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Base Engineering School

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AAFWTTC
FLIGHT ENGINEER
HANDBOOK
B-29

RESTRICTED

U. S. ARMY AIR FORCES

FLIGHT ENGINEER'S HANDBOOK

Prepared by the
FLIGHT ENGINEER DIVISION
DEPARTMENT OF B - 29 CREW TRAINING
ARMY AIR FORCES TECHNICAL SCHOOL
LOWRY FIELD, COLORADO

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FOREWORD

This Notebook has been prepared for the field use of the Flight Engineer graduates of this school. No material has been included that is classified either as secret or confidential.

The information herein is correct in detail at the time of compilation, but realizing the various deviations that will be made from time to time the T.O.'s should be consulted regularly and this book kept up to date.

TABLE OF CONTENTS

Cruise Control Section:
This section is to assist the engineer to: determine cargo loading, calculate range and aircraft performance required to successfully complete flight mission, check the forms and plot fuel consumption curves during flight.

Mechanical Maintenance Section:
This section is to assist the engineer in advising the ground crew to effect correct maintenance and servicing operations; instrument indications of mechanical malfunctions; engineer's check list and trouble shooting in general.

Tables Section:
This section contains conversion tables, reference dimensions, specifications, coding legends, technical order references, etc.

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CRUISE CONTROL SECTION

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FORMULAE

$L = C_L \frac{\rho}{2} SV^2$

$D = C_D \frac{\rho}{2} SV^2$

$V = \frac{V_{i_w} (\frac{W}{W_s})^{\frac{1}{2}}}{\sigma^{\frac{1}{2}}}$

$\text{Wind Reserve} = \frac{W_f}{\frac{D}{W_w} - 1}$

$V_t = \frac{V_i}{\sigma^{\frac{1}{2}}}$

$^oC = 5/9\ (^oF - 32)$

$^oF = 9/5^oC + 32$

2.54 cm = 1 in.

5280' = 1 mi. (statute)

$1 \text{ slug} = \frac{1 \text{ lb. sec.}^2}{\text{ft.}}$

work = force x dist.

$P = \frac{P_{i_w} (\frac{W}{W_S})^{3/2}}{\sigma^{\frac{1}{2}}}$

33000'#/min. = 1 HP.

1 mi./hr. = 88/60 = 1.467'/sec.

$BHP = \frac{BMEP \times RPM}{K}$

$K = \frac{792,000}{\text{Pist. Disp.}}$

$BHP = \frac{2\pi F L N'}{33,000}$

$\eta = \frac{THP}{BHP}$

$BHP_2 = BHP_1 (\frac{N_2}{N_1})^3$

$BHP_{cor.} = BHP_{obs.} \sqrt{\frac{T_{std}}{T_{obs}}}$

$\frac{\eta}{SFC}$

1 British gal. = 1.2 U.S. gal.

1 U.S. gal. oil weigh 7.5#

1 U.S. gal. gas weight 5.5# to 6.5#

100 rds. 30 cal. weigh 6.5#

100 rds. 50 cal. weigh 30.5#

100 rds. 20 m.m. weigh 55.0#

L = Lift—That component of the total air force acting on an aircraft or airfoil which is perpendicular to the relative wind.

C_L = The absolute lift coefficient.

ρ = (rho) The density of the air. Aerodynamics usually treats of the mass density of the atmosphere, but this symbol is also used for weight density.

S = Wing area

V = Velocity

D = Drag—That component of the total air force acting on an aircraft or airfoil which is parallel to the relative wind.

C_D = The absolute drag coefficient.

V_{i_w} = Velocity at sea level at standard weight under standard conditions.

W = Weight of plane.

W_s = Standard weight of plane.

σ = (sigma) The ratio of the density at altitude to that at sea level under standard conditions.

P = Power required.

P_{i_w} = Power required at sea level at standard weight under standard conditions.

W_f = Weight of fuel predicted for four-engine operation with no wind.

D = Distance from origin to destination.

H = Hours through which the headwind acts.

V_w = Velocity of the headwind in miles per hour.

V_t = True airspeed.

V_i = Indicated airspeed

^oC = Degrees Centigrade

^oF = Degrees Fahrenheit

cm = Centimeter

Statute = "land" miles - 5280 ft.

slug = That mass which would be accelerated 1 ft. per sec. per sec. by a force of 1 lb.

HP = Horsepower

BHP = Brake Horsepower

BMEP = Brake Mean Effective Pressure

RPM = Revolutions per minute.

K = "Engine" constant.

Pist. Disp. = Piston Displacement.

π = (pi) The number of times the linear measurement of the diameter of the circle can be laid off on its circumference.

F = Force

L = Length of the arm in feet.

N' = Propeller shaft RPM

η = (eta) Propulsive efficiency--the ratio of thrust horsepower to brake horsepower.

$BHP_{cor.}$ = Brake horsepower output as estimated from the power curve corrected for variation in carburetor air temperature.

$BHP_{obs.}$ = Brake horsepower output as estimated from the power curve under conditions normal to the chart.

$T_{std.}$ = Standard carburetor air temperature in absolute units.

$T_{obs.}$ = Actual carburetor air temperature in absolute units.

SFC = Specific Fuel Consumption--pounds per brake horsepower per hour.

' = Feet.

= Pounds.

rds. = Rounds.

cal. = Caliber

mm = Millimeter

H_p = Pressure altitude, which is the altimeter reading when the barometric scale on the altimeter is set to read 29.92 Hg.

H_d = Density altitude, which is the pressure altitude corrected for temperature.

Specific Volume	Specific volume is volume per unit weight.
Pressure Altitude	That altitude which corresponds to a given atmospheric pressure under standard conditions.
Density Altitude	That altitude which corresponds to a given density under standard conditions.
Aspect Ratio	The ratio of the square of the span of an airfoil to the area of the airfoil. In the special case of a rectangular airfoil it is the ratio of the span to the chord. In general it may be expressed as the ratio of the span to the average chord.
Relative Wind	The air current acting on the airfoil parallel and opposite to the line of flight of the airfoil.
Angle of Attack	The angle formed by the chord of the airfoil and the relative wind.
Angle of Incidence	The angle formed by the chord of the airfoil and the longitudinal axis.
Profile Drag	The drag built up by the flat plate area of the airfoil exposed to relative wind.
Parasite Drag	That drag caused by those portions of the airplane which do not contribute to lift.
Induced Drag	That drag caused by the production of lift by the airfoil.
Standard Temperature	The temperature for standard atmospheric conditions--59°F (15°C) at sea level and a decrease of 3.566°F (2°C) per thousand feet of altitude.
Indicated Airspeed	Airspeed shown on the airspeed indicator.
True Indicated Airspeed	Indicated airspeed corrected for pitot static tube position error and instrument error.
Position Error	Airspeed indicator error caused by the angle of attack of the pitot static tube.

True Airspeed	Actual speed of the plane with reference to the air--indicated airspeed corrected for pitot static tube position error, airspeed indicator instrument calibration error, density altitude.
Flap	An adjustable portion of the airfoil at its trailing edge which is capable of changing the lift and drag characteristics of the airfoil.
Slot	An opening or adjustable portion of the airfoil at its leading edge which is capable of changing the lift and drag characteristics of the airfoil.
Spoiler	A device on the upper surface of the airfoil capable of destroying its lifting ability.
War Emergency Power	The maximum power which may be taken from an aircraft engine. Because of the extreme strain it puts on the engine, it can be taken for only thirty seconds.
Military Horsepower or Take-Off Horsepower	The power rating which is used when extra power is needed during take-off. The time limit for operation at this power is five (5) minutes.
Rated Power	The maximum power which may be taken from an aircraft engine for an unlimited time under certain conditions specified by the manufacturer.
B.M.E.P.	Brake mean effective pressure is the average differential pressure between the compression and power strokes assumed to be acting on the piston during the power stroke to produce brake horsepower.
B.S.F.C.	Brake specific fuel consumption is pounds per brake horsepower per hour, usually abbreviated as S.F.C..
Thermal Efficiency	Theratio of the power output of the engine to the heat energy put into it.
Volumetric Efficiency	The ratio of the weight of the charge put into the engine corrected to standard atmospheric conditions to the weight of charge required to fill the piston displacement at standard atmospheric conditions.
Service Ceiling	That altitude above which the plane can no longer climb at rate of 100 ft/min.

Absolute Ceiling	That altitude at which the plane can no longer climb.
Detonation	A phenomena of combustion in which sufficient heat energy is developed by the burning charge to cause the remainder of the unburned charge to burn as an explosion instead of burning evenly as it should. The result is that the charge burns so quickly that the piston cannot absorb it in useful work and as a result this excess energy is lost through radiation.
Pre-ignition	A condition within the cylinder in which the charge begins to burn before the spark occurs.
Self-ignition	A condition within the cylinder in which the charge begins to burn due to heat of compression, before the spark occurs.
Service Pick-up	The increase in weight of the airplane due to absorption of moisture, the accumulation of dirt and oil and minor structural repair.
Maximum Range	The cruising condition in which is achieved the maximum miles/gallon for the engine-propeller-airfoil combination.
Maximum Endurance	The cruising condition in which is achieved the maximum hours of flight for a given amount of fuel.
M.A.C.	Mean Aerodynamic Chord (The chord of an imaginary wing of rectangular shape that, when substituted for the actual wing of irregular shape, will give exactly the same resultant lift to the airplane.
Wing Chord	Measurement of the width of the wing taken from the leading edge to the trailing edge.
Station	Any point on the airplane measured in inches from the nose or Station 0. The most aft or rearward station on the B-29 is station 1200.
Stick Force	Force applied to the controls by the pilot to overcome any unbalanced condition caused aerodynamically or by improper placement of load.
Useful Load	A load consisting of crew, fuel, oil, armament and photographic equipment.

Normal Gross Weight	The sum of the basic weight and the useful load.
Zero Stick Force	That condition existing when the airplane is aerodynamically balanced by the trim tabs or proper load placement thereby requiring no application of force on the controls by the pilot to assume level flight.
Maximum Overload Gross Weight	The maximum weight of the airplane under loaded conditions, with all equipment, disposal load, alternate load items and personnel present.
Maximum Allowable Overload Gross Weight	The maximum allowable weight of the airplane with all loadings beyond which weight it would be unsafe to fly.
Alternate Load Items	Items which are not necessary for normal flight, but are carried for certain missions or under certain conditions.
Maximu Allowable Landing Gross Weight	The total weight beyond which it would be unsafe to land.
Disposal Loads	Fuel, oil, ammunition, bombs, torpedoes, and all other items that may be used or disposed of during flight.
Index Unit	A gradation on the load adjuster proportional to the change in moment caused by a shift in the center of gravity.
C.G.	Center of Gravity--The point about which an airplane would balance if suspended.
Allowable C. G.	The range of movement which the center of gravity can have without making the airplane unsafe to fly. It is determined by the manufacturer in actual test flights and is expressed as Forward Limit and Rearward Limit.
Arm	The perpendicular distance in inches from the datum line to any point in the ship.
Moment	The result of multiplying the arm by the weight.

Basic Moment	The sum of the moments of all items making up the basic weight.
Optimum	The best or most favorable degree, quantity, number, etc.
Basic Weight	The weight of the airplane with normal fixed and operating equipment only.
Reference Line or Datum Line	An imaginary vertical line at or near the nose of the airplane. Its location is chosen by the manufacturer as a standard point from which all horizontal distances are measured. Diagrams of any airplane show the reference line as 0.

INDEX UNIT DETERMINATION

$$\text{Index} = 110 - \frac{\text{Basic Weight} \times (445.5 - \text{Basic Arm})}{25{,}000}$$

1. 110 is a constant which applies to the YB-29 Load Adjuster only. It represents the point on the Index Scale expressed in index units, about which the moments for the Load Adjuster were computed.

2. 445.5 is the distance in inches from the reference location of the Load Adjuster moments to the reference datum.

3. 25,000 is a constant for the YB-29 Load Adjusters and represents the ratio of inch - lbs. to index units.

4. The Basic Weight and Moment is obtained from Log Chart "C" in the Weight and Balance Handbook. The Basic Arm is obtained by dividing the Basic Moment by the Basic Weight.

WEIGHT AND BALANCE

1.	Basic Weight (Approx.)	71,800 lbs.
2.	Design Gross Weight	105,000 lbs.
3.	Allowable Maximum Weight	120,000 lbs.
4.	Maximum Allowable Loading	100,000 lbs.
5.	Loading Range:	
	Forward Station	419.29 - 18% MAC
	AST Station	440.91 - 32% MAC
6.	Length of MAC	154.4 Inches
7.	Distance from reference datum to leading edge of MAC.	319.5 Inches
8.	Leveling lugs (3) located above cat walk in forward bomb bay.	

DEFINITIONS

The following definitions will serve as standardized terminology for all data in the practical application of this system. It is important to know them thoroughly.

WEIGHT. - The weight is 16 ounces per pound, avoirdupois weight. All weights are to be calculated to the nearest whole pound.

BASIC WEIGHT. - The weight of the airplane, including all equipment that has a fixed location and is actually present in the airplane; that is, air frame; power plant and accessories; trapped fuel and oil; full hydraulic, cooling and anti-icing fluid systems and reservoirs; armor plate, ordnance (less ammunition and bombs); chemical, navigation, oxygen, pyrotechnics, and radio equipment. It never includes items commonly referred to as "disposable."

NOTE: The basic weight of an airplane varies with modifications and changes in the fixed equipment. This is not to be confused with empty weight which is a dry weight with certain contract equipment only. The term "basic weight," when qualified with a word indicating the type of mission, such as "basic weight for combat, for ferry, for transport, etc.," may be used in conjunction with directives stating what the equipment shall be for these missions; for example, extra fuel tanks and various items of equipment installed for long range ferry flights but not normally carried on combat missions which will be in "Basic Weight for Ferry" but not in "Basic Weight for Combat."

GROSS WEIGHT. - The total weight of an airplane and its contents.

REFERENCE DATUM LINE. - An imaginary vertical line at or near the nose of the airplane. Its location is chosen by the manufacturer as a standard line from which all horizontal distances are measured for balance purposes. Diagrams of each airplane show this reference line as zero.

ARM. - For balance purposes, arm is the horizontal distance in inches from the reference datum line to the cg of the item.

MOMENT. - The weight of an item multiplied by its arm.

AVERAGE ARM. - Average arm or location is obtained by adding the weights and the moments of a number of items, and dividing the total moment by the total weight.

BASIC MOMENT. - The sum of the moments of all items making up the basic weight. When using data from an actual weighing of an airplane, the basic moment is the sum of the moments around the reference datum line. For simplicity, it is permissible to divide the moment by a constant so as to reduce the number of digits. If this is done, the same constant must be used consistently for all computations, and must be indicated in the moment column on charts A, B, and C.

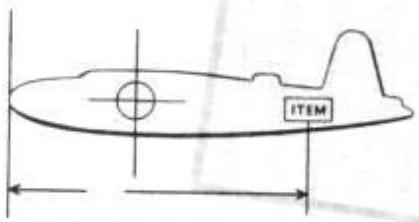
CENTER OF GRAVITY. - The point about which an airplane would balance if suspended. Its distance from the reference datum line is found by dividing the total moment by the gross weight of the airplane.

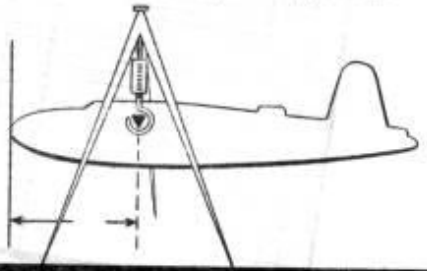
CG LIMITS. - The range of movement which the cg can have without making the airplane unsafe to fly. It is determined by actual test flights. The cg of the loaded airplane must be within these limits at take-off, in the air and on landing. In some special cases a "Landing Limit" is specified. On loading graphs the cg limits are indicated by cg limit lines. In all cases, the cg condition should be checked for landing without fuel and bombs.

LOADING RANGE. - The safe cg location under any load condition. It is shown on the balance computer as the white section labeled "Loading Range."

TARE. - Weight of equipment necessary for weighing the airplane (chocks, blocks, slings, jacks, etc.) which has been included in the scale readings but is not a part of the basic weight.

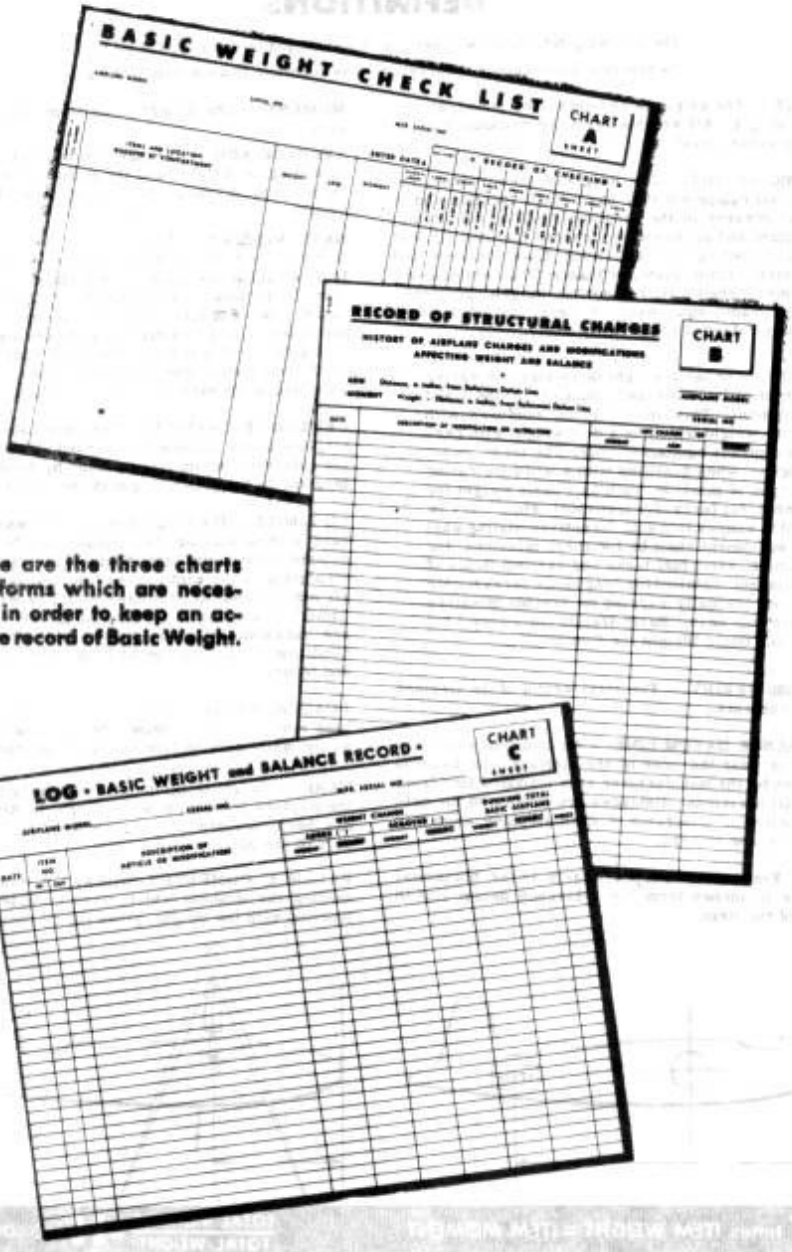
BALANCE COMPUTER INDEX. - A number representing the moment which, when considered in conjunction with the weight, gives the cg position.





Y times ITEM WEIGHT = ITEM MOMENT

$\frac{\text{TOTAL MOMENT}}{\text{TOTAL WEIGHT}} = \mathbf{H}$ (CG LOCATION)



These are the three charts and forms which are necessary in order to keep an accurate record of Basic Weight.

SECTION·2

CHARTS and FORMS . . . .

Any systematic operation in which records are kept requires the use of charts and forms. This system is no exception. They are not, as might be suspected, designed to harass the operator with a blizzard of paper work, but rather to provide him with organized data with which to do his job.

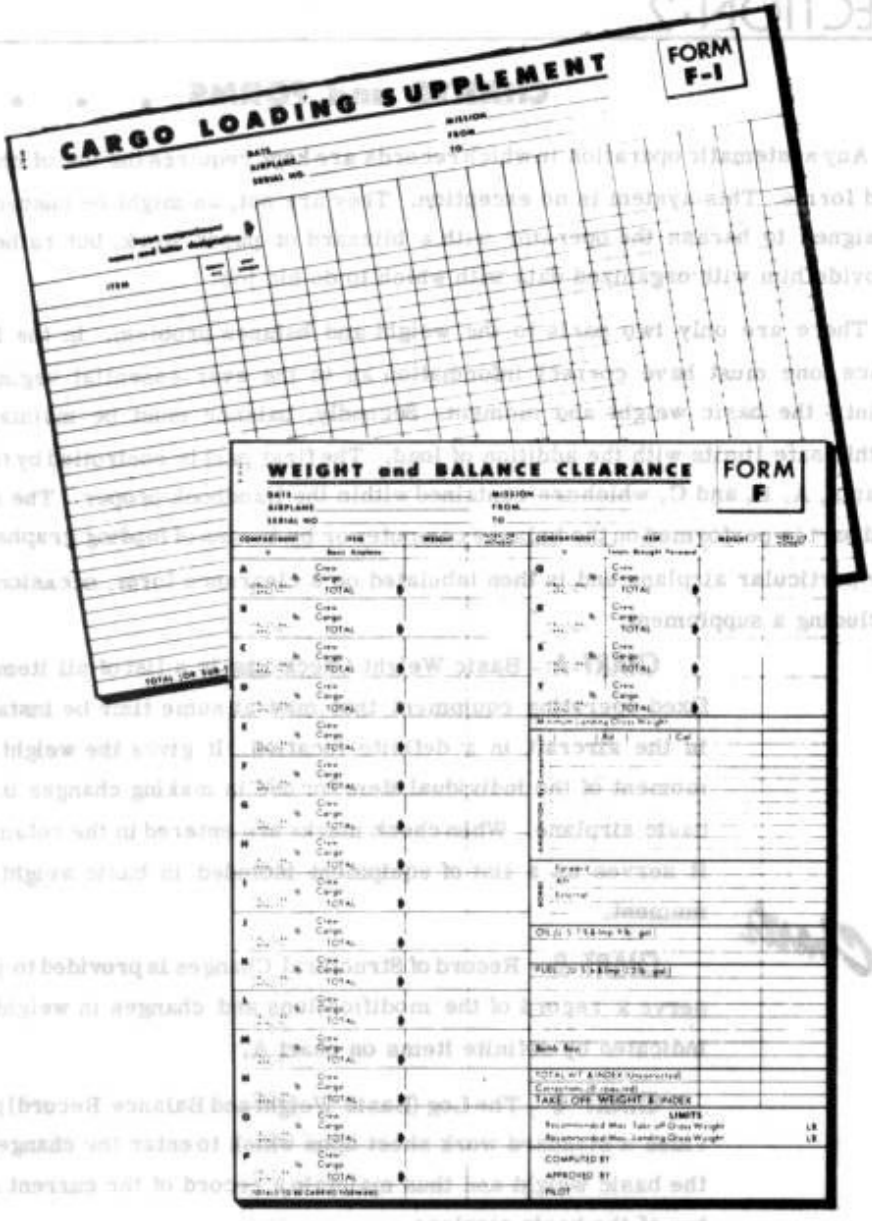
There are only two parts to the weight and balance problem. In the first place, one must have correct information as to the ever-essential beginning point - the basic weight and moment. Secondly, balance must be maintained within safe limits with the addition of load. The first part is controlled by three charts, A, B, and C, which are contained within the Handbook proper. The second part is performed on the balance computer or by means of loading graphs for the particular airplane and is then tabulated on a clearance form, occasionally including a supplement.

Charts

CHART A - Basic Weight Check List is a list of all items of fixed operating equipment that may at some time be installed in the aircraft in a definite location. It gives the weight and moment of the individual item for use in making changes in the basic airplane. When check marks are entered in the columns, it serves as a list of equipment included in basic weight and moment.

CHART B - Record of Structural Changes is provided to preserve a record of the modifications and changes in weight not indicated by definite items on chart A.

CHART C - The Log (Basic Weight and Balance Record) provides a standard work sheet upon which to enter the changes in the basic weight and thus maintain a record of the current status of the basic airplane.


CARGO LOADING SUPPLEMENT
FORM F-1
WEIGHT and BALANCE CLEARANCE
FORM F

Detailed instructions for filling in each of the charts mentioned will be found printed on the page preceding the first sheet of each set.

Charts A, B, and C should be checked and brought up to date as follows:

a. When the airplane is received at a new base.
b. When modifications or structural changes are made.
c. When the airplane has a major overhaul or engine change.
d. When changes in equipment are made for a different type of operation or mission.
e. When a pilot reports tail or nose heaviness in flight.
f. When it is suspected that the forms are not up to date.
g. When the airplane is reweighed.

To use a balance computer or loading graph satisfactorily, the total of variable load in each compartment must be known and tabulated. This may be done in detail on Form F-1 and the compartment totals then entered on Form F.

Form F is the summary of the actual disposition of load in the aircraft and records the balance status step by step. It is necessary to accomplish Form F prior to flight whenever an airplane is loaded in a manner for which no previous tabulation is available.

Form F-1 is a standard means for the ground crew to list in detail the items actually loaded in each compartment so that the pilot or weight and balance officer will have figures for checking the compartment totals. It may be used also as a form on which to list equipment requirements to aid loading crews in laying plans for the movement of groups of similar aircraft.

Commanding officers will prescribe the disposition of Forms F and F-1. However, it is recommended that one copy of each form completed for the current basic weight remain in the Handbook with that airplane. This will be an aid to personnel responsible for later loadings.

Form F is supplied as an expendable pad which can be replaced from stock when exhausted. These pads are loose leaf and have provisions for making duplicate copies. All original sheets are perforated along the binding edge and may be removed to serve as a certificate of proper balance, carrying the signature of responsibility. There will be found attached to the Form F pad a supply of Forms F-1 for use as needed.

ACTUAL WEIGHING OF AIRPLANE

The airplane must be weighed in a closed hangar, in the following manner:

Thoroughly clean the airplane inside and out. Check the airplane equipment against chart A and correct the chart as necessary so as to itemize accurately all items of fixed operating equipment that will be included in the basic weight to be determined by the weighing. See that the date at the top of the CHECK column corresponds with the date entered on the weighing form and final entry posted in the log, chart C.

Bombs, ammunition, cargo, crew members, and equipment not having a fixed location are not to be listed as a part of chart A and are not to be in the airplane when weighed. Reservoirs for drinking and washing water, hydraulic, anti-icer, and cooling fluids, etc., should be filled to capacity prior to weighing. Engine oil and fuel (except trapped) are not items of basic weight. Fuel and oil tanks should be drained using only tank drains, with the airplane in its normal ground attitude.

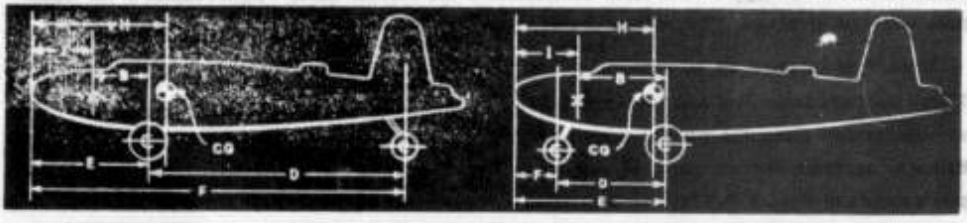
After the airplane is prepared for weighing as stated above, place calibrated scales of a suitable capacity under each wheel. Care must be exercised when placing a heavy airplane upon the platforms of scales because an abrupt application of the airplane's weight may seriously disturb the calibration of the scales and cause inaccuracy. Brakes shall be released at all times while the airplane is on the scales.

Level the airplane longitudinally and also laterally if possible. Use the regular airplane leveling lugs and a spirit level.

Enter the scale readings on the weighing form provided. Take measurements and compute the new basic weight and moment by completing the weighing forms.

Enter the new basic weight and moment in the log, chart C. All subsequent airplane loadings will be based on these figures.

FOR TAIL WHEEL AIRCRAFT • FOR NOSE WHEEL AIRCRAFT



DIAGRAMS FOR MEASURING VARIOUS TYPES OF AIRPLANES TO DETERMINE ARM OF SUPPORT POINTS

5-15-42

AIRPLANE WEIGHING FORM

DATE WEIGHED June 5, 1943 MODEL B-29 SERIAL No. 43081

PLACE WEIGHED Lowry Field, Colo. WEIGHING OFFICER J.B. Thomas, 2nd Lt. A.C.

WHEEL	SCALE READING	TARE	NET WEIGHT	ARM	MOMENT
LEFT MAIN	35416	0	35416		
RIGHT MAIN	35416	0	35416		
SUB-TOTAL (Both Main)	70832	0	70832	460.99 E	32,646,538
NOSE OR TAIL	6268	0	6268	49.35 F	309,012
TOTAL (As Weighed)	77100	0	77100	427.4 H	32,955,550

INSTRUCTIONS

1. Enter scale readings in first column.
2. Subtract tare, if any, from scale reading to obtain net weight.
3. Determine the arms, E and F.
4. Multiply the sub-total net weight of main wheels, and the net weight of nose or tail wheel, by their respective arms (dimensions E and F) to obtain their moments.
5. Add net weights and moments of the main wheels and nose or tail wheel.
6. Divide the total moment by the total net weight to obtain the cg position in inches from the reference datum line (H).

MEASUREMENTS

B. Distance from the jig point or frame to the center line of the main wheels. Obtained by measurements.

I. Distance from reference datum line to some accessible exterior jig point or frame of the airplane from which a plumb bob can be dropped to the ground. Obtain from diagram on balance computer or from Chart E.

E. Distance from reference datum line to center line of main wheels.

$$E = B + I$$

D. Wheel base. Obtain by measurement.

F. Distance from reference datum line to center line of nose or tail wheel.

$$F = E - D \text{ (nose wheel airplane)}$$
$$F = E + D \text{ (tail wheel airplane)}$$

	DESCRIPTION	NET WEIGHT	ARM	MOMENT	INDEX
*	TOTAL (As Weighed)	77100	427.4	32955550	
**	OIL IN AIRPLANE	-2550	391.5	1001025	
**	Total of Items Weighed but Not Part of Basic Weight	-		-	
***	Total of Basic Items Not in Airplane when Weighed	+		+	
	BASIC AIRPLANE (Post to Chart C)	74,550	428.6	31,954,525	59.7

*Post from upper chart to lower chart.
**Subtract weight and moment in accordance with actual weighing instructions in the test.
***Be absolutely sure these items are subsequently installed and checked off in chart A as actually being in the airplane.
†Applicable to the load adjusting computer.

INSTRUCTIONS FOR USING CHART A

This chart is a check-off list for all fixed operating equipment (machine guns, cameras, etc.), which (1) has a definite location in the airplane, (2) is, or at some time may be, in the airplane, and (3) is an alternate installation for standard equipment.

At the time of delivery of a new airplane, the manufacturer is to enter the above items on this form, in groups according to compartment location. The item number shall be prefixed with the compartment letter designation. For large airplanes a separate page shall be used for each compartment. This list should be as complete as possible, and must be kept up to date.

The weight, arm, and moment for each item may be listed for all items of equipment, including possible alternate positions. If a constant is used to simplify the moment, it should be inserted at the top of the moment column.

A check (✓) in the column headed "IN AIRPLANE" indicates the presence of the item in the airplane on the date at the head of the column. Items should not be checked unless they are installed and items not checked are not included in the basic weight and balance tabulated on chart C for the corresponding date. Check marks should never be changed or added in a previously checked column. When a complete inventory is taken at a later date, the next check column is used.

When a listed item not previously in the airplane is installed, the weight and moment shown on chart A should be added to the last basic weight and moment on chart C.

If an unlisted item is installed in the airplane, write in its name or description under the proper compartment, together with the authorizing change order number if applicable and list its weight, arm and moment on chart A. Add its weight and moment to the last weight and moment on chart C. The arm may be determined with the aid of chart E in section 7.

When an item is removed from the airplane, subtract its weight and moment on chart C.

During a complete inventory, any change made in equipment since the previous inventory becomes obvious when the check marks on the first inventory are compared with the second. Refer to chart C and ascertain whether correct changes in the basic weight and moment have been made in the interval between inventories. If each change indicated by the difference of check marks has been made, place a check mark in the "LOG ENTRY" column. If the change has not been made, add the entry and then place a check mark in the log entry column.

3-15-43

BASIC WEIGHT CHECK LIST

CHART A SHEET

AIRPLANE MODEL B-29 SERIAL NO 430862 MFR. SERIAL NO.

ENTER DATE ▸ DELIVERY 6/24/43 • RECORD OF CHECKING • 8/15/43

COMPARTMENT & ITEM NUMBER	ITEMS AND LOCATION GROUPED BY COMPARTMENT	WEIGHT	ARM	MOMENT	NORMAL EQUIP.	CHECK 1		CHECK 2		CHECK 3		CHECK 4		CHECK 5		CHECK 6		CHECK 7		CHECK 8	
						IN AIRPLANE	LOG ENTRY	IN AIRPLANE	LOG ENTRY	IN AIRPLANE	LOG ENTRY	IN AIRPLANE	LOG ENTRY	IN AIRPLANE	LOG ENTRY	IN AIRPLANE	LOG ENTRY	IN AIRPLANE	LOG ENTRY	IN AIRPLANE	LOG ENTRY
A-1	AFCE Directional Gyro	19	20	380	✓	✓		✓													
A-2	Bombardier's Seat + Belt	16	44	704				✓	✓												
B-1	Pilot's Seat + Safety Belt	26	100	2600	✓	✓		✓													
B-2	Co-Pilot's Seat + Safety Belt	26	100	2600	✓	✓		✓													
C-1	Radio Operator's Table	7	160	1120	✓	✓		✓													
C-2	Radio Operator's Seat + Belt	26	182	4740	✓	✓		✓													
C-3	Radio Power Unit	52	200	10400				✓	✓												
C-4	Radio Transmitter	48	200	9600				✓	✓												
D-1	Bomb Rack	20	350	7000				✓	✓												
D-2	Bomb Hoist	17	320	4220	✓	✓			✓												
D-3	Bomb Door Motors	10	400	4000	✓	✓		✓													
E-1	Emergency Flap Motor	12	480	5760	✓	✓			✓												
F-1	Bomb Rack	20	570	11400				✓	✓												
F-2	Bomb Hoist	17	540	9170	✓	✓			✓												
F-3	Bomb Doors Motors	10	480	4800	✓	✓		✓													
G-1	Anti-Icer Pumps	15	650	9750	✓	✓		✓													
H-1	Battery	70	750	52500	✓	✓		✓													
H-2	Thermos Bottle	5	800	4000																	
I-1	Camera	50	900	45000	✓	✓			✓												
I-2	Auxiliary Power Plant	160	950	152000	✓	✓		✓													
J-1	Ammunition Boxes (.50 Cal.)	20	950	19000																	
K-1	— — —	20	1050	21000	✓	✓		✓													
L-1	Tail Gunner's Seat + Belt	15	1160	17400	✓	✓		✓													

RESTRICTED C-21

RESTRICTED AN 01-1-40

SECTION·4

INSTRUCTIONS FOR USING CHART B

This chart serves as an historical record of structural changes and the replacement of major items such as engines, propellers, cowling, tires, ordnance installations, self-sealing fuel cells, etc., not covered by chart A.

The manufacturer made no entries on this form unless modifications or changes were made after actually weighing and determining the basic weight and moment. Entries are to be made by a weight and balance officer or by an engineering officer at an overhaul or modification center as follows:

Column 1 - Enter date of change.

Column 2 - Enter sufficient description of change to identify it, including the authorizing change order number if applicable.

Column 3 - Enter net weight increase or decrease (+ or -).

Column 4 - Enter arm (distance from reference datum line to the cg of the change). See chart E.

Column 5 - Enter the moment increase or decrease (+ or -).

Transfer total weight and moment of each group of entries to chart C and make any necessary change on chart A.

This form may also be used to list minor changes which are not great enough to justify changing the basic weight and moment. When the total number of small changes becomes appreciable, it may be entered on chart C. This reduces the number of basic log entries without losing the accumulative effect of numerous small changes.

RECORD OF STRUCTURAL CHANGES

CHART B

HISTORY OF AIRPLANE CHANGES AND MODIFICATIONS AFFECTING WEIGHT AND BALANCE

ARM — Distance, in inches, from Reference Datum Line

MOMENT — Weight × Distance, in inches, from Reference Datum Line

B-29
AIRPLANE MODEL

430862
SERIAL NO.

DATE	DESCRIPTION OF MODIFICATION OR ALTERATION	NET CHANGE + OR −		
		WEIGHT	ARM	MOMENT
9/15/43	Removal Forward Belly Turret	− 2200	200	-440000
9/15/43	Install Dummy Fwd. Belly Turret	+ 1800	200	+360000
9/15/43	Install Portable Radio & Brackets	+ 290	138	40046

SECTION·5

INSTRUCTIONS FOR USING CHART C

Chart C is a permanent running record of the changes in an airplane's basic weight, moment and index. At all times the last weight, moment and index entry is considered the current weight and balance status of the basic airplane. The basic index for the balance computer can be determined by means of the formula shown on the computer and included in the instructions for the use of the computer.

At time of delivery of a new airplane, the manufacturer enters on this chart the basic weight, moment and index of the airplane. The itemized list of the equipment included is shown and checked on chart A in the delivery column.

The log entry date must be consistent with the date entered at the top of the check column on chart A and with the date on the airplane weighing forms.

Whenever equipment is added to or removed from the airplane, the item number, nomenclature, weight and moment should be obtained from chart A and entered in the appropriate columns on chart C. The necessary corrections should then be made to the progressive totals. In order to preserve a record of added basic equipment, unlisted equipment which is installed in the airplane should be tabulated on chart A, using the actual weight and measured arm of the items.

If the index of the airplane is changed as a result of changes in the fixed operating equipment or structural changes made in the airplane, the index on the data card of the balance computer's carrying case must be changed to agree.

Structural modifications or changes are to be recorded first on chart B and the net change in weight and moment added to or subtracted from the last previous total on chart C.

The effect of changes in equipment which have been transferred from chart A and the effect of structural modifications which have been transferred from chart B keep the log correct and up-to-date.

Any change or modification which is caused by a specific order should carry a reference to the order number which authorizes the change.

LOG • BASIC WEIGHT and BALANCE RECORD •

CHART C SHEET

AIRPLANE MODEL B-29 SERIAL NO 430862 MFR. SERIAL NO.

