

MODEL SPECIFICATION

ENGINE, AIRCRAFT: MODEL V-1710-117

ALLISON DIVISION
General Motors Corporation
Indianapolis, Indiana

ALLISON MODEL V-1710-E21

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Allison Division of General Motors Corporation
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A. APPLICABLE SPECIFICATIONS

A-1. The specifications listed on pages 21 and 22 except as revised herein shall form a part of this specification.

B. TYPE AND MODEL

B-1. This specification covers the requirements for the V-1710-117 engine.

B-1a. The V-1710-117 is a 12 cylinder, liquid cooled, 60° Vee type engine equipped with an outboard reduction gear assembly. An auxiliary stage supercharger is located directly behind the engine and is driven through a variable speed hydraulic coupling. Automatic controls are provided for controlling manifold pressure and auxiliary stage speed.

C. MATERIAL AND WORKMANSHIP

C-1. The requirements for material and workmanship shall be as specified in Specification AN-9500.

D. GENERAL REQUIREMENTS

D-1. See Section E.

E. DETAIL REQUIREMENTS

E-2. The following Allison Division Drawings form part of this specification:

53916 Engine Assembly, Complete (Showing Accessory Drive Oil Seals).
53915 Installation Drawing (Showing clearances for engine accessories and their removal.
43590 Priming System Assembly
42295 Carburetor - Model PTL3E9 - Bendix-Stromberg
53466 Spark Plug Assembly Champion C34S*
44099 Spark Plug Assembly ACLS86
42354 Contact Assembly, Spark Plug (Terminal)
Lubrication System Diagram (To be included in Service Manual).
53122 Radio Shielding Assembly
53914 Control Assembly - Automatic Manifold Pressure
53712 Control Assembly - Supercharger

Photographs - one top and bottom, one each side, one front, one rear.

E-3. Acceptance
 E-3a. Model Test The engine shall be model tested in accordance with AN-9502 with the exceptions to paragraphs as listed below:

- (1) (Ref. Par. F-1 General) The model test shall be conducted at the contractors plant and the runs at altitude conditions will be made in an altitude chamber.
- (2) (Ref. Par. F-3 Test Methods) Two engines shall be used for the tests required by this specification. One of the engines shall be used for dynamometer runs to determine altitude performance data, automatic control operation, and other similar tests which may be required. The other engine shall be used for the endurance run only.
- (2) (3) (Ref. Par. F-3d(2) Two Stage, Two Speed Supercharged Engines) Tests outlined in this paragraph are not applicable. See Par. 4, Ref. F-3e(3) below.
- (4) (Ref. Par. F-3e(3) Special Features) Special tests shall be required for this engine in that design features differ from the conventional arrangement as follows:
 - (a) The carburetor body containing the air throttle shall be located on the air inlet side of the auxiliary stage.
 - (b) The fuel injection nozzle shall inject fuel into the inlet side of the engine stage supercharger.
 - (c) The automatic manifold pressure regulator and control arrangement are a part of the engine and are required for obtaining engine operating characteristics.
 - (d) The speed of the auxiliary stage shall be determined by an automatic device which controls the slip of the hydraulic coupling and is dependent upon altitude and manifold pressure.
- (5) (Ref. Par. F-3d 150 Hour Endurance Run) The following schedule for model testing the endurance engine shall be used. For all runs the automatic coupling control shall be set at the setting agreed upon between the contractor and the Procuring Agency at the time of model testing.

150 HOUR ENDURANCE SCHEDULE

Run No.	Ref.Par.	Hours	Alternate Periods	Power BHP	Speed RPM	Altitude	Conditions N.A.C.A. Report No.218
1.	F-3d(1)	7	3 1/2	1040 936	2600 2520	10,000 10,000	
2	F-3d(4)	7	3 1/2	1040 832	2600 2420	10,000 10,000	
3.	F-3d(5)	7	3 1/2	1040 728	2600 2315	10,000 10,000	
4.	F-3d(6)	7	3 1/2	1040 624	2600 2185	10,000 10,000	
5.	F-3d(1)	3	1 1/2	1000 900	2600 2520	21,000 21,000	
6.	F-3d(4)	3	1 1/2	1000 800	2600 2420	21,000 21,000	
7.	F-3d(5)	3	1 1/2	1000 700	2600 2315	21,000 21,000	
8.	F-3d(6)	3	1 1/2	1000 600	2600 2185	21,000 21,000	

Run No.	Ref. Par.	Hours	Alternate Periods	Power BHP	Speed RPM	Altitude N.A.C.A.	Conditions Rpt. No. 218
9.	F-3d(3)	15	15 min.	1100	3000	25,000	
10.			30 min.	Prop.Load	55-65%	25,000	
					Mill.		
10.	F-3d(1)	15	2 1/2	1050 945	2600 2520	Sea Level	
11.	F-3d(2)	15	5 min. 10 min.	1325 Idle	3000 Idle	Sea Level	
12.	F-3d(4)	15	2 1/2	1050 840	2600 2420	Sea Level	
13.	F-3d(5)	15	2 1/2	1050 735	2600 2315	Sea Level	
14.	F-3d(6)	15	2 1/2	1050 630	2600 2185	Sea Level	
15.	F-3d(7)	15	Continuous	441	1456*	Sea Level	
16.	F-3d(8)	5	Continuous	1050	2860	Sea Level	

- (6) (Ref. Par. F-4a(1) Knock Rating of Fuels) The fuel used for model testing shall conform to Grade 130, AN-F-28, Amendment No. 2.
- (7) (Ref. Par. F-4g Fuel and Oil Consumption) The specific fuel consumption for the normal power, 110% normal speed run (No. 16) shall be increased by .03 lbs/BHP/HR above the guaranteed value for normal power and speed. During the altitude chamber runs, the fuel air ratio shall be that determined from the fuel air ratio vs. air flow curve established by the sea level guarantees.
- (8) (Ref. Par. 41 Inspections and Adjustments) In addition to the normal cleaning and adjustments, the spark plugs may be cleaned before the 15 hour take-off period, (Run No. 11).

