

R E S T R I C T E D

LOCKHEED AIRCRAFT CORPORATION

BURBANK, CALIFORNIA



TITLE

PRELIMINARY SPECIFICATION FOR
TURBOSUPERCHARGER

SUBMITTED UNDER

PROCUREMENT DATA

MODEL 89-29 REFERENCE _____

PREPARED BY *RC Andrews* GROUP Technical Contract
 P. A. Beck
 R. C. Andrews

CHECKED BY *Philip Colman* APPROVED BY *C.L. Johnson*
 P.A. Colman - J. C. Duffendack C.L. Johnson - *E.L. Hibbard*
Stoney NO. PAGES _____ NO. PICTURES _____

NO. DRAWINGS _____

REVISIONS

DATE	REV. BY	PAGES AFFECTED	REMARKS
11-10-44	RCA	Noted	To agree with G. E. Comments.

DECLASSIFIED
 Authority NND 947020
 By SG NARA Date 10/6/02

R E S T R I C T E D

TABLE OF CONTENTS

	<u>Page</u>
1. Type	1
2. Reference	1
3. Materials and Workmanship	1
4. General Requirements	1
5. Detail Requirements	3
5.01 Performance	3
5.02 Cooling Provisions	4
5.03 Controls	4
5.04 Exhaust Wheel Inspection	5
5.05 Exhaust Connections	5
5.06 Lubricating System	5
6. Method of Inspection and Tests	6
6.01 Inspection	6
6.02 Acceptance	6
6.03 Rejection	6
6.04 Status of Specification	6

APPENDICES

Appendix A	7
------------	---

R E S T R I C T E D

R E S T R I C T E D

PRELIMINARY SPECIFICATION FOR
TURBOSUPERCHARGER

1. TYPE

1.01 This specification covers the requirements of the Lockheed Aircraft Corporation for a turbosupercharger suitable for delivering supercharged air to the engine and cabin when this unit is installed with a Pratt & Whitney R4360-18 Wasp Major engine in the Lockheed Model 89-29 (Navy Model XR60-1) airplane.

2. REFERENCE

2.01 General Electric Company Specification #S-3, "Model Specification Turbosupercharger - General Electric Company Model 7S-BH3-A1 (U. S. Navy designation GT-15-2) dated August 1944, forms a part of this specification with the exceptions as noted herein.

2.02 The provisions of this specification shall govern in the event of conflicting requirements between specifications.

2.03 All appendices to this specification, and drawings listed herein, are hereby made a part of this specification.

3. MATERIALS AND WORKMANSHIP

3.01 The materials used shall be the lightest practicable, consistent with strength and service requirements for safety, reliability, long service life, and shall be in agreement with applicable specifications.

3.02 The compressor housing and all other applicable parts shall be fabricated from a suitable magnesium alloy.

3.03 Workmanship shall conform with high grade commercial practice in the manufacture of exhaust driven turbosuperchargers for military aircraft.

4. GENERAL REQUIREMENTS

4.01 The turbosupercharger shall be designed for efficient operation at cruising powers to 25,000 ft. in conjunction with the single stage, single speed, supercharger model Pratt & Whitney R-4360-18 engine. The requirements of the turbine-engine combination shall be as summarized herein.

R E S T R I C T E D

Revised 11-10-44

R E S T R I C T E D

4. GENERAL REQUIREMENTS (Contd.)

4.02 The design and all tests of the supercharger required by this spec. shall be performed by the manufacturer, and it shall be his responsibility.

4.021 The manufacturer shall submit installation and detail drawings of the proposed design for review by the Lockheed Aircraft Corporation.

4.022 Approval of the manufacturer's design by the Lockheed Aircraft Corporation shall not relieve the manufacturer from responsibility for satisfactory performance or delivery of all items in conformance with this specification.

4.03 Interchangeability - Practical interchangeability shall be established and maintained for all units of an item released for production under this specification.