DATE	ITEM NO. IN	ITEM NO. OUT	DESCRIPTION OF ARTICLE OR MODIFICATION	WEIGHT CHANGE ADDED (+) WEIGHT	ADDED (+) MOMENT	REMOVED (−) WEIGHT	REMOVED (−) MOMENT	RUNNING TOTAL BASIC AIRPLANE WEIGHT	MOMENT	INDEX
6-5-43			Basic Airplane							
6-6-43	A-2		Bombardier's Seat & Belt	16	704			74550	3196000	59.7
	C-3		Radio Power Unit	52	10400					
	C-4		Radio Transmitters	48	9600					
	D-1		Bomb Rack	20	7000					
	F-1		Bomb Rack	20	11400					
9-12-43		D-2	Removed Bomb Hoist			17	4220	74706	3209104	58.3
		E-1	Removed Emergency Flap Motor			12	5760			
		F-2	Removed Bomb Hoist			17	9170			
		I-1	Removed Camera			50	45000	74610	3195495	57.8
9-15-43		✓	Removed Fwd. Belly Turret			2200	440000	72410	3151954	80.6
	✓		Install Dummy Fwd. Belly Turret	1800	360000			74210	3187495	62.0
	✓		Install Portable Radio & Bracket (2)	290	40048			74500	3191500	60.5
	✓		Service Pick-Up	✓	✓			74550	3195452	59.7

RESTRICTED C-25

RESTRICTED AN 01-1-40

SECTION 6

INSTRUCTIONS FOR USING FORM F

1. Insert the necessary identifying information at the top of the form.

2. Enter basic airplane weight and index at top of the left-hand column. Obtain these figures from the balance computer case data card or from the last entry on chart C. In case the figures do not agree, chart C is to be considered correct.

3. Using the same compartment letter identification as shown on the back of the balance computer, enter the crew and cargo weights for each compartment in the "ITEM" column. Enter each compartment total to the weight column.

4. Enter the minimum landing gross weight (basic weight plus compartment loads). When paratroops are to be evacuated in flight, this landing gross weight will be reduced, and hence the cg position must be rechecked carefully.

5. List the ammunition by compartment, giving the caliber and number of rounds, and enter weight in the weight column.

6. List the number and size of bombs, torpedoes, etc., and enter the total weights in the weight column.

7. List the amount and weight of the oil and enter weight in the weight column.

8. List by tanks, the amount and weight of all fuel loaded. Group fuel tank nomenclature where possible. Enter the respective weights in the weight column.

9. Enter "Recommended Max. Take-off Gross Weight" and "Recommended Max. Landing Gross Weight." Obtain these figures from the table in chart E.

10. Add the weight column and determine the gross weight. Check this figure against the gross weight allowable, and make any necessary changes or additions.

11. By using the balance computer or loading graph, determine the loaded airplane's balance in accordance with instructions. When the Load Adjuster is used, record in the index column the progressive movement of the indicator after each step. Shift load if required, and make changes or additions to the entries as necessary.

12. Enter "Take-off Weight and Index."

13. Secure necessary approval and signatures at the bottom of Form F.

WEIGHT and BALANCE CLEARANCE

FORM F

DATE November 27, 1943
AIRPLANE B-20
SERIAL NO 4308B2

MISSION Combat (Bomb)
FROM Denver (Lowry F) Colo.
TO Lowry Field, Colo Via Uvalde, Tex.

COMPARTMENT	ITEM	WEIGHT	INDEX OF MOMENT
	Basic Airplane	74550	59.7
A lb. (STRUCTURAL CAPACITY)	Crew 1-200 Cargo TOTAL 200	200	56.4
B lb. (STRUCTURAL CAPACITY)	Crew 3-200 Cargo TOTAL 600	600	48.4
C lb. (STRUCTURAL CAPACITY)	Crew 2-200 Cargo TOTAL 400	400	44.2
D lb. (STRUCTURAL CAPACITY)	Crew Cargo TOTAL		
E lb. (STRUCTURAL CAPACITY)	Crew Cargo TOTAL		
F lb. (STRUCTURAL CAPACITY)	Crew Cargo TOTAL		
G lb. (STRUCTURAL CAPACITY)	Crew 2-200 Cargo TOTAL 400	400	48.2
H lb. (STRUCTURAL CAPACITY)	Crew Cargo TOTAL		
I lb. (STRUCTURAL CAPACITY)	Crew 1-200 Cargo TOTAL 200	200	51.7
J lb. (STRUCTURAL CAPACITY)	Crew 1-200 Cargo TOTAL 200	200	55.8
K lb. (STRUCTURAL CAPACITY)	Crew Cargo TOTAL		
L lb. (STRUCTURAL CAPACITY)	Crew 1-200 Cargo TOTAL 200	200	61.2
M lb. (STRUCTURAL CAPACITY)	Crew Cargo TOTAL		
N lb. (STRUCTURAL CAPACITY)	Crew Cargo TOTAL		
O lb. (STRUCTURAL CAPACITY)	Crew Cargo TOTAL		
P lb. (STRUCTURAL CAPACITY)	Crew Cargo TOTAL		
TOTALS TO BE CARRIED FORWARD		76,750	61.2

COMPARTMENT	ITEM	WEIGHT	INDEX OF MOMENT
	Totals Brought Forward	76750	61.2
Q lb. (STRUCTURAL CAPACITY)	Crew Cargo TOTAL		
R lb. (STRUCTURAL CAPACITY)	Crew Cargo TOTAL		
S lb. (STRUCTURAL CAPACITY)	Crew Cargo TOTAL		
T lb. (STRUCTURAL CAPACITY)	Crew Cargo TOTAL		
Minimum Landing Gross Weight		76750	61.2
AMMUNITION (By Compartment)	( ) Rd. ( ) Cal.		
	C (2000) - (50)	610	54.9
	G (1000) - (50)	305	58.0
	I (1000) - (50)	305	64.0
	K (5000) - (50)	1525	100.5
BOMBS	Forward 20 - 500#	10,000	43.1
	Aft 20 - 500#	10,000	82.9
	External		
OIL (U. S. 7.5 & Imp. 9 lb./gal.)			
Inboard	170 Gal.	1275	79.5
Outboard	170 Gal.	1275	77.2
FUEL (U. S. 6 & Imp. 7.2 lb./gal.)			
Inboard	1533 Gal.	9198	73.5
Outboard	1533 Gal.	9198	73.6
Bomb Bay:			
TOTAL WT. & INDEX (Uncorrected)		120,441	73.6
Corrections (If required)	Man from A Tail Man from L Tail		74.8 73.2
TAKE-OFF WEIGHT & INDEX		120,441	73.4
T.O. Wt. & Index Wheels on LIMITS		120,441	69.4
Recommended Max. Take-off Gross Weight			LB.
Recommended Max. Landing Gross Weight			LB.

COMPUTED BY F. E. Bartlett, 2nd Lt. A. C.
APPROVED BY
PILOT Joe Blew, Col. A. C.

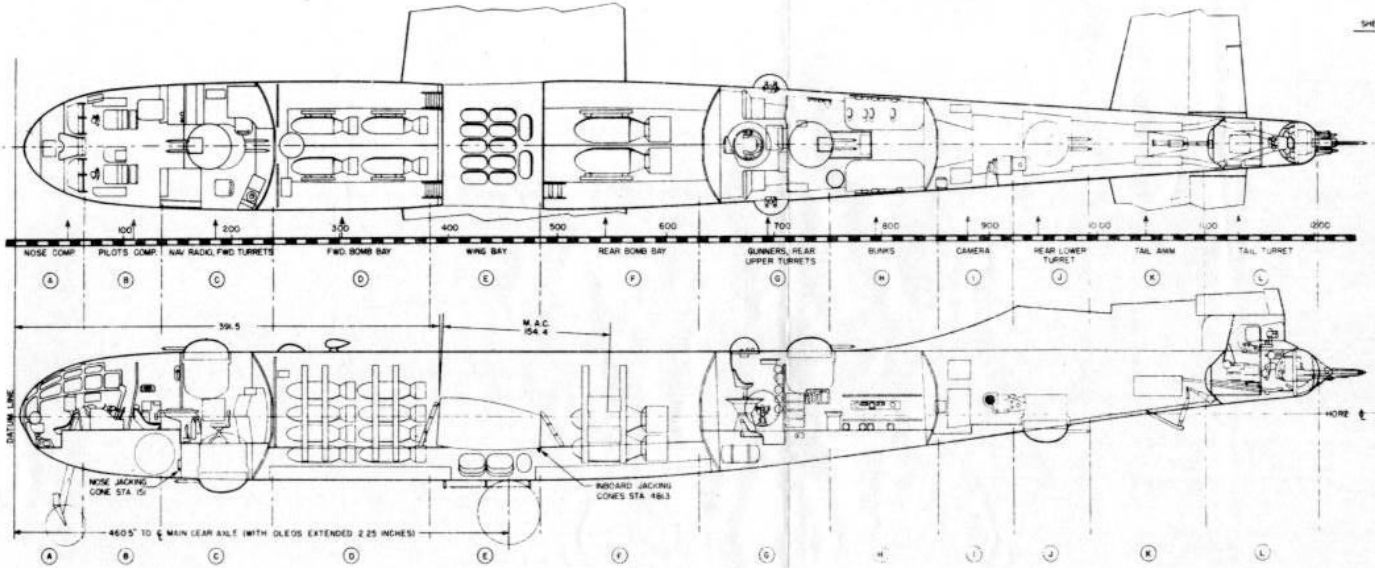
CARGO LOADING SUPPLEMENT

FORM F-1

DATE November 27, 1943 MISSION Combat (Bomb)
AIRPLANE B-29 FROM Lowry Field, Colo.
SERIAL NO. 430862 TO Lowry Field, Colo. Via Uvalde, Tex.

ITEM	QUANTITY	UNIT WEIGHT	Nose A	Pilots B	Nav. Radio C	Fwd. Bomb Bay D	Rear Bomb Bay F	Rear Upper Turret G	Camera I	Rear Lower Turret J	Rear Amm. K	Tail Turret L	Inboard Oil	Outboard Oil	Inboard Fuel	Outboard Fuel
Crew Member	1	200	200													
✓ ✓	3	200		600												
✓ ✓	2	200			400											
✓ ✓	2	200						400								
✓ ✓	1	200							200							
✓ ✓	1	200								200						
✓ ✓	1	200										200				
Ammunition	2000	50-4/100			610											
✓	1000	✓						305								
✓	1000	✓								305						
✓	5000	✓									1525					
Bombs	20	500				10,000										
✓	20	500					10,000									
Oil	170	15/Gal.											1275			
✓	170	75/Gal.												1275		
Fuel	1533	6%/Gal.													9198	
✓	1533	✓														9198
TOTAL (OR SUB-TOTAL)			200	600	1010	10000	10000	705	200	505	1525	200	1275	1275	9198	9198

C-28



MAXIMUM INTERNAL BOMB LOAD

(4)	4000 LB. BOMBS AND SHACKLES 16860 LBS.
(8)	2000 LB. BOMBS AND SHACKLES 16496 LBS.
(12)	1600 LB. BOMBS AND SHACKLES 19296 LBS.
(12)	1000 LB. BOMBS AND SHACKLES 11460 LBS.
(40)	500 LB. BOMBS AND SHACKLES 20068 LBS.
(56)	300 LB. BOMBS AND SHACKLES 16223 LBS.
(80)	100 LB. BOMBS AND SHACKLES 10056 LBS.

RETRACTING LANDING GEAR

MOMENT + - 112000 INCH POUNDS

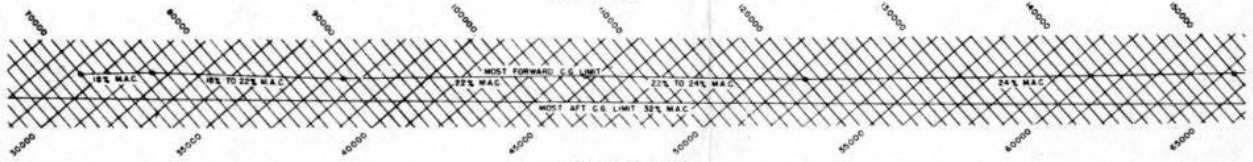
AMMUNITION

50 CALIBER WEIGHT PER 100 ROUNDS = 30.5 LBS.
20 M M WEIGHT PER 100 ROUNDS = 55.0 LBS.

LEVELING LUGS - ON FRAMES AT STA'S 310.5 AND 344.3 ON L.H. SIDE OF FWD. BOMB BAY

JIG POINT - USE JACKING CONE @ 151" ON AFT BLK. IN NOSEWHEEL WELL

CENTER OF GRAVITY CHART
(WEIGHT IN POUNDS)

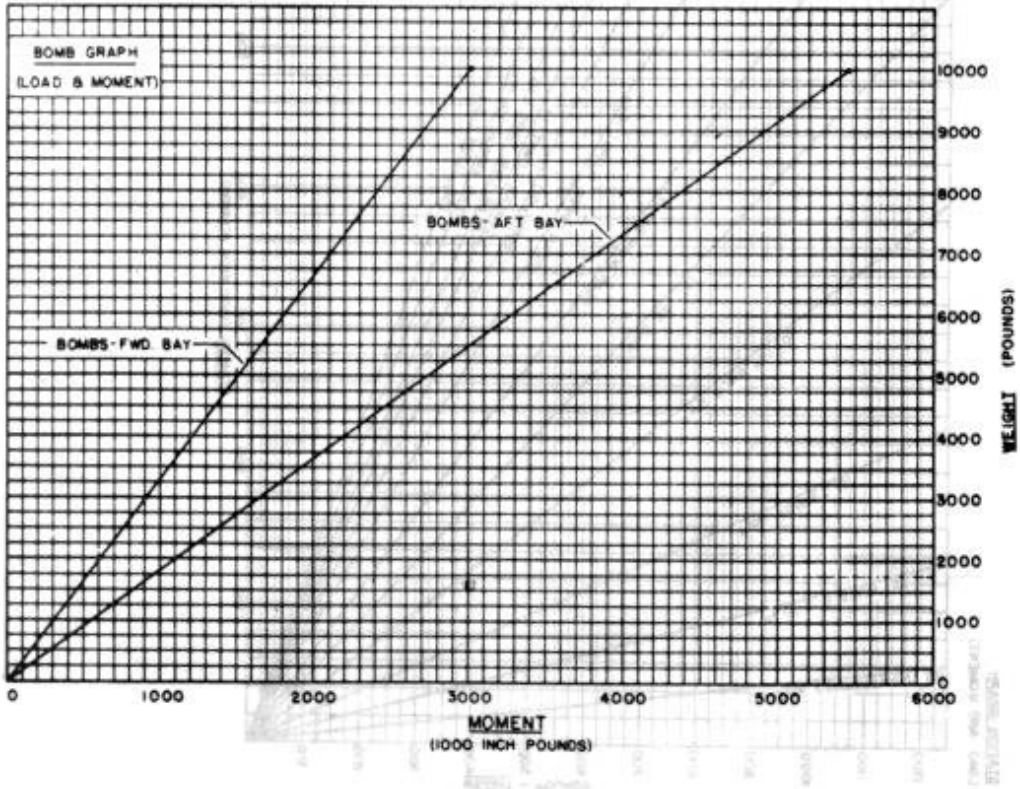


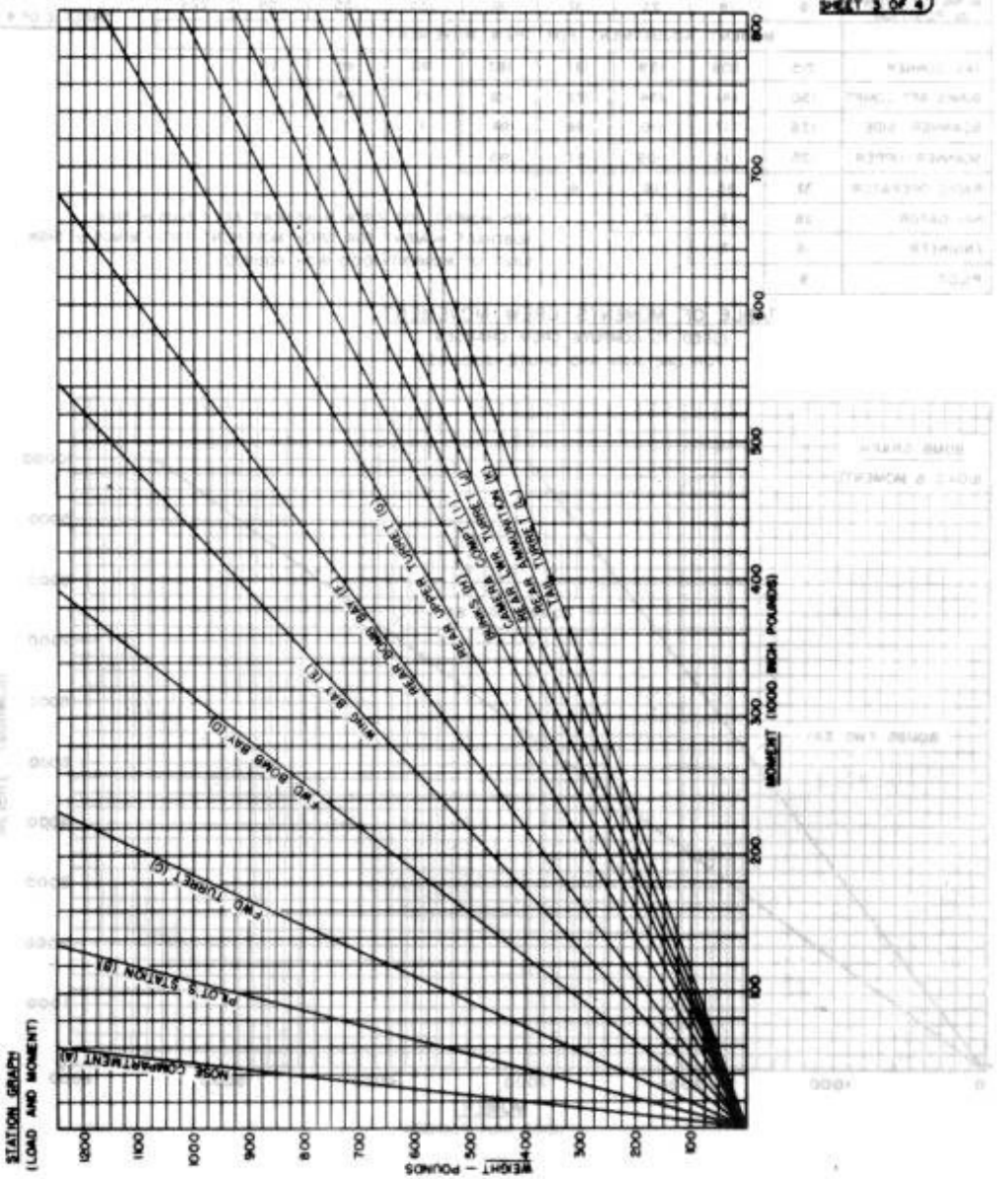
R7-#8600

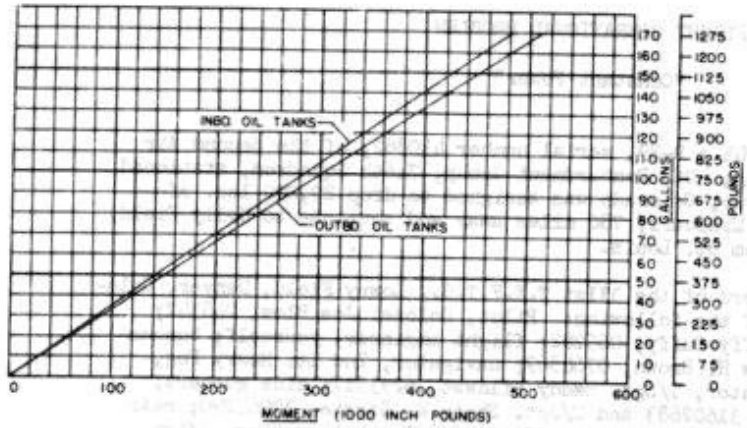
STATION	BOMBER	PILOT	ENGR	NAV.	RADIO OPERATOR	SCANNER UPPER	SCANNER SIDE	BUNKS AFT COMPT.	TAIL GUNNER
MOMENT - CREW IN POSITION	9	18	25	37	41	134	135	159	224
	MOMENT ADJUSTMENT FOR CREW MOVEMENT								
TAIL GUNNER	215	206	199	187	183	90	89	65	
BUNKS - AFT COMPT.	150	141	134	122	118	25	24		
SCANNER - SIDE	126	117	110	98	94	1			
SCANNER - UPPER	125	116	109	97	93				
RADIO OPERATOR	32	23	16	4					
NAVIGATOR	28	19	12						
ENGINEER	16	7							
PILOT	9								

ADD MOMENT FOR CREW MOVEMENT AFT = PLUS (+) SIGN
SUBTRACT MOMENT FOR CREW MOVEMENT FWD. = MINUS (-) SIGN
(UNIT OF MOMENT = 1000 INCH POUNDS)

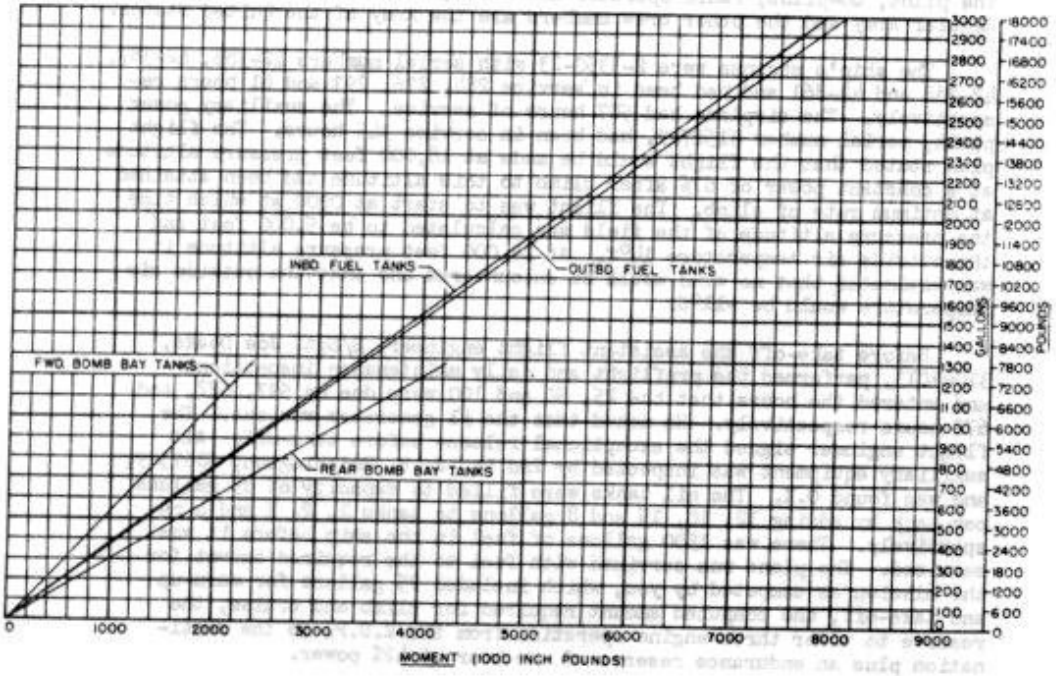
TABLE OF MOMENTS - CREW MOVEMENT
(USED TO COMPUTE CREW CHANGES
FOR ONE MAN AND CHUTE = 200 LBS.)




STATION GRAPH
(LOAD AND MOMENT)
WEIGHT - POUNDS
MOMENT (1000 INCH POUNDS)
NOSE COMPARTMENT (4)
PILOT'S STATION (8)
FWD TUNNEL (5)
FWD BOMB BAY (10)
WING BAY (3)
REAR BOMB BAY (2)
REAR UPPER TUNNEL (9)
REAR AMMUNITION TUNNEL (1)
CAMERA (11)
REAR AMMUNITION TUNNEL (6)
TAIL TUNNEL (7)



OIL GRAPH
(LOAD & MOMENT)



GASOLINE GRAPH
(LOAD & MOMENT)

FLIGHT OPERATIONAL PROBLEM

"Constant Power"

On 1 January 1944 a B-29, serial number 430862, of the Second Air Force, 58th Bomb Wing, 40th Bombardment Group, 746th Squadron, stationed at Lowry Field, Denver, Colorado was assigned to drop 20,000 lbs. of bombs on St. Louis, Missouri, 780 miles away and continue to Kelly Field, Texas, 780 miles from St. Louis.

The crew, members of the 331st T.E.F.T.G., Lowry Field, Denver, Colorado was composed of the following: Pilot, Colonel Joe Blow, 0483342; co-pilot, Major Snuffy Duffy, 065282; flight engineer, yourself; bombardier, 1st Lt. Andrew H. Brown, 0764869; navigator, 2nd Lt. Heavy Fog, 0867079; radio operator, T/Sgt. Reddy Kilowat, 6293517; side gunners, S/Sgt. Won I. Shut, 31602683 and M/Sgt. Shute M. Strate, 30964290; rear lower turret gunner, S/Sgt. G. I. Tuff, 32400837; photographer, S/Sgt. Click M. Kwik, 35328082; and rear gunner, S/Sgt. R. A. Sadsack, 26499020. The pilot, co-pilot, radio operator and rear gunner are members of the Regular Army and the other crew members are the Army of the United States.

The ship's engines were R-3350-23 with serial numbers 42-386, 42-387, 42-388 and 42-861 and had been in service 284, 276, 293 and 61 hours respectively. The airplane had 587 hours of service. The auxiliary power plant, serial number 3152749, had been in service 345 hours. The flight plan stated that the flight would be made at 18,000 feet pressure altitude at a constant power of 67% after climb to this altitude had been attained at optimum rate of climb. The flight was to start at 0900 at which time the pressure altitude of the field was calculated to be 5,000 feet and the outside air temperature 14°C. At 18,000 feet pressure altitude it was estimated that no wind would be encountered and that the outside air temperature would be -11°C.

Before take-off the assistant flight engineer, S/Sgt. Joe Doaks, 31061013, performed the preflight and daily maintenance inspections and entered the hours that the 25, 50 and 100 were due on 597, 622, and 672 hours respectively. He noted that the #1 generator was out. The flight engineer signed the exceptional release before take-off. All auxiliary equipment was inspected by 2nd Lt. J. B. Smithington, 0867349, and was found O.K. The oil tanks were filled to capacity of 85 gallons per tank by adding 12, 10, 15 and 8 gallons to tanks 1, 2, 3 and 4 respectively. There was 1500 gallons of fuel in the ship before it was serviced. The plane was serviced with fuel to the required amount for the mission as computed by you, which included 95 gallons for warm-up and take-off, the computed amount required for climb and cruise, the reserve to cover three-engine operation from the E.D.P. to the destination plus an endurance reserve of one hour at 42% power.

The basic weight of the ship was 74,550 lbs. and the basic index with the wheels down was 59.7 and with the wheels up was 55.7. In addition to the crew previously mentioned and the required fuel and oil, the plane was loaded with the following:

Twenty 500# bombs in forward bomb bay
Twenty 500# bombs in aft bomb bay
2,000 rounds 50 cal. ammunition in compt. C
1,300 rounds 50 cal. ammunition in compt. G
1,000 rounds 50 cal. ammunition in compt. J
5,000 rounds 50 cal. ammunition in compt. L

The take-off was successful at 0930 with the bombardier in compartment C and the tail gunner in compartment J during take-off. All other crew members were at their respective stations during take-off. The ship landed at the home base at 1530. The put-put was in use two hours during flight. All of the ammunition was used over the target.

1. Compute the estimated fuel required for the mission assuming a gross weight of 120,000 lbs. at the start of the climb. Make your calculations on a separate sheet of paper, identifying each figure or value in such a manner that the accuracy of the calculations can be easily checked. Show all necessary work on this sheet of paper. Use fuel density of 6 lbs./gal. Assume three-engine maximum range I.A.S. to be 20 MPH slower than four-engine maximum range I.A.S.

2. After the estimated fuel consumption has been calculated, load half of the required fuel in the inboard tanks and the remaining half in the outboard tanks. Complete the loading of the ship and fill out the Form F weight clearance.

3. Fill out all the information available from the above in the Flight Engineer's Report and on Form 1 and 1A.

4. Plot a flight progress curve showing the four-engine predicted for time and distance and the three-engine ahead for time and distance.

5. An alternate airport is found to be 100 miles off the course 1100 miles out.

NOTE: It is suggested that the work be accomplished in the above order, namely, 1, 2, 3, 4 and 5.

COMPUTATION OF FUEL REQUIRED FOR MISSION

Pressure altitude of 5000 ft. and OAT of 14°C	=	6000 ft. H_d
18000 H_p and OAT of -11°C	=	19000 ft. H_d
Fuel required to climb from 6000 ft. H_d to 19000 H_d = 450 - 115 = 335 gals. or		2010 lbs.
Distance covered in climb = 90 - 21.5	=	68.5 mi.
TAS at 6000 H_d	=	187 mi./hr.
TAS at 19000 H_d	=	230 mi./hr.
Av. TAS in climb = $\frac{187 + 230}{2}$	=	208.5 mi./hr.
Time to Climb in 68.5/208.5 = .328 hrs. or		19.7 min.
Gross Weight after climb = 120000 - 2010	=	117,990 lbs.
Remaining distance after climb = 780 - 68.5	=	711.5 mi.
TAS at 67% power, 19000 H_d and 117,990 lbs.	=	258 mi./hr.
Time to cruise to target at 258 mi./hr. = 711.5/258	=	2.76 hrs.
Fuel consumed at 434 gals./hr. for 2.76 hrs. = 1196 gals. or		7180 lbs.
Approximate weight at target = 117,990 - 7180	=	110,810 lbs.
TAS at 67% power, 19000 H_d and 110,810 lbs.	=	266 mi./hr.
Av. TAS = $\frac{266 + 258}{2}$	=	262 mi./hr.
Time to reach target = 711.5/262	=	2.718 hrs.
Fuel consumed at 434 gals./hr. for a.718 hrs = 1179 gals. or		7070 lbs.
Gross weight at target before dropping bombs = 117,990 - 7070	=	110,920 lbs.
Gross weight at target after dropping bombs = 110,920 - 22,745	=	88,175 lbs.
TAS at 67% power, 19000 H_d and 88,175 lbs.	=	286 mi./hr.

Time to return at 286 mi./hr. = 780/286 = 780/286	=	2.728 hrs.
Fuel consumed at 434 gal./hr. for 2.728 hrs. = 1182 gals.	or	7100 lbs.
Approximate final gross weight = 88,175 - 7100	=	81075 lbs.
TAS at 67% power, 19000 H_d and 81,075 lbs.	=	290 mi./hr.
Av. TAS = $\frac{290 + 286}{2}$	=	288 mi./hr.
Time to return at 288 mi./hr. = 780/288	=	2.705 hrs.
Fuel consumed at 434 gal./hr. for 2.705 hrs. = 1175 gals.	or	7050 lbs.
Fuel required for four-engine maximum range for 780 mi. at light weight	=	1052 gals.
Three-engine maximum range for 780 mi. at light weight = 115% of four-engine maximum range requirement or 115% x 1052 gals. = 1210 gal.	or	7280 lbs.
One-hour endurance at 42% power = 250 gal. or		1500 lbs.

ESTIMATED FUEL REQUIRED FOR MISSION

Fuel required for warm-up and take-off	=	570 lbs.
Fuel required for climb	=	2010 lbs.
Fuel required for cruise to target	=	7070 lbs.
Fuel required for three-engine maximum range from target to destination	=	7280 lbs.
Fuel reserve for one-hour endurance	=	1500 lbs.
TOTAL		18430 lbs.
	or	3070 gals.

WEIGHT and BALANCE CLEARANCE

FORM F

DATE January 1, 1944 MISSION Combat
AIRPLANE B-29 FROM Lowry Field, Colo.
SERIAL NO. 430862 TO Kelly Field, Texas via St Louis, Mo.

COMPARTMENT	ITEM	WEIGHT	INDEX OR MOMENT
Y	Basic Airplane	74,550	59.7
A (lb. STRUCTURAL CAPACITY)	Crew 1-200 Cargo TOTAL 200	200	56.4
B (lb. STRUCTURAL CAPACITY)	Crew 3-200 Cargo TOTAL 600	600	48.4
C (lb. STRUCTURAL CAPACITY)	Crew 2-200 Cargo TOTAL 400	400	44.2
D (lb. STRUCTURAL CAPACITY)	Crew Cargo TOTAL		
E (lb. STRUCTURAL CAPACITY)	Crew Cargo TOTAL		
F (lb. STRUCTURAL CAPACITY)	Crew Cargo TOTAL		
G (lb. STRUCTURAL CAPACITY)	Crew 2-200 Cargo TOTAL 400	400	48.2
H (lb. STRUCTURAL CAPACITY)	Crew Cargo TOTAL		
I (lb. STRUCTURAL CAPACITY)	Crew 1-200 Cargo TOTAL 200	200	51.7
J (lb. STRUCTURAL CAPACITY)	Crew 1-200 Cargo TOTAL 200	200	55.7
K (lb. STRUCTURAL CAPACITY)	Crew Cargo TOTAL		
L (lb. STRUCTURAL CAPACITY)	Crew 1-200 Cargo TOTAL 200	200	61.1
M (lb. STRUCTURAL CAPACITY)	Crew Cargo TOTAL		
N (lb. STRUCTURAL CAPACITY)	Crew Cargo TOTAL		
O (lb. STRUCTURAL CAPACITY)	Crew Cargo TOTAL		
P (lb. STRUCTURAL CAPACITY)	Crew Cargo TOTAL		
TOTALS TO BE CARRIED FORWARD		76750	61.1

COMPARTMENT	ITEM	WEIGHT	INDEX OR MOMENT
Y	Totals Brought Forward	76,750	61.1
Q (lb. STRUCTURAL CAPACITY)	Crew Cargo TOTAL		
R (lb. STRUCTURAL CAPACITY)	Crew Cargo TOTAL		
S (lb. STRUCTURAL CAPACITY)	Crew Cargo TOTAL		
T (lb. STRUCTURAL CAPACITY)	Crew Cargo TOTAL		
Minimum Landing Gross Weight			
AMMUNITION (by Compartment)	( ) Rd. ( ) Cal.		
	(C) 2000 - 50	610	64.8
	(G) 1300 - 50	397	59.2
	(J) 1000 - 50	305	65.4
	(K) 5000 - 50	1525	101.9
BOMBS	Forward 20 - 500#	10,000	44.0
	Aft 20 - 500#	10,000	89.9
	External		
OIL (U. S. 7.5 & Imp. 9 lb./gal.)			
	Inboard 170 Gal.	1275	80.3
	Outboard 170 Gal.	1275	78.2
FUEL (U. S. 6 & Imp. 7.2 lb./gal.)			
	Inboard 1535 Gal.	9215	74.7
	Outboard 1535 Gal.	9215	74.9
Bomb Bay:			
TOTAL WT. & INDEX (Uncorrected)		120,567	74.9
Corrections (If required)	Men A→C / L→J		74.6 / 74.2
TAKE-OFF WEIGHT & INDEX		120,567	74.6

LIMITS

Recommended Max. Take-off Gross Weight LB.
Recommended Max. Landing Gross Weight LB.

COMPUTED BY J. E. Filly, 1st Lt. A. C.
APPROVED BY
PILOT Joe Blow, Col. A. C.

Bombardier in C } Wheels Down Index 74.6 or 30.2% MAC
Tail Gunner in J } Wheels Up Index 70.6 or 29.7% MAC

Men in Battle Stations } Wheels Down Index 74.9
Wheels Up Index 70.9

Wt.			74,550				74,550
Crew and Cargo	A						
	B	3	200	600	3	200	600
	C	3	200	600	3	200	600
	D						
	E						
	F						
	G	2	200	400	2	200	400
	H						
	I	1	200	200	1	200	200
	J	2	200	400	2	200	400
	K						
	L						
Ammunition	C	2000/60	30.5/100	610		—	—
	G	1300/50	30.5/100	397		—	—
	J	1000/50	30.5/100	305		—	—
	K	5000/50	30.5/100	1525		—	—
Bombs	F.B.	20	500	10,000		—	—
	BB.	20	500	10,000		—	—
Oil	1	85	7.5	637.5	62.5	7.5	469
	2	85	7.5	637.5	62.5	7.5	469
	3	85	7.5	637.5	62.5	7.5	469
	4	85	7.5	637.5	62.5	7.5	469
Fuel	1	7625	6	4607.5	69.6	6	417
	2	7625	6	4607.5	69.6	6	417
	3	7625	6	4607.5	69.6	6	417
	4	7625	6	4607.5	69.6	6	417
	FB						
	RB						
Total				120,587			80,294
W.U.	Index =			70.6		Index =	52.4
C.G.	%MAC =			29.7		%MAC =	23.4
T.O. C.G.	Index =			74.6		Index =	56.4
	%MAC =			30.2		%MAC =	24.4

DATE 1 Jan. 44 PLACE Lowry Field, Colo.

ALT. 5000 Hp / 6000 Ho E.T.O. RUN Z200'=T.O.60

E. T. D. 0900 T.O. TIME 0930

E. T. A. 1447 LAND. TIME 1530

RUN UP & TAXI TIME .3 hrs.

TAKE-OFF & CLIMB TIME T.O.=.03 Cl=328

CRUISE TIME 6 hrs.

ENGINE MODEL NO. R-3350-23

ENGINE	1	2	3		Aux. P.P.
SERIAL NO.	42-386	42-387	42-388	42-861	312749
HRS. TO DATE	284	276	293	61	345
HRS. TODAY	6	6	6	6	2
TOTAL	290	282	299	67	347

AIRPLANE		
HRS. TO DATE	587	
HRS. TODAY	6	
TOTAL	593	

Flight Log Comp. J. E. Silly, 1st Lt. A.C.
Flight Engr.

Flight Rpt. Compl. H. Guy, 2nd Lt. A.C.
Navigator

Test Report None
Pilot

Mission C

Joe Blow
Col. A.C.
Pilot

Home Station Lowry Field, Colorado
Ship Commander Joe Blow, Col. A.C.
Co-pilot Lewis Guy Duffy, Maj.
Flight Engr. James E. Silly, 1st Lt.
Air Force Second
Wing 58th Bomb
Group 40th Bomb
Squadron 746th
Airplane No. —
Airplane Serial No. 430862
Airplane released for above mission.