E-3b. Acceptance Test The acceptance of this engine in production shall be based upon tests run in accordance with AN-9503 with the following exceptions:

- (1) (Ref. Par. F-5a(1) Two Hour Initial Run) During the last fifteen minutes of the 90% normal sea level power and the last ten minutes of the normal sea level power runs, the auxiliary stage coupling shall be adjusted for minimum slip and the manifold pressure reduced to a limit with a safe operating margin to prevent damage to engine. During the first part of the above runs and the 89% speed run the auxiliary stage coupling control shall be adjusted to give maximum slip.
- (2) (Ref. Par. F-5a(1)a Clutch Shift Run) The requirements of this paragraph shall not apply. Hydraulic coupling operation shall be checked by the changes in altitudes and powers during the endurance testing.
- (3) (Ref. Par. F-5a(1)b Take-off Run) The auxiliary stage coupling shall be set to obtain the slip required for take-off manifold pressure.
- (4) (Ref. Par. F-5a(3) Penalty Run) At the option of the contractor, penalty runs affecting any of the three major assemblies (Engine, Auxiliary Stage, Outboard Reduction Gear) may be run with other "workhorse" or standby assemblies.
- (5) (Ref. Par. F-5c(1) One Hour Final Run) The last ten minutes of the half-hour normal power run shall be made with the auxiliary stage coupling control set for minimum slip and the manifold pressure reduced to a limit with a safe margin to prevent detonation. During the first one-half-hour run and the first 20 minutes of the last run,

- the auxiliary stage coupling shall be set for maximum slip.
- (6) (Ref. Par. F-5c(2) Clutch Shifts) The requirements of this paragraph are not applicable. Hydraulic coupling operation shall be checked during the runs specified in paragraph E-3b (1) above.
 - (7) (Ref. Par. F-5c(3) Take-off Check) The take-off check shall be made with the auxiliary stage coupling control set to obtain the slip required for take-off manifold pressure.
 - (8) (Ref. Par. F-5c(4) Magneto Check) The magneto check shall be made starting at a speed of 2300 RPM instead of 85% normal rated speed. The auxiliary stage coupling shall be set as per above item 7 Ref. F-5c(3) slip.
 - (9) (Ref. Par. F-6j Multi-stage Superchargers) The carburetor is located on the inlet side of the auxiliary stage and provisions of this paragraph are inapplicable. The tests outlined under Par. E-3b of this specification are applicable.
 - (10) (Ref. Par. F-9 Preparation for Storage) The engine shall be prepared for storage in accordance with Par. E-14 of this specification.

E-4. Dry Weight of Complete Engine The total dry weight of the engine complete shall not exceed the value indicated below.

Basic engine including integral supercharger and drive mechanism, auxiliary stage power take-off drive adapter, coolant pump and piping on the engine, engine lubrication system oil pumps, starter connection (including starter dog) tachometer drives, fuel pump drives, generator drive, vacuum pump drives and all piping between engine parts.

Carburetor injection nozzle	1199.0 lbs.
Magneto and Magneto Control device	3.0 lbs.
Ignition Distributors (included with shielding)	16.0 lbs.
Radio Shielding and distributors	33.0 lbs.
Spark Plugs	6.0 lbs.
Priming system on engine	1.0 lbs.
Cooling air deflectors	none
Accessory Drive Covers	2.0 lbs.
Total, Power Section	1260.0 lbs.

Auxiliary stage supercharger, flexible drive, all piping and control linkages to the engine but without controls or carburetor	115.0	
Carburetor less injection nozzle	49.0	
Automatic Controls	13.0	
Total, Auxiliary Stage Unit		177.0 lbs.

Outboard Reduction Gear Assembly	175.0 lbs.
Two Extension shafts and Support Bearing	48.0 lbs.

TOTAL DRY WEIGHT OF ENGINE 1660.0 lbs.

E-5. Performance Characteristics The ratings specified herein and the curves specified herein and shown on pages 17, 18, 19 and 20 shall constitute the power and specific fuel consumption guarantees unless specifically stated otherwise on curve sheet. The terms used and the standard conditions shall be in accordance with the applicable definitions contained in either Specification AN-9502 or An-9503.

E-5a. Ratings The engine shall be rated as follows: Using fuel conforming to Specification AN-F-28, Grade 130, Amendment #2 and oil conforming to Specification AN-VV-O-446, Grade 1120.

1050 BHP at 2600 RPM at sea level
 1000 BHP at 2600 RPM at 21,000 feet normal rated altitude
 1325 BHP at 3000 RPM take-off for five minutes
 1100 BHP at 3000 RPM military rating at 25,000 feet military rated altitude for 15 minutes
 3120 RPM rated overspeed dive r.p.m.

Note: Military rating shall be 15 minutes duration for flight and 15 minutes for model test purposes.

E-5b. Curves The following curves shall be furnished as part of this specification.

- E-5b(1) Horsepower vs. altitude at rated speeds up to and including the guaranteed altitude of the engine as shown on page 17.
- E-5b(2) Estimated horsepower at full throttle vs altitude as shown on page 18.
- E-5b(3) Specific fuel consumption at low powers and low speeds and a table of estimated fuel consumption as shown on pages 19 and 20.
- E-5b(3)a The data furnished on the above curves shall be based upon standard temperature and pressure at the entrance to the carburetor. Since intercooling is not required, the requirements of paragraph E-5b(3)a of AN-9501 are not applicable.

