

Spec. No. 137-G
Date Issued: March 12, 1940

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February 18, 1941
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April 15, 1941
August 20, 1941
October 21, 1941
July 8, 1942

MODEL SPECIFICATION

ENGINE, AIRCRAFT: MODEL V-1710-47

ALLISON DIVISION
General Motors Corporation
Indianapolis, Indiana

(ALLISON MODEL DESIGNATION V-1710-E9)

MODEL SPECIFICATION

ENGINE, AIRCRAFT: MODEL V-1710-47

Allison Division of General Motors Corp.
(Allison Model Designation V-1710-E9)

A. APPLICABLE SPECIFICATIONS.

A-1. The following specifications of the issue in effect on date of invitation for bids shall form a part of this specification:

A-1a. Army-Navy Specification.

AN-9500 Engines, Aircraft; General Specifications and applicable specifications of the issues indicated on Page No. 16

A-1b. U.S. Army Specification.

None applicable.

B. TYPE AND MODEL.

B-1. This specification covers the requirements for the V-1710-47 engine.

C. MATERIAL AND WORKMANSHIP.

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

D. GENERAL REQUIREMENTS.

D-1. See Section E.

E. DETAIL REQUIREMENTS.

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

37851 Engine Assembly, Complete (showing accessory drive oil seals.)

37850-C Installation Drawing (showing clearances for engine accessories and their removal.)

36905-E Priming System Assembly
 41917-B Carburetor, PT-13E-5 Bendix Stromberg
 40600-J Spark Plug Assembly AC-LS85
 40601-B Spark Plug Assembly Champion - C34S
 42354-C Terminal, Spark Plug (Contact)
 Lubrication System Diagram
 42279-F Magneto
 41780-B Radio Shielding Assembly
 37583-B Manifold Assem. - Spark Plug Cooling R.H.
 37584-B Manifold Assem. - Spark Plug Cooling L.H.
 33536-K Nut - Magneto Cable Shielding Conn.
 41289-A Shielding - Spark Plug Cable - Intake
 37476-Q Shielding - Spark Plug Cable - Exhaust

E-3 Acceptance. The acceptance of engines on contract referring to this specification shall be based upon the satisfactory completion of an Acceptance Test conducted substantially in accordance with the requirements of AN-9503.

E-4 Weight. The total dry weight of the engine complete shall not exceed the values indicated below:

Basic Engine, including integral supercharger, supercharger drive mechanism, auxiliary stage supercharger and drive mechanism, propeller reduction gears, coolant pump and piping on the engine, engine lubrication system oil pumps, starter connection including starter dog, tachometer drives, fuel pump drive, generator drive, vacuum pump drives, propeller governor drive, automatic hydraulic coupling control, automatic boost control, and all piping and controls between engine parts	1488.3 lbs.
Carburetor and injection nozzle	52.0
Carburetor Screens and Gaskets	1.5

Magneto, Shielded	13.2
Ignition Distributors (included in Shielding Assembly)	
Radio Shielded Ignition Assembly, complete with Cable and Distributors	31.1
Spark Plugs	7.2
Priming System on Engine	.5
Cooling Air Deflectors and Baffles	None
Accessory Drive Covers	1.2
TOTAL DRY WEIGHT OF ENGINE	1595 lbs.

E-5. Performance Characteristics. The ratings specified herein, and the curves specified herein and shown on Pages 14 & 15 shall constitute the power and specific fuel consumption guarantees. The terms used and the standard conditions shall be in accordance with the applicable definitions contained in Spec. AN-9502.

E-5a. Ratings. The engine shall be rated as follows, using fuel conforming to Spec. AN-VV-F-781 (Amend. No. 5) and oil conforming to Spec. AN-VV-O-446, Grade 1120.

1050	BHP at 2600 RPM at sea level.
1000	BHP at 2600 RPM at 19,000 feet normal rated altitude.
1325	BHP at 3000 RPM take-off for five minutes.
1150	BHP at 3000 RPM military rating at 21,000 feet military rated altitude for 15 minutes.

