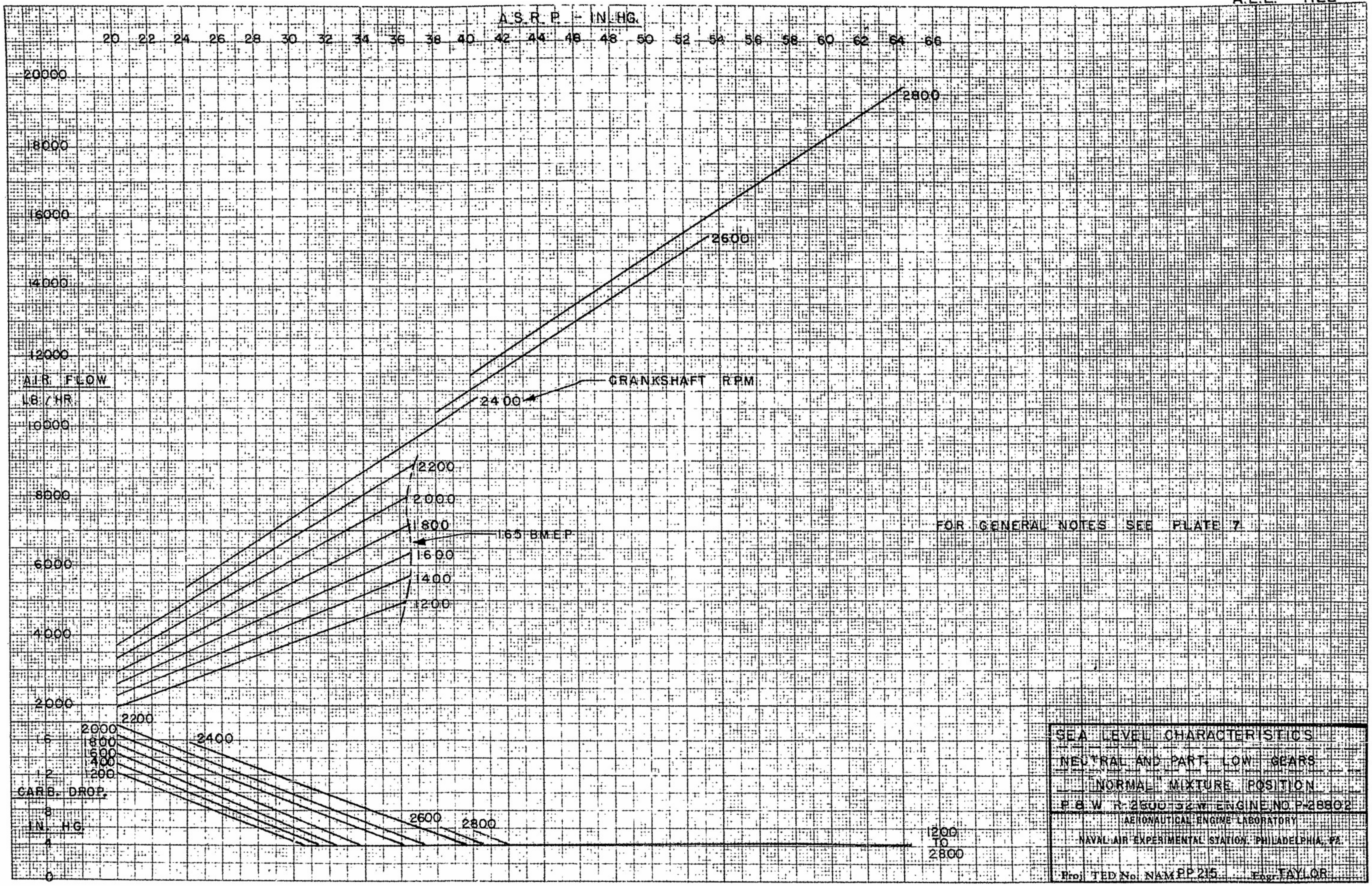
NOTE:

1. STROM. CD-3F AUTO. MANIFOLD PRESS. REG. NO B-10077
2. STROM. PR-64 B2 CARB. NO 728821, P.L. NO. 390940-10
3. F4U-5 AIRPLANE DUCTING AND INTERCOOLERS
4. 60°F AUX STAGE ENTRANCE TEMPERATURE
5. P-47N AIRPLANE EXHAUST COLLECTOR
6. CAT MAINTAINED AT 60°F FOR NEUTRAL GEAR RUNNING FOR AUX. LOW RUNNING INTERCOOLER EFFECTIVENESS DERIVED FROM F4U-5 FLIGHT DATA.
7. CAT IS AVER. OF 5 THERM. ON CARB. SCREEN AND 1 CARB SCOOP

SEA LEVEL CHARACTERISTICS
NEUTRAL AND PART LOW GEARS
"NORMAL" MIXTURE POSITION
P&W R-2800-32W ENGINE NO. P-28802

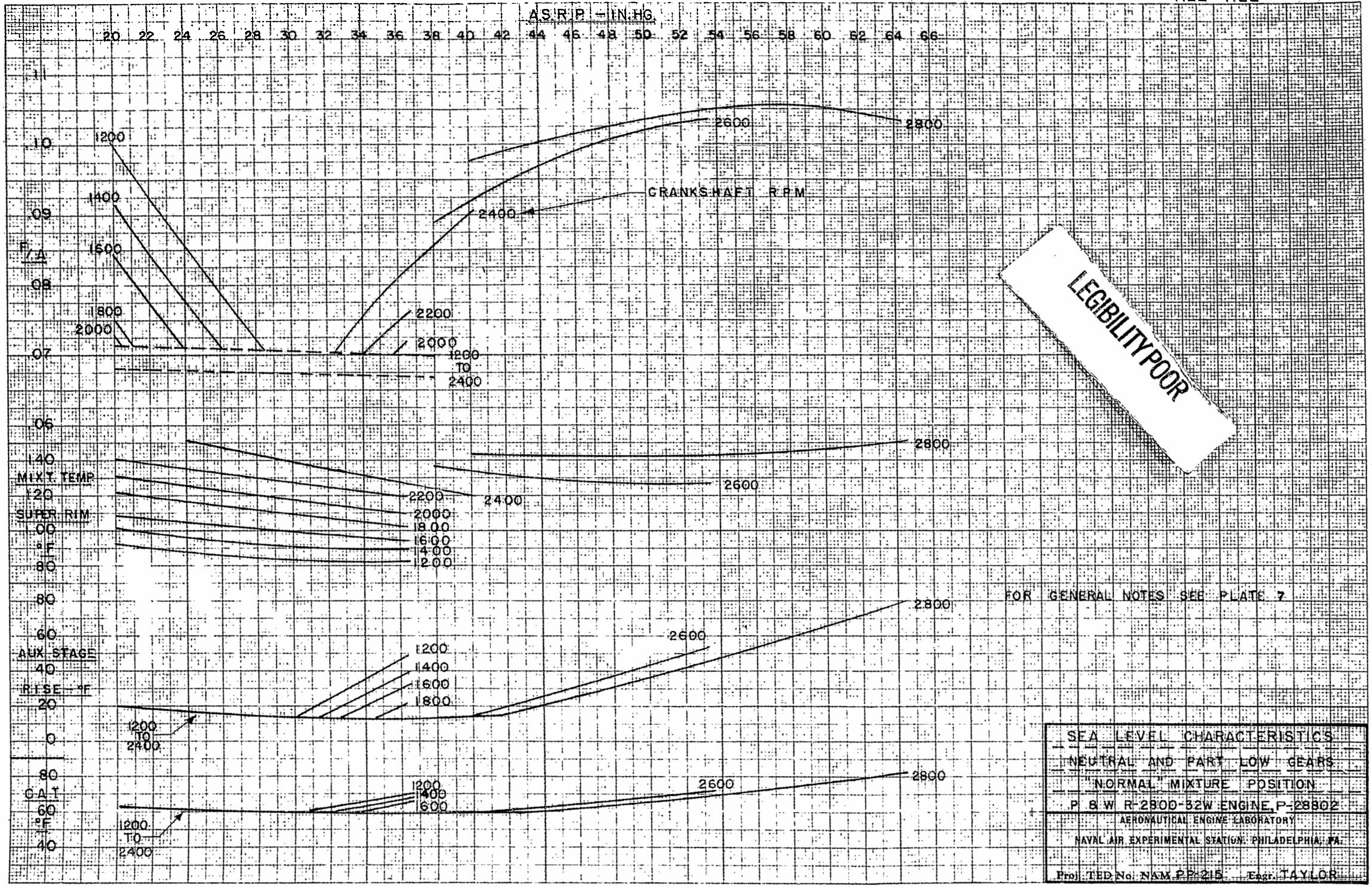
AERONAUTICAL ENGINE LABORATORY
NAVAL AIR EXPERIMENTAL STATION, PHILADELPHIA, PA.

Proj. TED No. NAM PP-215 Engr. TAYLOR



FOR GENERAL NOTES SEE PLATE 7

SEA LEVEL CHARACTERISTICS
NEUTRAL AND PART. LOW GEARS
NORMAL MIXTURE POSITION
P & W R-2800-32W ENGINE NO. P-28802
AERONAUTICAL ENGINE LABORATORY
NAVAL AIR EXPERIMENTAL STATION, PHILADELPHIA, PA.
Proj. TED No. NAM PP 215 Engr. TAYLOR



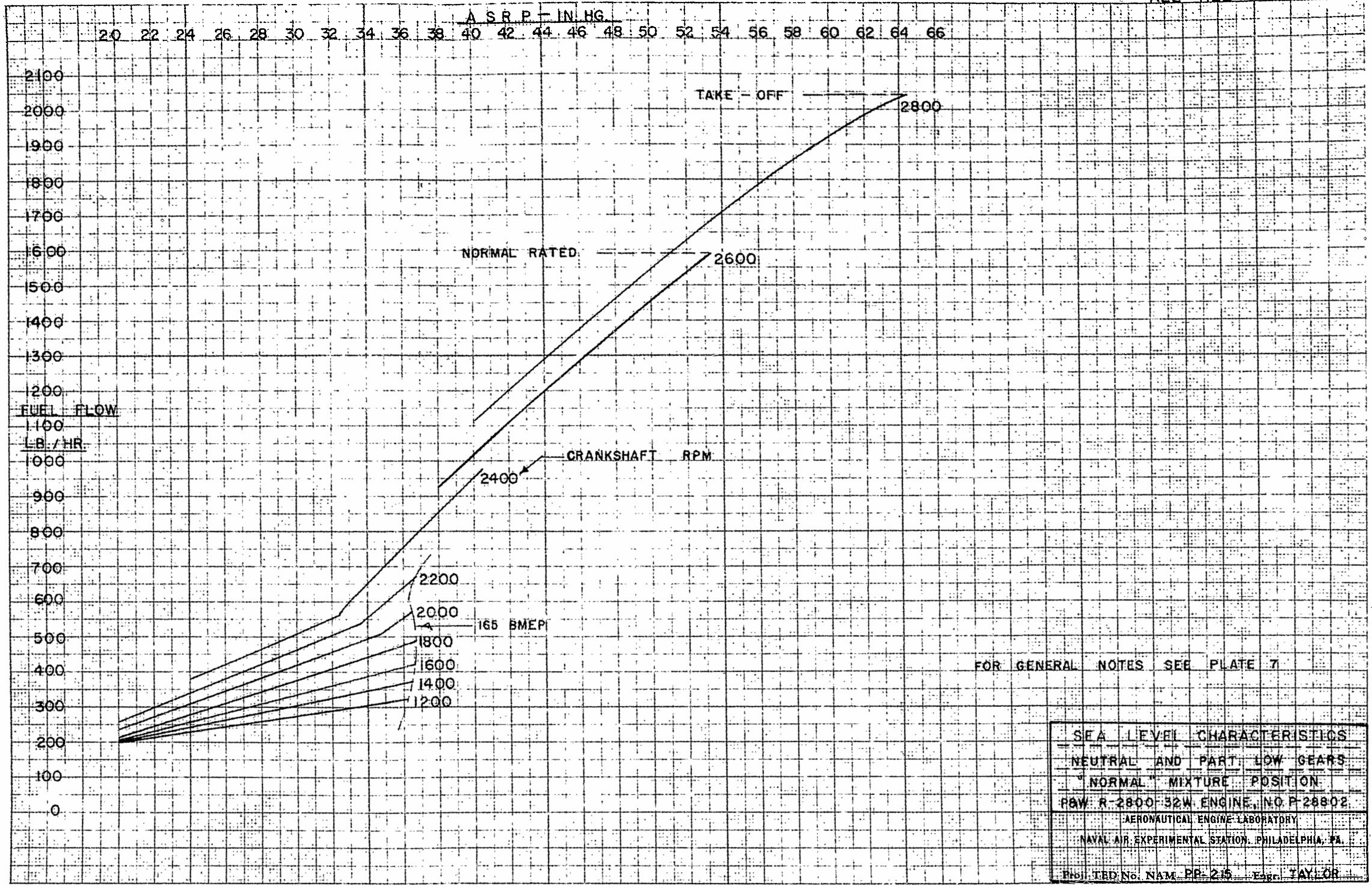
FOR GENERAL NOTES SEE PLATE 7

SEA LEVEL CHARACTERISTICS
NEUTRAL AND PART LOW GEARS
"NORMAL" MIXTURE POSITION
P & W R-2800-52W ENGINE, P-28802

AERONAUTICAL ENGINE LABORATORY
NAVAL AIR EXPERIMENTAL STATION, PHILADELPHIA, PA.

Proj. TED No. NAM PP-215   Engr. TAYLOR

AEL 1122

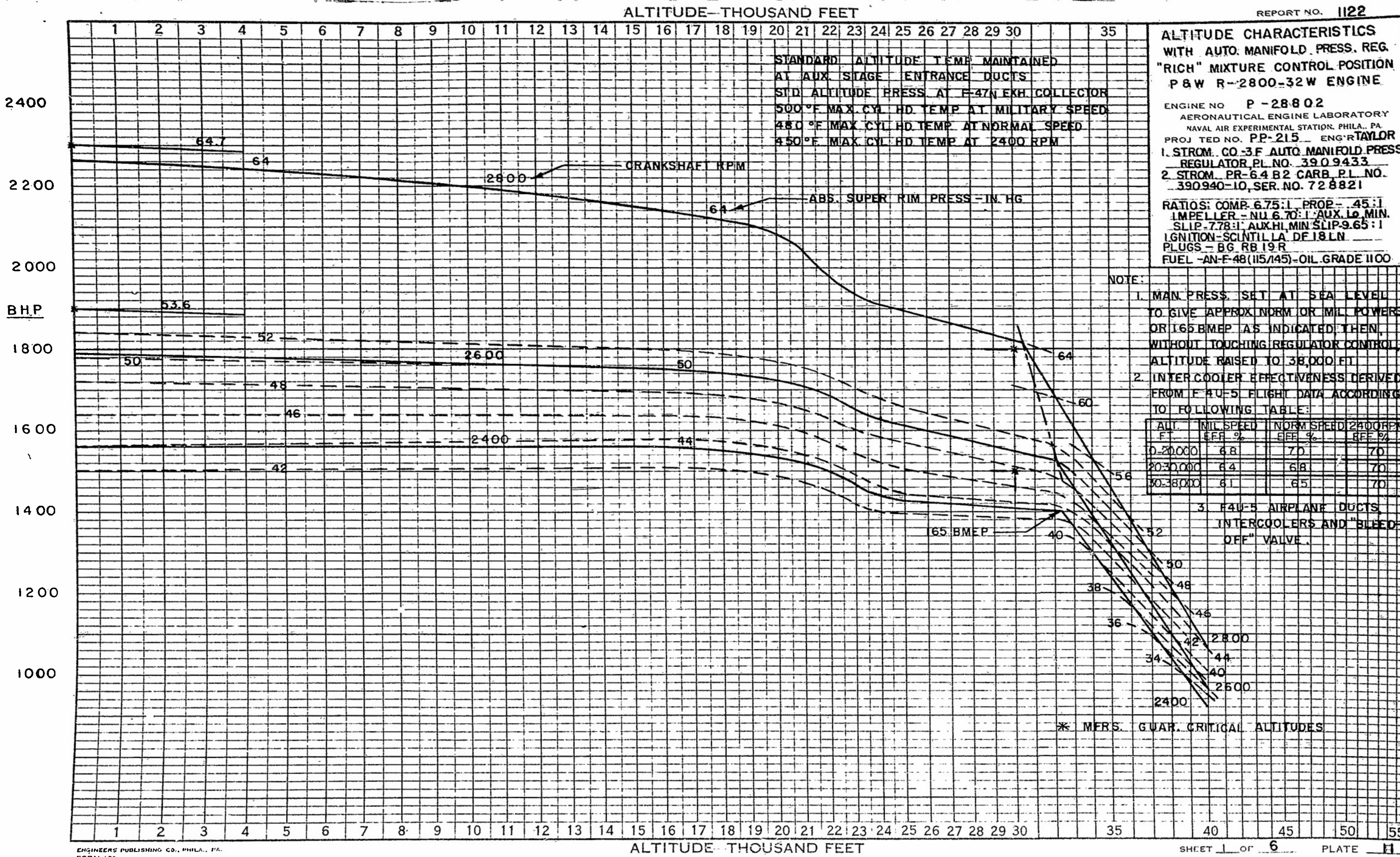


SEA LEVEL CHARACTERISTICS
NEUTRAL AND PART LOW GEARS
"NORMAL" MIXTURE POSITION
P&W R-2800-32W ENGINE, NO P-28802

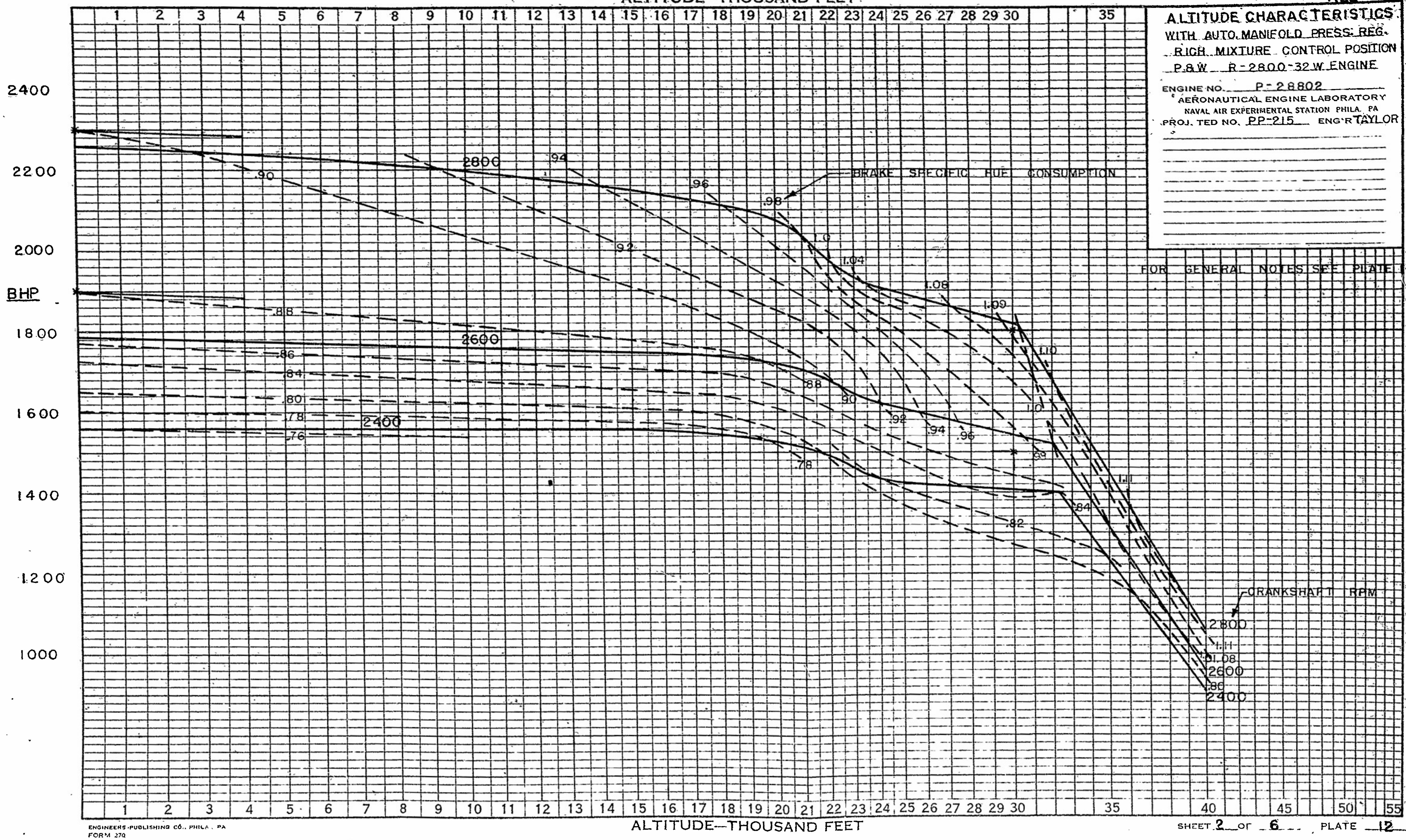
AERONAUTICAL ENGINE LABORATORY
NAVAL AIR EXPERIMENTAL STATION, PHILADELPHIA, PA.

Proj. TED No. NAM PP-215 Engr. TAYLOR

REPORT NO. 1122



REPORT NO. 1122



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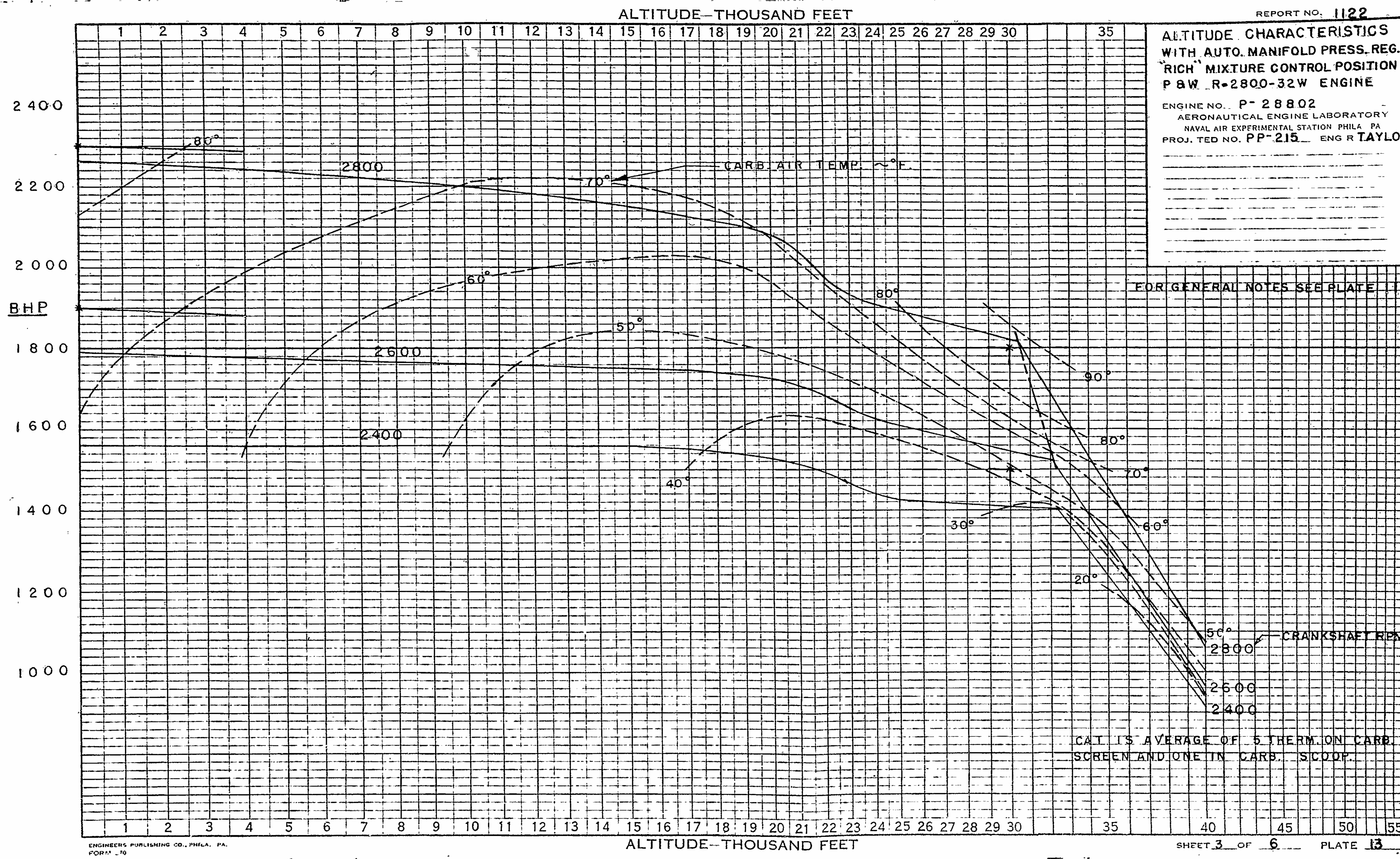
SHEET 2 OF 6 PLATE 12



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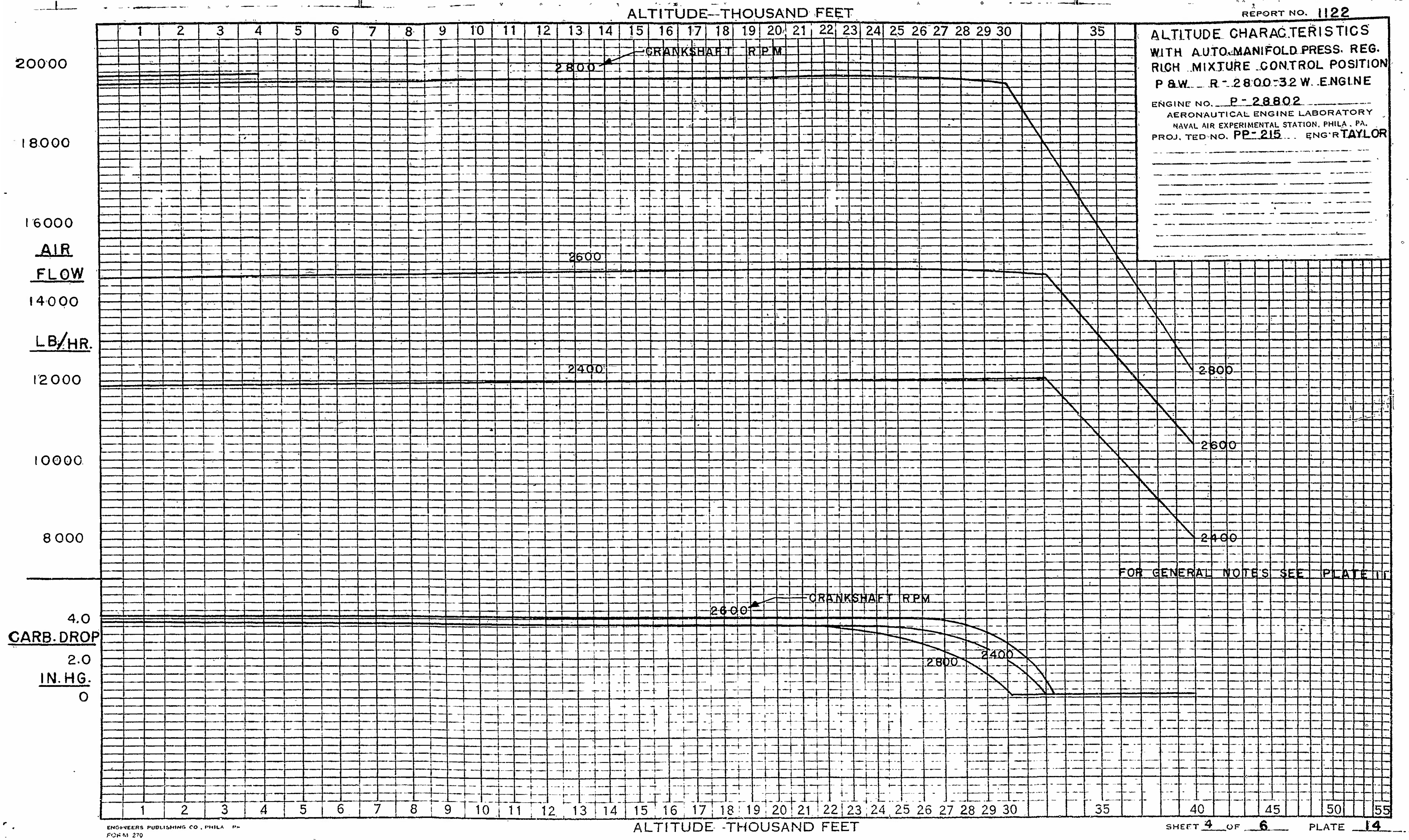
FORM 70