J. E. Silly, 1st Lt. A.C.
Flight Engineer

DAILY INSPECTION CHECK LIST

			Red	Inspection Status: Date of or Hours Due	Inspected Today: By	Inspected Today: Station
1	D	Cowl and Structures				
2	D	Landing Gear System				
3	D	Accessory Section				
4	D	Fuselage General	Preflight	1-1-44	Dooks	Lowry Field, Colo.
5	D	Information File	Daily	1-1-44	Dooks	" " "
6	D	Oxygen System	25 Hours	597		
7	D	Fire Extinguishers	50 Hours	622		
8	D	Auxiliary Power Plant	100 Hours	672		
9	D	Emergency Equipment				
10	D	Instruments				
11	D	Wing Flap				
12	D	Trim Tab System				
13	D	Control Lock System				
14	D	Flight Control System				
15	D	Propellers				
16	D	Brake and Hydraulic System				
17	D	Power Plant Control System				
18	D	Oil System				
19	D	Fuel Transfer System				
20	D	Fuel System				
21	D	Propeller Anti-Icer System				
22	D	Intercooler Control System				
23	D	Cowl Flap Control System				
24	D	Turbo Supercharger				
25	D	No. 1 Engine Operation				
26	D	No. 2 Engine Operation				
27	D	No. 3 Engine Operation				
28	D	No. 4 Engine Operation				
29	D	Heating System				
30	D	Surface De-Icer System				
31	D	Vacuum System				
32	Red	Electrical System				
33	D	Cabin Supercharger System				
34	D	Prop. Feathering System				
35	D	Cargo Loading				
36	D	Pitot Static System				
37	D	Cabins				

Inspection of Auxiliary Equipment

Equipment	Inspected By	Station
Bombardment	Smithington	Lowry, Colo.
Gunnery	Smithington	" "
Chemical		
Communication	Smithington	" "
Photographic	Smithington	" "

Joe Dooks, S/Sgt A.C.
Asst. Engineer

J. E. Lilly, 1st Lt. A.C.
Flight Engineer

1 Jan. '44 (DATE) — Lowry Field, Colorado (STATION) 2nd Air Force 58th Bomb Wing — 40th Bomb (H) (GROUP NO AND TYPE) — B-29 (AIRCRAFT MODEL)

Joe. Doaks S/Sgt. A.C. (CREW CHIEF OR AERIAL ENGINEER) — 746th Bomb (SQUADRON NO AND TYPE) — 430862 (AIRCRAFT SERIAL NO)

PERS. CLASS	— PRINT PLAINLY — NAME — RANK — ORGANIZATION	USE AS DIRECTED LOCALLY	ALWAYS ENTER DUTY SYMBOLS WHEN APPLICABLE. ENTER N - NIGHT OR I - INSTRUMENT. ENTER TIME FLOWN THEREUNDER				FLIGHT DATA	
			DUTY / N OR I	DUTY / N OR I	DUTY / N OR I	DUTY / N OR I	TERMINALS AND MISSION	
1	2	3	4	5	6	7	8	9
00	Blaw, Joe Col. 048342 -331 TEFTG		P / 3	CP / 3			FROM: Lowry Field, Colo.	09 : 30
00	Duffy, Snuffy Maj. 065282-331 TEFTG		CP / 3	P / 3			TO: Kelly Field, Tex. Via St. Louis, Mo.	15 : 30
18	Lilly, James L. 1st Lt. 0628250-331 TEFTG		E / 6				MISSION: C — NO. OF LANDINGS: 1	6:00
18	Brown, Andrew H. 1st Lt. 0764869-331 TEFTG		B / 6				FROM:	
18	Fog, Heavy 2nd Lt. 0867079-331 TEFTG		N / 6				TO:	
20	Kilowatt, Reddy T/Sgt. 6293517-331 TEFTG		R / 6				MISSION — NO. OF LANDINGS	
38	Shut, Won I. S/Sgt. 31602683-331 TEFTG		Q / 6				FROM:	
38	Strate, Shute M. M/Sgt. 30364290-331 TEFTG		Q / 6				TO:	
38	Tuff, G.I. S/Sgt. 32400837-331 TEFTG		G / 6				MISSION — NO. OF LANDINGS	
38	Kwik, Click M. S/Sgt. 35328082-331 TEFTG		F / 6				FROM:	
20	Sadsack, R.A. S/Sgt. 26490280-331-TEFTG		G / 6				TO:	
							MISSION — NO. OF LANDINGS	
							FROM:	
							TO:	
							MISSION — NO. OF LANDINGS	

C-37-

WAR DEPARTMENT A.A.F. FORM NO. 1 2-2-42

FLIGHT REPORT - OPERATIONS

CHECKED: LEGIBLE AND CORRECT — OPER CLERK

TRANSCRIBED: TOTAL FLIGHT TIME ENTERED ON FORM 1A — CREW CHIEF

TOTAL FLIGHT TIME 6:00

WAR DEPARTMENT
A. A. F.
FORM NO. 1-A
TENTATIVE 2-18-41

FLIGHT REPORT - ENGINEERING

INSPECTION STATUS

	DATE OF OR HOURS DUE	INSPECTED TODAY BY	STATION
PREFLIGHT	1-1-44	Dooks	Lowry Field, Colo.
DAILY	1-1-44	Dooks	" " "
25 HOURS	597		
50 HOURS	622		
100 HOURS	672		

SERVICING AT STATION OF TAKE-OFF
(CHECK IMMEDIATELY BEFORE TAKE-OFF)

SERVICE	FUEL (GALLONS) SERV-ICED	FUEL (GALLONS) IN TANKS	OIL (QUARTS) NO. 1 SERV-ICED	NO. 1 IN TANKS	NO. 2 SERV-ICED	NO. 2 IN TANKS	NO. 3 SERV-ICED	NO. 3 IN TANKS	NO. 4 SERV-ICED	NO. 4 IN TANKS	RADIATOR CHECKED
1ST	450	3070	48	340	40	340	60	340	32	340	I
2ND											
3RD											
4TH											
5TH											

INSPECTION OF AUXILIARY EQUIPMENT

EQUIPMENT	SYMBOL	INSPECTED BY	STATION
BOMBARDMENT	S	Smithington	Lowry Field, Colo.
GUNNERY	S	"	" " "
CHEMICAL	—		
COMMUNICATIONS	S	"	" " "
PHOTOGRAPHIC	S	"	" " "
NAVIGATION	S	"	" " "

STATUS TODAY: Red (1 2 3 4)

EXPLANATION: #1 Generator Out

EXCEPTIONAL RELEASE

WHEN THE "STATUS TODAY" IS INDICATED BY A RED SYMBOL, AND AN "EXCEPTIONAL RELEASE" HAS NOT BEEN GRANTED BY AN AUTHORIZED ENGINEERING OFFICER, THE PILOT OF THE AIRPLANE WILL SIGN THIS RELEASE BEFORE FLIGHT.

RELEASED FOR FLIGHT (1 2 3 4): J. P. Silly PIC

REMARKS PILOTS AND MECHANICS - SEE INSTRUCTIONS INSIDE FRONT COVER.

No. 1 Flight O.K. Joe Blow Col. A. C.

AIRPLANE AND ENGINE TIME RECORD
(ENTER IN HOURS AND MINUTES)

ENGINE	NO. 1	NO. 2	NO. 3	NO. 4
HOURS TO DATE	284	276	293	61
HOURS TODAY	6	6	6	6
TOTAL	290	282	299	67
OIL CHANGE DUE		— Hopper —		
CLEAN-ING DUE		- 25 Hour Insp. -		

AIRPLANE		
	HOURS TO DATE	587
	HOURS TODAY	6
	TOTAL	593

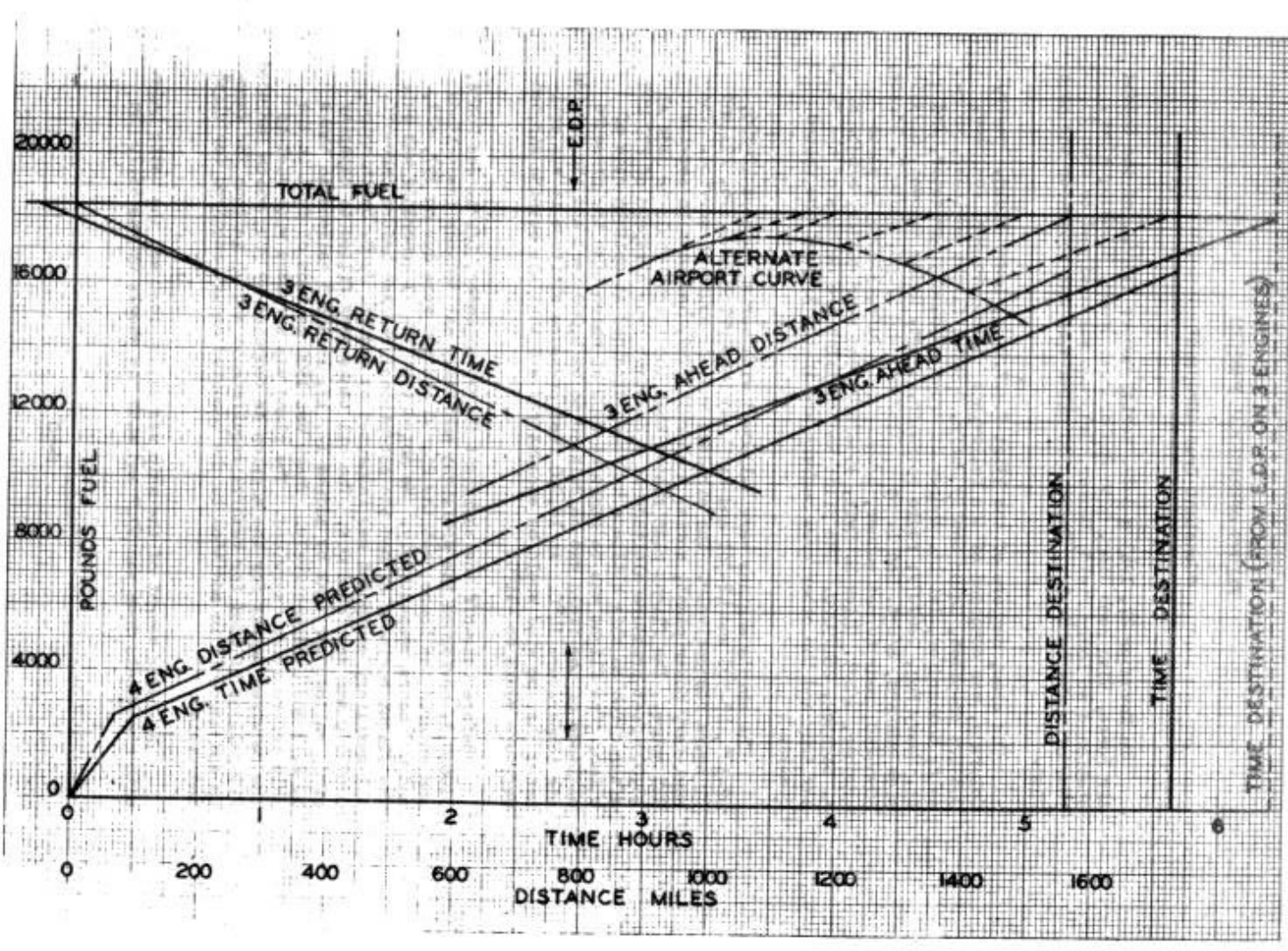
Serviced at Lowry Field, Colo.
by Joe Dooks, S/Sgt.

ENGINE DATA
(1) 42-386 ENGINE SERIAL NO.
(2) 42-387 ENGINE SERIAL NO.
(3) 42-388 ENGINE SERIAL NO.
(4) 42-861 ENGINE SERIAL NO.
R-3350-23 ENGINE MODEL

AIRPLANE DATA
430862 AIRPLANE SERIAL NO.
B-29 AIRPLANE MODEL
A.A.F. COMPONENT

AIRPLANE ORG. DATA
746th Bomb (H) SQUADRON NO. AND TYPE
40th Bomb(H) GROUP NO. AND TYPE
58th Bomb Wing COMMAND, CORPS AREA OR DEPT.
2nd AIR FORCE
Joe Dooks S/Sgt CREW CHIEF OR MECH. IN CHARGE
Lowry Field, Colo. STATION
1 Jan - 44 DATE

TOTAL FLIGHT TIME: 6:00


E.D.P.
TOTAL FUEL
ALTERNATE AIRPORT CURVE
3 ENG. RETURN TIME
3 ENG. RETURN DISTANCE
3 ENG. AHEAD DISTANCE
3 ENG. AHEAD TIME
4 ENG. DISTANCE PREDICTED
4 ENG. TIME PREDICTED
DISTANCE DESTINATION
TIME DESTINATION
TIME DESTINATION (FROM E.D.P. ON 3 ENGINES)
POUNDS FUEL
20000
16000
12000
8000
4000
0
0
1
2
3
4
5
6
TIME HOURS
0
200
400
600
800
1000
1200
1400
1600
DISTANCE MILES

FLIGHT OPERATIONAL PROBLEM

"Constant True Airspeed"

On November 27, 1943 a B-29, serial number 430362, of the Second Air Force, 58th Bomb Wing, 40th Bombardment Group, 746th Squadron, stationed at Lowry Field, Denver, Colorado was assigned to drop 20,000 lbs. of bombs on Uvalde, Texas, 730 miles away and return to the home base.

The crew, members of the 331st T.S.F.T.U., Lowry Field, Denver, Colorado, was composed of the following: pilot, Colonel Joe Blow, 0433142; co-pilot, Major Snuffy Duffy, 065282; flight engineer, yourself; bombardier, 1st Lt. Andrew H. Brown, 0764369; navigator, 2nd Lt. Heavy Fog, 0367079; radio operator, T/Sgt. Reddy Kilowat, 6293517; side gunners, S/Sgt. Won I. Shot, 31602633 and S/Sgt. Shute M. Strate, 30964290; rear turret gunner, S/Sgt. G. I. Duff, 32409337; photographer, S/Sgt. Click H. Kwik, 35320082; and rear gunner, S/Sgt. R. A. Sadsack, 26499020. The pilot and co-pilot are members of the Regular Army and the other crew members are in the Army of the United States.

The ship's engines were R-3350-23 with serial numbers 42-336, 42-337, 42-333 and 42-361 and had been in service 234, 276, 293 and 61 hours respectively. The airplane had 537 hours of service. The auxiliary power plant, serial number 3152749, had been in service 345 hours. The flight plan stated that the flight would be made at 13,000 feet pressure altitude at a constant true airspeed of 270 MPH after climb to this altitude had been attained at optimum rate of climb. The flight was to start at 0900 at which time the pressure altitude of the field was calculated to be 5,000 feet and the outside air temperature 14°C. At 13,000 feet pressure altitude it was estimated that no wind would be encountered and that the outside air temperature would be -11°C.

Before take-off the assistant flight engineer, S/Sgt. Joe Doaks, 31061013, performed the preflight and daily maintenance inspections and entered the hours that the 25, 50 and 100 were due on 597, 622, and 672 hours respectively. He noted that the #1 generator was out. The flight engineer signed the exceptional release before take-off. All auxiliary equipment was inspected by 2nd Lt. J. B. Smithington, 0367349, and was found O.K. The oil tanks were filled to capacity of 83 gallons per tank by adding 12, 10, 15 and 3 gallons to tanks 1, 2, 3 and 4 respectively. There was 1500 gallons of fuel in the ship before it was serviced. The plane was serviced with fuel to the required amount for the mission as computed by you, which included 250 gallons of fuel for reserve requirements and 95 gallons for warm-up and take-off in addition to the computed amount required for climb and cruise.

The basic weight of the ship was 74,550 lbs. and the basic index with the wheels down was 59.7 and with the wheels up was 55.7. In

addition to the crew previously mentioned and the required fuel and oil, the plane was loaded with the following:

Twenty 500# Bombs in forward bomb bay
Twenty 500# Bombs in aft bomb bay
2,000 rounds 50 cal. ammunition in compt. C
1,000 rounds 50 cal. ammunition in compt. G
1,000 rounds 50 cal. ammunition in compt. J
5,000 rounds 50 cal. ammunition in compt. K

The take-off was successful at 0930 with the bombardier in compartment C and the tail gunner in compartment J during take-off. All other crew members were at their respective stations during take-off. The ship landed at the home base at 1600. The put-put was in use two hours during flight. All of the ammunition was used over the target.

1. Compute the estimated fuel required for the mission assuming a gross weight of 120,000 lbs. at the start of the climb. Make your calculations on a separate sheet of paper, identifying each figure or value in such a manner that the accuracy of the calculations can be easily checked. Show all necessary work on this sheet of paper. Use fuel density of 6 lbs./gal.

2. After the estimated fuel consumption has been calculated, load half of the required fuel in the inboard tanks and the remaining half in the outboard tanks. Complete the loading of the ship and fill out the Form F weight clearance.

3. Fill out all the information available from the above in the Flight Engineer's Report and Log and Form 1 and 1A.

4. In column 1 of the Flight Engineer's Log fill in a set of values which would indicate normal operation during take-off. In column 4 of the Flight Engineer's Log fill in a set of values which would be normally expected immediately after the ship has finished the climb, leveled off and attained the required cruising speed.

NOTE: It is suggested that the work be accomplished in the above order, namely, 1, 2, 3 and 4.

COMPUTATION OF FUEL REQUIRED FOR MISSION

Pressure altitude of 5000 ft. and OAT of 14°C = 6000 ft. H_d	
18000 H_p and OAT of -11°C =	19000 ft. H_d
Fuel required to climb from 6000 ft. H_d to 19000 H_d = 450 - 120 = 330 gals. or	1980 lbs.
Distance covered in climb = 90.25 - 21.5 =	68.75 mi.
Av. climb TAS = $\frac{196 + 230}{2}$ =	208 mi./hr.
Time to climb = 68.75/208 = .330 hrs. or	19.8 min.
Gross Weight After Climb = 120000 - 1980 =	118,020 lbs.
Fuel flow at 118,020 lbs., 270 MPH, at 19000 ft. H_d = 537 gal./hr. or	3221 lbs./hr.
Time to Cruise = $\frac{730 - 68.75}{270}$ =	2.635 hrs.
Approximate fuel for cruise to target =	8500 lbs.
Approximate F.W. at target = 118020 - 8500 =	109,520 lbs.
Fuel flow at 109,520 lbs., 270 MPH, and 19000 H_d = 454 gals./hr. =	2722 lbs./hr.
Av. Fuel flow during cruise to target = $\frac{3221 + 2722}{2}$ =	2971 lbs/hr.
Final estimate of fuel required for cruise to target = 2971 x 2.635 =	7835 lbs.
G.W. at target with bombs and ammunition = 118,020 - 7835 =	110,165 lbs.
G.W. at target without bombs and ammunition = 110,165 - 22,745 =	87,420 lbs.
Fuel flow at 87,420 lbs., 270 MPH and 19000 H_d = 385 gals./hr. or	2310 lbs./hr.
Time to cruise home = 730/270 =	2.838 hrs.

Approximate fuel for return = 2.888 x 2310 = 6670 lbs.

Approximate final G.W. = 87420 - 6670 = 80750 lbs.

Fuel flow at 80750 lbs., 270 MPH and 19000 H_d = 367 gals./hr. or 2200 lbs./hr.

Av. fuel flow during return cruise = $\frac{2310 + 2200}{2}$ = 2255 lbs./hr.

Final estimate of fuel required for cruise target to base = 2255 x 2.838 = 6510 lbs.

ESTIMATED FUEL REQUIRED FOR MISSION

Fuel required for warm-up and take-off	=	570 lbs.
Fuel required for climb	=	1980 lbs.
Fuel required for cruise to target	=	7835 lbs.
Fuel required for return cruise	=	6510 lbs.
Fuel reserve of 250 gals.	=	1500 lbs.
TOTAL	=	18395 lbs.
	or	3066 gals.

WEIGHT and BALANCE CLEARANCE

FORM F

DATE 27 Nov. 1943
AIRPLANE B-29
SERIAL NO. 430862

MISSION Combat
FROM Denver, Colo.
TO Uvalde, Tex & Return

COMPARTMENT	ITEM	WEIGHT	INDEX OR MOMENT
V	Basic Airplane	74,500	59.7
A (STRUCTURAL CAPACITY) lb.	Crew 1-200 Cargo TOTAL 200	200	56.5
B (STRUCTURAL CAPACITY) lb.	Crew 3-200 Cargo TOTAL 600	600	48.4
C (STRUCTURAL CAPACITY) lb.	Crew 2-200 Cargo TOTAL 400	400	44.2
D (STRUCTURAL CAPACITY) lb.	Crew Cargo TOTAL		
E (STRUCTURAL CAPACITY) lb.	Crew Cargo TOTAL		
F (STRUCTURAL CAPACITY) lb.	Crew Cargo TOTAL		
G (STRUCTURAL CAPACITY) lb.	Crew 3-200 Cargo TOTAL 600	600	50.3
H (STRUCTURAL CAPACITY) lb.	Crew 1-200 Cargo TOTAL 200	200	53.1
I (STRUCTURAL CAPACITY) lb.	Crew Cargo TOTAL		
J (STRUCTURAL CAPACITY) lb.	Crew Cargo TOTAL		
K (STRUCTURAL CAPACITY) lb.	Crew Cargo TOTAL		
L (STRUCTURAL CAPACITY) lb.	Crew 1-200 Cargo TOTAL 200	200	58.8
M (STRUCTURAL CAPACITY) lb.	Crew Cargo TOTAL		
N (STRUCTURAL CAPACITY) lb.	Crew Cargo TOTAL		
O (STRUCTURAL CAPACITY) lb.	Crew Cargo TOTAL		
P (STRUCTURAL CAPACITY) lb.	Crew Cargo TOTAL		
TOTALS TO BE CARRIED FORWARD		76,750	58.8

COMPARTMENT	ITEM	WEIGHT	INDEX OR MOMENT
V	Totals Brought Forward	76,750	58.8
Q (STRUCTURAL CAPACITY) lb.	Crew Cargo TOTAL		
R (STRUCTURAL CAPACITY) lb.	Crew Cargo TOTAL		
S (STRUCTURAL CAPACITY) lb.	Crew Cargo TOTAL		
T (STRUCTURAL CAPACITY) lb.	Crew Cargo TOTAL		
Minimum Landing Gross Weight			
AMMUNITION (By Compartment)	( ) Rd. ( ) Cal.		
	C - 2000 - 50	610	52.3
	G - 1000 - 50	305	55.4
	H - 1000 - 50	305	61.5
	K - 5000 - 50	1525	98.2
BOMBS	Forward 20 - 500#	10,000	40.4
	Aft 20 - 500#	10,000	80.3
	External		
OIL (U. S. 7.5 & Imp. 9 lb./gal.)			
	Inboard 170 gal.	1275	77
	Outboard 170 gal.	1275	74.5
FUEL (U. S. 6 & Imp. 7.2 lb./gal.)			
	Inboard 1533 gal.	9,198	71.0
	Outboard 1533 gal.	9,198	71.3
Bomb Bay:			
TOTAL WT. & INDEX (Uncorrected)		120,441	71.3
Corrections (If required) A→C L→J		120,441	71.1
TAKE-OFF WEIGHT & INDEX		120,441	71.1

LIMITS

Recommended Max. Take-off Gross Weight 120,000 LB.
Recommended Max. Landing Gross Weight 100,000 LB.

COMPUTED BY S.C. Bartlett, 1st Lt. A.C.
APPROVED BY
PILOT Joe Blow, Col. A.C.

W.D. Crew at Sta. Index = 71.3 % MAC = 29.8
W.D. Crew Shifted Index = 71.1 % MAC. = 29.75
W.U. Crew at Sta. Index = 67.3 % M.A.C. = 29.15
W.U. Crew Shifted Index = 67.1 % M.A.C. = 29.1

WAR DEPARTMENT
A. A. F.
FORM NO. 1 &
TENTATIVE 12-18-41

FLIGHT REPORT - ENGINEERING

INSPECTION STATUS

	DATE OF OR HOURS DUE	INSPECTED TODAY BY	INSPECTED TODAY STATION
PREFLIGHT	11/27/43	J. D.	Lowry Field
DAILY	11/27/43	J. D.	Lowry Field
25 HOURS	597		
50 HOURS	622		
100 HOURS	672		

SERVICING AT STATION OF TAKE-OFF
(CHECK IMMEDIATELY BEFORE TAKE-OFF)

REMARKS	FUEL (GALLONS) SERV-ICED	FUEL (GALLONS) IN TANKS	OIL (QUARTS) NO. 1 SERV-ICED	NO. 1 IN TANKS	NO. 2 SERV-ICED	NO. 2 IN TANKS	NO. 3 SERV-ICED	NO. 3 IN TANKS	NO. 4 SERV-ICED	NO. 4 IN TANKS	RADIATOR CHECKED
1ST	1566	3066	48	340	40	340	60	340	32	340	
2ND											
3RD											
4TH											
5TH											

INSPECTION OF AUXILIARY EQUIPMENT

EQUIPMENT	SYMBOL	INSPECTED BY	STATION
BOMBARDMENT	S	J.B.d.	Lowry Field
GUNNERY	S	J.B.d.	" "
CHEMICAL	S	J.B.d.	" "
COMMUNICATIONS	S	J.B.d.	" "
PHOTOGRAPHIC	S	J.B.d.	" "
NAVIGATION	S	J.B.d.	" "

STATUS TODAY: 1. Red 2. 3. 4.

EXPLANATION: #1 Generator Out

EXCEPTIONAL RELEASE

WHEN THE "STATUS TODAY" IS INDICATED BY A RED SYMBOL AND AN "EXCEPTIONAL RELEASE" HAS NOT BEEN GRANTED BY AN AUTHORIZED ENGINEERING OFFICER THE PILOT OF THE AIRPLANE WILL SIGN THIS RELEASE BEFORE FLIGHT.

RELEASED FOR FLIGHT: 1. L.C. Bartlett 1st Lt. A.C. 2.

REMARKS PILOTS AND MECHANICS - SEE INSTRUCTIONS INSIDE FRONT COVER.

No. 1 Flight O.K. - Blow, Joe Col. A. C.

AIRPLANE AND ENGINE TIME RECORD
(ENTER IN HOURS AND MINUTES)

ENGINE	NO. 1	NO. 2	NO. 3	NO. 4
HOURS TO DATE	284:00	276:00	293:00	61:00
HOURS TODAY	6:30	6:30	6:30	6:30
TOTAL	290:30	282:30	299:30	67:30
OIL CHANGE DUE		— Hopper —		
CARB CLEANING DUE	597	597	597	597

AIRPLANE		
	HOURS TO DATE	587:00
	HOURS TODAY	6:30
	TOTAL	593:30

Serviced at Lowry Field, Colo.
by Joe Doaks, S/Sgt.

TOTAL FLIGHT TIME: 6:30

ENGINE DATA
(4) ENGINE SERIAL NO. 42-861
(3) ENGINE SERIAL NO. 42-388
(2) ENGINE SERIAL NO. 42-387
(1) ENGINE SERIAL NO. 42-386
ENGINE MODEL R-3350-23

AIRPLANE DATA
AIRPLANE SERIAL NO. 430862 C-45
AIRPLANE MODEL B-29
COMPONENT A.A.F.

AIRPLANE ORG. DATA
BOMBARDMENT NO. AND TYPE 746th Bomb Sq. (H)
GROUP NO. AND TYPE 40th Bomb Gp. (H)
COMMAND, CORPS AREA OR DEPT. 58th Bomb Wing
AIR FORCE 2nd Air Force
CREW CHIEF OR AERIAL ENGINEER S/Sgt. Joe Doaks
STATION Lowry Field, Colo.
DATE 27 Nov. 1943

November 27, 1943 (DATE) | Lowry Field, Colo. (2nd Air Force, 58th Bomb Wing — STATION) | 40th Bomb Gr.(H) (GROUP NO AND TYPE) | B-29 (AIRCRAFT MODEL)

S/Sgt Joe Doaks (CREW CHIEF OR AERIAL ENGINEER) | 746th Bomb Sq. (H) (SQUADRON NO AND TYPE) | 430862 (AIRCRAFT SERIAL NO)

PERS CLASS	— PRINT PLAINLY — NAME — RANK — ORGANIZATION	USE AS DIRECTED LOCALLY	ALWAYS ENTER DUTY SYMBOLS WHEN APPLICABLE. ENTER N. NIGHT OR I. INSTRUMENT ENTER TIME FLOWN THEREUNDER — DUTY / N OR I	FLIGHT DATA — TERMINALS AND MISSION	
1	2	3	4	8	9
	Blow, Joe Col. 048342		P	FROM: Lowry Field, Colorado	09:30
00	Lowry Field, 331 T.E.F.T.G.		6:30	TO: Lowry Field via Uvalde, Tex.	16:00
	Duffy, Snuffy Maj 065282		CP	MISSION: C — NO OF LANDINGS: 1	6:30
00	Lowry Field, 331 T.E.F.T.G.		6:30		
	Bartlett, Thomas E. 2nd. Lt. 086347		E	FROM:	
58	Lowry Field, 331 T.E.F.T.G.		6:30	TO:	
	Brown, Andrew H. 1st. Lt. 0764869		B	MISSION — NO OF LANDINGS:	
18	Lowry Field, 331 T.E.F.T.G.		6:30		
	Fog, Heavy 2nd Lt. 0867079		N	FROM:	
18	Lowry Field, 331 T.E.F.T.G.		6:30	TO:	
	Kilowatt, Reddy T/Sgt. 6293517		R	MISSION — NO OF LANDINGS:	
20	Lowry Field, 331 T.E.F.T.G.		6:30		
	Shut, Won I. S/Sgt. 31602683		G	FROM:	
38	Lowry Field, 331 T.E.F.T.G.		6:30	TO:	
	Strate, Shute M. M/Sgt 30964290		G	MISSION — NO OF LANDINGS:	
38	Lowry Field, 331 T.E.F.T.G.		6:30		
	Tuff, G.I. S/Sgt. 32400837		G	FROM:	
38	Lowry Field, 331 T.E.F.T.G.		6:30	TO:	
	Kwick, Click M. S/Sgt. 35328082		F	MISSION — NO OF LANDINGS:	
38	Lowry Field 331 T.E.F.T.G.		6:30		
	Sadsac, R.A. S/Sgt. 26499020		G	FROM:	
24	Lowry Field 331 T.E.F.T.G.		6:30	TO:	
				MISSION — NO OF LANDINGS:	
				FROM:	
				TO:	
				MISSION — NO OF LANDINGS:	
				FROM:	
				TO:	
				MISSION — NO OF LANDINGS:	

WAR DEPARTMENT A A F FORM NO. 1 2-2-42

FLIGHT REPORT - OPERATIONS

CHECKED: LEGIBLE AND CORRECT — ☐ OPER CLERK

TRANSCRIBED: TOTAL FLIGHT TIME ENTERED ON FORM 1A — ☐ CREW CHIEF

TOTAL FLIGHT TIME 6:30

Base Wt.				74,550			74,550
Crew and Cargo	A						
	B	3	200	600	3	200	600
	C	3	200	600	3	200	600
	D						
	E						
	F						
	G	3	200	600	3	200	600
	H	1	200	200	1	200	200
	I						
	J	1	200	200	1	200	200
	K						
	L						
Ammunition	C	2000 50C	30.5 /100	610	0	0	0
	G	1000 50C	30.5 /100	305	0	0	0
	J	1000 50C	30.5 /100	305	0	0	0
	K	5000 50C	30.5 /100	1525	0	0	0
Bombs	FB	20	500	10,000	0	0	0
	RB	20	500	10,000	0	0	0
Oil	1	85	7.5	637.5	58	7.5	435
	2	85	7.5	637.5	58	7.5	435
	3	85	7.5	637.5	58	7.5	435
	4	85	7.5	637.5	58	7.5	435
Fuel	1	765	6	4549	63	6	378
	2	765	6	4599	63	6	378
	3	765	6	4599	63	6	378
	4	765	6	4579	63	6	378
	FB						
	RB						
Total				120,441			79,990
W.U. C.G.		Index	% MAC	67.1 29.1%		Index	50.5 % MAC 23.0%
W.D. C.G.		Index	% MAC	71.1 29.75		Index	84.5 % MAC 23.85%

DATE 27 Nov 1943 PLACE Lowry Field, Colo.
ALT. 5000' Hp 6000' As E.T.O. RUN 7,200 ft.
E.T.D. 0900 T. O. TIME 0930
E.T.A. 1530 LAND TIME 1600
RUN UP & TAXI TIME .18 hr.
TAKE-OFF & CLIMB TIME 19.8 min.
CRUISE TIME 5.526 hr.
ENGINE MODEL NO. R-3350-23

ENGINE	1	2	3	4	Aux. P.P.
SERIAL NO.	42-386	42-387	42-388	42-861	3132749
HRS. TO DATE	284	276	293	61	345
HRS. TODAY	5:53	5:53	5:53	5:53	2:00
TOTAL	289:53	281:53	298:53	66:53	347:00

AIRPLANE		
HRS. TO DATE	587	
HRS. TODAY	5:53	
TOTAL	592:53	

FLIGHT LOG COMP. L.C. Bartlett 2nd Lt. A.C.
Flight Engr.

FLIGHT RPT COMPL. Fog, Heavy, 2nd Lt.
Navigator

TEST REPORT None
Pilot

Mission
Combat

Joe Blow, Col. A.C.
PILOT

HOME STATION Lowry Field, Colo.
SHIP COMMANDER
CO-PILOT Duffy, Snuffy Maj.
FLIGHT ENGR. Bartlett, L.E. 2nd Lt. AC
AIR FORCE 2nd
WING 58th.
GROUP 40th Bomb'd.
SQUADRON 746th Bomb.
AIRPLANE NO.
AIRPLANE SERIAL NO. 430862

AIRPLANE RELEASED FOR ABOVE MISSION
L.E. Bartlett 2nd Lt. A.C.
Flight Engineer

DAILY INSPECTION CHECK LIST

				Inspection Status		
				Date of or	Inspected Today	
				Hours Due	By	Station
1	D	Cowling and Structures				
2	D	Landing Gear System				
3	D	Accessory Section				
4	D	Fuselage General	Preflight	1-27-43	J. D.	Lowry Field
5	D	Information File	Daily	1-27-43	J. D.	"
6	D	Oxygen System	25 hours	597		
7	D	Fire Extinguishers	50 hours	622		
8	D	Auxiliary Power Plant	100 hours	672		
9	D	Emergency Equipment				
10	D	Instruments				
11	D	Wing Flap				
12	D	Trim Tab System				
13	D	Control Lock System				
14	D	Flight Control System				
15	D	Propellers				
16	D	Brake and Hydraulic System				
17	D	Power Plant Control System				
18	D	Oil System				
19	D	Fuel Transfer System				
20	D	Fuel System				
21	D	Propeller Anti-Icer System				
22	D	Intercooler Control System				
23	D	Cowl Flap Control System				
24	D	Turbo Supercharger				
25	D	No. 1 Engine Operation				
26	D	No. 2 Engine Operation				
27	D	No. 3 Engine Operation				
28	D	No. 4 Engine Operation				
29	D	Heating System				
30	D	Surface De-Icer System				
31	D	Vacuum System				
32	D	Electrical System				
33	D	Cabin Supercharger System				
34	D	Prop. Feathering System				
35	D	Cargo Loading				
36	D	Pitot Static System				
37	D	Cabins				
38						
39						

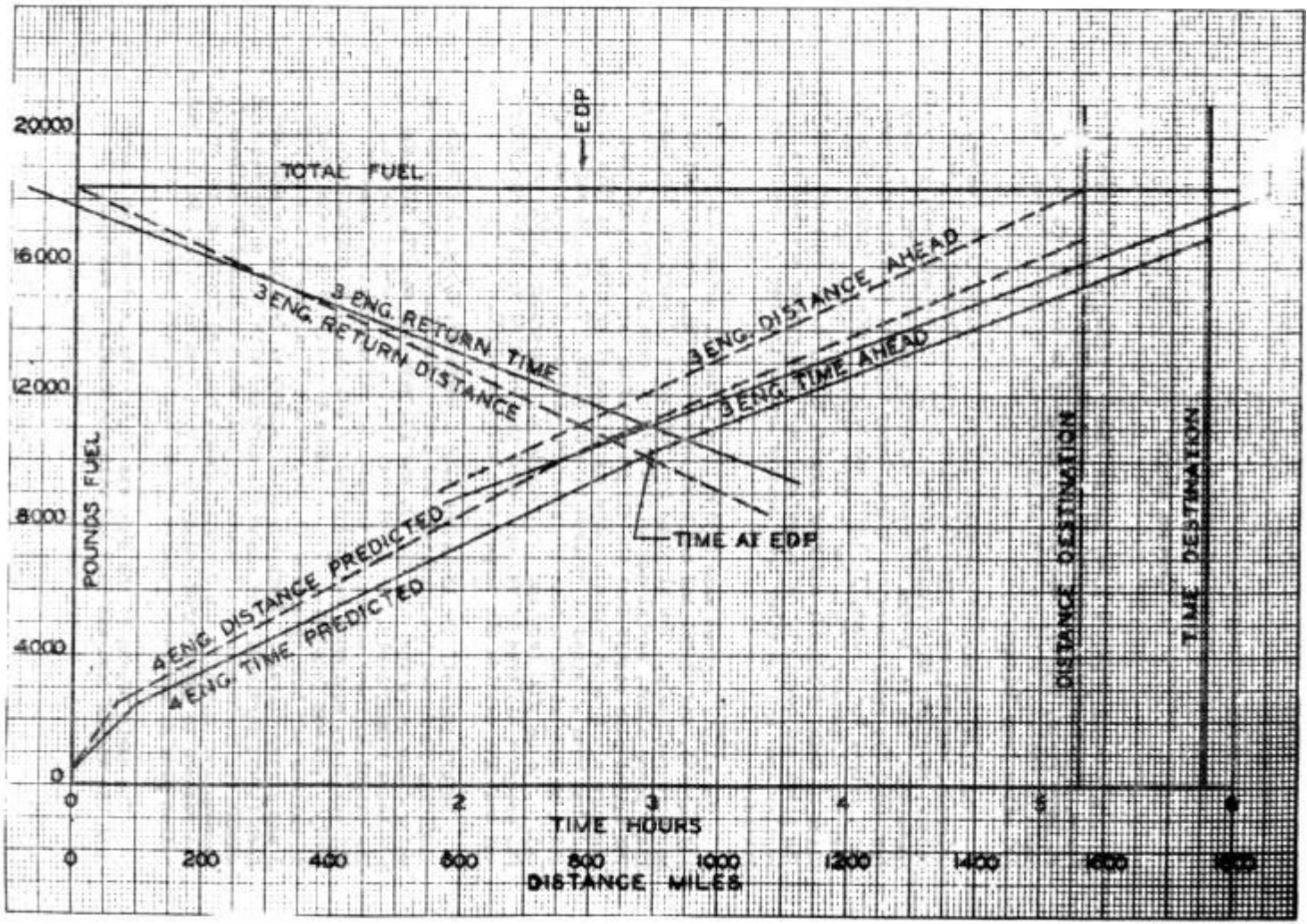
Inspection of Auxiliary Equipment

Equipment	Inspected by	Station
Bombardment	Smithington	Lowry
Gunnery	"	"
Chemical		
Communications	"	"
Photographic	"	"
Navigation	"	"

Signatures:

Joe Doaks, S/Sgt.
Asst. Engr.