4.04 Drawings and Performance Curves

4.041 Drawings to be furnished by the manufacturer shall consist of two vandyke sets of the necessary assembly drawings. Two vandyke sets of all changed drawings shall be furnished within 30 days following each change. The manufacturer shall also furnish the following: Lubrication System Diagram, Photographs, list of AN Parts, and Handbook of Service Instructions.

4.042 Performance curves as given by General Electric Company drawing #P-1090989-4, Estimated Compressor Performance Type BH-3, dated June 27, 1944 and P-1090989-5, Estimated Turbine Performance for Type BH-3 Turbosupercharger, dated June 28, 1944 shall form a part of this specification.

4.05 Reliability

4.051 The reliability of the unit is paramount and must be consistent with the requirements of commercial operation of a long range transport airplane.

4.06 Maintenance and Accessibility

4.061 The supercharger unit shall be designed and constructed in a manner such as to simplify inspection, maintenance and repair and provide for the easy inspection and servicing of attachments, mechanisms, bearings, brackets, joints, fittings, oil filter, turbine wheel, etc.

R E S T R I C T E D

Revised 11-10-44

R E S T R I C T E D

5. DETAIL REQUIREMENTS

5.01 Performance

5.011 The turbo supercharger shall be designed to operate in conjunction with a single-stage single-speed model of the Pratt & Whitney R-4360-18 engine and provide cabin supercharging. The performance of the turbine-engine combination (minimum requirement) is summarized in Figure 1 of Appendix A. Figure 2 shows the normal operating engine speeds to be used with each engine power. Figures 3 and 4 show the airflows and carburetor pressure, and the values for design are to correspond to the Best Economy requirements shown. The cabin air flow requirement is 30 lbs./min. per turbo at engine power of 2500 BHP/eng. or less.

5.012 Information necessary for the determination of the turbine and compressor performance is supplied on Figures 3, 4, 5, 6 and 7 of Appendix A. G.E. Curve L-1097581-1 summarizes G.E. estimated performance Curve P-1090989-4. The turbo supercharger shall be capable of supplying the volume flows and pressure ratios as shown on G.E. Curve L-1097581-1. The compressor efficiency at point D shall not be less than 0.68.

5.0121 Figures 3 and 4 are the information obtained from the Pratt & Whitney Aircraft Corporation at the date of this specification. It shall be the responsibility of General Electric and Lockheed to maintain coordination with the Pratt & Whitney Corporation relative to any changes in airflows or carburetor pressures that may arise in the development of the Pratt & Whitney R-4360-18 engine. Any changes in the engine performance data from that on which this specification is based may necessitate revision of the contract and/or specification.

R E S T R I C T E D

Revised 11-10-44

R E S T R I C T E D

5. DETAIL REQUIREMENTS (Contd.)

5.01 Performance (Contd.)

5.013 The exhaust back pressure on the engine must be kept to a minimum. In the determination of the back pressure, the effect of the exhaust heat exchanger and the tail pipe nozzle must be considered, all the exhaust flow passing through these units. The cabin air supply of 30 lbs./min. must be included in the compressor airflow.

5.014 The turbosupercharger shall operate satisfactorily, meeting all conditions of this specification when supplied with exhaust at temperature² of $1600^{\circ}\text{F} \pm 50^{\circ}$ from an engine operating at a lean carburetor mixture setting and using fuel in accordance with AN Aeronautical Specification #AN-F-28.

5.015 All performance given herein is based on exhaust gas leakage being equal to or less than fuel added.

5.02 Cooling Provisions

5.021 The design of the supercharger shall include adequate provisions for cooling of the turbine and moving parts. The air passages shall be sealed to minimize entrainment of air with the exhaust stream.

5.022 A cooling cap shall be installed on the downstream side of the exhaust wheel.

5.023 Provisions for cooling the interior of the unit just ahead of the exhaust wheel shall be provided. The air passages shall be sealed to minimize entrainment of air with the exhaust stream.