These ratings are based on standard sea level and altitude temperatures and pressures at the carburetor inlet. Control of the auxiliary stage supercharger hydraulic coupling is to be obtained by use of an automatic control so adjusted as to give best air flow characteristics through the entire induction system.

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

E-5b(1) BHP vs. Altitude at rated speeds as shown on Page 14

E-5b(3) Fuel consumption curves and Ram vs. Altitude as shown on Page 15

E-5e. Specific Oil Consumption. The specific oil consumption of the engine, but not including that consumed by the auxiliary stage or drive shall not exceed .025 lbs./BHP/hr. at normal rated power and speed, .025 lbs./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 estimate is given for the coolant flow and heat rejection to the coolant.

Conditions:

Operation On dynamometer for 5 minutes
 Power Take-off 1325 BHP
 Speed Take-off 3000 RPM
 Fuel Consumption. Guaranteed Specific
 Oil Inlet Temp. 185°F.
 Oil Pressure. 65 p.s.i.
 Coolant Outlet
 Temperature 250°F.
 *Oil Flow. 150 lb./min.
 Air Blast on Engine. 60°F. at 10 MPH

Estimates:

Coolant flow not to exceed - 265 gal./min.
 Heat rejection to coolant not to exceed - 430 HP

*The above value does not include oil flow from the auxiliary stage supercharger or auxiliary stage drive.

E-5i. Oil Flow and Heat Rejection. The following estimate is given for the oil flow and heat rejection to the oil.

Conditions:

Operation On dynamometer for 5 minutes
 Power Take-off 1325 BHP
 Speed Take-off 3000 RPM
 Fuel Consumption. Guaranteed Specific
 Oil Inlet Temp. 185°F.
 Oil Pressure 65 p.s.i.
 Coolant Outlet
 Temperature 250°F.
 Coolant flow 265 GPM
 Air Blast on Engine. 60°F. at 10 MPH

Estimates:

*Oil flow not to exceed - 150 lb./min.
 *Heat rejection to oil not to exceed - 150 HP

*The above values do not include oil flow or heat rejection to the oil from the auxiliary stage supercharger or auxiliary stage drive.

E-7. Propeller. This engine shall have a No. 60 (modified) propeller shaft end as shown on Installation Drawing No. 37850. Provision shall be made for a governor type of propeller control mechanism. No provision shall be made for hydraulic propeller operation. An oil vapor opening shall be provided on the governor mounting pad as shown on the Installation Drawing No. 37850; oil pressure shall not be supplied to the pad.

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

Length	215-17/32 inches
Width	29-9/32 inches
Height	40 inches

E-14. Preparation for Storage. The engine shall be prepared for storage in accordance with the engine manufacturers current practice on production engines.

E-16b. Parts List of the Engine. The parts list applicable in all details to the engine which successfully completes Government tests shall constitute a requirement of this specification.

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 shall be 7.48:1 and 6.85:1 and the impellers shall be 9-1/2 inches and 12-3/16 inches in diameter. These ratios and impeller diameters are subject to change at the option of the engine manufacturer.

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-LS85, or Champion C34S Spark Plugs.

E-23b. Radio Shielded Ignition Assemblies. The engine shall be equipped with Allison designed radio shielded ignition assemblies with the following exceptions to Spec. AN-9510:

- (1) (Ref. Par. D-1e, Mounting Lugs) Mounting clamps shall be provided in place of integral, soldered, or welded mounting lugs.
- (2) (Ref. Par. E-8, Capacitance) The capacitance between the shielding and each ignition cable contained therein shall not exceed 175 micro-microfarads.
- (3) (Ref. Par. E-1a, Single Cable Conduits) Single cable conduit connections shall be as shown on Allison Drawing Nos. 33536, 37476, and 41289.