E. E. Bartlett, 2nd Lt. A.C.
Flight Engineer


EDP
TOTAL FUEL
20000
16000
12000
8000
4000
0
POUNDS FUEL
3 ENG. RETURN TIME
3 ENG. RETURN DISTANCE
3 ENG. DISTANCE AHEAD
3 ENG. TIME AHEAD
4 ENG. DISTANCE PREDICTED
4 ENG. TIME PREDICTED
TIME AT EDP
DISTANCE DESTINATION
TIME DESTINATION
0
2
3
4
5
TIME HOURS
0
200
400
600
800
1000
1200
1400
DISTANCE MILES

FLIGHT OPERATIONAL PROBLEM

"Maximum Range"

On 6 January 1944 a B-29, serial number 430862, of the Second Air Force, 58th Bomb Wing, 40th Bombardment Group, 746th Squadron stationed at Lowry Field, Denver, Colorado was assigned to drop 20,000 lbs. of bombs on Chicago, Illinois, 900 miles away and continue to Bryan, Texas, 900 miles from Chicago.

The crew, members of the 331st T.E.F.T.G., Lowry Field, Denver, Colorado, was composed of the following: pilot, Colonel Joe Blow, 048342; co-pilot, Major Snuffy Duffy, 065282; flight engineer, yourself; bombardier, 1st Lt. Andrew H. Brown, 0764869; navigator, 2nd Lt. Heavy Fog, 0867079; radio operator, T/Sgt. Reddy Kilowat, 6298517; side gunners, S/Sgt. Won I. Shut, 31602683; and M/Sgt. Shute M. Strate 30964290; rear turret gunner, S/Sgt. Gee I. Tuff, 32400837; photographer, S/Sgt. Click M. Kwik, 35323082; and rear gunner, S/Sgt. R. A. Sadsack, 26499020. The pilot and co-pilot, radio operator and rear gunner are members of the regular Army and the other crew members are in the Army of the United States.

The ship's engines were R-3350-23 with serial numbers 42-386, 42-337, 42-388, and 42-861 and had been in service 284, 276, 293 and 61 hours respectively. The airplane had 587 hours of service. The auxiliary power plant, serial number 3152749, had been in service 345 hours. The flight plan stated that the flight would be made at 18,000 feet pressure altitude at maximum range conditions after climb to this altitude had been attained at optimum rate of climb. The flight was to start at 0900 at which time the pressure altitude of the field was calculated to be 5000 feet and the outside air temperature 14°C. At 18000 ft. pressure altitude it was estimated that no wind would be encountered and that the outside air temperature would be -11°C.

Before take-off the assistant flight engineer, S/Sgt. Joe Doaks, 31061013, performed the preflight and daily maintenance inspections and entered the hours that the 25, 50, and 100 were due on 597, 622, and 672 hours respectively. He noted that the No. 1 generator was out. The flight engineer signed the exceptional release before take-off. All auxiliary equipment was inspected by 2nd Lt. J. B. Smithington, 0867349 and was found o.k. The oil tanks were filled to capacity of 85 gallons per tank by adding 12, 10, 15 and 8 gallons to tanks 1, 2, 3 and 4 respectively. There was 1500 gallons of fuel in the ship before it was serviced. The plane was serviced with fuel to the required amount for the mission as computed by you, which included 95 gallons for warm-up and take-off, the computed amount required for climb and cruise, the reserve to cover three-engine operation from the E.D.P. to the destination plus an endurance reserve of one hour at 42% power.

The basic weight of the ship was 70,145 lbs. and the basic index with the wheels down was 59.7 and with the wheels up was 55.7. In

addition to the crew previously mentioned and the required fuel and oil, the plane was loaded with the following:

Twenty 500# bombs in forward bomb bay
Twenty 500# bombs in aft bomb bay
2,000 rounds 50 cal. ammunition in compt. C
1,000 rounds 50 cal. ammunition in compt. G
1,000 rounds 50 cal. ammunition in compt. J
5,000 rounds 50 cal. ammunition in compt. K

The take-off was successful at 0930 with the bombardier in compartment C and the tail gunner in compartment J during take-off. All other crew members were at their respective stations during take-off. The ship landed at Bryan, Texas at 1730. The put-put was in use two hours during flight. All of the ammunition was used over the target.

1. Compute the estimated fuel required for the mission assuming a gross weight of 120,000 lbs. at the start of the climb. Make your calculations on a separate sheet of paper, identifying each figure or value in such a manner that the accuracy of the calculations can be easily checked. Show all necessary work on this sheet of paper. Use a fuel density of 6 lbs./gal. Assume the three-engine maximum range I.A.S. to be 20 MPH slower than the four-engine maximum range I.A.S.

2. After the estimated fuel consumption has been calculated, load half of the required fuel in the inboard tanks and the remaining half in the outboard tanks. Complete the loading of the ship and fill out the Form F weight clearance.

3. Fill out all the information available from the above in the Flight Engineer's Report and on Form 1 and 1A.

4. Plot a flight progress curve showing the four-engine predicted for time and distance and the three-engine ahead and return for time and distance.

NOTE: It is suggested that the work be accomplished in the above order, namely, 1, 2, 3 and 4.

COMPUTATION OF FUEL REQUIRED FOR MISSION

Pressure altitude of 5000 ft. and OAT of 14°C	=	6000 ft. H_d
18000 H_p and OAT of -11°C	=	19000 ft. H_d
Fuel required to climb from 6000 ft. H_d to 19000 H_d = 450 - 115 = 335 gals.	or	2010 lbs.
Distance covered in climb = 90 - 21.5	=	68.5 mi.
TAS at 6000 H_d	=	187 mi./hr.
TAS at 19000 H_d	=	230 mi./hr.
Av. TAS in climb = $\frac{187 + 230}{2}$	=	208.5 mi./hr.
Time to climb = 68.5/208.5 = .328 hrs.	or	19.7 min.
Gross weight after climb = 120000 - 2010	=	117,990 lbs.
Remaining Distance after climb = 900 - 68.5	=	831.5 mi.
Fuel Required to Cruise 831.5 mi. at 19000 Hd at Long Range Cruising = 1703 gals.	or	10,220 lbs.
IAS of 187 at 19000 H_d = TAS of		253 mi./hr.
Time to Cruise to Target = 831.5/253	=	3.29 hrs.
Gross Weight at Target Before Dropping Bombs = 117,990 - 10,220	=	107,770 lbs.
Gross Weight at Target After Dropping Bombs = 107,770 - 22,745	=	85,025 lbs.
Fuel required to Cruise from target to destination at 19000 H_d and maximum range = 1250 gals.	or	7500 lbs.
IAS of 177 at 19000 H_d = TAS of		240 mi./hr.
Time to Cruise from Target to Destination = 900/240	=	3.75 hrs.
Three-engine Cruising from Target to destination is approximately 15% more than four-engines or 1.15 x 7500	=	8630 lbs.
IAS for three-engine maximum range is approximately 20 mi./hr. less than IAS for four-engine	or	157 mi./hr.
IAS of 157 at 19000 H_d = TAS of		212 mi./hr.

Time to Cruise from Target to Destination on Three-engines = 900/212 or 4.24 hrs.

One hour endurance at 42% power = 250 gals. or 1500 lbs.

ESTIMATED FUEL REQUIRED FOR MISSION

Fuel Required for Warm-up and Take-off	= 570 lbs.
Fuel Required for Climb	= 2010 lbs.
Fuel Required for Cruise to Target	= 10220 lbs.
Fuel Required for three-engine cruise from Target to Destination	= 8630 lbs.
Fuel Reserve for One-hour Endurance	= 1500 lbs.
TOTAL	22930 lbs.
or	3820 gals.

ESTIMATED TIME REQUIRED FOR MISSION

Time required to Climb	= .328 hrs.
Time required for cruise to target	= 3.29 hrs.
Time required for cruise from target to destination	= 3.75 hrs.
TOTAL	7.368 hrs.

WEIGHT and BALANCE CLEARANCE

FORM F

DATE 6 January 44 MISSION Combat
AIRPLANE B-29 FROM Lowry Field, Colorado
SERIAL NO. 430862 TO Bryan, Texas Via Chicago, Ill.

COMPARTMENT	ITEM	WEIGHT	INDEX OR MOMENT
Y	Basic Airplane	70,145	59.7
A (STRUCTURAL CAPACITY) lb.	Crew 1 - 200 Cargo TOTAL 200	200	56.3
B (STRUCTURAL CAPACITY) lb.	Crew 3 - 200 Cargo TOTAL 600	600	48.3
C (STRUCTURAL CAPACITY) lb.	Crew 2 - 200 Cargo TOTAL 400	400	44.1
D (STRUCTURAL CAPACITY) lb.	Crew Cargo TOTAL		
E (STRUCTURAL CAPACITY) lb.	Crew Cargo TOTAL		
F (STRUCTURAL CAPACITY) lb.	Crew Cargo TOTAL		
G (STRUCTURAL CAPACITY) lb.	Crew 2 - 200 Cargo TOTAL 400	400	48.0
H (STRUCTURAL CAPACITY) lb.	Crew Cargo TOTAL		
I (STRUCTURAL CAPACITY) lb.	Crew 1 - 200 Cargo TOTAL 200	200	56.8
J (STRUCTURAL CAPACITY) lb.	Crew 1 - 200 Cargo TOTAL 200	200	55.8
K (STRUCTURAL CAPACITY) lb.	Crew Cargo TOTAL		
L (STRUCTURAL CAPACITY) lb.	Crew 1 - 200 Cargo TOTAL 200	200	61.1
M (STRUCTURAL CAPACITY) lb.	Crew Cargo TOTAL		
N (STRUCTURAL CAPACITY) lb.	Crew Cargo TOTAL		
O (STRUCTURAL CAPACITY) lb.	Crew Cargo TOTAL		
P (STRUCTURAL CAPACITY) lb.	Crew Cargo TOTAL		
TOTALS TO BE CARRIED FORWARD		72,345	61.1

COMPARTMENT	ITEM	WEIGHT	INDEX OR MOMENT
Y	Totals Brought Forward	72,345	61.1
Q (STRUCTURAL CAPACITY) lb.	Crew Cargo TOTAL		
R (STRUCTURAL CAPACITY) lb.	Crew Cargo TOTAL		
S (STRUCTURAL CAPACITY) lb.	Crew Cargo TOTAL		
T (STRUCTURAL CAPACITY) lb.	Crew Cargo TOTAL		
Minimum Landing Gross Weight			
AMMUNITION (By Compartment)	[ ] Rd. [ ] Cal.		
	C - 2000 - 50	610	54.9
	G - 1000 - 50	305	58.0
	J - 1000 - 50	305	64.0
	K - 5000 - 50	1525	100.4
BOMBS	Forward 20 - 500#	10,000	43.1
	Aft 20 - 500#	10,000	83.0
	External		
OIL (U. S. 7.5 & Imp. 9 lb./gal.)			
	Inboard 170 Gal.	1275	70.6
	Outboard 170 Gal.	1275	77.3
FUEL (U. S. 6 & Imp. 7.2 lb./gal.)			
	Inboard 1910 Gal.	11,460	73.0
	Outboard 1910 Gal.	11,460	73.3
Bomb Bay:			
TOTAL WT. & INDEX (Uncorrected)		120,560	73.3
Corrections (If required)	1 → 5 2 → 3		74.7 73.1
TAKE - OFF WEIGHT & INDEX		120,560	73.1

LIMITS

Recommended Max. Take-off Gross Weight LB.
Recommended Max. Landing Gross Weight LB.

COMPUTED BY J. L. Lilly, 1st Lt. A.C.
APPROVED BY
PILOT Joe. Blow, Col. A.C.

Bombardier in C } Wheels Down Index 73.1 or 30% M.A.C.
Tail Gunner in J } Wheels Up Index 69.1 or 29.4% M.A.C.

Men at regular } Wheels Down Index 73.3 or 30.1% M.A.C.
Battle Stations } Wheels Up Index 69.3 or 29.5% M.A.C.

Base Wt.				70,145			70,143
Crew & Cargo	A	3	200	600	3	200	600
	B	3	200	600	3	200	600
	C						
	D						
	E						
	F						
	G	2	200	400	2	200	400
	H						
	I	1	200	200	1	200	200
	J	2	200	400	2	200	400
	K						
	L						
Ammunition	C	2000 50 Cal.	30.5 /100	610		—	—
	G	1000 50 Cal.	30.5 /100	305		—	—
	J	1000 50 Cal.	30.5 /100	305		—	—
	K	500 50 Cal.	30.5 /100	1,525		—	—
Bombs	FR	20	500#	10,000			
	RR	20	500#	10,000			
Oil	1	85	7.5	637	51	7.5	383
	2	85	7.5	637	51	7.5	383
	3	85	7.5	637	51	7.5	383
	4	85	7.5	637	51	7.5	383
Fuel	1	955	6	5,730	109	6	654
	2	955	6	5,730	109	6	654
	3	955	6	5,730	109	6	654
	4	955	6	5,730	109	6	654
	FR		—	—		—	—
	RR		—	—		—	—
Total		C.G.		120,550			76,433
W.U. C.G.		Index M.A.C.		69.1 29.4%		Index M.A.C.	53.5 23%
W.D. C.G.		Index M.A.C.		73.1 30%		Index M.A.C.	57.3 24%

DATE 6-Jan-44 PLACE Lowry Field, Colo.

ALT. 5000' Hp 5000 ft S.T.O. RUN 7,200 ft

E.T.D. 0900 T.O. TIME 0930

E.T.A. 1622 LAND. TIME 1730

WARM UP & TAXI TIME 20 min.

TAKE-OFF & CLIMB TIME 30 min. 2,328 ft

CRUISE TIME 7.04 Hrs.

ENGINE MODEL NO. R-3350-23

ENGINE	1	2	3	4	Max. P.P.
SERIAL NO.	42-316	42-317	42-318	42-761	3452749
HRS. TO DATE	224	276	293	61	345
HRS. TODAY	8	8	8	8	2
TOTAL	292	284	301	69	347

AIRPLANE		
HRS. TO DATE	587	
HRS. TODAY	8	
TODAY	595	

Flight Log Comp. J. E. Eilly 1st Lt A.C.
Flight Engr.

Flight Rpt. Compl. Henry Log 2nd Lt A.C.
Navigator

Test Report None
Pilot

Mission Combat

Joe Blow, Col. A.C.
Pilot

Home Station Lowry Field, Colo.
Ship Commander Col. Joe Blow
Co-Pilot Maj. Scuffy Duffy
Flight Engineer J. E. Eilly 1st Lt
Air Force 2nd.
Wing 58th
Group 40th Bomb. Group
Squadron 746th
Airplane No.
Airplane Serial No. 430862

Airplane Released for above mission. J. E. Eilly, 1st Lt. A.C.
Flight Engineer

DAILY INSPECTION CHECK LIST

			Inspection Status			
				Date of or	Inspected Today	
				Hours Due	By	Station
1	D	Cowling and Structures				
2	D	Landing Gear System				
3	D	Accessory Section				
4	D	Fuselage General	Preflight	1-6-44	Dooks	Lowry, Colo.
5	D	Information File	Daily	1-6-44	Dooks	Lowry, Colo.
6	D	Oxygen System	25 hours	597		
7	D	Fire Extinguishers	50 hours	622		
8	D	Auxiliary Power Plant	100 hours	672		
9	D	Emergency Equipment				
10	D	Instruments				
11	D	Wing Flap				
12	D	Trim Tab System				
13	D	Control Lock System				
14	D	Flight Control System				
15	D	Propellers				
16	D	Brake and Hydraulic System				
17	D	Power Plant Control System				
18	D	Oil System				
19	D	Fuel Transfer System				
20	D	Fuel System				
21	D	Propeller Anti-Icer System				
22	D	Intercooler Control System				
23	D	Cowl Flap Control System				
24	D	Turbo Supercharger				
25	D	No. 1 Engine Operation				
26	D	No. 2 Engine Operation				
27	D	No. 3 Engine Operation				
28	D	No. 4 Engine Operation				
29	D	Heating System				
30	D	Surface De-Icer System				
31	D	Vacuum System				
32	D	Electrical System				
33	D	Cabin Supercharger System				
34	D	Prop. Feathering System				
35	D	Cargo Loading				
36	D	Pitot Static System				
37	D	Cabins				
38						
39						

Inspection of Auxiliary Equipment

Equipment	Inspected By	Station
Bombardment	Smithington	Lowry
Gunnery	"	"
Chemical		
Communications	"	"
Photographic	"	"

Signatures:

Jos Dooks S/Sgt
Asst. Engr.

J. L. Eilly, 1st Lt. A.C.
Flight Engineer

WAR DEPARTMENT
A. A. F.
FORM NO. 1 A
TENTATIVE 12-15-41

FLIGHT REPORT - ENGINEERING

INSPECTION STATUS

	DATE OF OR HOURS DUE	INSPECTED TODAY BY	STATION
PREFLIGHT	1-6-44	Deaks	Lowry Field, Colo.
DAILY	1-6-44	Deaks	" " "
25 HOURS	587		
50 HOURS	622		
100 HOURS	672		

INSPECTION OF AUXILIARY EQUIPMENT

EQUIPMENT	SYMBOL	INSPECTED BY	STATION
BOMBARDMENT	S	Smithington	Lowry Field
GUNNERY	S	"	" "
CHEMICAL			
COMMUNICATIONS	S	"	" "
PHOTOGRAPHIC	S	"	" "
NAVIGATION	S	"	" "

SERVICING AT STATION OF TAKE-OFF
(CHECK IMMEDIATELY BEFORE TAKE-OFF)

ENGINES	FUEL (GALLONS) SERVICED	FUEL (GALLONS) IN TANKS	OIL (QUARTS) NO. 1 SERVICED	OIL NO. 1 IN TANKS	OIL NO. 2 SERVICED	OIL NO. 2 IN TANKS	OIL NO. 3 SERVICED	OIL NO. 3 IN TANKS	OIL NO. 4 SERVICED	OIL NO. 4 IN TANKS	RADIATOR CHECKED
1ST	2320	3820	40	340	40	340	60	340	32	340	✓
2ND											
3RD											
4TH											
5TH											

STATUS TODAY: 1. Red 2. 3. 4.

EXPLANATION: #1 Generator Out

EXCEPTIONAL RELEASE

WHEN THE "STATUS TODAY" IS INDICATED BY A RED SYMBOL AND AN "EXCEPTIONAL RELEASE" HAS NOT BEEN GRANTED BY AN AUTHORIZED ENGINEERING OFFICER, THE PILOT OF THE AIRPLANE WILL SIGN THIS RELEASE BEFORE FLIGHT.

RELEASED FOR FLIGHT: J. F. Lilly, 1st Lt. A.C.

REMARKS: PILOTS AND MECHANICS - SEE INSTRUCTIONS INSIDE FRONT COVER.

No. 1 Flight O.K. Joe Blow, Col. A.C.

AIRPLANE AND ENGINE TIME RECORD
(ENTER IN HOURS AND MINUTES)

ENGINE	NO. 1	NO. 2	NO. 3	NO. 4
HOURS TO DATE	284	276	293	61
HOURS TODAY	8	8	8	8
TOTAL	292	284	301	69
OIL CHANGE DUE	— Hopper —			
CLNG. CLEANING DUE	-25 Hour Insp —			

AIRPLANE	
HOURS TO DATE	587
HOURS TODAY	8
TOTAL	595

Serviced at Lowry Field, Colo.
by Joe. Deaks, S/Sgt.

DATE	6-Jan-44
STATION	Lowry Field, Colo.
CREW CHIEF OR AERIAL ENGINEER	Joe. Deaks, S/Sgt.
AIR FORCE	2nd
COMMAND, CORPS AREA OR DEPT.	58th Bomb Wing
GROUP NO. AND TYPE	40th Bomb (H)
SQUADRON NO. AND TYPE	740th Bomb (H)

AIRPLANE DATA

COMPONENT	AAF C-57
AIRPLANE MODEL	B-29
AIRPLANE SERIAL NO.	430862

ENGINE DATA

(1) ENGINE SERIAL NO.	42-386
(2) ENGINE SERIAL NO.	42-387
(3) ENGINE SERIAL NO.	42-388
(4) ENGINE SERIAL NO.	42-861
ENGINE MODEL	R-3350-23
TOTAL FLIGHT TIME	8:00

6 Jan. 44 — DATE

Lowry Field, Colo. — STATION: 2nd Air Force, 58th Bomb Wing, Bomb Comm.

40th Bomb (H) — GROUP NO. AND TYPE

B-29 — AIRCRAFT MODEL

Joe Doaks, S/Sgt — CREW CHIEF OR AERIAL ENGINEER

746th Bomb. (H) — SQUADRON NO. AND TYPE

430862 — AIRCRAFT SERIAL NO.

PERS. CLASS	PRINT PLAINLY — NAME — RANK — ORGANIZATION	USE AS DIRECTED LOCALLY	ALWAYS ENTER DUTY SYMBOLS. WHEN APPLICABLE, ENTER N, NIGHT OR I, INSTRUMENT. ENTER TIME FLOWN THEREUNDER						FLIGHT DATA: TERMINALS AND MISSION	
			DUTY	N OR I	DUTY	N OR I	DUTY	N OR I		
1	2	3	4		5		6	7	8	9
00	Blow, Joe - Col. 048342 - 331 TEFTG		P		CP				FROM: Lowry Field, Colo.	09:30
			4		4					
00	Duffy, Snuffy - Maj. 0652B2 - 331 TEFTG		CP		P				TO: Bryan, Texas via Chicago, Ill.	17:30
			4		4					
			E						MISSION: C — NO. OF LANDINGS: 1	8:00
18	Lilly, James L - 1st Lt - 0830803 - 331 TEFTG		8							
			B						FROM:	
18	Brown, Andrew H. - 1st Lt - 0764869 - 331 TEFTG		8							
			N						TO:	
18	Fog, Heavy - 2nd Lt - 0867079 - 331 TEFTG		8							
			R						MISSION — NO. OF LANDINGS	
38	Kilowatt, Reddy - T/Sgt - 6293517 - 331 TEFTG		8							
			G						FROM:	
38	Shut, Won I. - S/Sgt. - 31602683 - 331 TEFTG		8							
			G						TO:	
38	Strate, Shute M. - M/Sgt. - 30964290 331 TEFTG		8							
			G						MISSION — NO. OF LANDINGS	
20	Tuff, G.I. - S/Sgt. - 32400837 - 331 TEFTG		8							
			F						FROM:	
38	Kwik, Click M. - S/Sgt - 35328082 - 331 TEFTG		8							
			G						TO:	
20	Sadsack, R.A. - S/Sgt - 26499020 - 331 TEFTG		8							
									MISSION — NO. OF LANDINGS	
									FROM:	
									TO:	
									MISSION — NO. OF LANDINGS	

C-58

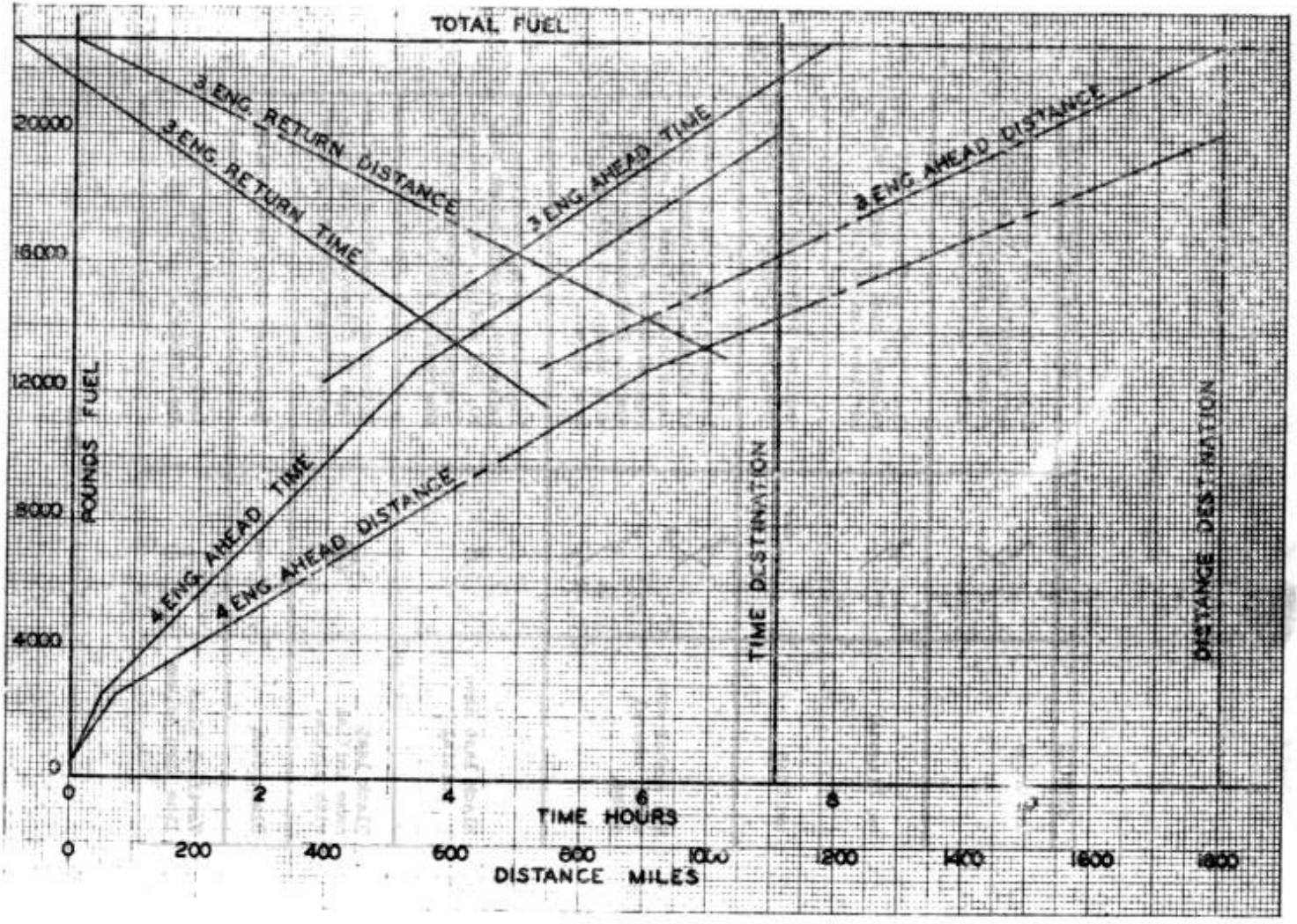
WAR DEPARTMENT A.A.F. FORM NO. 1 2-2-42

FLIGHT REPORT - OPERATIONS

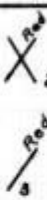
CHECKED — LEGIBLE AND CORRECT — OPER. CLERK

TRANSCRIBED — TOTAL FLIGHT TIME ENTERED ON FORM 1A — CREW CHIEF

TOTAL FLIGHT TIME: 8:00


TOTAL FUEL
3 ENG. RETURN DISTANCE
3 ENG. RETURN TIME
3 ENG. AHEAD TIME
3 ENG. AHEAD DISTANCE
4 ENG. AHEAD TIME
4 ENG. AHEAD DISTANCE
TIME DESTINATION
DISTANCE DESTINATION
POUNDS FUEL
20000
16000
12000
8000
4000
0
0
2
4
6
8
TIME HOURS
0
200
400
600
800
1000
1200
1400
1600
1800
DISTANCE MILES

FORM SYMBOLS

SYMBOLS	COLUMN	EXPLANATION OF SYMBOLS
Red Cross		Major defects or unsatisfactory condition. This symbol grounds the airplane until defects are corrected.
Red Diagonal		Minor defect. "Exceptional release" must be signed before airplane can be flown
Red Dash		Required inspection not made. Requires "Exceptional release".
Red symbol with small numeral added.		Indicates more than one defect in column. Small numeral indicates total defects in column regardless of predominating symbol. Predominating symbol will always indicate most serious defect.
Black last name initial	B	Inspection made, condition satisfactory, except column Nos. 10, 19, and 30, which indicate "Inspection Performed" but not the results thereof.
Black last name initial with circle.	Ⓑ	Indicates "Greased or Oiled except in Column 36 which indicates "Water Added to Battery".
Black dash	—	Inspection today not required.
Vertical black line thru column	|	Indicates this column "Not Applicable".

PERSONNEL CLASSES

COMMISSIONED (Air Forces Operations)	
Regular Army	00
E.A.D. Reserve	01
Reserve, 14—Day	02
Reserve, inactive	03
National Guard—Federal	04
National Guard	05
British (U.K.)	06
Chinese	07
Philippine	08
Mexican	09
Cuban	10
Argentine	11
A.U.S.	18
Other Foreign	19

ENLISTED (Air Forces Operations)	
Regular Army	20
E.A.D. Reserve	21
	22
Reserve, inactive	23
National Guard—Federal	24
National Guard	25
British (U.K.)	26
Chinese	27
Philippine	28
Mexican	29
Cuban	30
Argentine	31
A.U.S.	38
Other Foreign	39

COMMISSIONED (Students)	
Regular Army	40
E.A.D. Reserve	41
	42
Reserve, inactive	43
National Guard—Federal	44
National Guard	45
British (U.K.)	46
Chinese	47
Philippine	48
Mexican	49
A.U.S.	58
Other Foreign	59

ENLISTED (Students)	
Regular Army	60
E.A.D. Reserve	61
Aviation Cadets	62
U.S.W.A.A. Cadets	63
National Guard—Federal	64
National Guard	65
British (U.K.) A/C	66
Chinese A/C	67
Philippine A/C	68
Other Foreign	69
A.U.S.	79

CIVILIANS	
Civilian Ferry Command	80
Civilian Instructor	81
Civilian Test Pilot	82
Civilian-Crew or passenger (Army plane)	84
Civilian Employees (nonpilot)	85
Civilian Receiving Instruction (or demonstrating pilot efficiency)	86
Other U.S. Services	87
Civilian Pilots-Civilian Aircraft Operat's	88

MISSIONS	
Administrative	A
Combat	C
Training	T
Transportation	"
Ferrying	F
Reconnaissance & Observation	R

MISCELLANEOUS	
Non military U.S. personnel in foreign Aircraft	90
Foreign Civilian Flying in U.S.A.A.F. Aircraft	91
W.A.A.F.	93
W.A.F.S.	94
Women Civilian Pilots	95
Unknown	99

DUTY CODES

AIR FORCES	
First Pilot	P
Co-pilot	CP
Command Pilot	C
Acting Command Pilot	CA
Qualified Pilot Dual	QD

NONPILOT	
Bombardier	B
Engineer, Flight *	FE
Engineer	E
Flight Surgeon	M
Gunner	G
Navigator	N
Observer	O
Radar Operator	V
Radio Personnel	R
Photographer	F
Other Crew	W
Passengers	X
Safety Observer	Z
Parachute Troops or other troops	T

PILOTAGE SCHOOLS	
Flying Instructor	S
Student First Pilot	SP
Student Dual	SD
Student Co-pilot	SC

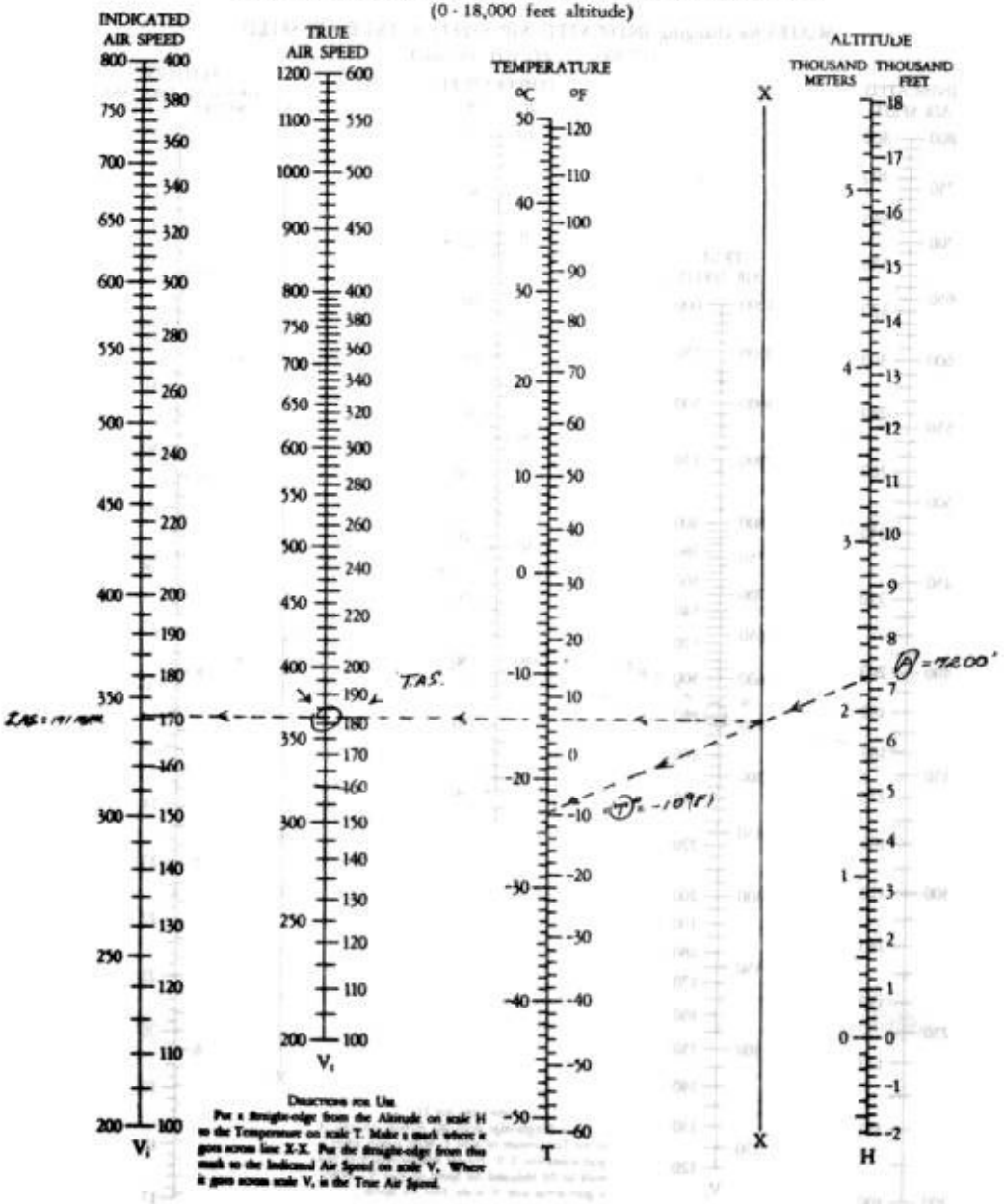
NONPILOTAGE SCHOOLS
S - used with "Nonpilot" symbols Example: SN - Student Navigator

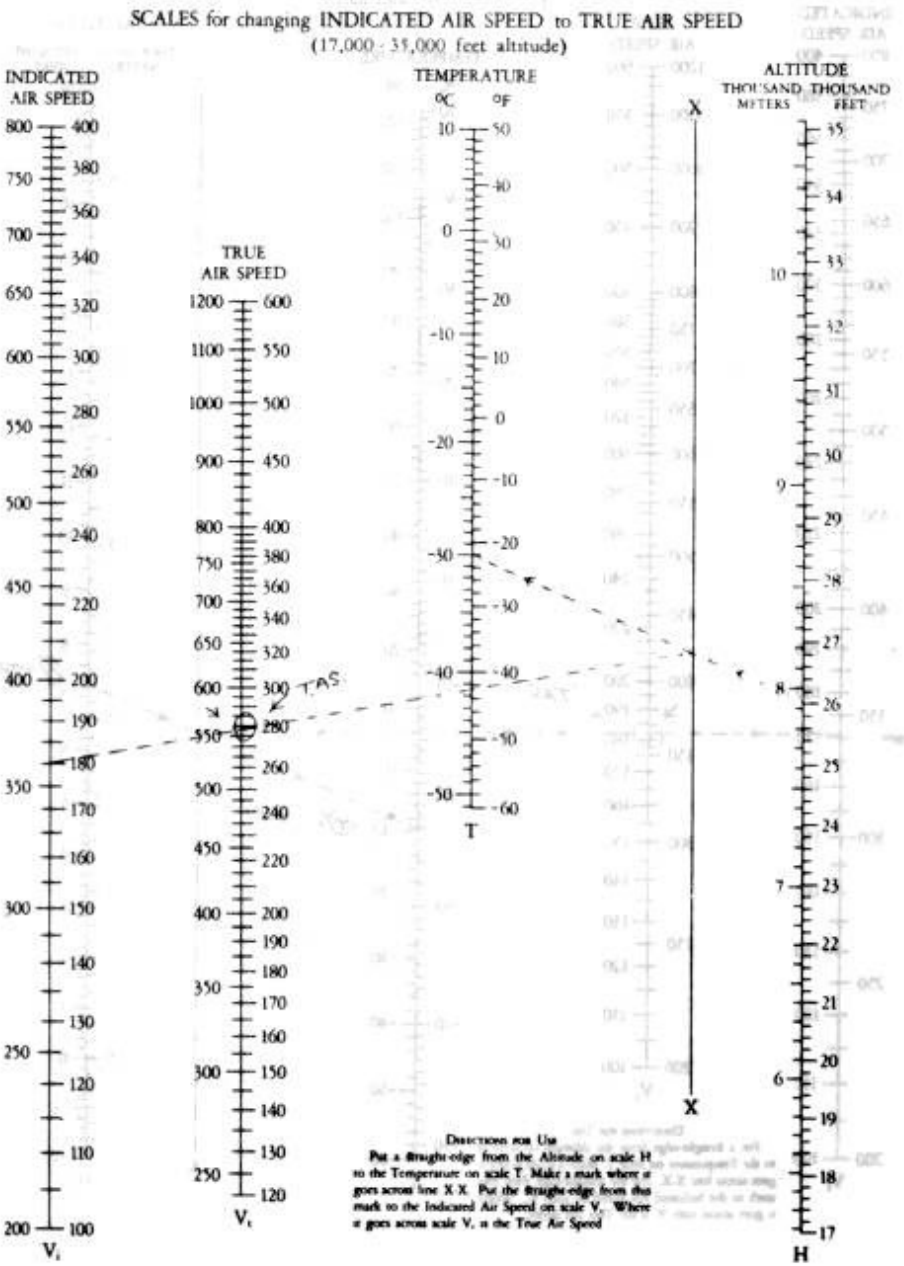
NOTE: These codes are to be used in lieu of the Duty Codes printed on the inside front cover of the Pads of Form 1 and 1A.

* Not authorized or adopted to date, A.A.F., but recommended for use.