5.024 Exhaust back pressures as imposed on the turbo wheel by the heat exchanger and tail pipe nozzle not exceeding 6" Hg above ambient shall not impair the operation of the unit.

5.03 Controls

5.031 A speed control generator suitable for operating a G.E. #3GPR8A1 regulator and a suitable G.E. speed indicator shall be installed on and furnished with the turbosupercharger.

R E S T R I C T E D

DECLASSIFIED

Authority *NND 947020*

By *SS* NARA Date *10/26/02*

Revised 11-10-44

R E S T R I C T E D

5. DETAIL REQUIREMENTS (Contd.)

5.04 Exhaust Wheel Inspection

5.041 Suitable provisions shall be made for the inspection of the exhaust wheel.

5.05 Exhaust Connections

5.051 The exhaust inlet connections shall be capable of supporting small sections of exhaust pipes fastened to ball joints weighing not more than 20# without impairing the operation or dependability of the unit, and be capable of withstanding the load and vibration, imposed by the engine under motion, transmitted through the tail pipe flex joints.

5.052 The adaptor section from the "2" ring to the connection of the heat exchanger transition section shall provide:

- (1) provisions for inspection of the turbo wheel, (2) provision for minimizing exhaust gas leakage.

5.06 Lubricating System

5.061 The unit shall have a suitable lubricating system.

This system shall be a part of the turbosupercharger assembly and shall be complete with pump, suitable oil filter (located on the pressure side of the pump) and suitable accessible connections.

5.062 The turbosupercharger shall operate satisfactorily when adequately supplied with uncontaminated oil conforming to Specification AN-VV-O-446a Grade 1100 at temperatures not to exceed 212° F (minimum 104° F).

5.063 The turbosupercharger shall operate satisfactorily when the oil specified in Item 5.062 is diluted with fuel conforming to Specification AN-F-28 under any condition that is satisfactory for the engine operation.

R E S T R I C T E D

R E S T R I C T E D

6. METHOD OF INSPECTION AND TESTS

6.01 The type test of this turbosupercharger may be subject to witness by a representative of the Lockheed Aircraft Corporation.

6.02 Acceptance of material or parts in course of manufacture shall not be construed as a guarantee of acceptance of the finished part or assemblies thereof.

6.03 Rejection

6.031 Each turbo assembly which does not fulfill the requirements of this specification shall be subject to rejection.

6.032 A rejected assembly may be resubmitted by the manufacturer for inspection and test, providing that it is accompanied by a statement of changes or modifications.

6.033 Acceptance of this equipment or parts thereof by Lockheed Aircraft Corporation shall not relieve the contractor of responsibility for satisfactory performance and service under normal operating conditions.

6.04 Status of Specification

6.041 This specification is subject to cancellation or revision.

6.042 No deviations from this specification shall be issued except as an amendment, which shall have the approval of the Engineering Department of Lockheed Aircraft Corporation.

6.043 The data contained in this specification are "Restricted", and all Federal and Lockheed Instructions and Regulations concerning restricted data shall apply to this specification.

R E S T R I C T E D

R E S T R I C T E D

APPENDIX A

- Fig. 1 Engine Brake Horsepower Versus Altitude
- Fig. 2 Engine Speed Versus Engine Brake Horsepower
- Fig. 3 Engine Air Consumption Versus Engine Brake Horsepower
- Fig. 4 Carburetor Pressure Versus Brake Horsepower
- Fig. 5 Estimated Engine Air Pressure Drop Thru Intercooler and
Ducts.
- Fig. 6 Estimated Back Pressure on Exhaust Driven Turbine Due to
Heat Exchanger and Exhaust Nozzle.