E-23c. High Tension Ignition Cable. (Ref. Spec. AN-9500 Par. D-23c.) High tension ignition cable conforming to U.S. Army Spec. 95-32152 (5mm) shall be used on all distributor head to spark plug leads. All other high tension cable shall conform to Spec. AN-J-C-56. (7mm)

E-23d. Magneto. The engine shall be equipped with one Scintilla Type DFLN-6 magneto in accordance with Spec. AN-9511 with the following exceptions:

- (1) (Ref. Par. D-1b.(1)., Threads) Connections for the high tension terminals are 15/16-18 threads.
- (2) (Ref. Par. E-2c., Normal Operating Temperature) The temperature rise of this magneto is 55.5°C. (100°F.) above room temperature.
- (3) (Ref. Par. E-2d., Endurance) These requirements shall be met except that during the Operating Run, Par. F-4a(11)a, the breaker shall be lubricated at intervals of approximately 100 hours, and during the Elevated Temperature Run, Par. F-4a(11)b, the ambient temperature shall be 150°F.

E-23f. Cooling. (Ref. Spec. AN-9500 Par. D-23f.) The engine shall be so designed as to permit the installation of adequate means for cooling the magnetos to required maximum temperature of 80°C. (176°F.) Provision for cooling the spark plugs and spark plug elbows shall consist of air ducts, as shown on Installation Drawing No. 37850 and Drawing Nos. 37583 and 37584, to which the airplane manufacturer shall connect.

For flight and ground operation, spark plug elbows shall be satisfactory, provided the ignition wire temperature measured in the elbow does not exceed 115°C. (239°F.) and provided the cable furnished in accordance with U.S. Army Spec. 95-32152 does not fail below this temperature.

E-24. Lubricating System. The oil supply for the out-board 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-24c. Oil Leakage Test. (Ref. Spec. AN-9500 Par. D-24c.) With a mixture of equal parts of aviation gasoline and oil conforming to Spec. AN-VV-O-446, Grade 1100, supplied to the pressure oil pump inlet under a head of 36 inches the total flow of oil into the engine shall not exceed 0.2 pounds per hour.

E-24e. Provided no air traps exist in the external scavenging systems, the engine and auxiliary stage scavenging systems shall adequately scavenge the engine and auxiliary stage for extended periods of time under normal operating conditions with a back pressure on the scavenging systems not to exceed 30 p.s.i. at maximum flow, and 2 p.s.i. at minimum idling speeds when using either Grade 1100, or Grade 1120 oil conforming to Spec. AN-VV-O-446 at an inlet viscosity of 100±5 Saybold Universal seconds.

E-24f. Pressure Pump. The oil pressure pumps shall function satisfactorily when the inlet pressures are 88% or more of the absolute atmospheric pressure, down to a minimum of 10 in. Hg. absolute, when no air leaks exist in the external oil inlet lines.

E-24g. Oil Cleaner. The engine shall be equipped with one Automatic Cuno No. 10863, oil strainer, and shall meet with the requirements of Spec. AN-9500, Par. D-24g, under normal operating conditions. The auxiliary stage shall be equipped with one Automatic Cuno oil strainer which shall meet with the requirements of AN-9500, Par. D-24g, under normal operating conditions.

E-24c. 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 Par. E-18
Extension Shaft Center Bearing	Manual lubrication at specified intervals
Aux. Stage Supercharger	Separate system as described in Par. E-24
Aux. Stage Supercharger Flexible Drive	Manual lubrication at specified intervals

E-24q. Crankcase Breathers. Ample breathing capacity shall be provided in accordance with Par. D-24q, of Spec. AN-9500, however, the airplane manufacturer shall locate the front and rear breather outlets to maintain a crankcase pressure measured at the front within the limits of +8 to -4 inches of water on any new or modified airplane installation. It is desired that the pressure at the front of the breather be held to 2 to 6 inches of water higher than pressure at the rear breather, to provide proper ventilation through the engine from the front to the rear.

E-25. Fuel Metering System. The engine shall be equipped with one Bendix Stromberg Model PT-13E-5 injection carburetor in accordance with Spec. 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-17, Mixture Control) The mixture control positions are located as follows:

- (A) Idle cut-off Full Forward.
- (B) Automatic Lean directly back of A.
- (C) Automatic Rich directly back of B.
- (D) Full Rich directly back of C.

(3) (Ref. Par. D-26, Protective Treatment of Steel Parts.) Cadmium plated parts shall have a minimum plating of .0003".