REPORT NO. 1122
ALTITUDE CHARACTERISTICS
WITH AUTO-MANIFOLD PRESS. REG.
RICH MIXTURE CONTROL POSITION
P & W R-2800-32 W. ENGINE
ENGINE NO. P-28802
AERONAUTICAL ENGINE LABORATORY
NAVAL AIR EXPERIMENTAL STATION, PHILA., PA.
PROJ. TED NO. PP-215 ENG'R TAYLOR
ALTITUDE-THOUSAND FEET
CRANKSHAFT RPM
2800
2600
2400
AIR FLOW LB/HR.
20000
18000
16000
14000
12000
10000
8000
FOR GENERAL NOTES SEE PLATE 11
CARB. DROP IN. HG.
4.0
2.0
0
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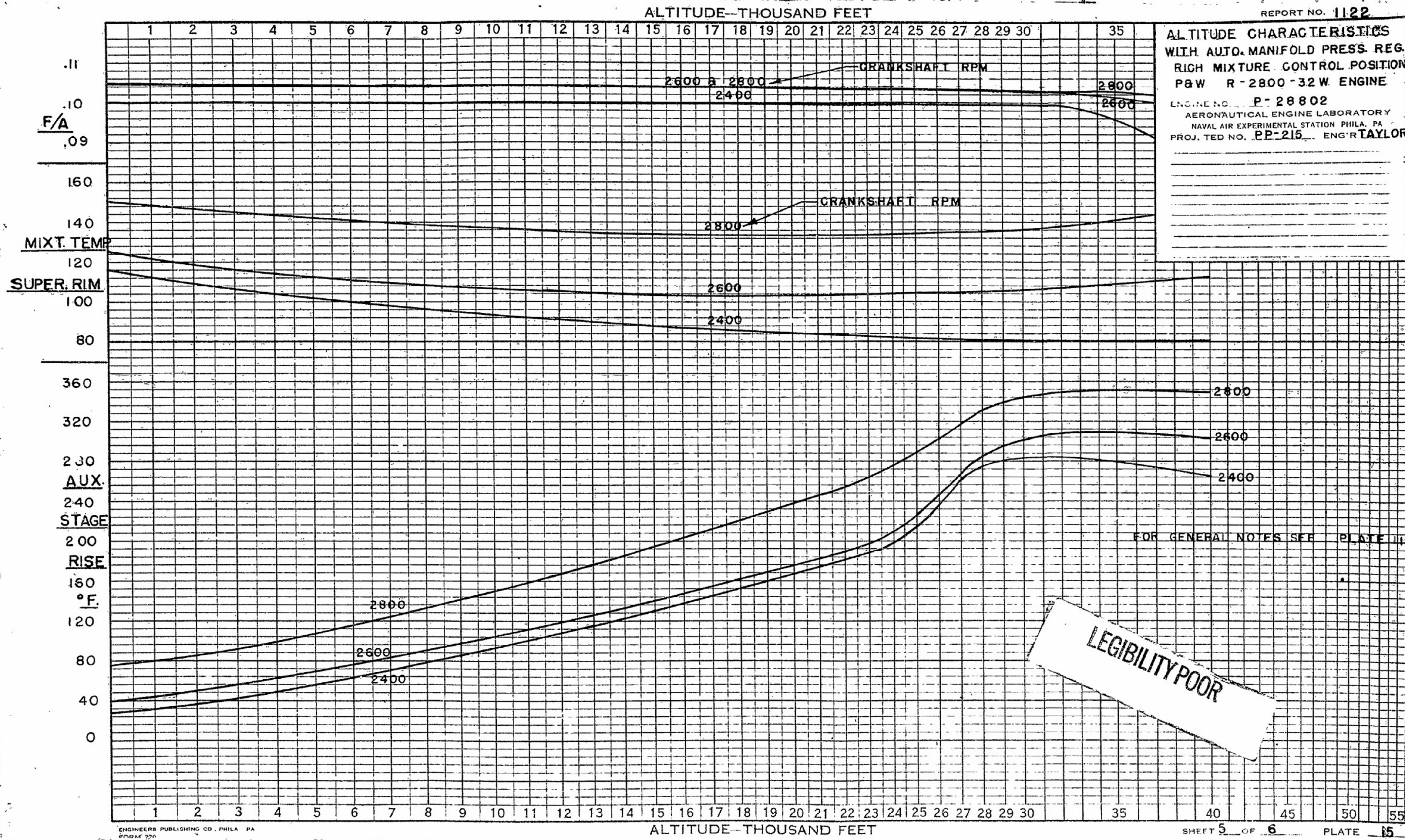
FORM 270
SHEET 4 OF 6
PLATE 14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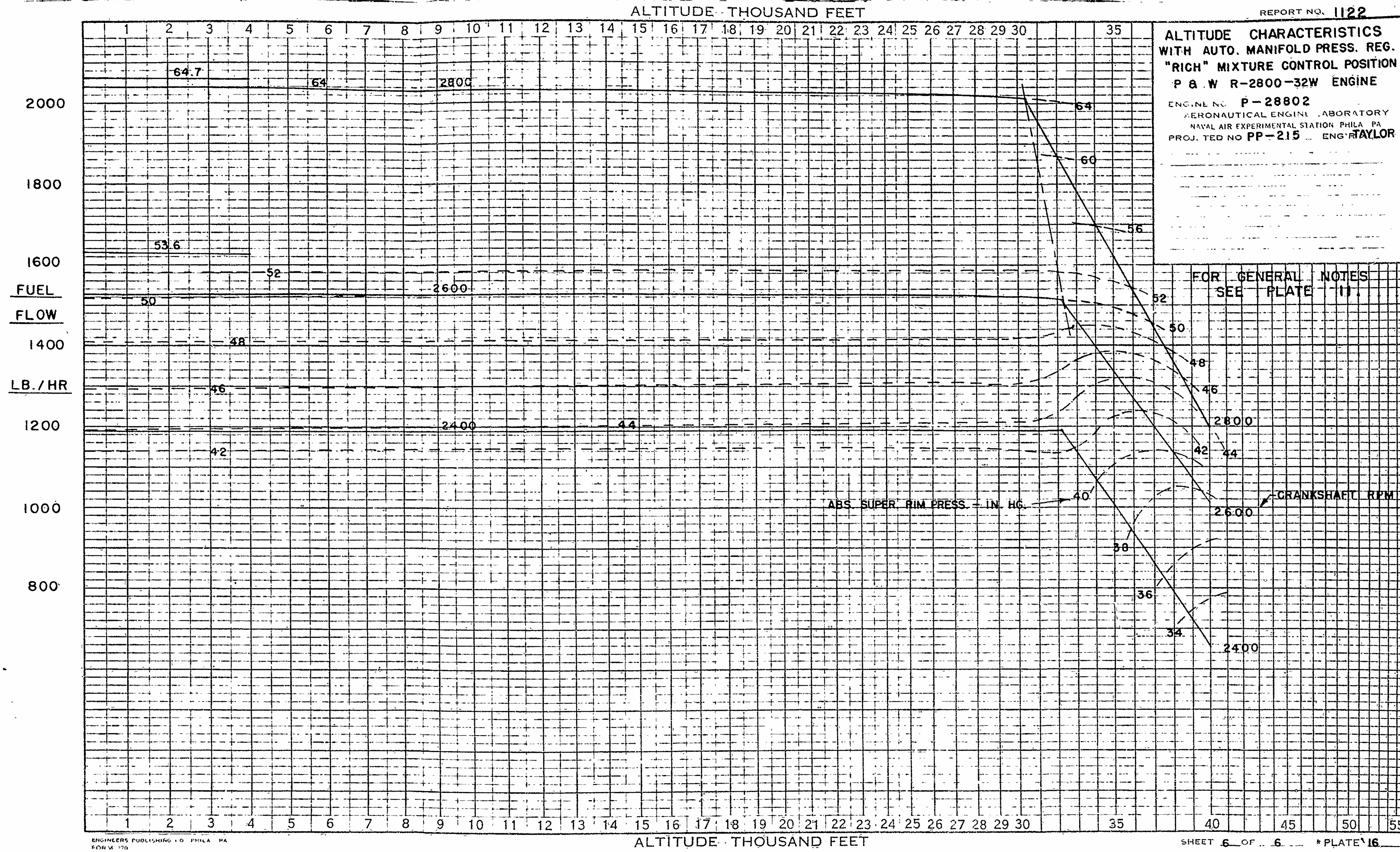
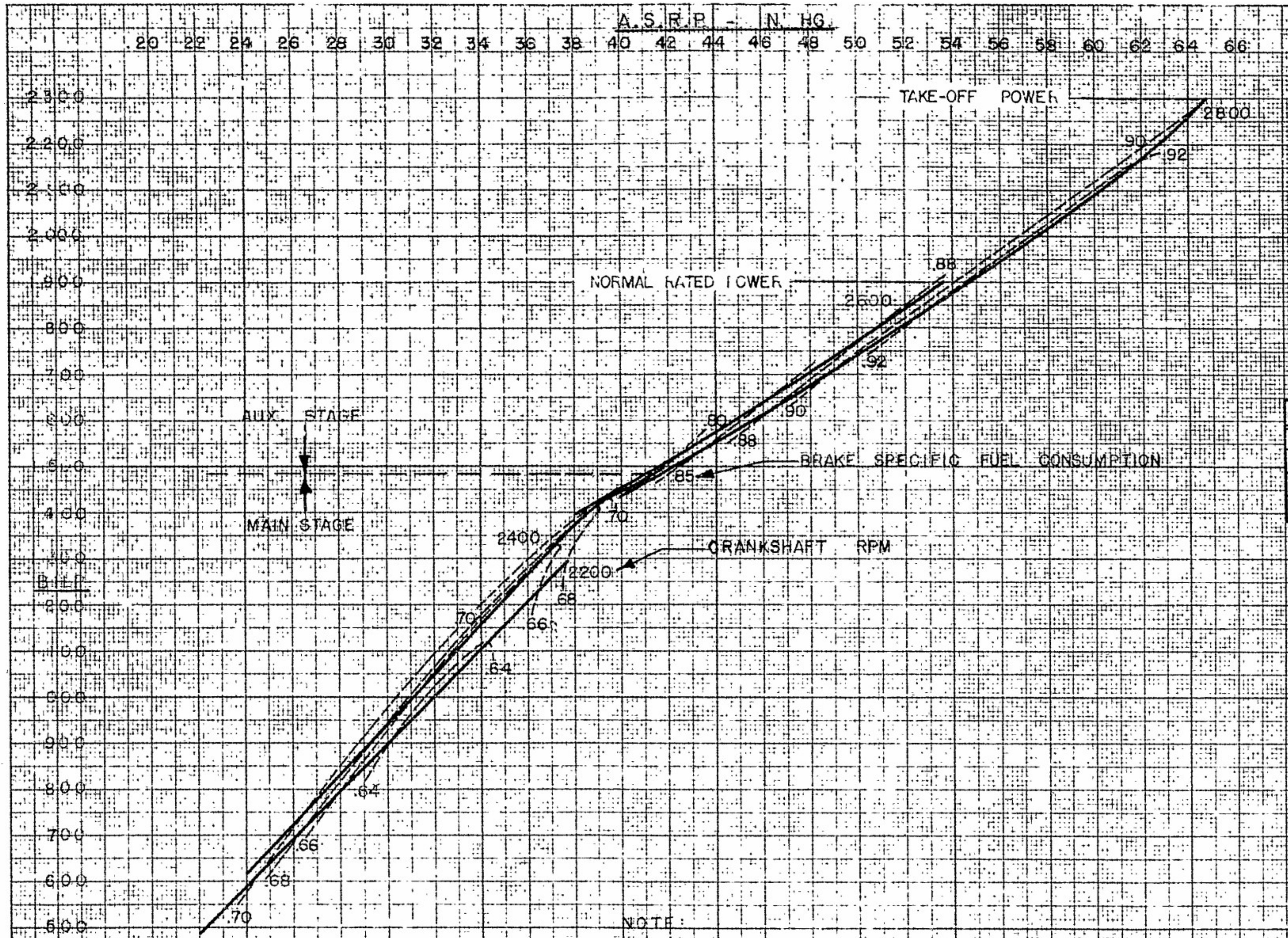
ALTITUDE CHARACTERISTICS
WITH AUTO. MANIFOLD PRESS. REG.
RICH MIXTURE CONTROL POSITION
P&W R-2800-32W ENGINE
ENGINE NO. P-28802
AERONAUTICAL ENGINE LABORATORY
NAVAL AIR EXPERIMENTAL STATION PHILA. PA
PROJ. TED NO. PP-215 ENG'R TAYLOR
ALTITUDE—THOUSAND FEET
F/A
.11
.10
.09
CRANKSHAFT RPM
2600 & 2800
2400
2800
2600
MIXT. TEMP
SUPER. RIM
160
140
120
100
80
2800
2600
2400
AUX. STAGE RISE °F.
360
320
280
240
200
160
120
80
40
0
FOR GENERAL NOTES SEE PLATE 1
LEGIBILITY POOR
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 35 40 45 50 55
ENGINEERS PUBLISHING CO., PHILA. PA
SHEET 5 OF 6
PLATE 15

REPORT NO. 1122





CONDITION	RPM	BHP	A.S.R.P.	BSFC
TAKE-OFF	2800	2300	64.7	.90
NORM RATED	2600	1900	53.6	.88
PROP LOAD	2400	1490	41.6	.75
.65 BMEP	2200	1290	37.6	.68

NOTE:

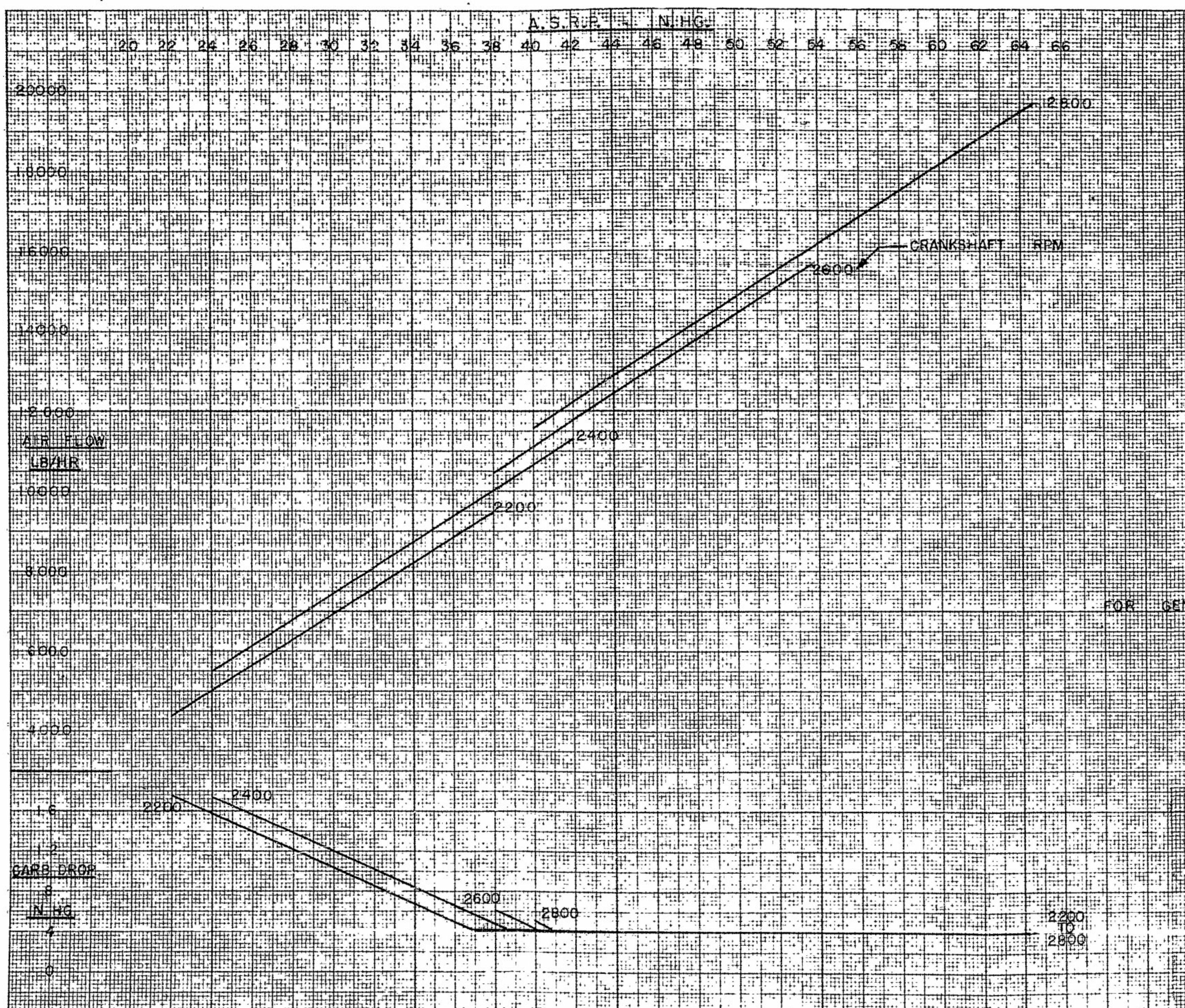
1. STROM. CO-3F AUTO MANIFOLD PRESS. REG., NO. B-10077
2. STROM. PR-64B2 CARB. NO. 728821, P.L. NO. 390940-10
3. F4U-5 AIRPLANE DUCTING AND INTERCOOLERS.
4. 60°F AUX. STAGE ENTRANCE TEMPERATURE.
5. F-47N AIRPLANE EXHAUST COLLECTOR.
6. C.A.T. MAINTAINED AT 60°F FOR NEUTRAL GEAR RUNNING; FOR AUX. LOW RUNNING, INTERCOOLER EFFECTIVENESS DERIVED FROM F4U-5 FLIGHT DATA.
7. C.A.T. IS AVER. OF 5 THERM. ON CARB. SCREEN AND 1 IN CARB. SCOOP.

SEA LEVEL CHARACTERISTICS
NEUTRAL AND PART LOW GEARS
"RICH" MIXTURE POSITION
P&W R-2800-32W ENGINE, NO. P-28802

AERONAUTICAL ENGINE LABORATORY
NAVAL AIR EXPERIMENTAL STATION, PHILADELPHIA, PA.

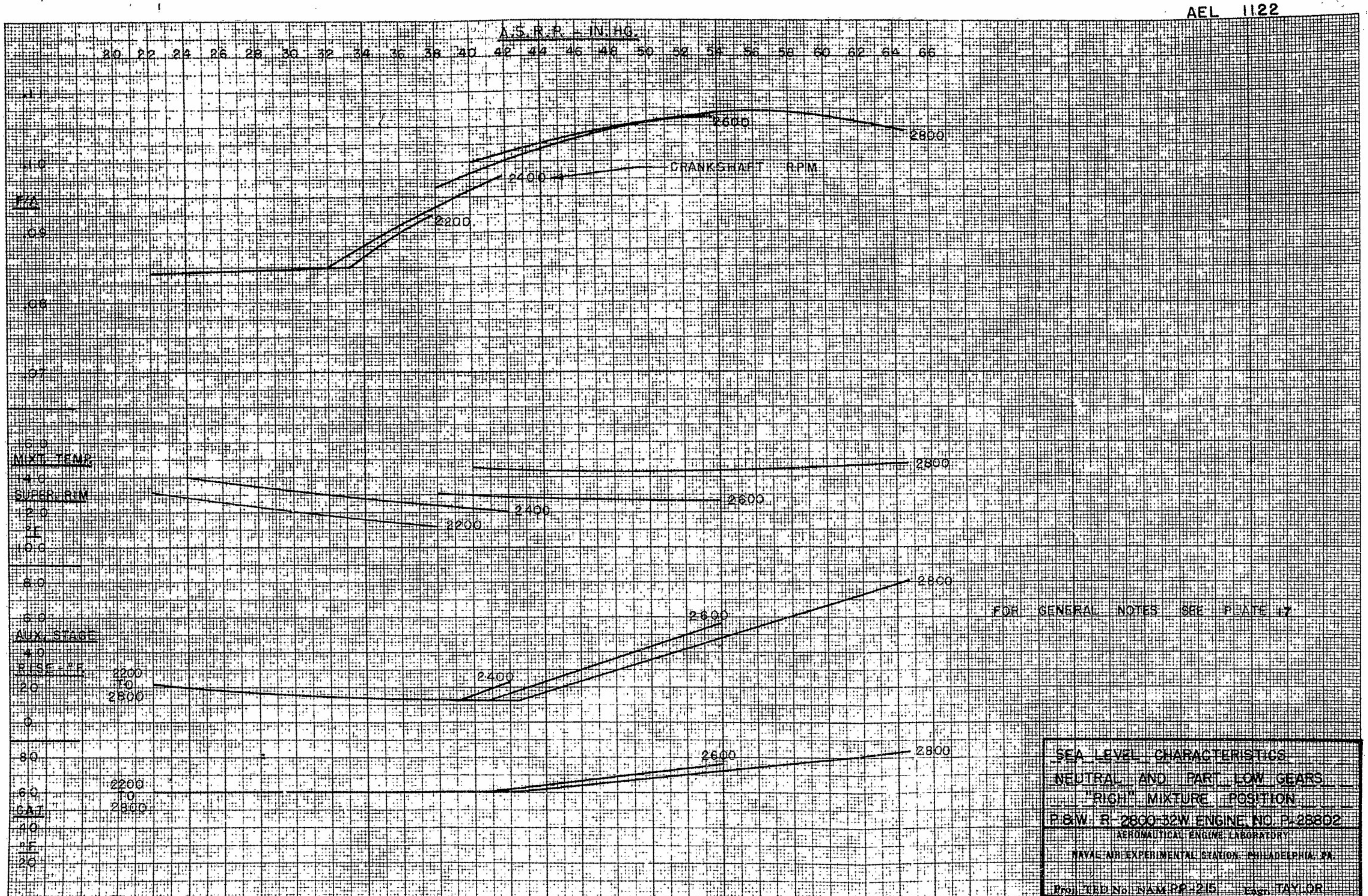
Proj. TED No. NAM PP-215 Engr. TAYLOR

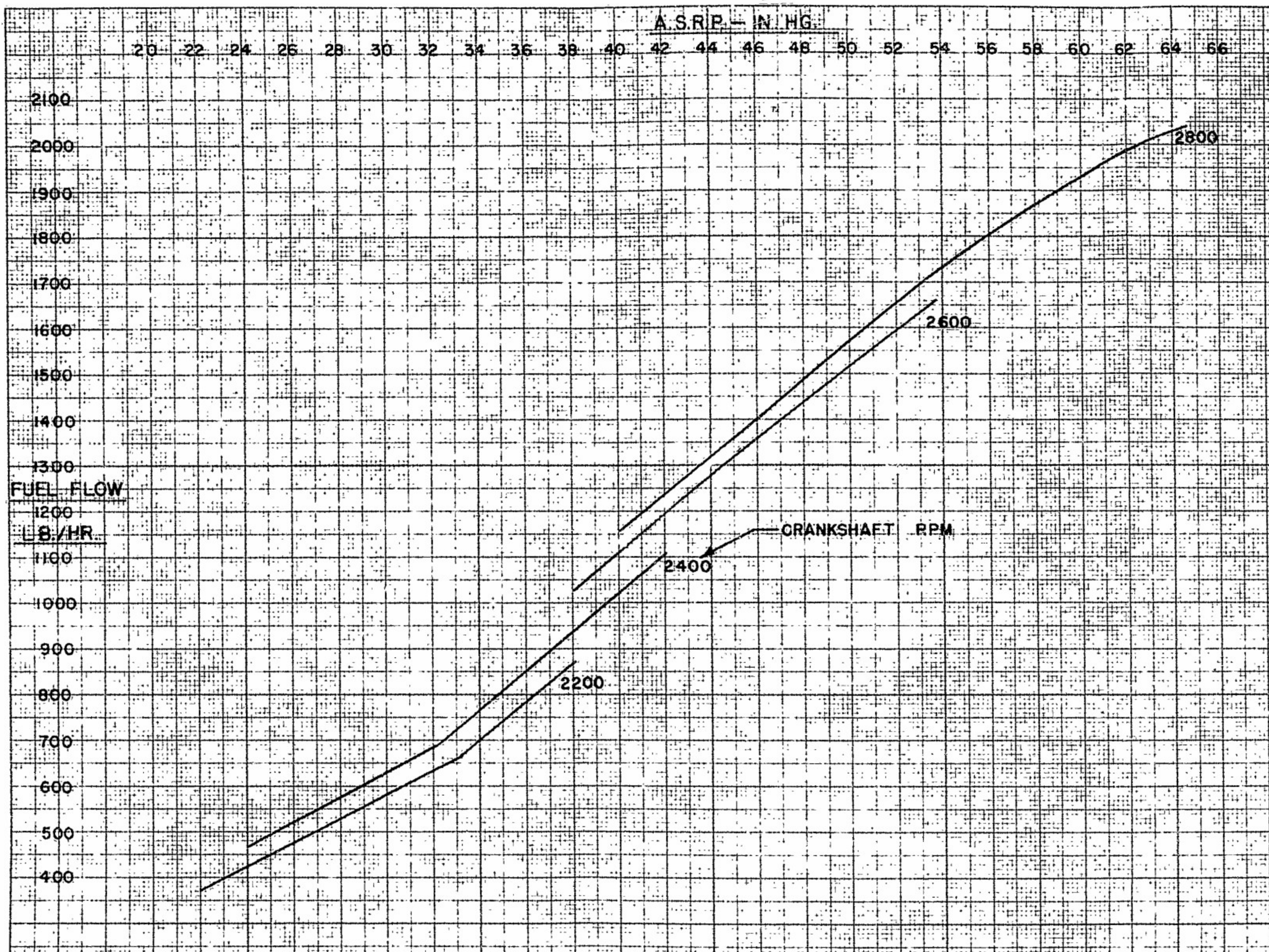
AEL 1122



SEA LEVEL CHARACTERISTICS
NEUTRAL AND PART LOW GEARS
"RICH" MIXTURE POSITION
P & W R-2800-32W ENGINE NO. P-28802
AERONAUTICAL ENGINE LABORATORY
NAVAL AIR EXPERIMENTAL STATION, PHILADELPHIA, PA.
Proj. TED No. NAM PP-215 Engr. TAYLOR

SHEET 2 OF 4 PLATE 18


A.S.R.P. – IN. HG.
20 22 24 26 28 30 32 34 36 38 40 42 44 46 48 50 52 54 56 58 60 62 64 66
F/A
.1
.10
.09
.08
.07
2600
2800
2400
CRANKSHAFT RPM
2200
MIXT. TEMP.
SUPER. RIM
°F
16.0
14.0
12.0
10.0
8.0
6.0
4.0
2.0
0
AUX. STAGE
RISE – °F
2200 TO 2800
2400
CAT
80
60
40
20
FOR GENERAL NOTES SEE PLATE 17
SEA LEVEL CHARACTERISTICS
NEUTRAL AND PART LOW GEARS
"RICH" MIXTURE POSITION
P.&W. R-2800-32W ENGINE, NO. P-28802
AERONAUTICAL ENGINE LABORATORY
NAVAL AIR EXPERIMENTAL STATION, PHILADELPHIA, PA.
Proj. TED No. NAM PP-215 Engr. TAYLOR



FOR GENERAL NOTES SEE PLATE 17

SEA LEVEL CHARACTERISTICS
NEUTRAL AND PART LOW GEARS
"RICH" MIXTURE POSTION
P & W R-2800-32W ENGINE NO. P-29802
AERONAUTICAL ENGINE LABORATORY
NAVAL AIR EXPERIMENTAL STATION, PHILADELPHIA, PA.
Proj. TED No. NAM PP-215 Engr. TAYLOR

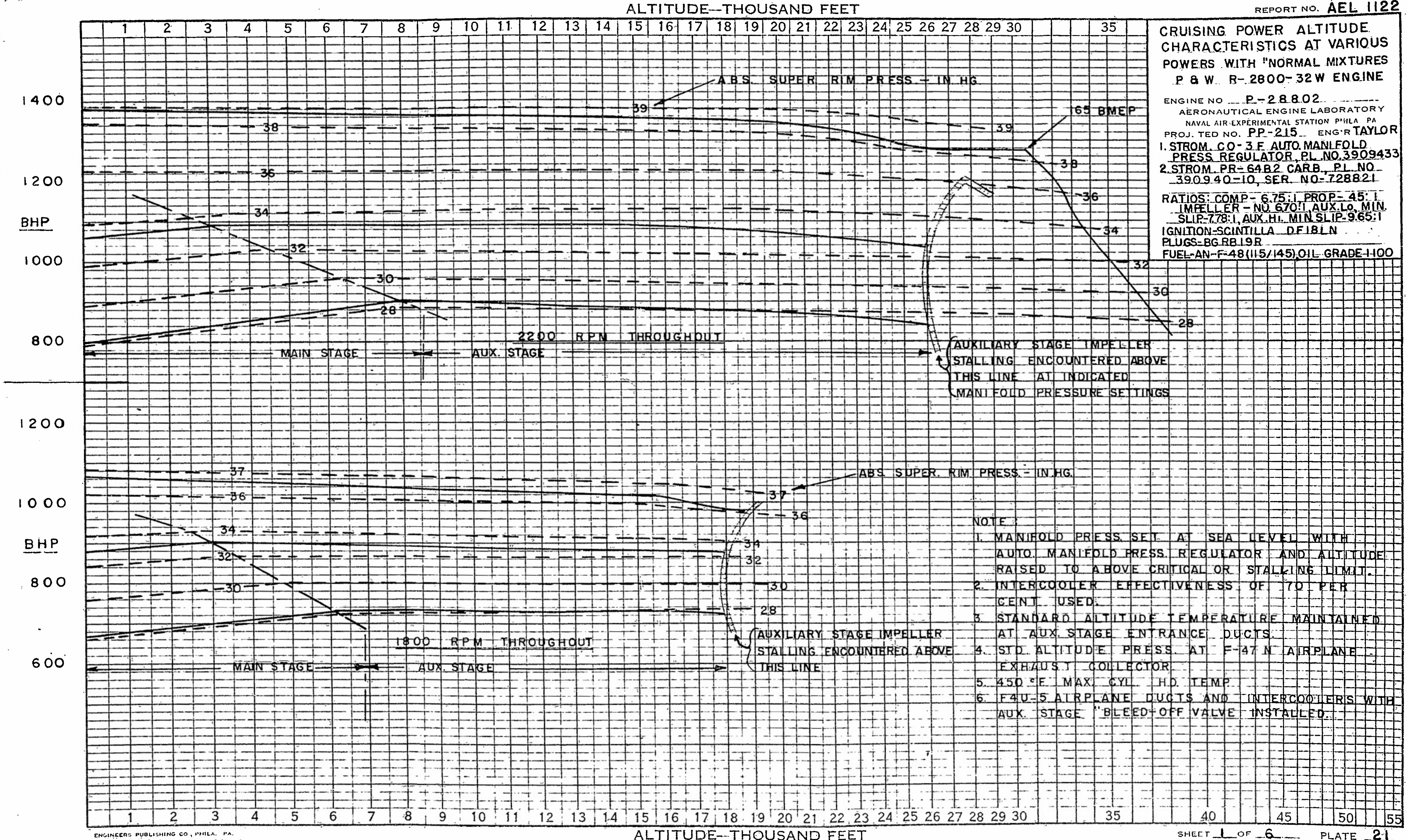
REPORT NO. AEL 1122

CRUISING POWER ALTITUDE CHARACTERISTICS AT VARIOUS POWERS WITH "NORMAL MIXTURES
P & W R-2800-32W ENGINE

ENGINE NO P-28802
AERONAUTICAL ENGINE LABORATORY
NAVAL AIR EXPERIMENTAL STATION PHILA PA
PROJ. TED NO. PP-215 ENG'R TAYLOR

1. STROM. CO-3 F AUTO. MANIFOLD PRESS REGULATOR, PL. NO. 3909433
2. STROM. PR-64B2 CARB, PL. NO 390940-10, SER. NO-728821

RATIOS: COMP- 6.75:1, PROP- 45:1 IMPELLER - NO. 6.70:1, AUX. Lo. MIN. SLIP-7.78:1, AUX. HI. MIN SLIP-9.65:1
IGNITION-SCINTILLA DF18LN
PLUGS-BG RB19R
FUEL-AN-F-48 (115/145), OIL-GRADE-1100



NOTE:
1. MANIFOLD PRESS. SET AT SEA LEVEL WITH AUTO. MANIFOLD PRESS. REGULATOR AND ALTITUDE RAISED TO ABOVE CRITICAL OR STALLING LIMIT.
2. INTERCOOLER EFFECTIVENESS OF 70 PER CENT USED.
3. STANDARD ALTITUDE TEMPERATURE MAINTAINED AT AUX. STAGE ENTRANCE DUCTS.
4. STD. ALTITUDE PRESS. AT F-47 N AIRPLANE EXHAUST COLLECTOR.
5. 450 °F. MAX. CYL. HD. TEMP.
6. F4U-5 AIRPLANE DUCTS AND INTERCOOLERS WITH AUX. STAGE "BLEED-OFF VALVE" INSTALLED.