R E S T R I C T E D

ENGINE BRAKE HORSEPOWER VERSUS ALTITUDE
PRATT & WHITNEY R-4360 ENGINE
REQUIRED OPERATION WITH EXHAUST TURBO-SUPERCHARGER

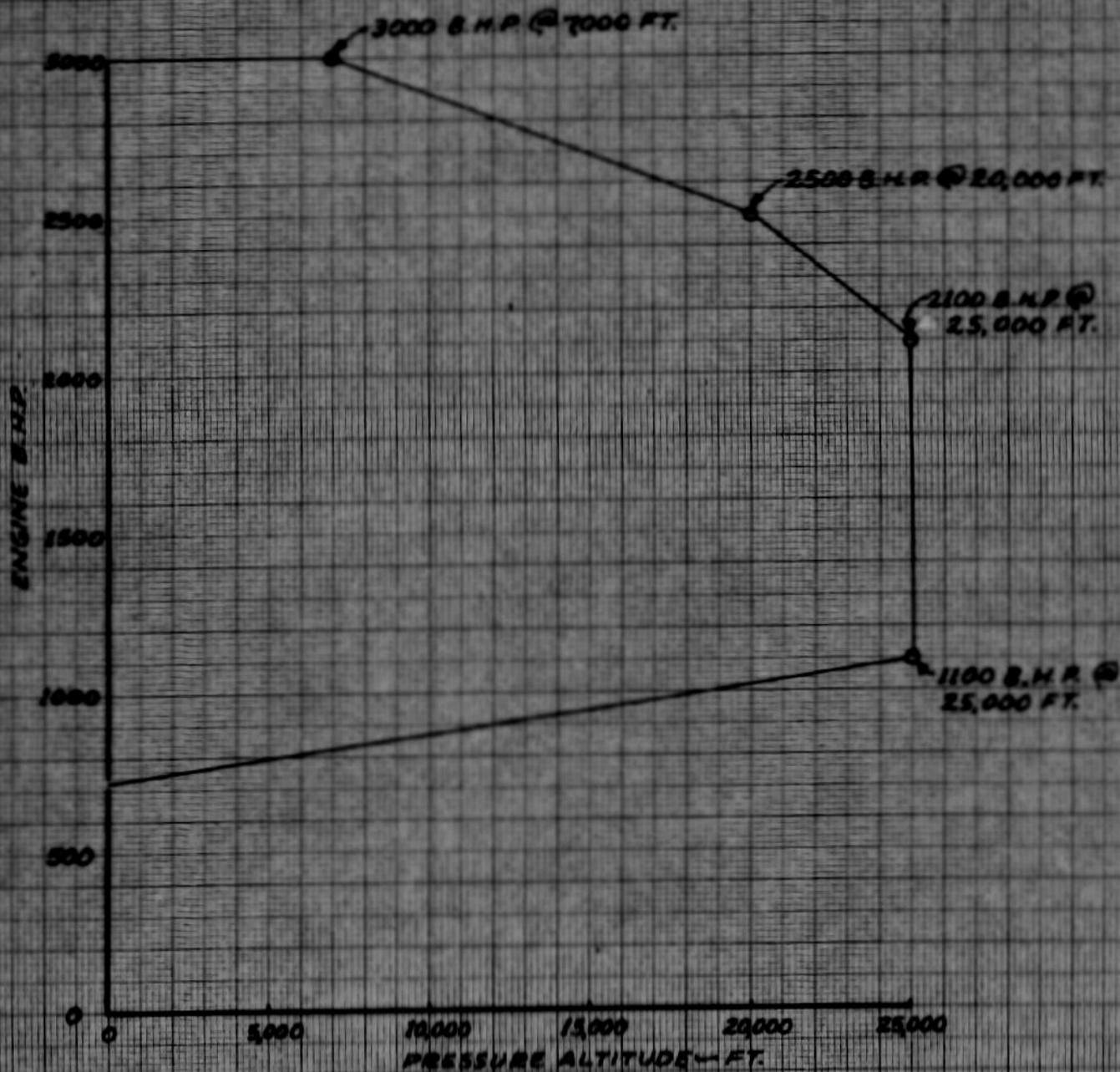
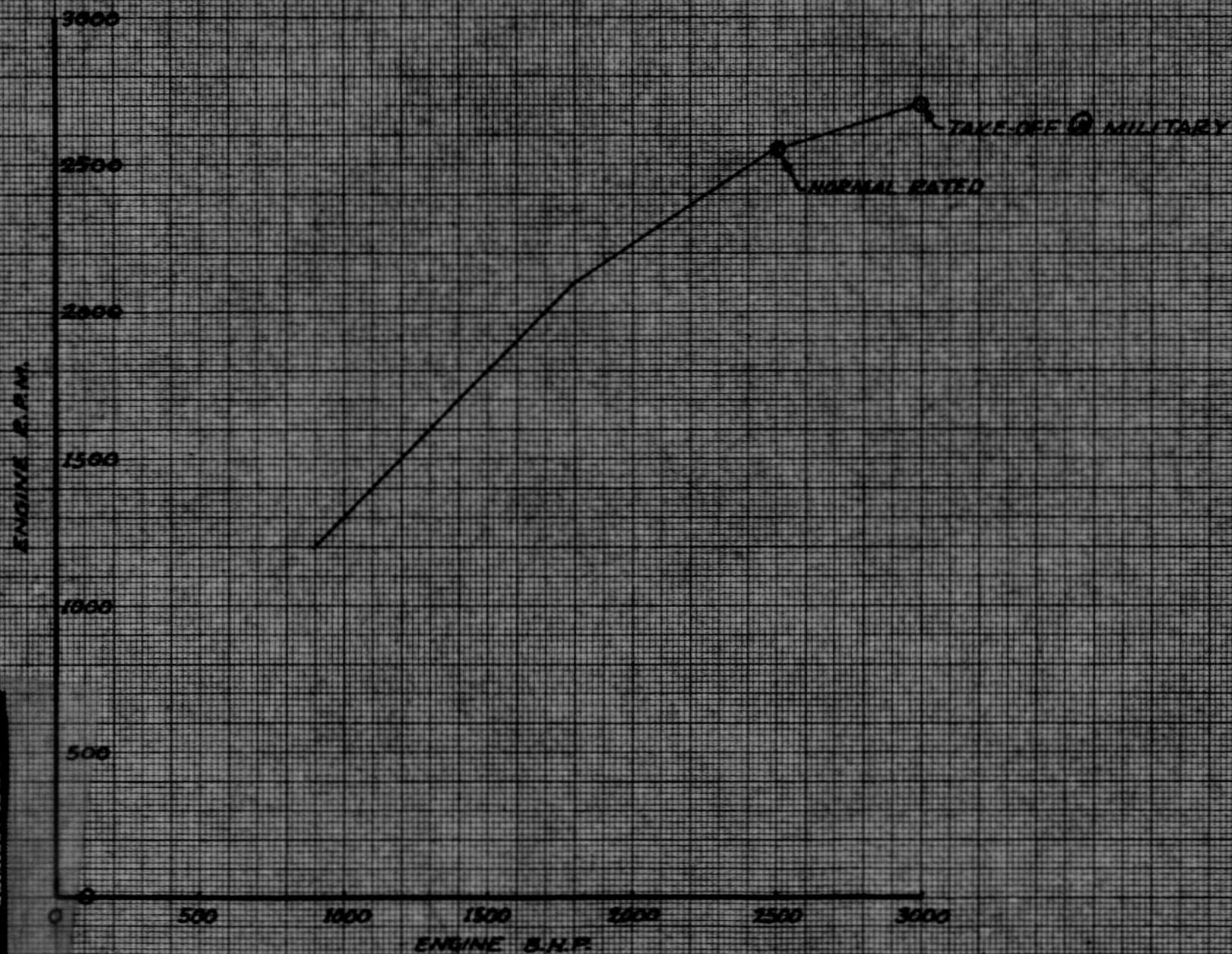