(4) (Ref. Par. D-32a.(1), Metering Characteristics-Sea Level) The carburetors shall meet requirements except that 30 to 70 per cent of airflow for normal rated power and speed the variation in fuel/air ratio shall be plus or minus 2 per cent.

(5) (Ref. Par. D-32b(1), Metering Characteristics, Master Carb.) At Take-off power and speed, the carburetor shall contain a setting which in the rich mixture control position will furnish mixture strengths within +4 -0 per cent of guaranteed fuel consumption.

(6) (Ref. Par. D-32b (13) Carburetor Heat on Test.) The complete airflow to the carburetor shall be heated to avoid icing conditions on test. Duplication of the airplane method of admitting warm air shall not be attempted.

(7) (Ref. Par. D-32b (10)) Idling Tests shall be conducted with exhaust stacks acceptable in design to the procuring agency and the Contractor.

(8) (Ref. Par. D-32c., Metering Characteristics of Production Carburetors.) The carburetors shall meet requirements except that at 30 to 70 per cent of airflow for normal rated power and speed the variation in fuel/air ratio shall be plus or minus 2 per cent of master carburetor flow.

(9) (Ref. Par. F-4e(3), Metering Tests of Production Carburetors.) A procedure for air box testing production carburetors, in accordance with War Department, Air Corps, Materiel Division letter of April 29, 1938, Serial No. E-57-809-16, shall be used, the procedure being as follows:

Mixture readings are obtained on the normal rated power and speed propeller load curve, using the following points; such points being subject to change to agree with individual carburetor specifications:

<u>AIR FLOW</u>	<u>METERING TOLERANCE</u>	<u>MIXTURE CONTROL POSITION</u>
Take-off Airflow	±2%	Auto.Rich Auto.Lean Full Rich
100% rated power airflow	"	" "

<u>AIR FLOW</u>	<u>METERING TOLERANCE</u>	<u>MIXTURE CONTROL POSITION</u>		
75% rated power airflow	±2%	Auto.	Rich	
62-1/2% " " "	"	"	"	Auto.Lean
50% rated power airflow	"	"	"	" " Full Rich
35% " " "	"	"	"	" "
22-1/2% " " "	±5%	"	"	
15% " " "	"	"	"	
10% " " "	"	"	"	
Airflow at min. idling speed	"	"	"	Idle cut-off

In addition, carburetors designed for automatic altitude compensation are checked at an airflow equivalent to 50% of normal rated power airflow with the mixture control in the automatic rich position and readings are taken at air box pressures of 0, 4, 8, and 14 inches of Hg. less than atmospheric pressure.

E-26. Fuel Priming System. Provision shall be made for priming the engine with fuel from a separately installed priming pump and lead line, supplied by the airplane manufacturer and attached to the engine priming connection.

E-29. Coolant Pump. The coolant pump shall be supplied with an internal spring loaded packing. Replacement of the packing is made by disassembly of the pump. No provision shall be made for external packing adjustment.

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

E-31a(3) Supercharger Drain Valve. A fuel aspirator without a valve shall be the only provision made for automatic drainage of the induction system of the integral supercharger.

E-32a. Exhaust Flanges. (Ref. Par. D-32a Spec. AN-9500.) Exhaust flanges and gaskets in accordance with installation drawing No. 37850 shall be supplied, but shall not be included in the engine dry weight. Flanges and gaskets shall be shipped with, or separate from the engine, at the request of the procuring agency.

E-36. Accessory Drives. The gear ratio of each accessory drive to the engine crankshaft, based on the lowest normal rated speed of the engine, 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:

<u>Accessory Drives</u>	Ratio to Crankshaft	<u>Torque Ratings</u>		<u>Rotation</u>
		<u>In.</u> Continuous	<u>Lbs.</u> Static	
<u>Starter</u>	1.000:1	-	16200	C
<u>Generator</u>	1.440:1	600	6000	C
<u>Fuel Pump</u>	0.864:1	25	450	CC
<u>Gun Synchronizer Impulse Generator</u>	0.449:1	25	125	CC
<u>Vacuum Pump (Rear) Type II</u>	1.440:1	150	2250	C
<u>Vacuum Pump (Side)</u>	1.440:1	150	2250	CC
<u>Tachometer (two drives)</u>	0.500:1	2.5	12.5	C
<u>Propeller Governor</u>	0.832:1	15	150	CC

NOTE: CC indicates counter-clockwise rotation
C indicates clockwise rotation.