E-5e. Specific Oil Consumption The specific oil consumption shall not exceed .025 lb/BHP/hr at normal rated power and speed, and .025 lb/BHP/hr at 70 per cent normal rated power and 89 per cent normal rated speed.

E-5h. Coolant Flow and Heat Rejection The following guarantee is given for coolant flow and heat rejection to the coolant when operating on a dynamometer for 5 minutes with a 60°F., 10 MPH air blast over the engine.

Conditions:

Power	Take-off 1325 BHP
Speed	Take-off 3000 RPM
Fuel Consumption	Guaranteed
Oil Inlet Temperature	203°F
Oil Pressure	65 p.s.i.
Coolant Outlet Temperature	250°F

Guarantee:

Coolant flow through the radiator not to exceed 265 GPM
Heat rejection to coolant not to exceed 18,886 Btu/min.
(445 HP)

E-5h(1). Coolant Pump Characteristics In lieu of the coolant pump flow data required by AN-9501, Paragraphs E-5h(1), E-5h(1)a, E-5h(1)b, the engine manufacturer will supply estimated coolant pump performance characteristics to the airplane manufacturer for preliminary design purposes. Characteristic Curves required by AN-9501, Par. E-5h(1), E-5h(1)a, and E-5h(1)b will be supplied prior to the 10th production engine delivery.

E-5j. Oil Flow and Heat Rejection The following guarantee is given for oil flow and heat rejection to the oil when operating on a dynamometer with a 60°F., 10 MPH air blast over the engine.

Conditions:

Power	Take-off 1325 BHP
Speed	Take-off 3000 RPM
Fuel Consumption	Guaranteed
Oil Inlet Temperature	203°F
Oil Pressure	65 p.s.i.
Coolant Outlet Temperature	250°F.
Coolant Flow	265 GPM

Guarantee:

Engine - Oil flow not to exceed 160 lbs/min.
Heat rejection to oil not to exceed 7215 Btu/min.(170 HP)
Auxiliary Stage - Oil flow not to exceed 40 lb/min.
Heat rejection to oil not to exceed 2122
Btu/min.(50HP)

E-6. Engine Performance. The complete engine shall function satisfactorily up to the military powers and speeds shown on page 17.

E-7. Propeller The engine shall have a No. 60 propeller shaft end in accordance with AN-9506 except as modified below:

- (a) Dimension "E" of Table II shall be 2 13/16" instead of 3 5/16"
- (b) Dimension "F" of Table II shall be 8 1/2" instead of 10.500
±.015.
- (c) Dimension "H" of Table II shall be 1 1/4" instead of 1 1/8"
- (d) Dimension "J" of Table II shall be 6.125 ±.030 instead of
7.062 ± .015
- (e) Dimension "N" of Table II shall be 5.750 ±.030 instead of
6.687 ±.030
- (f) Since no provision shall be made for supplying oil to the propeller, the dimensions shown in Fig. 4 and Table III are inapplicable.
- (g) The 11.125 ±.030 dimension shown in Fig. 9 shall be 9 1/8"
- (h) The stud projection shall be 1" ±.041 - .028 instead of
.0938 ±.030.

No provision shall be made for hydraulic propeller operation. Provision shall be made for mounting a governor by a pad conforming to AND10010 except that oil pressure shall not be supplied to the pad. (See Par. E-36g.)

E-12. Overall Dimensions The overall dimensions of the engine shall not exceed the following:

Length - - - - -	215 13/16
Width - - - - -	29 9/32
Height - - - - -	40 13/16

E-14. Preparation for Storage The engine shall be prepared for storage in accordance with AN-F-E-568 with the exceptions to paragraphs as listed below:

- (1) (Par. B-1a AN Aero Specification) The requirements of Specification AN-C-80 shall not be applicable.
- (2) (Par. B-1b ANA Standard Drawings) The following Allison drawings shall apply in lieu of AN parts:
 - 42288 - Plug - Crankcase dehydrator
 - 41616 - Envelope - engine protector
 - 41310 - Cap - Propeller shaft thread
- (3) (Par. C-2 Auxiliary Oil Tank) The use of an auxiliary oil tank will depend upon the procedure as decided upon in reference to Par. F-2a (1).
- (4) (Par. F-2a (1) Operation Procedure) The method of introducing the compound lubricating oil mixture into the engine shall be that agreed upon between the Procuring Agency and the Contractor.
- (5) (Par. F-3d Exhaust Ports and Manifolds) Dehydrating agent shall not be installed in the exhaust ports.
- (6) (Par. F-3h Intake Manifold) A one-pound bag of dehydrating agent shall be placed on top of the carburetor screen and the carburetor sealed by securing a gasketed cover to the carburetor.
- (7) (Par. F-3m Crankcase) A dehydrator plug, Allison Part No. 42258 shall be installed in a suitable opening of the crankcase.
- (8) The auxiliary stage supercharger and outboard reduction gear assembly storage as nearly as practical in conformance with AN-F-E-568.

E-15a(1) Cadmium Plating (Ref. AN-9500 Par D-15a(1)) Cadmium plating shall be in accordance with Specification AMS 2400 in lieu of Specification AN-QQ-P-421.

E-18. Propeller Drive The engine shall be equipped with a reduction gear ratio of 2.23:1. The propeller drive shall be mounted on a remote gear box located outboard of an extension shaft which operates at crankshaft speed. The gear box shall be lubricated from an external tank of not less than 2 gallons capacity, which shall not be provided with the engine. The direction of propeller rotation when viewed from the anti-propeller end, shall be clockwise. The maximum oil flow required for the reduction gear box is 20.0 lbs/min. at military speed. The gear box will function satisfactorily provided the correct specified lubricant is used and an oil inlet temperature of 60°C. (140°F.) is not exceeded. The lubricant for the gear box oil system shall conform to Air Corps Spec. Y-3587.