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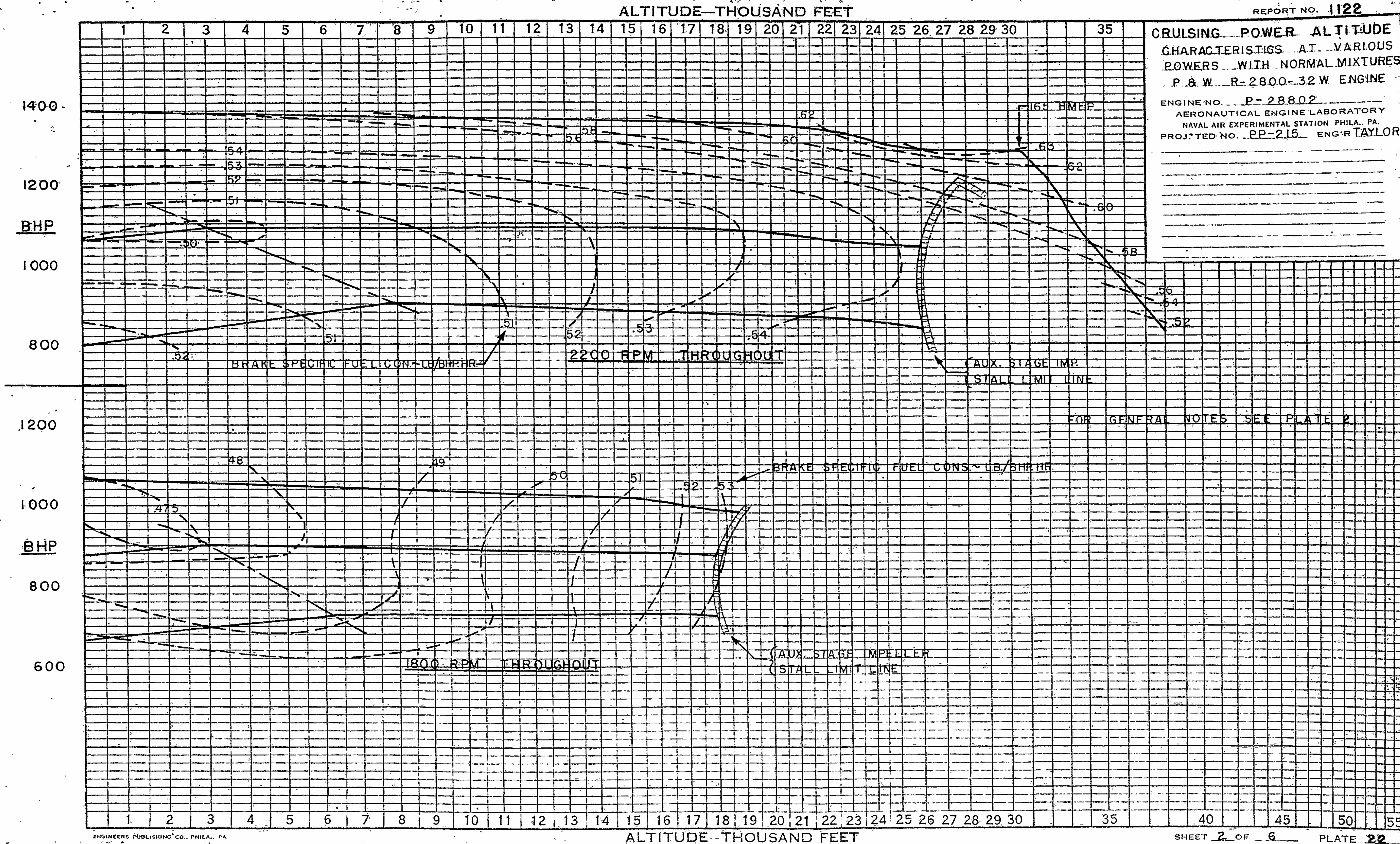
SHEET 1 OF 6 PLATE 21

REPORT NO. 1122

CRUISING POWER ALTITUDE CHARACTERISTICS AT VARIOUS POWERS WITH NORMAL MIXTURES
P & W R-2800-32 W ENGINE

ENGINE NO. P-28802
AERONAUTICAL ENGINE LABORATORY
NAVAL AIR EXPERIMENTAL STATION PHILA., PA.
PROJ. TED NO. PP-215 ENG'R TAYLOR



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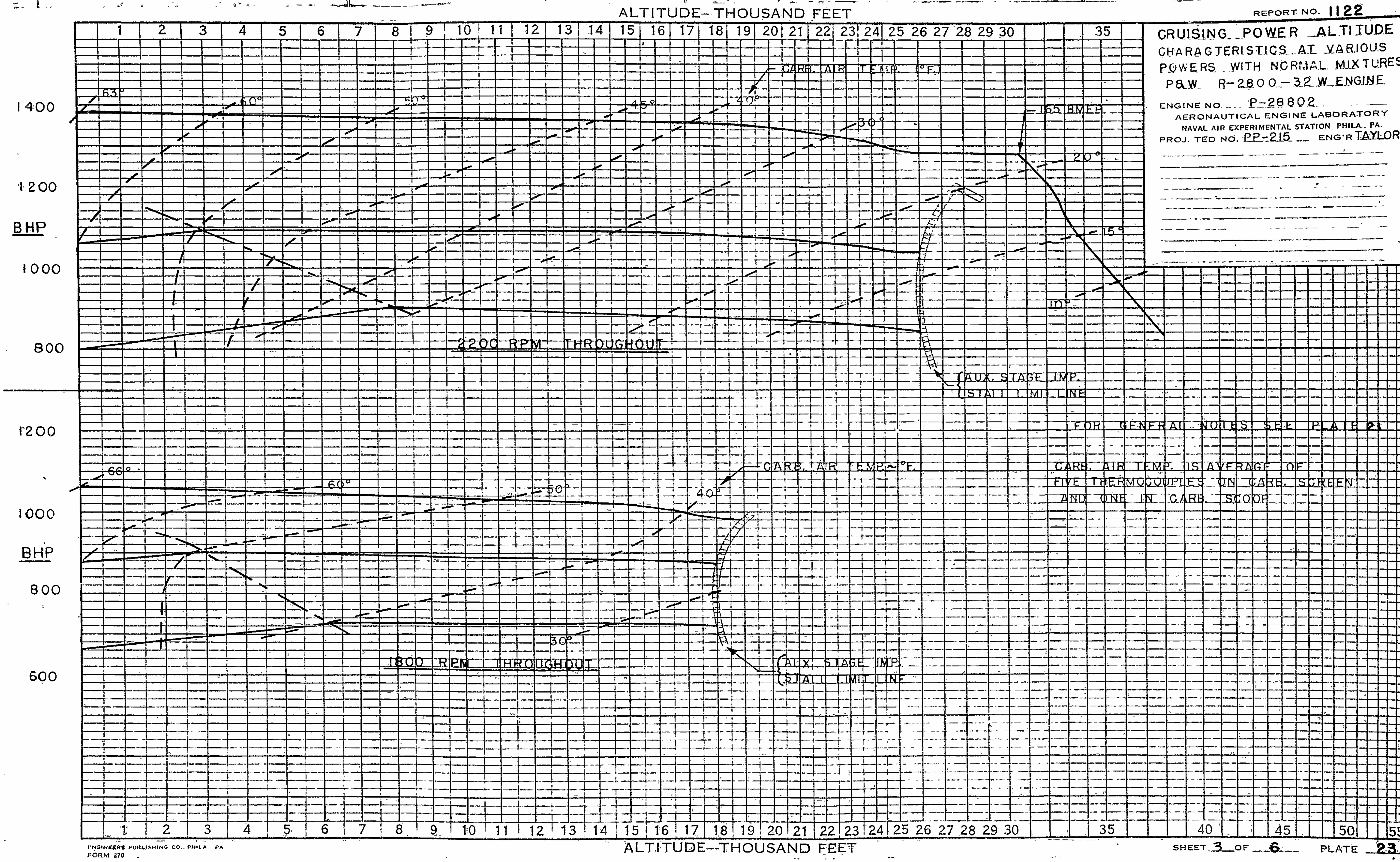
SHEET 2 OF 6 PLATE 22

REPORT NO. 1122



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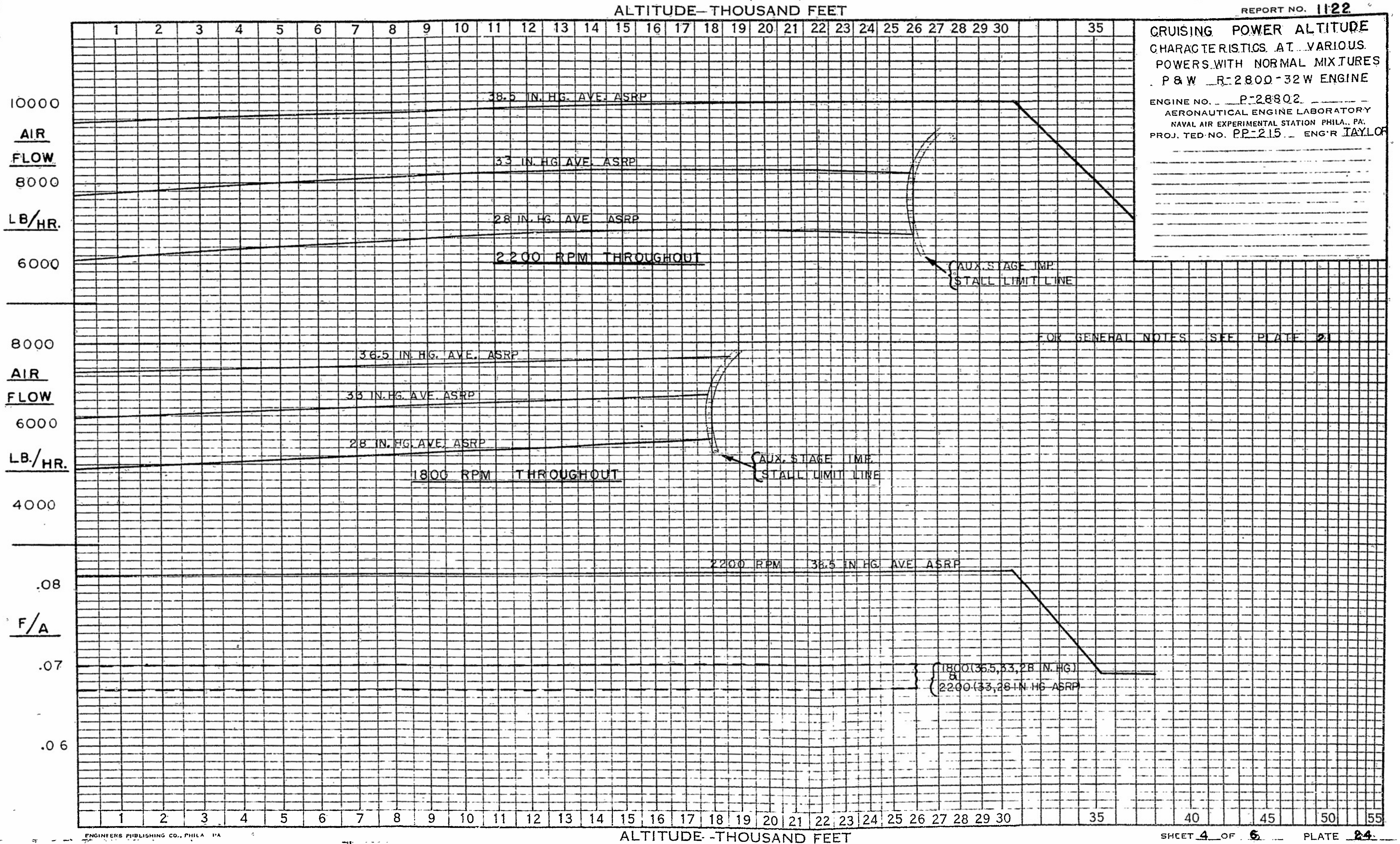
FORM 270

SHEET 3 OF 6 PLATE 23



REPORT NO. 1122

CRUISING POWER ALTITUDE CHARACTERISTICS AT VARIOUS POWERS WITH NORMAL MIXTURES P & W R-2800-32W ENGINE

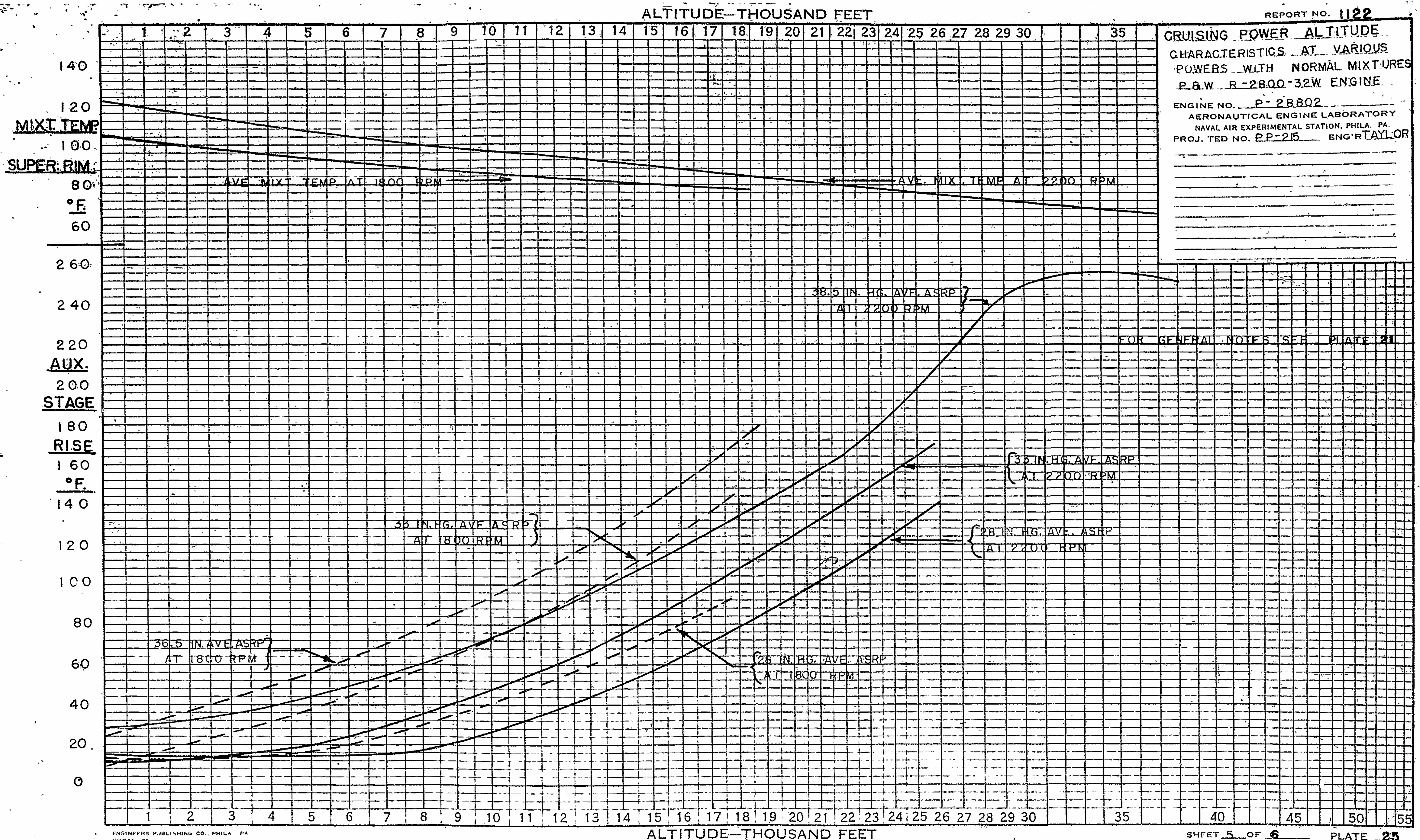
ENGINE NO. P-28802

AERONAUTICAL ENGINE LABORATORY

NAVAL AIR EXPERIMENTAL STATION PHILA., PA.

PROJ. TED NO. PP-215 ENG'R TAYLOR

ENGINEERS PUBLISHING CO., PHILA. PA.



ALTITUDE—THOUSAND FEET
REPORT NO. 1122
CRUISING POWER ALTITUDE CHARACTERISTICS AT VARIOUS POWERS WITH NORMAL MIXTURES P & W R-2800-32W ENGINE
ENGINE NO. P-28802
AERONAUTICAL ENGINE LABORATORY
NAVAL AIR EXPERIMENTAL STATION, PHILA. PA.
PROJ. TED NO. PP-215 ENG'R TAYLOR
MIXT. TEMP.
SUPER. RIM.
°F.
AUX. STAGE RISE °F.
AVE. MIXT. TEMP. AT 1800 RPM
AVE. MIXT. TEMP. AT 2200 RPM
38.5 IN. HG. AVE. ASRP AT 2200 RPM
FOR GENERAL NOTES SEE PLATE 21
33 IN. HG. AVE. ASRP AT 2200 RPM
33 IN. HG. AVE. ASRP AT 1800 RPM
28 IN. HG. AVE. ASRP AT 2200 RPM
36.5 IN. AVE. ASRP AT 1800 RPM
28 IN. HG. AVE. ASRP AT 1800 RPM
ENGINEERS PUBLISHING CO., PHILA. PA.
SHEET 5 OF 6
PLATE 25

REPORT NO. 1122

CRUISING POWER ALTITUDE CHARACTERISTICS AT VARIOUS POWERS WITH "NORMAL" MIXTURES

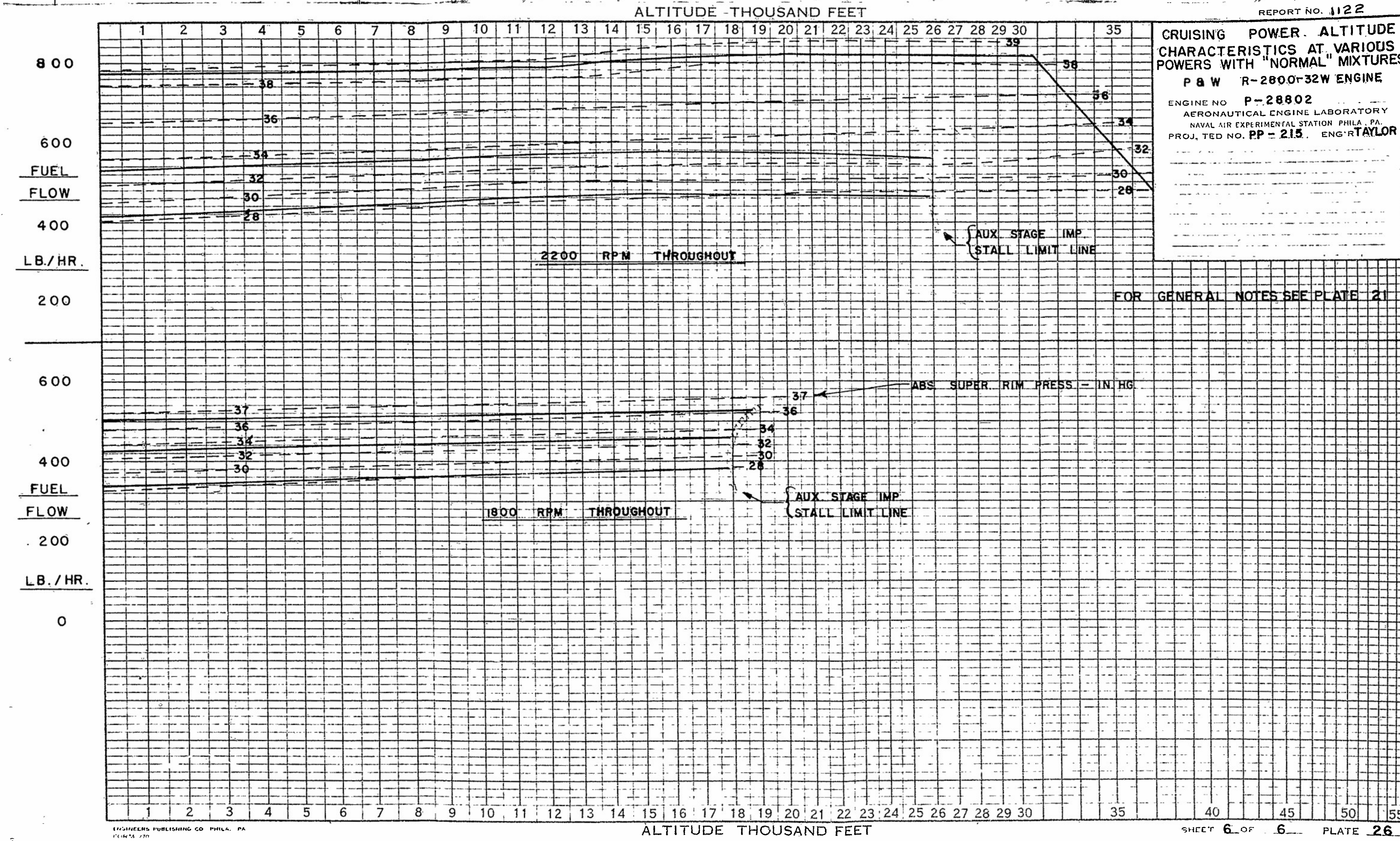
P & W R-2800-32W ENGINE

ENGINE NO P-28802

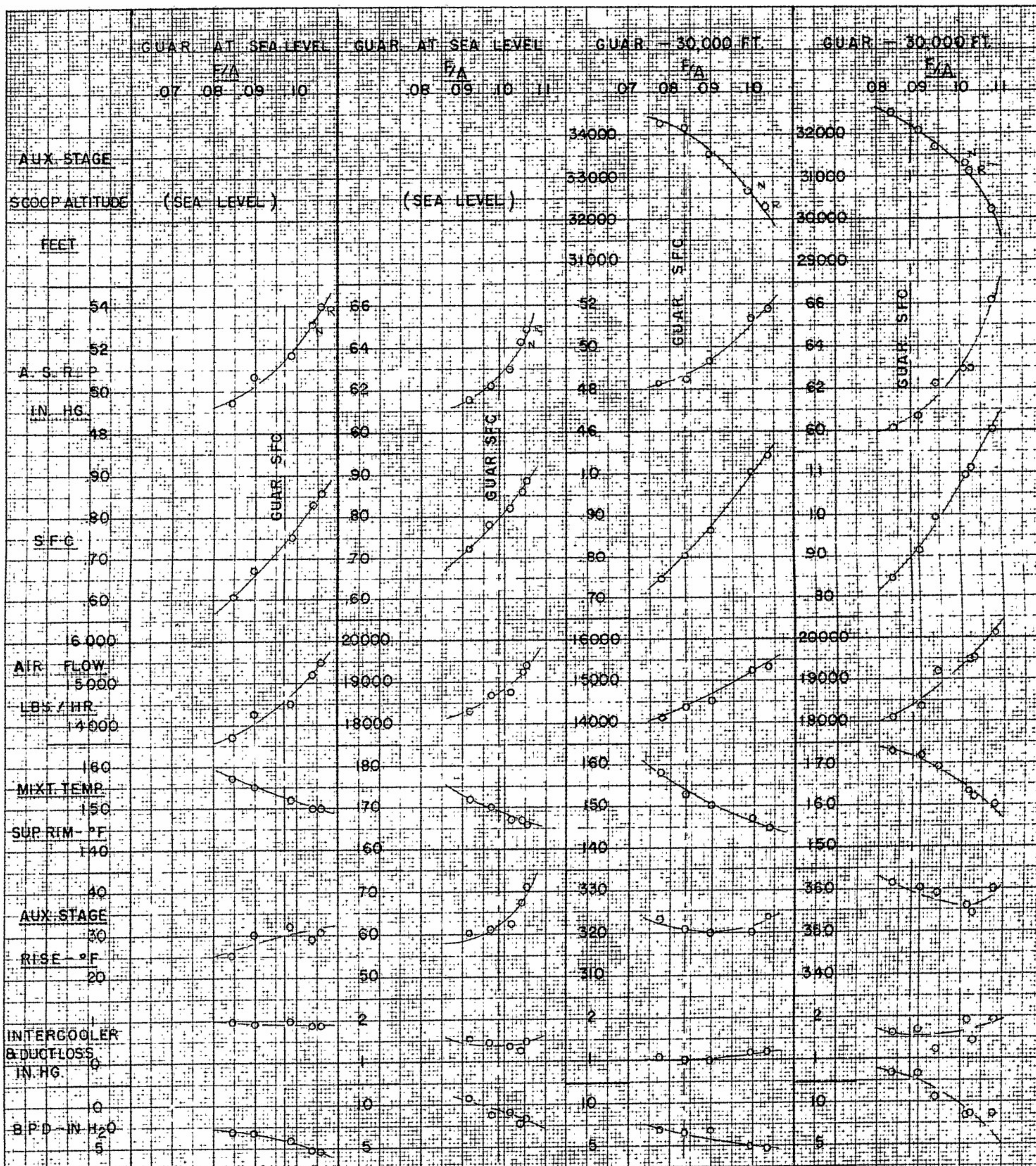
AERONAUTICAL ENGINE LABORATORY

NAVAL AIR EXPERIMENTAL STATION PHILA., PA.

PROJ. TED NO. PP-215 ENG'R TAYLOR



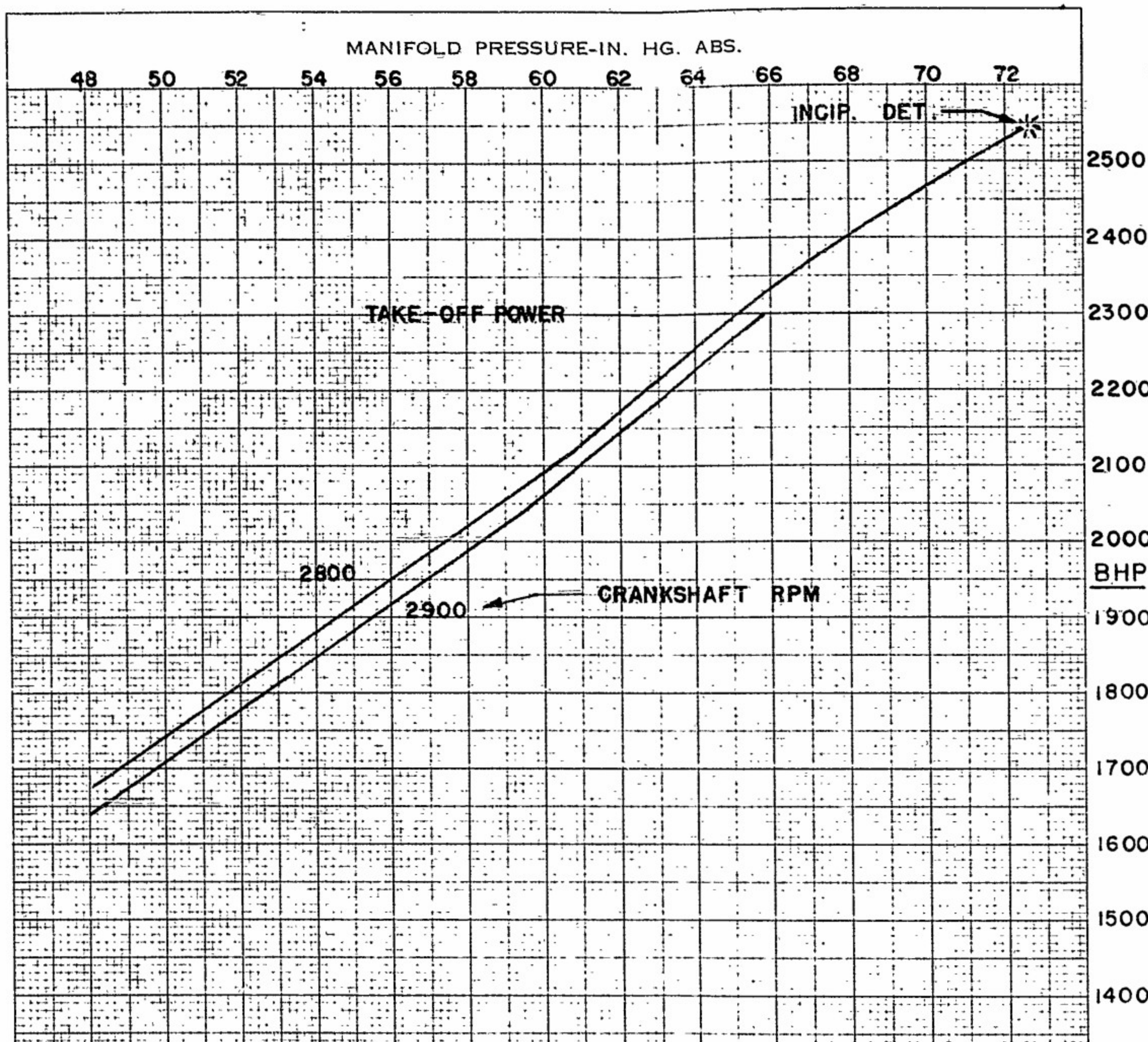
SHEET 6 OF 6 PLATE 26



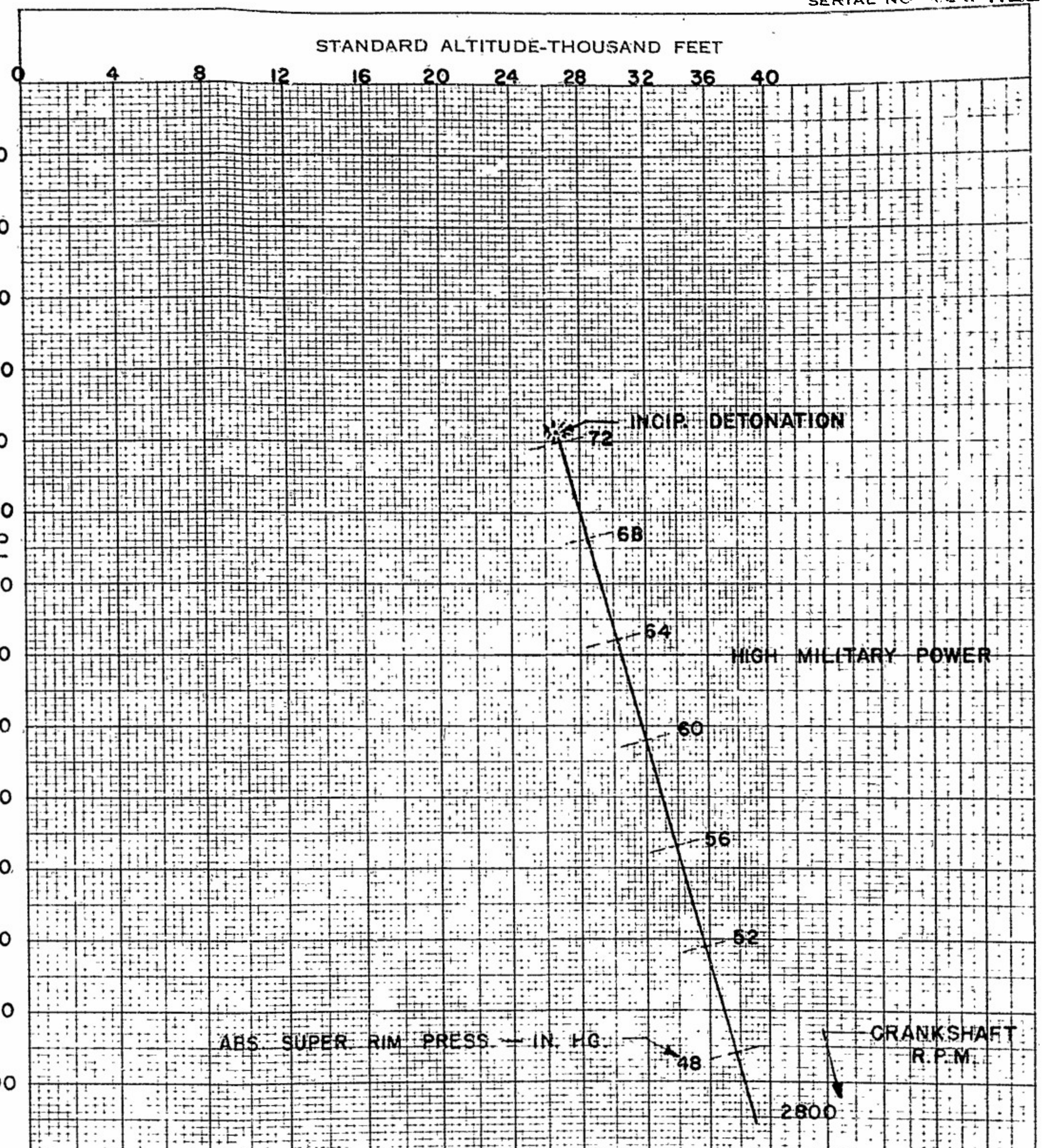
	NORMAL RATED AT SEA LEVEL	MILITARY RATED AT SEA LEVEL	NORMAL RATED AT CRITICAL ALTITUDE	MILITARY RATED AT CRITICAL ALTITUDE
SUPER. GEAR	FULL CARB. THROT. PLUS PART. LOW. AUX. STAGE	FULL CARB. THROT. PLUS PART. LOW. AUX. STAGE	FULL CARB. THROT. — MIN. SLIP. HIGH AUX. STAGE	FULL CARB. THROT. — MIN. SLIP. HIGH AUX. STAGE
R.P.M.	2600	2800	2600	2800
B.H.P.	1900	2300	1500	1800
°F. CAT. (AVE.)	88	89	88	93
°F. AUX. SUPER. ENT.	STD. ALT.	STD. ALT.	STD. ALT.	STD. ALT.
°F. MAX. CYL. TEMP.	480	480	482	474
°F. MAX. BASE TEMP.	339	346	343	345
°F. COOLING AIR	84	85	78	77

NOTE: 1. OPERATION WITHOUT AUTOMATIC MANIFOLD PRESSURE REGULATOR.
2. F4U-5 AIRPLANE DUCTING AND INTERCOOLERS INSTALLED.
3. AUX. STAGE SCOOP ALTITUDE MEASURED BY STATIC FITTINGS LOCATED ON F4U-5 AIRPLANE ENTRANCE DUCTS(OUTSIDE FACES) APPROX. 9 IN. UPSTREAM OF AUX. TOP DECK.
4. STROMBERG PR64B2 CARB.(NO. 72882) MANUALLY CONTROLLED.
5. CAT. IS AVERAGE OF 5 THERM. LOCATED ON CARB. SCREEN AND 1 IN CARB. SCOOP.
6. F-47N AIRPLANE TYPE EXHAUST COLLECTOR STD. ALT. PRESS. MAINTAINED.
7. GUAR. SFC AS PER P&W SPEC. NO. N-8119 OF 16 DEC. 46.
8. AN-F-48 (115/145) GRADE FUEL.