E-36a. Starter. The starter mounting pad and drive shall be Type I, in accordance with Spec. AN-9517. The direction of rotation when looking at the starter dog attached to the engine shall be clockwise.

E-36a(1) (Ref. Spec. An-9517 Par. E-4b.) Clearance values as specified shall not be provided. (Clearance shall be provided as shown on the Installation Drawing No. 37850.

E-36b. Generator. (Ref. Spec. AN-9518 Par. E-4.) Clearance values as specified shall not be provided. (Clearance shall be provided as shown on Installation Drawing No. 37850.

E-36c. Power Take-off Drive. A power take off drive shall not be provided for driving a gear box assembly.

E-36e. Pad and Drive for Gun Synchronizer Impulse Generator. Provision shall be made for driving Gun Synchronizing Impulse Generators by a Type I pad and drive in accordance with Spec. AN-9520, with the following exception to Par. D-1a: 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(1) Gun Synchronizing Impulse Generators shall not be furnished.

E-36f. Vacuum and Hydraulic Mechanism Oil Pump. Two type II mounting pads and drives in accordance with AN-9521 shall be furnished with the exceptions to Par. E-3b that the slotted adapter bushing shall not be furnished on either pad and the adapter flange shall not be furnished on the side drive.

F. METHODS OF SAMPLING, INSPECTION, AND TESTS.

F-1. The requirements for sampling, inspection and tests shall be as shown in Spec. AN-9500.

G. PACKAGING, PACKING, AND MARKING FOR SHIPMENT.

G-1. The requirements for packaging, packing and marking for shipment shall be as shown in Spec. AN-9500.

PERFORMANCE
AT
STD. PRESSURE

ALTITUDE PERFORMANCE
HORSE POWER AND MANIFOLD PRESSURE
WITHOUT RAM
SUBJECT TO $\pm 2\frac{1}{2}\%$ VAR.

MAXIMUM POWER
(UNLESS OTHERWISE NOTED)
ALLISON DIVISION G.M. CORP. MANUFACTURER
ENGINE MODEL **V-1710-47 (E9)**
PROP. GEAR RATIO 2.23:1
COMPRESSION RATIO 16:1
SUPPLY GEAR RATIO 7.48:1 & 6.85:1
IMPELLER DIAMETER IN 9 $\frac{1}{2}$ & 12 $\frac{3}{16}$
FUEL METERING PT 13E5
FUEL GRADE **AV-14-F-781 (AN 105)**
DATE 7-8-42
ENG. SPEC. No. 137-G APPROVED