E-19. Impeller Gear The impeller gear ratios and diameters shall be as follows:-

Engine stage 8.1:1 and 9-1/2 inches
Aux. stage 7.23:1 and 12-3/16 inches.

E-20. Pistons The engine shall be fitted with pistons of 6.65:1 compression ratio.

E-23a(1). Spark Plugs. The engine shall be fitted with AC LS86 or Champion C34S* spark plugs.

E-23b. Radio Shielded Ignition Assemblies The ignition distributors and magneto shall be designed to permit supercharging from the auxiliary stage supercharger outlet. The engine shall be equipped with Allison designed radio shielded ignition assemblies with the following exceptions to Spec. AN-9510:

- (1) (Ref. Par. A-1) The following specification except as modified herein shall apply in lieu of those listed in AN-9510.

AAF Spec. 32427	High Tension Cable
AN-P-4	Plugs - Spark
AN-M-4	Magnetos - (except as modified herein)
- (2) (Ref. Par. D-1b Accessibility) The requirement shall be met except that it shall be necessary to loosen part of the shielding assembly to replace the intake spark plug conduits or cable.
- (3) (Ref. Par. D-1e Mounting Lugs) Mounting clamps shall be provided in place of integral, soldered, or welded mounting lugs.
- (4) (Ref. Par. D-3 Marking) The high tension ignition cables shall be marked with the proper cylinder designation.
- (5) (Ref. Par. D-5 Bonding) The requirements of this paragraph shall not apply.
- (6) (Ref. Par. D-8 Nameplate) A nameplate shall not be provided.
- (7) (Ref. Par. E-1a Single Cable Conduits) Single cable conduit connections shall be as shown on Allison Drawing Nos. 44888, 44890, and 53166.
- (8) (Ref. Par. E-5b Shielding Properties) The requirements of the last sentence of this paragraph shall not apply.
- (9) (Ref. Par. E-6 Weight) The requirements of this paragraph shall not apply.
- (10) (Ref. Par. E-8 Capacitance) The capacitance between the shielding and each ignition cable contained therein shall not exceed 175 micromicrofarads.

E-23c. High Tension Ignition Cable. (Ref. AN-9500, Par. D-23c) High tension cable shall conform to AAF Specification No. 32427 except the requirements of Par. E-1a (3), Sealing, shall not be met.

E-23d. Magnetos The engine shall be equipped with one Scintilla type DFLN5 magneto in accordance with AN-M-4 with the following exceptions:

- (1) (Ref. Par. D-1g(1)a Type Designation) The type designation shall be DFLN5, utilizing the "F" to denote a flange type mount and omitting the numeral to designate the number of cylinders.
- (2) (Ref. Par. D-1h Distributor Block Cable Connection) The requirements of this paragraph are not applicable. The distributor blocks are not furnished with the magneto.
- (3) (Ref. D-1j Ground Terminal) Each magneto shall be provided with a primary ground terminal conforming to AN-3105 and terminal socket as shown in Figure 2 except that the terminal shall be secured by a hexagon nut.
- (4) (Ref. Par. D-3b Installation Instruction) The requirements of this paragraph are not applicable.
- (5) (Ref. Par. D-4g (4)a Rain and Spray) Requirements of this paragraph shall not be applicable. The installation of this magneto on Vee Type engines requires and permits maximum ventilation in the breaker cover.
- (6) (Ref. Par. D-4h Endurance) The requirements of this paragraph shall be applicable except as modified by deviations to paragraphs F-6h(1) and F-6h(2).
- (7) (Ref. Par. E-2a Mounting Pad) The mounting pad and drive shall conform to the dimensions shown on the applicable Allison Division drawing of the magneto.
- (8) (Ref. Par. E-2b Coupling) The coupling shall conform to the detail requirements indicated on the applicable Allison Division drawing of the magneto.
- (9) (Ref. Par. F-5 Test Conditions) The requirements of this paragraph shall apply except that the tests specified at room temperature shall be performed at an atmospheric temperature of 15°C. to 35°C. (Approx. 59°F to 95°F).
- (10) (Ref. Par. F-6a Conditioning) In lieu of the requirements specified the following shall apply: The standard sphere gap as shown in Figure 3 set at 3 millimeters, unless otherwise specified, shall be used to calibrate test gaps used on all test described below.
- (11) (Ref. Par. F-6h(1) Operating Run) In lieu of the requirements of this paragraph the following shall apply:

The magneto shall be run for 600 hours continuously, except when stopped for short intervals for servicing, in an ambient air temperature of 60°C. (140°F) with the air passing over the magneto at 20 M.P.H., full spark advance, and rated maximum rotor speed with each lead connected to a standard test gap shunted by a normal load. No attention shall be required except by the breaker mechanism which may be reset and lubricated at 100-hour intervals. At the end of each hour, the primary current shall be short circuited and grounded for a period of 5 seconds.

- (12) (Ref. Par. F-6h(2) Elevated Temperature Run) The requirements of this paragraph shall be applicable except that the ambient air temperature shall be 150°F. instead of 200°F.

E-23f. Cooling (Ref. Spec. AN-9500, Par. D-23f) Provision for cooling the spark plugs and the spark plug elbows shall consist of spark plug cooling manifolds as shown on installation Drawing No. 53915 to which the airplane manufacturer shall connect. The airplane manufacturer shall make provision for circulating sufficient air through the cooling manifolds, and shall maintain engine compartment temperature suitable for operation of ignition parts when manufactured and installed in accordance with the following specifications:

Spark Plug - AN-P-4
 High Tension Cable - AAF Specification 32427
 Magneto - AN-M-4 (except as modified herein)

E-24. Lubricating System The oil supply for the outboard reduction gear assembly shall be separate from the engine as stated in Par. E-18 of this specification.