CRITICAL ALTITUDE CHECKS
NORMAL AND MILITARY POWERS
P&W R-2800-32W ENGINE
SERIAL NO. P-28802
AERONAUTICAL ENGINE LABORATORY
NAVAL AIR EXPERIMENTAL STATION, PHILADELPHIA, PA.
Proj. TED No. NAM PP 218 Engr. TAYLOR



NOTE:
1. STANDARD ALTITUDE TEMP. MAINTAINED AT AUX. STAGE ENTRANCE DUCTS.
2. STD. ALTITUDE PRESS. AT F-47N EXH. COLLECTOR.
3. ENGINE OPERATED WITHOUT AUTO. MAN. PRESS. REG., BUT THROTTLES REGULATED TO GIVE CARB. DROP VALUES AS WOULD BE OBTAINED WITH STROM. CO-3F AUTO. MAN. PRESS. REGULATOR.
4. INTERCOOLER EFFECTIVENESS DERIVED FROM F4U-5 FLIGHT DATA (68% AT S.L., 64% AT 20-30,000 FT., 61% AT 30-40,000 FT.)
5. F4U-5 AIRPLANE DUCTS, INTERCOOLERS AND "BLEED-OFF" VALVE.



RATIOS - COMP. 6.75 : 1
CARB. STROM. PR-64B2*
SPARK ADV. 20° BTC
IMPELLER DIAM.
* SETTING P.L. NO. 390940-10

IMPELLER NU. 6.70:1
MIN. SLIP, AUX LO-7.78:1, AUX HI. 9.65:1
PLUGS BG RB 19R

PROP. .45 : 1
OIL 1100
FUEL AN-F-48 (115/145)

TEST DATE
AV. ROOM BAR. IN. HG
AV. CARB. AIR TEMP. °F
AV. OIL INLET TEMP °F
AV. COOL. AIR TEMP. °F

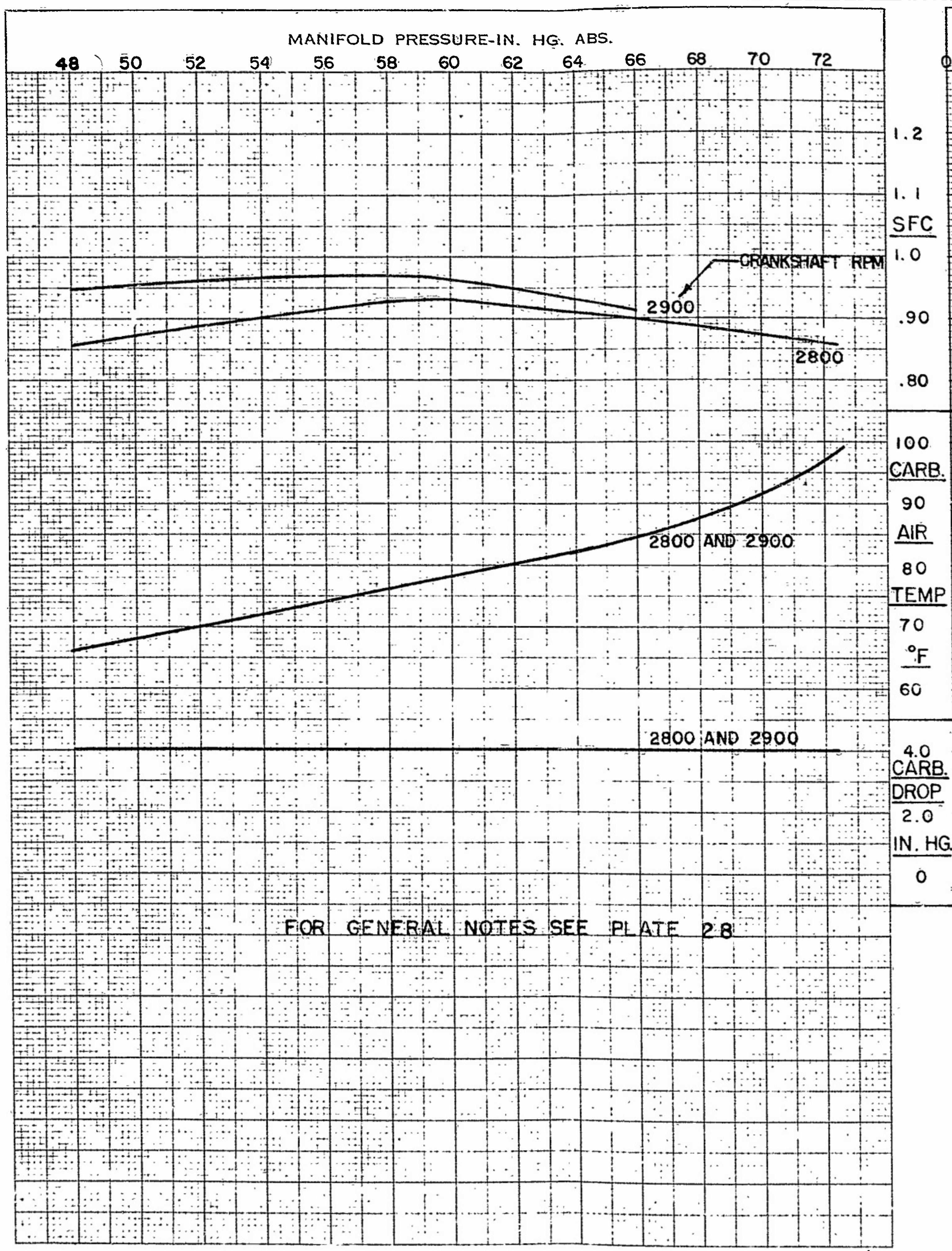
TEST EQUIPMENT AEL DYN. NO. 1, BLDG. 599

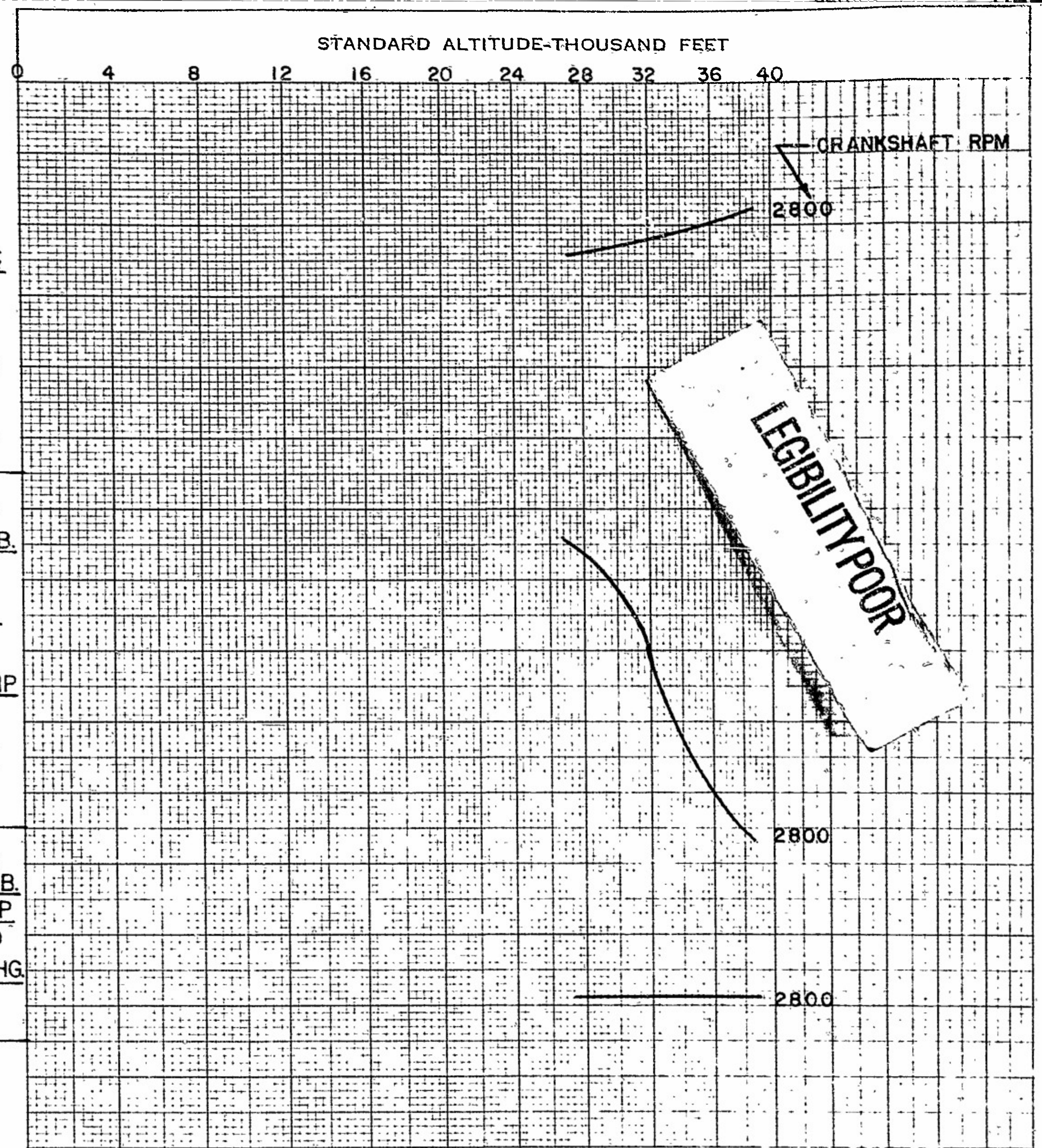
OVERPOWER RUNS AT SEA-LEVEL AND CRITICAL ALTITUDE "RICH" MIXTURES - R-2800-32W ENGINE

ENGINE BU. NO MFG. NO. P-28802
AERONAUTICAL ENGINE LABORATORY
NAVAL AIRCRAFT FACTORY, PHILA., PA.

PROJ PP-215 ENG'R. TAYLOR

SHEET 1 OF 3



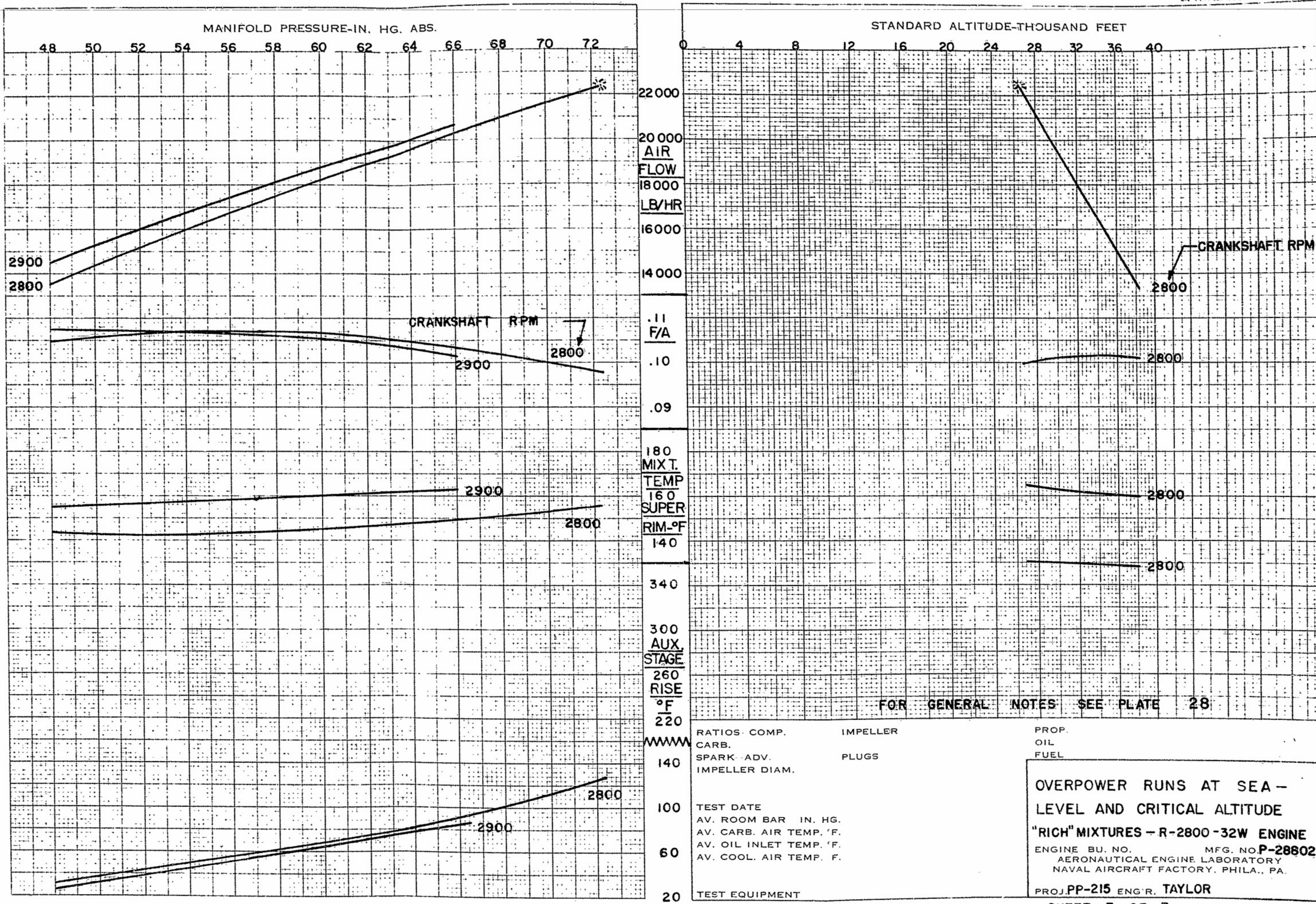


RATIOS--COMP. IMPELLER PROP.
CARB. OIL
SPARK ADV. PLUGS FUEL
IMPELLER DIAM.

TEST DATE
AV. ROOM BAR. IN. HG.
AV. CARB. AIR TEMP. °F
AV. OIL INLET TEMP. °F
AV. COOL. AIR TEMP. °F

TEST EQUIPMENT

OVERPOWER RUNS AT SEA-LEVEL AND CRITICAL ALTITUDE
"RICH" MIXTURES-R-2800-32W ENGINE
ENGINE BU. NO. MFG. NO. P-28802
AERONAUTICAL ENGINE LABORATORY
NAVAL AIRCRAFT FACTORY PHILA., PA.
PROJ. PP-215 ENG'R TAYLOR



RATIOS COMP. | IMPELLER | PROP.
CARB. | | OIL
SPARK ADV. | PLUGS | FUEL
IMPELLER DIAM.

TEST DATE
AV. ROOM BAR IN. HG.
AV. CARB. AIR TEMP. °F.
AV. OIL INLET TEMP. °F.
AV. COOL. AIR TEMP. °F.

TEST EQUIPMENT

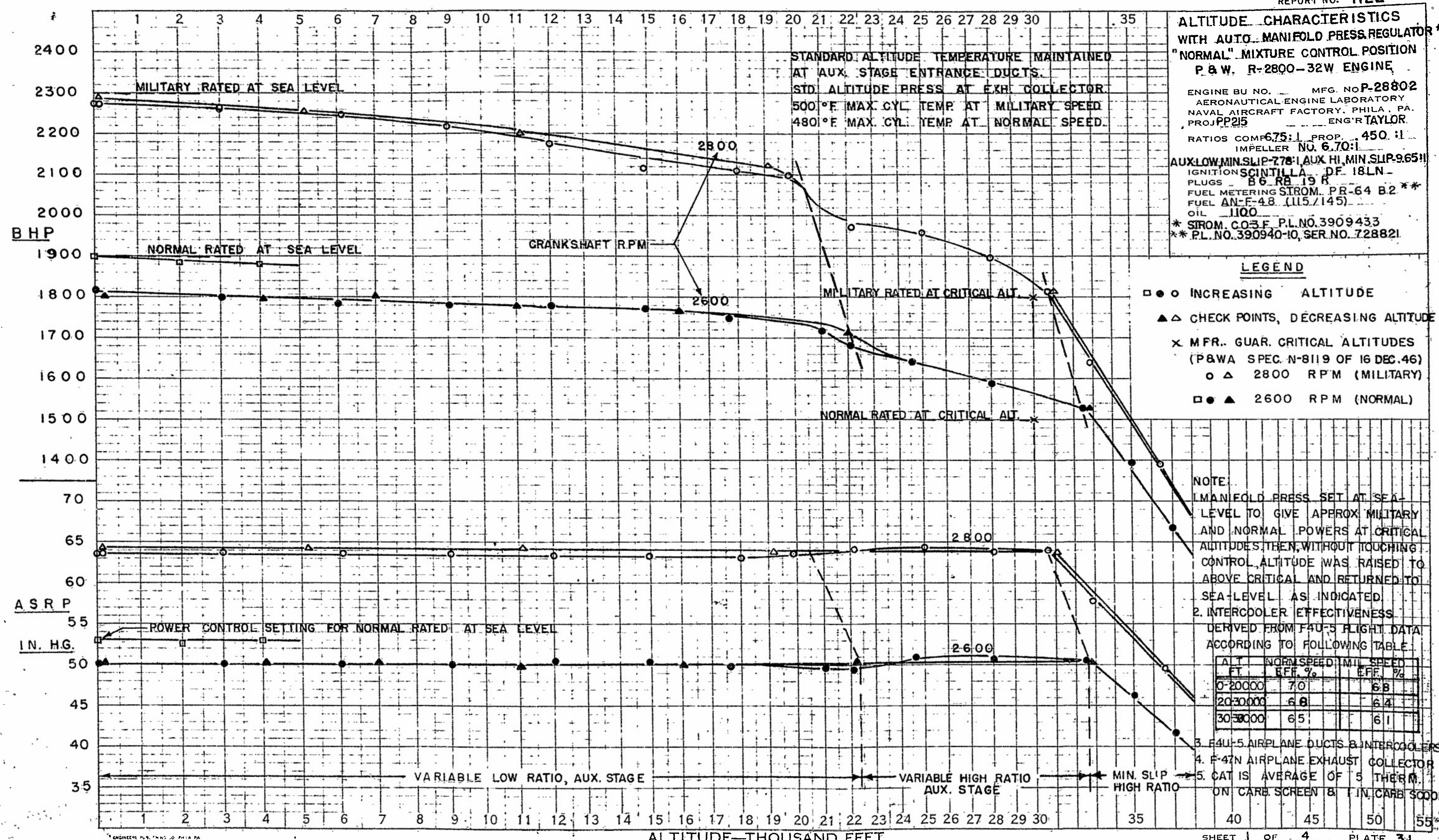
OVERPOWER RUNS AT SEA-LEVEL AND CRITICAL ALTITUDE "RICH" MIXTURES — R-2800-32W ENGINE

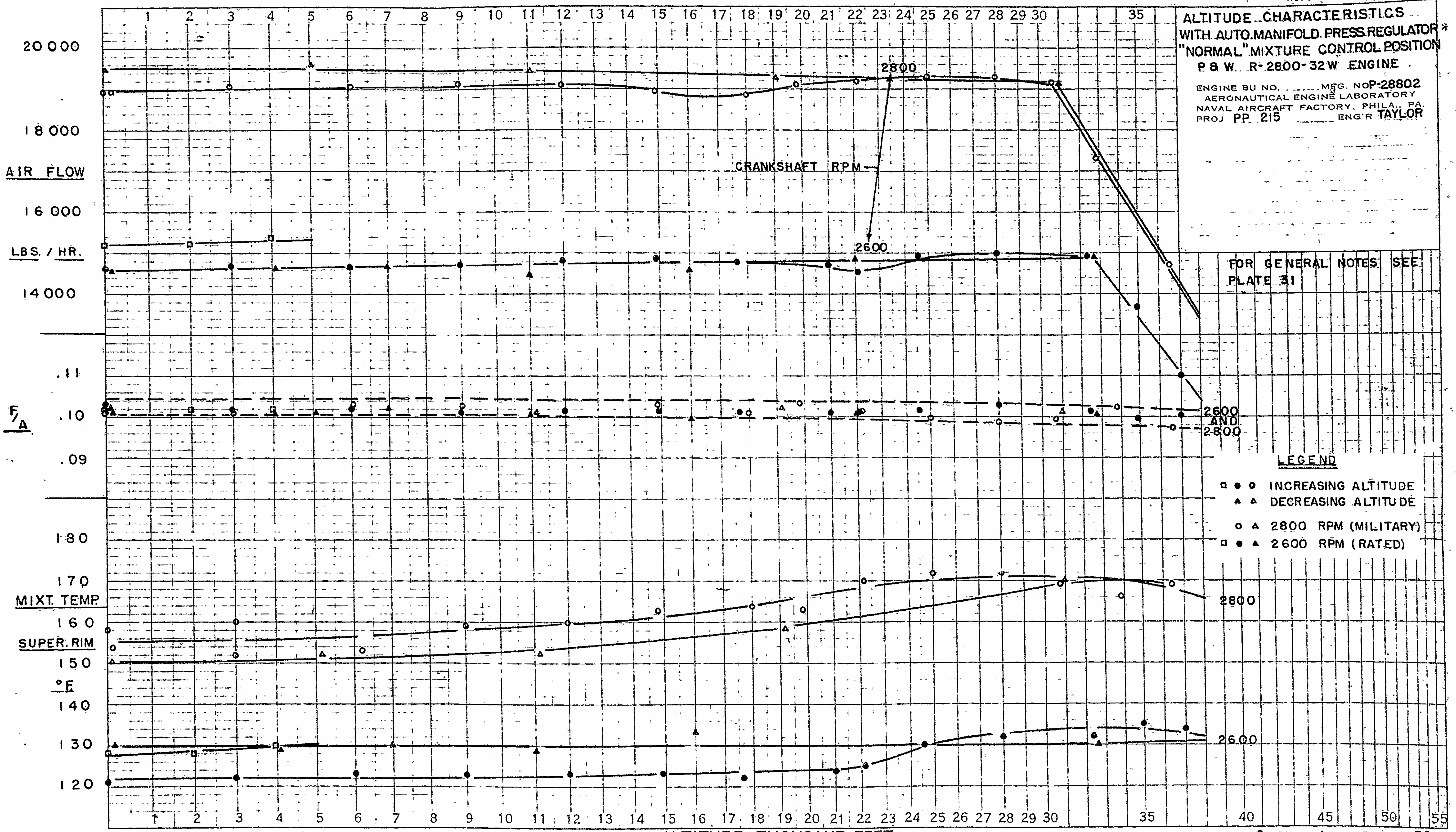
ENGINE BU. NO. MFG. NO. P-28802
AERONAUTICAL ENGINE LABORATORY
NAVAL AIRCRAFT FACTORY, PHILA., PA.

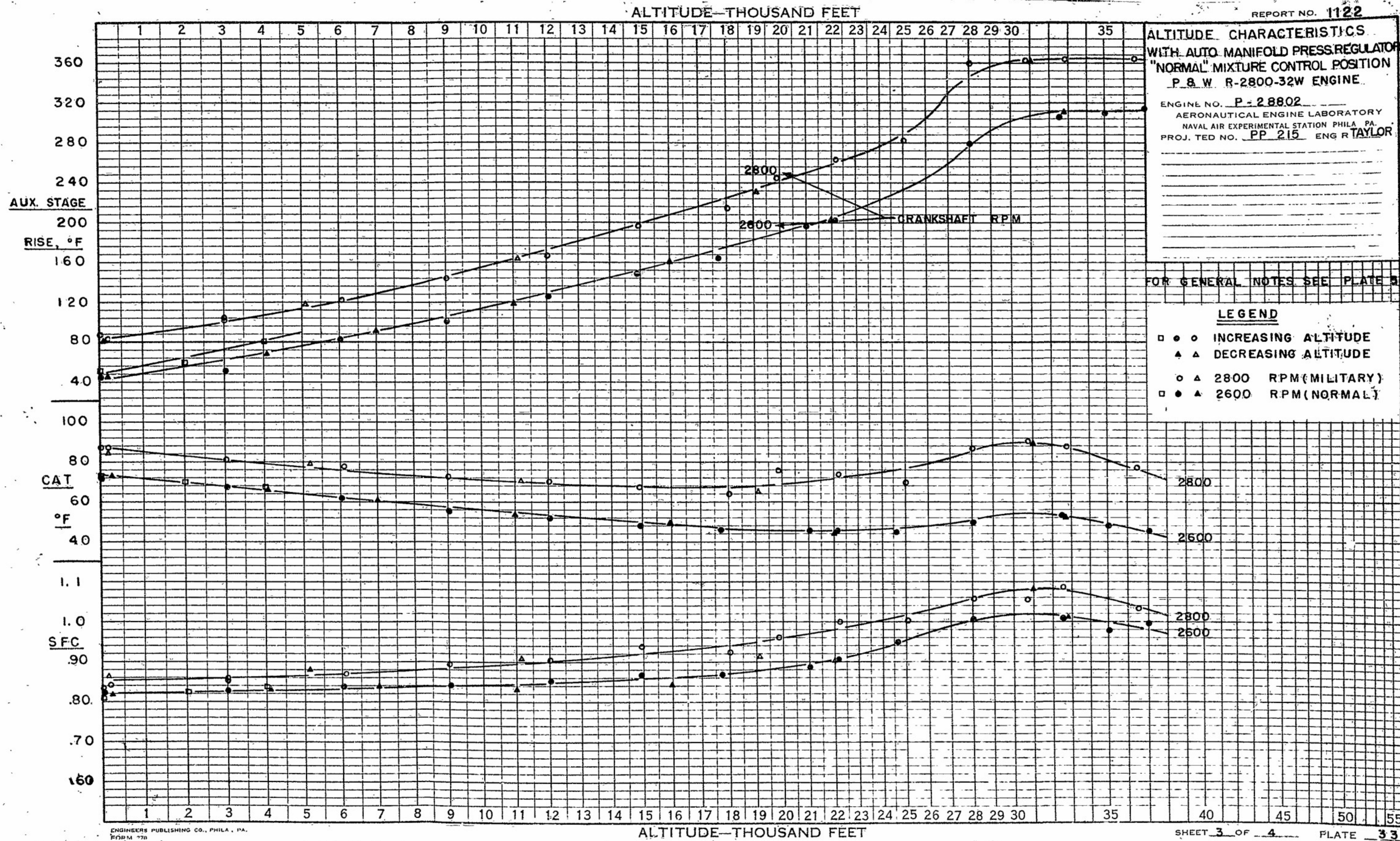
PROJ. PP-215 ENG'R. TAYLOR

SHEET 3 OF 3

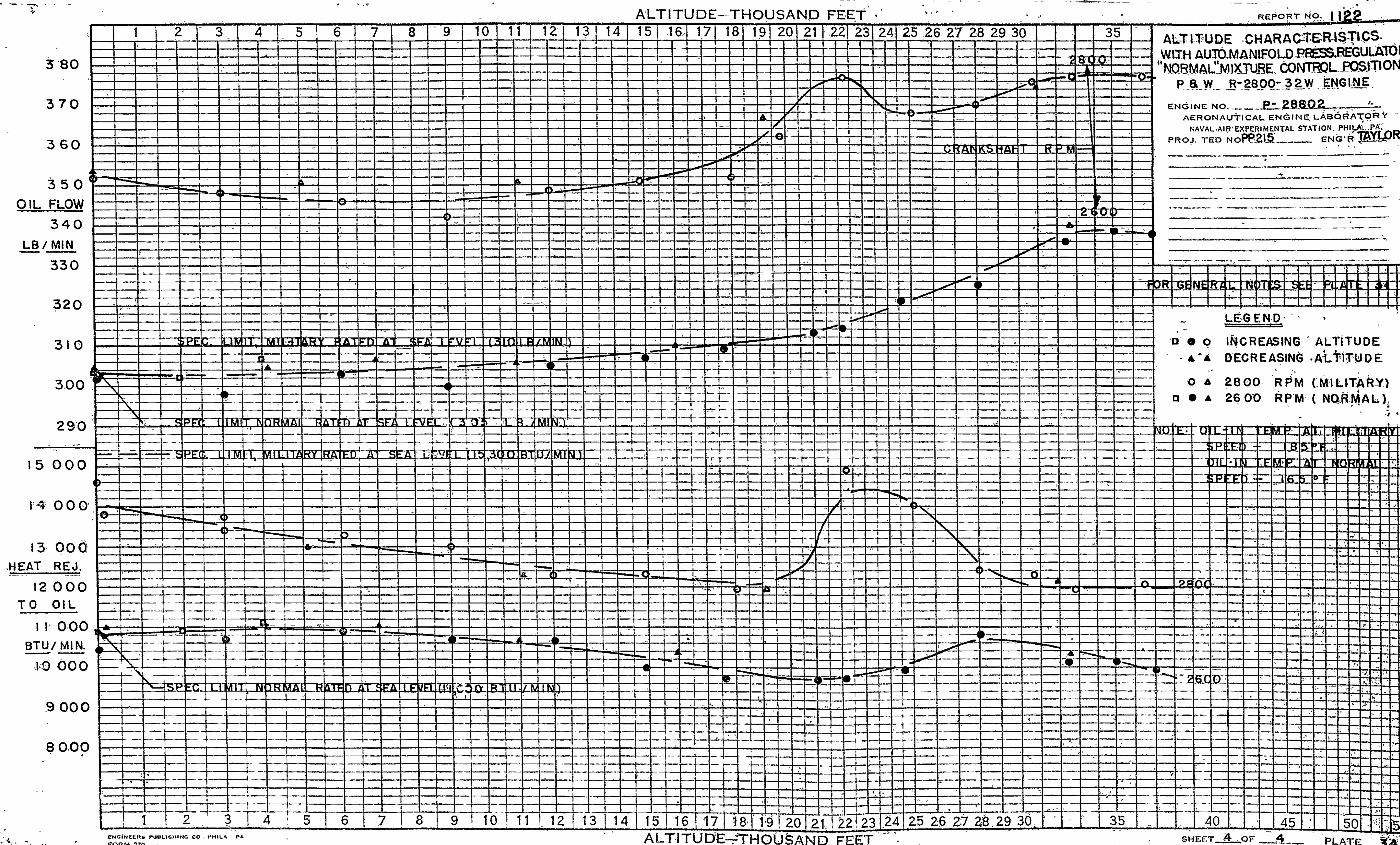
REPORT NO. 1122



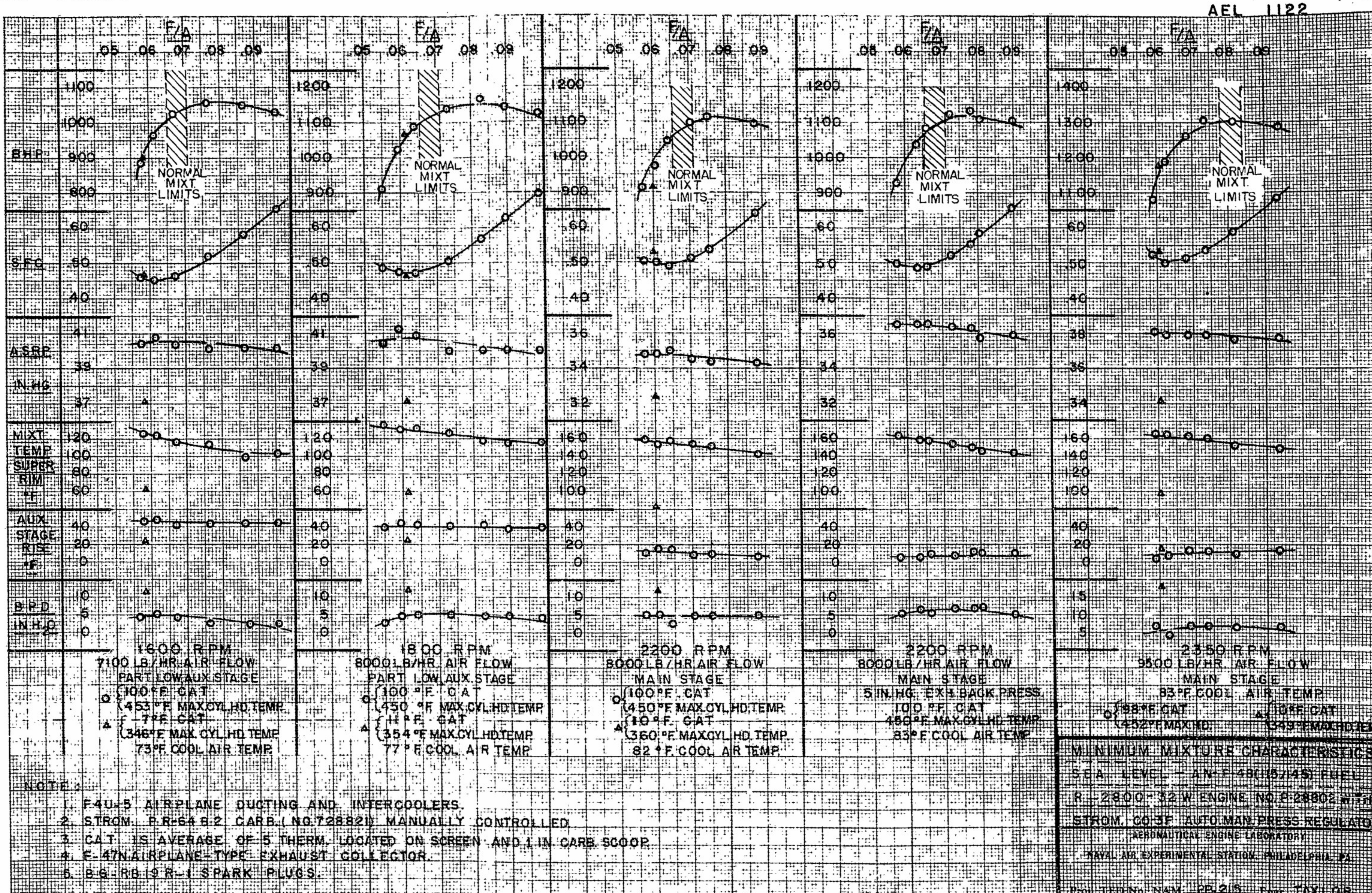

ALTITUDE CHARACTERISTICS
WITH AUTO. MANIFOLD PRESS. REGULATOR *
"NORMAL" MIXTURE CONTROL POSITION
P & W. R-2800-32W ENGINE
ENGINE BU NO. ______ MFG. NO P-28802
AERONAUTICAL ENGINE LABORATORY
NAVAL AIRCRAFT FACTORY, PHILA., PA.
PROJ PP 215 ______ ENG'R TAYLOR
FOR GENERAL NOTES SEE PLATE 31
AIR FLOW
LBS. / HR.
20 000
18 000
16 000
14 000
CRANKSHAFT RPM
2800
2600
F/A
.11
.10
.09
2600 AND 2800
LEGEND
INCREASING ALTITUDE
DECREASING ALTITUDE
2800 RPM (MILITARY)
2600 RPM (RATED)
MIXT. TEMP.
SUPER. RIM
°F
180
170
160
150
140
130
120
ALTITUDE—THOUSAND FEET