1400
PRESS.
AND
TEMP.
1300
1200
1100
STD.
1000
AT
900
POWER
800
HORSE
700
BRAKE
600
+15
0
-25
-50
-55

1325 BHP AT 3000 RPM
TAKE-OFF RATING FOR
5 MINUTES. 51.5 IN. HG. M.P.

3000 RPM

1150 BHP AT 3000 RPM
MILITARY RATING AT
21,000 FEET.
49.7 IN. HG. MAN. PRESS.

2600 RPM

1050 BHP AT
2600 RPM NORMAL
RATING AT SEA LEVEL
51.5 IN. HG. MANIFOLD PRESSURE.

1000 BHP AT 2600 RPM
NORMAL RATING AT
19,000 FT.
40.5 IN. HG. MAN. PRESS.

3000 RPM
2600 RPM

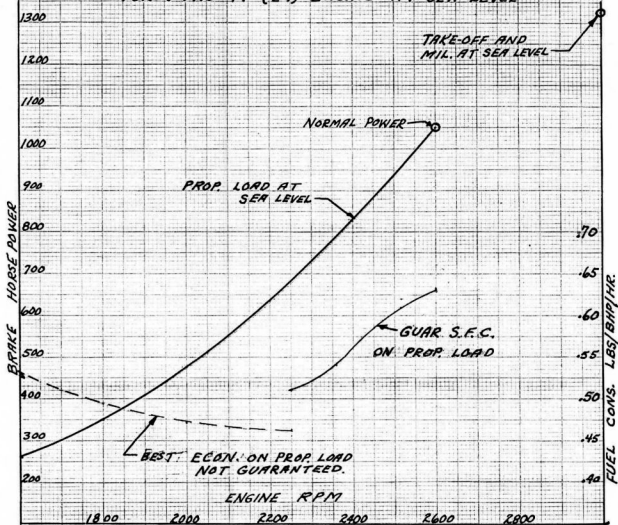
THE POWER CURVE CHARACTERISTICS
SHOWN MAY BE OBTAINED WITH
SUBSTANTIALLY CONSTANT CONTROL
SETTING ON THE HYDRAULIC COUPLING
AND MANIFOLD PRESSURE REGULATOR.

STANDARD ALTITUDE TEMPERATURE °C (Ts)

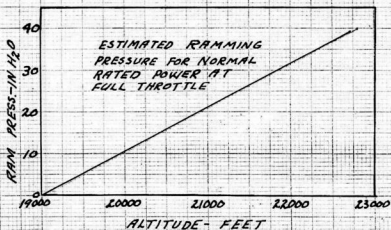
DENSITY ALTITUDE IN FEET

ALL VALUES SHOWN ARE
AT GUARANTEED SPECIFIC
FUEL CONSUMPTION.

GUARANTEED SPECIFIC FUEL CONSUMPTION
FOR V-1710-47 (E9) ENGINE AT SEA LEVEL



GUAR. SPECIFIC FUEL CONS. ON PROP. LOAD AT SEA LEVEL	
T.O. POWER	.70
NORMAL POWER	.63
90% " "	.61
80% " "	.57
75% " "	.54
65% " "	.51



Specifications as of dates listed below shall be applicable to this model specification. Any specification 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.

Army-Navy Spec.	AN-9500a	March 30, 1940
" " "	AN-9501a	March 30, 1940
" " "	*AN-9502a	March 30, 1940
" " "	*AN-9503a	March 30, 1940
" " "	*AN-9504	March 1, 1939
" " "	(2)*AN-9506	March 1, 1939
" " "	(3)*AN-9507	March 1, 1939
" " "	*AN-9510a	July 31, 1940
" " "	AN-9511a	July 31, 1940
" " "	AN-9513	March 1, 1939
" " "	*AN-9515a	March 30, 1940
" " "	AN-9516	March 1, 1939
" " "	AN-9517	March 1, 1939
" " "	AN-9518	March 1, 1939
" " "	AN-9519	March 1, 1939
" " "	(2)*AN-9520	March 1, 1939
" " "	*AN-9521	March 1, 1939
" " "	AN-9533	March 1, 1939

A-N Aero Spec.	AN-F-E-568	Nov. 27, 1941
" " "	*AN-GGG-S-126	July 5, 1939
" " "	*AN-J-C-56	Oct. 10, 1941
" " "	*AN-P-4	Jan. 14, 1942
" " "	(2)*AN-QQ-M-181	March 24, 1939
" " "	*AN-VV-C-566	August 1, 1939
" " "	*AN-VV-F-746	Oct. 5, 1940
" " "	*AN-VV-F-748	Sept. 22, 1941
" " "	(5)*AN-VV-F-781	Sept. 26, 1940
" " "	AN-VV-O-446	Dec. 15, 1941

U. S. Army Spec.	95-32152	Nov. 5, 1941
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Army-Navy Dwg.	AN-4033	March 1, 1939
" " "	AN-4034	Feb. 25, 1939
" " "	AN-4037	June 10, 1940

AND Dwg.	AND-10201	April 12, 1940
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Note: *(Asterisk) and preface number in () (parentheses) indicate that the specification has been amended and the particular amendment that is applicable.