The auxiliary stage supercharger shall be equipped with scavenge and pressure oil pumps which are independent from the engine. The unit is designed to operate from either the engine oil supply tank or a separate oil supply tank.

E-24e. Scavenging System The scavenging system shall also operate satisfactorily at take-off power and speed with an oil having a viscosity equivalent at 100°F. to specification AN-VV-O-446, Grade 1100 plus 30% by volume of gasoline in accordance with specification AN-F-28 with 40 lbs./sq. in. gage back pressure on the scavenging pump outlet. For demonstration purposes the oil shall contain no gasoline.

A five-minute run at room temperature conditions with temperatures stabilized at 90°F. to 110°F. "oil in", and 160°F. to 180°F. "coolant out" and at take-off power and speed on an engine other than the model test endurance engine shall constitute the requirements for demonstrating satisfactory scavenging.

E-24g. Oil Cleaner The engine shall be equipped with one Airmaze oil strainer, Allison Part No. 53073. The auxiliary stage shall be equipped with one Airmaze oil strainer Allison No. 53238. Foreign matter removed by the cleaner shall not reenter the lubricating system under normal operating conditions.

E-24o. Lubrication Points The various components of the assembly requiring lubrication other than from the engine lubrication system are as follows:

<u>Component</u>	<u>How Lubricated</u>
Outboard Reduction Gear Assembly	Separate oil tank, see Par. E-18
Extension Shaft Center Bearing	Manual lubrication AN-G-3
Auxiliary Stage Supercharger	Separate system as described in Par. E-24.
Auxiliary Stage Supercharger-Flexible Drive	Manual lubrication Use Texaco #629

E-25. **Fuel Metering System** The engine shall be equipped with one Bendix-Stromberg Model P113E9 injection carburetor in accordance with Specification AN-9515 except for the following:

- (1) (Ref. Par. D-7 Strainer) The carburetor shall meet requirements except that foreign material is not removed with the strainer.
- (2) (Ref. Par. D-9) The normal operating fuel pressure shall be 17 ± 1 lb./sq.in. in excess of the pressure of the air entering the carburetor.
- (3) (Ref. Par. D-10 Fuel Line Connections) The carburetor shall be furnished with one 3/4 inch pipe thread fuel line connection.
- (4) (Ref. Par. D-22a Name Plate) The carburetor will be furnished with present name plate until such a time that new name plates are available and present name plate stock is exhausted.
- (5) (Ref. Par. D-32a(2) and Par. D-32a(3) Density Compensation) Carburetors which compensate automatically for densities shall hold at constant air flow the fuel air ratios obtained at standard sea level conditions to within the following limits at carburetor entrance densities and temperatures given below:

DENSITY COMPENSATION

Density (#/cu.ft.)	Temp. °F.	% Limits
.09 - .05	-40° - +120°	±3%
.05 - .034	-40° - +100°	±5%
.034 - .018	-60° - 0	±5%

- (6) (Ref. Par. D-32b(1)) The military power referred to in this paragraph shall be sea level military or take-off power. The military guaranteed fuel consumption at critical altitude shall not apply to this paragraph.
- (7) (Ref. Par. D-32b(2)C) In the range from a speed midway between minimum idling speed and 50% of normal rated speed to 30% of normal rated power the mixture strength shall not be richer than a straight line drawn between the following points:
 - (a) A point at the speed midway between the minimum idling speed and 50% of normal rated speed which is 12% richer than best power at this speed.
 - (b) A point at the air flow corresponding to 30% of normal rated power on propeller load which is 29% richer than best power.
- (8) (Ref. Par. D-32b(2)D) In the range between the air flows corresponding to 30% of normal rated power and 65% of normal rated power on propeller load the mixture strength in auto rich shall fall within the limits specified below:
 - (a) The minimum mixture strength at any point shall not be leaner than best power.
 - (b) The rich limit shall not exceed 29% richer than best power at the air flow corresponding to 30% of normal rated power and 26% richer than best power at the corresponding airflows from 40% to 60% of normal rated power. At 65% of normal rated power the mixture strength shall fall between 22% and 27% richer than best power.

- (9) (Ref. Par. D-32b(3)) With the mixture control in the automatic lean position and in the range between the air flows corresponding to 30% of normal rated power and 65% of normal rated power on propeller load the mixture strength of the reference carburetor shall fall within the limits specified below:
- (a) The minimum mixture strength at any point shall not be leaner than best economy.
 - (b) The rich limit shall not exceed 9% richer than best economy at the airflows corresponding to 30% and 65% of normal rated power and 6% richer than best economy at the corresponding airflows from 40% to 60% of normal rated power.
- (10) (Ref. Par. F-4e(3) Metering Test of Production Carburetors) The requirements of this paragraph shall be met except that mixture readings in automatic lean shall not be checked at air flows corresponding to 40, 80, 90% normal rated air flows.

The carburetor shall be checked for automatic altitude compensation at airflows equivalent to 50% of normal rated power airflow with the mixture control in the auto-lean position at air box pressure of 0, -8, -14, -21 inches Hg. less than atmospheric pressure.

The mixture ratio on production carburetor tests at altitude air box conditions shall be within $\pm 2\%$ of the reference carburetor at densities of .076 to .050 lbs./cu.ft. at any constant temperatures in the range of 65°F. to 85°F. and within $\pm 3\%$ of the reference carburetor at densities of .050 to .020 lb./cu.ft.