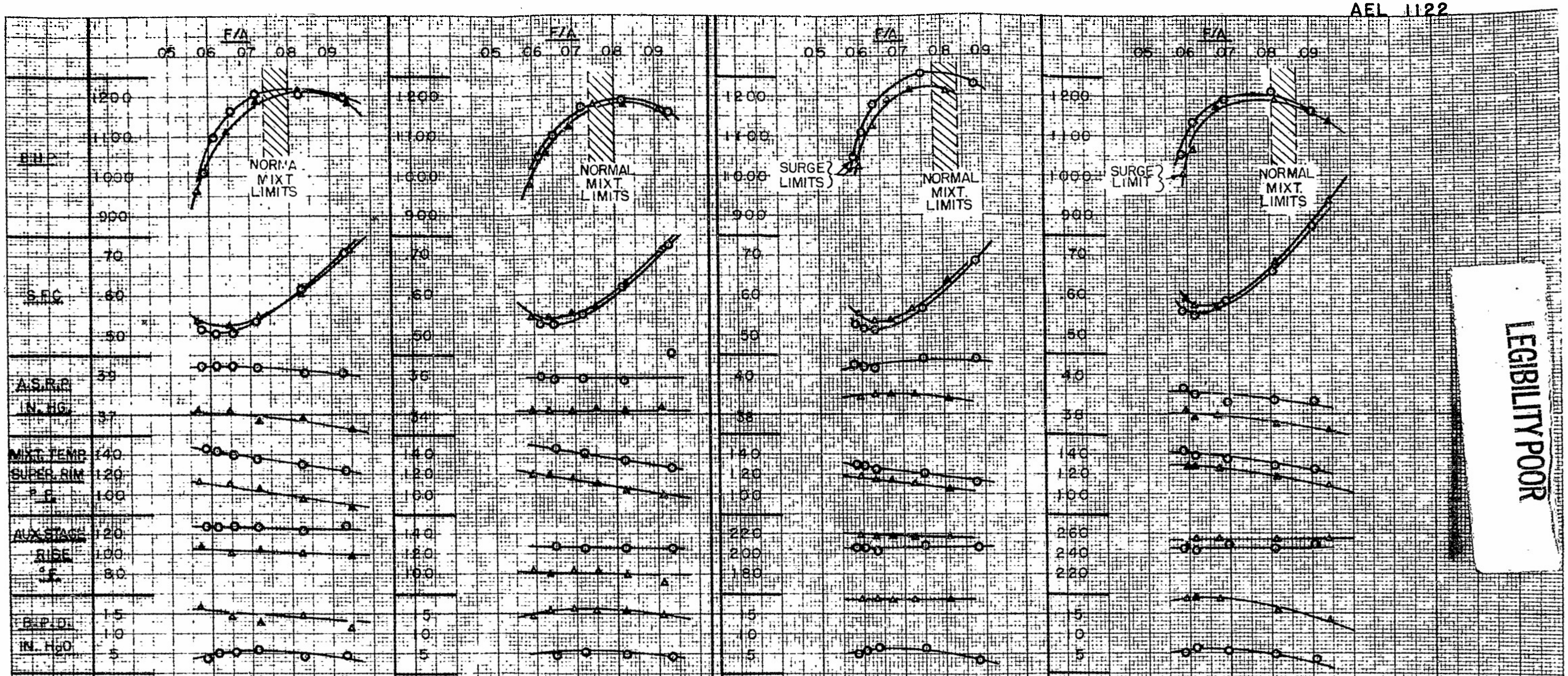


REPORT NO. 1122
ALTITUDE CHARACTERISTICS
WITH AUTO MANIFOLD PRESS REGULATOR
"NORMAL" MIXTURE CONTROL POSITION
P & W R-2800-32W ENGINE
ENGINE NO. P-28802
AERONAUTICAL ENGINE LABORATORY
NAVAL AIR EXPERIMENTAL STATION PHILA. PA.
PROJ. TED NO. PP 215 ENG R TAYLOR
FOR GENERAL NOTES SEE PLATE 31
LEGEND
INCREASING ALTITUDE
DECREASING ALTITUDE
2800 RPM (MILITARY)
2600 RPM (NORMAL)
ALTITUDE—THOUSAND FEET
AUX. STAGE RISE, °F
CAT °F
SFC
CRANKSHAFT RPM
2800
2600
ENGINEERS PUBLISHING CO., PHILA., PA. FORM 270
SHEET 3 OF 4
PLATE 33



REPORT NO. 1122
ALTITUDE - THOUSAND FEET
ALTITUDE CHARACTERISTICS
WITH AUTO.MANIFOLD PRESS.REGULATOR
"NORMAL" MIXTURE CONTROL POSITION
P & W R-2800-32W ENGINE
ENGINE NO. P-28802
AERONAUTICAL ENGINE LABORATORY
NAVAL AIR EXPERIMENTAL STATION, PHILA., PA.
PROJ. TED NO. PP215 ENG'R TAYLOR
FOR GENERAL NOTES SEE PLATE 34
LEGEND
INCREASING ALTITUDE
DECREASING ALTITUDE
2800 RPM (MILITARY)
2600 RPM (NORMAL)
NOTE: OIL-IN TEMP. AT MILITARY SPEED = 185°F
OIL-IN TEMP. AT NORMAL SPEED = 165°F
CRANKSHAFT RPM
2800
2600
OIL FLOW LB/MIN
HEAT REJ. TO OIL BTU/MIN.
SPEC. LIMIT, MILITARY RATED AT SEA LEVEL (310 LB/MIN.)
SPEC. LIMIT, NORMAL RATED AT SEA LEVEL (305 LB/MIN.)
SPEC. LIMIT, MILITARY RATED AT SEA LEVEL (15,300 BTU/MIN.)
SPEC. LIMIT, NORMAL RATED AT SEA LEVEL (11,050 BTU/MIN.)
ENGINEERS PUBLISHING CO. PHILA. PA
FORM 270
SHEET 4 OF 4
PLATE 34

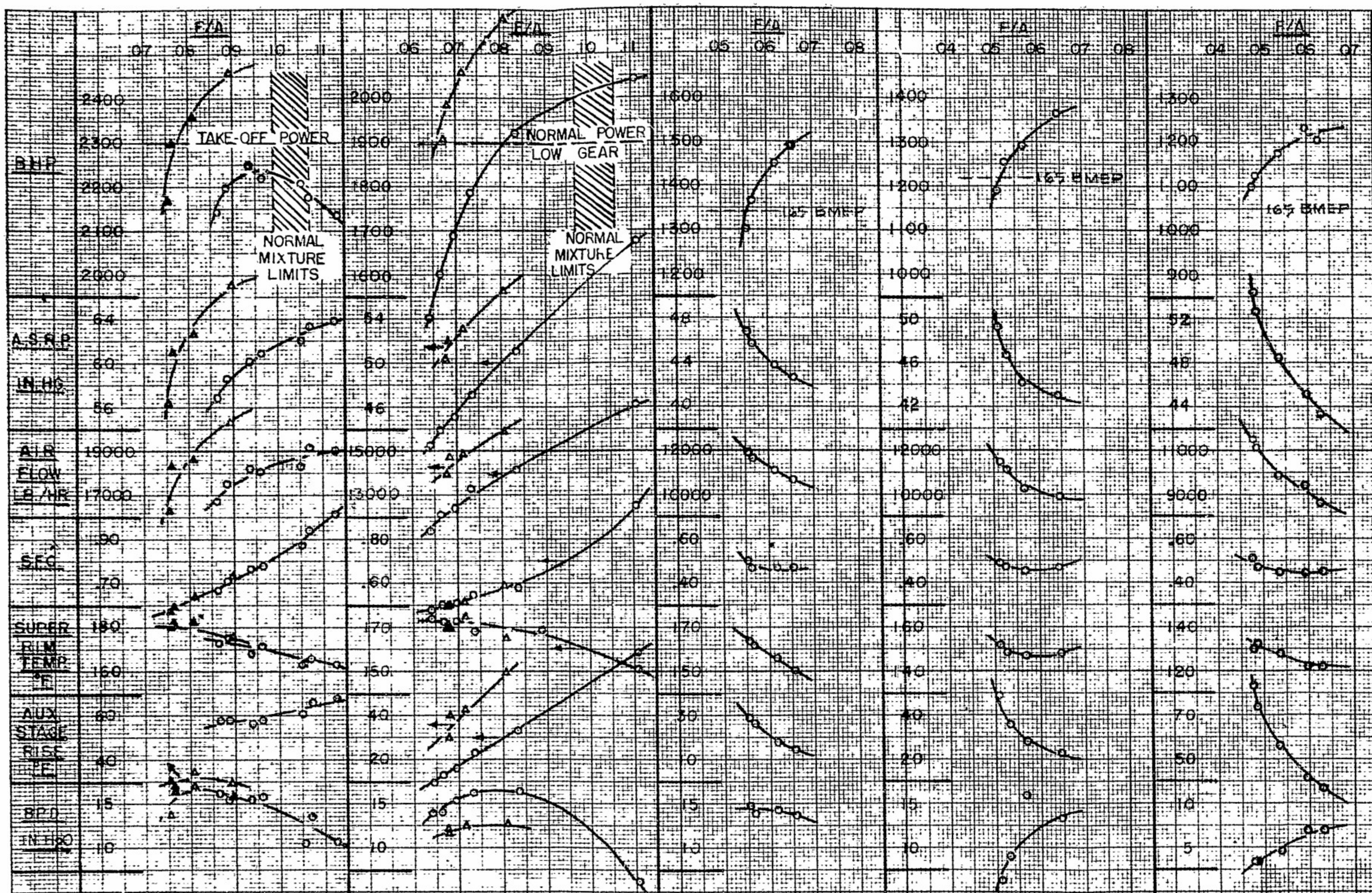

F/A
.05 .06 .07 .08 .09
BHP
S.F.C.
A.S.R.P. IN. HG.
MIXT. TEMP. SUPER. RIM °F
AUX. STAGE RISE °F
B.P.D. IN. H2O
NORMAL MIXT. LIMITS
1600 R.P.M.
7100 LB/HR. AIR FLOW
PART LOW AUX. STAGE
○ {100°F. CAT. / 453°F. MAX. CYL. HD. TEMP.
△ {-7°F. CAT. / 346°F. MAX. CYL. HD. TEMP.
73°F. COOL. AIR TEMP.
1800 R.P.M.
8000 LB/HR. AIR FLOW
PART LOW AUX. STAGE
○ {100°F. CAT. / 450°F. MAX. CYL. HD. TEMP.
△ {11°F. CAT. / 354°F. MAX. CYL. HD. TEMP.
77°F. COOL. AIR TEMP.
2200 R.P.M.
8000 LB/HR AIR FLOW
MAIN STAGE
○ {100°F. CAT. / 450°F. MAX. CYL. HD. TEMP.
△ {10°F. CAT. / 360°F. MAX. CYL. HD. TEMP.
82°F. COOL. AIR TEMP.
2200 R.P.M.
8000 LB/HR AIR FLOW
MAIN STAGE
5 IN. HG. EXH. BACK PRESS.
100°F. CAT.
460°F. MAX. CYL. HD. TEMP.
83°F. COOL. AIR TEMP.
2350 R.P.M.
9500 LB/HR. AIR FLOW
MAIN STAGE
83°F. COOL. AIR TEMP.
○ {98°F. CAT. / 452°F. MAX. HD.
△ {10°F. CAT. / 349°F. MAX. HD. TEMP.
NOTE:
1. F4U-5 AIRPLANE DUCTING AND INTERCOOLERS.
2. STROM. PR-64 B2 CARB. (NO. 728821) MANUALLY CONTROLLED.
3. CAT. IS AVERAGE OF 5 THERM. LOCATED ON SCREEN AND 1 IN. CARB. SCOOP.
4. F-47N AIRPLANE-TYPE EXHAUST COLLECTOR.
5. B.G.-RB19R-1 SPARK PLUGS.
MINIMUM MIXTURE CHARACTERISTICS
SEA LEVEL - AN-F-48(115/145) FUEL
R-2800-32W ENGINE NO. P-28902 WITH
STROM. CO-3F AUTO. MAN. PRESS. REGULATOR
AERONAUTICAL ENGINE LABORATORY
NAVAL AIR EXPERIMENTAL STATION, PHILADELPHIA, PA.
Proj. TED No. NAM PP-218 Engr. TAYLOR



	2000 RPM 9000 LB/HR. AIR FLOW PART. LOW, NEAR MIN. SLIP		2200 RPM 9000 LB/HR. AIR FLOW PART. LOW NEAR MIN. SLIP		2000 RPM 9500 LB/HR. AIR FLOW FULL HIGH, MIN. SLIP		2200 RPM 10,000 LB/HR. AIR FLOW FULL HIGH, MIN. SLIP	
	—o—	—▲—	—o—	—▲—	—o—	—▲—	—o—	—▲—
CAT., °F	100	62	91	51	90	73	87	74
MAX. CYL. HD. TEMP., °F	450	350	450	350	450	350	452	348
AVE. ALT., FT.	12,500	12,500	16,000	16,000	22,000	25,200	28,500	30,700
AUX. ENT. TEMP., °F	50	-6	41	-17	23	-55	-4	-54
COOL AIR TEMP., °F	83	92	76	86	85	95	77	92

FOR GENERAL NOTES SEE PLATE 35.

MINIMUM MIXTURE CHARACTERISTICS
LOW AND HIGH AUX. GEARS - AN-F-48 [illegible] FUEL
R-2800-32W ENGINE, NO. P-28802 WITH
STROM. CO-3F AUTO. MAN. PRESS. REGULATOR
AERONAUTICAL ENGINE LABORATORY
NAVAL AIR EXPERIMENTAL STATION, PHILADELPHIA, PA.
Proj. TED No. NAM 22-215 Engr. TAYLOR



RPM	2800	2600	2300	2100	1800
SUPER GEAR	PART. LOW	PART. LOW	PART. LOW	PART. LOW	PART. LOW
ALT., FT.	SEA LEVEL	SEA LEVEL	SEA LEVEL	SEA LEVEL	SEA LEVEL
CAT, °F	97	98	99	102	97
MAX. HD, °F	477	475	445	452	444
MAX. FL'GE, °F	338	325	305	302	300
COOL AIR, °F	94	100	108	114	102

LEGEND

—o— AN-F-48 (100/130) GRADE FUEL

—Δ— CHECK POINTS WITH AN-F-48 (115/145) GRADE FUEL

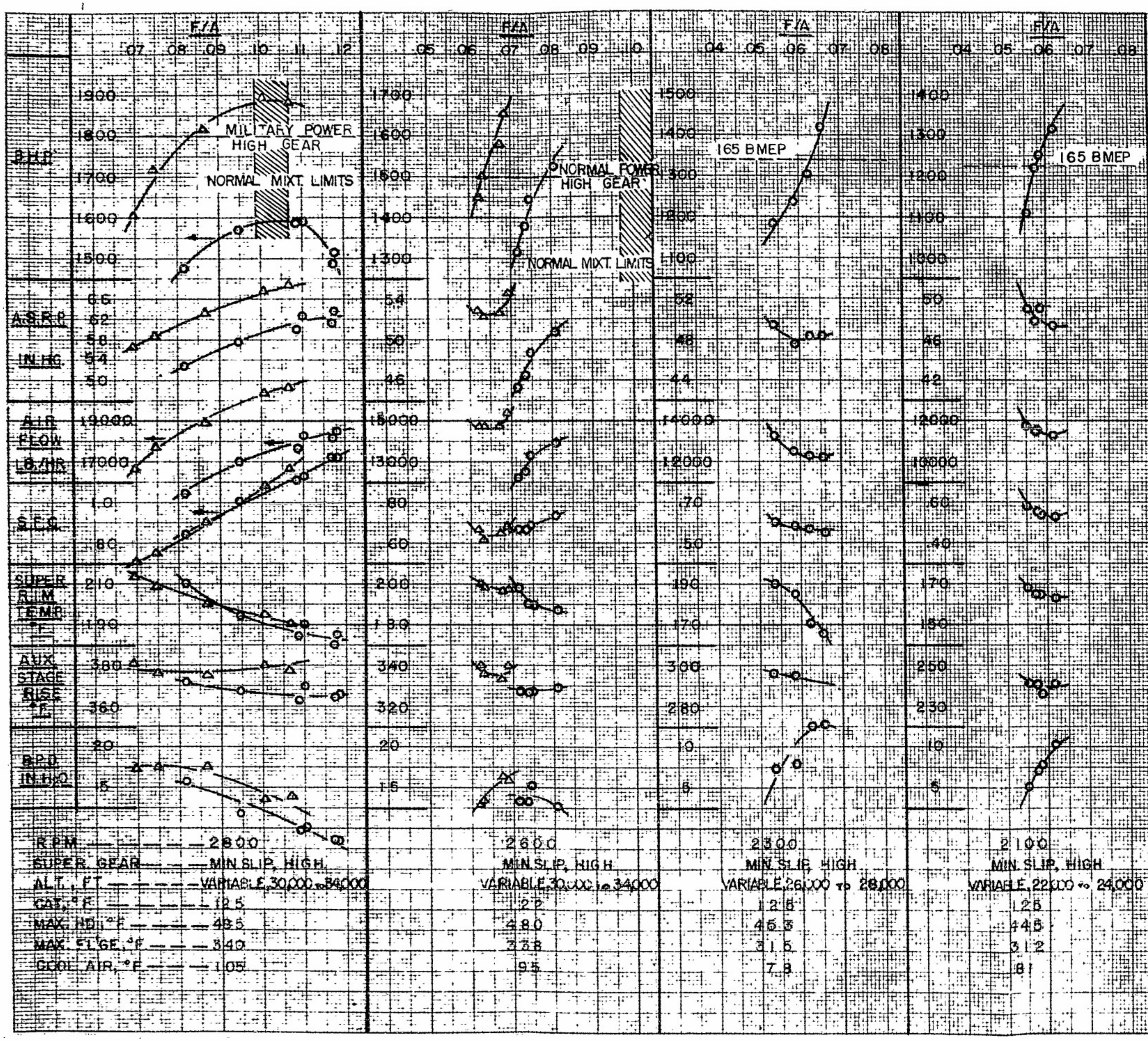
NOTE:

1. OPERATION WITHOUT AUTOMATIC MANIFOLD PRESSURE REGULATOR.
2. F4U-5 AIRPLANE DUCTING AND INTERCOOLERS INSTALLED.
3. STROMBERG PR-64B2 CARB. (NO. 728821) MANUALLY CONTROLLED.
4. F-47N AIRPLANE-TYPE EXHAUST COLLECTOR.
5. CAT IS AVERAGE OF 5 THERM. LOCATED ON CARB. SCREEN AND 1 IN CARB. SCOOP.
6. PARTIAL LOW, AUX. STAGE NECESSARY TO OBTAIN DETONATION AT CRUISE SPEEDS. INSTABILITY ENCOUNTERED BEFORE DETONATION IF OPERATED IN MAIN STAGE ONLY AT THESE CONDITIONS.
7. NORMAL MIXTURE LIMITS INDICATED ARE THOSE OF THE P.L. NO.390940-D SETTING OF THE PR64B2 CARB. AT THE AVERAGE AIRFLOW OF THE RUN.

DETONATION-LIMITED MIXTURE RESPONSE CURVES, SEA LEVEL
P & W R-2800-32W ENGINE NO. P-28802
USING AN-F-48 (100/130) AND (115/145) FUELS

AERONAUTICAL ENGINE LABORATORY
NAVAL AIR EXPERIMENTAL STATION, PHILADELPHIA, PA.

Proj. TED No. NAM PP-215 Engr. TAYLOR



LEGEND

—○— AN-F-48 (100/130) GRADE FUEL

—△— CHECK POINTS WITH AN-F-48 (115/145) GRADE FUEL.

NOTE

1. AUX. STAGE "BLEED-OFF" VALVE INSTALLED FOR 2300 AND 2100 RPM RUNS.
2. NO DATA OBTAINED AT 1800 RPM BECAUSE OF AUX. STAGE STALLING EVEN WITH BLEED-OFF VALVE.
3. ALL DATA WERE TAKEN AT MIN. SLIP, HIGH BLOWER CONDITIONS, AND ALTITUDE VARIED TO CHANGE AIR-FLOW.
4. AUTOMATIC MANIFOLD PRESSURE REGULATOR INSTALLED FOR 2300 AND 2100 RPM RUNS ONLY.
5. NOTES 2,3,4,5 AND 7 OF PLATE 37. ARE APPLICABLE.

DETONATION LIMITED MIXTURE RESPONSE CURVES-FULL HIGH GEAR

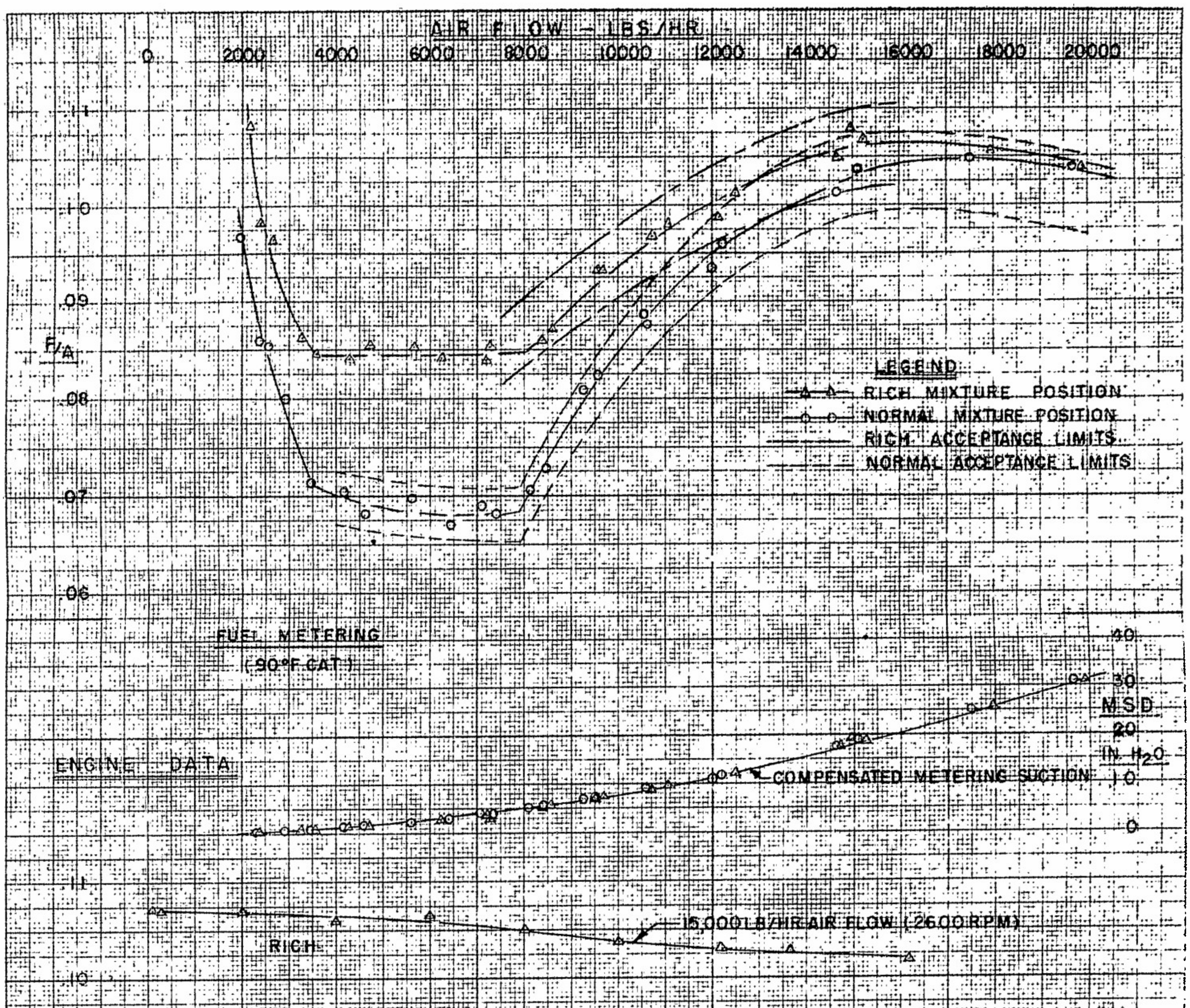
P & W R-2800-32W ENGINE, NO. P-25802

USING AN-F-48 (100/130) AND (115/145) FUELS

AERONAUTICAL ENGINE LABORATORY

NAVAL AIR EXPERIMENTAL STATION, PHILADELPHIA, PA.

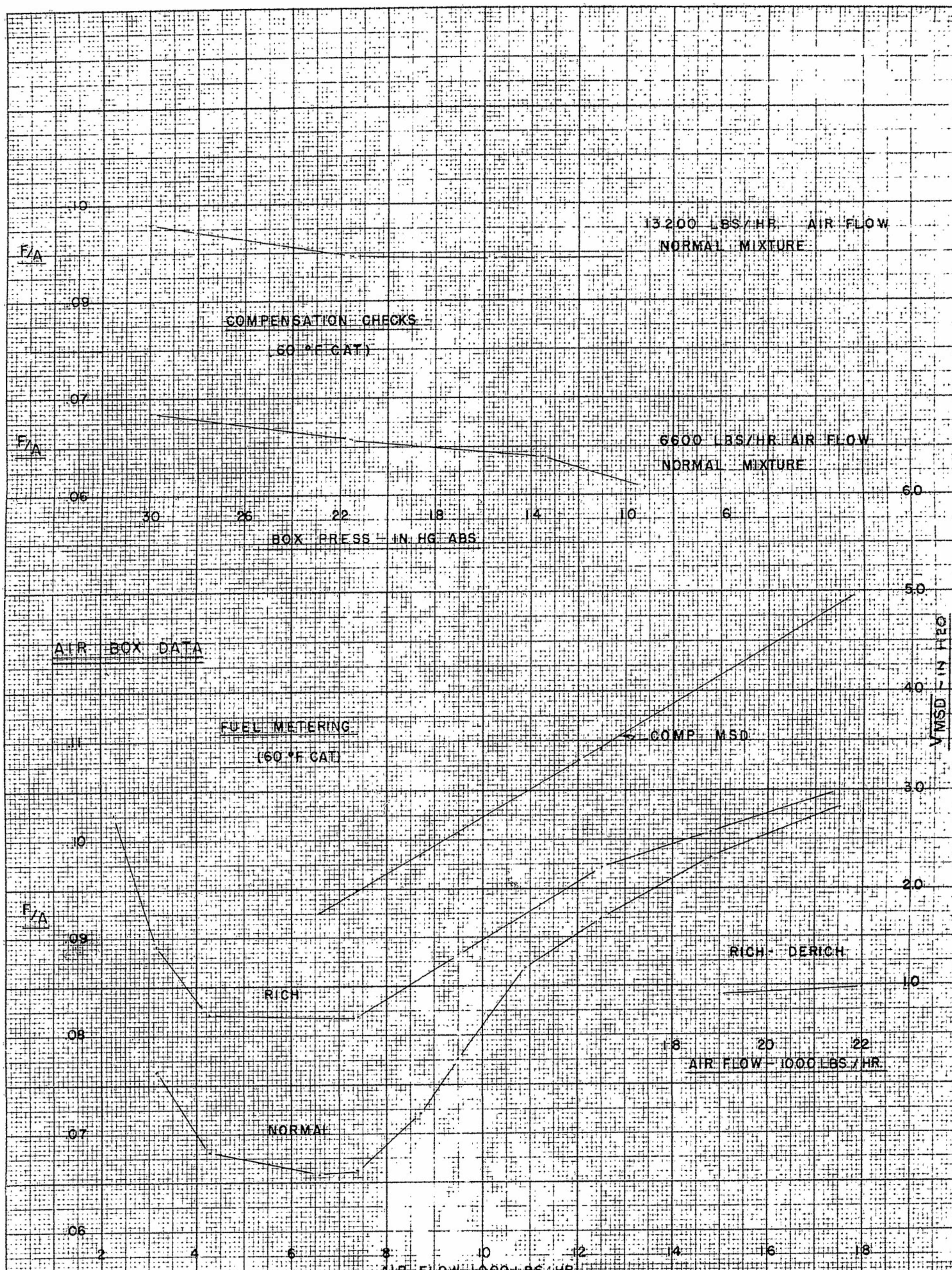
Proj. TED No. NAM PP-215 Engr. TAYLOR



NOTES.