SCALES for changing INDICATED AIR SPEED to TRUE AIR SPEED

(0 - 18,000 feet altitude)




SCALES for changing INDICATED AIR SPEED to TRUE AIR SPEED
(17,000 - 35,000 feet altitude)
INDICATED AIR SPEED
TRUE AIR SPEED
TEMPERATURE
°C °F
ALTITUDE
THOUSAND METERS
THOUSAND FEET
X
X
T
H
V_i
V_t
TAS
Directions for Use
Put a straight-edge from the Altitude on scale H to the Temperature on scale T. Make a mark where it goes across line X X. Put the straight-edge from this mark to the Indicated Air Speed on scale V_i. Where it goes across scale V_t is the True Air Speed

S.F.R.S. (FE-6642)

ALTITUDE PRESSURE TEMPERATURE RELATIONSHIP

Density lbs/cu ft	Altitude Feet	Ins. Hg.	lbs/sq. in.	C°	F°
.07651	Sea Level	29.921	14.697	15.0	59.0
.07430	1000	28.86	14.18	13.0	55.4
.07213	2000	27.82	13.67	11.0	51.9
.07001	3000	26.81	13.17	9.1	48.3
.06794	4000	25.84	12.69	7.1	44.7
.06592	5000	24.89	12.23	5.1	41.2
.06395	6000	23.98	11.78	3.1	37.6
.06202	7000	23.09	11.34	1.1	34.0
.06013	8000	22.22	10.91	-0.8	30.5
.5829	9000	21.38	10.50	-2.8	26.9
.05649	10000	20.58	10.11	-4.8	23.3
.05474	10000	19.79	9.72	-6.8	19.8
.05303	12000	19.03	9.35	-8.8	16.2
.05136	13000	18.29	8.98	-10.8	12.6
.04973	14000	17.57	8.63	-12.7	9.1
.04814	15000	16.88	8.29	-14.7	5.5
.04658	16000	16.21	7.96	-16.7	1.9
.04507	17000	15.56	7.64	-18.7	-1.6
.04359	18000	14.94	7.34	-20.7	-5.2
.04216	19000	14.33	7.04	-22.6	-8.7
.04075	20000	13.75	6.75	-24.6	-12.3
.03938	21000	13.18	6.47	-26.6	-15.9
.03806	22000	12.63	6.20	-28.6	-19.5
.03676	23000	12.10	5.94	-30.6	-23.0
.03550	24000	11.59	5.69	-32.5	-26.6
.03427	25000	11.10	5.45	-34.5	-30.2
.03308	26000	10.62	5.22	-36.5	-33.7
.03192	27000	10.16	4.99	-38.5	-37.3
.03078	28000	9.72	4.77	-40.5	-40.9
.02968	29000	9.29	4.56	-42.5	-44.4
.02861	30000	8.88	4.36	-44.4	-48.0
.02757	31000	8.48	4.17	-46.4	-51.6
.02656	32000	8.10	3.98	-48.4	-55.1
.02558	33000	7.73	3.80	-50.4	-58.7
.02463	34000	7.38	3.62	-52.4	-62.3
.02369	35000	7.04	3.46	-54.4	-65.8
.02265	36000	6.71	3.30	-55.0	-67.0
.02160	37000	6.39	3.14	-55.0	-67.0
.02059	38000	6.10	3.00	-55.0	-67.0
.01963	39000	5.81	2.85	-55.0	-67.0
.01872	40000	5.54	2.72	-55.0	-67.0
.01783	41000	5.28	2.60	-55.0	-67.0
.01702	42000	5.04	2.47	-55.0	-67.0
.01621	43000	4.80	2.36	-55.0	-67.0
.01547	44000	4.58	2.25	-55.0	-67.0
.01472	45000	4.36	2.14	-55.0	-67.0
.01405	46000	4.16	2.04	-55.0	-67.0
.01341	47000	3.97	1.95	-55.0	-67.0
.01277	48000	3.78	1.86	-55.0	-67.0
.01217	49000	3.60	1.77	-55.0	-67.0
.01161	50000	3.43	1.69	-55.0	-67.0

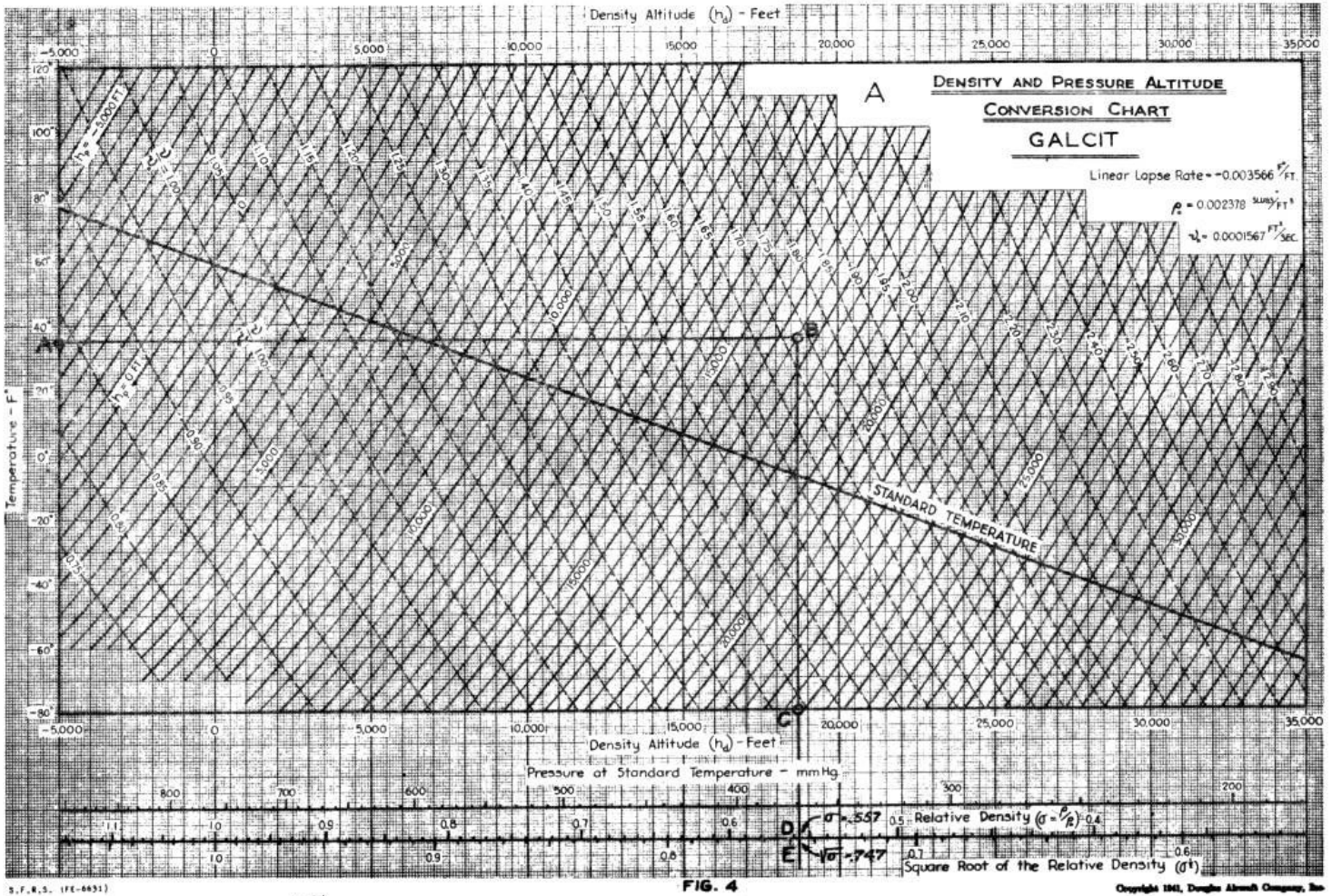
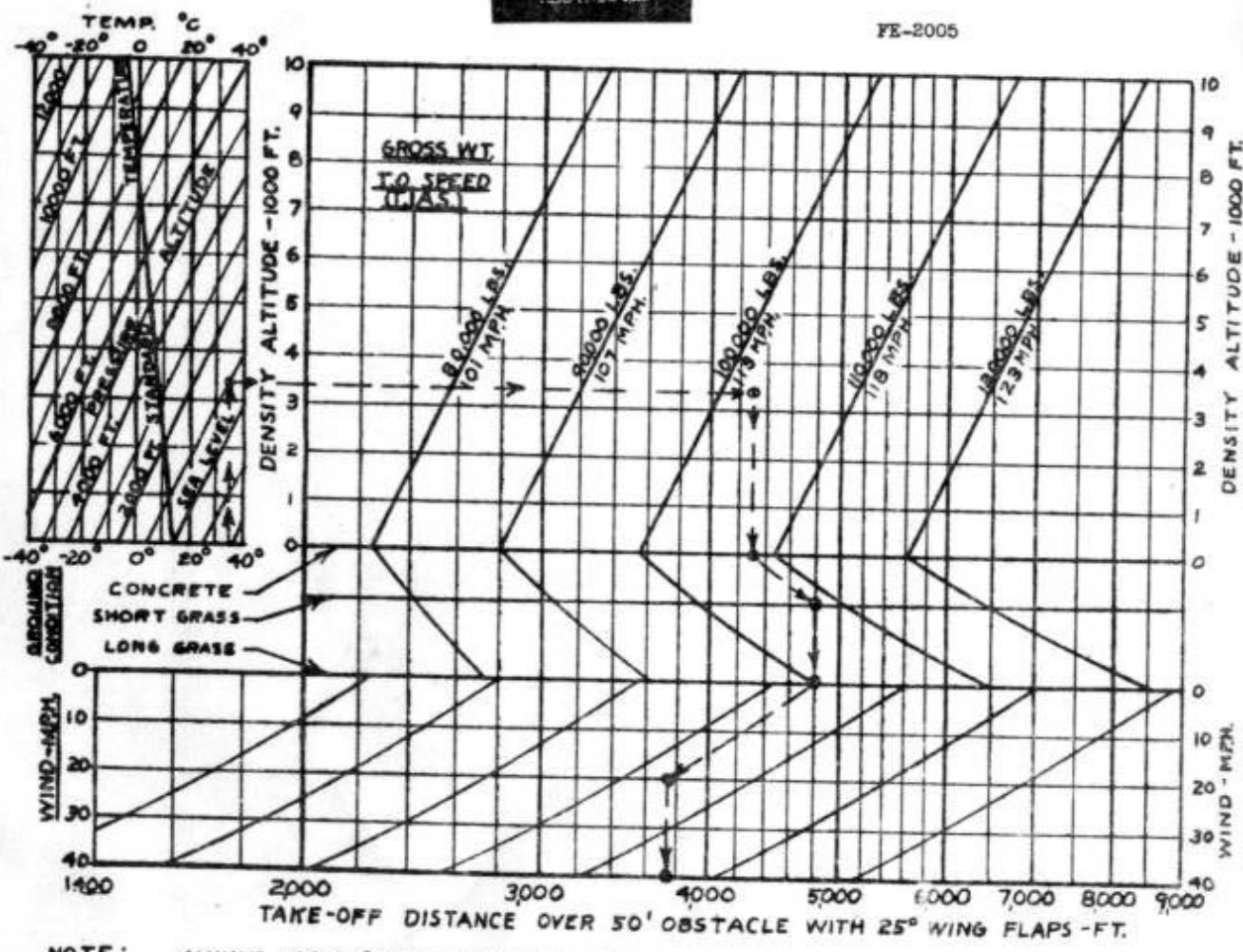


FIG. 4

S.F.R.S. (FE-6651)

FE-2005



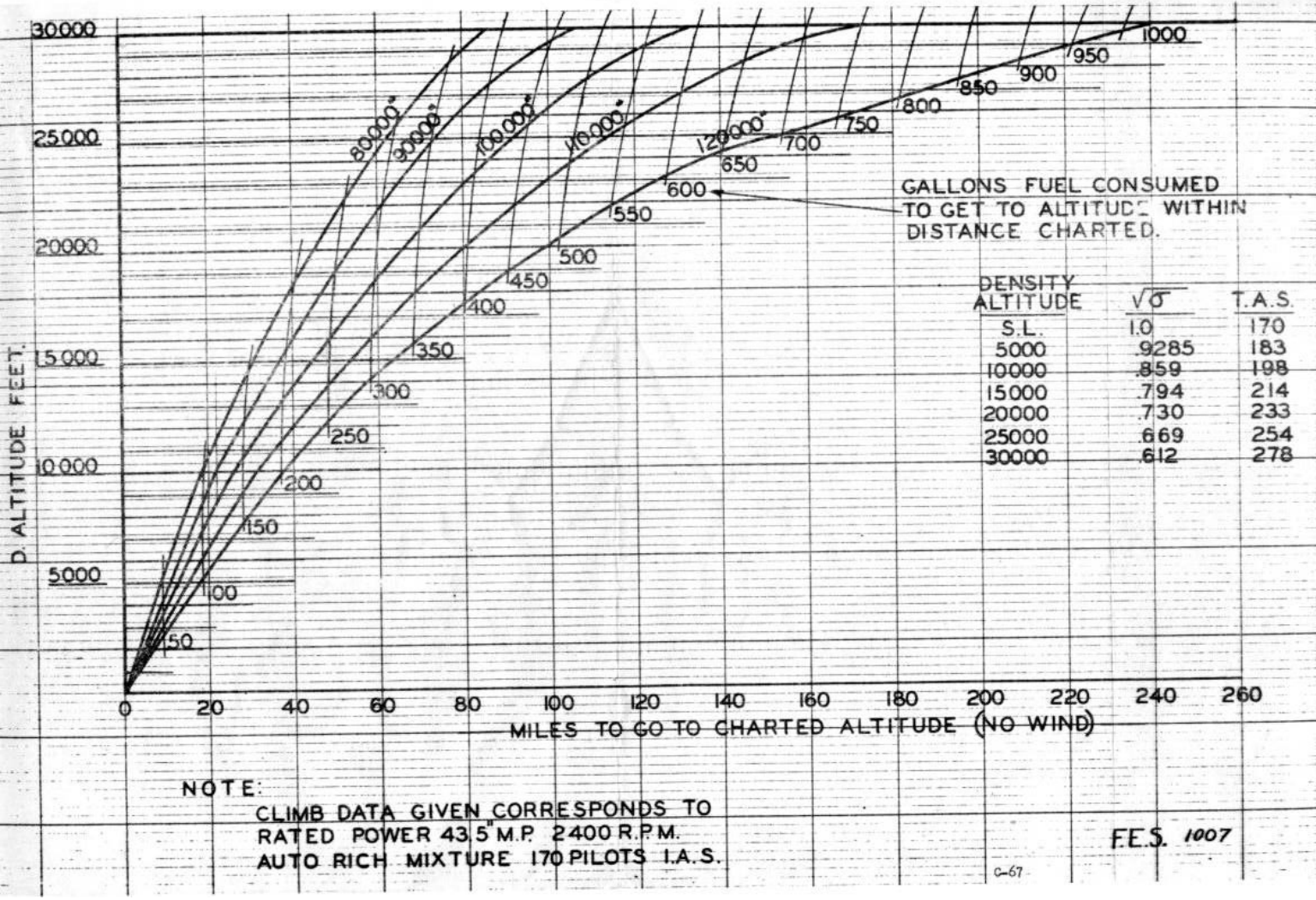
NOTE: ALWAYS USE 25° WING FLAPS TO AVOID EXCESSIVELY LONG TAKE-OFF DISTANCES. DISTANCE TO LEAVE GROUND IS APPROX. 70% OF THE TOTAL DISTANCE.

CALC.	ALEX	5-26-[illegible]	DATE
TRAC		REVISED	
CHECK			
APPR.			
APPR.			

TAKE OFF DISTANCE TO CLEAR A 50' OBSTACLE WITH 25° WING FLAPS AND TAKE OFF POWER

B-29

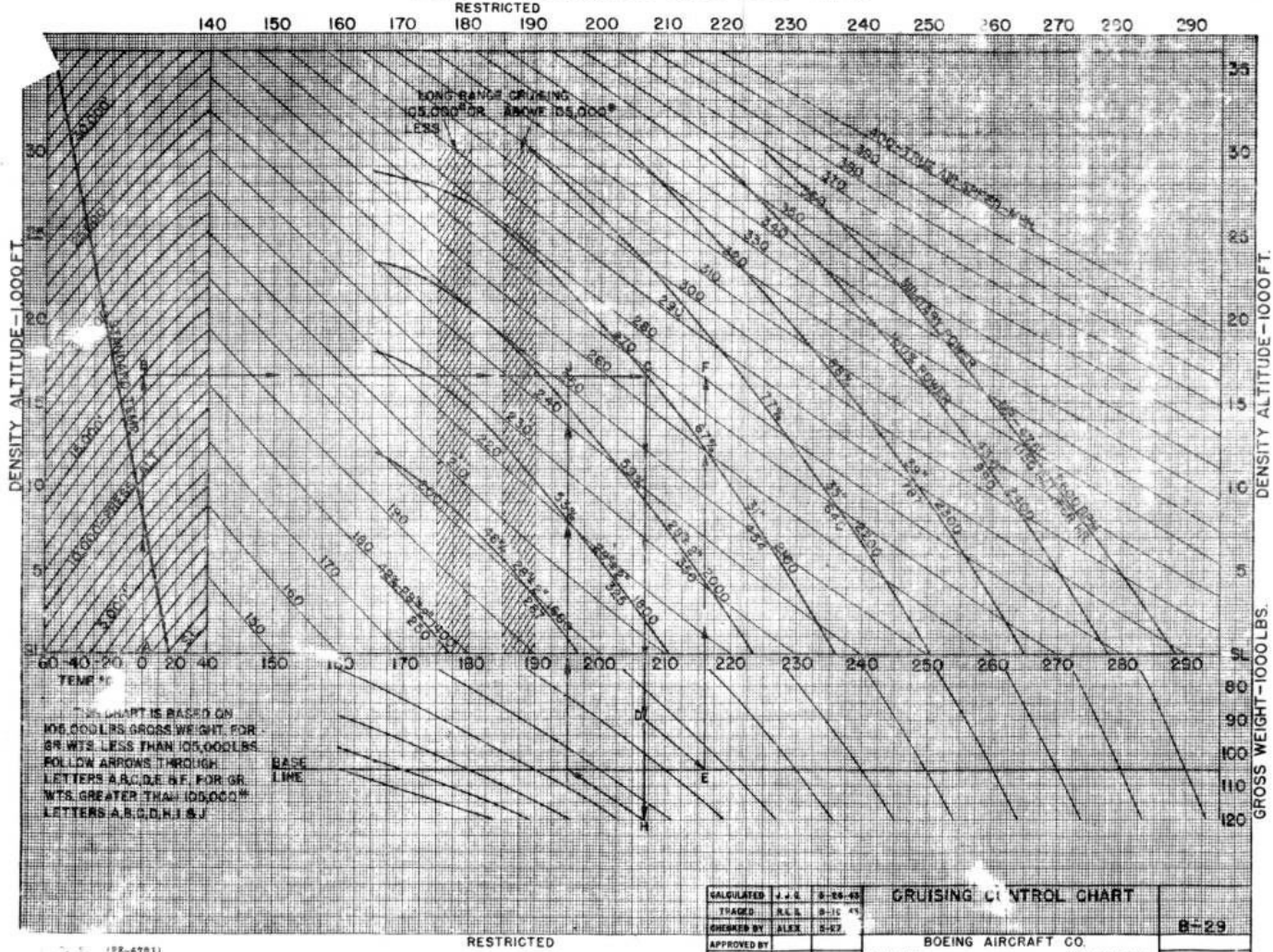
BOEING AIRCRAFT CO. SEATTLE WASHINGTON



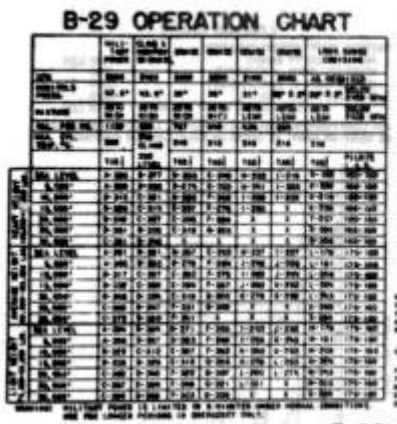
NOTE:
CLIMB DATA GIVEN CORRESPONDS TO
RATED POWER 43.5" M.P. 2400 R.P.M.
AUTO RICH MIXTURE 170 PILOTS I.A.S.

F.E.S. 1007

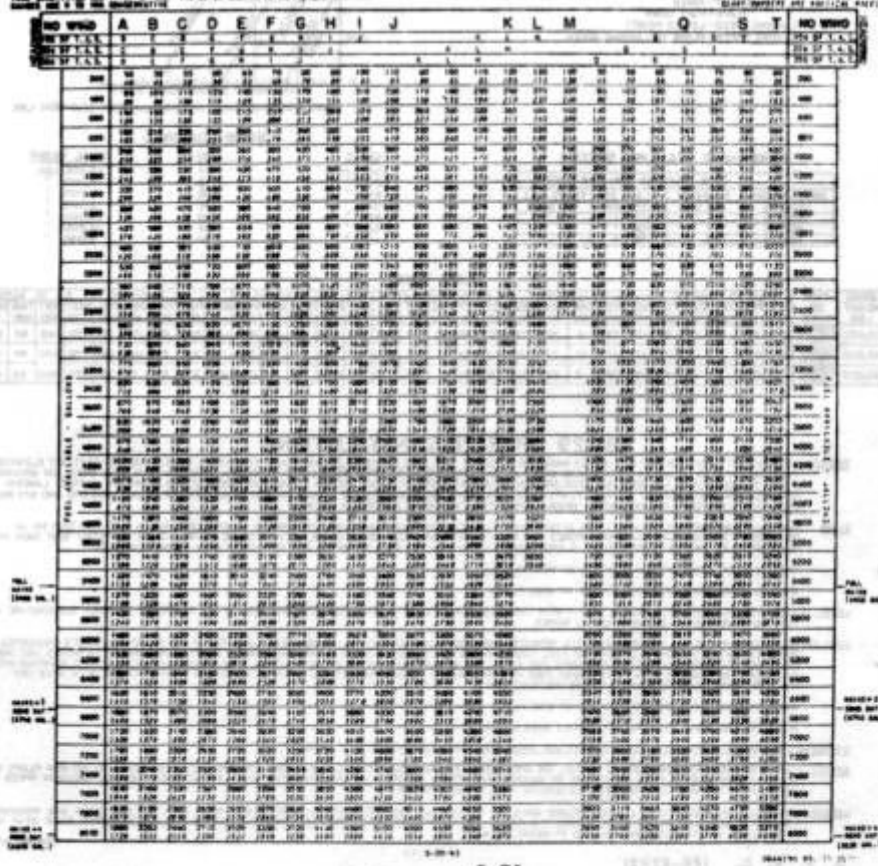
C-67


PILOTS INDICATED AIRSPEED—MPH
DENSITY ALTITUDE—1000 FT.
GROSS WEIGHT—1000 LBS.
LONG RANGE CRUISING
105,000# OR ABOVE
105,000# OR LESS
MAX. CRUISE POWER
MAX. ECONOMY
BASE LINE
TEMP °C
THIS CHART IS BASED ON 105,000 LBS GROSS WEIGHT. FOR GR WTS LESS THAN 105,000 LBS FOLLOW ARROWS THROUGH LETTERS A,B,C,D,E & F. FOR GR WTS GREATER THAN 105,000# LETTERS A,B,C,D,H,I & J
CRUISING CONTROL CHART
B-29
BOEING AIRCRAFT CO.
SEATTLE WASHINGTON
CALCULATED J.J.C. 8-26-43
TRACED R.L.S. 8-31-43
CHECKED BY ALEX 9-1-43
APPROVED BY
APPROVED BY
FORM 461A

B-29 OPERATION CHART



B-29 RANGE CHART



B-29

NOTE: ALL INFORMATION ON THIS CHART IS BASED ON FLIGHT TEST.

TAKE-OFF

THE MINIMUM TAKEOFF DISTANCE TO CLEAR A 50 FOOT OBSTACLE WILL BE APPROXIMATELY 4000 FEET. THIS DISTANCE MAY BE ATTAINED UNDER THE FOLLOWING CONDITIONS

WEIGHT - 105,000 LBS OR LESS
POWER - TAKEOFF RATING
DENSITY ALTITUDE - SEA LEVEL
TAKEOFF DIRECTION - INTO WIND
RUNWAY - HARD PAVEMENT
FLAPS - DOWN 25°
UNSTICK SPEED - MINIMUM TAIL SKID ON GROUND)
CLIMB OUT SPEED - CLOSE TO UNSTICK SPEED

BECAUSE OF THE LOW GROUND ANGLE IT WILL BE IMPOSSIBLE TO STALL THIS AIRPLANE OFF THE GROUND

LANDING

THE MINIMUM LANDING DISTANCE OVER A 50 FOOT OBSTACLE WILL BE APPROXIMATELY 4000 FEET. THIS DISTANCE MAY BE ATTAINED UNDER THE FOLLOWING CONDITIONS

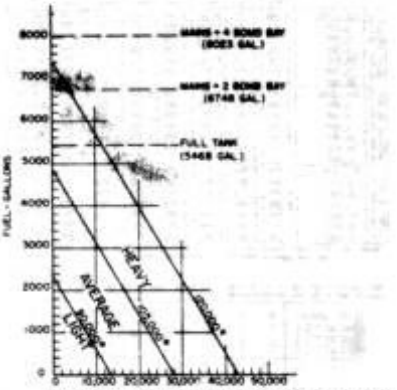
GROSS WEIGHT - 105,000 LBS OR LESS
DENSITY ALTITUDE - SEA LEVEL
LANDING DIRECTION - INTO WIND
RUNWAY - PAVED
FLAPS - FULL DOWN
LANDING SPEED - LOW (3 POINT)
GLIDING SPEED - CLOSE TO LANDING SPEED

LOADING CHART

TACTICAL EMPTY WEIGHT INCLUDES:

AIRPLANE EMPTY WEIGHT	71,189 LBS.
10-50 CAL. GUNS 1-20MM GUN	4060 "
10-MAN CREW AT 200 LBS EACH	2000 "
OIL-FULL TANKS 540 GAL.	7360 "
TOTAL TACTICAL EMPTY WEIGHT	76,709 LBS.

ANY LOAD ITEMS NOT INCLUDED IN TACTICAL EMPTY WEIGHT SHOULD BE ADDED ON CHART AS CARGO OR MISCELLANEOUS EQUIPMENT



POWER-OFF STALLING SPEEDS

	TRUE INDICATED STALLING SPEEDS		
GROSS WEIGHT	FLAPS UP	FLAPS 25°	FLAPS FULL
105,000	118 MPH	106 MPH	101 MPH
100,000	114 "	103 "	98 "
95,000	111 "	100 "	95 "
90,000	107 "	97 "	92 "
75,000	103 "	93 "	87 "

BOMB LOADINGS

CLASS	NO	TOTAL WEIGHT
4000 LBS	4	16,000 LBS
2000 "	8	16,000 "
1600 "	12	19,200 "
1000 "	12	12,000 "
500 "	40	20,000 "
300 "	56	16,800 "
100 "	80	8,000 "

CLIMB DATA

GROSS WEIGHT LBS.	TYPE OF CLIMB	SL TO 5,000 FT.					SL TO 10,000 FT.						SL TO 15,000 FT.						SL TO 20,000 FT.						SL TO 25,000 FT.						SL TO 30,000 FT.					
		IAS	MPH	TIME (MIN)	DIST (MI)	FUEL (GAL)	IAS	MPH	TIME (MIN)	DIST (MI)	FUEL (GAL)	IAS	MPH	TIME (MIN)	DIST (MI)	FUEL (GAL)	IAS	MPH	TIME (MIN)	DIST (MI)	FUEL (GAL)	IAS	MPH	TIME (MIN)	DIST (MI)	FUEL (GAL)	IAS	MPH	TIME (MIN)	DIST (MI)	FUEL (GAL)	IAS	MPH	TIME (MIN)	DIST (MI)	FUEL (GAL)
120,000	COMBAT EMERG.	170	815	6	17	95	170	730	12	38	205	170	590	20	64	330	170	440	30	100	485	170	260	43	156	715	170	140	63	241	1030					
105,000	COMBAT EMERG.	170	1065	5	13	75	170	970	10	29	155	170	850	15	48	245	170	715	21	71	350	170	550	29	104	480	170	340	40	151	660					
90,000	COMBAT EMERG.	170	385	4	10	60	170	1090	7	22	120	170	1160	11	36	185	170	1050	16	55	260	170	870	21	75	350	170	800	28	105	460					

B-29 OPERATING INSTRUCTIONS

TAKEOFF - ON RUNUP SET 2600 RPM AND 47.5 INCHES MANIFOLD PRESSURE. SET WING FLAPS TO 25° AND COWL FLAPS FULL OPEN (4-1/2 INCH GAP). SET ELEVATOR TRIM TAB BETWEEN 1/4 AND 1/2 DIVISION NOSE DOWN. AT 2600 RPM AND 47.5 INCHES ACCELERATE TO 105 MPH INDICATED WITH NOSE WHEEL ON GROUND. LOWER TAIL GRADUALLY AND CONTINUE ACCELERATION TO TAKEOFF SPEED OF ABOUT 120 MPH. CLIMB OVER OBSTRUCTIONS AT 140 MPH. RETRACT LANDING GEAR AS SOON AS CONVENIENT. RETRACT FLAPS WHEN CONVENIENT ABOVE 500 FEET AT 150 MPH. DO NOT REDUCE POWER BELOW 2600 RPM AND 47.5 INCHES UNTIL FLAPS AND GEAR ARE RETRACTED. MINIMUM SPEED FOR TWO-ENGINE CONTROL IS 130 MPH.

CLIMB - MAKE ALL CLIMBS (EXCEPT INITIAL CLIMBS AFTER TAKEOFF) AT 2600 RPM 43.5 INCHES AND 170 MPH. USE 1/2 OPEN COWL FLAPS (2-1/2 INCH GAP) OR AS REQUIRED TO MAINTAIN LIMITING TEMPERATURES. TOO MUCH COWL FLAP WILL REDUCE CLIMB AND HIGH SPEED AND WILL CAUSE SUFFETING. BEST RATE OF CLIMB SPEED ON TWO OR THREE ENGINES IS APPROXIMATELY 160 MPH. USE FULL THROTTLE AND SET POWER WITH TURBO REGULATOR.

WHEN CLIMBING ABOVE 25,000 FEET USE 5° WING FLAPS.

WHEN CLIMBING ABOVE 30,000 FEET USE 10° WING FLAPS.

LEVEL FLIGHT - USE FULL THROTTLE AND SET POWER WITH TURBO REGULATOR. COWL FLAPS CLOSED (1/2 INCH GAP) OR SET TO PROPER CYLINDER TEMPERATURE MIXTURE AUTO RICH ABOVE 2100 RPM AND 30 INCHES.

LONG RANGE CRUISING - FLY AT 175 TO 190 MPH PILOT'S INDICATED AIRSPEED BELOW 105,000 LBS. ABOVE 105,000 LBS. FLY AT 185 TO 190 MPH PILOT'S INDICATED AIRSPEED. 23° 4' 0" MP ON FULL THROTTLE FULL TURBO, WHICHEVER IS LESS. IF SPEED CAN NOT BE OBTAINED UP TO 2000 RPM AND 28 INCHES USE HIGHER RPM'S AND RECOMENDED MANIFOLD PRESSURES. USE AUTO LEAN MIXTURE WHEN AT OR BELOW 2100 RPM. COWL FLAPS CLOSED OR SET TO MAINTAIN PROPER CYLINDER TEMPERATURE. RESET RPM EVERY TWO TO THREE HOURS TO MAINTAIN DESIRED CRUISING SPEED. SET UP CONDITIONS WITH AFCE OFF. FOR LONG RANGE CLIMB, USE ABOVE CLIMB INSTRUCTIONS.

WHEN CRUISING ABOVE 25,000 FEET USE 5° WING FLAPS.

WHEN CRUISING ABOVE 30,000 FEET USE 10° WING FLAPS.

EMERGENCY OPERATION AT HIGH ALTITUDES - ALWAYS USE 2500 RPM - MANIFOLD PRESURE 47.5 INCHES.

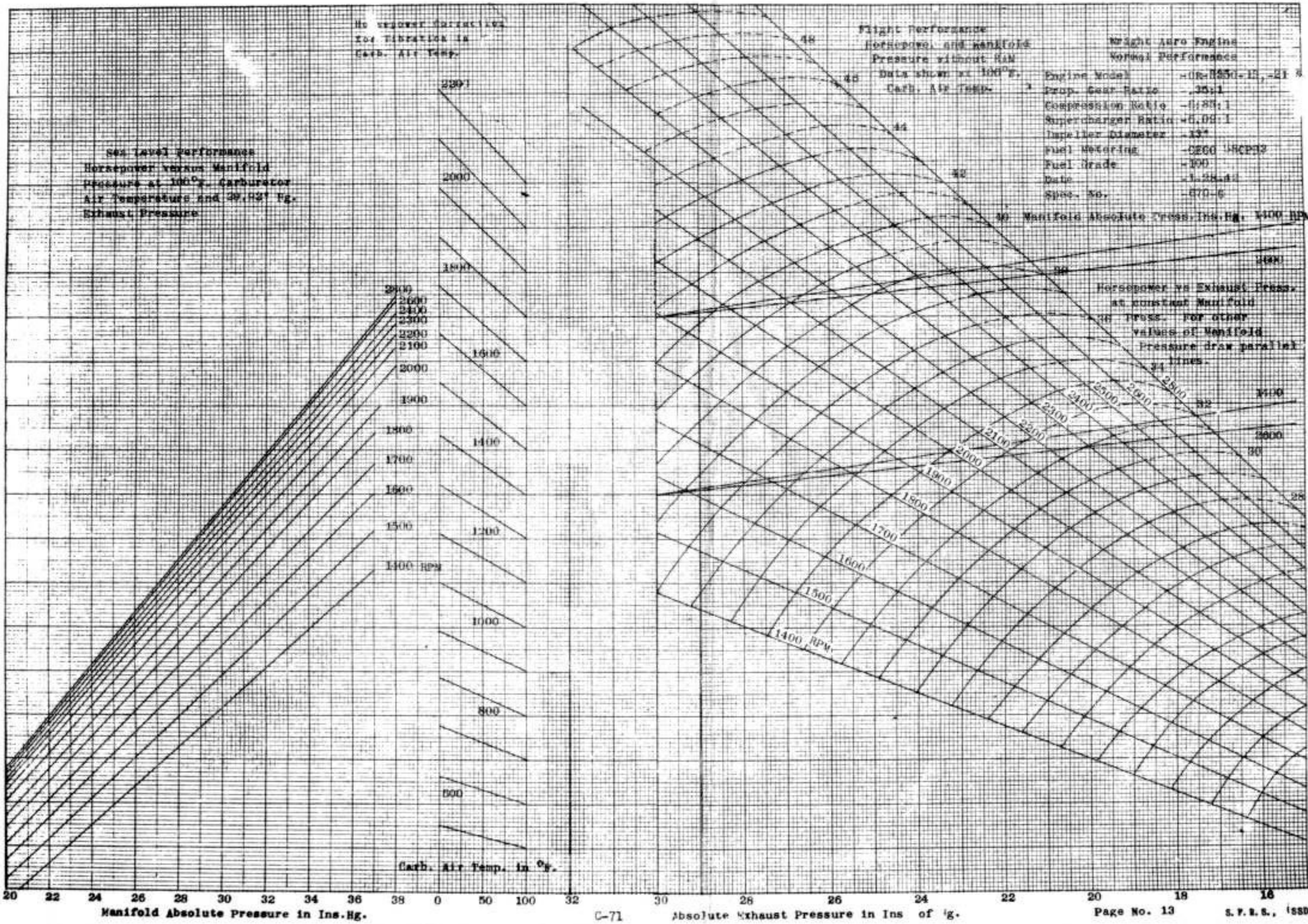
APPROACH - MOVE SUPERCHARGER REGULATORS TO FULL ON AND PROPELLER CONTROLS TO 2100 RPM BEFORE LANDING. INITIAL APPROACH AT 150 MPH. FLAPS 25°. DO NOT LOWER LANDING GEAR UNTIL SURE OF MAKING FIELD. FINAL APPROACH AT 140 MPH WITH FULL FLAPS AT END OF RUNWAY. MAXIMUM SPEED FOR 25° FLAPS IS 180 MPH. LANDING GEAR EXTENSION TIME IS 60 SECONDS.

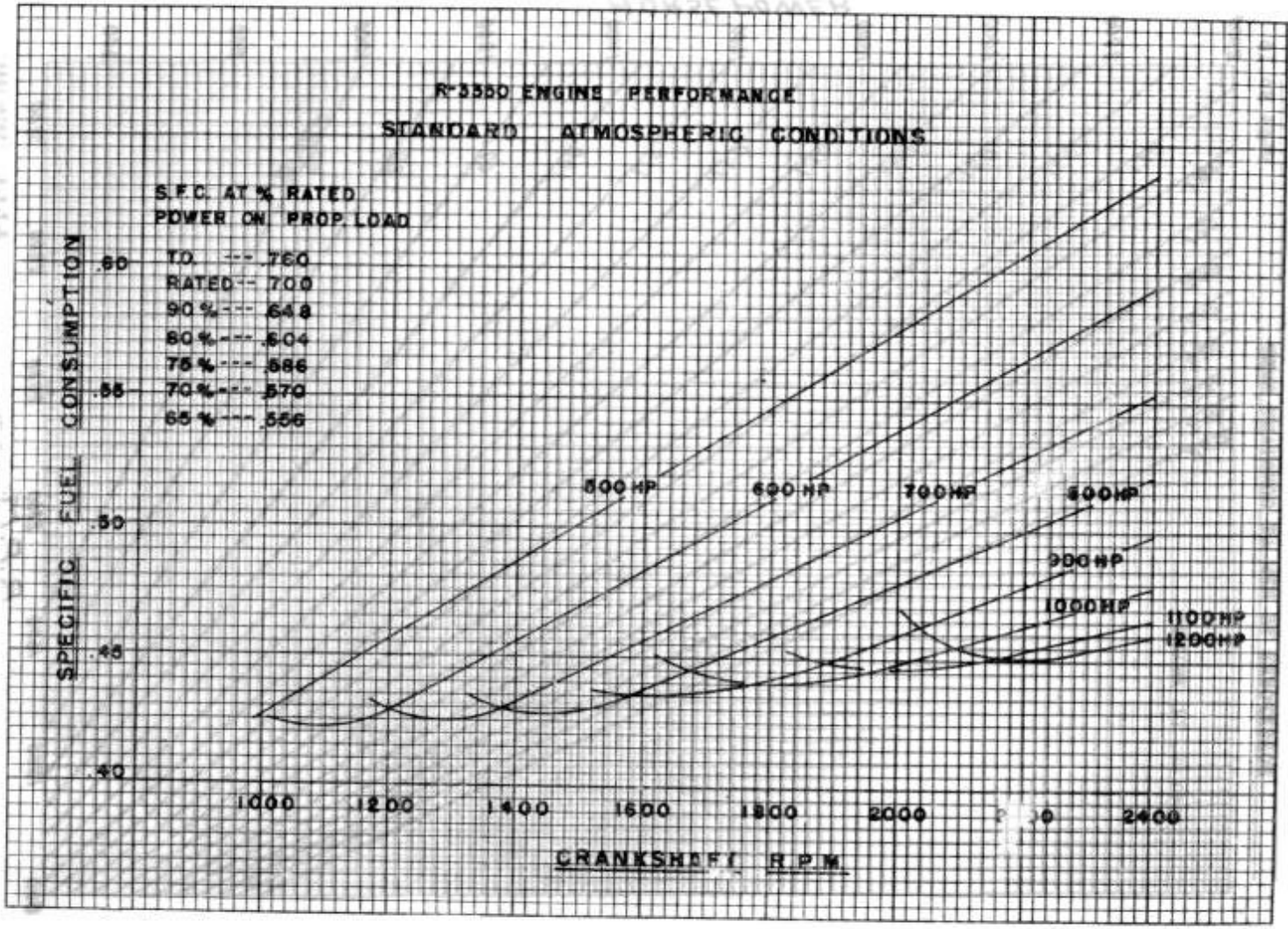
LANDING - MAKE ALL LANDINGS WITH FULL FLAPS. FLARE AIRPLANE RAPIDLY JUST BEFORE CONTACT. LAND ON MAIN GEAR WITH TAIL LOW. OPEN SIDE WINDOWS IN LANDING TO HEAR AND HEDGE AVOID SLIDING THE TIRES. TO GO AROUND AGAIN: USE FULL THROTTLE, FULL TURBO, AND 2600 RPM. RAISE GEAR AND RAISE FLAPS TO 25° BELOW 150 MPH AND 0° ABOVE 150 MPH.