FIG. 1

DECLASSIFIED

Authority NND 947020

ENGINE SPEED VERSUS ENGINE BRAKE HORSEPOWER
PRATT & WHITNEY R-4360 ENGINE



R.W. MILLER - 8-15-49

LOCKHEED AIRCRAFT CORPORATION

FIG. 2

DECLASSIFIED
Authority NND 947020
1977

ENGINE AIR CONSUMPTION VERSUS ENGINE BRAKE HORSEPOWER - PRATT & WHITNEY R-4360 ENGINE

DATA FROM:

- (1) P&W CURVE NO. 3372 (REVISED 12-7-43)
- (2) P&W CURVE T-807 (REVISED 6-26-42)

AIR CONSUMPTION - LB5/HR.

25,000
20,000
15,000
10,000
5,000

BEST ECONOMY
BEST POWER

ENGINE B.H.P.

0 500 1000 1500 2000 2500 3000

R. N. MERRILL - 12-10-43

LOCKHEED AIRCRAFT CORPORATION

FIG. 3

DECLASSIFIED
AUTHORITY NND 947020

CARBURETOR PRESSURE VERSUS BRAKE HORSEPOWER
- PRATT & WHITNEY R-4360 ENGINE

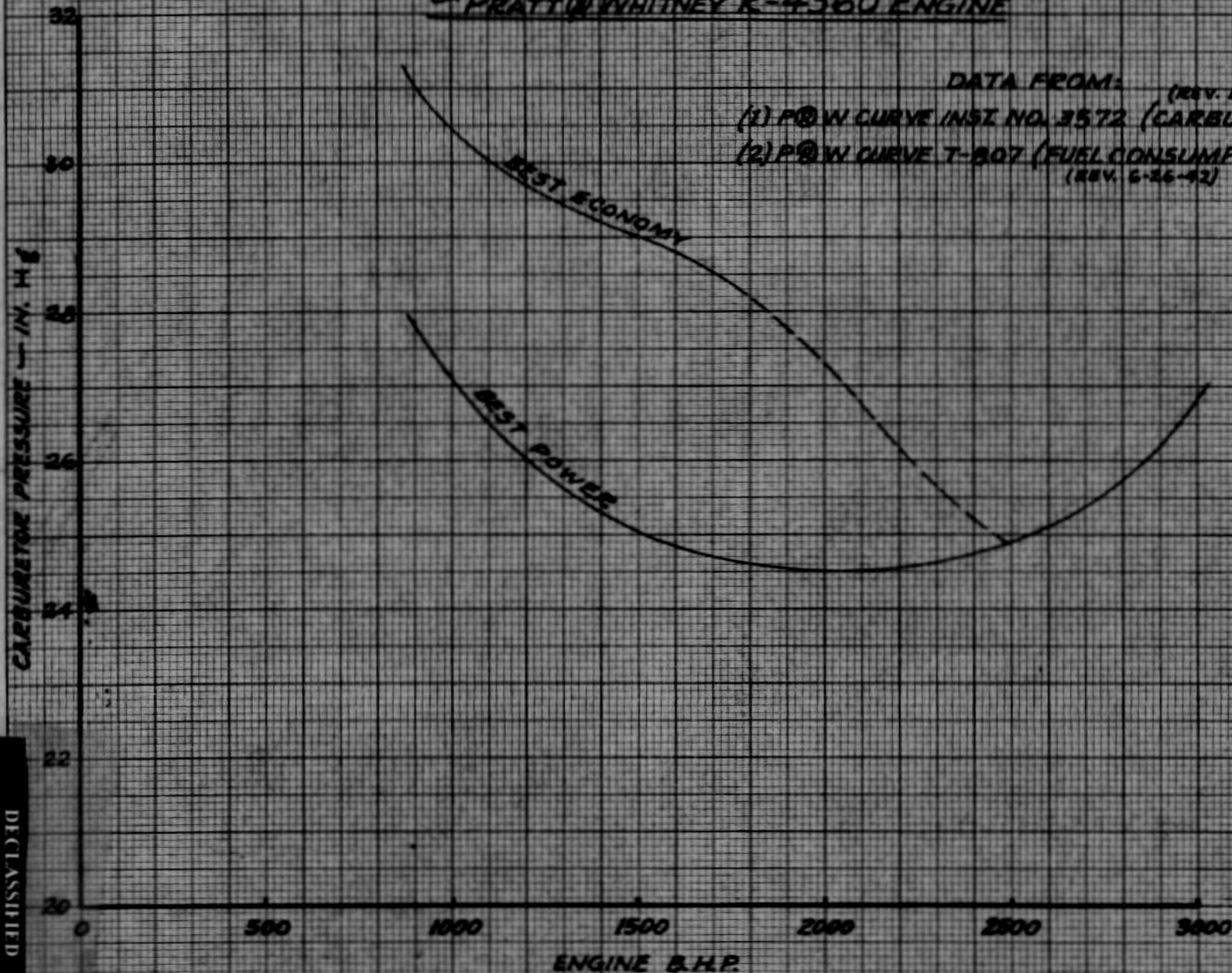


FIG. 4

DECLASSIFIED
Authority NND 947020

R.M. AIRLINES 12-30-43

LOCKHEED AIRCRAFT CORPORATION

ESTIMATED ENGINE-AIR PRESSURE DROP
THRU INTERCOOLER AND DUCTS

FIG. 5
AIR PRESSURE DROP - INCHES Hg

$$\Delta P = \frac{\sigma \Delta P}{\sigma}$$

$$\sigma = \frac{T_0}{P_0} \times \frac{P}{T} = \left(\frac{460 + 59}{29.92} \right) \times \frac{P}{T} = 17.35 \frac{P}{T}$$

P = INTERCOOLER INLET PRESSURE - IN. Hg ABSOLUTE
T = INTERCOOLER INLET TEMPERATURE - °F ABSOLUTE.