1. F4U-5 AIRPLANE INDUCTION SYSTEM.
2. ENGINE OPERATED ON NORMAL PROP LOAD CURVE.
3. CARB. AIR TEMP. WAS AVERAGE OF 5 THERMOCOUPLES LOCATED ON CARB. SCREEN AND ONE IN CARB. SCOOP.
4. DOTTED LINES ARE ACCEPTANCE LIMITS FOR PR-64B2-2 CARBURETORS METERING TO PARTS LIST NO'S 390940-8, 9, 10. (P&W CURVE OF 10-28-47)

METERING CHARACTERISTICS
STROMBERG PR-64B2 CARBURETOR
P.L. NO. 390940-10, SER. NO. 728821
P&W R-2800-32W ENGINE NO. P-28802
AERONAUTICAL ENGINE LABORATORY
NAVAL AIR EXPERIMENTAL STATION, PHILADELPHIA, PA.
Proj. TED No. NAM PP215 Engr. TAYLOR



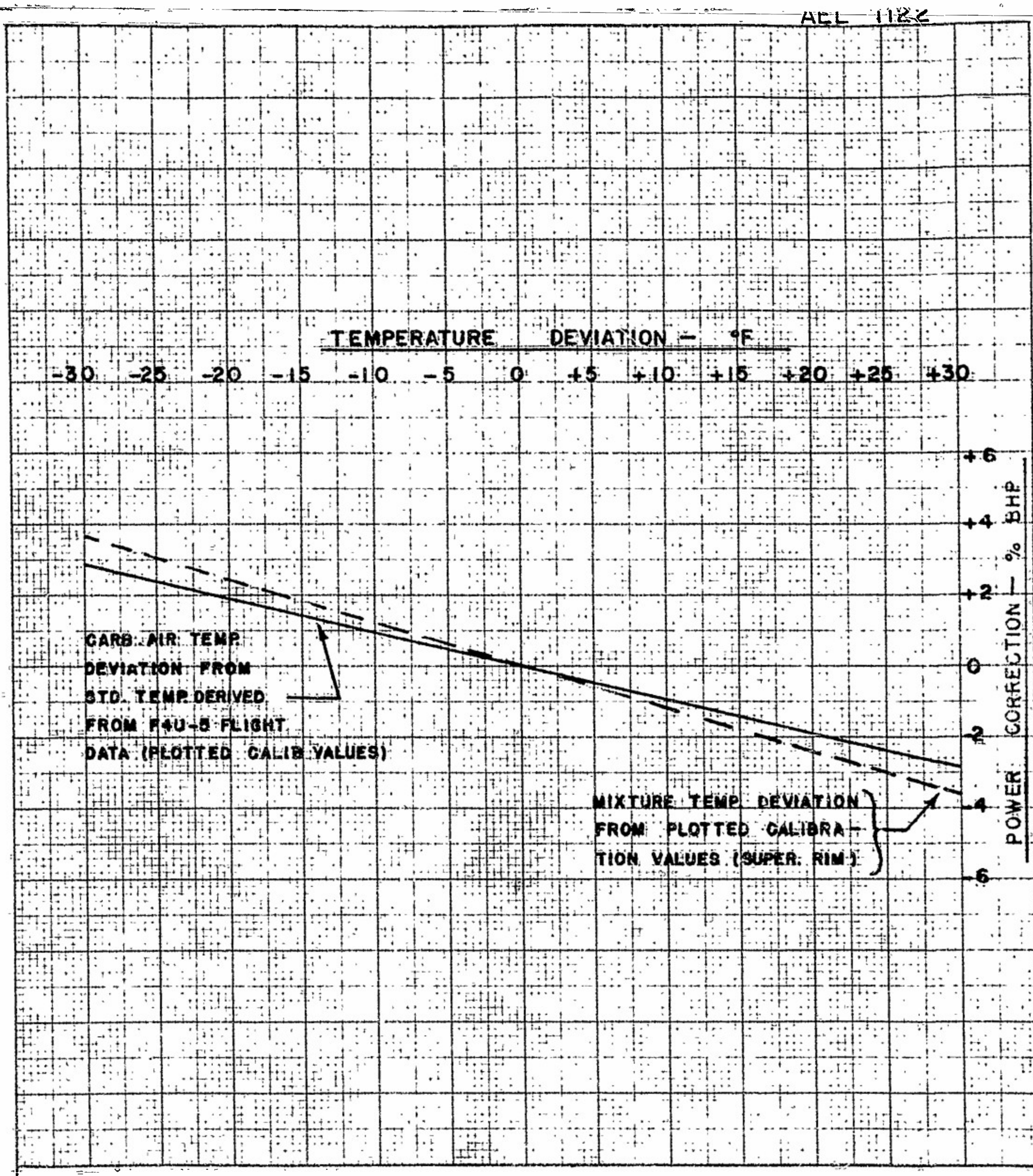
TEST CONDITIONS:

1. 60°F CAT. SCOOP, NO SCREEN.
2. VIBRATOR ON SCOOP FLANGE
3. INLET FUEL PRESS - 25 PSI
4. DISCH FUEL PRESS - 10 PSI
5. FUEL SP. GR. ~ .695 @ 78°F

TEST EQUIP.
NO. 1 AIR BOX

TEST DATE 17-18 FEB. 1947

AIR BOX TESTS OF A
PR-64 B2 CARBURETOR
SER. NO. 72 8821, PL. 391740-10
R-2800 - 32W ENGINE
AERONAUTICAL ENGINE LABORATORY
NAVAL AIR EXPERIMENTAL STATION, PHILADELPHIA, PA.
Proj. TED No. NAM PP215 Engr. TAYLOR



DATA OBTAINED FROM RUNS MADE AT MILITARY, RATED, AND CRUISE POWERS AT SEA LEVEL AND HIGH GEAR CRITICAL ALTITUDES.

CONSTANT A.S.R.P., FUEL-AIR RATIO, AND CYLINDER HEAD TEMPS.

CARBURETOR AIR AND MIXTURE TEMPERATURE CORRECTION CURVES
MAIN STAGE AND AUX. STAGE OPERATION
P&W R-2800-32W ENG, NO. 28802
AERONAUTICAL ENGINE LABORATORY
NAVAL AIR EXPERIMENTAL STATION PHILA PA
ENGR TAYLOR

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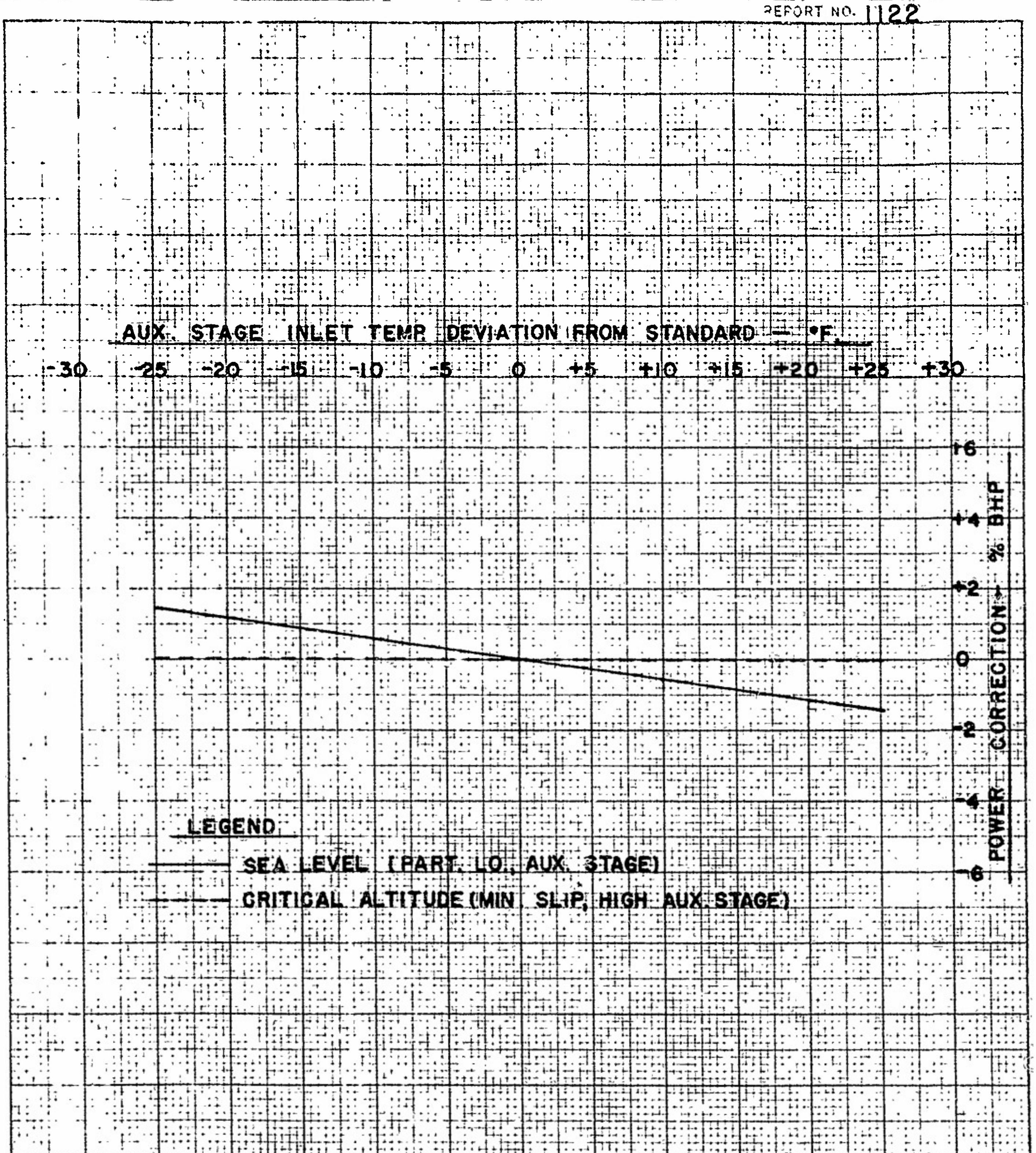


NOTE:

1. DATA OBTAINED FROM RUNS MADE AT SEA LEVEL AND HIGH BLOWER, MIN. SLIP CRITICAL ALTITUDE, AT 2800, 2600, AND 2200 RPM.
2. ALL INLET CONDITIONS TO CYLINDERS MAINTAINED CONSTANT, i.e. CONSTANT F/A, MIXT. TEMP, A.S.R.P., AND CYL. HD. TEMPS.

AUXILIARY STAGE INLET CORRECTION CURVES.

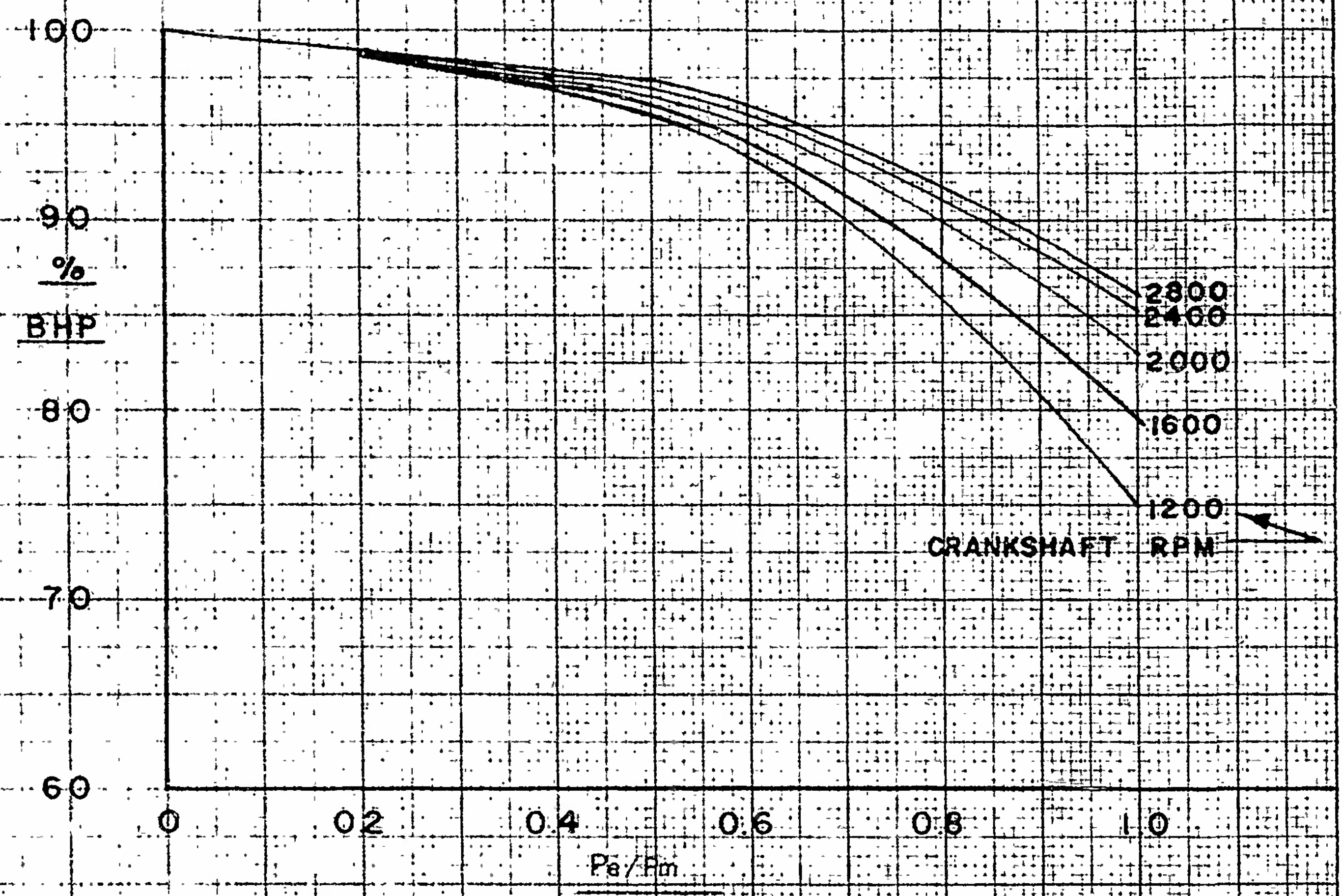
SEA LEVEL AND CRITICAL ALTITUDE

P&W R-2800-32W ENG., NO. P-28802

AERONAUTICAL ENGINE LABORATORY

NAVAL AIR EXPERIMENTAL STATION, PHILA., PA.

PROJECT NO. NAM PP-215 ENG R TAYLOR



NOTE 1. THIS CORRECTION FOR EXHAUST PRESS. ONLY - ADDITIONAL CORRECTION MUST BE MADE FOR MIXTURE OR CARB. AIR TEMP. VARIATION FROM CALIBRATION DATA.

2. RUNS MADE AT SPEEDS INDICATED MAINTAINING A.S.R.P., F/A, MIXTURE TEMP., AND CYL. HD. TEMP. AT CONSTANT VALUES THROUGHOUT RUN.

EXAMPLE:

OBSERVED DATA: 1115 BHP (CALIB. DATA)
2200 RPM
Pe = 33 IN. HG - EXHAUST PRESS.
Pe1 = 29 IN. HG. PLANE ALT. PRESS.
Pm = 34 IN. HG. MANIFOLD PRESS.

DETERMINE FROM THE ABOVE CORR. CURVES

$Pe/Pm = \frac{33}{34} = .97 = 85.2\%$ BHP

$Pe_1/Pm = \frac{29}{34} = .852 = 89\%$ BHP

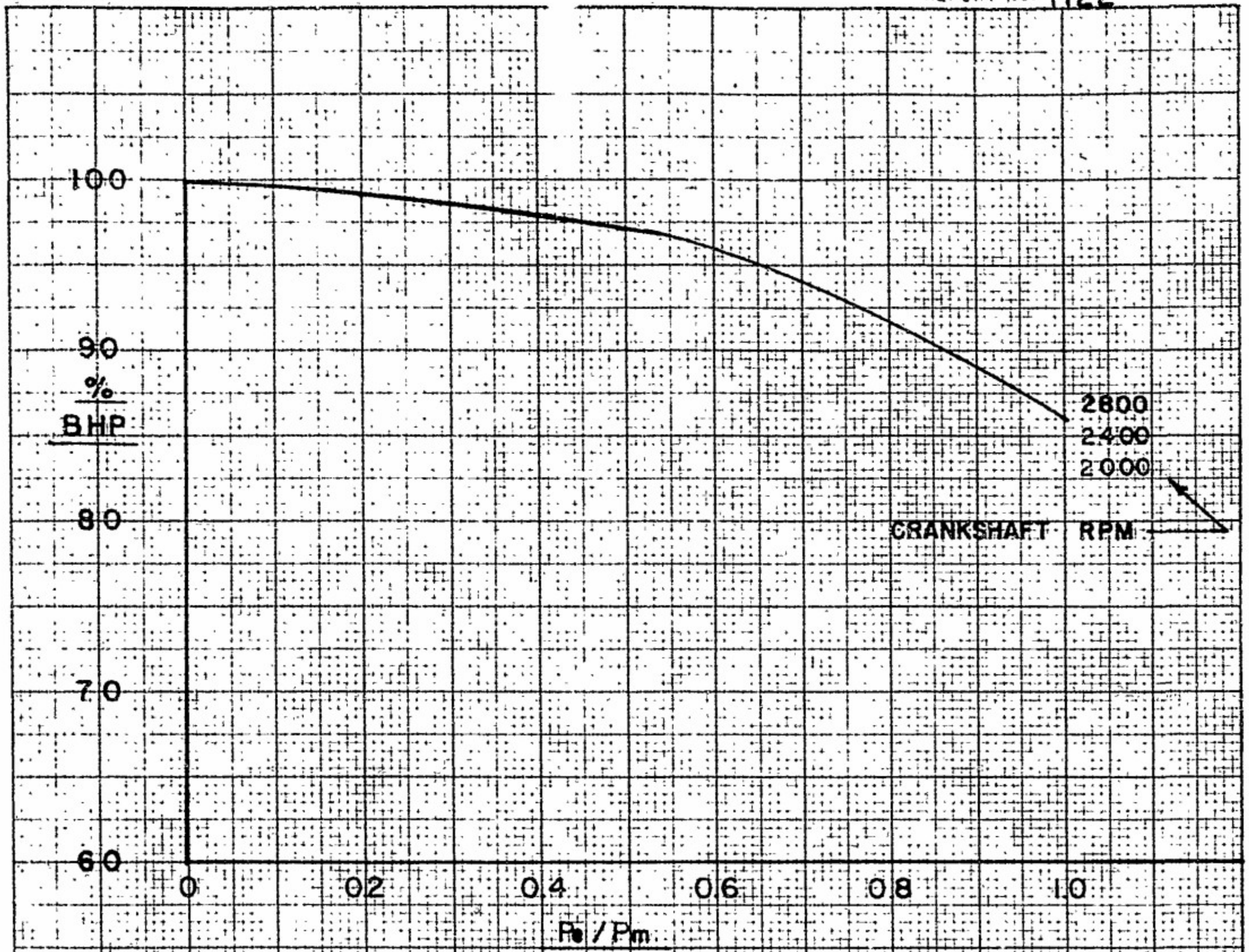
$BHP = 1115 \times \frac{85.2}{89.0} = 1067$ BHP

DUE TO 4" BACK PRESS. ON EXHAUST.

EXHAUST BACK PRESSURE CORRECTION CURVES
NEUTRAL GEAR
P & W R-2800-32W., ENG. NO. P28802
AERONAUTICAL ENGINE LABORATORY
NAVAL AIR EXPERIMENTAL STATION, PHILA., PA.
PROJ TED NO NAM PP-215 ENG'R TAYLOR

PLATE 43

REPORT NO. 1122



NOTE: 1. THIS CORRECTION FOR EXHAUST PRESSURE ONLY — ADDITIONAL CORRECTION MUST BE MADE FOR MIXTURE OR CARB. AIR TEMP. VARIATION FROM CALIBRATION DATA.

2. RUNS MADE AT SPEEDS INDICATED MAINTAINING A.S.R.P., F/A MIXTURE TEMP. AND CYLINDER HEAD TEMPERATURE AT CONSTANT VALUES THROUGHOUT RUN.

EXAMPLE:

OBSERVED DATA: 1400 BHP (CALIB. DATA)
2400 RPM
P_e = 11 IN. HG. EXHAUST PRESS.
$P_{e'}$ = 7 IN. HG. PLANE ALT. PRESS.
P_m = 42 IN. HG. MANIFOLD PRESS.

DETERMINE FROM THE ABOVE CORR. CURVES

$P_e/P_m = \frac{11}{42} = .262 = 98.9\ \%$

$P_{e'}/P_m = \frac{7}{42} = .167 = 99.4\ \%$

BHP = 1400 $\frac{98.9}{99.4}$ = 1392 BHP

DUE TO 4" EXH. PRESS ON EXHAUST

EXHAUST BACK PRESSURE CORRECTION CURVES

HIGH GEAR, MIN. SLIP.

P & W R-2800-32W ENG., NO. P-28802

AERONAUTICAL ENGINE LABORATORY
NAVAL AIR EXPERIMENTAL STATION, PHILA., PA

PROJ. TED NO. NAM PP-215 ENG'R. TAYLOR

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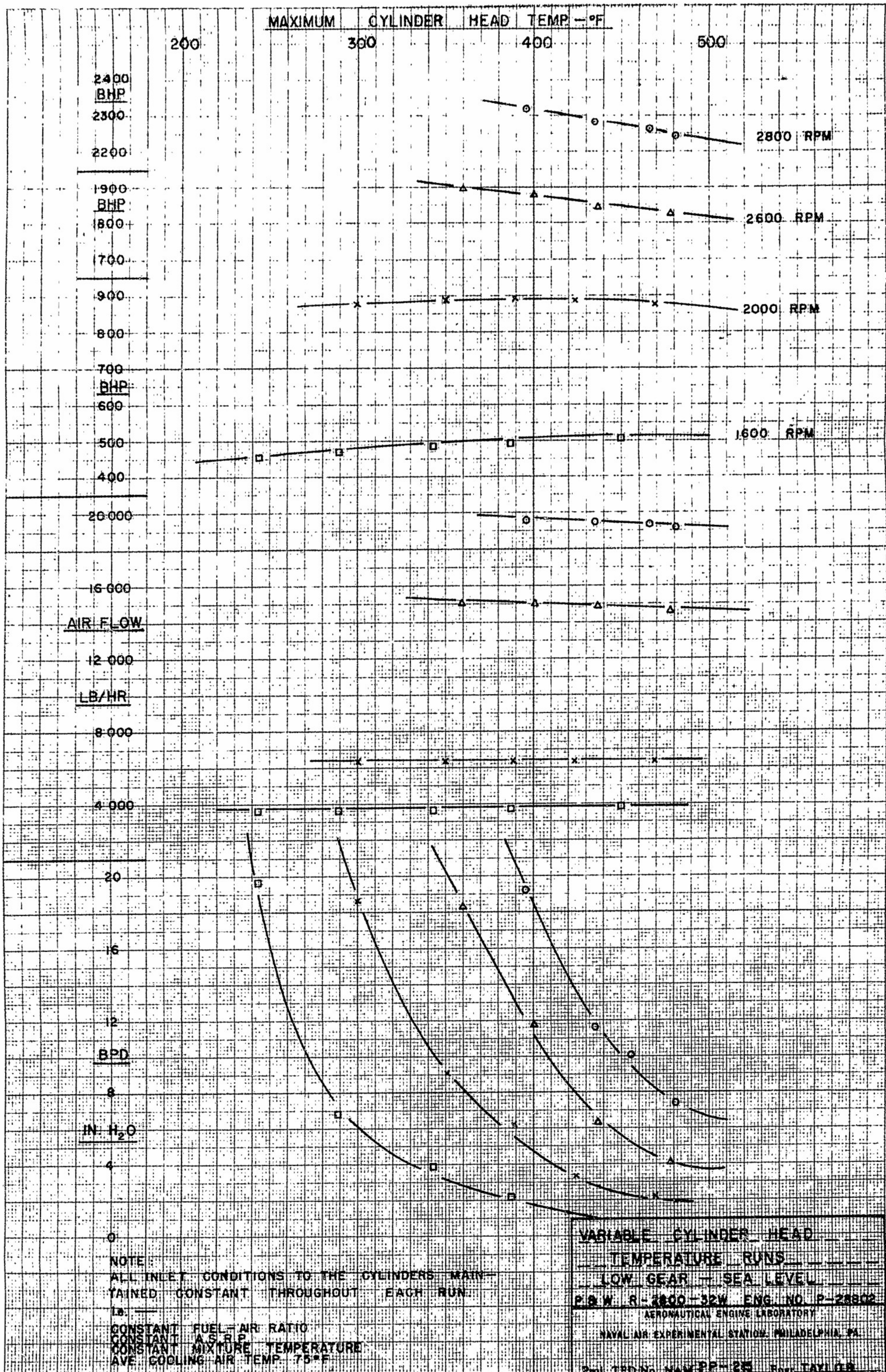
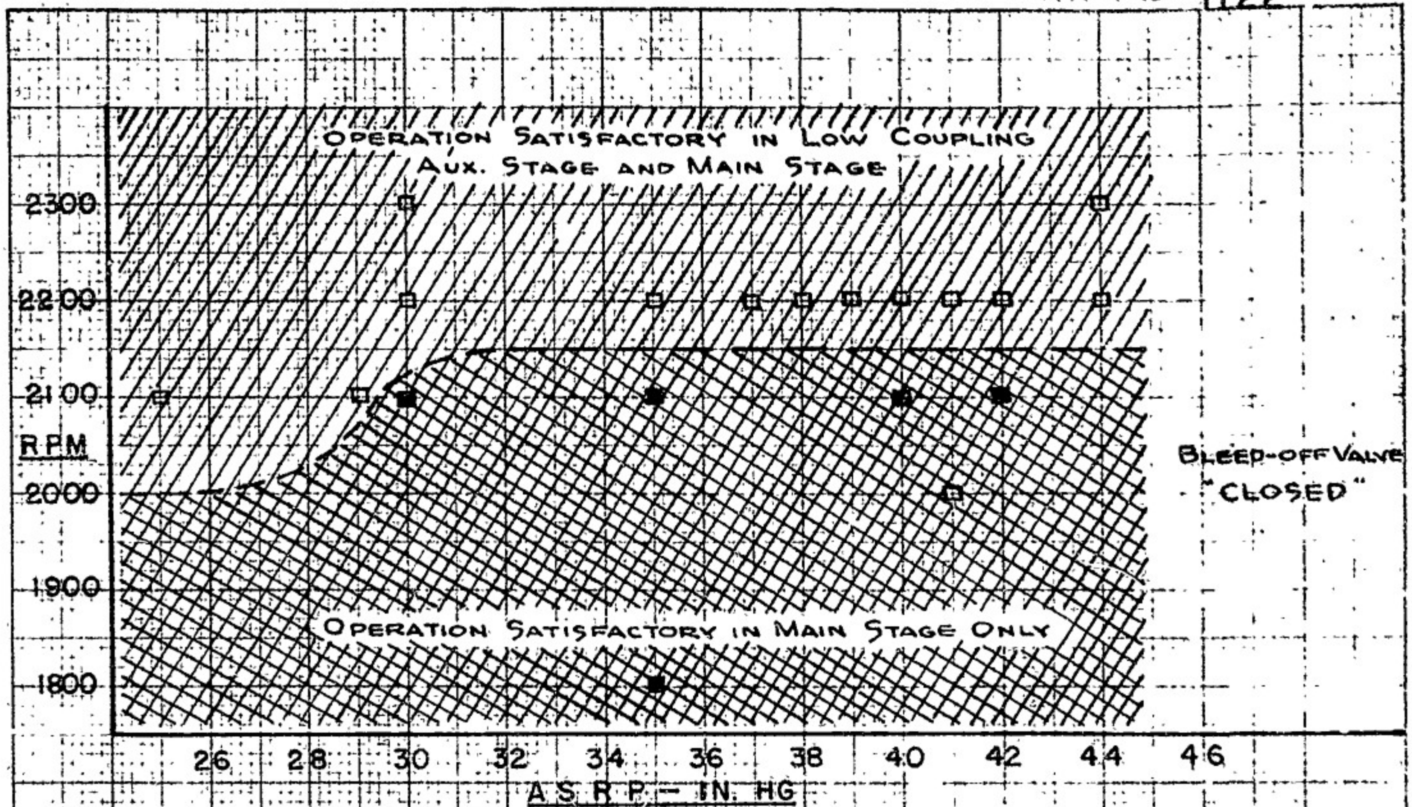
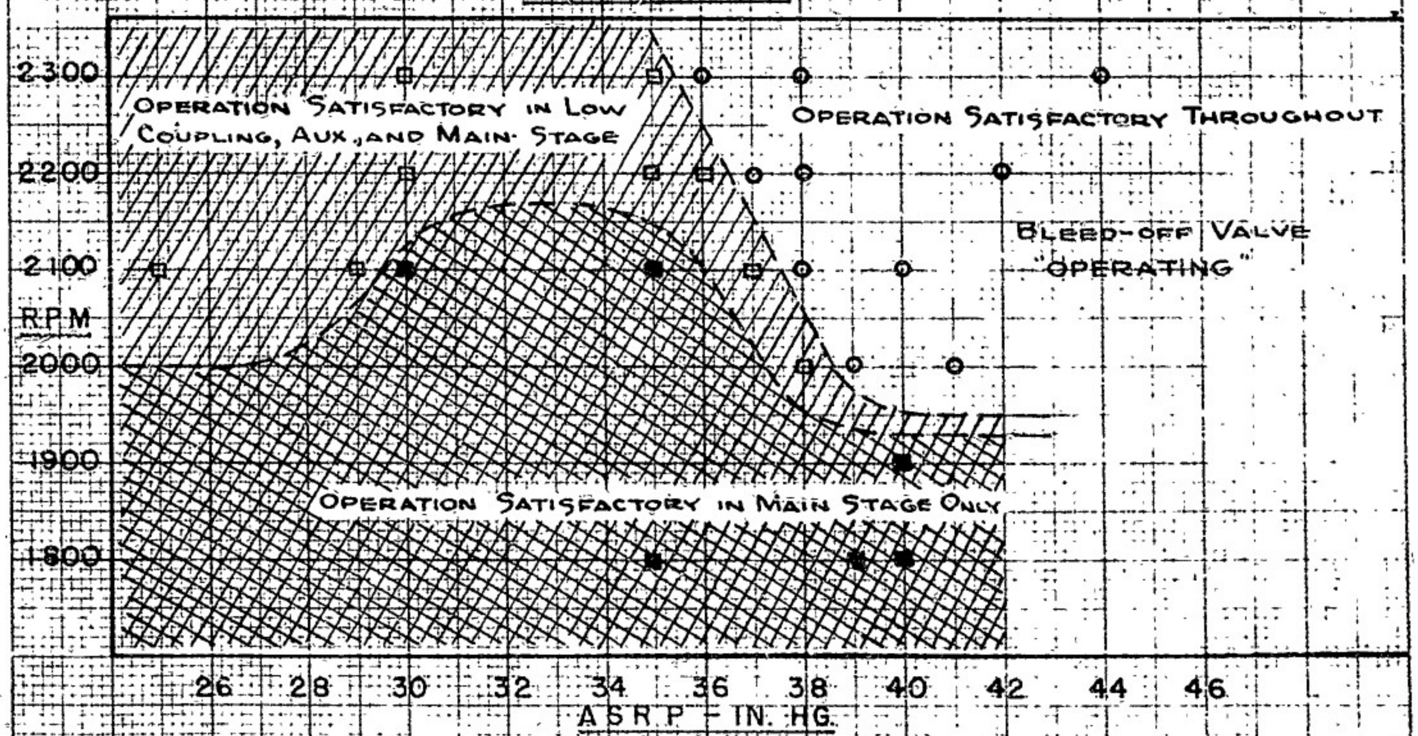
FORM 165

PLATE 44



MAXIMUM CYLINDER HEAD TEMP — °F
200
300
400
500
2400
BHP
2300
2200
2800 RPM
1900
BHP
1800
1700
2600 RPM
900
800
2000 RPM
700
BHP
600
500
400
1600 RPM
20 000
16 000
AIR FLOW
12 000
LB/HR
8 000
4 000
20
16
12
BPD
8
IN. H_2O
4
0
NOTE:
ALL INLET CONDITIONS TO THE CYLINDERS MAINTAINED CONSTANT THROUGHOUT EACH RUN.
i.e. —
CONSTANT FUEL-AIR RATIO
CONSTANT A.S.R.P.
CONSTANT MIXTURE TEMPERATURE
AVE. COOLING AIR TEMP. 75°F
VARIABLE CYLINDER HEAD
TEMPERATURE RUNS
LOW GEAR — SEA LEVEL
P & W R-2800-32W ENG. NO. P-28802
AERONAUTICAL ENGINE LABORATORY
NAVAL AIR EXPERIMENTAL STATION, PHILADELPHIA, PA.
Proj. TED No. NAM PP-25 Engr. TAYLOR





LEGEND

- O NO INSTABILITY FROM S.L. TO 35,000 FT. AND RETURN.
- □ INSTABILITY ONLY WHEN SHIFTING FROM HIGH TO LOW COUPLING
- ■ INSTABILITY IN LOW COUPLING, AUX. STAGE.