(DRAWING NO 14-5509)

8-14-43

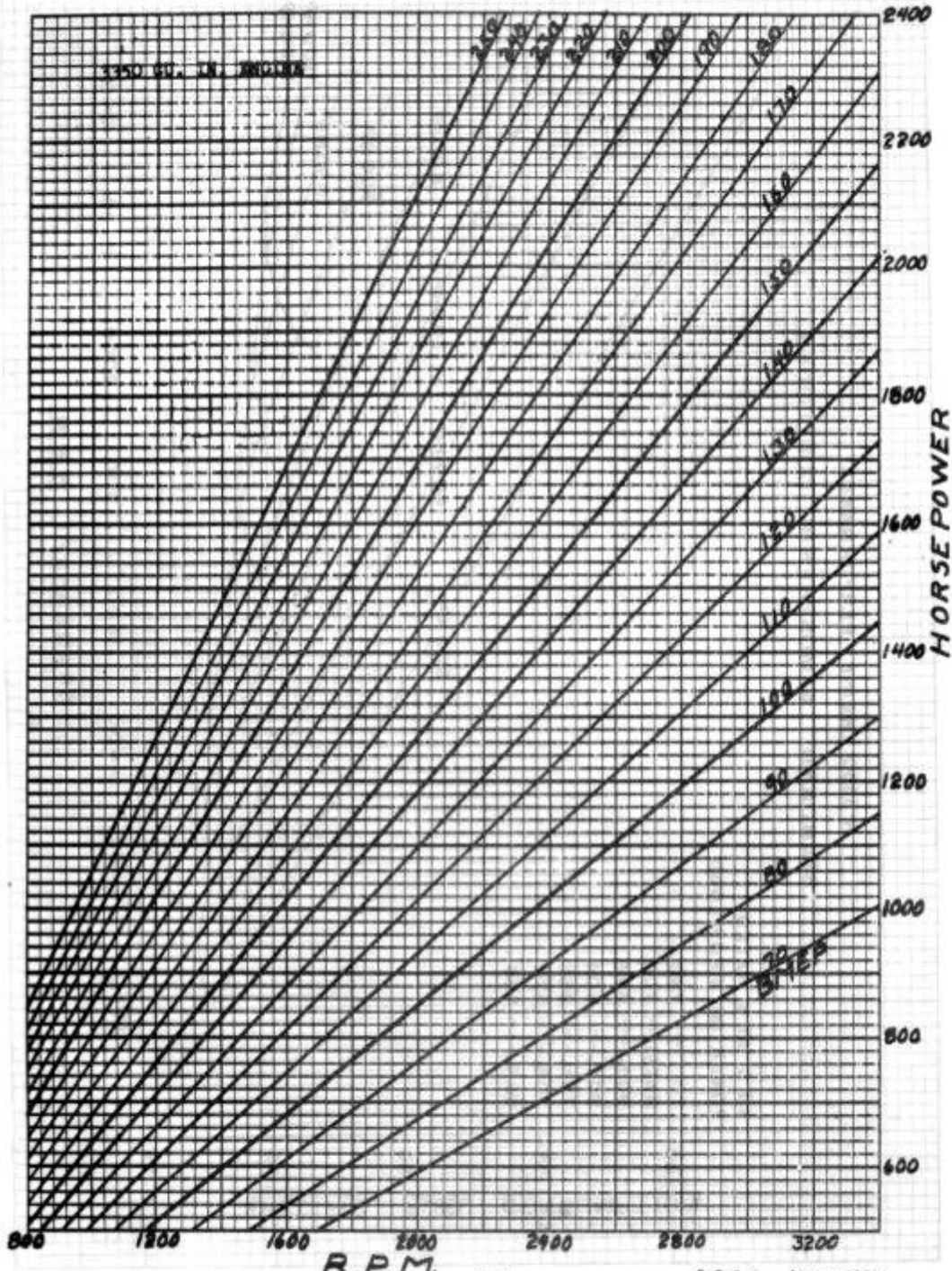
S. P. R. S. (PS-6702)


Sea Level Performance
Horsepower versus Manifold
Pressure at 100°F. Carburetor
Air Temperature and 29.92" Hg.
Exhaust Pressure
Horsepower Correction
for Variation in
Carb. Air Temp.
Flight Performance
Horsepower and Manifold
Pressure without RAM
Data shown at 100°F.
Carb. Air Temp.
Wright Aero Engine
Normal Performance
Engine Model -GR-1820-15, -21
Prop. Gear Ratio -.35:1
Compression Ratio -6.35:1
Supercharger Ratio -6.09:1
Impeller Diameter -11"
Fuel Metering -CE00 -HCP02
Fuel Grade -100
Date -1-28-41
Spec. No. -870-G
30 Manifold Absolute Press. Ins.Hg. 1400 RPM
Horsepower vs Exhaust Press. at constant Manifold Press. For other values of Manifold Pressure draw parallel lines.
1400 RPM
Carb. Air Temp. in °F.
Manifold Absolute Pressure in Ins.Hg.
Absolute Exhaust Pressure in Ins of Hg.


R-3350 ENGINE PERFORMANCE
STANDARD ATMOSPHERIC CONDITIONS
S.F.C. AT % RATED
POWER ON PROP. LOAD
T.O. --- .760
RATED --- .700
90% --- .648
80% --- .604
75% --- .586
70% --- .570
65% --- .556
SPECIFIC FUEL CONSUMPTION
.60
.55
.50
.45
.40
500 HP
600 HP
700 HP
800 HP
900 HP
1000 HP
1100 HP
1200 HP
1000
1200
1400
1600
1800
2000
2200
2400
CRANKSHAFT R.P.M.

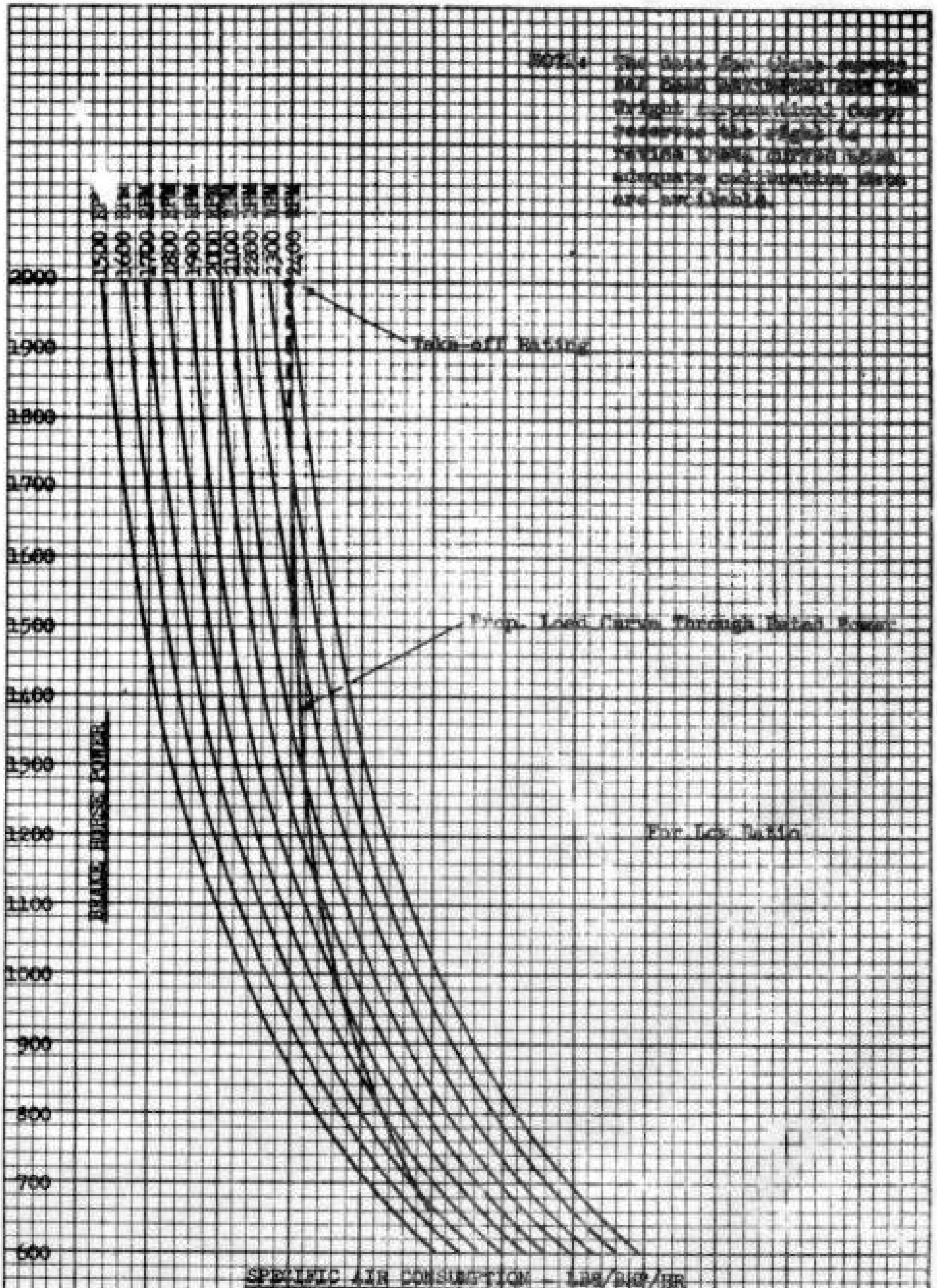
C-73

FC-6536

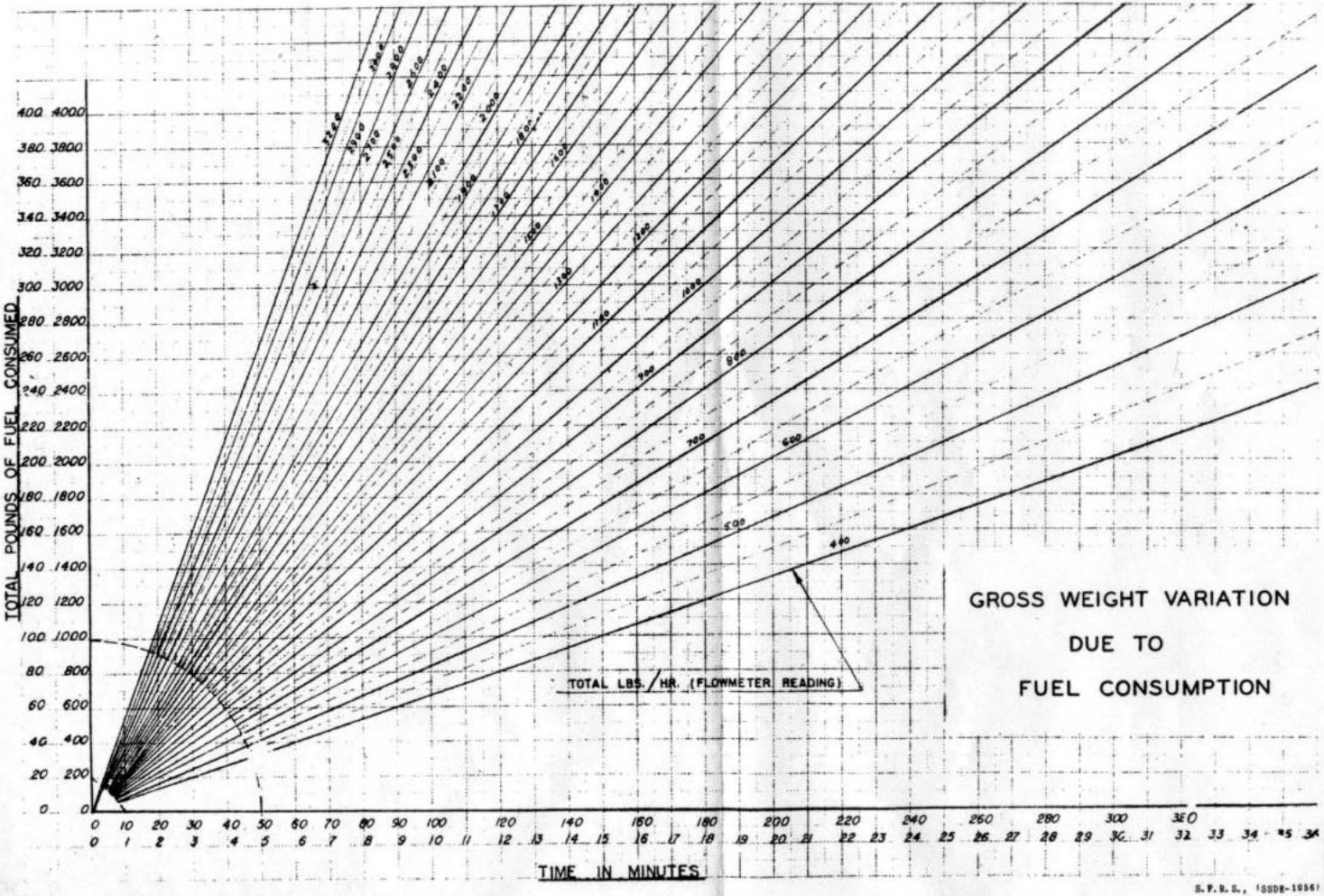


S. P. E. S., (SSDB-1066)

R-3350 Specific Air Consumption At Best Power



S. P. R. S., 'SSDE-1084'



S.F.R.S., (SSDR-1056)

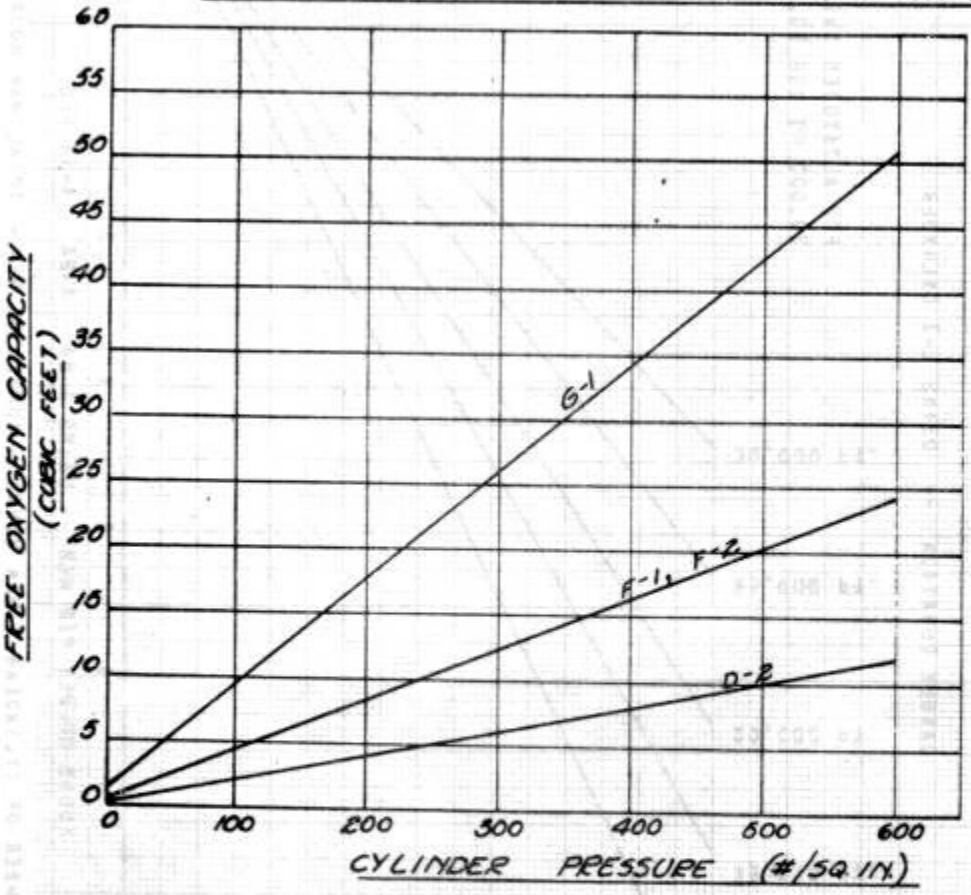


Figure 12—Free oxygen capacities (STPD) of low-pressure cylinders at various pressures.

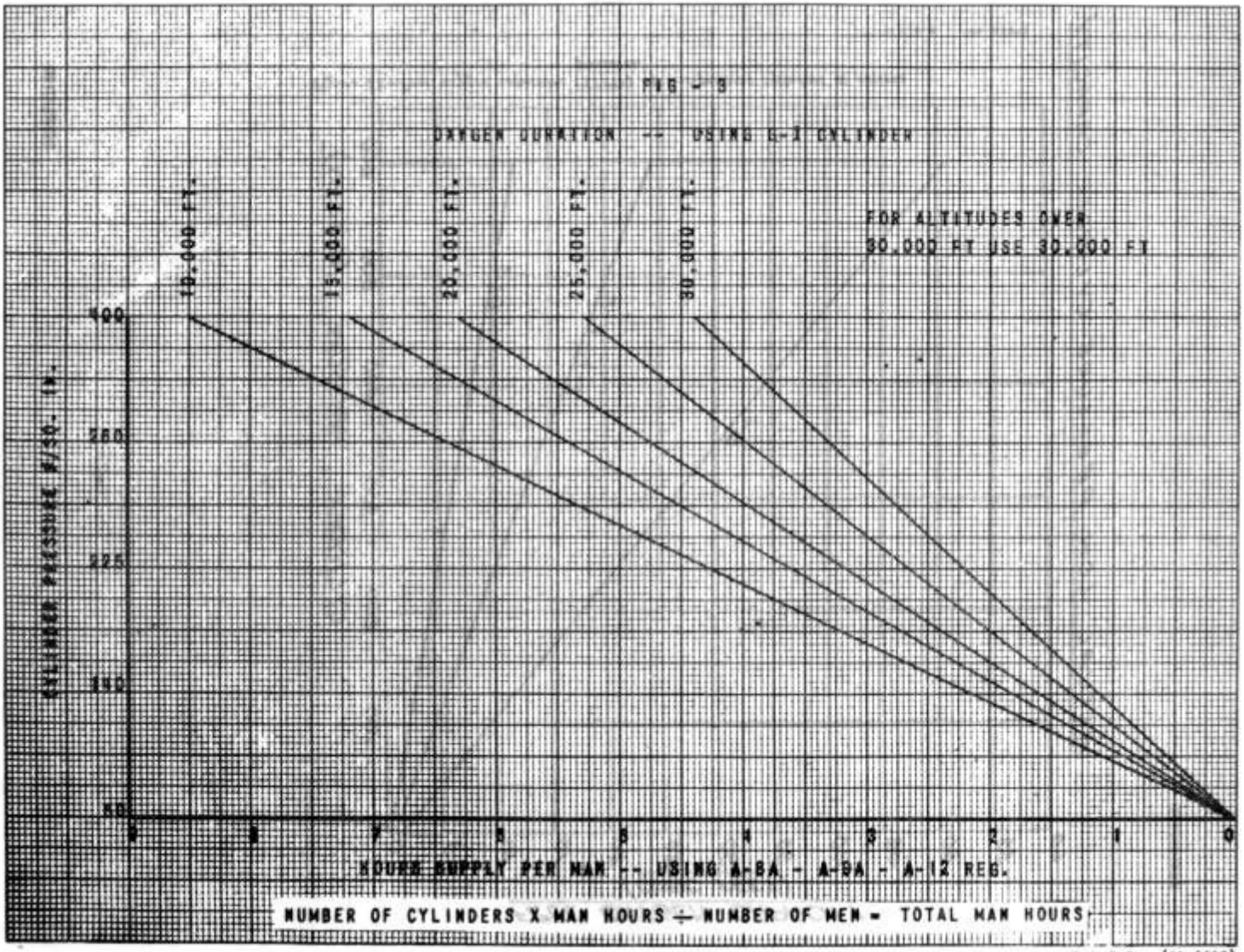
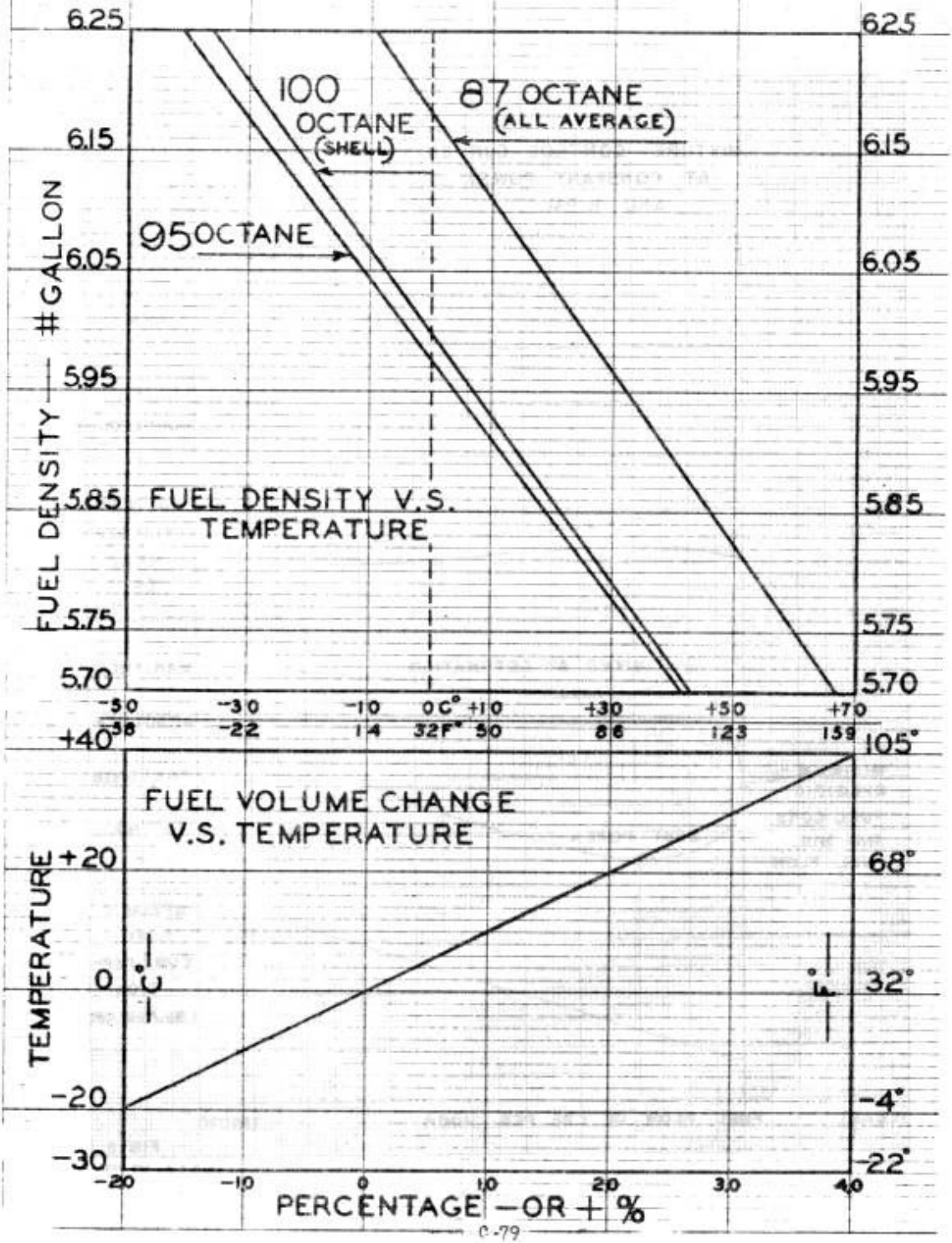


FIG - 3
OXYGEN DURATION -- USING G-I CYLINDER
FOR ALTITUDES OVER
30,000 FT USE 30,000 FT
10,000 FT.
15,000 FT.
20,000 FT.
25,000 FT.
30,000 FT.
CYLINDER PRESSURE PSIG (T)
400
300
225
150
50
9
8
7
6
5
4
3
2
1
0
HOURS SUPPLY PER MAN -- USING A-8A - A-9A - A-12 REG.
NUMBER OF CYLINDERS X MAN HOURS ÷ NUMBER OF MEN = TOTAL MAN HOURS

S.P.R.S. (FE-6609)


100 OCTANE (SHELL)
87 OCTANE (ALL AVERAGE)
95 OCTANE
FUEL DENSITY — # GALLON
6.25
6.15
6.05
5.95
5.85
5.75
5.70
FUEL DENSITY V.S. TEMPERATURE
-50 -30 -10 0C° +10 +30 +50 +70
+40 -58 -22 14 32F° 50 86 123 159 105°
FUEL VOLUME CHANGE V.S. TEMPERATURE
TEMPERATURE
+20
0
-20
-30
-C°-
°F
68°
32°
-4°
-22°
-20 -10 0 10 20 30 40
PERCENTAGE — OR + %

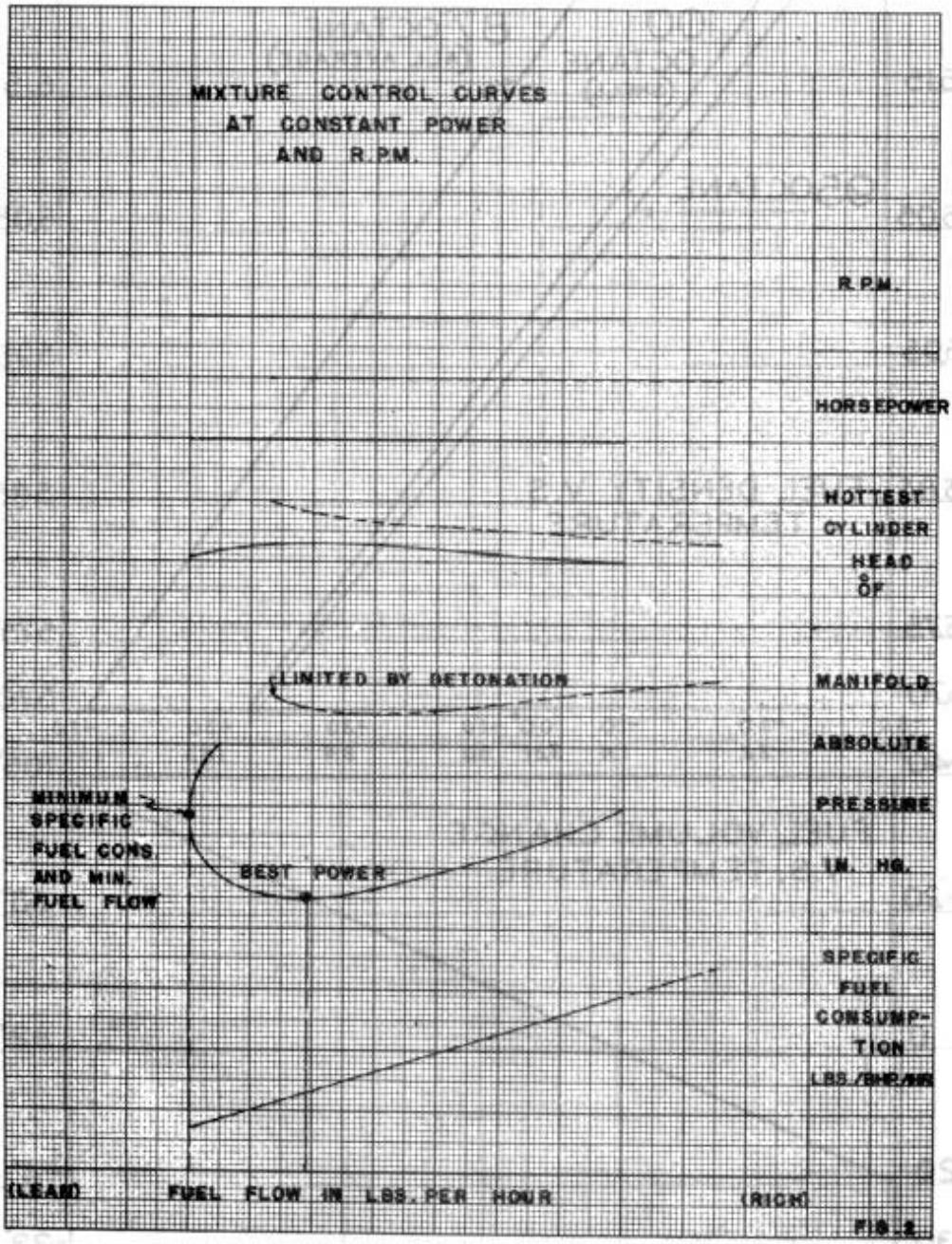


FIG. 2

A.F.S.S. (FS-6025)

ENGINEER'S CHECK LIST

BEFORE STARTING ENGINES

1. Weight and C.G. location
2. Flight Log
3. Props pulled through
4. Emergency flap motor
5. Crew Chief tool kit
6. Voltage reg. vent valve
7. Parachutes
8. Oxygen
9. Clothing
10. Life preserver
11. Cabin pressure relief valve
12. Battery switch
13. Emergency switch (pilots)
14. Master ignition switches
15. Auxiliary power plant
16. Lights
17. Control freedom of movement
18. Normal and emergency hyd. pressure
19. Parking brakes and blocks
20. Fuel quantity
21. Oil quantity
22. Inverter
23. Cowl flaps
24. Oil cooler shutters
25. Intercooler shutters
26. Propeller
27. Turbo
28. Fuel valves
29. Mixture control
30. Fuel booster
31. Fire extinguishers
32. Mg. switch (and starting)

DURING WARM-UP

1. Oil pressure - nose
2. Oil pressure - rear
3. Fuel pressure
4. Cylinder head temperature
5. Oil temperature
6. Wing de-icers
7. Generator switches
8. Vacuum system

BEFORE TAKE-OFF

1. Cabin supercharger
2. Magneto drop
3. Generators
4. Cowl Flaps
5. Fuel booster
6. Cylinder head temperatures
7. Oil pressure - nose
8. Oil pressure - rear
9. Oil temperature

DURING FLIGHT

1. Intercooler shutters
2. Fuel booster pump
3. Auxiliary power plant
4. Cowl flaps
5. Mixture
6. Oil pressure - nose
7. Oil pressure - rear
8. Fuel Pressure
9. Generators
10. Cylinder head temperature
11. Oil temperature
12. Cabin supercharger system
13. Log

BEFORE LANDING

1. Weight and C.G.
2. Auxiliary power plant
3. Mixture
4. Fuel booster pump
5. Oil pressure - nose
6. Oil pressure - rear
7. Oil temperature
8. Generators
9. Cylinder head temperature
10. Fuel pressure
11. Cabin supercharger system
12. De-icers
13. Hydraulic system
14. Intercooler shutters

AFTER LANDING

1. Generators
2. Cowl flaps
3. Fuel booster
4. Oil cooler flaps
5. Parking brakes and blocks
6. Engines
7. Oil dilution
8. All switches
9. Auxiliary power plant
10. Control lock

INSTRUCTIONS FOR ENGINEER'S CHECK LIST

1. WEIGHT AND C.G. LOCATION:

The weight and balance portion of the Flight Engineer's Log and T.O. 01-1-40 will be completed and the total weight and location of the C.G. determined. Sample calculation will also be conducted to determine the affect on C.G. location due to depletion of fuel and oil, dropping of bomb bay tanks or bombs, all from one bomb bay or both bays to determine if an unstable condition could be encountered. Max gross weight 120,000 pounds; C.G. limits 18% - 32% M.A.C.

2. FLIGHT LOG:

The engineer log will be completely filled out with the exception of that portion of the log which must necessarily be accomplished in flight.

3. PROPELLERS PULLED THROUGH:

With all ignition switches "off" the propellers will be pulled through by hand five revolutions using a maximum of three (3) men per blade. Care must be exercised especially while pulling through the first revolution so that the slightest engine obstruction encountered can be felt and corrective action taken. If an obstruction is encountered, reverse the direction of rotation of the propeller for one revolution; if this is impossible, remove the front plugs from the lower cylinders and drain the oil until the propeller can be pulled through easily. If the engine is not started within thrity (30) minutes of the last run up or the time that the propellers were pulled through, the engines must be pulled through again. Under no circumstances will the propeller be pulled through with a cylinder head reading above 100°C.

4. EMERGENCY FLAP MOTOR:

Visually check to see that the emergency Flap Motor is installed in its proper location over the middle of the rear spar.

5. CREW CHIEF TOOL KIT:

One (1) complete Crew Chief Tool Kit will be in the airplane.

6. VOLTAGE REGULATOR VENT VALVE:

These valves mounted on the top of each voltage regulator container will be open at all times--valve handle pulled in the up position.

7. PARACHUTE:

Visually check parachute inspection record, rip cord and fasten it on. Check other crew stations for presence of parachute.

8. OXYGEN:

Visually check to see that your oxygen mask is in good condition and within reach of the engineers stand. The oxygen supply pressure gage should read between 350# and 450#. Check the operation of the flow indicator and emergency valve of the regulator by turning on the emergency valve and the indicator should show a flow indication.

9. CLOTHING:

Visually check to see that you have satisfactory clothing and personal equipment for the proposed mission, particularly in connection with high-altitude and cold-weather flying where the electric suit will be worn. The suit should be turned on and a check made to see that all circuits are operating.

10. LIFE PRESERVER:

Visually check life preserver for tears and to see that the CO_2 bottle has not been used and the bottle puncture arm is safeties in position.

11. CABIN PRESSURE RELIEF VALVE:

The cabin pressure relief valve under the engineer's seat should be in the closed position.

12. BATTERY SWITCH:

Turn "on".

13. EMERGENCY SWITCH (PILOTS):

Turn "on".

14. MASTER IGNITION SWITCHES:

Turn both master ignition switches "on".

15. AUXILIARY POWER PLANT:

Order auxiliary power plant started and allow it to run in idle position for three-five (3-5) minutes before ordering it placed in high speed operation. This must be accomplished in accordance with the auxiliary power plant check list.

16. LIGHTS:

For night flights, the engineers three (3) fluorescent lights should be checked for proper operation, and the dome light adjacent to the engineers stand. Check landing gear lights.

17. CONTROL FREEDOM OF MOVEMENT:

All controls on the engineers stand should be operated through their entire range to determine that no obstacles are present.

18. NORMAL AND EMERGENCY HYDRAULIC PRESSURE:

Both hydraulic system gages should read between 800# to 1000#. Turn the hydraulic shut-off valve to "open" and operate the hydraulic pump in the emergency position. A pressure increase should be noted on both gages. Return hydraulic pump to "auto" position and close valve.

19. PARKING BRAKES AND BLOCKS

Apply parking brake from the pilots position and check that blocks are in front and in back of at least one wheel on each side of the ship.

20. FUEL QUANTITY:

Check all four (4) fuel tanks to see that sufficient fuel is aboard for the mission to be performed, this amount having previously been estimated by the Flight Engineer.

21. OIL QUANTITY:

Check all four (4) oil tanks to see that sufficient oil is aboard for the mission to be performed. Usually the tank is filled to within 80%.

22. INVERTER:

Check the alternate inverter for operation - twenty-six (26) volts, Normal. Check the "normal" inverter for twenty-six (26) volts output and leave "normal" inverter operating. When checking inverters allow the first one to stop rotating before turning on the second.

23. COWL FLAPS:

Open cowl flaps to the full open position--approximately 5 1/2" (20°). This indicator will go past both red lines.

24. OIL COOLER SHUTTER:

Place oil cooler shutters in the "auto" position.

25. INTERCOOLER SHUTTERS:

Open the intercooler shutters to 4 1/2" (15°) - instrument panel indicator to red line.

26. PROPELLER:

Put propeller governor in high RPM position until indicator lights come on.

27. TURBO:

Place turbo control to the "off" position.

28. FUEL VALVES:

Put fuel valve switches in the open position and allow to return to normal position.

29. MIXTURE CONTROL:

Place mixture control in the "Idle Cut Off" position.

30. FUEL BOOSTER:

Turn fuel booster switches on and adjust the booster pressure between 14½ to 16½ with the booster pump rheostat. Leave the rheostat as is until fuel drains out of supercharger drain line, then turn the booster pump switch "off".

31. FIRE EXTINGUISHER:

Turn the fire extinguisher to the engine to be started.

32. MAG. SWITCHES AND STARTING:

At all times when an engine is to be started, either the pilot's or co-pilot's seat will be occupied depending on which side engines are to be started, for signalling to the ground crew. It will be this man's responsibility to see that the two firemen are standing by on either side of the engine and that all personnel are clear when the engineer so indicates. Open throttle to 800 - 1000 RPM. With the magneto switches "off" accelerate the starter for five (5) seconds and turn booster pump on; continue to accelerate for ten (10) seconds and then mesh the starter. After one revolution of the propeller, turn the ignition switch "on" and then commence priming as needed. When the engine fires, continue to prime until the engine is operating smoothly and then place the mixture control in Auto Rich. If the engine dies, return the mixture control to "Idle Cut Off" immediately and repeat the procedure. As soon as engine is operating properly, turn the booster pumps off. Watch fuel pressure for possible drop.

DURING WARM UP

1. OIL PRESSURE - NOSE:

Immediately after the engine is started, check the nose oil pressure and if a rise in pressure is not noted in thirty (30) seconds, shut the engine down and investigate. Normal oil pressure is between 30# and 50# and may be higher with cold oil. Continue to check this pressure all during warm up.

2. OIL PRESSURE - REAR:

Immediately after the engine is started, check the rear oil pressure and if a rise in pressure is not noted in thirty (30) seconds shut the engine down and investigate. Normal oil pressure is between 60# and 90# and may be higher with cold oil. Continue to check this pressure all during warm up.