ENGINE B.H.P.
1000
1200
1400
1600
1800
2000
2500
3000

ENGINE AIRFLOW - LBS./MIN.

DECLASSIFIED
Authority NND 947020
By SG NARA Date 10/27/03

W.W. AIRCRAFT CORPORATION

ESTIMATED BACK PRESSURE ON EXHAUST-DRIVEN TURBINE,
DUE TO HEAT EXCHANGER AND EXHAUST NOZZLE



25,000 FT. ALTITUDE

TO OBTAIN APPROXIMATE BACK PRESSURE AT
ALTITUDES OTHER THAN 25,000 FT., MULTIPLY
 ΔP SCALE READING BY RATIO OF ATMOSPHERIC
PRESSURES.

$$\text{EXAMPLE: } \Delta P_{20,000} = \Delta P_{25,000} \times \frac{P_{25,000}}{P_{20,000}}$$

ENGINE B.H.P.

1000	1400	1600	1800	2000	2500	3000
------	------	------	------	------	------	------

EXHAUST GAS FLOW - LBS./MIN.

ACROSS HEAT EXCHANGER AND NOZZLE - INCHES Hg

FIG. 6

DECLASSIFIED
Authority: NND 947020
By: SG NARA Date: 10/2/13

N.M. MERBULL © R. 30-43
LOCKHEED AIRCRAFT CORPORATION

Revised 11-10-44

R E S T R I C T E D

Compressor Inlet Pressures and Temperatures.

<u>BHP/Engine</u>	<u>Engine RPM</u>	<u>Inlet Temp. Degrees F</u>	<u>Inlet Press. Inches of Hg.</u>
3000	2700	38	23.8
2500	2550	0	14.5
2100	2300	-18.2	11.8
1600	2000	-18.2	11.8
1100	1400	-18.2	11.8

FIGURE 7

R E S T R I C T E D

DECLASSIFIED

Authority *NND 947020*

By *SG* NARA Date *10/6/02*