NOTE:

1. INSTABILITY ENCOUNTERED WAS STALLING OF RIGHT-HAND AUX. STAGE IMPELLER.
2. F4U-5 AIRPLANE DUCTS, INTERCOOLERS, AND CARB. SCOOP. BLEED-OFF VALVE CLOSED BY AIR PRESSURE ON THE DIAPHRAGM. AIR FROM BLEED-OFF VALVE PIPED TO INDUCTION SYSTEM UPSTREAM OF AUX. ENTRANCE DUCTS.
3. CROSS-HATCHING IN ABOVE CURVES INDICATES INSTABILITY AT CONDITIONS SHOWN.

CRUISE STABILITY OPERATING LIMITS
WITH AND WITHOUT AUX. "BLEED OFF" VALVE
STROM. CO-3F REGULATOR - "NORMAL" MIXTURES
P & W R-2800-32 W ENGINE P-28802
AERONAUTICAL ENGINE LABORATORY
NAVAL AIR EXPERIMENTAL STATION, PHILA. PA.

PROJ. TED NO. NAM PP215 ENG.R TAYLOR

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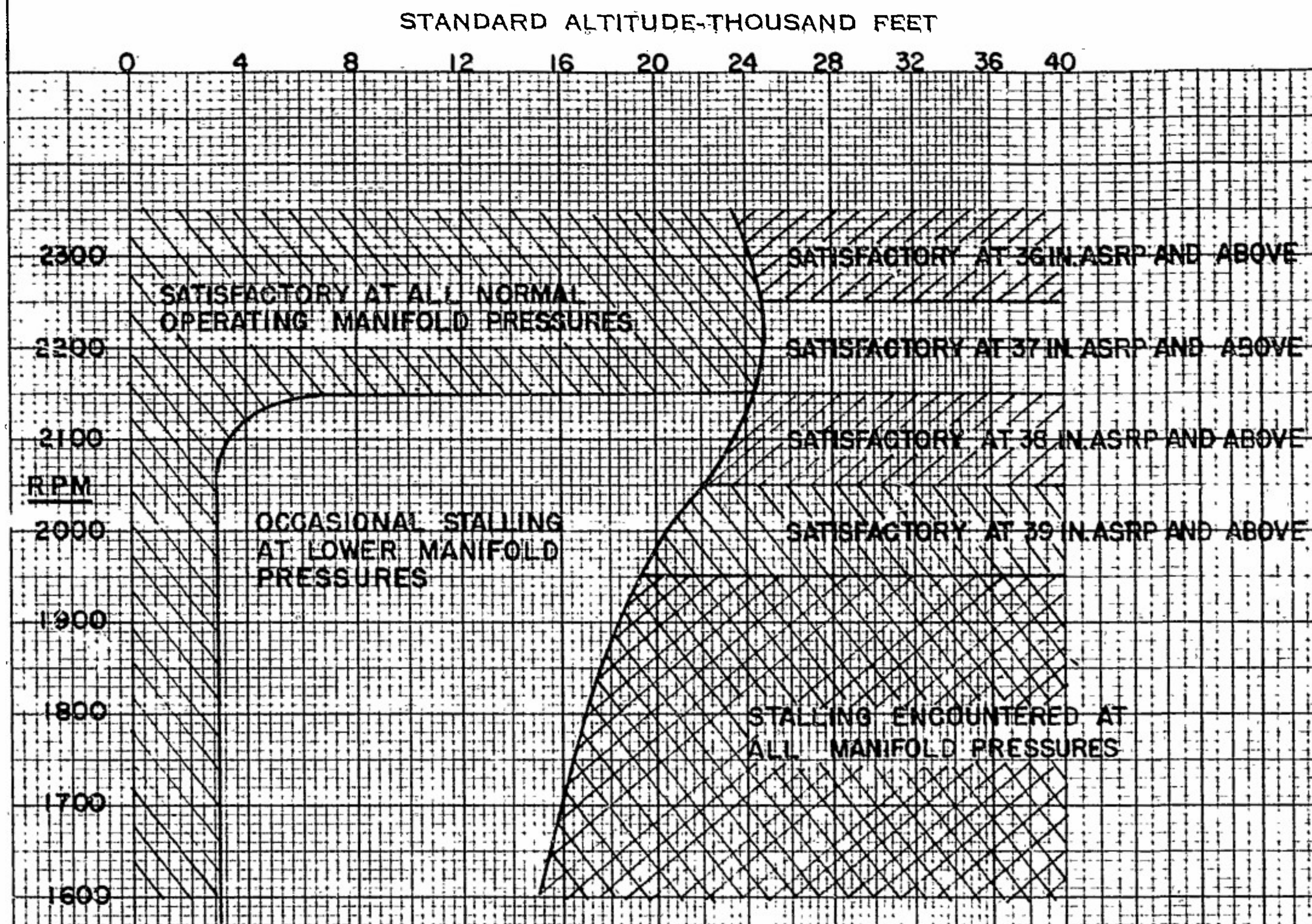
FORM 185



EXAMPLE OF USE OF CURVES

RPM - 2200

ASRP - 33 IN.

CLIMB SATISFACTORY AT THESE CONDITIONS UP TO APPROX. 24,000 FT. AT THIS ALTITUDE ASRP SHOULD BE INCREASED TO 37 IN. HG. OR ABOVE TO PREVENT STALLING, AND CLIMB CONTINUED.

NOTE:

1. STROMBERG CO-3F MANIFOLD PRESSURE REGULATOR
2. STALLING ENCOUNTERED WAS ON RIGHT HAND DUAL AUX. STAGE IMPELLER
3. F4U-5 AIRPLANE DUCTS, INTERCOOLERS, AND "BLEED-OFF" VALVE

RATIOS - COMP. 6.75:1 IMPELLER NU-6.70:1 PROP. .450:1
CARB. PR-64 B2 MIN. SLIP, AUX. Lo-7.78:1 AUX. Hi-9.65:1 OIL GRADE 1100
SPARK ADV. PLUGS BG RB 19R FUEL AN-F-48 (115/145)
IMPELLER DIAM. MAIN - 11 in., AUX. - 13 in.

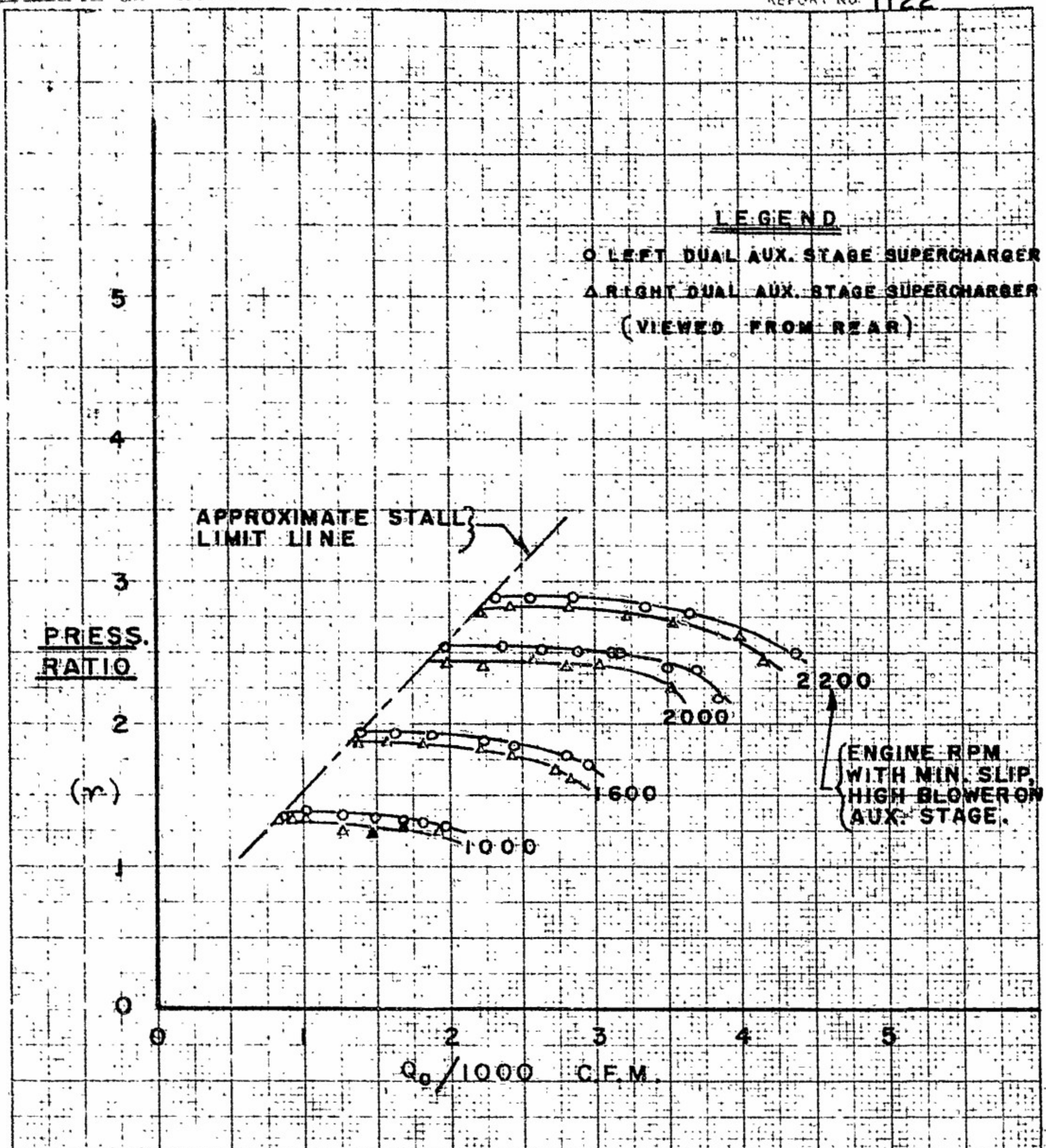
TEST DATE
AV. ROOM BAR. - IN. HG.
AV. CARB. AIR TEMP. °F.
AV. OIL INLET TEMP. °F.
AV. COOL. AIR TEMP. °F.

TEST EQUIPMENT NO. 1 DYN. BLDG. 599

CRUISE STABILITY OPERATING LIMITS
WITH AUX. STAGE "BLEED-OFF" VALVE
R-2800-32 W ENGINE

ENGINE - BU NO. P-28802 MFG. NO.
AERONAUTICAL ENGINE LABORATORY
NAVAL AIRCRAFT FACTORY, PHILA., PA.

PROJ PP 215 ENG'R. TAYLOR



NOTE:
1. RUNS WERE MADE ON THE ENGINE INSTALLED IN NO. I DYN. ROOM USING F4U-5 DUCTING AND INTERCOOLERS.
2. EACH AUXILIARY STAGE IMPELLER WAS TESTED SEPARATELY.
3. BOTH SUPERCHARGERS EXHAUSTED TO ATMOSPHERE. AIRFLOW THROUGH THE ONE BEING TESTED WAS CONTROLLED BY THROTTLING THE INLET AIR.
4. THE RUNS WERE MADE AT THE INDICATED ENGINE SPEEDS WITH MIN. SLIP, HIGH BLOWER ON AUX. STAGE.

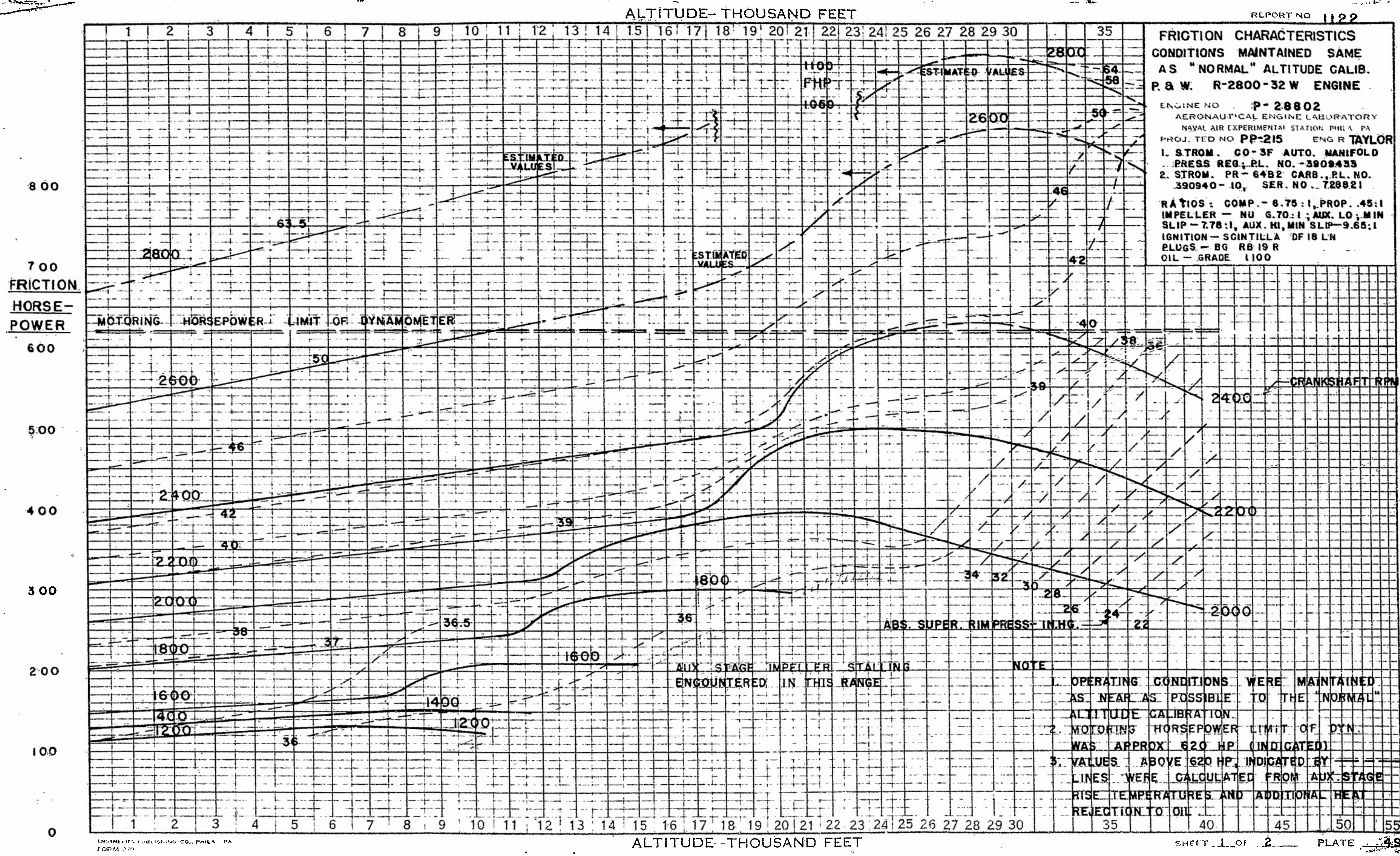
AUXILIARY STAGE IMPELLER PERFORMANCE CHARACTERISTICS AT CRUISING SPEEDS.

P&W. R-2800-32W ENG., NO.P-28802

AERONAUTICAL ENGINE LABORATORY

NAVAL AIR EXPERIMENTAL STATION, PHILA PA

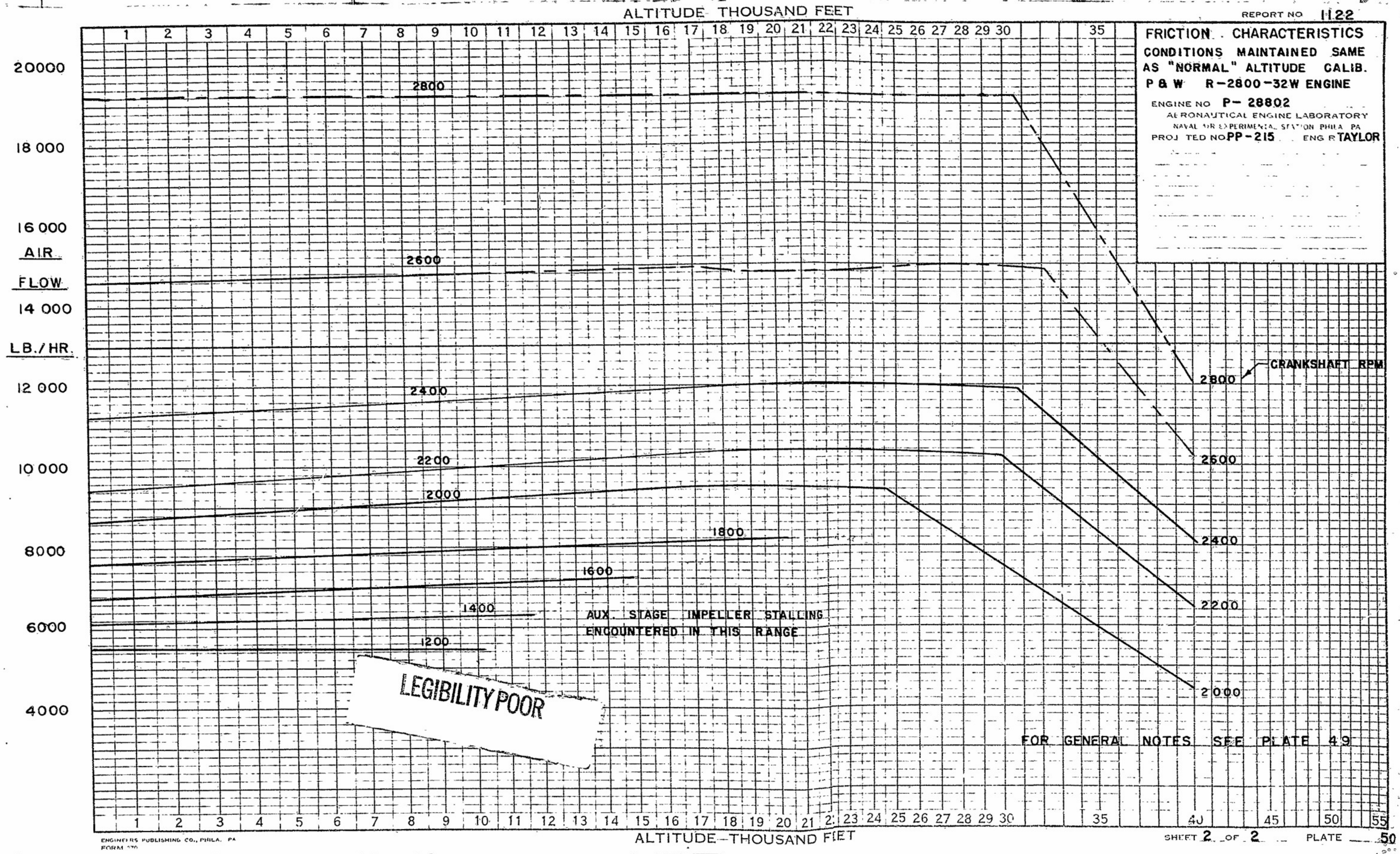
PROJ. TED NO. NAM PP-215 ENGR TAYLOR


REPORT NO 1122
FRICTION CHARACTERISTICS
CONDITIONS MAINTAINED SAME AS "NORMAL" ALTITUDE CALIB.
P. & W. R-2800-32 W ENGINE
ENGINE NO P-28802
AERONAUTICAL ENGINE LABORATORY
NAVAL AIR EXPERIMENTAL STATION PHILA PA
PROJ. TED NO PP-215 ENG R TAYLOR
1. STROM. CO-3F AUTO. MANIFOLD PRESS REG; P.L. NO.-3909433
2. STROM. PR-64B2 CARB., P.L. NO. 390940-10, SER. NO. 728821
RATIOS: COMP.-6.75:1, PROP. .45:1
IMPELLER — NU 6.70:1; AUX. LO, MIN SLIP-7.78:1, AUX. HI, MIN SLIP-9.65:1
IGNITION — SCINTILLA DF 18 LN
PLUGS — BG RB 19 R
OIL — GRADE 1100
ALTITUDE - THOUSAND FEET
FRICTION HORSE-POWER
MOTORING HORSEPOWER LIMIT OF DYNAMOMETER
ESTIMATED VALUES
1100 FHP 1050
CRANKSHAFT RPM
ABS. SUPER. RIMPRESS-IN.HG.
AUX STAGE IMPELLER STALLING ENCOUNTERED IN THIS RANGE
NOTE
1. OPERATING CONDITIONS WERE MAINTAINED AS NEAR AS POSSIBLE TO THE "NORMAL" ALTITUDE CALIBRATION.
2. MOTORING HORSEPOWER LIMIT OF DYN. WAS APPROX 620 HP (INDICATED)
3. VALUES ABOVE 620 HP, INDICATED BY — — — LINES WERE CALCULATED FROM AUX. STAGE RISE TEMPERATURES AND ADDITIONAL HEAT REJECTION TO OIL.
ENGINEERING PUBLISHING CO. PHILA. PA
FORM 220
SHEET 1 OF 2
PLATE 49

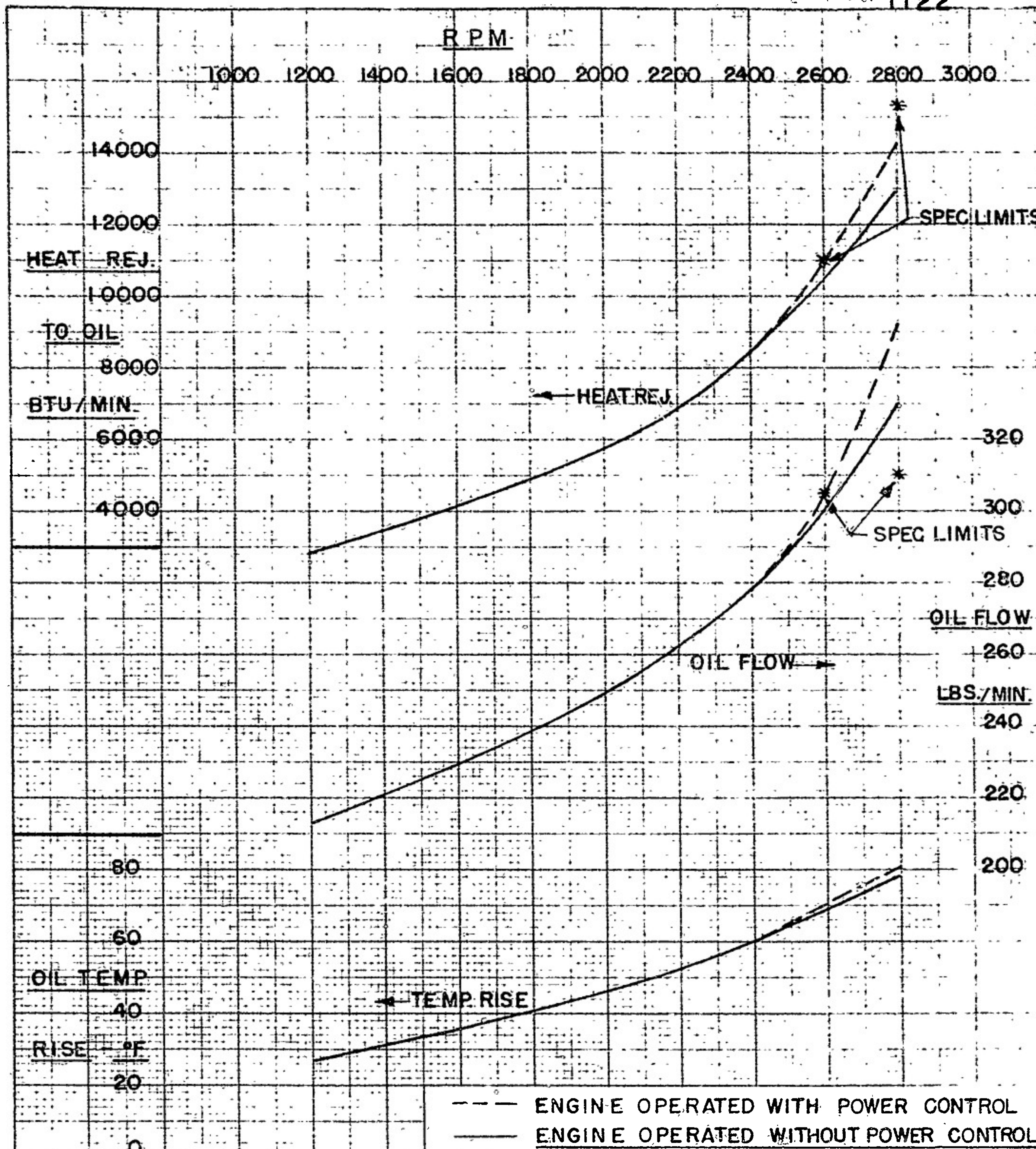
REPORT NO 1122

FRICTION CHARACTERISTICS
CONDITIONS MAINTAINED SAME AS "NORMAL" ALTITUDE CALIB.
P & W R-2800-32W ENGINE

ENGINE NO P-28802
AERONAUTICAL ENGINE LABORATORY
NAVAL AIR EXPERIMENTAL STATION PHILA PA
PROJ TED NO PP-215 ENG R TAYLOR



ENGINEERS PUBLISHING CO., PHILA. PA FORM 270



NOTES:

1. 167 °F OIL-IN TEMP. EXCEPT AT 2800 RPM WHERE 185 °F IS SPECIFIED.
2. PARTIAL AUX. STAGE OPERATION AT TAKE-OFF (2800 RPM) AND RATED (2600 RPM)
3. 118 P.S.I. AVE. MAIN OIL PRESS.
4. 12 P.S.I. AVE. OIL-OUT PRESS.

OIL FLOW AND HEAT REJECTION CHARACTERISTICS

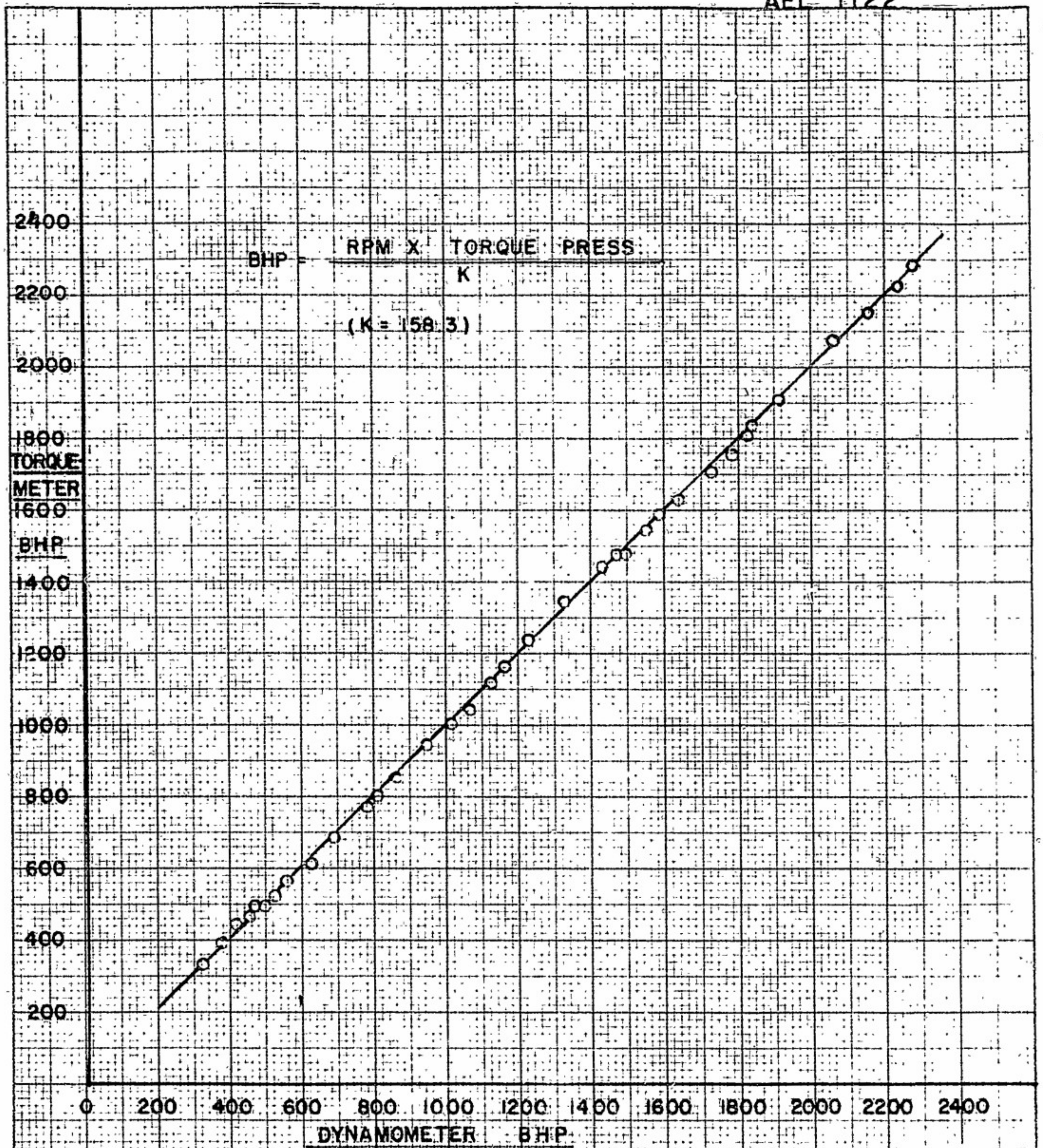
SEA LEVEL – PROPELLER LOAD

P&W R-2800-32W ENG., NO. P-28802

AERONAUTICAL ENGINE LABORATORY

NAVAL AIR EXPERIMENTAL STATION

PROJECT NO. NAM PP-215 ENG'R TAYLOR



NOTES:

RED. GEAR RATIO ---- .45 : 1

OIL-IN TEMP. ------ 167 °F.