E-26. Engine Starting The engine shall be furnished with priming lines in accordance with Allison Division Drawing No. 43590. The airplane manufacturer shall supply fuel to the priming lines for engine priming. In lieu of the requirements of Par. D-26 of AN-9500 the following shall apply:

"The engine shall be capable of consistent starting when its temperature has been stabilized in an ambient temperature of minus 30°F. when cranked at a minimum of 30 RPM. This shall be accomplished with the specified lubricant diluted 30% by volume using the fuel specified in the engine model specification. The pour point of the diluted oil shall be minus 40°F. or lower. The use of special starting fuel shall be permitted. Consistent starting shall be defined as a complete start following not more than two 30-second cranking periods. Starting demonstrations when required shall be made in a laboratory under controlled conditions."

The specified lubricant for cold starting demonstration only shall be Grade 1100 P of specification AN-0-5.

E-30. Coolant Temperature The cooling liquid outlet temperature shall be 121°C. (250°F.)

E-30a. Coolant Pressure The maximum inlet pressure to the cooling liquid pump shall be 50^W Hg. absolute.

E-31a(3). Supercharger Drain Valve (Ref. Spec. AN-9500 Par. D-31a(3)) A fuel aspirator without a valve shall be the only provision made for automatic drainage of the induction system.

E-32a. Exhaust Flanges (Ref. Spec. AN-9500 Par. D-32a) The use of exhaust flanges in accordance with Allison Part #44018 (AMS-5080) or Part #34667 (AMS-5645) and exhaust flange gaskets Part #40751 shall be a requirement in the installation of this engine. The exhaust flanges shall not be furnished with the engine and separate procurement must be initiated by the airplane manufacturer. The gaskets and nuts shall be furnished with the engine.

E-34c. Coating Threaded Parts Thread anti-seize compound shall be in accordance with AMS-3080 instead of AN-C-53.

E-36. Accessory Drives The gear ratio of each accessory drive to the engine crankshaft, the maximum permissible torque in inch-pounds for continuous operation, the maximum permissible static torque in inch-pounds, and the direction of rotation when looking at the end of the accessory drive shaft in the engine shall be as follows:

ACCESSORY AND TYPE	NO. USED	RATIO TO C.S.	MAX. TORQUE CONTINUOUS		MAX. TORQUE STATIC		ROTATION C - CLOCKWISE CC - COUNTER CL.
			LEBS.	IN.	LEBS.	IN.	
Starter							
Type I	1	1.000:1	-----		16,200		C
Generator							
Type I	1	1.440:1	600		3,600		C
Fuel Pump							
Type I	1	0.864:1	25		450		CC
Vac. & Hyd. Power Pump Side Drive Type II	1	1.440:1	150		2,250		CC
Vac. & Hyd. Power Pump Rear Drive Type II	1	1.440:1	150		2,250		C
Tachometer Type I & II (2 drives)		0.500:1	2.5		12.5		C
Propeller Governor	1	0.832:1	125		2,300		CC
Gun Syn.	2	0.449:1	25		125		CC

E-36a. (Ref. AN-9400 Par. D-36a Starter) The starter mounting pad and drive shall conform to AND10004 Type I with the following exceptions:

- (1) One stud shall be off location by 15° to facilitate removal of the starter.
- (2) The studs shall be located by rectangular dimensions from the center line of the pad with $\pm .005$ tolerance instead of by a stud circle and angles.

E-36a(1). (Ref. Par. AN-9500 Par. D-36a(1) Starter Clearance) Clearance shall not be provided in accordance with AND10304. (Interference with AND10304 outline is shown on the Installation Drawing.)

E-36b. Generator and Power Take-off One type I pad and drive shall be furnished in accordance with AND10002 except as follows:

- (1) Provision for supplying oil to the pad shall be furnished except that the oil shall not be transferred through the adapter described below.
- (2) The studs shall be located by rectangular dimensions from the center line of the pad with $\pm .005$ tolerance instead of by a stud circle and angles.
- (3) A special adapter to facilitate removal of the generator shall be provided. The adapter shall consist of two flanges; one secured to the accessory mounting pad, and the other to be secured to the generator flange. The two special flanges shall be bolted together by four bolts. Two aluminum gaskets $1/32$ thick shall be utilized instead of AN-4047. The gasket on the generator side of the adapter shall have 12 holes instead of 6.

E-36b(1). Lubrication Provision shall be made for supplying oil to the pad and for draining oil back into the engine except that oil shall not be transferred through the adapter.

E-36b(2). (Ref. AN-9500 Par. D-36c(2) Generator Accessibility) Clearance shall not be provided in accordance with AND10305. (Interference with AND10305 outline is shown on the Installation Drawing.)

E-36c. Fuel Pump The fuel pump mounting pad and drive shall conform to AND10003 except that the stud length shall be $.906 \pm .020$ instead of $7/8 \pm 1/32$.

E-36d. Gun Synchronizing Impulse Generator Provision shall be made for driving Gun Synchronizing Impulse Generators by a Type I pad and drive in accordance with Specification AN-9520, with the following exception to Par. D-1a of AN-9520 and to Par. D-36d(2) of AN-9500. The two pads shall be located on the rear face of the reduction gear box and the face of the mounting pad shall be perpendicular to the longitudinal axis of the engine.

E-36e. Vacuum and Hydraulic Power Pump Provision shall be made for two Type II vacuum and hydraulic power pump pads and drives in accordance with AND10001 with the exception that the dowel hole shall be .141 - .148 diameter instead of #23 drill (.1540) diameter and the adapter flange AN-4055 shall not be furnished on the side drive.