3. FUEL PRESSURE:

Fuel pressure should be steady at 15# to 18#.

4. CYLINDER HEAD TEMPERATURE:

Normal operating range is 150° to 250°C.

5. OIL TEMPERATURE:

Normal operating temperature is between 55° and 90°C. However, an engine may be run up or take-off made as soon as any rise in oil temperature is noted. Engines also have been operated satisfactorily with oil temperature as high as 120°C. Operating in these extreme ranges should be considered satisfactory for short times only and then only if the oil pressure are within limits. Operation in these extreme limits indicate that some part of the oil cooler system is not functioning and should be carefully checked. Take-off should not be made with extreme temperature.

6. WING DE-ICERS:

With all engines running, turn the wing de-icers on and visually inspect each segment for proper operation. De-icer air pressure should be between 7# $\pm$ 1/2#. Leave switch in the "off" position.

7. GENERATOR SWITCHES:

If night flight, generator switches "on"; if day flight generator switches not "on" until before take-off.

8. VACUUM SYSTEM:

Check operation of both #2 and #3 vacuum pumps when directed by pilot. Normal suction reading should be 4" $\pm$ 2" Hg.

1. CABIN SUPERCHARGER:

During engine warm-up--immediately after magneto check, check the operation of the cabin supercharger system by turning on the compressors and checking duct flow-limits. Operation of the cabin relief valves is indicated by difference in outside altitude which should not exceed 100 ft. below 8000 ft.

2. MAGNETO DROP:

With the engine operating between 2000 and 2200 RPM or when directed by the pilot, check the magneto drop by turning the magneto switch from "Both" to "Right" and noting drop. Return switch to "Both" and when engine has recovered original speed, turn the switch to "Left" and note drop. Return switch to "Both". Maximum allowable RPM drop on either magneto is 10 RPM consistent with smooth engine operation.

3. GENERATORS:

Immediately after checking the magneto at 2000 to 2200 RPM the generator check should be made while the pilot is checking the propeller governor. Voltage reading 28 1/2; ammeter should show a charge.

4. COWL FLAPS

Just prior to the take-off, close the cowl flaps to the 15° (4 1/2") position which is indicated by the long red line on the cowl flap indicator.

5. FUEL BOOSTER:

Just prior to the take-off run, turn the fuel booster pump on and turn rheostat to the lowest position or as needed to maintain operating limits. Operating limits 15# to 18# fuel pressure.

6. CYLINDER HEAD TEMPERATURE:

Operating limits are 150°C to 250°C. However, if temperatures at the extreme end of these limits are encountered under normal OAT readings, the condition should be investigated before take-off. If temperatures above 260°C are encountered during take-off, notify the pilot but do not open the cowl flaps wider unless detonation is encountered with resultant loss of power. If this condition should occur it should be investigated prior to the next flight. This engine may be operated at 25°C cylinder head temperature.

7. OIL PRESSURE - NOSE:

Constantly observe the nose oil pressure and report any irregularities immediately to the pilot either during run up or take-off. Operating limits are 30# to 50# except during propeller governing when this pressure will drop as low as 5#.

8. OIL PRESSURE - REAR:

Constantly observe the rear oil pressure and report any irregularities immediately to the pilot either during run up or take-off. Operating limits are 60# to 80#.

9. OIL TEMPERATURE:

Constantly observe the oil temperature and report any irregularities immediately to the pilot either during run up or take off. Normal operating limits are 55° to 90°C. Take off should not be made with oil temperature above 90°C.

DURING FLIGHT

1. INTERCOOLER SHUTTERS:

During take-off the turbos are "on" so intercoolers are "open". The intercooler shutters should be closed to 1° - 2½° as soon as the turbo is in the "off" position. The intercooler shutters should remain closed until the turbo is again turned on or until they are needed for ice elimination. Carburetor icing conditions can be encountered with OAT of -3°C to ± 15°C or when ice is being picked up on the wings. Carburetor air temperatures maintained between -25°C and -3°C and ≠ 15° and ≠ 35°C are desirable. Carburetor air temperature rise due to the induction filters is 5° to 10°C depending on engine power. With a constant throttle setting a drop in manifold pressure is an indication of carburetor ice. To clear the carburetor, pull back on the throttle and maintain manifold pressure with the turbo. The heat of compression with the intercooler closed will eliminate the ice.

2. FUEL BOOSTER PUMP:

When power condition 2 (climbing power) has been set up and engine operation is normal, turn the booster pumps off one at a time, carefully observing any drops in fuel pressure. Leave pumps "off" until needed or above 10,000 ft. altitude.

3. AUXILIARY POWER PLANT:

After climbing 5000 feet or when the airplane is leveled off and it is seen that the engine generators are operating normally, the engineer should check with the co-pilot to determine if the auxiliary power plant can be turned off. The engineer will then order the auxiliary power plant to be turned off.

4. COWL FLAPS:

As soon as the power has been reduced to 2300 RPM and 34" or below and the cylinder heads have reached 210°C or lower, the cowl flaps should be closed to 7½° which is the short red line on the cowl flap indicator. At all times during flight the cowl flaps should be kept as nearly closed as possible but the cylinder heads should be held at 210°C or below for level flight.

5. MIXTURE:

As soon as power is reduced to 2000 RPM and 30" the mixture control should be moved to "auto lean" one engine at a time and any change in power noted carefully. Feed for control detent.

6. OIL PRESSURE - NOSE:

Constantly observe the nose oil pressure - operating limits 30# to 50# except when the propeller is governing at which time the pressure may drop as low as 5# but will recover immediately.

7. OIL PRESSURE - REAR:

Constantly observe the rear oil pressure during flight. Operating limits 60# to 80#.

8. FUEL PRESSURE:

Constantly observe the fuel pressure during flight. Operating limits 15# to 18#.

9. GENERATORS:

Check all generators during flight. Voltage should read 28½ volts amperage as required by the electrical load with a maximum of 200 amperes per generator.

10. CYLINDER HEAD TEMPERATURE:

Constantly observe cylinder head temperature in flight. Operating limits 150° to 250°C. While in level flight keep cowl flaps as nearly closed as possible without exceeding 210°C.

11. OIL TEMPERATURE:

Constantly observe the oil temperature during flight. Operating limits 55°C to 90°C. if the automatic shutters do not maintain these limits, operate the shutters manually as required. Check with side gunners as to position of door. High oil temperature may indicate a concealed oil cooler if the door is in an open position—thus necessitate closing the door for thaw out before proper oil temperature can be obtained.

12. CABIN SUPERCHARGER SYSTEM:

When in operation the cabin supercharger system should regulate as follows:

Altimeter Reading	
Outside	Cabin
0-8000	Same as outside ± 100'
8000-30,000	8,000 ± 100'
30,000-40,000	8,000 to 12,000' (proportional to outside)

13. LOG:

The engineer's flight log should be filled in each half hour in flight or after each change in engine power or altitude of the airplane depending on the data desired. Maximum time lapse between taking data should be one-half hour.

BEFORE LANDING

1. WEIGHT AND C. G.:

Compute the gross weight and C.G. location of the airplane at time of landing with the load adjuster.

2. AUXILIARY POWER PLANT:

Order the tail gunner to start the auxiliary power plant and place in high-speed operation when warm.

3. MIXTURE:

Place mixture control in "auto rich". Feel for control detent.

4. FUEL BOOSTER:

Turn fuel booster pumps "on".

5. OIL PRESSURE - NOSE:

Limits 30# to 50# except when propeller is governing.

6. OIL PRESSURE - REAR:

Limits 60# to 80#.

7. OIL TEMPERATURE:

Normal limits 55° to 90°C.

8. GENERATORS:

All generators should be showing 28½ volts and ampere reading as required.

9. CYLINDER HEAD TEMPERATURE:

Limits 150° to 250°C.

10. FUEL PRESSURE:

15# to 18#

11. CABIN SUPERCHARGER SYSTEM:

If cabin heat is desired, keep cabin supercharger on; check that cabin altitude and outside altitude is within 100 feet of each other. If heat is not desired, turn cabin supercharger "off".

12. DE-ICERS:

Turn wing de-icers "off".

13. HYDRAULIC SYSTEM:

Both systems charged to 1000#.

14. INTERCOOLER SHUTTERS:

Open intercooler shutters 15° when turbo goes on unless carburetor heat is needed for vaporization of fuel.

AFTER LANDING

1. GENERATORS:

As soon as landing is made and landing flaps are up, generators "off" if daytime flight; if at night leave "on" until engines are shut down.

2. COWL FLAPS:

Full open.

3. FUEL BOOSTER:

Fuel booster pumps "off".

4. OIL COOLER FLAPS:

Watch oil temperature. May have to manually operate switch.

5. PARKING BRAKES AND BLOCKS:

Place blocks under wheels and leave parking brakes "off" until brakes have cooled; then apply parking brakes.

6. ENGINES:

(As required) Cool down to about 150°C before shutting down engine.

7. OIL DILUTION:

(As required) To be done at same time engine is being cooled.

8. ALL SWITCHES:

Turn all switches off. After engine has cooled sufficiently close intercooler shutters, cowl flaps and oil cooler shutters.

9. AUXILIARY POWER PLANT:

Order auxiliary power plant stopped.

10. CONTROL LOCK:

Lock controls.

Operating Condition	H.P.	R.P.M.	M.P. Hg.	Pressure Altitude	Mixture Control	Flow-Fuel	Maximum Cyl. Head	Remarks
Take Off	2200	2800	47.0	S.L.	Auto Rich	305	260	5 minutes
Military Rated	2200	2600	47.0	25,000	" "	290	248	5 "
Normal Rated 100%	2000	2400	43.0	25,000	" "	245	232	
Maximum Cruise 75%	1500	2100	36.0	25,000	" "	150	218	
Desired Cruise 67%	1340	2100	33.0	25,000	Auto Lean	120	218	
Desired Cruise 60%	1200	2050	31.0	25,000	" "	105	218	
Cruise for Minimum Fuel Flow	635	1400	26.0	S.L.	" "	50	218	
	685	1400	27.0	9,000		52		
	740	1400	28.5	10,000		55		
	800	1500	28.5	15,000		59		For Maximum L/D Condition
	870	1600	28.5	20,000		65		
	945	1700	28.5	25,000		71		

CROSS REFERENCE READING OF INSTRUMENTS

The purpose of this Section is to aid the Engineer in determining if an undesirable indication is due to a malfunction of the instrument or due to an undesirable condition as indicated by that instrument. To determine this, reference is made to other instruments which might also indicate the undesirable condition. Since an instrument usually gives a correct or a completely wrong indication, it may be assumed that all undesirable indications are correctly given by good instruments due to the actual presence of an undesirable condition.

Only the instrument troubles likely to occur in flight are included.

The charts are self-explanatory, being arranged in four columns titled respectively: Indication, Other Indications, Probable Cause and corrective Procedure.

GENERAL AUTOSYN INSTRUMENT TROUBLES

Indication	Probable Cause
No Indication	(a) Blown fuse in instrument circuit (b) Disrupted means of getting indication to transmitter. Examples: 1. Broken tach. drive shaft 2. Leaking oil pressure transmitter line (c) Power lead open.
Fluctuating Indication	(a) Loose connection

CYLINDER TEMPERATURE GAGE

Symptom	Conditions	Probable Cause	Corrective Procedure
1. High indication	a. Ground run-up oil temp. high	Engine overheating from inadequate air circulation over cylinders	Check cowl flaps for full open. NOTE: Be sure to head nose of airplane into wind during ground operation.
	b. Ground run-up RPM High M.P. Hight	b. Excessive power output	b. close throttle
2. Low or High Indication	With cold engine gage reading does not check with Free Air Temperature	Instrument not properly set	Adjust to free air temperature
3. Gage reads cabin temperature	Engine in operation sudden drop in indication	Faulty thermocouple circuit	Continue to operate if oil temperature, oil pressure indicated normal.
4. High Indication (Slow)	Oil temperature high	Oil shutters not properly adjusted	Adjust shutters and watch for normal oil temperature. Indication followed by decreased in cylinder temperature

CYLINDER TEMPERATURE GAGE

Symptom	Conditions	Probable Cause	Corrective Procedure
5. High indication	M.P. Low, oil temp. rising, RPM low if high R.P.M.	Mixture too lean	Adjust mixture control
	Oil pressure low And fluctuating. Oil Temp. high	Insufficient oil supply	Check with liquidometer Shut down engine
	Prolonged climb	Engine overheating from excessive power requirement	a. Open cowl flaps b. Reduce angle of climb c. Reduce power
6. Low indication	Long glide; oil temperature low	Excessive cooling of engine	Close cowl flaps to keep engine temperature normal. Increase power
	Low power setting	a. Too rich mixture b. Cowl flaps open	a. Adjust mixture control b. Adjust flaps

Questions: 1. What should a cylinder temperature gage read before battery switches are turned on?

2. When will it read cabin temperature? Why?

MANIFOLD PRESSURE

Symptom	Other Indication	Probable Cause	Corrective Procedure
1. No Indication on right indicator	a. Other autosyns give no indications	a. Interrupted power supply from inverter	a. If other autosyn gages fail to respond switch to alternate inverter
	b. Left autosyn indicators OK. Other right autosyn also out	b. Fuse in aft engineers fuse panel	b. Replace fuse for tight autosyns
	c. Others OK	c. Instrument trouble	
2. High indication on ground run-up	RPM low for power setting but above 1200RPM	Propeller not in low pitch	Check prop limit light and adjust as necessary
3. Low indication	a. RPM low. Cyl. temp. hot engine running rough	a. 1. Fouled plugs 2. Mag. trouble	a. 1. Clean plugs 2. Mag. check
	b. Normal	b. Turbo amplifies fuse blown out	b. Replace fuse
4. Fluctuating at normal	a. Cyl. temp. cool RPM fluctuation	a. Overly high mixture Surging turbo	a. Lean out mixture setting Check MP & throttle settings
5. Indication low for quadrant setting	Tachometer dropping Free Air temp. warm or cold or humid	Ice in carburetor	Close intercooler flaps
6. Low indication	a. Cyl. temp. increasing & later drop in RPM b. High RPM	a. Lean mixture b. Leak in induct system	a. Adjust mixture control b. Shut down & investigate.
7. High	Idling or low RPM and cyl. cyl. temp. high	Leak in induction system	Shut down and investigate

MANIFOLD PRESSURE

Symptom	Other Indications	Probable Cause	Corrective Procedure
8. Excessive MP	Alt. where using turbo	1. Runaway supercharger 2. Regulator set wrong	1. Decrease boost 2. Decrease boost

*One fuse for right autosyn indicator in aft engineer's fuse panel.
One fuse for left autosyn indicators in aft engineer's fuse panel.
One fuse for the relay in forward engineer's panel.
One fuse for all D.C. instruments in forward engineer's fuse panel.

TACHOMETER

Indication	Other Indications	Probable Cause	Corrective Procedure
1. Low fluctuating indication	a. Rough running engine b. Everything else normal	a. Fouled plugs or mag. trouble b. Whipping tach. drive shaft	a. Clean plugs b. Investigate installation for lubricating radius of bend
2. Tach. will not reach max. allowable indication	a. Ground run-up. Man. press. tends to pass allowable indication b. Man. press. will not reach max. allowable indication--humid atmosphere	a. Prop not in full high RPM b. Ice in carburetor	a. Increase RPM Check with limit light b. Close intercoolers
3. Excessive	Manifold Pressure increases rapidly	Runaway prop resulting a. Too high prop RPM setting b. Governor inoperative	a. Decrease RPM with Prop RPM control switch b. Throw prop switch into feathering for 2-3 seconds increasing blade angle. If it still runs away, decrease RPM with throttle setting.

CARBURETOR AIR TEMPERATURE

Indication	Other Indications	Probable Cause	Corrective Procedure
1. Low	High dew point Man. press. drop	Carburetor icing	Close shutters
2. High	Loss of power. Cyl. Temp. rise rapidly	Intercooler shutters closed. Extremely high OAT	Open shutters
3. Full scale:			
a. Low	a. Normal	a. Shorted resistance bulb	Repair
b. High	b. Normal	b. Open instrument circuit	

OIL TEMPERATURE

Indication	Other Indications	Probable Cause	Corrective Procedure
1. Low "in" temp.	Everything else normal	Oil shutters open	Close shutters and check automatic position of switch
2. Full scale low	Low indication before run-up	Resistance bulb shorted	Replace
3. High "in" temp.	Everything else normal	a. Oil shutters closed b. Oil shutters open, oil congealed in cooler	a. Open shutters & check automatic position of switch. b. Close shutters
4. Full scale high	Everything else normal	Open instrument circuit	Continue to operate; Repair later.
5. Oscillation	Everything else normal	Loose connection	Continue to operate; Repair later.
6. High	High cy. temp. Open Oil Flaps, Fluctuating oil pressure	Low oil quantity	Shut down engine

OIL PRESSURE

Indication	Other Indications	Probable Cause	Corrective
1. Sluggish indication	Low free air temp. Other indications normal.	Improper oil in transmitter line	(Should be instrument oil)
2. Low	1. Cyl. temp. increasing Oil temp. high 2. Everything else normal 3. Oil pressure drops low then returns back near normal	1. a. Oil dilution valve stuck open. b. Oil flaps closed 2. a. Relief valve set too low 3. Dirty cuno	1. a. Operate oil dilution valve to "close" several times. 2. b. Open flaps 2. a. Change valve setting 3. Clean as soon as possible
3. High	Low oil temperature	Oil flaps open	Close flaps
4. Low	High oil temp/ Open flaps	Oil congealed in cooler	Close flaps
5. No indication	No increase in oil temp. No increase in cyl. temp.	Sheared oil pump drive	Shut down engine- to check open oil cooler shutters & if decrease in temp is noted, there is an oil flow, therefore, OK to continue operation.

IMPORTANT: A reduction of oil pressure, regardless of the reason/will be followed by an increase in oil temperature because of the increased friction resulting from insufficient lubrication. Engine temperatures may increase for the same reason. The most common troubles are: oil too light, dirty oil cleaner, obstructed line, open oil pressure relief valve, leak of prime in pumps, oil foaming in tank, and/or if the oil is cold and not diluted it may be congealed in the inlet to the oil pump.

FUEL PRESSURE GAGE

Indication	Other Indications	Probable Cause	Suggested Remedy
1. Low	Loss of power	Improperly adjusted relief valve	Adjust valve
2. Very low indication	Engine losing power	Vapor leak	Shart booster pumps
3. Low	Oil pressure low Oil temperature high	Oil dilution vapor leaking	Turn oil dilution valve "on" and "off" several times to seat valve.
4. Low or none	Loss of power or engine failure	a. Leak or broken line between tank & carburetor b. Exhausted fuel supply c. Loss of engine fuel pump	a. Repair b. Transfer fuel c. Start booster pumps
5. Low	All symptoms of rich mixture in flight	Leaking primer valve	Operate primer switch several times to attempt to seat valve

Question: What are the symptoms of rich mixture in flight?

FAILURE OF ENGINE TO START

If the engine fails to start, it may be due to any of the following conditions:

1. Lack of fuel.
2. Ignition switch off or cables grounded with switch on.
3. Over or under priming.
4. Booster ignition or its connections defective.
5. Throttle opening incorrect. The throttle should be nearly closed so that the engine speed at starting will be 800 to 1000 r.p.m.
6. Mixture control in wrong position. The mixture control should be set at cut-off before starting and opened to automatic rich as soon as the engine has started.
7. Dirty spark plugs. Check the spark plugs for proper functioning. Clean and set the gaps.
8. Defective ignition cable. Examine ignition cable for wear, breaks, or bad connections. Test with a light or buzzer system for open circuit from distributor to spark plug terminal and short circuit check on cable.
9. Defective spark plug terminal insulator sleeves. Check the sleeves for cracks or burns.
10. Incorrect valve clearance. Remove the rocker box cover and check the valve clearances.
11. Incorrect timing. Check the ignition timing.
12. Water in carburetor. Remove the drain plug and allow all the gasoline and water to run from the carburetor. Replace the plug and bring the fuel pressure up to the correct reading by operating the auxiliary fuel pump.
13. Cold oil. With the ignition switch off, turn the propeller through several revolutions by hand or by cautious use of the starter. If the oil is very viscous, it will be necessary to drain and pre-heat the oil before starting can be accomplished.
14. Distributor breaker points. See that the breaker points are clean and properly adjusted. Test the spark delivered according to the ignition manufacturer's instructions.
15. Internal trouble. When internal trouble is suspected, drain the oil from both sumps and carefully inspect it for foreign material. The oil filters and magnetic plugs should be closely examined for foreign particles.

FAILURE OF ENGINE TO RUN PROPERLY AT IDLING SPEEDS

If the engine fails to idle as it should, the trouble may be traced to one of the following causes:

1. Incorrect carburetor idle and adjustment. Warm the engine thoroughly before making adjustment. With the mixture control in automatic rich position, adjust the throttle stop so that the engine idles at 400 r.p.m. Adjust the idle mixture control to give maximum speed at this throttle setting. Readjust the throttle stop to idle the engine at 400 r.p.m. Readjust the idle mixture control to give maximum speed. Reset the throttle stop to the minimum idle speed desired. Although the minimum idle speed desired may vary among operators, the mixture control should always be set as above for best power at 400 r.p.m.
2. Leak in induction system. Check the induction system for cracks, leaky gaskets, loose flange, loose packing or loose or missing pipe plug in intake port.
3. Improper valve clearances. Stop the engine and check the valve clearances.
4. Faulty ignition.

FAILURE OF ENGINE TO DEVELOP FULL POWER

1. Throttle lever out of adjustment
2. Faulty ignition. The ignition system may be out of timing, the breaker points may be burned or excessively pitted, the spark plugs may be defective, or the spark plug terminal insulator sleeves may be cracked or burned.
3. Incorrect fuel metering. The fuel-air mixture may be too rich as evidenced by uneven running and black smoke from the exhaust, or too lean as evidenced by uneven running, overheating, and back-firing. Use of an improper grade of fuel or incorrect fuel pressure may prevent the engine from developing full power.
4. Leaks in the induction system. Examine the intake pipes for cracks and leaks at the cylinder crankcase connections. Inspect the carburetor flange for tightness.
5. Restriction in carburetor air scoop.

ENGINE STOPS

1. Lack of fuel.
2. Ignition grounded.
3. Air or vapor lock in fuel line.
4. Carburetor jets restricted.
5. Stalling load imposed on engine.

TROUBLE SHOOTING

ENGINE MISSES INTERMITTENTLY

1. Incorrect mixture
2. Air leaks in the induction system.
3. Improper grade of fuel.
4. Defective ignition generator.
5. Dirty breaker points.
6. Moisture shorting high tension system.

ENGINE MISSES REGULARLY ON ONE OR MORE CYLINDERS

1. Fouled spark plug.
2. Broken or grounded ignition cable
3. Improper valve clearance.
4. Low compression on one or more cylinders.

I. TROUBLE CHART

A. Trouble (General) - Excessive Vibration

Symptoms: Engine rocking, shaking on mount.

Causes :
1. Propeller out of balance or not properly mounted.
2. Bent crankcase
3. Rocker-arm clearances not properly adjusted.
4. Engine loose on mount.
5. Engine temperature too low.
6. Mixture temperature too low.
7. Detonation
8. Pre-ignition

Check : Run engine through various r.p.m. ranges and notice if there is a tendency for it to smooth out any given r.p.m.

B. Trouble (Local) Single cylinder Miss at Low Speed

Symptoms: Fluctuation of tachometer, a noticeable rhythmic miss in firing of cylinders.

Causes :
1. Defective plugs.
2. Plug gaps too small.
3. Weak compression.
4. Air leak around intake valve stem.
5. Weak exhaust valve spring.

Check : Hold hand over exhaust of doubtful cylinder

C. Trouble (Local) Single Cylinder Miss at High Speed

Symptoms: Same as above.

Causes :
1. Defective plugs.
2. Short circuited distributor blocks.
3. Too wide a plug gap.
4. Exhaust valve springs being weak.

Check : Same as above.

D. Trouble (General) Engine Not Turning Up to Proper R.P.M. But Not Missing.

Symptoms: Low r.p.m. but no fluctuation of tachometer.

Causes :
1. Incorrect valve timing.
2. Too light grade of oil, cold oil.
3. Too lean or too rich a mixture.
4. Overheating of engine.
5. Tight engine (one just overhauled).
6. Throttle adjustments incorrect not permitting full opening of the throttle.
7. Supercharger clutch slipping.
8. Improper propeller pitch (too high).

Check : Check manufacturer's specifications.

E. Trouble (General) Scattering Miss-Fire (Intermittent Engine)

Symptoms: Uneven miss-firing of engine and engine running rough.

Causes :
1. Intake valve holding open.
2. Lean mixture
3. Water in gasoline
4. Air leak in intake manifold
5. Sticky valve guides
6. Weak valve springs
7. Excessive breaker point clearance.
8. Weak breaker arm spring
9. Moisture on distributor blocks
10. Weak magneto

Check: Check exhaust of cylinders and note if miss-fire is regular or scattering.

F. Trouble (Local) Spit Back Through the Carburetor

Symptoms: Loud popping in the carburetor (fire hazard).

Causes :
1. Air leak in intake pipe.
2. Worn intake valve.
3. Weak valve springs.
4. Valves sticking in guides.

Check : The trouble will be evident. The engine should be stopped and the trouble located instead of letting this hazardous condition continue.

G. Trouble (General) - Loss of Compression

Symptoms: Loss of r.p.m., excessive oil consumption, excessive oil consumption, excessive oil vapors, excessive oil temperatures, excessive head temperatures, oil slinging, lack of pressure when pulling propeller.

Causes : 1. Loss of piston ring wall tension due to high temperature.
2. Improper piston ring clearance.
3. Piston rings stuck in grooves.
4. Improper grade of oil (too light)
5. Insufficient oil.
6. Insufficient valve tappet clearances
7. Cylinders scored or out of round.
8. Valves out of time.

Check : Same as for local troubles

H. Trouble (Local) Loss of Compression

Symptoms: Uneven idling, hissing in exhaust manifold, hissing in carburetor air intake, hissing in crankcase, lack of pressure when pulling propeller through, overheating of cylinder affected.

Causes : 1. Valve holding open
2. Insufficient tappet clearance
3. Warped or burned valve
4. Foreign particles on valve seat
5. Bent valve stems
6. Broken valve springs
7. Valves out of time
8. Rocker arm binding
9. Leaky cylinder head and spark plug gaskets.
10. Piston rings not seating properly or losing wall tension.

Check : To check for compression troubles pull the propeller through the compression stroke and listen for hissing noise in the exhaust manifold, carburetor air intake, and crankcase. An alternate method is by the use of a pressure gage on the suspected cylinder while pulling the propeller through the compression stroke.

I. Trouble (General) Spit Back Through the Carburetor

Symptoms: Loud popping in the carburetor

Causes : 1. Cold engine
2. Lean mixture
3. Ignition out of time (retarded)
4. Valves out of time
5. Water in gasoline
6. Low test gasoline
7. Worn carburetor throttle shaft.

Check : The trouble will be evident. The engine should be stopped and the trouble located instead of letting this hazardous condition continue.

J. Trouble (General) Back-Fire Through the Exhaust

Symptoms: Loud popping at the exhaust accompanied with orange flame and sometimes sooty smoke.

Causes :
1. Incorrect timing
2. Rich mixture
3. Retard spark
4. Faulty spark
5. Missing cylinders
6. Sticking valves

Check : If possible advance spark and see if condition is stopped. Mixture control may also be adjusted as a means for eliminating the condition.

K. Trouble (General) Engine Running Unevenly

Symptoms: Engine vibrating on the mount. Oscillation of the tachometer.

Causes :
1. Lean or rich mixture
2. Uneven compression
3. Air Leaks
4. Weak sparks
5. Defective valve

Check : Test engine at various r.p.m.'s to see if rough condition prevails. Also test it on either magneto, check compression

L. Trouble (General) Misfiring of Engine at High Speed

Symptoms: Engine coughing, spitting or failing to fire above cruising speeds.

Causes :
1. Defective magneto coil, distributor or breaker assembly.
2. Defective wiring harness
3. Defective spark plugs
4. Mixture too lean
5. Engine operating temperatures too low.
6. Restricted fuel flow.
7. Clogged vents in fuel tanks.
8. Fuel control valve not fully open.
9. Engine overheated

Check : Check exact r.p.m. where engine starts to mis-fire by placing hand over short exhaust stacks and check magneto operation at this speed and above.

M. Trouble (General) Complete Failure of Engine

Symptoms: Engine refuses to run regardless of measures taken to accelerate it. Sudden stopping of engine.

Causes :
1. Fuel supply exhausted.
2. Water in the fuel system.
3. Clogged gas tank vents.
4. Clogged fuel strainers.
5. Air or vapor lock in fuel lines.
6. Structural failure.
7. Faulty ignition.
8. Overheating and seizing.
9. Complete stoppage of main jet.

Check: With switch off pull propeller through. If there has been no structural failure this can be done. Then check all systems for possible failure

N. Reasons for Warming up Engine Before Take-Off

1. To elongate cylinders and obtain correct valve timing.
2. To properly expand steel and aluminum parts and obtain correct clearances.
3. To warm oil and obtain proper operating temperature.
4. To warm induction system to obtain proper distribution of mixture.
5. To obtain full power.
6. To check performance of power plant units.

O. Trouble (General) Excessive Oil Temperatures

Symptoms: High oil temperature gage reading, excessive foaming of the oil, excessive oil vapors, excessive carbon deposits, excessive engine operating temperatures.

Causes :
1. Improper grade or viscosity of oil
2. Diluted or contaminated oil
3. Insufficient oil cooling capacity
4. Insufficient oil supply
5. Protracted overheating of engine
6. Excessive master rod bearing clearances.

Check : Check for defective temperature gage, check engine time, check oil supply, check oil viscosity, check oil temperature regulators and controls.

P. Trouble (General) Oil Temperature Too Low

Symptoms: Low oil temperature gage reading, high oil pressure, engine stiff.

Causes :
1. Defective temperature gage.
2. Insufficient heating of oil in tank (cold weather).
3. Insufficient or no lagging of oiling system (cold weather)
4. Engine not properly "warmed up".

Check : Check for defective temperature gage, check oil temperatures regulators and controls, check atmospheric temperature.

Q. Trouble (General) Low Oil Pressure

Symptoms: Low oil pressure gage reading overheating of the engine.

Causes :
1. Oil temperature too high.
2. Oil too light in viscosity.
3. Worn or defective pump.
4. Defective gage.
5. Pressure relief valve sticking open.
6. Pressure relief spring tension too low.
7. Worn bearings in the pressure system.
8. Plug out of pressure system.
9. Oil supply exhausted.

Check: Check oil pressure gage, check pressure relief valve, check viscosity of oil.

R. Trouble (General) High Oil Pressure

Symptoms: High oil pressure gage reading, oil consumption, oil slinging, excessive oil vapors.

Causes :
1. Oil pressure relief spring tension too great.
2. Defective pressure gage.
3. Oil temperature too low.
4. Oil viscosity too high.

Check : Check oil pressure gage, check pressure relief valve, check oil viscosity, check atmospheric temperatures.

S. Trouble (General) Loss of Oil Pressure

Symptoms: Fluctuation of oil pressure gage

Causes : 1. Broken oil line (pressure).
2. Pressure relief valve sticking open.
3. Broken pump.
4. Oil supply exhausted.
5. Failed structural part in pressure system.
6. Plug out of pressure system.

Check : Check oil pressure gage, check pressure relief valve spring, check oil supply.

T. Trouble (General) High Oil Consumption

Symptoms: Blue smoke from exhaust manifold or "Stacks", especially after the engine has been idled for a short time. Sometimes the oil will short circuit the spark insulators or points and cause fouling or misfiring of the plugs.

Causes : 1. Worn connecting rod bearings.
2. Oil viscosity too low.
3. Oil pressure too high.
4. Oil temperature too high.
5. Oil leakage anywhere in the system.
6. Worn or defective supercharger oil seals.
7. Cracked induction housing oil chambers.
8. Improper functioning of scavenging pumps and system.

Check : Check oil consumption against manufacturer specification, check for blue smoke from stacks, check for fouling of plugs.

U. Trouble (General) Engine "Pumping" Oil

Symptoms: Same as under high oil consumption.

Causes : 1. Piston rings poor fit in grooves.
2. Piston rings fitting cylinder poorly.
3. Broken rings.
4. Carbonized ring grooves.
5. Scored cylinder walls.
6. Excessive piston clearance.
7. Excessive oil pressure.
8. Light oil.
9. Inferior quality of oil.
10. Excessive bearing clearance.
11. Improper scavenging of return oil.
12. Loose cylinder head or excessive valve guide clearance.

Check : Excessive carbon deposits, plugs fouling, oil viscosity too low.

V. Trouble (General) Overheating of Engine (Air-Cooled)

Symptoms: High head temperature reading, loss of r.p.m.

Causes :
1. Octane rating of fuel too low.
2. Lean mixture.
3. Climbing ship too steeply (low air speed)
4. Viscosity of oil too low.
5. Excessive "blow-by" (defective piston rings, or cylinders).
6. Retarded spark
7. Oil radiator core clogged.
8. Insufficient oil supply.
9. Air leak in the induction system.
10. Over-speeding engine.
11. Manifold pressure too high.
12. Detonation.
13. Inlet air temperature too high (carburetor)
14. Pre-ignition.
15. Improper design of cowling or engine installation.

Check: Paint cracking off of cylinders.

W. Trouble (General) Overheating of Engine (Liquid Cooled)

Symptoms: High coolant temperatures, high oil temperatures, loss of r.p.m.

Causes : Those listed above and in addition:
1. Insufficient supply of coolant (Prestone)
2. Worn or broken circulating pump.
3. Clogged radiator core (internally or externally)
4. Clogged hose connections
5. Defective coolant temperature gage.

X. Trouble (General) Rich Mixture

Symptoms: Rich mixture is indicated by black smoke and dark red flame from exhaust stacks, "galloping" or uneven running of engine, reduced power if too rich, and excessive fuel consumption. Due to the fuel cooling characteristics of a rich mixture, the engine will usually overheat only after the mixture is so rich that the power is considerably reduced.

Causes :
1. Fuel pressure too high.
2. Float level too high.
3. Mixture control setting too rich.
4. Loose jets.
5. Jets too large.
6. Air bleeds too small or clogged.

7. Partially clogged screen in air scoop
8. Economizer set to open too early.
9. Acceleration pump and valve leaking.
10. Primer valve leaking.
11. Worn float valve.
12. Logged float

Check: Full mixture control toward "full lean" and if engine smooths out a rich mixture is predominate.

Y. Trouble (Local) Lean Mixture

Symptoms: Lean mixture is indicated by long light blue or yellow-tipped flame from the exhaust stacks, reduced power, serious overheating, detonation, pre-ignition, and "spitting" or "popping" back through the air scoop (the latter creates a fire hazard).

Causes :
1. Crossed magneto wires which cause a local 2-cylinder miss sometimes accompanied by spit-back in carburetor.
2. Intake or exhaust valve holding open.
3. Valve adj. off not permitting valves to open.
4. Worn intake valve guides.
5. Air leak or crack in induction system.

Check : Check ignition wiring and valve tappets, squirt oil on any suspected crack and if oil disappears, a crack is the cause.

Z. Trouble (General) Lean Mixture

Symptoms: Lean mixture is indicated by long light blue or yellow-tipped flame from the exhaust stacks, reduced power, serious overheating, detonation, pre-ignition and "spitting" or "popping" back through the air scoop. (The latter causes a fire hazard.)

Causes:
1. Low fuel pressure
2. Mixture control set too lean
3. Fuel level too low
4. Jets too small
5. Accelerator pump not functioning properly
6. Economizer not functioning properly
7. Clogged fuel lines or strainers
8. Clogged vents in fuel tanks
9. Control valve not fully open
10. Vapor lock due to overheated line.
11. Engine not properly warmed up.

12. Oiling system not properly lagged to keep induction system warm in cold weather.
13. Insufficient warm air supply to carburetor.
14. Surging of fuel fore and aft in long lines during take-off.
15. Worn carburetor throttle shaft.
16. Valve timing off.

Check : Put obstruction over carburetor air intake, and if engine smooths out a lean mixture is predominate.

A-1 Trouble (General) Excessive Fuel Consumption

Symptoms: Probable engine running cooler, fuel consumption above normal.

Causes :
1. Power output too high
2. Operating in economizer range
3. Jets too large or loose in carburetor body
4. Air bleeds too small
5. Fuel pressure too high
6. Logged carburetor float (partially filled with fuel due to air leak).
7. Mixture control set too high
8. Float level too high
9. Overspeeding engine (fixed pitch propeller)
10. Improper calibration of carburetor.
11. Primer system leaking.

Check : To check for the approximate fuel consumption of an engine, check fuel supply, fly engine at full throttle for a few minutes and again check supply. Figure the amount that would have been consumed if flown at full throttle for 1 hour. Compare the actual consumption above against the theoretical consumption given by the following formula:

$$\frac{BHP \times .55}{6}$$

B-1 Trouble (General) Vapor Lock

Symptoms: Sudden stoppage of the engine, particularly in hot weather during take-off.

Causes :
1. Vertical humps or short bends in fuel line.
2. Volatility or vapor pressure of fuel too high (auto-gas)
3. Excessive fuel line temperatures (located too close to exhaust system or insufficient cold air circulation in accessory compartment.
4. Inefficient arrangement of fuel system.

Check : Let engine cool, then try to start. Usually it will, if the above trouble prevails.

C-1 Trouble (General) Air Leak

Symptoms: An air leak usually is indicated by the engine idling fast or not at all. It is sometimes accompanied by a high-pitched whistling noise while the engine is idling.

Causes :
1. Cracked induction housing.
2. Leaking intake pipe flange or gland gaskets
3. Leaking carburetor flange gasket
4. Worn throttle shaft or bushings
5. Manifold pressure too high

Check : Using an oil can, squirt oil on any suspected leak. If it is leaking, it will draw the oil into the openings. If engine smooths out at higher speeds, it is an identification of an air leak.

D-1 Trouble (General) Internal Troubles on Magnetos

Symptoms: Drop in r.p.m. on faulty magneto, or complete failure.

Causes :
1. Weak magnets
2. Short-circuited windings
3. Loose or broken connections
4. Bad condenser
5. Burnt breaker points
6. Excessive air gaps between distributor blocks and rotor.
7. Safety gap being too small.

Check : Remove spark plug wire and note spark, if weak or noticeable trouble is in the internal part of magneto.

S-1 Trouble (Local) Faulty Spark

Symptoms: Drop in r.p.m. when switch is turned to faulty magneto.

Causes :
1. Broken spark plug wire.
2. Loose spark plug wire connections in distributor block.
3. Distributor block connections worn or corroded.
4. Faulty spark plug
5. Worn or corroded distributor spool electrodes.

Check : Remove spark plug wire and note spark; if good, trouble is in plug; if not noticeable, trouble is from wire to magneto.