OIL ---------- GRADE 1100

TORQUEMETER CALIBRATION
P&W R-2800-32W ENGINE
NO. P-28802
NO. 1 DYNAMOMETER, BLDG. 599
AERONAUTICAL ENGINE LABORATORY
NAVAL AIR EXPERIMENTAL STATION PHILA., PA
ENGR. TAYLOR

ENGINEERS PUBLISHING CO
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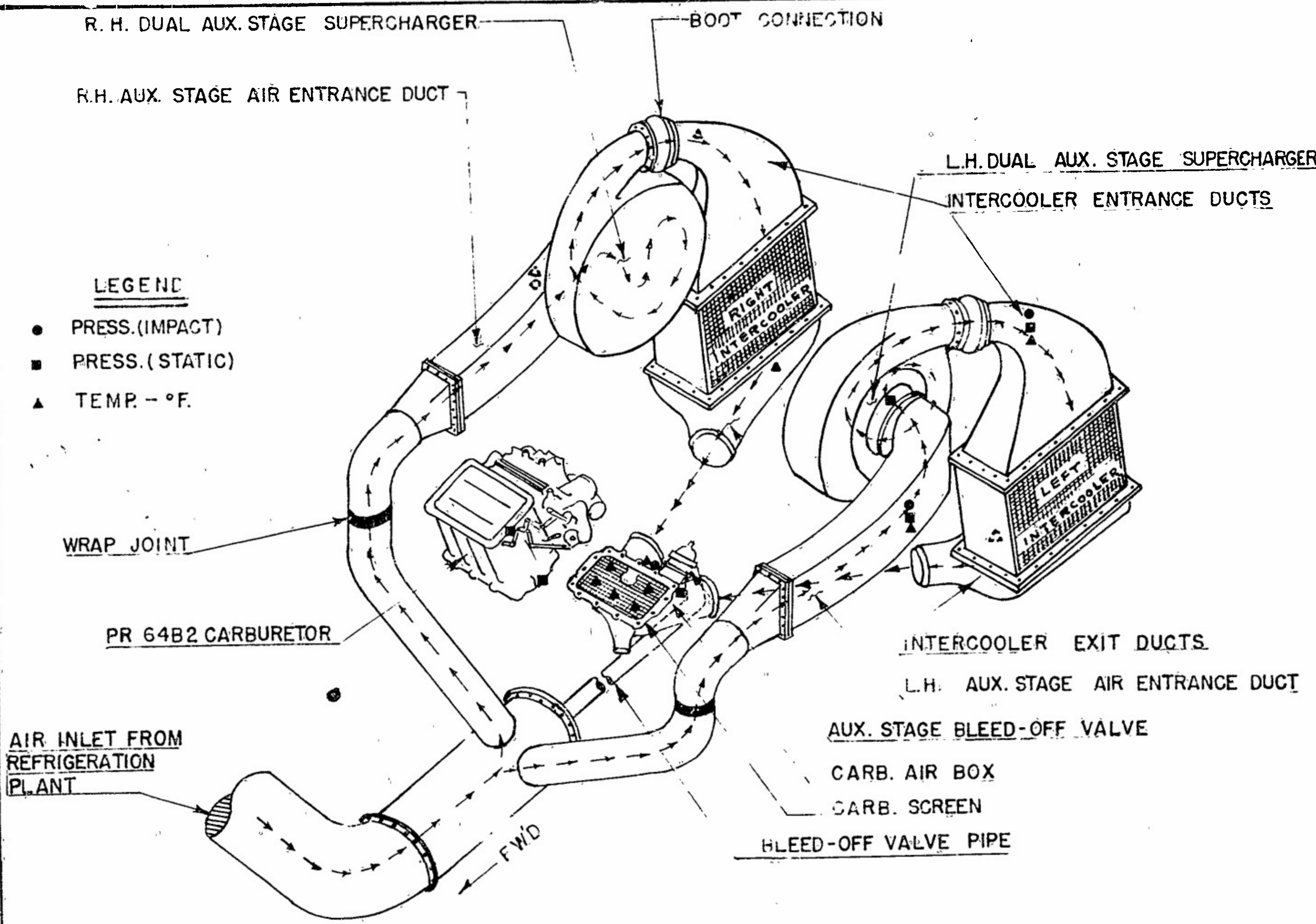
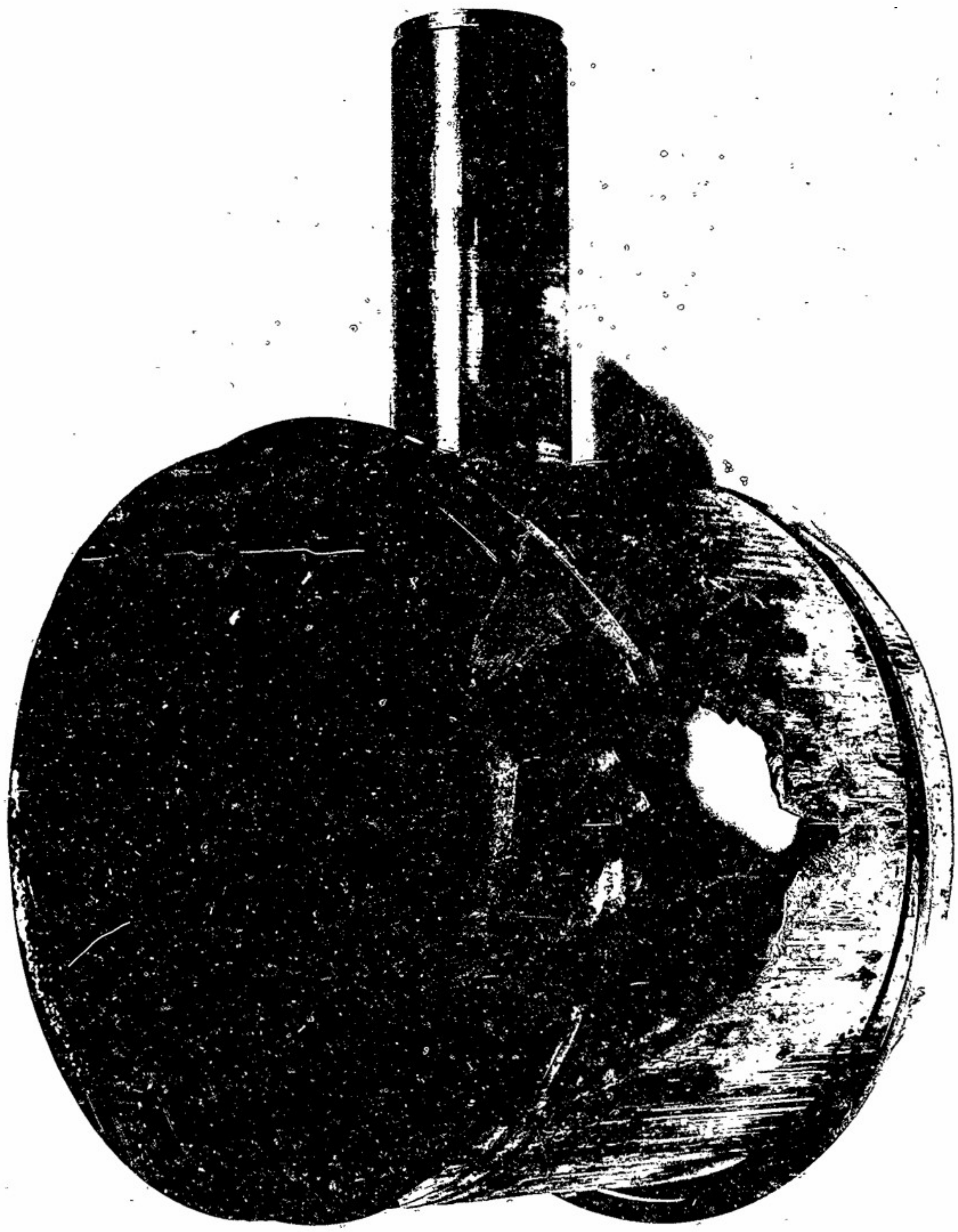


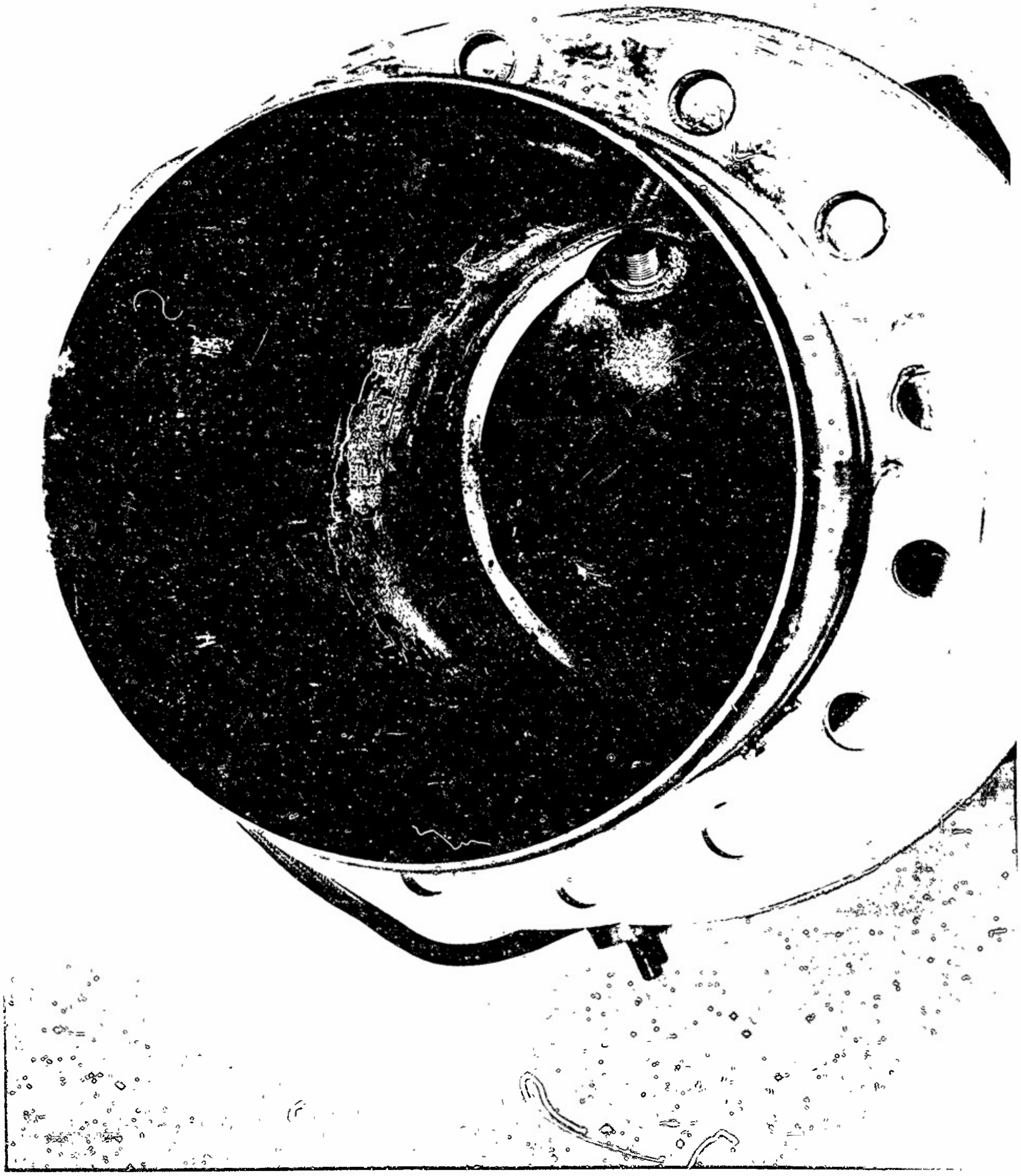
F4U-5 INDUCTION SYSTEM R-2800-32W CALIBRATION

NP(3)-255395(L)-4-48
MAIN ACCESSORY DRIVE SHAFT FAILURE, YR-2800-32W
ENGINE NO. P-28015 AFTER 24 HOURS OPERATING TIME



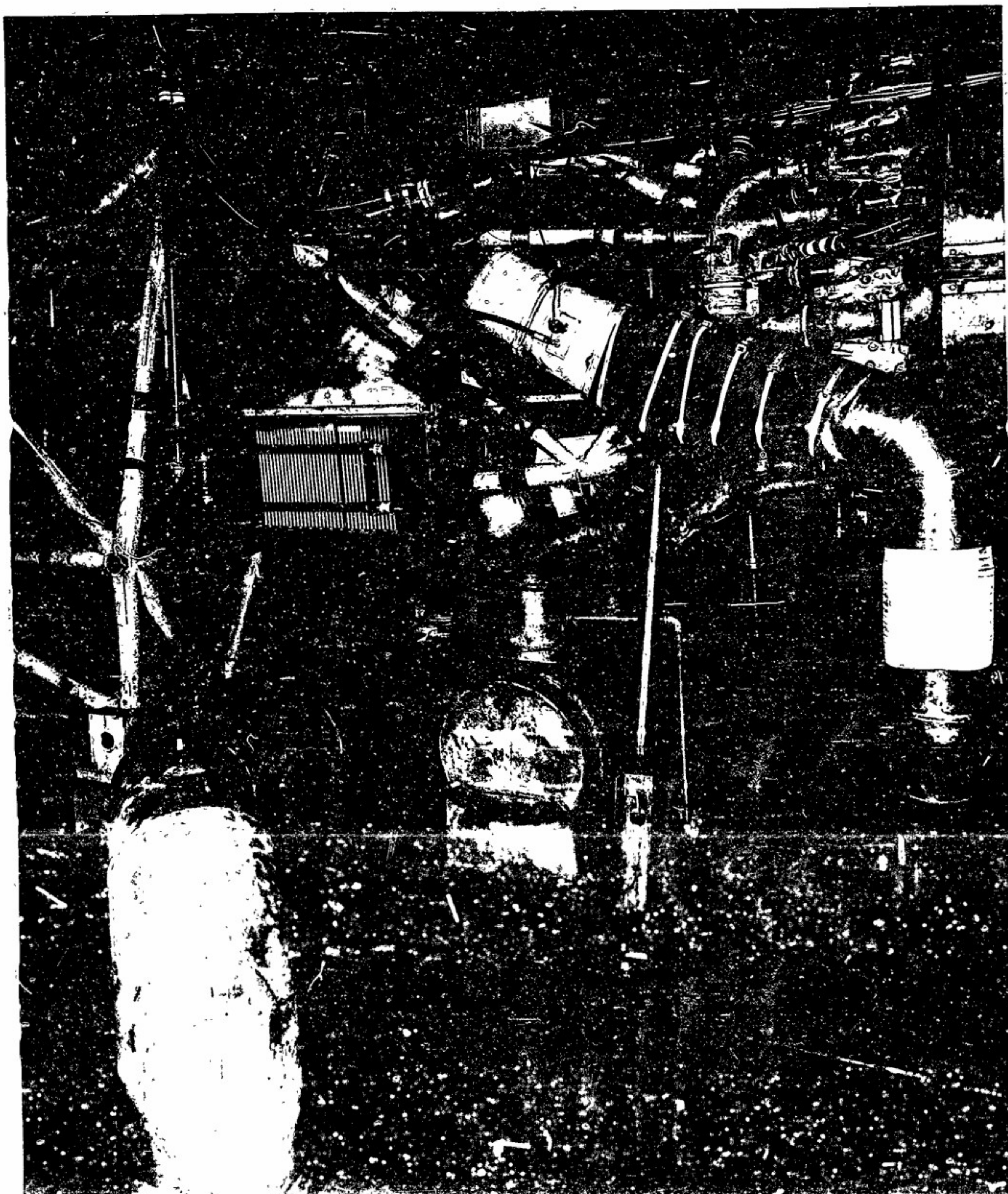
NP(3)-256637(L)-7-48

NO. 8 PISTON FAILURE, R-2800-32W ENGINE
NO. P-28802 AFTER 40 HOURS OPERATING TIME



NP(3)-256636(L)-7-48.

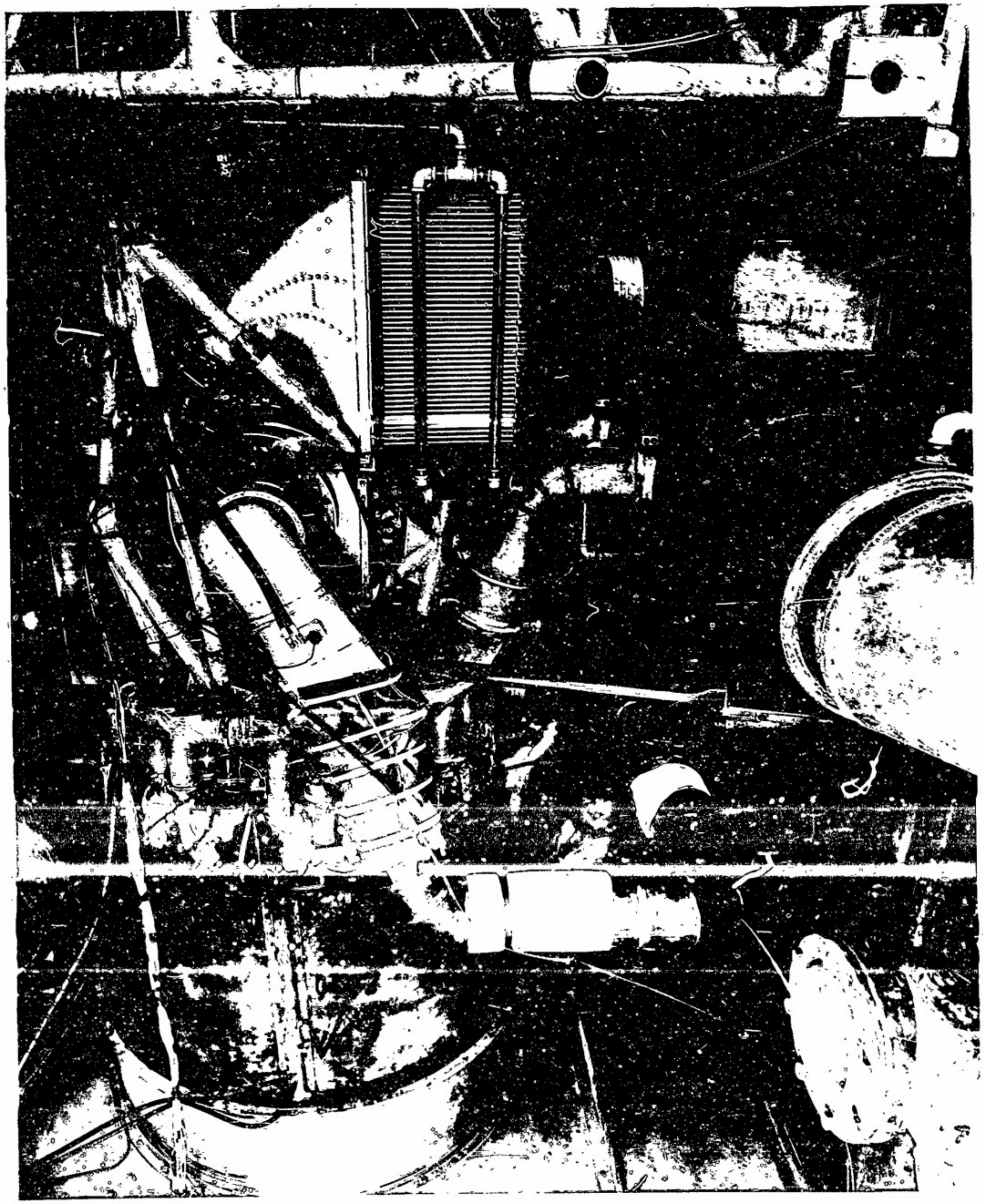
NO. 8 CYLINDER AT FAILURE OF NO. 8 PISTON, R-2800-32W ENGINE AFTER 40 HOURS OPERATING TIME



NP(3)-254864(L)-3-48

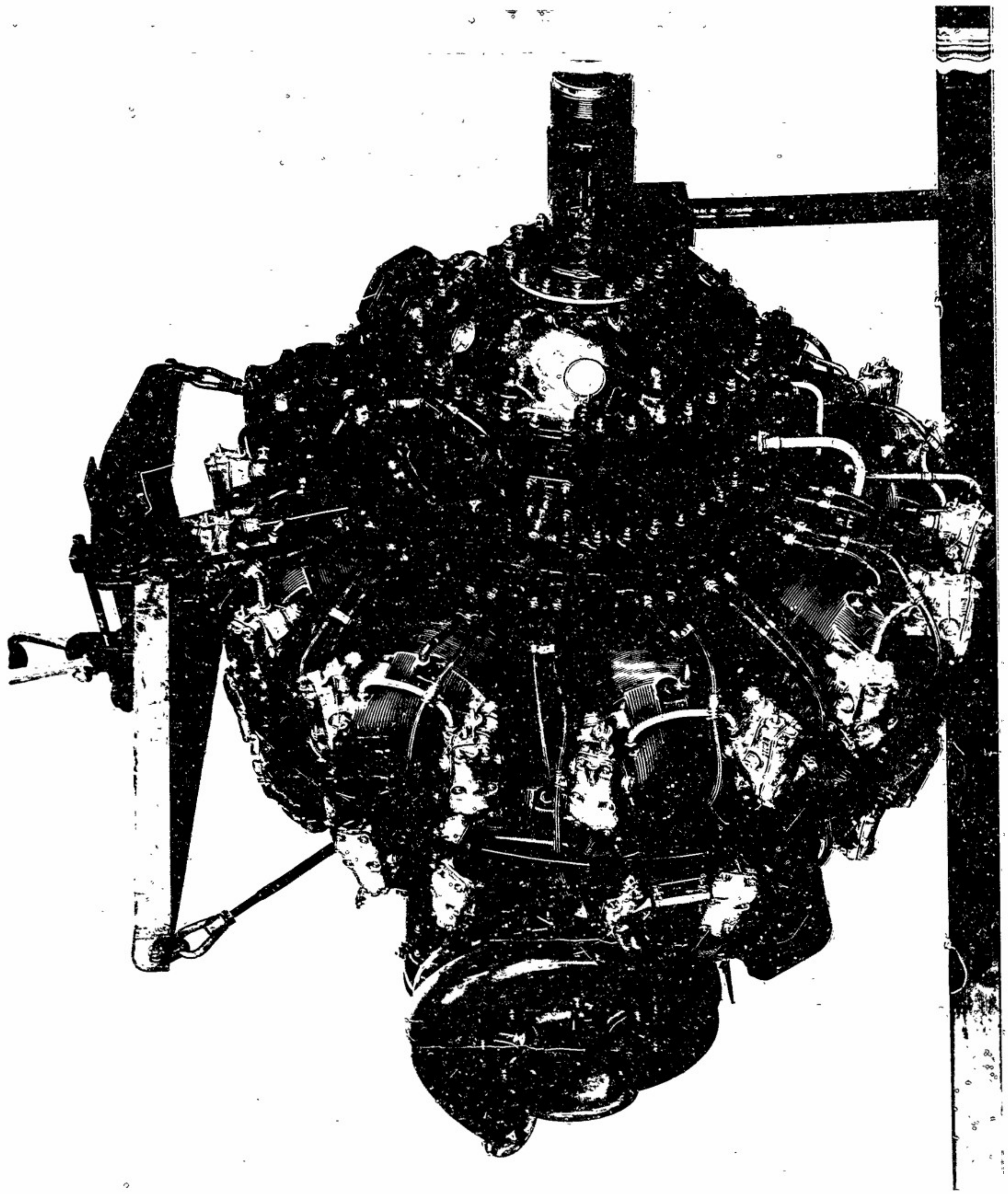
P & W R-2800-32W ENGINE SET-UP IN
NO. 1 DYNAMOMETER ROOM

PLATE 57



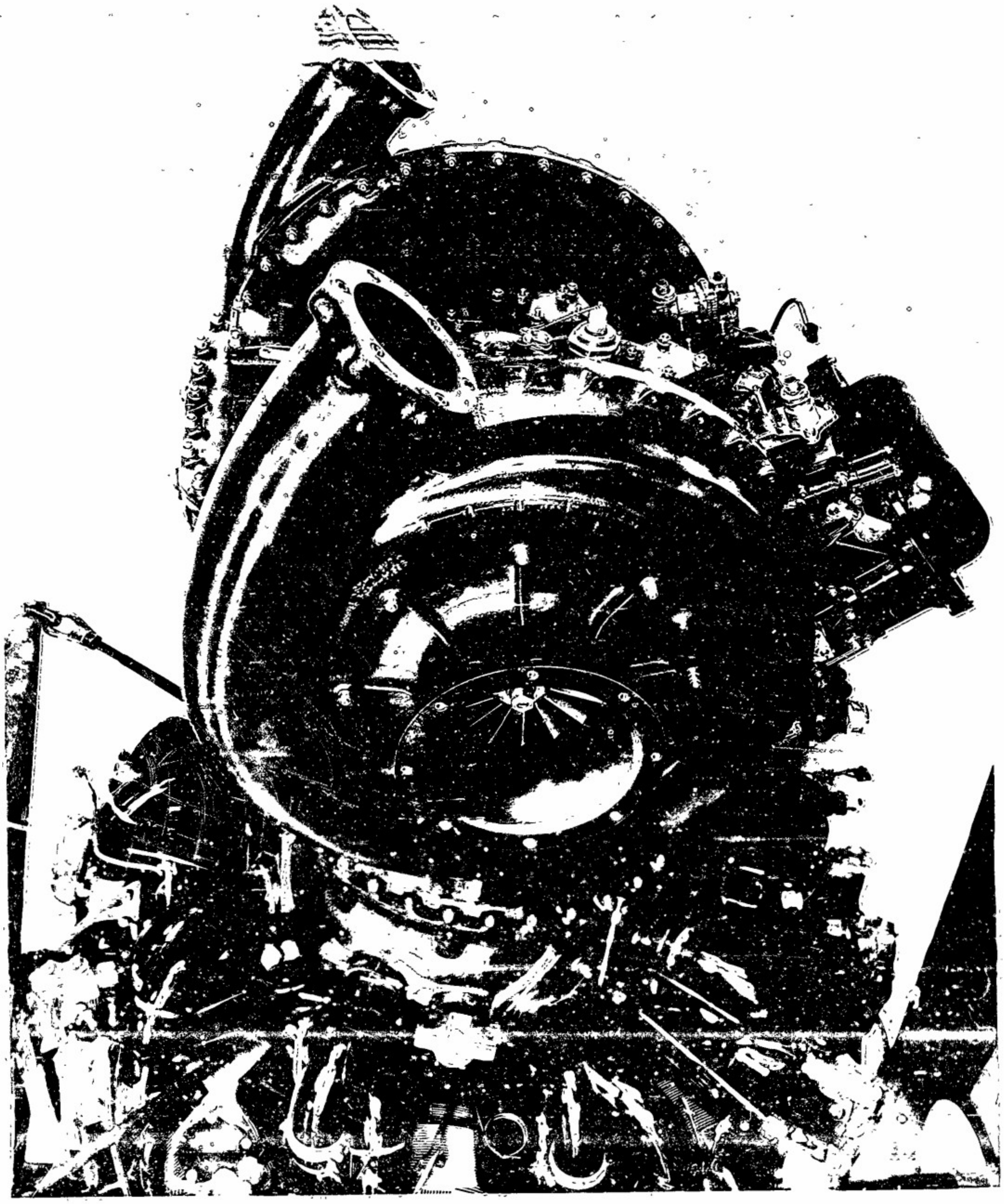
NP(3)-254865(L)-3-48

P & W R-2800-32W ENGINE SET-UP IN
NO. 1 DYNAMOMETER ROOM



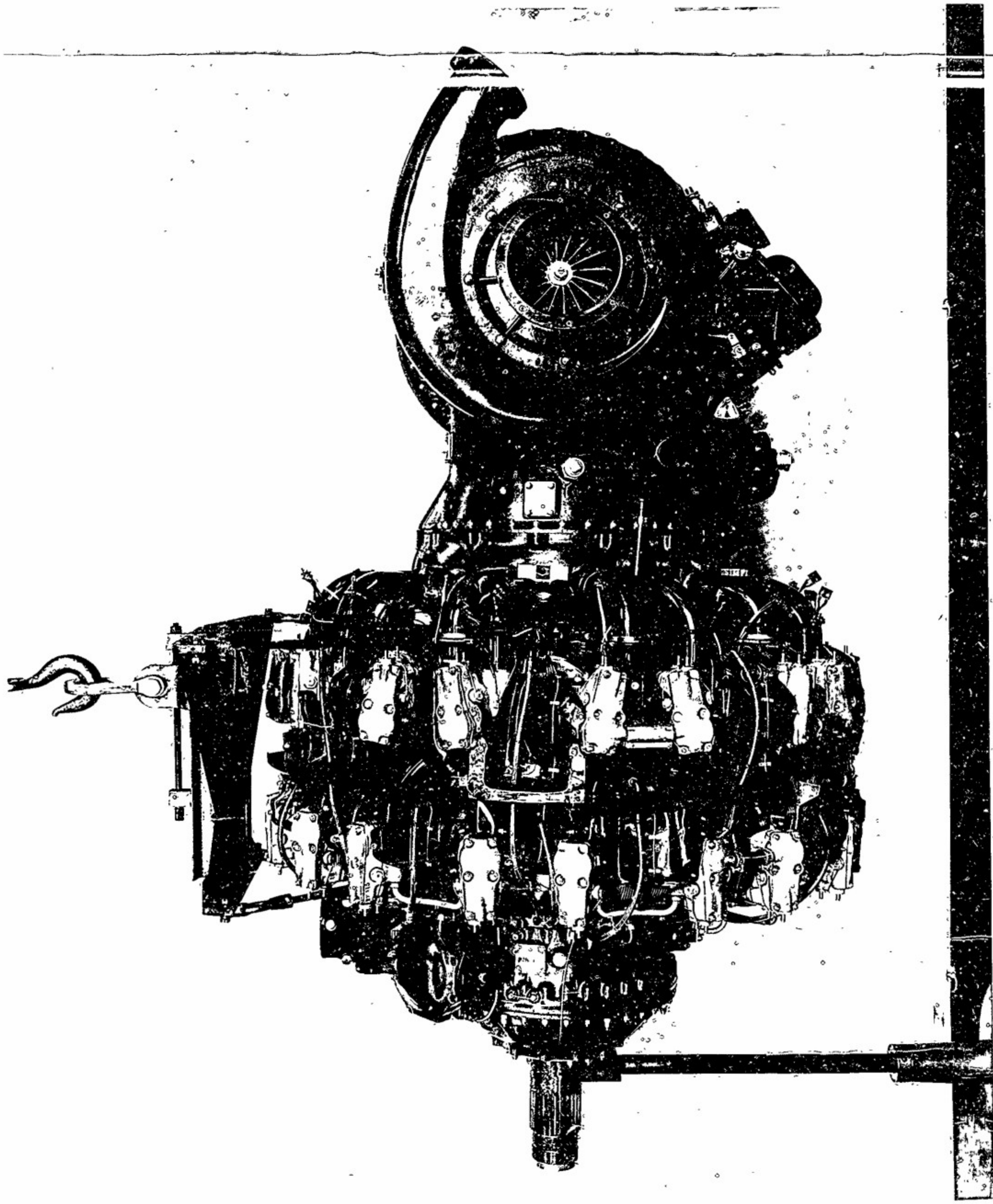
NP(3)-253490(L)-11-47
RIGHT FRONT VIEW OF P & W R-2800-32W ENGINE

PLATE 59



NP(3)-253487(L)-11-47

VIEW OF AUXILIARY STAGE SUPERCHARGERS,
P & W R-2800-32W ENGINE



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SIDE VIEW OF P & W R-2800-32W ENGINE