E-36f(1). Tachometer Accessibility The clearance requirements of Par. D-36g(1) of AN-9500 and AND10310 shall not be met. Provision back of the Type I pad shall be made for installing a flexible cable drive. Clearance back of the Type II pad shall be made in accordance with AN-5531-1.

E-36g. Propeller Governor Drive Provision for mounting a propeller governor shall be made by a pad and drive conforming to AND10010 except as follows:

- (1) The drive shaft shall rotate counter-clockwise.
- (2) No oil holes shall be provided for supplying oil to the governor nor for hydraulic propeller operation. An oil vapor opening shall be provided for governor lubrication.
- (3) The length of the studs shall be 15/16 in. instead of 1 in.
- (4) The length of the threaded portion of the studs shall be 5/8 in. instead of 11/16 in.

E-36g(2). Accessibility - Governor Space shall not be provided back of the governor mounting pad in accordance with AND10307. Clearance shall be provided as required in Specification AN-9507.

E-44. Supercharger and Manifold Pressure Regulator The engine shall be equipped with automatic controls designed to coordinate magneto timing, manifold pressure and auxiliary stage supercharger speed and with provision for the application of water injection.

E-46. Torquemeter The engine shall not be equipped with a torquemeter.

ALTITUDE PERFORMANCE—HORSEPOWER AND MANIFOLD PRESSURE

AT STANDARD ATMOSPHERIC CONDITIONS

AIRCRAFT ENGINE
NORMAL PERFORMANCE

ENGINE MODEL V-1710-E21

PROP GEAR RATIO 2.23:1

COMPRESSION RATIO 6.65:1

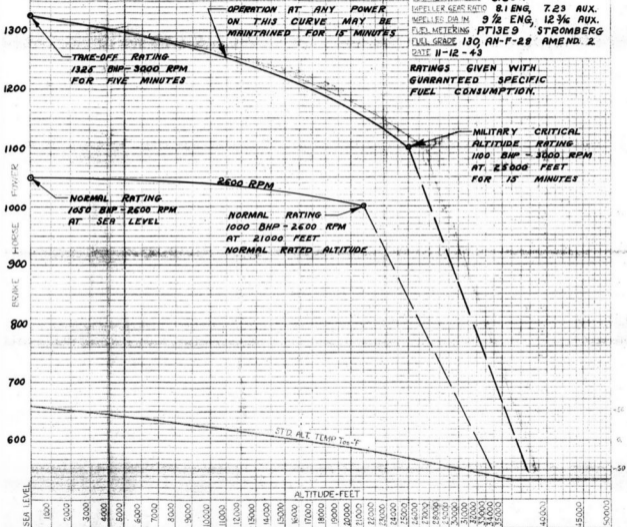
MPELLER GEAR RATIO 8.1 ENG, 7.23 AUX.

MPELLER DIA IN 9 1/2 ENG, 12 3/4 AUX.

FUEL METERING PT13E9 STROMBERG

FUEL GRADE 130 AN-F-28 AMEND. 2

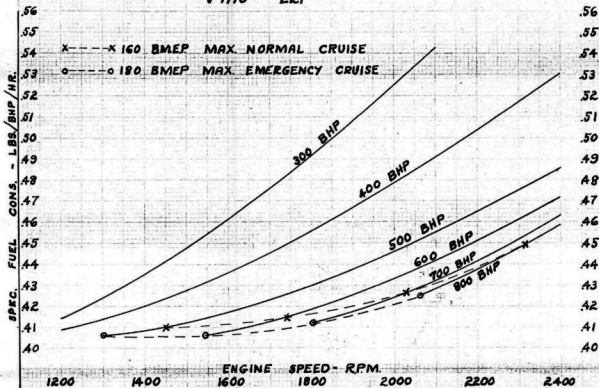
DATE 11-12-43

RATINGS GIVEN WITH
GUARANTEED SPECIFIC
FUEL CONSUMPTION.

Estimated performance curves throughout the operating range will be included on this page when sea level and altitude calibration data is available.

ESTIMATED BEST ECONOMY SPECIFIC FUEL CONS.
BASED ON ENGINE REQUIREMENTS AT SEA LEVEL.

V-1710- E21



GUARANTEED B.S.F.C. ON
NORMAL S. L. RATED
PROP. LOAD AT
SEA LEVEL.

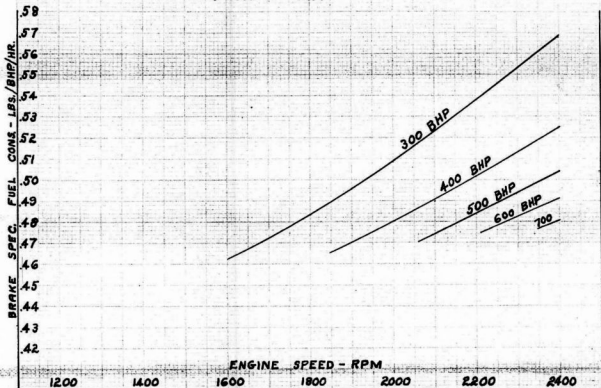
%NORMAL POWER	LBS./BHP/HR.
100 %	0.630
90 %	0.574
80 %	0.530
70 %	0.500
60 %	BEST ECON.

TAKE-OFF POWER -- 0.763

MILITARY POWER -- 0.83
AT CRITICAL ALTITUDE

ESTIMATED BEST ECONOMY SPECIFIC FUEL CONS.
BASED ON ENGINE REQUIREMENTS AT NORMAL RATED ALTITUDE.

V-1710- E21



ESTIMATED B.S.F.C. AT
NORMAL RATED ALTITUDE
ON PROPELLER LOAD.

% NORMAL POWER	LBS./BHP/HR.
100 %	0.69
90 %	0.62
80 %	0.56
70 %	0.53
60 %	BEST ECON.