F-1 Trouble (General) Faulty Spark

Symptoms: Drop in r.p.m. when switch is turned to faulty magneto.

Causes :
1. Breaker point clearance incorrect or dirty.
2. Defective contact between secondary coil and distributor spool or blocks being short circuited.
3. Distributor spool or blocks being short circuited.
4. Distributor out of time with the armature.
5. Insufficient safety gap clearance.
6. Mags being weak or crossed.
7. Loose or corroded connections in the magnets
8. Ground wire and switch short circuited.

Check : Remove distributor blocks and holding screw driver near distributor spool electrode rotate magnet to see if spark jumps. If not, trouble is within the magneto.

G-1 Trouble (Local) Failure of Spark Plug

Symptoms: Cylinders missing or cold when engine is operated on one magneto.

Causes :
1. Plug too "hot" for operation condition (pre-ignition)
2. Plug too "cold" (fouling)
3. Insulator shorted
4. Points shorted with oil or carbon
5. Dirt or foreign matter on outside of insulator (furnishes path for current to ground)
6. Radio shielding coupling shorted.

Check : Remove spark plug connections and of cold cylinder and see if spark jumps to engine; if so, the spark plug is at fault.

H-1 Trouble (General) Failure of Engine to Stop with the Switch in the "Off" Position.

Symptoms: Engine continues operation when switch is in "both off" position.

Causes :
1. Switch ground wire broken
2. Defective switch.
3. Ground wire connecting magnetos to switch broken
4. Engine cylinders overheated (auto-ignition)
5. Idle cut-off not functioning.

Check : Check ground wire connections.

I-1 Trouble (General) Detonation

Symptoms: Overheating of engine, knocking, rough running, drop in r.p.m., excessive oil temperatures.

Causes :
1. Excessive cylinder temperatures
2. Low grade or octane fuel
3. Mixture too lean
4. Overspeeding engine
5. Climbing ship at low air speed
6. Excessive "blow-by" (defective pistons, rings, or cylinders)
7. Viscosity of oil too low.
8. Improper lubrication of cylinders, pistons, and rings.

Check : Mixture control, oil viscosity, baffling, etc.

J-1 Trouble (General) Pre-Ignition

Symptoms: Loss r.p.m., engine knocking, excessive cylinder temperatures, excessive oil temperatures.

Causes :
1. Continued detonation of mixture in cylinder.
2. Excessively lean mixture
3. Excessive cylinder temperature
4. Spark plugs too "hot".
5. "Feather-edged" valves or seats.
6. Excessive carbon deposit in cylinder heads.

Check : Mixture control, oil viscosity, baffling, etc.

INSPECTION PERIODS

Inspection	Type of Inspection	When Accomplished	Symbols if not made	How long without
Pre-Flight	Instruments, controls auxiliary systems & power plant for proper functioning servicing of plane & fastening of cowling, fuel caps, etc.	Prior to first flight of the day & for all transcient aircraft	Red dash	6 days
Daily	General condition of airplane & engine	Each flying day	Red dash	6 days
25 Hour	Thorough & searching includes the pre-flight & daily.	Between 20th & 30th hour after last 50 hour inspection	Red dash 25th hour Red diagonal after 30 hours	1 month
50 hour	Includes pre-flight daily & 25 hour, Complete thorough & searching inspection.	Between 40th & 50th hour after last 50 hour inspection	Red dash after 50 hr. Red diagonal after 60 hour.	3 months
100 Hr, 200 Hr & 300 Hr.	Special inspection including 50 hour inspection	With applicable 50 hour inspection	Red dash after 100 hr. Red diagonal after 180 hour	3 months
Engine Change	Special inspections & maintenance work	Each time an engine is changed		
25 Hours After Engine Change	Engine shakedown inspection	Between 20th & 30th flying hrs. after engine change	Red dash after 25th hr. Red diagonal after 30th hour.	
WEEKLY	Batteries	Each Week	Red dash	

MAGNETO

Mag Breaker Contact Adjustment

Connect a timing light to both breakers and ground to the magneto housing. Turn engine in normal direction of rotation until the cam followers are in the cam dwell ahead of the No. 1 lobe on the compensated cam. (marked with a dot)

Put straight edge on cam and continue rotation until it aligns with mark on post. Then adjust points so they are just opening. Maximum tolerance when checking alignment is 1/32".

New breaker point springs should have tension of 20 to 32 ounces and at least 15 ounces on points that have been in service.

Caution: When inspecting breaker points do not raise beyond 1/16". After every 50 hours with engine stopped remove oil protector cap and push plunger in all the way. Be sure to push only once.

Pitch 21.25° Low
86° Feathered
72" Static

LIMIT SWITCH SETTINGS

1. Prop Governor Head Limit Switches (as viewed from rear of engine)

   Right side - low pitch, high RPM screw
   Left side - High pitch, low RPM screw
   Turn clockwise to increase RPM on either

   a. Prop Gear Preload

      Desired - .018"
      Tolerance - Plus .003" or minus .008"
      Prop Thrust
      Nut Torque - 600 ft. lbs.

2. Main and Nose Wheels

   Normal: # Up 1/4 turn of motor drive shaft from mechanical stop.

   # Down 1/4 turn of motor drive shaft from mechanical stop.
   (Note: ATG recommends 1 turn)

   Emergency: Automatically taken care of with the setting of normal limit switches.

3. Nacelle Doors

   Up 1/2 turn of door screw from mechanical stop
   Down 1/2 turn of door screw from mechanical stop

4. Wing Flap

   Up 3/4 turn of torque drive shaft from mechanical stop
   Down 1-1/2 turns

5. Bomb Doors

   Up 1.3 turns of retracting screw housing from stop
   Down 2.7 turns of retracting screw housing from stop

6. Bomb Door Safety Switches

   Adjust to close 2 turns of retracting screw housing before down limit switch opens

7. Reverse Current Relays

   Adjust so generator cuts in at 26.6 V.

8. Oil Cooler Flap

Open - 2 turns of jack screw before mechanical stop
Close - 2 turns of jack screw before mechanical stop

9. Intercooler Flap

Open - 2 turns of jack screw before mechanical stop
Close - 2 turns of jack screw before mechanical stop

10. Cowl Flaps

Bench set motor to rotate 2000 turns between limits.
Synchronize with flap upon installation.

ELECTRICAL ADJUSTMENTS

1. Agasfat (bomb formation light)

   Adjust valve to five seconds of closed contacts on each cycle.

2. Voltage Regulator

   Adjust individually to 28.5 volts with all generator switches off including auxiliary power unit. Check load balance in flight.

FUEL SYSTEM

Use 100 octane or aromatic fuels
Boost Pump pressure variable 0 to 25 psi.
Fuel Pump Pressures:

Desired	17 psi
Minimum	15 psi
Maximum	19 psi

One turn clockwise on adjustment increases pressure approximately 2 psi.

HYDRAULIC SYSTEM

Fluid Specification AN-VV-O-366A .... Red Color
Fill to 1/2 mark with 1000 psi both accumulators, parking brake set.
With all hydraulic pressure Zero, preload accumulators with 400 psi dry air.

Caution: Never use oxygen in accumulator.

"Service System" warning light on at 625 psi.

"Emergency" warning light on below 900 psi.

Nozzle Box to Bucket Wheel Clearance

Desired	.095"		.120"
Minimum	.070	Max	.160"

Shaft End Play

Maximum	.015

Radial Shake

Maximum	.012

Cooling Cap to Bucket Wheel

Desired	.080"
Minimum	.060"
Maximum	.100"

Turbo Settings: Air Corps Setting #1 is L.H. and Setting #2 is R.H.

Governor Drive Shaft lubricated with lubriplate #107

Numbers on all wires from "J" boxes prefixed with PC

Caution: No adjustments are made on any unit "ON THE LINE" except the wastegate.

Unless change is specified where turbo is connected with engine oil system, use AN-W-O-366A or 3530 C as a substitute.

ANTI-ICER

Fluid Specification AC3535

81% Grain Alcohol, 4% Wood Alcohol, 15% Glycerine

Minimum Flow 1/2 G.P.H.

Maximum Flow 2 G.P.H.

PRAFE SHOES

Maximum Clear .05" or .075"

Minimum Clear .01"

CABIN COMPRESSOR

0' to 8000' Ventilation of cabin

8000' to 30,000' Cabin Altitude of 8000'

Over 30,000' Cabin differential pressure must not exceed 13.34" Hg.

In flight, locking device on cabin pressure regulators must be off, and shut off valve must be open.

CABLE TENSIONS

Aileron & Elevator	140#	3/16" Cable
Rudder	150#	3/16" Cable
Bomb Control	30#	1/8" Cable
Surface Lock	60#	1/8" Cable

All 3/32" Cable have 40# except spring loaded systems and: - Rudder and Elevator Tab 60# for 3/32".
Emergency Bomb Door control rigged to eliminate slack only.

CARBURETOR ADJUSTMENTS

A. Idling Mixture

Have cylinder head temperature 180 Degrees C. to 200 Degrees C. and engine idling at 550 rpm. Starting with rich mixture, move mixture adjustment clockwise (toward lean) a notch at a time.

Check engine rpm. If speed increases more than 25 rpm, reduce to 550 with idling adjusting screw, open throttles by 1000 rpm, then close throttle.

Continue moving mixture adjustment clockwise, keeping rpm near 550 until such movement gives no further rpm increase, then richen adjustment two notches counter clockwise.

B. Idling Speed

Turn adjusting screw to right or left as required to obtain desired idling speed of 550 rpm. One notch on the adjusting screw will change the rpm about 25.

VACUUM DE-ICER

Pressure relief valves in nacelles relieve at 9 psi.
Wing Center section valves relieve at 7 psi.
Inboard nacelle suction valves relieve at 6" Hg.
Lower vacuum regulator, in cockpit, should be set 4.8" Hg and upper valve at 4" Hg.
Regulator valve for camera should be set at 2" Hg.

Oleo Air

Nose Gear - Main Gear - Tail Skid
With Oleo collapsed, fill until oil is level with filler plug hole. Use specification 3580C or AN-O-366A mineral base oil.

Nose Gear	2.35 gal.
Main Gear	13.5 gal.
Tail Skid	.83 gal.

Oleo Air

Inflate to following clearance between center of torsion pins:

Nose Gear	10 inches
Main Gear	13.25 inches
Tail Skid	15.00 psi

Retraction screw lubrication

Use a very thin coat of M-286 Besconlube

Shimmy Damper Oil

Pressure gun required to fill. When filled to proper level, fluid indicator is up to mark on cap. Use Specification AN-JJJ-O-316 Caster Oil. Never run bomb doors up after emergency release without fastening doors to locks on retracting screws.

OIL SYSTEM

Use Oil AN 1120 (AN-VV-O-446)

Grades	#1065
	#1080
	#1100
	#1120

Operating Oil Temperatures

Desired	70 degree C
Minimum	60 degree C
Maximum	80 degree C

Operating Oil Pressures

Desired	70 psi
Minimum	60 psi
Maximum	80 psi
Idle	40 psi

One turn of adjusting screw changes pressure about 10 psi.

OXYGEN SYSTEM

Charge system to 450 psi ± 25 psi. Use glyndog on tube fittings.

WRENCH TORQUE VALUES FOR BOLTS AND NUTS

For tightening elastic self-locking and castellated nuts or bolts to proper torque values, the following procedure is recommended:

1. Install the bolt or nut fairly tight to cut or free the threads.
2. Back it off.
3. Note the torque required to turn the nut or bolt before it is seated.
4. Tighten to the torque value shown on the chart plus the torque value in Step 3.

Bolt Size	STEEL: Self-Locking & Castellated Nuts — Standard Type: AC 365 / AN 310	STEEL: Self-Locking & Castellated Nuts — Shear Type: AN 320 / AC 364	STEEL: Internal Wrenching Nuts: BAC 1093	ALUMINUM: Self-Locking & Castellated Nuts: AC 365D / AN 310D
		TORQUE - INCH POUNDS		
10/32	20-25	12-15		10-12
1/4-28	50-75	30-40	65-90	25-35
5/16-24	100-140	60-85	130-180	50-70
3/8-24	170-280	100-170	220-360	85-140
7/16-20	290-480	175-290	370-610	185-240
1/2-20	490-740	300-450	630-950	250-370
9/16-18	800-1000	480-600	1000-1300	
5/8-18	1100-1300	600-780	1400-1700	
3/4-16	1900-2400	1100-1500	2400-3100	
7/8-14	2900-3800	1700-2300	3700-4900	
1-14	4000-6200	2400-3700	5100-7900	
1-1/8-12	5400-7400	3200-4400	6900-9500	
1-1/4-12	9000-11000	5400-6600	11500-14000	

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1. Principal Dimensions

a. Dimensions and Specifications (Airplane and Engines).

(1) Airplane

(a)	Over all span	141'	2.76"
(b)	Over all length	99'	0 "
(c)	Over all height thrust line level taxi	29'	6.7 "
(d)	Over all height, at rest	27'	9 "
(e)	Height, propeller hub, taxi position at tip of propeller dome:		
	Inboard	9'	7.5 "
	Outboard	10'	5 "
(f)	Clearance, propeller tips, thrust line	14.1"	

(2) Wings

(a)	Airfoil Section Boeing	117
	(1) Root	22%
	(2) Tip	9%
(b)	Chord Root	17'0"
(c)	Chord Tip 70'10" from fuselage	7'5"
(d)	Incidence	4°
(e)	Dihedral	4°29'23"
(f)	Sweepback	7° 1'26"

(3) Stabilizer

(a)	Span	43'0"
(b)	Chord	11'2¼"

b. Areas

(1)	Wing (lessailerons) total	1,609.68	Sq. Ft.
(2)	Ailerons	129.2	" "
(3)	Aileron trim tabs (total)	12.0	" "
(4)	Flaps (total)	332.	" "
(5)	Stabilizer (including elevators)	333.	" "
(6)	Elevators (total)	115.	" "
(7)	Elevator Trim Tabs (total)	10.	" "
(8)	Dorsal Fin	40.6	" "

(9)	Vertical Fin	131.9 Sq. Ft.
(10)	Rudder (including tab)	65.5 " "
(11)	Rudder Trim Tab	5.8 " "

2. Leading Particulars

a. Control Surface Angles of Travel

(1) Ailerons

Up Travel	$18^\circ \pm 1^\circ$
Down Travel	$18^\circ \pm 1^\circ$

(2) Elevators

Up Travel	$25^\circ \pm 1^\circ$
Down Travel	$15^\circ \pm 1^\circ$

(3) Rudder

Right Travel	$18^\circ \pm 2^\circ$
Left Travel	$18^\circ \pm 2^\circ$

(4) Trim Tabs

Elevator Up and Down	$12^\circ \pm 2^\circ$
Rudder each way	$15^\circ \pm 2^\circ$
Aileron each way	$15^\circ \pm 2^\circ$

(5) Flap $45^\circ \pm 2^\circ$

b. Alighting Gear

(1) Main Landing Gear

(a) Type-Dual Wheel Single Shock Strut retractable.
(b) Tread 27'11"
(c) Shock Struts
  (1) Type - Air-oil
  (2) Make and Part Number A.O. Smith A.O.S. 100015
  (3) Fluid Required - Hydraulic AN-VV-O-366a
(d) Wheel
  (1) Type - Heavy Duty, smooth contour
  (2) Part Number H-14-320-M-1
  (3) Tires 56" smooth contour 16 ply rayon
  (4) Tubes 56" diameter puncture proof
  (5) Tire pressure - 70 p.s.i.
(e) Brakes - dual duplex expander type

(2) Nose Gear

(a) Type - Dual Wheel, single shock strut, retractable, self-centering caster type, capable of 136° total swivel.

(b) Shock Strut

(1) Type - Air Oil
(2) Make and Part Number A.O. Smith, A.O.S. 100023
(3) Fluid required - Hydraulic

(c) Shimmy damper

(1) Type - Fluid and Vane
(2) Make - Houdaille Hershey
(3) Part Number A-10330
(4) Fluid Required - Houdaille No. 1404

(d) Wheels

(1) Type - Smooth contour Type II
(2) Tube - 36" diameter smooth contour dual seal
(3) Tire - 36" diameter smooth contour 10 ply
(4) Tire pressure - 44 psi.

(3) Tail Skid

(a) Type - Shock Strut retractable type
(b) Shock Type - Air Oil
(c) Make and Part Number A.O. Smith, A.O.S. 100027
(d) Fluid- Hydraulic MIL-H-0-366-A

Outboard 1367
Inboard 1436
Center 1315
Bombay (ea) 640

R-3350 ENGINE INFORMATION

Spark Plug Types	BG LS465 AC LS87 C 345 Champion
Carburetor Air Inlet Temperature	15-35°C

OPERATING INSTRUCTIONS

Condition	Fuel Pressure	Oil Pressure	Oil Temp.
Desired	15-19 psi.	70 psi.	50-70
Maximum	19	80	85
Minimum	15	60	
Idling		40	

MAXIMUM OIL CONSUMPTION AT:

Normal Rated	27 Qts./hr.
Maximum Cruising	12 Qts./hr.
Minimum Spec. Fuel Flow	8 Qts./hr.
Fuel Grade	100 Octane

MAXIMUM PERMISSIBLE OVERSPEED . . . . . 2880 rpm

ENGINE ACCESSORIES

Accessory	Type	Dr or Spec.	Mfg.	Style
Starter	G-10	JH4E	Jack & Heintz	12T Jaw
Generator	P-2 or B-1	Dwg. E101294	Eclipse	
Generator Overdrive		Dwg. D-232	Chrysler	24 teeth bushed
Cabin Supercharger	898X Mod. 1	BAC Spec D-2755-D	Eclipse	24 teeth spline
Constant Speed Control		3H-8-AIC	Hamilton-Standard	12 teeth spline
Prop	4 blade	Spec 1-204163	Hamilton-Standard	(AN 9506 (No 60 (32 teeth
Fuel Pump	G-10	Spec AN-XX-P-291	-	11 T spline
Vacuum Pump	B-3	Dwg. 211-J	Pesco	12 T spline
Elec. Tach.	E-10	Spec 94-27972	-	Key

COMPARISON CHART OF ARMY AIR FORCES AND
ROYAL AIR FORCE LINE CODING

LINE	ARMY AIR FORCES	ROYAL AIR FORCE
AIRSPEED		
Pitot	Black	*
Static	Black-Light Green	
ANTI-ICER	White-Red	De-icing Wing, Blue-White-Blue De-icing Propeller, Yellow-White-Yellow-Yellow
COMPRESSED AIR		
20 PSI Max	Lt. Blue-Lt. Green	
25 PSI Min	Yellow-Lt. Green	
COOLING SYSTEM		Blue
Prestone	White-Black-White	
Water	White	
EXHAUST ANALYZER	Lt. Blue-Brown	*
FIRE EXTINGUISHERS	Brown	White-red
FLOATATION & BILGE	Lt. Blue	White-green
FUEL	Red	Red
HYDRAULIC	Lt. Blue-Yellow Lt. Blue	White
MANIFOLD PRESSURE	White-Lt. Blue	*
OIL	Yellow	Black
OXYGEN		White-Blue
Distribution Lines	Lt. Green	
Filler Lines	Lt. Green-Yellow-Lt. Green	
PURGING	Lt. Blue-Yellow	*
SMOKE SCREEN EQUIP	Brown-White	*
STEAM	Lt. Blue-Black	*
VACUUM	White-Lt. Green	White-Black
VENT	Red-Black	*

Note: * Royal Air Force has no coding for these lines.

Manifold Pressure Control:

Increase	White-blue
Decrease	White-black-blue

Mixture Controls:

Auto Rich	Brown
Fuel Cut Off	Brown-black

Throttle:

Open	Black-black
Close	Black-red-black
Cold and Hot Air Distr.	Blue-blue-yellow

Emergency Bomb Release:

Release	Red-white-red
Resel	Red-white-white

Emergency Bomb Door:

Release	Red-green-red

Lift Raft	Blue-black-blue
Prop Pitch	White-yellow

TUBING COLOR CODE

Fuel	Red
Oil	Yellow
Oxygen Distribution Lines	Green
Oxygen Filler	Green-yellow-green
Airspeed Pitot Pressure	Black
Airspeed Static Pressure	Black-green
Glycol	White-black-white
Manifold Pressure	White-blue
Vacuum	White-green
Fluid, Anti-Icer	White-red
Hydraulic Oil Pressure	Blue-yellow-blue
Air Pressure Max. 20 psi	Lt. Blue-Lt. Green
Alcohol	Yellow-white
Propeller Feathering	Blue-Yellow Blue
CO_2 Fire Extinguisher	Brown
De-Icer	Lt. Blue-Lt. Green

CABLE CODE COLOR

Aileron and Aileron Trim Tab:	
Left up and right down	White
Left down and right up	White-black
Aileron and Aileron Trim Tab:	
Up	Yellow
Down	Yellow-black
Rudder and Rudder Trim Tab:	
Right	Green
Left	Green-black
Surface Control Locks:	
Lock	Red
Unlock	Black-red
Servo Cables	**White-white**
Carburetor Air:	
Cold	White-green
Hot	White-black-green

A. C. FUEL GRADES AND USE OF ALTERNATE GRADE FUEL

Grade 62	unleaded	Spec. No. AN-F-22
Grade 73	leaded	Spec. No. AN-VV-F-761
Grade 87	leaded	Spec. No. AN-F-25
Grade 91	leaded	Spec. No. AN-F-26
Grade 90/130	leaded	Spec. No. AN-F-27
Grade 100/130	leaded	Spec. No. AN-F-28

If the proper grade is not available, use next lower grade to prevent grounding plane. Never use fuel grade of less than nine (9) octane points below required grade. Consult Technical Order 02-1-38 for proper power settings when using lower grades.

To find availability of various octane fuels at an army field, consult Technical Order 08-15-2, pages 14 and 15. This Technical Order will be carried in the airplane.

CONVERSION FACTORS

DENSITY

MULTIPLY	BY	TO OBTAIN
Pounds/cu in.	27.63	Grams/cu cm
	27630	Kg/cu meter
	1728	Pounds/cu ft
Pounds/cu ft	.01602	Grams/cu cm
	16.02	Kg/cu meter
Grams/cu cm	62.46	Pounds/cu ft
	.03613	Pounds/cu ft
	1000	Kg/cu meter
Kg/cu meter	.0624	Pounds/cu ft

ENERGY

Hp-Hr	2545	Btu
	641.7	Kg cal
Kg calories	3.968	Btu
	3086	Foot-lb
	426.9	Meter kg
Foot-pounds	.1383	Meter kg
Meter Kg	7.233	Foot-lb
BTU	777.98	Foot-lb
Ergs	7 x 376 x 10-8	Foot-pounds

CONVERSION FACTORS

AREA

MULTIPLY	BY	TO OBTAIN
Sq. Inches	6.452	Sq. cm
Sq. Ft.	929	Sq. cm
	144	Sq. inches
	.09290	Sq. meters
	.111	Sq. yards
Sq. Yards	9	Sq. feet
	.8361	Sq. meters
Sq. Miles	640	Acres
	2.590	Sq. km
Square cm	.1550	Sq. inches
Square meters	10.76	Sq. feet
	1.196	Sq. yards
Square Km	.3361	Sq. miles
Hectares	2.471	Acres
Acres	43560	Sq. feet
Circular Miles	.785	Sq. mile
	$.785 \times 10^{-7}$	Sq. inches
	5.067×10^{-6}	Sq. cm

DECIMAL FRACTION CONVERSION

Inch Fraction Conversion	Decimal Equivalent	Area Sq. In.	mm Equivalent
1/64	.0156	.0002	.397
1/32	.0312	.0008	794
3/64	.0469	.0017	1.191
1/16	.0625	.0031	1.587
5/64	.0781	.0048	1.984
3/32	.0937	.0069	2.381
7/64	.1094	.0094	2.778
1/8	.125	.0123	3.175
9/64	.1406	.0154	3.572
5/32	.1562	.0192	3.969
11/64	.1719	.0232	4.366
3/16	.1875	.0276	4.762
13/64	.2031	.0324	5.159
7/32	.2187	.0376	5.556
15/64	.2344	.0431	5.953
1/4	.25	.0491	6.350
17/64	.2656	.0553	6.747
9/32	.2812	.0621	7.144
19/64	.2969	.0692	7.540
5/16	.3125	.0767	7.937
21/64	.3281	.0845	8.334
11/32	.3437	.0928	8.731
23/64	.3594	.1014	9.128
3/8	.375	.1105	9.525
25/64	.3906	.1193	9.922
13/32	.4062	.1296	10.319
27/64	.4219	.1398	10.716
7/16	.4375	.1503	11.112
15/32	.4687	.1726	11,906
31/64	.4844	.1842	12.303
1/2	.5	.1964	12.700
33/64	.5156	.2038	13.097
17/32	.5312	.2217	13.494
35/64	.5469	.2349	13.891
9/16	.5625	.2485	14.288
37/64	.5781	.2625	14.684
19/32	.5937	.2769	15.081
39/64	.6094	.2916	15.478
5/8	.625	.3068	15.875
41/64	.6406	.3223	16.272
12/32	.6562	.3382	16.669
43/64	.6719	.3545	17.065
11/16	.6875	.3712	17.462
45/64	.7031	.3883	17.859
23/32	.7187	.4057	18.256
47/64	.7344	.4235	18.653
49/64	.7656	.4604	19.447

DECIMAL FRACTION CONVERSION

Inch Fration Conversion	Decimal Equivalent	Area Sq. Inch	mm Equivalent
3/4	.75	.4418	19.050
25/32	.7812	.4794	19.844
51/64	.7969	.4987	20.241
13/16	.8125	.5185	20.637
53/64	.8281	.5386	21.034
27/32	.8437	.5591	21.431
55/64	.8594	.5800	21.828
7/8	.875	.6013	22.225
57/64	.8906	.6229	22.622
29/32	.9062	.6450	23.019
59/64	.9219	.6675	23.416
15/16	.9375	.6903	23.812
61/64	.9531	.7134	24.209
31/32	.9687	.7371	24.606
63/64	.9844	.7610	25.003
1	1.	.7854	25.400

INTERNATIONAL MORSE CODE

Letters

a	.-	n	-.
b	-...	o	---
c	-.-.	p	.--.
d	-..	q	--.-
e	.	r	.-.
f	..-.	s	...
g	--.	t	-
h	....	u	..-
i	..	v	...-
j	.---	w	.--
k	-.-	x	-..-
l	.-..	y	-.--
m	--	z	--..

Figures

1	.----	6	-....
2	..---	7	--...
3	...--	8	---..
4	....-	9	----.
5	.....	0	-----

ARMY AIR FORCES PROPERTY CLASSES

No.	NAME
00	Indexes and Maintenance Publications of a General Nature
01	Airplanes and Maintenance Parts - General
02	Engines and Maintenance Parts - General
03	Aircraft Accessories
04	Aircraft Hardware and Rubber Materials
05	Aircraft Instruments and Laboratory Test Equipment
06	Fuels and Lubricants
07	Dopes, Paints and Related Materials
08	Electrical Equipment and Supplies
09	Gliders and Target Airplanes
10	Photographic Equipment and Supplies
11	Aircraft Combat Material
12	Fuel and Lubricating Equipment and Supplies
13	Clothing, Parachutes, Equipment and Supplies
14	Hangars and Demountable Buildings
16	Gas Cylinders
17	Machinery, Shop Equipment and Tools
18	Special Tools
19	Flying Field and Hangar Equipment
22	Woods
23	Metal and Composition Materials
24	Chemicals
25	Office Equipment and Supplies
29	Commercial Hardware and Miscellaneous Supplies
30	Training Aids

T. O. REFERENCES (Numerical)

T.O. No.	
00-20-A	The AAF Visual Inspection System for Airplanes.
00-25-A	Aircraft Maintenance Procedure and overhaul of engines
00-25-5	Procedure to be followed in case of fires during flight.
00-25-22	Movement of Aircraft Engines to, through and from overhaul facilities.
01-1-1	Cleaning of Aeronautical equipment
01-1-2	Anti-corrosion treatment of airplanes operating in salt water areas.
01-1-3	Aircraft finishes
01-1-8	Ventilation of Airplanes in hot weather.
01-1-23	Replacement of frayed cables.
01-1-26	Cleaning of carburetor air cleaners.
01-1-27	Use of landing wheel brakes.
01-1-29	Use of surface control locks and inspection of surface controls.
01-1-36	Precaution to be observed in the operation of bomb bay doors.
01-1-39	Installation of Air Intake Dust Excluders.
01-1-50	Towing, mooring and handling of airplanes.
01-1-50-A	Towing, Mooring and Handling of Airplanes.
01-1-58	Installation, Inspection and Reworking of Rubber Engine Mount Bushings. (Tightening of Radial Engine Mount Bolts)
01-1-62	Inspection of Bomb Sight Plug Connections.
01-1-63	Inspection of Valves of permanently installed Aircraft CO_2 Fire Extinguishers.

T.O. No.	
01-1-68	Inspection of all Electrical Junction Boxes - All Aircraft.
01-1-87	De-Icing and Anti-Icing Systems
01-1-89	Installation of Drain Cock, Oil Tank Sump.
01-1-109	Precautions Against Fouling Controls
01-1-20BJ-1	Pilots Flight Operating Instructions for B-29.
01-20BJ-2	Erection and Maintenance Instructions for B-29.
01-20BJ-3	Structural Repair for B-29 Plane
02-1-6	Periodic Inspection and Adjustment of Valves.
02-1-7	Detonation in Aircraft Engines.
02-1-8	Restrictions on Removal of Engines
02-1-22	Pre-Oiling of Aircraft Engines
02-1-28	Inspection & Tightening of Intake Pipe Packing Nuts
02-1-29	Ground Operation Instructions for Aircraft Engines
02-1-34	Tightening Crankshaft and Prop Shaft Thrust bearing nuts
02-1-35	Protection of propeller Shaft Threads
02-1-38	Use of Alternate Grade Fuel, Aircraft Engines
02-1-42	Overspeeding of aircraft engines.
02-1-44	Elimination of push rod lagging all Radial Eng.
02-35JA-1	Handbook of Operating Instructions of R-3350
02-35JA-2	Handbook of Services Instructions for R-3350
02-35JA-3	Overhaul Instructions for R-3350 13-18-21-23-33 and -35

T.O. No.	
03-1-1	Periodic Inspection of Accessories in storage
03-1-2	Safety Belts
03-1-4	Overhaul of Accessory Pumps
03-1-15	Failure, Inspection and Repair of Self Sealing Fuel and Oil Tanks.
03-1-15-A	Failure, Inspection and Repair of Self Sealing Fuel and Oil Tanks.
03-1-17	Storage & Handling of Fuel and Oil Cells (Self Sealing and Metal)
03-1-24	Marking of Inspection Doors, Self Sealing Fuel and Oil Cells.
03-5-1	Battery Circuit Solenoid Switches, Handbook of Instructions, Types B-1 and C-1
03-5-4	Cleaning and Polishing Landing Lamp Reflectors
03-5-9	Booster Coil Handbook, Types A-1 and C-1
03-5AA-1	Handbook of Instructions, Aircraft Engine Generators and Control Boxes.
03-5AA-3	Generator Control Panels and Control Box Types B-1 and B-2.
03-5AB-2	Generator Control Panels Types A & A-2.
03-5AB-5	Handbook of Instructions with parts catalog - Aircraft Generators. Types M-2 and O-1.
03-5AD-1	Handbook of Instructions for Type P-1 Engine Driven Generator.
03-5AD-2	Generator Voltage Regulator, Handbook of Instructions (Models 3GBD2B4 and 3GBD2B11)
03-5C-2	Solenoid Switches (Eclipse-Handbook of Instructions)
03-5CA-1	Aircraft Engine Starters and Starter Motors (Eclipse) Handbook of Instructions.
03-5CA-2	Electric Starters, Direct Cranking (Eclipse Type E-160) Handbook of Instructions.
03-5CA-3	Aircraft Engine Starters & Starter Motors (Eclipse) Handbook of Instructions.

T.O. No.	
03-5CA-5	Electric Starters Direct Cranking (Eclipse Type 397 & 756) Handbook of Instructions.
03-5CC-1	Retracting Mechanism Motors (Eclipse) Handbook of Instructions
03-5CC-2	Retracting Mechanism Motors (Electric Specialty Company)
03-5CC-3	Retracting Mechanism Motors (Electric Development Company)
03-5E-1	Spark Plugs - Use and Reconditioning
03-5F-1	Dynamotor-Aircraft Instruments
03-5F-2	Alternator, Type KA-215; Regulator, Type XC-78, Dynamotor, Type AF-2
03-5G-1	Flourescent Lighting System - Inverters, Auxiliary Boxes and Lamps Assemblies.
03-10-9	Inspection, Marking and Modification of Fuel Systems for Aromatic Fuels.
03-10-13	Operation and Inspection of Fuel Cock Controls.
03-10-15	Operating Fuel Systems
03-10-22	Fuel Cocks (Pesco)
03-10-26	Repair Instructions - Self-Sealing Fuel Oils
03-10D-2	Supercharger Regulator, Type A-7 Preliminary Handbook of Instructions
03-10DA-2	Operation & Service Instructions With Parts Catalog - Turbine Driven Superchargers
03-10EA-1	Fuel Pumps - Engine Driven (Pesco) Handbook of Instructions with Parts Catalog
03-10EC-1	Engine Driven Fuel Pumps, Handbook of Instructions with Parts Catalog
03-10ED-1	Handbook of Instructions with Parts Catalog for the Engine Driven Fuel Pumps, Types G-6, G-9 and F-10
03-10G-1	Operation of Carburetor Mixture Controls

T.O. REFERENCES (Numerical)
Cont'd

T.O. No.	
03-15-3	Inspection of Oil Dilution Valve and Linkage.
03-15-4	Repair & Cleaning of Oil Temperature Regulators
03-15-10	Cleaning of Oil System and Accessories
03-20CA-2	Service and Overhaul Instructions with Parts Catalog, Constant Speed Propeller Governors and Controls. Hydromatic Constant Speed Propeller Governors and Control (Hamilton)
03-20CC-1	Operation and Flight Instructions, Hamilton Hydromatic Controllable Propellers.
03-20CC-2	Services and Overhaul Instructions with Parts Catalog. Hydromatic Controllable Propeller, Full Feathering (Hamilton)
03-25A-1	Inspection and Lubrication of Anti-Friction Bearings.
03-25A-3	Streamline Tail or Nose Wheels Smooth Contour Auxiliary Wheels (Hayes) Handbook of Instructions with Parts Catalog.
03-25E-1	Air Oil Shock Absorber Struts
03-30AA-1	Vacuum Pumps, Engine Driven - Handbook of Instructions with Parts Catalog.
03-30CC-3	Engine Driven Gear Type Oil Pumps - Handbook of Instructions with Parts Catalog.
03-35-1	Icing of Aircraft
03-35A-3	Anti-Icer Pumps, Propeller (Pesco)
03-35B-1	Maintenance & Inspection of De-Icer Shoes
03-45-1	Fire Extinguishers - Installation and Inspection. One quart pump type.
03-45B-1	Fire Extinguisher - Type A-2
03-45C-1	Fire Extinguisher Type A-11, A-12 and A-13
03-50-1	Use of Oxygen and Oxygen Equipment

T.O. No.	
03-50-2	Charging of Oxygen Cylinders (Equalizer Method)
03-50A-1	Oxygen Regulators Type A-6, A-8, A-8A, A-9 and A-9A - Handbook of Instruction with Parts Catalog
03-55A-2	CO_2 Inflation Equipment - Instructions for inflation cylinder and valve assembly Type A-2, Raft-Walter Kidde
04-1-11	Marking Tires and Wheel Rines to determine tire slippage.
04-5-10	Maintenance & repair and Tires & Tubes
04-5-12	Identification, Installation and Handling of Fuel and Oils and Collant Hose
04-10-1	Inflation and Use of Aircraft Tires and Inner Tubes (Pressured)
04-10-2	Maintenance and Inspection - Tires, Tubes and Wheel Rims
05-1-1)) 05-1-10)	Inspection, Maintenance and Storage and shipment of Instruments.
05-1-15	Autosyn Instruments
05-1-16	Identification of Aircraft Thermometers
05-1-17	Marking of Aircraft Instruments
05-10-2	Service and Overhaul Instructions Airspeed Indicators
05-15-2	Service and Overhaul Instructions Magneto Type Compasses
05-20-2	Bank and Turn Indicators (Pioneer) Handbook of Instructions with Parts Catalog
05-20-3	Flight Indicators, Types C-1, C-3, C-4, C-5 and C-7 Handbook of Instructions with Parts Catalog
05-20-4	Turn Indicators (Sperry) Handbook of Instructions with Parts Catalog.
05-20-17	Rate of Climb Indicators, Type A-6 (Pioneer-Handbook of Instructions with Parts Catalog)

T.O. No.	
05-25-26	Rate of Climb Indicator, Type A-6 (Kallison)
05-25BB-2	Service and Overhaul Instructions - Type B-3 Driftmeter
05-30-1	Operation and Service Instructions Alti-meter Assemblies
05-35-4	Aircraft Sextant, Type A-5 and A-7 (Pioneer)
05-35-7	Aircraft Sextants. Types A-6, A-6A and A-B and A-8A
05-40-3	Thermocouple Thermometers, Types B-6, B-7, B-8, B-9 and B-11 (Weston)
05-40-9	Thermometers, Free Air, Types C-3, C-5, C-6 and C-13. Handbook of Instructions with Assembly Parts List.
05-40-12	Service Instructions - Thermometers, Resistance Type
05-50-1	Pitot Static Airspeed Tubes, Handbook of Instructions
05-65A-1	Handbook - Electrically Operated Fuel Level Gages
05-70-1	Manifold Pressure Gage, Types D-1 and D-2
05-75-1	Engine Gage Units, Types B-1, B-2 and B-7. Handbook of Instructions with Parts Catalog.
05-80-1	Suction Gages, Type F. Handbook of Instructions with Parts Catalog
06-1-2	Fluids for Hydraulic Equipment
06-5-1	Use and Disposition of Fuels
06-10-1	Aircraft Engine Lubrication Oils - Grades and Use
06-10-3	Prevention of Thread Siezures
08-5-1	Shielding and Bonding of Aircraft
08-5-2	Installation, Operation, Maintenance and Inspection
08-10-33	Interphone Equipment RC-36 (Identifying Order)
11-1-28	Cleaning, Lubrication and Maintenance of .30 and .50 caliber aircraft machine guns.

T.O. No.	
16-20-2	Maintenance and Inspection of CO_2 Cylinders
19-1-18	Hydraulic Airplane Jack - Airplane Hoisting Precautions
19-1-30	Replacement of a purifier assemblies - Types A-1, A-2 and A-4.
23-20-1	Repair and Maintenance of Plexiglass and other plastic sheets.
29-1-3	Cleaning, inspection and lubrication of Anti-Friction Bearings.

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TECH ORDER CHANGES

N O T E S