The following specifications and drawings of the issue in effect as listed below and as modified herein shall form a part of this specification. Any revisions and/or amendments issued prior to date of bid for this model engine and after the particular dates listed below shall not be applicable.

<u>ANA SPECS.</u>	<u>Rev.</u>	<u>Amend.</u>	<u>Dated</u>	<u>Title (In Brief)</u>
AN-VV-C-576	(a)	(1)	6/3/43	Compound - Corrosion Preventive
AN-F-E-568	(a)		12/4/42	Preparation for Storage
AN-GGG-P-363		(2)	5/9/42	Pipe Threads
AN-GGG-S-126	(a)	(1)	1/30/43	Screw Threads
AN-QQ-M-181	(a)	(1)	11/18/42	Magnetic Inspection
AN-VV-F-746		(1)	11/5/40	Fuel - Gen. (Knock Test)
AN-VV-F-748	(a)	(1)	3/23/43	Fuel - Gen. (Super Knock Test)
AN-V ^V -F-756		(2)	6/6/41	Fuel Grade 65
AN-F-26			4/15/43	Fuel Grade 91
AN-F-28		(2)	3/23/43	Fuel Grade 130 (Modified herein)
AN-VV-O-446	(a)		1/5/43	Oil Lubricating
AN-P-4		(1)	2/13/42	Spark Plugs
AN-O-5			4/27/43	Oil-Low Pour Lubricating
AN-M-4			12/7/42	Magnetos

Army-Navy Specs.

AN-9500	(b)		8/26/42	Engines - General
AN-9501	(b)		8/10/42	Engines - Model Spec.
AN-9502	(b)		8/11/42	Engines - Type Test
AN-9503	(b)		8/6/42	Engines - Acceptance Test
AN-9504		(1)	12/25/40	Engines - Torsional Vibration
AN-9506		(2)	4/1/40	Noses - Engine
AN-9507		(3)	12/28/39	Governors
AN-9510	(a)	(2)	6/19/42	Shielding - Radio
AN-9515	(b)		8/6/42	Carburetors
AN-9520		(2)	6/28/40	Gun Synch. Pad & Drive

AAF Specs.

32427			4/24/43	Cable-High Tension Ignition
Y-3587		(2)	7/6/39	E. P. Gear Oil

<u>ANA Standard Dwgs.</u>	<u>Rev.</u>	<u>Amend.</u>	<u>Dated</u>	<u>Title (In Brief)</u>
AN-4028			12/12/42	Markers-Ignition Cable
AN-4034			11/2/42	Data Plate
AN-4037			6/10/40	Oil Flange-3 bolt
AN-4048			1/6/42	Oil Flange-4 bolt
AN-5531-1			4/13/43	Generator - Electric Tachometer
 <u>ANA Design Standard</u>				
AND-10001	1		10/3/42	Hyd. & Vac. Pump Pad - Type II
AND-10002			10/30/42	Generator Pad
AND-10003	1		9/5/42	Fuel Pump Pad
AND-10004	2		4/30/43	Starter Pad (All types)
AND-10005	1		8/20/42	Tachometer Pad (Both types)
AND-10010	1		6/12/43	Governor Pad
AND-10201			4/12/40	Carb. Screens and Gaskets
AND-10301	1		3/28/42	Vac. Pump Clearance Type II
AND-10302	1		3/19/42	Hyd. Pump Clearance Type II
AND-10304			9/2/41	Starter Clearance Type I
AND-10305			2/28/42	Generator Clearance
AND-10307			11/25/41	Prop. Gov. Clearance
AND-10310			12/5/41	Tachometer Clearance
AND-10320			2/16/42	Fuel Pump Clearance
 <u>AMS Specs.</u>				
2400	B		12/1/42	Cadmium Plating
3080			6/13/40	Compound Anti-Sieze

REVISION RECORD
Allison Specification No. 178 to 178A
V-1710-117 (E-21)

The above specification was revised November 29, 1943 to incorporate changes requested by the Materiel Command by phone conversation November 27, 1943 between Captain McNamara, Lt. Conrad, and Mr. Parmakian of Wright Field and Mr. Hazen and Mr. McCrae of Allison.

Except for the changes listed below the specification was accepted, and it was agreed that after the following changes were made the specification should be submitted to the airplane manufacturer and Wright Field for approval.

CHANGES:

1. In the revision of Par. E-6 noted below one page was omitted which reduced the total number of pages from 23 to 22. Therefore reference to page numbers throughout the specification was corrected and will not be referred to hereafter.
2. Page 1. Revision A and date, November 29, 1943, added.
3. Par. E-6. Engine Performance. The entire paragraph which itemized the provisions for (1) Coolant System (2) Lubrication System, and (3) Fuel System installation requirements was omitted and the statement added, "The complete engine shall function satisfactorily up to the military powers and speeds shown on page 17."
This change was made in as much as Materiel Command did not consider the requirements as specification material.
4. Par. E-25 (7) and (8) Fuel Metering System. Changes were made which described the auto rich setting on the basis of "Best Power" instead of "Best Economy". The original carburetor setting for the model V-1710-93 (E11) engine was based on a nominal auto rich setting of 15% in excess of Best Economy. The later production setting of the -93 carburetor was raised 5% or 20% richer than "Best Economy". These limits were shown in the -93 specification by a curve which was part of the specification. At the request of Materiel Command it was necessary to submit a written description of the setting rather than a curve sheet. In the original Spec. 178 this material was based on the actual setting of the carburetor to be used in the -117 engine - or a nominal of 20% richer than Best Power. At the request of Materiel Command this same curve has now been described in Spec. 178A on the basis of Best Power and it is not the intention to indicate that a new carburetor setting is to be made for the -117.